MODELLING A LABOUR MARKET :

THE CASE OF ENGINEERING CRAFTSMEN

by

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However, I am indebted most of all to Graham Pyatt for his constructive criticism and stimulating interest in my research and to Sheila Lindley, my wife, for her patience and encouragement throughout the preparation of this thesis.

DECLARATION

Chapters 4 and 5 and Appendix 1 are based substantially upon previously published material cited in the references as Lindley (1974), (1975b) and (1976a) respectively.

ABBREVIATIONS

DE	Department of Employment
EIG	Engineering Industry Group
EITB	Engineering Industry Training Board
GTC	Government Training Centre
ITB	Industrial Training Board
TOPS	Training Opportunities Scheme
n.a.	Figures not available

Equations are numbered within each chapter. Sometimes reference is made to equations in other chapters by prefixing the equation number using the appropriate chapter number.

SUMMARY

The purpose of this thesis is to contribute to the development of economic models of labour markets. The case of engineering craftsmen is explored with special reference to the recruitment of apprentices. The research methodology involves a synthesis of the evidence available from studies of local labour markets, management decision-making in relation to manpower, and occupational choice, as well as from econometric investigations of different aspects of labour markets reflected in aggregate statistics. A population or manpower accounting system is proposed as a useful framework for statistical analysis and modelling of manpower stocks and flows. The information available about the engineering craft group is viewed through this device and, because of its more promising situation as regards data and its importance in terms of active manpower policy in the United Kingdom, the apprentice recruitment flow is selected for econometric analysis in the central part of the thesis. The relationship between modelling a labour market and evaluating national training policies is then considered. The thesis concludes by recording the main empirical findings established for engineering craftsmen, summarising the model which has begun to evolve for this labour market and discussing areas for further research and, finally, by making some general points on modelling labour markets, drawn from the study of engineering craftsmen.

CHAPTER 1 INTRODUCTION

The subject of this thesis is an empirical study of the labour market for skilled engineering craftsmen with special reference to the recruitment of apprentices. The impetus for research in this area came from grappling with the difficulties of providing an economic rationale on which to base 'active manpower policies'. The problem of establishing the likely consequences of alternative policies and then of measuring the costs and benefits associated with them followed from the lack of adequate models of the labour markets in question. There seemed to be a need for quantitative models which could be used to place approximate magnitudes upon theoretically possible market effects and which would provide a framework for assessing alternative methods of intervention in the operation of the labour market. Such models are difficult to construct. They pose awkward theoretical problems and demand a range of reliable economic and social statistics well in excess of those presently available. The following chapters are intended to contribute to the development of the kind of model which will allow for a more informed discussion of the economic aspects of manpower policy. They do not yield a comprehensive model of the engineering craft labour market but concentrate upon those areas where further empirical work seemed to be most worthwhile given the research findings of others and the limitations of statistical evidence.

This study is concerned with an occupational and industrial labour market. In addition, the author has been analysing manpower flows in aggregate terms disregarding the effects of regional and occupational differences and identifying only 24 separate industries.[1] This is a level at which the broader impact of economic changes upon the dynamics of the labour market can be investigated. Such analysis is an essential part of economic planning but to those concerned with specific manpower

(1) See Lindley (1974, 1976a).

policies it is obviously not enough. Work on the theoretical specification of flow models which largely disregard heterogeneities in supply and demand is continuing but the purpose of this thesis is to explore the difficulties involved in moving to a more detailed level. By focussing on a major sector of the economy and a skill which has a central place in its production activities, it is hoped that insights will be obtained both into the operation of this particular market and into the problems which arise when attempting to develop models of specific labour markets for use in forecasting and evaluation.

As regards the engineering sector, not only has this group of industries a special place in the research conducted by the author and his colleagues at Warwick but it has also been the subject of considerable study at the local labour market level from both economic and industrial relations standpoints. The relative abundance of institutional and statistical evidence on the engineering sector enables us to extend our 'development work' further than if we were to choose almost any other group of industries. Moreover, given the crucial role played by engineering in an industrial economy and the investment in human and physical capital required for its operations, many of the planning difficulties faced by manpower agencies are experienced most acutely in this sector.

The study of an occupational-industrial labour market at the aggregate economy level rather than at the local labour market level involves a synthesis and analysis of research findings and statistics arising from disparate sources. In sifting through the findings of local labour market studies one is looking for microeconomic patterns which appear robust enough to reassert themselves at national level. One is seeking not for the idiosyncratic observation which purports to invalidate neoclassical economic theory but for evidence of systematic market failure such as barriers to mobility, rigid wage structures and imperfections in decision-making processes. Studies which try to encompass more than wage bargaining, or wages and labour turnover in a selection of plants, by investigating movements of manpower resources and the state of the local labour market over several years, are especially valuable in providing material for aggregate theory construction.

One of the main difficulties facing economists who are dissatisfied with the neoclassical paradigm but wish to develop quantitative models of labour markets is the extent to which they should embrace economic sociology.[2] Should they adopt that approach as the basis of their work in which the specification of sociological variables receives as much attention as does that of economic variables? Or should they adopt an empirical criterion by which to direct their intellectual energies? If and only ir a fully specified economic model does not provide a certain level of statistical explanation of the behaviour of the dependent variable, then search sociology for richer insights and re-specify the model. The dependent as well as independent variables may be redefined in the course of this activity but the quantitative emphasis in the research will discriminate against many sociological variables unless the methodological approach is also open to revision. If the initial intention was to explain variations in recruitment of apprentices to the engineering industry it goes much against the grain to drop this specific objective in favour of investigating the 'social reality of the entry of young people into employment'. Yet it does matter if the economist, ignorant of the micro-economics (let alone the micro-sociology) of the behavioural process being studied, relies too much upon the statistical significance of coefficients. It matters most because the economist imbued with the apparent success of his model may advise on policy designed to interfere at the micro-level rather than merely provide aggregate predictions. It matters also because the aggregate predictions may themselves be vulnerable where

(2) See, for example, Smelser (1963).

certain micro features have been ignored.

The solution to this problem involves a compromise between two extremes: the first is an excessive concern for the complexity of labour market behaviour where the essence is smothered by the detail, and the second is a tendency to play games of economic chess using rules or assumptions which are irrelevant to real life and yielding strategies which cannot be translated into useful policy prescriptions. Whether or not this thesis has managed to strike the right balance will emerge in due course. However, the model-builder is bound to disappoint to some extent those whose prime interest is either in the detailed description of socio-economic processes or in the development of economic theory per se. Thus one must recognise that no doubt there will be places where too much concern is shown for the vagaries of local labour market evidence and the construction of statistical patchworks, and places where model assumptions are wrung from the available evidence and wedded to other model assumptions which are imposed theoretically but equally deserve empirical corroboration had this been possible.

A basic theme of the research described in this thesis is the value of establishing an accounting framework through which to view the changes in manpower flows which lie behind changes in the distribution of manpower resources observed at different points in time. One of the main characteristics of studies of wages and labour mobility conducted at the aggregate level is the willingness of the authors to do so much with so little.(3) Regressions between changes in employment levels and changes in the wage structure are expected to reveal insights into whether or not relative wages do play a significant part in deploying labour. Despite the fact that a priori views on the statistical

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(3) Typical of this kind of empirical work are the studies by Reddaway (1959) and the OECD (1965).

relationships likely to be observed require numerous qualifications about the relative stability of supply and demand schedules during the period of observation, little attention is usually paid to these important preliminaries.[4] Even if rigorously specified aggregate models did produce only weak relationships between movements in prices and movements in resources, it is possible that whilst certain flows of manpower could be highly responsive to changes in economic variables, their response is being masked by the behaviour of other flows. For example, shifts in the industrial distribution of labour can arise through industrial mobility and through changes in the industrial pattern of entry and retirement from the labour force. One would expect these manpower flows to be influenced to a different degree by changes in relative earnings.

In advocating the construction of a set of manpower accounts, the objective is not to achieve a comprehensive description of resource movements in the labour market for its own sake. Active manpower policies are mainly concerned with influencing selected manpower flows. Frequently such policies presume a fairly direct relationship between controlling a given flow and changing the level of a manpower stock, for example, the link between apprentice recruitment and the supply of qualified craftsmen. A manpower account which places these 'control' flows in the context of other and sometimes much larger flows lends an important perspective to discussion about policy. Moreover the descriptive statistical exercise is a useful guide to how flows should be disaggregated for modelling purposes. The accounts then provide a framework for the whole modelling activity, starting with the resolution of inconsistencies between data series on stocks and flows and subsequently playing a

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(4) Note especially the rather cavalier approach taken by the OECD (1965, pp.90-1). Although Wilkinson (1962) does explore these matters, his theoretical analysis seems only loosely connected with his empirical work.

formal part in defining the identities to be satisfied by the model when used in simulating the behaviour of the flow system.

In essence, two accounting systems are seen as forming the basis for modelling a national labour market. The first, which is still very much under development, concerns the deployment of the population in relation to economic activity and the second, which is relatively well established in developed countries, deals with the results of such activity as measured by market valuations. The demographic accounting system can be summarised by means of a matrix which displays a set of control totals for more detailed disaggregations where appropriate. This will be called the 'Population Accounting Matrix' or 'PAM' for short. Linked to PAM via the control totals are a set of more detailed matrices (such as the engineering craft matrix to be described later) of special relevance to manpower research. The specification of the accounting system reflects an interest in those population 'stocks and flows' which most affect the supply of labour.

The second system of accounts underlies the Cambridge Growth Project model and has been elaborated for more general applicability in United Nations Statistical Office (1968). The 'Social Accounting Matrix' (SAM) is now well established as a useful way of looking at the flows of goods and services between different production activities and to final consumers together with the corresponding flows of incomes to factors of production and thence to the different institutions for consumption, saving and investment. A System of National Accounts published by the U.N. has acquired the status of a set of guidelines for producing national economic statistics by providing a framework 'in which countries may systematize, expand and use their national accounts and co-ordinated basic statistics'.

Professor Richard Stone, the individual most associated with the

S.N.A., has also been one of the leading advocates of a similar systematic treatment of social and demographic statistics. He has recently published under the auspices of the U.N. a study entitled Towards a System of Social and Demographic Statistics. This does not purport to be as fully specified an accounting system as the S.N.A. not has it been adopted by the U.N. Statistical Commission. The publication of the study is however an extremely important step in promoting the kind of discussion and experimentation which will eventually lead to a set of 'suitable international guidelines on a system of social and demographic statistics'.

The relationship between the aggregate demographic accounting system and the treatment of a specific sub-sector of the labour market will be discussed at the beginning of Chapter 2 and in related appendices. The remainder of that chapter then concentrates upon the deployment of engineering craftsmen. The statistical evidence is presented in the form of disaggregated manpower accounts from which we obtain a view of the most significant components of the manpower flow system covering this group of skilled workers. Then, by examining the results of a major study of local labour markets some attempt is made to compensate for the deficiences of the national statistics. Hypotheses about the determinants of skilled engineering labour supply are discussed in the light of these findings together with the national statistics on manpower flows and relative earnings. Finally, Chapter 2 assesses the scope for model-building and leads to the conclusion that one of the most promising subjects for this work is the recruitment of apprentices. This is certainly the main flow in the craft labour market as seen by the manpower agency concerned, the Engineering Industry Board (EITB). There has been considerable debate about the determinants of recruitment and the extent to which it should be controlled at industry level. At the same time very little quantitative analysis of this important manpower flow has been attempted, certainly none which employs a formal economic model. Furthermore, as shown in Chapter 2, this is really the only flow in the engineering craft labour market for which regular statistics have been collected. In fact taking the British economy as a whole, the only set of flows statistics which bear an occupational and industrial identity is that covering the entry of young people into apprenticeships and other training categories in different industries.

Having chosen to focus upon the apprentice recruitment flow, Chapters 3 to 6 are devoted to a study of the factors which influence it. Chapter 3 moves first to the level of the firm, reviewing studies of management decision-making with respect to manpower and especially the recruitment of apprentices. The relationship between craft employment, output and investment is then examined econometrically for different industry groups within the engineering sector, using both neoclassical and vintage production formulations. The econometric analysis is extended to include the association between craft employment, apprentice employment and apprentice recruitment. Having examined both the practice of manpower planning and its outcome in relation to the activity of different engineering industry groups, we return to the aggregate market level with which the previous chapter began and show the extent to which the market has apparently tended to move away from equilibrium during the last two decades. Chapter 3 finally raises the general problem of evaluating the efficiency of firms in deploying their manpower and of assessing the costs and benefits of national attempts to tackle shortages.

The analysis of the determinants of apprentice recruitment is taken up by presenting first a model of supply in Chapter 4. The sociological literature on occupational choice by young entrants to employment is reviewed briefly and its relevance to the specification and estimation of a quantitative model of the flow into engineering apprenticeships is discussed. The broad demographic and educational trends likely to have affected the supply of potential recruits are then examined. With the previous sections as background we move towards the specification of a testable model of supply by presenting a simple theory followed by a characterisation of alternative labour market situations which might arise given different possible supply and demand elasticities and shifts in the corresponding schedules. A single equation model of the supply of engineering apprentices is then estimated together with a similar model for all school leavers entering engineering.

Chapter 5 analyses the demand for apprentice recruits by the engineering industry. Having already reviewed, in Chapter 3, the main studies of manpower decision-making by firms we set up a theory of demand for skilled labour services which takes account of this behavioural evidence whilst also drawing upon the economic theory of the firm. The initial hypothesis is one which rests on assumptions of highly competitive markets for craftsmen and apprentices and views apprentice recruitment as a short-run response to skilled labour shortages where recruits substitute for craftsmen at the margin. After estimating the model based upon this hypothesis it is progressively modified and tested to accommodate bottlenecks in the craftsmen labour market and lags in the adjustment of actual to desired apprentice recruitment. There follows some discussion of further theoretical and empirical problems associated with the treatment of supply, the production of skilled labour services, technical progress and the objective function of the firm. Finally, we allow for a re-interpretation of the results in which expectations of future demand, in addition to current production difficulties, influence the recruitment decision. This in turn provokes the estimation of another single equation model of demand for apprentice recruits.

The results of Chapters 4 and 5 rest upon the analysis of engineering apprentice recruitment taken in aggregate. The purpose of Chapter 6 is to investigate the extent to which different groups of engineering industries reproduce the behaviour observed at the aggregate level. Some shortening of the period of estimation is unfortunately necessary in order to negotiate additional data deficiences which arise when studying the thirteen separate industry groups into which the sector has been divided. However, despite the greater standard errors present in the basic data on dependent variables at the more detailed level, the results do yield useful information about the applicability of the supply and demand models described in Chapters 4 and 5 to parts of engineering facing different product markets and using different production technologies.

With a clearer view of the labour market for skilled engineering craftsmen and especially of the market determinants of a major flow of manpower, apprentice recruitment (and the one most critically monitored by the government agency concerned), we return to the cost-benefit issues alluded to in Chapter 3. The methodology underlying a series of recent cost-benefit analyses of government training is investigated in some detail in Chapter 7. The appropriateness of assumptions and choice of range of simulations is examined bearing in mind the evidence presented in earlier chapters. The stochastic simulation of trainee work experience proves to be an interesting application of a class of stochastic model discussed in Chapter 2 but, as in the case of inter-industry mobility, much work remains to be done before this model can be integrated satisfactorily with economic theory and certainly before it can be accepted as a main prop of cost-benefit analysis of training. The studies which have been conducted so far show clearly how sterile was the debate between proponents of rate of return analysis and those of the manpower requirements approach. Both methods in practice imply incomplete models of the labour market which share a major common weakness: scant regard for the determinants of labour supply.

In order to apply cost-benefit analysis to training, estimates of replacement, displacement, complementarity and macroeconomic effects are required. Complementarity effects concern the results of removing shortages of one skill experienced by a particular industry (or firm) upon the employment of other skills in that same industry or elsewhere. This leads to the question of how strong are the linkages between industries employing skilled engineering craftsmen and to what extent might a shortage affecting one be transmitted to other industries whether inside or outside the engineering sector. Chapter 8 provides a simple empirical analysis of these linkages. A theoretical approach to the treatment of complementarity and macroeconomic effects is also outlined.

Chapter 9 concludes the thesis, firstly, by reviewing the main statistical and econometric findings, secondly, by presenting a summary of the model which is beginning to emerge from combining the separate components investigated in previous chapters, thirdly, by commenting upon the implications of this work for future research activity on modelling the labour market for engineering craftsmen and , finally, by drawing out some general principles which might be used to guide the construction of models for other labour markets at a similar level of aggregation.

CHAPTER 2 A REVIEW OF EVIDENCE ON THE DEPLOYMENT OF ENGINEERING CRAFTSMEN

2.1 Introduction

In the previous chapter reference was made to the need for a set of manpower accounts on which to base models of manpower flows. The construction of such models is a means of analysing rigorously the behaviour of the system of flows underlying changes in the distribution of labour usually observed only through shifts in the occupational or industrial levels of employment. Since active manpower policies tend to be concerned with controlling this or that stock of manpower through one particular flow it is as well to put that flow in its proper context. Typically this flow is the influx of newly trained manpower. Manpower agencies are inclined to develop notions of the appropriate level of training to be achieved without studying very thoroughly the dynamics of the labour market with which they are concerned. They concentrate on the stock of manpower and their main 'control' flow. A particularly worrying situation for these agencies is a down-turn in the amount of training being conducted when the economy is in a recessionary phase. Firms are urged not only to invest in physical capital well in advance of the expected boom but also to learn from past mistakes and engage in 'training for the future'. Even more worrying is a situation where it is not clear how long the recession will be nor how much of the decline is due to longer term changes in the economy such that the recovery is unlikely to recreate conditions of labour demand experienced during the last real boom in employment. Doubts are multiplied where data is deficient. Few industrial training boards have continuous series of occupational statistics for their industries which cover a complete trade cycle.

In these circumstances there is a temptation to cut through the debate about the optimal level of training and simply assert that the risks of over-investing in trained manpower, whether technologists, technicians or skilled manual workers, are negligible and that, in searching for rules of thumb to apply, the ratio of apprentices to craftsmen observed in the heyday of 1967-71 will do for the purposes of setting the norm for training of skilled craftsmen in engineering.(1)

The purpose of this chapter is to glean as much as possible from the available statistics on manpower resources, as well as wages, about changes occurring in the deployment of engineering craftsmen during the last two decades. There is a great deal of information about the earnings of engineering workers but much less about the changes in employment and the amount of labour mobility taking place. The analysis of price movements with little regard for what is happening to the disposition of resources which they are supposed to be aimed at controlling is not a particularly revealing exercise from the point of view of modelling a labour market. Wage determination is of course a social process worth studying in itself but if we are primarily interested in what factors affect the distribution of manpower, then far more needs to be investigated. However the impact of the wage structure upon manpower supply and vice versa is a phenomenon which has been studiously ignored in the publications of Britain's manpower agencies. This seems to have been regarded as a delicate issue, a matter for industrial relations policy where it is difficult enough to get agreement over incomes without interposing complications stemming from certain types of manpower policy.

Thus although the empirical work to be described later has focussed upon developing the analysis of manpower flows, this should not be taken

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(1) See, for example, EITB (1975).

to imply that the estimation of better models of the determination of wage differentials is an unimportant area of research.

The remainder of this chapter is divided into five sections. The role of the manpower accounts is discussed in section 2.2. The aggregate Population Accounting Matrix is described briefly, followed by a more detailed discussion of the disaggregate Engineering Craftsmen Matrix. The relationship between models and accounts is then taken up. Section 2.3 looks at the evolving pattern of manpower stocks and flows beginning with the aggregate levels of employment in engineering trades and moving on to present separate aggregate accounts for occupational and industrial mobility as far as the statistics will allow. Finally, using the EITB's own statistical returns, the stocks and flows of manpower associated specifically with craft employment in the engineering industry are fitted together to form an estimate of the Engineering Craftsmen Matrix. Given the lack of data series on the mobility of craftsmen it is not possible to estimate econometric models of the relationship between mobility and such variables as relative earnings. Section 2.4 assesses the evidence presented mainly by MacKay et al. (1971) on the industrial and occupational mobility of engineering workers in selected local labour markets. Section 2.5 then takes up the question of changes in relative wages in the light of the findings on mobility described in previous sections. Skill differentials within engineering and between engineering and other industries are analysed and several recent econometric studies of the industrial wage structure for male manual workers are reviewed. Section 2.6 concludes the chapter, firstly, by commenting on the overall progress made with the manpower accounts and the improvements to statistics required for further development, secondly, by summarising the main features of the flows system embracing the engineering craft labour market and finally, by assessing the scope for model-building.

2.2 An Accounting Framework

The construction of demographic accounts as envisaged by Stone in his United Nations (1975) publication is in its very early stages compared to that of national economic accounts. As regards the latter there is now some measure of international agreement on the basic structure of the information system most likely to meet the needs of planners, at least in developed countries. In contrast, at present there appears to be no example of an integrated system of social and demographic statistics, work so far having concentrated on particular areas, notably the education system; see for example the use of the deterministic flow model by Thonstad (1969) and Armitage et al (1969). However, the information systems which these and other authors have employed are introduced only implicitly in the course of describing their models. Stone (1971) on the other hand begins by establishing certain principles for a demographic accounting system and only then pursues his example of model-building using the accounts he has elaborated for the education system. Clearly the accounting system is established with an eye for the quantities and parameters (for example, the need for flow data as well as stock data) which the most promising models are likely to distinguish, given the sort of policy problems which they are intended to assist with, but in practice a whole class of models may be developed on the basis of the underlying accounting system subject to minor modification.

The first aim of this section is to outline a set of accounts which might be used in modelling manpower flows at the aggregate level but which also acts as a key to the various disaggregate accounts constructed for specific labour markets, such as the one for engineering craftsmen.

2.2.1 A schematic Population Accounting Matrix[2]

We begin by defining the states of the system from the point of view of modelling the population flows which determine changes in the labour force and numbers in full-time education and training. The Population Vector (PV) contains elements representing the numbers in each state. The states are mutually exclusive possibilities for a given individual and we have one population vector for each sex. Table 2.1 gives the components of the population vector and the corresponding notation adopted for subvectors and scalars. The population is divided into three main groups: the labour force, people in full-time training and education, and the rest of the population who are neither engaged in market activities nor in augmenting their stock of human capital. These are briefly described below.

Labour Market

The states involving participation in the labour market are full-time and part-time employment and registered and unregistered unemployment. The definition of the 'production boundary' determining those activities regarded as economic is the same as that of the S.N.A. People employed in such activities or seeking to be so are counted as part of the labour force. It is believed to be essential to distinguish between full-time and part-time employment and to include within the labour force the unregistered unemployed although they are excluded from the Department of Employment's definition of 'working population'.[3]

Education and Training System

Many undergoing full-time vocational training at the time of a

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(2) The ideas expressed in this section are now being developed within the research programme of the Manpower Research Group at the University of Warwick. A more detailed description is given in Lindley (1976b).

(3) This is easier said than done. See Elias (1976) for a method of estimating the unregistered unemployed given present British statistics.

census will be counted as employees in DE statistics and so only those not attributed to an employer will be covered by the category 'Training full-time n.e.c.'. People undergoing courses in Government Training Centres will normally be included in this group. Those in full-time education are divided into two states of activity: compulsory and non-compulsory education.

Rest of the Population

The first group under this broad heading consists of people who view themselves as having retired permanently, together with a small number of those in special institutions who must be regarded as being incapable of employment. The remainder of the population is classified according to five age groups: 0 - 4, 16 - 24, 25 - 59, 60 - 64 and 65+. All children aged 5 - 15 are assumed to be either at school or in permanent retirement as explained above.[4]

Movement Between States

At any given time it is theoretically possible to distribute the population among the activities grouped together as states of the population vector. Leaving aside the practical problems of estimation, a time series of PV_t would provide a very useful basis for the analysis of labour supply. Very quickly however one would wish to relate successive vectors or perhaps vectors separated by several periods of time by estimating movements among the states of activity which give rise to the snap-shots of population distribution yielded by these vectors. PAM does this in the simplest way possible, namely by ignoring multiple moves between states during the period concerned and registering

(4) There are some doubts as to whether or not it is possible, with present statistics, to maintain a meaningful distinction between the permanently retired and those in the two oldest ROP age classes. This problem will be discussed fully elsewhere but for the time being the separate state of 'retired permanently' will be included in PV and PAM. The number of children and others under age 60 attributed to this state will be relatively small.

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only the single move or flow implied by a record of the individual's state of origin and final destination.

Table 2.1 Components of the Population Vector (PV)

Employed full-time	LFT	Vector
Employed part-time	LPT	Vector
Unemployed registered	LRU	Vector
Unemployed unregistered	LUU	Vector
Training full-time n.e.c.	TFT	Vector
Education full-time ≥16	EFT	Vector
Education full-time <16	EC	Vector
Retired permanently	RP	Scalar
Others aged 65+	OA1	Scalar
Others aged 60 - 64	OA2	Scalar
Others aged 25 - 59	OA3	Scalar
Others aged 16 - 24	OA4	Scalar
Others aged 0 - 4	OA5	Scalar
Total population	POP	Scalar

$$POP_t = i' \, PV_t$$

Table 2.2 shows a PAM linking population vectors at moments of time t and t + τ. Entries within the body of the matrix are denoted by P_{ij} for sub-matrices, p_{ij} for sub-vectors (with the transpose where appropriate) and π_{ij} for scalars.(5)

With a closed population the states identified in the population vector are sufficient to define all possible moves. In order to take into account births, deaths and migration which may give rise to changes in total population size and in any case comprise important flows in their own right it is necessary to invoke an additional state

(5) For example, to take the industrial disaggregation of LFT, P_{11} will be a matrix of flows of full-time workers between industries and p_{18} will be a column vector of flows of full-time workers from industries into permanent retirement. All scalar entries concern flows between ROP/ROW states; for example, $\pi_{14,13}$ is the number of children born during the period who have survived to time $(t + \tau)$.

Table 2.2 PAM (t,t + τ)

t \ t + τ			Labour Market				Education and Training System			Rest of the Population						Rest of World		Total
			LFT	LPT	LRU	LUU	TFT	EFT	EC	RP	OA1	OA2	OA3	OA4	OA5	δ	EM	Σ_t
Labour Market	Employed full-time	LFT	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}	P_{16}	-	p_{18}	p_{19}	$p_{1,10}$	$p_{1,11}$	$p_{1,12}$	$p_{1,13}$	$p_{1,14}$	$p_{1,15}$	LFT_t
	Employed part-time	LPT	P_{21}	P_{22}	P_{23}	P_{24}	P_{25}	P_{26}	-	p_{28}	p_{29}	$p_{2,10}$	$p_{2,11}$	$p_{2,12}$	-	$p_{2,14}$	$p_{2,15}$	LPT_t
	Registered unemployed	LRU	P_{31}	P_{32}	P_{33}	P_{34}	P_{35}	P_{36}	-	p_{38}	p_{39}	$p_{3,10}$	$p_{3,11}$	$p_{3,12}$	-	$p_{3,14}$	$p_{3,15}$	LRU_t
	Unregistered unemployed	LUU	P_{41}	P_{42}	P_{43}	P_{44}	P_{45}	P_{46}	-	p_{48}	p_{49}	$p_{4,10}$	$p_{4,11}$	$p_{4,12}$	-	$p_{4,14}$	$p_{4,15}$	LUU_t
Education and Training System	Training full-time n.e.c	TFT	P_{51}	P_{52}	P_{53}	P_{54}	P_{55}	P_{56}	-	0	0	0	0	0	-	$p_{5,14}$	$p_{5,15}$	TFT_t
	Non-compulsory education	EFT	P_{61}	P_{62}	P_{63}	P_{64}	P_{65}	P_{66}	-	0	0	0	$p_{6,11}$	$p_{6,12}$	-	$p_{6,14}$	$p_{6,15}$	EFT_t
	Compulsory education	EC	P_{71}	P_{72}	P_{73}	P_{74}	P_{75}	P_{76}	P_{77}	0	-	-	-	0	-	$p_{7,14}$	$p_{7,15}$	EC_t
Rest of Population	Retired permanently	RP	-	-	-	-	0	0	-	π_{88}	-	-	-	-	-	$\pi_{8,14}$	$\pi_{8,15}$	RP_t
	Others aged 65 +	OA1	p'_{91}	p'_{92}	p'_{93}	p'_{94}	0	0	-	π_{98}	π_{99}	-	-	-	-	$\pi_{9,14}$	$\pi_{9,15}$	$OA1_t$
	Others aged 60 - 64	OA2	$p'_{10,1}$	$p'_{10,2}$	$p'_{10,3}$	$p'_{10,4}$	0	0	-	$\pi_{10,8}$	$\pi_{10,9}$	$\pi_{10,10}$	-	-	-	$\pi_{10,14}$	$\pi_{10,15}$	$OA2_t$
	Others aged 25-59	OA3	$p'_{11,1}$	$p'_{11,2}$	$p'_{11,3}$	$p'_{11,4}$	$p'_{11,5}$	0	-	$\pi_{11,8}$	-	$\pi_{11,10}$	$\pi_{11,11}$	-	-	$\pi_{11,14}$	$\pi_{11,15}$	$OA3_t$
	Others aged 16 - 24	OA4	$p'_{12,1}$	$p'_{12,2}$	$p'_{12,3}$	$p'_{12,4}$	$p'_{12,5}$	$p'_{12,6}$	-	0	-	-	$\pi_{12,11}$	$\pi_{12,12}$	-	$\pi_{12,14}$	$\pi_{12,15}$	$OA4_t$
	Others aged 0-4	OA5	-	-	-	-	-	-	$p'_{13,7}$	0	-	-	-	-	$\pi_{13,13}$	$\pi_{13,14}$	$\pi_{13,15}$	$OA5_t$
Rest of World	Demographic Row flows	B	-	-	-	-	-	-	-	-	-	-	-	-	$\pi_{14,13}$	$\pi_{14,14}$	$\pi_{14,15}$	$B_{t,t+\tau}$
	Migratory Row flows	IM	$p_{15,1}$	$p_{15,2}$	$p_{15,3}$	$p_{15,4}$	$p_{15,5}$	$p_{15,6}$	$p_{15,7}$	$\pi_{15,8}$	$\pi_{15,9}$	$\pi_{15,10}$	$\pi_{15,11}$	$\pi_{15,12}$	$\pi_{15,13}$	$\pi_{15,14}$	-	$IM_{t,t+\tau}$
Total	Total population	$\Sigma'_{t+\tau}$	$LFT_{t+\tau}$	$LPT_{t+\tau}$	$LRU_{t+\tau}$	$LUU_{t+\tau}$	$TFT_{t+\tau}$	$EFT_{t+\tau}$	$EC_{t+\tau}$	$RP_{t+\tau}$	$OA1_{t+\tau}$	$OA2_{t+\tau}$	$OA3_{t+\tau}$	$OA4_{t+\tau}$	$OA5_{t+\tau}$	$\delta_{t+\tau}$	$EM_{t,t+\tau}$	

Zero by definition (-); zero by assumption (0). P sub-matrix; p sub-vector; π scalar.

termed 'Rest of World'. Since our prime interest is in a very small part of the world population we do not attempt to record the population attributed to ROW as part of the population vector. However, because the birth-death process differs greatly from the migration process, we differentiate in the summary version of PAM shown in Table 2.2, between births and immigration flows and between deaths and emigration flows.

Thus, as a 'control matrix', compromising as it does between too much and too little detail, the PAM of Table 2.2 seems to offer a useful overall view of the population flows most affecting the numbers in the labour force and the education and training system. At least it will do so if a further amendment is made and that is to sum the elements of all matrices and vectors in order to replace them by scalars. Then we have a truly aggregate PAM behind which lurks the additional detail indicated by the matrix and vector entries retained in Table 2.2.

Note finally from Table 2.2 that it is possible at this stage to set some of the cells (whether they be matrices, vectors or scalars) to zero either by definition of the states giving pairs between which there can be no movement within a single accounting period or by assumption where we expect the flows to be negligible.

There are many difficulties associated with setting up an accounting system in which data is assembled in the form of a regular time series of PVs linked by PAMs. The availability of data on PAM flows will mean that it will be feasible to construct such matrices only for selected periods. One would hope that the estimation of stocks will present fewer problems. Some idea of the main difficulties which beset the estimation of manpower accounts will be obtained from section 2.3 which also refers to Appendix 1 in which the accounting framework used in testing a stochastic model of industrial mobility is described and the following definitional problems are mentioned.

(a) The specification of the accounting period

(b) The choice of a 'unit of account'

(c) The treatment of multiple activity and multiple movement.

However, the purpose of introducing the aggregate scheme is to lead into the description of the Engineering Craftsmen Matrix and no attempt will be made to discuss the full PAM system in detail.

2.2.2 The Engineering Craftsmen Matrix

In studying the labour market for engineering craftsmen we need an accounting framework which presents information on flows of trainee craftsmen as well as qualified craftsmen. Ideally one would wish to achieve two main objectives in this respect:

(i) provide summary statistics on training activity taking place in the economy;

(ii) show how this training is associated with the manpower flow system expecially in relation to (a) entry to the labour force, (b) occupational mobility and (c) employment-unemployment experience.

The training and education states given in the aggregate PAM are for substantial acquisition of skills and knowledge. In the case of training however, all those employed whilst in full-time as well as part-time training (whether on or off the job) are excluded from the training category and included as part of the labour force. The vocational training received by employees may well involve using the facilities of educational institutions on a part-time or full-time basis. These facilities will also be used by people inside and outside the labour force for part-time study unconnected with their employment, in addition to the usage already recorded in the aggregate PAM under the two states of full-time education. So in the present scheme we fail to capture the training activity engaged in by the employed labour force and the part-time educational activity affecting a wide spectrum of the population. On the other hand, the choice of categories in the aggregate PAM is intended to provide a 'key' to more detailed tabulations. Although we should like to show more of the nation's training activity in the aggregate PAM, all summaries must omit certain details and because the avialable training statistics yield a very patchy coverage of training in industry (despite more than a decade of the ITB system) it would seem best to tackle this item more selectively.

The first problem in dealing with engineering craftsmen is to define an appropriate vector of states of activity which include training activity. An Engineering Craftsmen Vector (ECV) is shown in Table 2.3. Three main occupational groups are identified within the engineering industry: craftsmen, technicians and others. Trainees are allocated to the related occupational group. Craftsmen are then divided into trained people and trainees. Those who are qualified may well be undergoing further training and this possibility is recognised by introducing three disaggregate states ECV_1, ECV_2 and ECV_3. Most trainees will be under 21 but we have allowed for adult trainees undergoing upgrading from semi-skilled work or a supplementary training period (which may or may not include formal training) with a firm after attending a government training course. Younger trainees are identified according to year of training and, for the first year, the type of training undergone (see the notes to Table 2.3).

Others in the labour force but not employed by the engineering sector are divided into four groups: those employed in other industries, people qualified in a skilled engineering trade and registered as unemployed, others registered as unemployed and all those unemployed but not registerd as such.

Outside the labour force we show five aggregate states of population

Table 2.3 Engineering Craft Vector (ECV)[1]

					Equivalent PV state[2]
Engineering industry	Craft group	Trained Craftsmen	Modules	ECV_1	LFT + LPT
			OT	ECV_2	
			n.e.c.	ECV_3	
		Adult trainees		ECV_4	
		Craft trainees	Year 5	ECV_5	
			Year 4	ECV_6	
			Year 3	ECV_7	
			Year 2	ECV_8	
			Year 1 OFFJT	ECV_9	
			Year 1 FER	ECV_{10}	
			Year 1 OT	ECV_{11}	
	Technicians			ECV_{12}	
	Other occupations			ECV_{13}	
Rest of industry (ROI)				ECV_{14}	
Unemployed registered	Engineering trades			ECV_{15}	LRU
	Other			ECV_{16}	
Unemployed unregistered				ECV_{17}	LUU
Training FT	Engineering trades			ECV_{18}	TFT
	Other			ECV_{19}	
Non-compulsory education				ECV_{20}	EFT
Compulsory education				ECV_{21}	EC
Rest of population (ROP)				ECV_{22}	RP + OA1 to OA5

Notes

(1) OT - other training
OFFJT - first year EITB approved off the job training
FER - further education via day or block release

(2) See Table 2.1.

activity. The first four cover full-time involvement in the education and training system and the fifth is just the residual group of the population. 'Training full-time n.e.c.' includes all those not in employment who are undergoing full-time training. This is taken to be equivalent to the numbers in government training under the Training Opportunities Scheme (TOPS). The two education states are self-explanatory. Note that government training courses sponsored via the education system are included under the training category and not under non-compulsory education.

In principle, a population vector and related disaggregations may be constructed for any point in time during the accounting period in addition to the beginning and end. The availability of data on flows is such that the limited construction of PAMs must be based on an annual period beginning in April/May. If necessary it may then be converted to a mid-year basis to fit in with the regular employment estimates produced by the Department of Employment (DE). When dealing with training for which the intake of recruits is highly concentrated in one or two periods during the year the positioning of the training vectors in relation to the annual training cycle is an important issue. However, on juggling with various alternatives it becomes clear that it is not possible to satisfy the two main objectives given earlier, namely, to provide summary statistics on training activity in the economy and to show how this trainining is related to the manpower flow system, by a judicious choice of one annual training vector (which would thereby define the preferred accounting period for training). So although April, for example, may not be the best month for which to estimate the training vector, others apparently more conveniently linked to the training cycle, such as October, are also insufficient by themselves to record training activity. This applies to forms of training in which one or more of the following features is present:

(i) highly seasonal intakes of trainees,

(ii) wide variations in course lengths,

(iii) high and variable loss rates during the course.

These aspects of training make it difficult to obtain an adequate view of the activity by only estimating one craftsmen vector (ECV) per year allied to the corresponding craftsmen matrix (ECM) . Since all three are present in the case of engineering craftsmen we must recognise that any matrix ECM (t, t + 1), together with its initial and final vectors ECV (t) and ECV (t + 1), will omit some feature which will be important.

The estimation of ECV and ECM is discussed in the following section and in Appendix 2. For the present, we must refer to a further difficulty in designing stock-flow accounts for use in manpower research. This is the fact that PAM forgets where people have come from. Thus with an occupational disaggregation, the flow from skilled to semi-skilled occupations and vice versa would be recorded in period (t, t + 1) but the accumulation of trained craftsmen up to time t in occupations not requiring high levels of skill is not monitored. Such a phenomenon would be important in investigating options for 'labour supply management' by government. The distinction to be drawn between education and skills acquired, and actual occupation becomes more significant as the disaggregation of the accounts proceeds. Thus in the case of engineering craftsmen it is relevant to ask how many qualified and partly trained craftsmen are to be found elsewhere in the labour force. This is where the information system about the craft labour market begins to break down. The main problems are:

(i) the deployment of engineering craftsmen in non-craft jobs within engineering and other industries is not covered by the available statistics;

(ii) the numbers of engineering craftsmen working outside engineering can only be obtained from census of population data (i.e., 1951, 1961, 1966 and 1971).

The National Training Survey will yield information on both items for 1975 but there is no prospect of obtaining a regular source of statistics for either in the near future. Hence in specifying ECV these aspects have not been identified separately. However, although there are far more people skilled in engineering trades employed in other jobs than there are unemployed, ECV_{15} has been defined separately from the rest of registered unemployment because we have regular observations for skilled engineering trades from DE statistics. The same reasoning applies to identifying the two government training states ECV_{18} and ECV_{19}.

Other disaggregations which have been included in ECV but have yet to be discussed relate to the main craft groups. The division of trained craftsmen into three groups is intended to recognise the increasing importance of additional module training and to record the amount of other training (OT) going on amongst craftsmen. For want of a better term, 'adult trainees' covers all forms of systematic training undergone by those being upgraded from semi-skilled to skilled work and includes dilutees under 'probationary' periods prior to being regarded as equivalent to other trained craftsmen. All four of the above categories have been identified separately in the accounting scheme but with the exception of those under additional module training it is doubtful whether we shall be able to estimate these stocks satisfactorily. In the remainder of this chapter the first four states will be aggregated and termed 'trained craftsmen'. The phrase 'craft trainee' will be used to cover young people progressing through apprenticeships whether of the new kind or the more traditional variety.

Finally we come to the Engineering Craftsmen Matrix itself, linking as it does successive observations of ECV. As with PAM it is possible to rule out certain flow elements by definition and set others to zero by approximation. Doing this we obtain a version of the craftsmen matrix shown in Table 2.4. Note that elements dealt with a priori in this fashion might be worth estimating when more data is available and Table 2.4 should not be regarded as definitive. A third group of elements which will not be discussed (those denoted by asterisks) consists of flows only tenuously linked to the engineering craft labour market, connecting parts of the labour force (other than the engineering craft group) to the ROP/ROW states, and flows among the states of training full-time n.e.c., education and ROP/ROW. On similar grounds three stock elements are excluded from attempts to estimate ECM. The remaining elements of ECM have either been represented algebraically (E_{ij}) or have been labelled as part of five sub-matrices or vectors. The first group are amenable to estimation with present data but the second group are not.

2.2.3 Model-building and the accounting base

Models established on the basis of manpower accounts can be split into two groups: those which are mechanistic and have no behavioural content other than some hoped-for stability in sets of statistical parameters identified from stocks and flows in the accounting system, and those which are developed from theories about the determinants of the various flows. The latter also rely on the stability of statistical relationships estimated over past data but they are distinguished from the former by the fact that these relationships involve variables which lie outside the accounting system. The degree to which mechanistic models are acceptable depends on the flow concerned. For example in a population accounting system which disaggregates by age, the estimation of mortality flows using age-specific mortality rates calculated from previous observations of the appropriate parts of the accounts is likely

Table 2.4 The Engineering Craftsmen Matrix (ECM (t, t + 1)

t \ t+1		1-4	5	6	7	8	9	10	11	12-13	14	15	16	17	18	19	20-21	22-23	$\sum_t$ 24
Engineering craft group: Trained craftsmen	1-4	$E_{1-4,1-4}$	–	–	–	–	–	–	–	$E_{1-4,12-13}$	$E_{1-4,14}$	$E_{1-4,15}$	$E_{1-4,16}$	$E_{1-4,17}$	$E_{1-4,18}$	$E_{1-4,19}$	–	$E_{1-4,22-23}$	
Engineering craft group: Craft trainees: Year 5	5	$E_{5,1-4}$	–	–	–	–	–	–	–	Losses from engineering craft training					–	–	–	0	
Year 4	6	$E_{6,1-4}$	E_{65}	–	–	–	–	–	–						–	–	–	0	
Year 3	7	–	–	E_{76}	–	–	–	–	–						–	–	–	0	
Year 2	8	–	–	–	E_{87}	–	–	–	–						–	–	–	0	
Year 1 OFFJT	9	–	–	–	–	E_{98}	–	–	–						–	–	–	0	
Year 1 FER	10	–	–	–	–	$E_{10,8}$	–	–	–						–	–	–	0	
Year 1 OT	11	–	–	–	–	$E_{11,8}$	–	–	–						–	–	–	0	
Rest of Engineering	12-13	$E_{12-13,1-4}$	–	–	–	–	–	–	–	Labour force flows not connected with engineering craft group					Other flows into TOPS		–	*	
RoI	14	$E_{14,1-4}$	–	–	–	–	–	–	–								–	*	
Unemployed registered: Eng. trades	15	$E_{15,1-4}$	–	–	–	–	–	–	–								–	*	
Unemployed registered: Other	16	$E_{16,1-4}$	–	–	–	–	0	0	0								–	*	
Unemployed unregistered	17	$E_{17,1-4}$	–	–	–	–	–	–	–						0	0	–	*	*
Training FT n.e.c: Eng. trades	18	$E_{18,1-4}$	–	–	–	–	–	–	–	Other flows from TOPS					–	–	–	0	
Training FT n.e.c: Other	19	0	–	–	–	–	–	–	–						–	–	–	0	
Education	20-21	0	–	–	–	–	$E_{20-21,9}$	$E_{20-21,10}$	$E_{20-21,11}$	Other flows from education					*	*	*	*	*
ROP + ROW	22-23	0	–	–	–	–	–	–	–	*	*	*	*	*	*	*	*	*	*
$\sum_{t+1}$	24													*			*	*	*

Source: See text and Appendix 2.

Note: Matrix elements set a priori are denoted according to : zero by definition (-) and by assumption or approximation (0); elements not discussed (*).

to yield satisfactory short to medium run forecasts, given the relative stability of mortality rates and the errors likely to arise in the modelling of other flows. In a situation where the institutional provisions for retirement are changing and especially where greater flexibility is being allowed in the timing of the decision to retire one would be less happy with an age-specific parameter treatment of retirement flows. Similarly, with changes in the provision of full-time education the projection of numbers of young people entering the labour force, even in aggregate, needs to be based upon more sophisticated models than those using combinations of drop-out, repetition and completion rates. The disaggregation by industry or occupation of a flow such as young entrants to the labour force takes one further away from being able to exploit stable aspects of demographic and institutional structures in devising simple models. For similar reasons one might expect that flows within the labour force will be more difficult to model than retirement and young entrant flows.

To say that mechanistic models may not predict well is to presume the solution of another dilemma: what are they predicting? Basically such models project some function of past resolutions of demand and supply but the extrapolation need not itself be a recognisable market situation. Thus, forecasts using fixed coefficient demand models may embody sub-optimal combinations of inputs experienced during the past due to supply constraints, ignoring substitution possibilities open to the economy within the planning horizon or the fact that measures to relax supply constraints are being considered and a presumption that they will continue is not the best approach to demand forecasting. Assessments of manpower forecasting as a tool for educational planning have stressed particularly the weaknesses of naive demand models but the supply models accompanying them are equally vulnerable to criticism.(6)

(6) Ahmed and Blaug (1973) present a series of cases studies of the use of manpower forecasting. On a shorter time scale, in connection with active manpower policies, see also the comments of Evans and Lindley (1973) when laying to rest the 'RAS model' of labour demand.

Numerous applications of demographic accounts are reviewed and extended by Stone in United Nations (1975). The essential methodology is analogous to input-output analysis and involve the choice of suitable parameters which link changes of state to a set of reference stocks. In the case of population (or manpower) flows the use of inflow or outflow proportions in which the flow between two states is expressed as a proportion of the stock in the state of destination or origin, respectively, is the most common device. The use of outflow proportions in deterministic flow models[7] suggests an analogy with stochastic models in which proportions are interpreted as probabilities. This is an attractive prospect because, if appropriate, it would bring to bear upon the analysis of manpower flows a range of stochastic theory on Markov chains, yielding standard results for the mean vectors and variance-covariance matrices of forecasts. However whilst Markov models represent a step forward in the statistical representation of flows systems, their reconciliation with economic theory is no easier than in the case of their less elegant, mechanistic counterparts.

We shall not pursue the subject of overall flow models much further in the main text. In the following section information about stocks and flows of manpower identified in the Engineering Craftsmen Matrix will be discussed for its own sake and as a means of deciding where modelling should begin, given the importance of the flows and the availability of data. The question of estimating stochastic models is taken up in Appendix 1 but reference to this is made in sub-section 2.3.3 on aggregate industrial mobility.

The position adopted here is that the use of a mechanistic model of manpower flows may act as a useful starting point for specifying

(7) There have been several such models of the British education system, for example, Armitage et al (1969) and Stone (1965, 1971 and 1972).

the accounting system and simulating with alternative sets of parameter values. This must then be followed by the selective modelling of those flows for which the simpler treatment is least acceptable. In fact it is not possible with present data to establish a 'satisfactory' mechanistic model of the whole system for engineering craftsmen, as anticipated in the labelling of the five blocks of unknown flows in Table 2.4. Since this is not the main purpose of the study we shall move on, in later chapters, to concentrate upon an economic analysis of one main flow rather than attempt to complete the estimation of a mechanistic model for the engineering craft flow system as a whole.

2.3 The Evolving Pattern of Manpower Stocks and Flows

This section is in four parts which reflect the forms in which statistics are available. First, aggregate changes in employment in skilled engineering trades, regardless of industry, are described using census of population data. Second, information about aggregate occupational mobility is assembled from government surveys and the 1971 Census of Population. Third, aggregate mobility between engineering and other industries, ignoring occupational characteristics, is discussed using DE statistics. Finally, estimates of the main elements of ECM are presented on the basis of EITB statistics.

2.3.1 Changes in aggregate stocks 1951-71

For the period 1951-71, numbers employed in different occupations throughout the economy are obtainable only from the censuses of population. Since the census is based on households rather than production establishments respondants must classify themselves to the nearest appropriate occupation. There is a tendency for the element of skill to be exaggerated but there is no evidence on whether or not this tendency has changed significantly over time. In Table 2.5 we show the numbers

Table 2.5 Numbers in engineering trades 1951-71.

(thousands)

Region	Occupational classification	1951	1961	1966	1971
England and Wales	Parts of 1951 order VI-workers in metal manuf.(1)				
	Males	1,789	2,014	n.a.	n.a.
	Females	155	157		
	Total	1,944	2,172		
UK	Skilled engineering occupations excluding unemployed(2)				
	Total	2,347	2,589	n.a.	n.a.
GB	1961 order VI - electrical and elctronics workers (3)				
	Males	n.a.	478	528	529
	Females		56	87	88
	Total		534	615	617
GB	1961 order VII - engineering and allied trades workers (3)				
	Males	n.a.	2,381	2,462	2,501
	Females		272	306	296
	Total		2,653	2,768	2,797
GB	1961 orders VI and VII				
	Total	n.a.	3,087	3,383	3,414
GB	Parts of 1961 orders VI and VII(4)				
	Total	n.a.	2,605	2,743	2,817

Sources: Census tabulations and Department of Employment (1967).

(1) The census occupational classification underwent major changes between 1951 and 1961. The 1961 Census General Report for England and Wales classifies the 1961 data on the basis of the 1951 classification. The figures given above combine selected parts of order VI in order to approximate the other estimates on the basis of the 1961 classification (orders VI and VII). Details are given in Appendix 3.

(2) These figures correspond to the definition of skilled engineering occupations in Department of Employment (1967). Only these figures in the table exclude the unemployed.

(3) The changes in classification between 1961 and 1971 are relatively minor and will not affect significantly the comparison at the aggregate level.

(4) Certain occupations have been excluded from orders VI and VII to make the figures more comparable with the definition of skilled engineering workers used in the L7A surveys (see Appendix 3). These surveys are conducted by the DE and results for the period from 1963 are available for the engineering sector.

of males and females classified to the broad occupational group closest to what we might call 'skilled engineering trades'. Differences in occupational classification referred to in the notes to the table make a direct comparison between census estimates for 1951 and 1971 too unreliable to be of value but percentage growths for the two decades separately may be linked together using the available data. These are summarised in Table 2.6 where we find that the numbers attributed broadly to skilled engineering occupations expanded by about 11 per cent in each decade. The sample census estimate for 1966 implies that almost all the growth during the second decade was achieved in the first five years. No such inter-censal figure is available for the nineteen-fifties but the boom of 1956-57 contrasts with the shake-out' of 1966-67 and one would be surprised if the two sub-periods of the first decade were as dissimilar as those of the second. However, the selection of census unit groups within orders VI and VII to match the L7A survey definition of skilled engineering craftsmen more closely produces a less marked difference between 1961-66 and 1966-71 and a lower overall percentage increase of 8.2 compared to 10.6 for the decade. Data from the L7A survey will be used in Chapter 3.

Table 2.6 Percentage increases in skilled engineering occupations 1951-71

Regional basis for the estimate	1951-61	1961-66	1966-71	1961-71
England and Wales	11.7	n.a.	n.a.	n.a.
United Kingdom	10.3	n.a.	n.a.	n.a.
Great Britain (VI+VII)	n.a.	9.6	0.9	10.6
Great Britain (pt VI+VII)	n.a.	5.3	2.7	8.2

Source: Table 2.5

Increases in the occupational group were accompanied by changes in age structure. For any large class of the working population these cannot be expected to be dramatic but some features are worthy of note (see Table 2.7). The entrant-retirement balance (percentage aged 15-19 minus percentage aged 60-64) for male workers was 5.8 per cent in 1951 and 7.2 per cent in 1961. This is a notional statistic ignoring occupational mobility, early and late retirement and death, but it is a useful measure of the balance between potential additions to the fully skilled group (assuming a 20 year old is 'qualified') and potential retirements. There is some difficulty in making a reliable comparison between 1951 and 1971. Two sets of figures are given for 1961 and 1971 each. They correspond to the broad definition of engineering trades and the definition more akin to that used in the L7A survey. The former figures show a bias away from the younger age-group relative to the latter. Splitting up the comparison in order to match the available figures, the other main feature of change between 1951 and 1961, apart from an increase in the entrant-retirement balance, is the decline in the proportion aged 25-34 from 27.4 to 21.9 per cent. It is tempting to speculate that this reflects a loss of skilled men, trained during the war and immediately afterwards under the special circumstances of 1948-49, mainly due to the freer labour market in peace-time and the rapid expansion in demand for non-manual skills. Between 1961 and 1971 the proportion aged 55 and over was stable at about 13.4 per cent; the percentage aged 15-24 increased during 1961-66 but then fell slightly to 26.2 per cent in 1971. The last two years of the decade experienced a severe cut-back in apprentice recruitment so that from what was close to a post-war peak of 14.0 per cent in 1966 the proportion aged under 20 fell to 11.7 per cent in 1971 and certainly continued to fall thereafter. The entrant-retirement balance consequently fell from 8.8 to 6.5 per cent between 1966 and 1971.

The changes in age distribution can be associated with shifts in

Table 2.7 Age distribution of males classified to skilled engineering trades 1951-71. Great Britain.

Age group	1951 (1)	1961 (2)	1961 (3)	1966 (3)	1971 (3)	1971 (2)
15	1.8	1.8	1.9	1.3	0.8	0.7
16	2.3	2.6	2.8	2.6	2.0	1.9
17	2.3	2.8	3.0	3.2	3.0	2.8
18-19	3.3	5.0	5.4	6.9	5.9	5.5
20-24	11.2	10.5	10.9	12.7	14.5	14.0
25-34	27.4	21.9	22.0	20.9	22.3	22.1
35-44	22.3	23.0	22.9	21.7	19.2	19.3
45-54	17.8	18.4	17.6	17.4	19.0	19.5
55-59	5.6	7.5	7.1	6.7	7.1	7.6
60-64	4.0	5.0	4.7	5.2	5.2	5.6
65-69	1.5	1.3	1.2	1.1	0.9	0.9
70+	0.6	0.4	0.4	0.3	0.3	0.3
Total	100.0	100.0	100.0	100.0	100.0	100.0
Percentage aged 15-19 minus percentage aged 60-64	5.8	7.2	8.4	8.8	6.5	5.3
Percentage aged 15-24	20.9	22.7	24.0	26.7	26.2	24.8
Percentage aged 55 and over	11.7	14.1	13.4	13.3	13.5	14.3

Source: Census Occupation Tables for the relevant years.

(1) The definition of skilled engineering trades is the same as for the England and Wales figures in Table 2.5 but the age structure given is based on a complete coverage of Great Britain.

(2) These age distributions for 1961 and 1971 represent the census occupational orders VI and VII combined.

(3) These age distributions correspond to the parts of orders VI and VII comprising the closest census equivalent to the L7A definition of skilled engineering workers. See also Table 2.5.

absolute numbers subject to the age-group categories used in the censuses. Thus 529 thousand aged 15-24 in 1961 compares with 593 thousand aged 25-34 in 1971; an increase of 12 per cent. All other age-groups suffer decreases which increase with age. Hence in 1971 there were 25 per cent fewer men aged 55-64 in skilled engineering occupations than there were aged 45-54 in 1961. This together with effective losses of 6 and 11 per cent for the age "cohorts" 25-34 and 35-44 respectively amounts to a considerable depletion in the apparent deployment of men previously occupied in skilled engineering work before the normal official retirement age. Early retirement and deaths will account for a major part of the fall for the older group as can be seen from the results for all males in the labour force. However, there is a 4 to 5 per cent reduction, over and above the reductions recorded for all males, which affects the numbers classified to skilled engineering occupations in each age "cohort". The position is summarised below in Table 2.8.

Table 2.8 Skilled engineering tradesmen in selected age-groups 1961-71

(thousands)

"Cohort"	Skilled engineering tradesmen 1961	Skilled engineering tradesmen 1971	Percentage change relative to 1961: Skilled engineering tradesmen	Percentage change relative to 1961: All males in labour force
15-24 in 1961	529	593	12.1	17.0
25-34 in 1961	542	509	-6.1	-1.9
35-44 in 1961	566	505	-10.8	-6.5
45-54 in 1961	435	326	-25.1	-20.4

Source: Census reports 1961 and 1971.

In terms of ECV, the stocks described in this sub-section correspond to an aggregate of three elements: (a) the engineering craft group $\sum_{i=1}^{11} ECV_i$, (b) craftsmen and trainees employed in other industries as part of ECV_{14} and (c) unemployed craftsmen, mainly covered by ECV_{15}.

2.3.2 Aggregate occupational mobility

It is well known that people in occupations which require considerable training exhibit less mobility than others. The differences between skilled and semi-skilled workers are not as obvious as might be expected however. Prior to the 1971 census, the available national statistics on occupational mobility were based on samples which were too small to allow for separate identification of the main skilled and semi-skilled jobs found in engineering. The two government social surveys, conducted in 1949 and 1963,[8] provide information about mobility between only broad groups of skilled and semi-skilled occupations and adopt different definitions of each. Unfortunately the significance of the results gained from small sample, ad hoc surveys seems fated to slip through the fingers. Changes of occupational classification make them unsuitable for comparative purposes and the changes in analytical methods would have made them difficult to compare even in the absence of classification problems.

However, Thomas (c. 1953) and Harris and Clausen (1967) in their reports of the 1949 and 1963 surveys respectively make certain observations which point to where investigations should begin.

(a) About 50 per cent of both skilled and semi-skilled workers had entered the labour market via those same occupational groups (encompassing trainees as well as the fully trained). But a greater proportion of current semi-skilled workers had switched occupations at least once than was the case for skilled workers. (1949 survey)

(b) The occupational transitions exhibited by skilled and

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(8) The New Earnings Surveys have yet to yield published estimates of occupational mobility although in principle this would be possible. There are however certain problems of coverage and sample maintenance which would detract from its usefulness as the basis of an 'all embracing' manpower survey.

semi-skilled workers among skilled, semi-skilled and managerial or supervisory occupations are of quite similar magnitudes. (Both surveys)

(c) Harris and Clausen observed that of skilled manual workers (41 per cent of males in the labour force) only 27 per cent had served apprenticeships recognised by the Ministry of Labour. Even had all apprentice trained men plus those with minor technical qualifications been employed as skilled workers they would comprise barely 50 per cent of the group. The two main destinations of apprentice trained men outside skilled employment (69 per cent) were managerial etc. and semi-skilled occupations (about 10 per cent each).

(d) The 1963 survey indicates that relatively small changes in occupational structure were accompanied by considerable occupational mobility. Thus between 1953 and 1963 an 8 per cent fall in the proportion and an 11 per cent rise in numbers of skilled workers were associated with changes of job by 45 per cent of skilled workers employed during that period, of which (changes) 32 per cent led to different occupations (21 per cent to semi-skilled and unskilled work). For skilled workers in 1953 still in the labour force in 1963, 22 per cent had joined another occupational group.

(e) The process of outward mobility mentioned in (d) occurred largely through the external labour market. For all job spells initiated as skilled workers, including unexpired spells, 99 per cent 'ended' (by a job change or the intervening survey interview) in the same occupational group.

The above observations may not apply with the same force to the occupational mobility affecting all skilled groups nor to the whole of the post-war period. They suggest, however, that it would be as well to be very wary of devising active manpower policies solely in terms of one particular group of labour market flows. To concentrate upon the flow of new trainees and virtually ignore the flows of already trained men between occupations and industries could yiled inappropriate policies. Moreover, the importance of being precise about flow measurement, in order to avoid the loss of information and lack of comparability from which many <u>ad hoc</u> surveys have suffered, suggests that it is desirable at least to <u>begin</u> with a comprehensive accounting framework and then proceed to approximate as necessary and highlight the crucial flows.

The accounting framework described in section 2.2 is designed for this purpose. For craftsmen in engineering industries we shall be able to estimate an approximate set of manpower accounts to match the Engineering Craftsmen Matrix. At the aggregate level all that can be established is based on the 1971 census where respondants employed in 1971 (i.e. excluding the unemployed) were asked to give their occupation a year previously. The results are shown in Table 2.9 (a).

The matrix given in (a) lacks columns 5-8 because of the absence of a census in 1970 as well as 1971 from which to obtain the total stocks of manpower and because of the form of the census questionnaire which excluded those currently without jobs in April 1971. A part of the employed labour force is not amenable to analysis because the occupation was not stated or was inadequately described - this has been denoted by an 'L' shaped partition of the matrix. The absence of row totals means that we cannot say what proportion of skilled engineering tradesmen in 1970 left to join other occupations or became unemployed. It can be seen though from flows within the employed labour force whose occupations in 1970 and 1971 were known that there was a net loss of about one per cent (21 thousand) assuming that the stock of skilled engineering tradesmen was roughly 2.5 million, the gross loss to other occupations being 3.6 per cent. One cannot assess the effect of the flows into and out of unemployment but in 1971 there were 96 thousand (including females) unemployed in this skilled group according to the population census. The Department of Employment's occupational analysis of registered unemployed for March indicates that unemployment among engineering trades rose from 43 to 57 thousand between 1970 and 1971 (the occupational classification differs from both the census and the L7A survey and the unregistered unemployed are excluded). The period was thus one of net entry to unemployment by those in engineering trades. If employment itself did not change there must have been a total outflow to unemployment, retirement etc. of at least 110 thousand relative to the inflow

Table 2.9 Aggregate manpower accounts for males in Great Britain

(thousands)

(a) Occupation

	Occupation in 1970		Occupation in 1971			
			1	2	3	4
Labour Market	Skilled engineering trades plus apprentices	1	2,365	7	82	1
	Other engineering trades	2	6	312	16	0
	Other occupations	3	62	19	11,087	3
	Occupation not stated or inadequately described	4	42	8	506	91
	Unemployed engineering trades Unemployed others	5 6	90	9	421	5
	ROP + ROW	7				
	Total	8	2,565	356	12,112	100

Source: Census of Population 1971

(b) Industry

State in 1970		State in 1971			
		1	2	3	4
Engineering (employed + unemployed)	1	2,613 - l_1	202	l_1	2,815
Other industries	2	186	11,593 - l_2	l_2	11,789
ROW + ROP + LF residual	3	l_1 - 127	l_2 - 14	-	-
Total	4	2,672	11,781	-	-

Source: Appendix 3 plus recent data from the Department of Employment.

Notes: (1) Diagonal elements are imputed from row and column totals and estimates of the inter-industry flows. The flows l_1 and l_2 are gross outflows from the employee labour force to the rest of the population which now includes a residual labour force group. Rough magnitudes for l_1 and l_2 are suggested in the text.

(2) State (3) includes the unemployed not attributed to an industry and the self-employed.

of 90. Male employment in the metal industries which employ about 60 per cent of engineering tradesmen fell by 0.85 per cent during this period. For all industries the decline was 2.01 per cent so, bearing in mind labour hoarding is inclined to affect skilled workers most of all, there was probably a net outflow from our skilled group to unemployment of between 20 to 50 thousand. This compares with the net outflow to non-engineering occupations of 21 thousand. Clearly, the relative magnitudes of the flows are likely to depend very much on the state of the economy when unemployment is treated as a separate account (see Appendix 1).

A more detailed study of the occupational changes summarised in Table 2.9 (a) will be found in Lindley (1976c). If we disaggregate the skilled engineering trade group and consider only those employed in both 1970 and 1971, the net flow into each group expressed as a percentage of the 1971 employment is as follows.

	Aggregate net flow (percentages)
Metal fabrication	-1.3
Welding	-0.2
Electrical engineering	-2.0
Mechanical engineering	-1.0
Maintenance engineering	-0.2
Vehicle body building	-1.0
General apprentices	-2.5
Other skilled engineering	-0.9
Other engineering	1.7
All other occupations	0.2

Thus during a period when the engineering sector's employment of craftsmen declined but their percentage of the total labour force was stable at 26.9 per cent,[9] the net trade within the census sample population identified above was markedly in favour of the 'other engineering trades' and non-engineering occupations. Unfortunately 1970-71 was a year of high unemployment. Under these extreme conditions the pattern of net mobility recorded

(9) The decline was 1.9 per cent according to L7A Survey results for May in each year. They include firms with more than 10 employees only.

Table 2.10 Occupation changes among engineering trades: Great Britain 1970-71.

Males in employment in 1971. 10% sample figures.

Engineering trade in 1971		Occupation in 1970				
EOG	Total in employment 1971	Same unit group	Different		Not stated	None
			Eng. trade	Non-eng. trade		
Metal fabrication	333,91	91.75	1.28 (1.00)	2.01 (1.57)	1.58 (1.23)	3.38 (2.64)
Welding	123,77	89.92	1.66 (1.00)	2.92 (1.76)	2.34 (1.41)	3.15 (1.90)
Electrical engineering	502,29	92.49	1.19 (1.00)	1.62 (1.36)	1.15 (0.96)	3.56 (2.99)
Mechanical engineering	958,04	91.42	1.75 (1.00)	2.19 (1.25)	1.60 (0.91)	3.03 (1.73)
Maintenance engineering	208,92	90.81	2.92 (1.00)	2.66 (0.91)	1.41 (0.48)	2.20 (0.75)
Vehicle body building	29,46	93.21	0.75 (1.00)	2.68 (3.57)	0.98 (1.30)	2.38 (3.17)
General apprentices	46,64	63.61	0.96 (1.00)	1.84 (1.92)	2.53 (2.63)	31.05 (32.34)
Other skilled engineering	360,80	89.57	1.79 (1.00)	4.09 (2.28)	2.05 (1.14)	2.50 (1.40)
Other	355,60	87.55	2.35 (1.00)	5.37 (2.28)	2.17 (0.92)	2.55 (1.08)
Total	2,919,43	90.41	1.74 (1.00)	2.76 (1.59)	1.67 (0.96)	3.42 (1.96)

Source: Lindley (1976c). Figures in brackets are the percentages expressed as multiples of the percentages in the column for engineering trades.

by the census sample will have been affected considerably. Without time series information on mobility we can therefore draw no firm conclusions about the aggregate level of net trade between skilled and semi-skilled or unskilled engineering trades or indeed between engineering and non-engineering trades. It is worth noting however that the percentage net losses given above are well below the percentage inflows from outside the labour force as shown in the final column of Table 2.10. These include apprentice recruits.(10)

2.3.3 Aggregate industrial mobility

The industrial mobility of skilled engineering craftsmen has yet to be covered in national statistics. All we have are the aggregate flows of manpower between industries. These however may be taken as a guide to the sorts of magnitudes that might be involved at the craftsmen level although the outcome in terms of the proportionate net trade of manpower may be very different. Appendix 1 describes the basic statistical work involved. Recently acquired data for 1970-71 has meant that inter-industry flows almost corresponding to the census flow period used for aggregate occupational mobility can be presented here instead of the latest year 1967-68 covered in the more extensive statistical analysis given in the appendix.

Appendix 1 is concerned with both the adequacy of statistics on manpower flows which determine the industrial distribution of labour and the adequacy of a class of stochastic models for representing the flows about which we do have some information. The statistical accounting exercise shows that, owing to the absence of complete data on 'external

(10) The bases from which these two sets of percentages are calculated are numbers employed in 1970 and still occupied in 1971, and numbers employed in 1971 respectively. This difference is not important in the above context.

flows' between the labour force and the rest of the population, significant errors would arise in forecasting the industrial distribution of manpower even if inter-industry mobility was predicted very precisely. Turning to the representation of the mobility process by a first order stationary Markov model it is found that, quite apart from theoretical objections to the model, the hypothesis of stationarity may be rejected on empirical grounds for all three aggregate engineering industries (engineering and electrical goods, vehicles and metal goods n.e.s.) during the period 1959-68. This means that there are statistically significant changes over time in mobility flow patterns of male employees. They might be amenable to modelling by a non-stationary Markov model. Work in this area is proceeding but will not be reported here. Theoretical objections to the Markov model may be side-stepped to some extent by associating the stochastic model with the mobility propensities rather than with actual mobility. Lindley (1974) develops the theoretical arguments in favour of this re-interpretation. This question of the determinants of supply propensities and of actual movement will arise in a later chapter when discussing cost benefit evaluations which use the Markov model. At this stage it is necessary only to note the magnitudes of inter-industry flows of male employees.

Table 2.9(b) shows that 202 thousand (7.1 per cent) of the 2.8m males attributed to engineering in June 1970 had joined another industry by June 1971. The external flows (which include the very small number joining self-employment) are not all known but probably amount in total to about two per cent or so of the stock of manpower at the beginning of the period (see Appendix 1). The reverse mobility flow from the rest of industry into engineering is 6.6 per cent of the 1970 stock, the net gain by engineering through mobility being 0.5 per cent. Between 1970 and 1971 there was a fall in engineering employment and the net flow with the rest of the population etc. was 127 thousand or 4.5 per cent of the opening stock. Thus the reduction of employees attributed to engineering was achieved through external flows, mobility flows actually contributing a net gain to the sector. This yields the interesting conclusion that whilst the industrial mobility of labour resulted in a net inflow to engineering, occupational mobility relating to its major occupational group resulted in a net outflow during a period when employment of that group by engineering remained a constant proportion of total sector employment. Differences of classification between the industrial and occupational data (mentioned above and in Appendices 1 and 3) should not affect the validity of this observation.

2.3.4 A view through the Engineering Craftsmen Matrix

Looking at Tables 2.9 (a) and 2.9 (b) it is clear that the estimation of an occupational-industrial matrix on assumptions about the independence of occupational and industrial mobility processes would not be worthwhile because the two data sets differ too much in basic coverage of the labour force. Even if it were possible as a statistical exercise, the results would simply beg one of the most important questions about mobility, namely, the connection between changes of occupation and industry. Thus from the census of population we have some idea of the magnitude of flows between skilled engineering trades (employed in all industries) and other occupations but, as with the stock estimates, one which does not fit the ECM categories. From the DE industrial flows statistics we have an estimate of industrial mobility between all engineering states (1 to 13) and ROI marred only by the different treatment of unemployment and the self-employed.

In order to investigate the possibility of joint changes of occupation and industry involving engineering craftsmen we must turn to two other main sources. First the EITB's survey of craftsmen employed in its industry and second, the local labour market studies conducted by Professor MacKay and his colleagues. In this sub-section we shall deal only with the former.

Table 2.11 shows an estimate of ECM for 1972-73. The sources of data are listed below and described more fully in Appendix 2.

(i) Craftsmen survey available only for 1972-73

(ii) EITB statistics on training completions

(iii) EITB statistics on stocks of trained and trainee craftsmen in engineering

(iv) EITB statistics on stocks of other occupational groups in engineering

(v) Training Services Agency (TSA) statistics on TOPS trainees and completers

(vi) DE statistics on employment and unemployment for the whole economy.

Adjustments to the data had to be made in order to establish one common accounting period for stocks and flows.. EITB statistics adopt a definition of the engineering industry which is roughly eqivalent to the three 1958 SIC orders, engineering and electrical goods, vehicles and metal goods n.e.s. The Board covers about 90 per cent of this group of industries plus small parts of other SIC orders such as marine engineering. Reliable occupational and training statistics are only available for the industry in aggregate and no adjustment for the difference in industrial coverage has been made to the EITB statistics. The Board also adopts a narrower definition of craftsmen than that used in the L7A Survey but in order to use the information from the craft survey and the training statistics the Board's definition has been used consistently throughout this sub-section. The main difference between EITB and L7A groupings of observations is that the former allocates foremen to a separate supervisory occupation and regards some 'craftsmen' as semi skilled operatives. A further point to note is that employment in engineering whether in craft or non-craft occupations excludes

Table 2.11 Engineering Craftsmen Matrix (ECM) for 1972-73

1972 \ 1973			1-4	5	6	7	8	9	10	11	12-13	14	15	16	17	18	19	20-21	22-23	Σ_{1972} 24
Engineering craft group	Trained craftsmen	1-4	494.8	–	–	–	–	–	–	–	17.4	12.2	(0.9)			0	0	–	7.6	532.9
Engineering craft group	Craft trainees: Year 5	5	6.0	–	–	–	–	–	–	–	Losses from engineering craft training				0	–	–	–	0	6.0
Engineering craft group	Craft trainees: Year 4	6	13.0	4.0	–	–	–	–	–	–					0.9	–	–	–	0	17.9
Engineering craft group	Craft trainees: Year 3	7	–	–	18.1	–	–	–	–	–					2.3	–	–	–	0	20.4
Engineering craft group	Craft trainees: Year 2	8	–	–	–	19.1	–	–	–	–					3.0	–	–	–	0	22.1
Engineering craft group	Craft trainees: Year 1 OFF JT	9	–	–	–	–	13.6	–	–	–					1.4	–	–	–	0	15.0
Engineering craft group	Craft trainees: Year 1 FER	10	–	–	–	–	2.9	–	–	–					0.5	–	–	–	0	3.2
Engineering craft group	Craft trainees: Year 1 OT	11	–	–	–	–	0.4	–	–	–					0	–	–	–	0	0.4
Rest of Engineering		12-13	8.5	–	–	–	–	–	–	–	Labour force flows not connected with engineering craft group					Other flows into TOPS		–	*	2,487.6
RoI		14	9.9	–	–	–	–	–	–	–								–	*	20,688.5
Unemployed registered	Eng. trades	15	(0)	–	–	–	–	–	–	–								–	*	58.0
Unemployed registered	Other	16		–	–	–	–	0	0	0								–	*	870.2
Unemployed	unregistered	17		–	–	–	–	–	–	–						0	0	–	*	*
Training FT n.e.c	Eng. trades	18		–	–	–	–	–	–	–	Other flows from TOPS					–	–	–	0	4.8
Training FT n.e.c	Other	19	0	–	–	–	–	–	–	–						–	–	–	0	10.4
Education		20-21	0	–	–	–	–	11.9	2.9	0.2	Other flows from education					*	*	*	*	*
ROP + ROW		22-23	0	–	–	–	–	–	–	–	*	*	*	*	*	*	*	*	*	*
Σ_{1973}		24	532.2	4.0	18.1	19.1	16.9	11.9	2.9	0.2	2521.4	21,251.2	26.4	665.5	*	4.3	14.5	*	*	*

Source: See text and Appendix 2.

Note: Matrix elements set *a priori* are denoted according to: zero by definition (-) and by assumption or approximation (0); elements not discussed (*).

employers and the self-employed, all of whom are allocated to ROI. These amount to about 20,000 but nothing is know of their flows and occupational classification, and estimates of stocks are available only from censuses of population.

With these caveats in mind it is clear from the matrix that the main flows affecting the stock of craftsmen in engineering are the supply of newly qualified craftsmen from fourth and fifth year training (19,000) and the loss via occupational mobility within engineering (gross 17,400 but offset by an inflow of 8,500). However there are also large flows of qualified craftsmen between engineering and other industries resulting in a small net outflow of 2,300 at a time when the level of craft employment in engineering was quite stable. Estimated total losses during training amount to 7,900. Flows out of the labour force (mainly retirements) were 7,600. The two bracketed estimates, one each in the trained craftsmen row and column, were set so as to balance the trained craftsmen account with flows into craftsmen employment from unemployment and government training arbitrarily taking the zero value and the outflows (the net outflow) taking the residual value (outflows to both categories of government training were assumed to be negligible whereas inflows from Skillcentre engineering courses would be significant as mentioned below). This unsatisfactory procedure is necessary because of a feature of the questionnaire design whereby those entering or leaving an engineering firm via unemployment or full-time training would be attributed to their previous or subsequent job. These flows will have been included already in flows between engineering craft employment and the rest of engineering and other industries.

Figures given in Table 2.11 differ very much in their reliability as indicated in Appendix 2. Note here that the annual flows into and out of craft employment were grossed up from flows estimated for the first quarter of 1973. This presumes that multiple movement within the year by the same individuals is not important. The quarterly estimates themselves depend upon a sample grossing up procedure and the EITB method produces slightly lower estimates of flows between engineering craft employment and other states of employment than those shown in Table 2.11. The general pattern of the flows remains roughly the same however.

Looking at the accounts for an isolated year in order to obtain some sense of which flows are most important may lead to giving undue weight to one flow rather than another. The matrix has been estimated for a period of recovery in the labour market when mobility between industries begins to rise. During sustained economic expansion we may find that the outflow of craftsmen to other jobs in engineering or to other industries increases much more rapidly than does the corresponding inflow. A change in the structure of flows might also arise. Additional information from the craft survey shows that of the 17,400 leaving craft jobs but remaining within the industry about 15,000 were promotions or transfers within the firm (7,500 to supervisor jobs and 4,000 to technicians jobs). During a boom period a greater proportion of these flows may be to semi-skilled jobs yielding higher pay than skilled craft work. Whether or not flows into engineering offset these outflows and how much the 'net trade' position changes during an economic cycle are matters which ought to be cleared up before concentrating on one main flow for policy purposes. With present data we cannot do this.

To study what is happening in a labour market a time series of these matrices is required or at least of the main stocks and flows within them. Table 2.12 presents those stock and flow elements for which it is possible to make estimates from 1967-75. Given the structure of the training system and the treatment of the statistics some of the

Table 2.12 ECV and Selected Elements of ECM, 1967-75

Males plus females (thousands)

Vector element (t)	Equivalent flow where applicable (t-1,t)	1967	1968	1969	1970	1971	1972	1973	1974	1975
ECV_{1-4}	-	590.2	579.3	571.7	561.6	548.8	532.9	532.2	530.8	500.4
ECV_5	E_{65}	20.1	17.2	16.0	15.0	9.4	6.0	4.0	3.0	3.8
ECV_6	E_{76}	19.8	19.4	20.4	20.9	19.5	17.9	18.1	17.2	12.8
ECV_7	E_{87}	23.3	24.2	24.7	22.5	21.0	20.4	19.1	14.8	12.5
ECV_8	$E_{98}+E_{10,8}+E_{11,8}$	29.8	30.1	26.9	24.6	23.9	22.1	16.9	13.8	14.2
ECV_9	$E_{20-21,9}$	18.4	20.3	20.0	19.9	19.6	15.0	11.9	12.3	18.3
ECV_{10}	$E_{20-21,10}$	11.2	8.0	6.3	5.6	4.7	3.2	2.9	2.8	3.5
ECV_{11}	$E_{20-21,11}$	5.9	2.3	1.4	0.9	0.6	0.4	0.2	0.2	0.4
ECV_{12}	-	239.3	247.1	246.7	252.7	249.4	237.0	235.1	232.6	224.6
ECV_{13}	-	2,456.9	2,422.7	2,473.8	2,498.6	2,424.8	2,250.6	2,286.3	2,345.8	2,276.0
ECV_{14}	-	20,924.1	20,850.4	20,823.1	20,776.7	20,469.2	20,688.5	21,251.2	21,235.8	21,270.5
ECV_{15}	-	19.7	25.8	22.2	24.0	35.7	58.0	26.4	21.3	34.1
ECV_{16}	-	505.8	541.1	527.8	569.5	694.5	870.2	665.5	625.5	865.6
ECV_{18}	-	1.9	2.7	3.2	3.6	3.9	4.8	4.3	4.8	5.2
ECV_{19}	-	5.4	5.4	5.4	5.2	5.4	10.4	14.3	20.2	25.4
Additional flows not equivalent to stocks						(Year ending)				
$E_{5,1-4}$		n.a	20.1	17.2	16.0	15.0	9.4	6.0	4.0	3.0
$E_{6,1-4}$		n.a	1.4	2.2	4.3	10.2	12.6	13.0	14.6	14.6
$E_{9,8}$		n.a	15.6	17.9	17.8	18.0	17.4	13.6	10.9	11.5
$E_{10,8}$		n.a	9.5	7.0	5.6	5.1	4.2	2.9	2.7	2.5
$E_{11,8}$		n.a	5.0	2.0	1.2	0.8	0.5	0.4	0.2	0.2
TOPS Annual flow (1966 to 1974)		3.9	4.5	5.3	5.9	6.4	6.6	7.9	7.3	7.0

Source: Appendix 2

flows are identical to stocks and this is indicated in the table. One important flow which is not recorded adequately in the accounts because it is susceptable to the problem of multiple movement within an annual period (see Appendix 2) is the outflow of trainees from TOPS. The annual flow of trainees completing Skillcentre engineering courses, usually of six months' duration, is shown at the bottom of Table 2.12. This outflow has now reached about 40 per cent of the numbers completing craft training within the engineering industry; a decade ago the figure was 20 per cent.

The increase in government training shown by ECV_{18} and ECV_{19} and the flow mentioned above was mainly caused by a definite policy to increase the provision of training independently of the ITB system. The utilisation of training places within the capacity ceiling is a further factor of course but the scale of the increase in stocks and flows can be explained by the institutionally determined increase in the supply of training opportunities. Other flows identified in our matrix and shown in Table 2.12 also change magnitude very considerably over time. For example, in 1972-73 apprentice recruitment fell to 40 per cent of its level in 1966-67. Furthermore the trainee flows change not only absolutely but also relative to the corresponding stocks at the beginning of the year. This is not clear from Table 2.12 but is shown in Table 2.13 where trainee flows of ECM have been divided by the trainee stocks of ECV (the row totals of ECM). The resulting 'continuation rates' are precisely the sort of outflow parameters employed in the matrix models of flow systems discussed in sub-section 2.2.3.

Continuation rates will depend upon (a) the abilities and aptitudes of those entering training, (b) the quality of training available, (c) the standards set for courses and (d) the incidence of redundancy. All of these factors will vary but two main influences

Table 2.13 Continuation Rates for Engineering Craft Training

Flow period	c_1	c_2	c_3	c_4	c_5 (3)
1967-68	0.848	0.812	0.833	0.869	1.0
1968-69	0.879	0.821	0.843	0.825	1.0
1969-70	0.888	0.836	0.846	0.735	1.0
1970-71	0.905	0.854	0.867	0.450	1.0
1971-72	0.888	0.854	0.852	0.308	1.0
1972-73	0.909	0.864	0.887	0.223	1.0
1973-74	0.920	0.876	0.901	0.166	1.0
1974-75	0.928	0.905	0.865	0.221 (2)	1.0

Source: Calculations based on EITB (1976), Table 9.

Note (1) These estimate reflect the phasing out of the five-year apprenticeship. Alternative estimates of c_5 are considered later in the paper.

(2) This figure includes those on modules in their fifth year as part of completers in 1974-75. Previously they were excluded.

(3) All fifth year trainees are assumed to complete their training.

will affect the outcome. First, the numbers of young people coming forward for training and second, the demand for labour. If the former is high relative to demand one would expect firms to be able to be more selective than otherwise; but if demand is declining, then the possibility of redundancy during the course is increased (even though firms generally have agreements with trade unions to avoid such action). If demand is high relative to supply then the redundancy factor diminishes but initial hiring standards will tend to fall and unless the minimum acceptable standards of achievement required during the course also fall this will probably increase failure rates. Furthermore if labour demand is high generally, this will encourage voluntary quitting in favour of moving to other jobs. With this mixture of possible effects it is difficult to anticipate the resulting outcome without independent information about some of these factors. The estimates given in Table 2.13 show that the reduction in demand for labour and the fall in numbers leaving school which dominate the period have increased continuation rates especially for the second year (c_2), redundancy amongst apprentices not having offset the other influences mentioned above. However, the continuation rates shown will also reflect changes in the structure of engineering training initiated by the EITB and, were it not for a marked deterioration in the labour market situation between 1966 and 1975, the impact of changing market pressure upon continuation rates would have been masked probably by the institutional effects (associated as they were with the inevitable problems of comparability in the statistics: see Appendix 2).

There seems to be no information about rates of repitition but one would guess that these are very low when measured in terms of the proportion repeating a complete year. These rates have been set to zero in order to calculate training flows.

Additional comparisons of elements of ECM and ECV are shown in Table 2.14. These also cover apprentice training but in relation to the craftsmen stock. Table 2.12 shows the monotonic decline in trained craftsmen which has occurred since 1967; the 1975 stock was 85 per cent of the 1967 stock. Apprentice recruitment held initially but then plummeted in 1971-72 both in absolute terms and as a proportion of craftsmen. During this period the five year apprenticeship was almost phased out and so apprentice employment was reduced at both ends of the training cycle.

The stocks and flows shown in Tables 2.11 and 2.12 form the accounting framework constructed for engineering craftsmen. The

Table 2.14 Selected Stock-Flow Comparisons

	Apprentices as %	First year apprentices as %		Fourth and fifth year completers as %	
	trained craftsmen (1)	trained craftsmen (2)	all apprentices	trained craftsmen (3)	initial cohort size (4)
1967	21.8	6.0	27.6	3.6	n.a.
1968	21.0	5.3	25.2	3.4	n.a.
1969	20.2	4.8	23.9	3.6	n.a.
1970	19.5	4.7	24.1	4.5	n.a.
1971	18.0	4.5	25.2	4.0	71.0
1972	16.0	3.5	21.9	3.6	71.9
1973	13.7	2.8	20.5	3.5	68.6
1974	12.1	2.9	23.9	3.3	70.4
1975	13.1	4.4	33.9	n.a.	70.7

Source: Table 2.12

Notes: (1) $\sum_{i=5}^{11} ECV_i(t)/ECV_{1-4}(t)$.

(2) $\sum_{i=9}^{11} ECV_i(t)/ECV_{1-4}(t)$.

(3) $\sum_{i=5}^{6} E_i(t,t+1)/ECV_{1-4}(t)$.

(4) $\sum_{i=5}^{6} E_i(t,t+1)/ECV_{1-4}(t-4)$.

availability of data on flows connected with training obviously far exceeds that on flows of trained craftsmen throughout the labour force. In fact a further series on apprentice recruitment is also available. This covers a much longer period (1951-73) than the EITB series and can be disaggregated by MLH industries. It is also accompanied by series on other categories of employment in each industry entered by young people. Fluctuations in apprentice recruitment as reflected by this more satisfactory data source will be analysed in Chapters 4-6.

Despite recognising that their survey results convered only a short period the EITB (1975, p.17) argue that: 'Nevertheless they give for the first time some indication of the scale of recruitment required to maintain the stock of engineering craftsmen at a stable level'. The training board has now revised the flow estimates given in that report but with the new figures it would have concluded that to maintain the craft labour force at 530,000 requires about 19,000 newly trained craftsmen each year ($E_{5,1-4}$ plus $E_{6,1-4}$) implying that the stock of first year craft trainees should be held at about 27,000.(11) During 1972-73 the 15,000 in approved first year training (ECV_9 (1972) in Table 2.11) will provide only about 10,500 qualified entrants to craft employment in engineering in 1976-77. However, this 'steady state solution' ignores what is likely to happen to engineering demand and to the labour market outside engineering and the fact that there were many craftsmen unemployed at the time of writing (see ECV_{15} (1975), Table 2.12). Moreover it fails to consider possibilities for changing the levels of other flows rather than trainee input.

The compilation of successive manpower accounts would guard against these pitfalls to some extent but there remains a further source of

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(11) The method used to derive these figures follows the one used in EITB (1975).

error. By continually ignoring those craftsmen 'lost' to the occupation regardless of industry during each period, no picture of the resulting utilisation of available human capital is obtained. Only a cross-classification of occupation by skills acquired but not necessarily deployed will reveal how many trained craftsmen are employed in less skilled work as opposed to the occupations which the EITB survey highlights; technicians and foremen. The National Training Survey will provide for the first time a large enough sample of the population on which to base analysis of previous education and training in relation to actual employment and from which it will be possible to estimate how many skilled men have been accumulated in the 'remaining occupations' of our matrix. Without some knowledge of the size of this group for one benchmark year, in addition to the subsequent flows into and out of it, a proper evaluation of the deployment of skilled engineering craftsmen is not possible.

The only information about the distribution of people with skilled engineering craft training concerns those who are actually using their skills in their current occupations. This does, however, indicate the large numbers of such craftsmen employed outside engineering and the other metal industries. As in the case of the aggregate occupational structure of the labour force, the distributions of these occupations among industries throughout the economy for 1951-71 can only be obtained from the censuses of population. The change in occupational classification between 1951 and 1961 has been bridged in the Department of Employment (1967) study which also gives, for the United Kingdom, the numbers in skilled engineering occupations employed in different industries. Figures for 1961, 1966 and 1971 covering Great Britain have been derived from the appropriate census tabulations. The occupational groups covered by the estimates given for the two separate decades are not exactly comparable but the correspondence is sufficient for our purposes. From Table 2.15

Table 2.15 The industrial distribution of skilled engineering trades.

Industry (1958 SIC orders)	United Kingdom(1) 1951	1961	Great Britain(2) 1961	1966	1971
Engineering (VI, VIII, IX) Shipbuilding and marine engineering (VII) Metal Manufacturing (V)	63.8	63.7	59.6	56.9	57.0
Mining (II) plus rest of manufacturing	9.3	9.3	8.8	8.9	8.9
Construction (XVII)	7.9	8.0	9.2	10.7	10.6
Gas, electricity and water (XVIII)	3.5	3.4	3.4	3.8	3.4
Transport and communication (XIX)	3.6	3.6	6.3	6.4	6.7
Miscellaneous services (XXIV)	6.8	6.3	7.3	7.5	7.7
Rest of services plus agriculture	5.0	5.6	5.1	5.5	5.6
Industry inadequately described	-	-	0.2	0.2	0.1
Total (per cent)	100.0	100.0	100.0	100.0	100.0
Total (thousands employed)	2,347	2,589	2,559	2,704	2,720
Total out of employment	-	-	53	37	96
Percentage of all workers out of employment			2.0	1.4	3.4

Sources: Census tabulations and Department of Employment (1967).

(1) Figures for the United Kingdom are based on the definition of skilled engineering occupations adopted in Department of Employment (1967).

(2) Figures for Great Britain are based on the 1961 Census classification of occupations as adjusted to match the L7A Survey definition of engineering craftsmen (see Table 2.5). Disparities between the two figures given for 1961, especially for the metal industries and transport and communication, have yet to be satisfactorily explained.

it can be seen that the industrial distribution of skilled engineering trades has been quite stable. About 60 per cent of this occupational group are employed in the metal industries with mining plus manufacturing, and construction employing a further 9 per cent or so each. The main changes seem to have occurred during 1961-66 with the metal industries' share falling whilst the proportion employed by construction, especially, increased.

In the following section we shall make considerable use of the findings of the MacKay study to shed light on those flows within the labour market which have tended to be played down by manpower agencies - the mobility of adult craftsmen between skilled engineering jobs and jobs in other industries and occupations. Of special note is the fact that this study took place during a period of high employment by recent standards leading up to the peak of activity in 1966 prior to the 'shake-out' of labour. It should therefore show the behaviour of the labour market when there is a greater likelihood of skill bottlenecks developing. In addition, because the authors select several local labour markets, some of which experience major shortages and others relatively high unemployment throughout, we obtain a view of the situation in a range of circumstances encapsulating in a cross-sectional fashion the conditions under which manpower policy must operate.

This section has presented evidence on the occupational and industrial mobility of engineering workers through the framework of manpower stock-flow accounts. The accounts themselves are very simple in construction given the lack of comparable data on various aspects of mobility. Nonetheless, they do reveal much more about the dynamics of the skilled engineering labour market than would the tabulation of craftsmen stocks and trainee recruitment flows alone. The exercise also indicates the potential value of extending the accounts and their use as a framework for organising current data and guiding the collection of new data to fill the important gaps.

2.4 Industrial and Occupational Mobility in Local Labour Markets

The study by MacKay et al.(1971) is marked particularly by its wide scope relative to other British local labour market studies. It is genuinely an attempt to understand how the labour market works. Other research such as the Department of Employment's (1971a) investigation of skilled shortages in the Leicester area ostensibly deals with market phenomena but does not attempt to embrace the interaction between wage structures and resource movements using a systematic framework. Resource movements continue to be the centre of interest in this section but their connection with wage relativities will be pursued in section 2.5.

For the purpose of their mobility analysis the authors include the whole of order VII (shipbuilding and marine engineering on the 1958 SIC) as part of engineering whereas in most of our work this order is excluded. The occupational titles referred to below relate to the trades particularly used in engineering so 'skilled' and 'semi-skilled' recruits are those whose previous occupations 'required a type of skill specific to, or closely allied to, the engineering industry'.[12] 'Non-production' workers are semi-skilled and unskilled manual workers not engaged in production directly and 'miscellaneous' recruits include a small number of people previously employed in non-manual occupations but mainly consist of those skilled and semi-skilled in trades not transferable to engineering (it also includes welders, inspectors and others 'whose skill could not be accurately ascertained').

MacKay and his colleagues found that the (previous) occupational structures of recruits from other engineering firms and from firms in metal manufacturing were very similar, underlining the strong mobility link between these industries observed by them (p.255) as well as in national statistics of labour mobility (see Appendix 1). Otherwise

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(12) MacKay et al.(1971) p.262.

recruits from engineering firms are much more likely to be skilled or semi-skilled than are recruits from other industries.[13] The outcomes from the point of view of the industrial mobility of recruited males previously in those two occupational groups are shown in Table 2.16 for the Birmingham and Glasgow labour markets. The similarity between the results for both groups in each market is obvious. In Birmingham 47.6 per cent of all recruits were from engineering firms compared with 45.0 per cent of the insured population of employees. For Glasgow the corresponding figures were 64.8 and 28.3. Hence the less buoyant Glasgow market produced a much more limited circulation of employees between engineering and other industries despite having a smaller proportion of engineering employment. This is shown clearly in Table 2.16 Glasgow engineering firms recruited only 15 per cent of their skilled and semi-skilled workers from outside the industry. Birmingham recruited almost twice this percentage. The investigators comment that this greater recourse to recruiting from outside the industry by Birmingham firms

> 'is an important means of adjustment to tighter labour market conditions, and suggests that the labour force is more flexible than a superficial reading of employment and unemployment statistics might convey.'[14]

Such statistics however only encompass 'flexibility' vis a vis changing industry. Let us now consider the extent of coincident changes of occupation. Figures for the five different labour markets are presented in Table 2.17. A comparison of these markets is given in MacKay et al.(Chapter 3). It is enough here to note that the three

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(13) Ibid, p.261.

(14) Ibid, p.267.

Table 2.16 Percentages of male recruits, by previous occupation, moving from other engineering establishments during 1959-66.

Previous Occupation	Birmingham: Previous industry Engineering	Birmingham: Previous industry Other	Birmingham: Total numbers	Glasgow: Engineering	Glasgow: Other	Glasgow: Total numbers
Skilled	72.5	27.5	1,506	85.0	15.0	1,951
Semi-skilled	72.3	27.7	3,194	85.6	14.4	1,034
Unskilled	38.1	61.9	1,434	43.6	56.4	392
Non-production	32.7	67.4	981	30.0	70.0	260
Miscellaneous	20.3	79.7	3,298	17.5	82.5	629

Source: MacKay et al (1971) Table 9.10.

Table 2.17 Occupational mobility among male engineering recruits: 1959-66.

Occupational group on joining	Birmingham	Glasgow	Other Scottish Areas: North Lanarkshire	Other Scottish Areas: New Town	Other Scottish Areas: Small Town
	Percentages of recruits remaining in same occupation				
Skilled	65.1	90.5	87.7	82.9	66.2
Semi-skilled	45.1	56.8	34.7	27.3	4.9
Unskilled	49.2	41.8	29.5	33.6	15.2
Non-production	32.5	29.5	24.1	23.1	13.3
Total	47.4	68.9	47.0	42.6	18.7
Previous Occupation	Percentages of skilled recruits by previous occupation				
Skilled	65.1	90.5	87.7	82.9	66.2
Semi-skilled	17.8	4.4	5.4	5.2	9.1
Unskilled	1.8	0.6	0.4	1.0	1.3
Non-production	3.5	0.7	0.5	0.0	1.3
Miscellaneous	11.8	3.8	5.9	10.8	22.1
Total numbers	1,436	2,110	955	287	77
Previous Occupation	Percentages of semi-skilled recruits by previous occupation				
Skilled	12.1	12.8	15.0	12.5	19.1
Semi-skilled	45.1	56.8	34.7	27.3	4.9
Unskilled	10.1	8.3	10.5	12.3	13.4
Non-production	7.6	6.7	9.3	10.0	6.1
Miscellaneous	25.1	15.4	30.5	37.9	56.5
Total numbers	6,663	1,502	1,456	512	246

Source: MacKay et al.(1971) Tables 10.1, 10.2 and 10.4.

smallest Scottish areas experienced expanding employment in engineering and although local supplies of engineering trained labour were limited, the high general level of unemployment combined with choices of technology which made training problems less acute helped to ensure, in the main, adequate supplies of skilled labour to the case study plants. All four Scottish labour markets suffered reductions in aggregate employment during the period whereas 'on any reasonable definition, Birmingham enjoyed full employment through most of 1959-66'.[15] Engineering plants in Glasgow and Birmingham followed, in direction if not magnitude, the contraction and expansion in aggregate employment experienced in those markets respectively. In the former, engineering employment decreased by 19 per cent compared with the 5 per cent decrease in aggregate; in the latter the corresponding increases were 3 and 10 per cent respectively.

Bearing those situations in mind there are several aspects of the mobility percentages given in Table 2.17 which raise questions about the appropriateness of the local wage structure. First despite the fact that Birmingham plants found difficulty recruiting skilled labour, only 65 per cent of male recruits to engineering plants who were previously engaged in skilled engineering trades continued to work as skilled men. Secondly, again despite skilled shortages, Birmingham plants recruited as great a proportion of their semi-skilled employees from the ranks of previously skilled workers as did Glasgow plants where skilled unemployment prevailed. Thirdly, in the three other areas, semi-skilled recruits were also drawn from the ranks of the skilled to the same extent as in Glasgow whereas one might have expected that the expansion of engineering demand would tend to encourage firms

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(15) Ibid, p.61.

to retain their skilled men rather than retrain others.[16] The downward occupational mobility in Glasgow may be explained by skilled men accepting semi-skilled work because they could find no skilled jobs but this would not apply in general to the other areas. These statistics must however be interpreted carefully particularly with regard to the relative sizes of the occupational groups in each labour market and the fact that they view the impact of occupational mobility from the point of view of the recruiting firms rather than the individual worker. Hence the authors also analyse their mobility statistics relative to the size of the previous occupational group in addition to the size of the group into which recruitment takes place.

As can be seen below, in Birmingham only a half of recruits who were previously skilled took up skilled jobs whereas almost two-thirds

Table 2.18 Percentages of male recruits by previous occupational group joining the same group with new employer (case-study plant).

Previous occupation	Birmingham	Glasgow	North Lanarkshire	New Town
Skilled	50.4	89.6	75.0	76.3
Semi-skilled	77.9	76.8	66.5	74.5
Unskilled	58.8	59.5	46.6	55.1
Non-production	27.4	29.2	30.0	15.0

Source: MacKay et al.(1971), Table 10.5.

of recruits into skilled jobs came from skilled jobs (Table 2.17). In contrast, 77.9 per cent of previously semi-skilled males took up similar jobs with their new (engineering) employer whilst only 45.1 per cent of recruits into semi-skilled jobs came from semi-skilled jobs. Thus

(16) In two of these areas the high proportion of skilled recruits who were previously skilled is partly explained by strong mobility links between metal industries (North Lanarkshire), inward migration of skilled labour (New Town) and the development of significant flows among case-study plants themselves towards the end of the period (New Town). Ibid., p.277.

the figures for Birmingham in Table 2.17 if interpreted loosely, can give an impression of less mobility out of skilled occupations and more out of semi-skilled occupations than is actually the case. Indeed they mask completely the fact that the semi-skilled are the most 'stable' occupational group in Birmingham. MacKay et al. go into some detail over this phenomenon. After investigating the mobility of flows at a greater level of disaggregation to check whether a quirk of the occupational classification combined with certain features of the production technology may be the root cause, they conclude that

> 'considerable real downward occupational mobility occurred when employees joined the case-study plants in Birmingham, and ... this was more substantial than the upward occupational mobility involved in changing employers. This indicates a serious malfunctioning of the labour market, as both unemployment and vacancy data and the recruitment experience of the case-study plants clearly indicated that skilled labour was most difficult to obtain ...' (17)

Finally we come to the extent of internal occupational mobility. The results of the 1963 national mobility survey (Harris and Clausen, 1967) showed that barely one per cent of 'skilled manual workers' and 4 per cent of 'partly skilled manual workers' changed occupations during a job spell with the same employer (including those interupted by the interview). The notion of the internal labour market has become a valuable analytical device applied extensively in American labour market studies. (18) Its relevance to the employment of manual workers in British engineering plants is nonetheless undermined by the findings of the above research.

The main factors affecting the evolution of an internal labour market in which significant proportions of the actual and potential imbalances between the firm's labour demand and supply are removed by internal mobility are (i) the state of the external labour market,

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(17) Ibid., p.284.

(18) Doeringer and Piore (1971).

(ii) the types of jobs and the transferability of skills between them as determined by the technology of production, and (iii) institutional provision for or restriction of the development of an internal labour market. MacKay et al. deal with each of these in turn predicting that Glasgow plants would, an all three counts, show very limited internal mobility but that for Birmingham and the other Scottish areas conditions were favourable. There, plants were not faced with surpluses of skilled labour available for recruitment, the technology was mass or large-batch production creating configurations of skilled and semi-skilled jobs which overlapped in skill content, and an absence of trade union resistance to dilutee agreements (except in North Lanarkshire) meant that plant manpower policy was relatively unfettered. Table 2.19 shows that for Birmingham, New Town and Small Town about 20 per cent of those recruited during 1959-66 and whose present jobs were skilled had joined semi-skilled occupations initially. Lest this should be thought to indicate more upward internal mobility than it does it is necessary to look at the proportion of those initially recruited to semi-skilled who had taken up skilled jobs by 1966. In Glasgow this was particularly low at 2 per cent as might be expected but in Birmingham, North Lanarkshire and Small Town it reached only about 6 per cent and in New Town, 12 per cent.(19) Various possible explanations of these observed patterns of internal mobility are entertained by the MacKay team. They look at the 'random' hypothesis applied to the relative levels of mobility between semi-skilled and skilled groups in Glasgow and Birmingham, and at differences in

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(19) In tight labour markets where fear of unemployment is diminished, union objections to dilutees may stem from the extent to which their introduction cuts across established criteria for transfer and promotion, especially the seniority principle. MacKay et al. found that procedures were informal and not normally the subject of collective bargaining (ibid., p.298).

technology, giving rise especially to the association between machine-tool setters (skilled) and setter-operators (semi-skilled) between which much movement occurs in Birmingham. Whilst both these contribute to an explanation of the disparity between Glasgow and Birmingham they are incomplete. On the other hand, when the lack of trade union constraints to internal mobility and the recurrent shortage situation in Birmingham are acknowledged the major question is not so much why is there more upgrading in Birmingham than in Glasgow, but rather why is the difference not greater? The answer seems to lie in two other aspects of the firm's strategic position when deciding whether or not to train or to recruit on the external market. The latter 'might impose prohibitive costs through competitive wage bidding or higher recruitment expenditure'[(20)] whereas the former may be technically very difficult in the short-run and will also be accompanied by costs and a risk of loss of investment through labour turnover. If indeed then the wage structure was such as to encourage downward occupational mobility from skilled jobs in low-paying firms to semi-skilled jobs in high-paying firms and furthermore even within firms from, notably, skilled timework to less-skilled piecework[(21)], management would seem to leave itself no means of controlling labour supply if it ruled out changing the wage structure. If it increased training facilities for apprentices and adults without such changes then high labour turnover would result. Given also that the latter is in any case a feature of tight labour markets, the acquisition of sufficient work experience to enable upgrading of semi-skilled workers is rendered less likely.[(22)]

Thus at least from the study of the above labour markets and

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(20) Ibid., p.299.

(21) Ibid., p.308.

(22) Ibid., pp.309-310.

Table 2.19 Last job skilled: percentages in each occupation on joining the plant: males

Occupational group on joining	Birmingham	Glasgow	North Lanarkshire	New Town	Small Town
Apprentices	2.6	8.6	10.2	3.1	9.0
Skilled	74.9	86.2	75.6	74.7	65.2
Semi-skilled	20.3	2.7	7.5	19.2	18.0
Unskilled	1.8	2.2	6.4	3.1	7.9
Non-production	0.4	0.3	0.3	0.0	0.0
Total numbers	1,686	5,167	966	261	89

Source: MacKay et al. (1971), Table 11.2.

especially Birmingham, the scope for management to counterpoise the impact of external market occupational mobility by manipulating the internal labour market without altering the pattern of incentives appears to have been extremely limited. Whereas 43.5 per cent of previously skilled men took up semi-skilled jobs on joining Birmingham plants, 42.7 per cent were still in semi-skilled jobs at the end of the study period. A small amount of reverse mobility had occurred internally. Upgrading, albeit limited was associated as expected with internal rather than external mobility and in Birmingham whereas 6.6 per cent of previously semi-skilled men changing plants were recruited into skilled occupations, 16.8 per cent had acquired skilled status by the end of the study period. We shall return to the question of internal mobility in Chapter 3 but meanwhile note that MacKay et al. found that internal markets in British engineering plants were not very well developed and links with the external market existed at each skill level.(23)

(23) Ibid., p.323.

2.5 The Relevance of Changes in Wage Differentials

MacKay et al. (1971) have suggested that in certain labour markets the skill differentials are insufficient to maintain the potential suppliers of skilled labour in skilled jobs. Let us first consider this for the engineering industry in isolation. If skill differentials are being eroded and/or inter-firm differentials are sufficiently out of line for some semi-skilled work to be paid more highly than some skilled work and if the labour market is sufficiently tight for there to be an excess demand for semi-skilled as well as skilled labour then skilled labour may be drawn into semi-skilled occupations and potential craftsmen may be discouraged from joining training schemes. This however would only be necessarily sub-optimal for the engineering industry if the excess demand for semi-skilled workers could in fact be satisfied in the short-run by recruiting those who are not craftsmen. In reality the engineering industry does not operate in a closed labour market and people employed in other industries as well as potential entrants to the labour force provide the means of satisfying the demand for semi-skilled workers assuming suitable operator training facilities are available. On the other hand unless the recruiting firms discriminate against people they believe to be skilled in engineering trades (and firms are not noted for their reluctance to hire the "overqualified" manual worker) it is likely that since those having already had work experience in the engineering industry and having access to the predominantly informal information channels[24] will form a large proportion of potential recruits, then some will be skilled workers moving down the conventional occupational hierarchy. However the presence of other industries implies a source of competing demand as much as potential supply. Discrimination per se will only solve

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(24) Ibid., Chapter 13.

the problem providing the engineering sector pays its skilled workers sufficient to make a transfer to other industries unattractive. There is of course the possibility of 'complex mobility' by which MacKay et al. mean joint changes of industry and occupation. Semi-skilled work in the chemical industry may draw skilled craftsmen from engineering. All sorts of short-run cycles of complex mobility may be envisaged but we shall consider wage differentials in the light of the loss of engineering craftsmen only through occupational mobility within the engineering industry and through the 'pure' inter-industry mobility of craftsmen.

There are two further points to be made before looking at the statistics. First, in addition to the phenomenon of downward occupational mobility there is also the possibility of transfer to non-manual occupations whether in the draughtsman and technician fields of employment or in supervisory roles. Evidence of the latter is clear from the matrices of occupational transitions presented earlier in this chapter. For the former we have only to turn to the results of the survey of technicians published by the E.I.T.B. (1970) from which there emerge two patterns, one superseding the other in prime importance.

The first pattern is the one most applicable to older technicians and traces their careers through skilled craft employment. The second is the increasing importance of direct entrants from schools into technician training schemes, or at least schemes which provide common initial training for craft and technician jobs and a career structure involving limited work experience as a craftsman prior to becoming a technician.

This raises the second of the additional points alluded to above. One response to a situation in which craftsmen in engineering were leaving their jobs for more attractive employment whether inside or outside the sector is for the industry to attempt to train its way out of the problem. Such a policy would presume a degree of collaboration between firms which could not be envisaged without the E.I.T.B. or a similar institution. Its success in 'supply management' terms would rest on the ability of the engineering sector to attract and retain young craft trainees sufficiently to provide an adequate level of trained manpower. Its cost-effectiveness would depend on the costs of training and labour turnover and the premium placed upon not disturbing the wage determination process by revisions of differentials according to the state of the labour market. If taken to an extreme there would be wider ramifications affecting efficiency, for example, through a reduction in the informal acquisition of additional skill on the job due to a fall in average lengths of service (to the firm and industry) and through a possible deterioration in the climate of industrial relations.

The stress on the recruitment and retention of young craft trainees under the above policy becomes greater because they consitute a larger proportion of the supply of craftsmen. This magnifies the impact of fluctuations in apprentice recruitment upon labour supply. The role of dilutees needs to be considered in this context. The 'supply management' policy relies on the presence of two particular imperfections in the labour market: poor information[25] and the immobility of the individual (due to socio-economic factors not directly related to the recurrent pay and working conditions attaching to jobs once they have been taken up). It may be argued that the more experience workers will have acquired

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(25) The development of careers advisory services and the new job centres are of course intended to improve this state of affairs.

better information about their own abilities and the labour market than will young entrants. The latter will take longer to realise that there are financial advantages to leaving crafts normally associated with greater job security, pay and status. On the other hand once trained they are likely to be more mobile than the average dilutee, being younger and having fewer family responsibulities. In addition to these factors the cost of adult training to the firm and the acceptability of the non-apprenticed skilled man to the trade unions will vary especially according to whether or not he or she is being trained internally or being recruited already trained or partly trained by a Government Training Centre or another firm. Hall and Miller (1975) have studied the experiences of dilutees trained by government but did not compare their fortunes with those of workers upgraded by the firm. In fact they conclude that the acceptability of GTC trainees in future is very much dependent upon traditionally trained men perceiving that 'secure, fair wages (are) at least less dependent than in the past on maintaining their skill in constant short supply'. As for the perceptions of the authors, whilst arguing generally that the buoyancy of the labour market is of major importance to the integration of dilutees, they press (p.168) the more specific claim that

> 'if wage rates did not depend to such an extent on the economic forces of supply and demand, which at this time they so often do, and especially so for craftsmen, then this may help to open the tradition-guarded doors of craft skills'.

Many of these matters either lie outside the scope of this study, notably the effects upon the relationship between employers and unions of attempting to implement such policies, or cannot be analysed thoroughly because of the lack of data, especially on labour costs and industrial earnings relativities for particular occupations. The remainder of this section will, however, take a closer look at the presumption about wage responsiveness contained in the above quotation.

We shall deal with the evidence on earnings under three headings: skill differentials within engineering; industrial differentials for all male manual workers and selected occupations common to engineering; and the findings of econometric studies of the determinants of the wage structure. Routh (1965) covering the period 1906-1960 sets the movement of relativities within the engineering sector in a wider occupational and industrial context. Our own period of analysis begins in 1951 at the start of a general narrowing of differentials which continued until about 1955. From 1955 until the middle and late nineteen-sixties there was a period of sustained increases in relativities for the first time since 1924-33 but under very different labour market conditions with the unemployment rate for males reaching about three per cent towards the end of the period compared with about twenty per cent in the early nineteen-thirties.

2.5.1 Skill differentials within engineering

Earnings of manual workers in the engineering industry have been the subject of many investigations by industrial relations specialists and economists.[26] These studies have concentrated upon the mechanism by which wages are determined rather than the effects of wage changes upon the allocation of resources. The lack of information on the employment of different skills in engineering and other industries would have obstructed the testing of theories about supply responses although the availability of price-quantity observations does not guarantee precise formulation and adequate evaluation of theories about the connection between the two variables.[27]

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(26) Particularly relevant to the post-second world war period are Knowles and Hill (1954), Lerner and Marquand (1962, 1963), Knowles and Robinson (1969), Robinson (1970), MacKay et al.(1971), Brown (1973) and Hart and MacKay (1975).

(27) Knowles and Robinson (1969), using employment and earnings changes for skilled production workers in 13 Coventry engineering plants, perform the inevitable test of association between them. They state that the absence of an association despite trying simple lags implies that 'earnings are not increased . . . in the expectation of attracting labout' (p.18). This does not distinguish between managerial intention and supply response.

Only Evans (1974) appears to have used the annual occupational data provided since 1963 but then in order to obtain estimates of the extent of labour hoarding of different skills. His first concern with 'the role of earnings as an allocator in engineering labour market' sounds promising but, like many other authors, Evans turns his study into one about the relationship between changes in earnings and excess demand, adopting the former as the dependent variable. Regardless of how poor the econometric results may be, they cast little light upon the responsiveness of supply to wage changes unless one assumes that if supply were responsive firms would be only too willing and able to adjust wages appropriately and hence wages would be affected very much by market imbalances.

Without a longer time series of statistics on resource allocation than the annual observations for 1963-74 it is unlikely that a comprehensive supply theory for the skilled engineering labour market can be tested satisfactorily. We shall limit our discussion here to developments in wage relativities within engineering since 1951 but in doing so we shall note those features of the occupational - industrial wage structure with which a supply theory would have to contend.

The paper by Hart and MacKay (1975) provides a series of average weekly earnings for fitters and labourers for 1914-68 constructed from the data compiled by the Engineering Employers Federation. From 1963 the Department of Employment has conducted a survey of engineering earnings according to skilled, semi-skilled and labourer categories. Whereas the EEF survey covers only federated firms, the government survey is more representative of the engineering industry as a whole.[28] The

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(28) See, for example, the results for June 1974 reported by Department of Employment (1974b).

correspondence of differentials and absolute figures for overlapping years is however quite close except for 1964.[29] Figure 2.1 shows the fitter - labourer differentials for 1951-66 and 1968 plotted together with the skilled worker - labourer differentials for 1963-74. The former are based on the weighted means of average weekly earnings figures compiled for 28 different EEF local associations. The latter are based on the relevant survey averages except that as well as combining timeworkers and pieceworkers (as do the EEF results reported by Hart and MacKay) the average earnings figures relate to all skilled workers, not just the major skilled group of fitters.

Over the 1951-74 period the earnings of fitters rose from 27 per cent above those of labourers in 1951 to a peak of 41-42 per cent during 1966-69 and then fell to 32 per cent by 1974. The rising trend was broken at three points 1954-55, 1957-58 and 1963-64 although the last one is not picked up by the Department of Employment series. The extrapolation of a linear trend through the observations for 1951-66, which covers approximately three complete trade cycles would yield a 47 per cent differential for 1974 instead of the observed 32 per cent.

In Chapter 3 the engineering sector is disaggregated into 15 engineering industry groups. Comparable disaggregations of the above earnings statistics are not available but it is possible from the DE survey to look at five different groups of which one (marine engineering) is not included in our later coverage. From these we can compare the broad earnings structure for motor vehicles with the structure for mechanical engineering, electrical engineering, aerospace and marine engineering. In view of the findings of the study by MacKay and colleagues these comparisons are especially pertinent to

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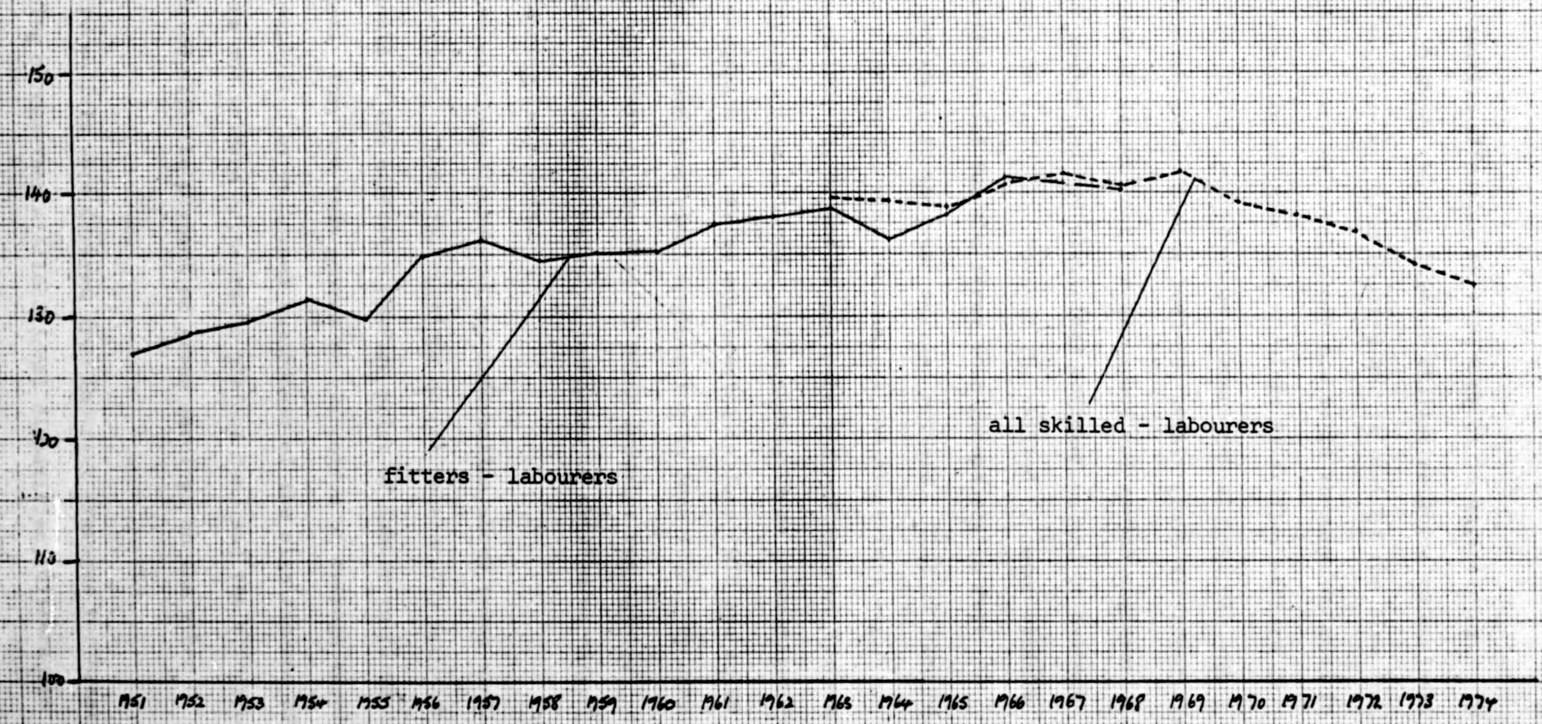
(29) See also Hart and MacKay (1975).

Figure 2.1 Changes in earnings of skilled engineering workers as a percentage of the earnings of labourers. 1951-74



Source: Hart and MacKay (1975).

the mobility situation affecting skilled workers in engineering.

Table 2.20 shows the earnings of skilled relative to semi-skilled workers in all engineering firms covered and in each of the five industry groups separately. Part of metal goods n.e.s. is thereby excluded in the disaggregation. In addition the earnings of skilled workers in each of these five groups are shown as percentages of semi-skilled workers in motor vehicles. During 1963-69, within group differentials were of the order of 22 per cent for aerospace and marine engineering, 16 per cent for mechanical and electrical engineering and on average about 9 per cent for vehicles. However the skilled to motor vehicle semi-skilled differential for the first four groups are in fact favourable on the whole to the semi-skilled workers. Thus skilled men in aerospace, marine engineering, mechanical and electrical engineering earned on average 100, 91, 92 and 92 per cent respectively of the vehicles semi-skilled figure during 1963-69. Subsequently these percentages fell to 89 and 86 for aerospace and marine engineering in June 1973 and to 86 for both mechanical and electrical engineering in June 1972. By June 1975, however, the state of the British motor industry was clearly reflected in the considerable relative increases in skilled earnings in other engineering industries.

The above earnings figures convey information about gross weekly pay before deductions. Their fluctuations do not necessarily indicate relative movements in the effective average price of labour to firms in those industries. They are thus geared to the notion of average earnings opportunities exploited by employees regardless of the significance of obligatory taxes and welfare payments on the one hand and the effort/hours bargain associated with the payment of gross earnings on the other hand.

The differentials were derived from industry averages for Great Britain. Cutting across them are locational disparities, differences

Table 2.20 Skilled weekly earnings as percentages of semi-skilled earnings in (a) the same industry and (b) motor vehicles: men in Great Britain

Industry[1]	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
(a)													
Mechanical engineering	115	115	116	117	117	116	117	112	107	113	113	113	112
Electrical engineering	115	116	116	118	117	116	117	115	115	113	113	114	117
Aerospace	123	122	122	123	123	124	124	123	123	120	117	119	116
Marine engineering	124	121	123	121	122	123	118	119	119	113	120	111	118
Vehicles	105	106	106	108	114	111	113	113	109	110	107	108	104
All engineering	109	109	110	112	114	112	113	112	110	109	107	110	111
(b)													
Mechanical engineering	86	89	90	94	98	92	95	88	86	86	86	94	98
Electrical engineering	88	89	89	93	97	92	93	90	87	86	87	91	96
Aerospace	96	96	96	102	109	101	102	96	92	94	89	97	105
Marine engineering	87	86	90	93	100	90	92	93	93	88	86	95	104

Source: June figures from the biannual DE earnings surveys. See, for example, Department of Employment (1974b). Average gross weekly earnings for pieceworkers and timeworkers have been combined using the appropriate numbers covered by the surveys as weights.

(1) Industries covered by the enquiries are (1958 SIC):
Mechanical engineering, MLHs 331-349
Electrical engineering, MLHs 361, 363-369
Aerospace, MLH 383
Marine engineering, MLH 370.2
Vehicles, MLHs 381-382
In addition 'All engineering' includes MLHs 384, 385, 391, 393 and 399.

between constituent industry groups and skilled occupations, and the effects of different payment systems. Each of these sources of variation may be investigated in several ways according, for example, to the choice of geographical breakdown and industry product groups.

Only the study by MacKay and colleagues comes near to dealing with the complexities of a British local labour market in such a way as to shed light on the impact of economic forces upon the wage structure and manpower movements. That they should have chosen labour markets dominated by the engineering industry is most fortunate from out point of view. The conclusions of major relevance to the qualifications expressed in the previous two paragraphs are as follows[30]:

(1) Inter-plant wage differentials persisted in all the markets studied. Plant rankings were less stable when using gross as opposed to standard weekly earnings (these excluded overtime payments) but fluctuations in the former tended to be of a short-run nature, being subsequently reversed.

(2) Inter-plant differentials at different skill levels reflect the overall ranking and so relative wages of all groups of workers in a plant are similarly affected when the plant average changes relative to other plants.

(3) The persistence of wage differentials cannot be explained in terms of the general state of the labour market, nor can it alternatively be attributed mainly to factors found to be important in earlier (predominantly American) studies: 'imperfect knowledge, inertia on the part of employees, collusion between employers through anti-pirating agreements, discrimination in favour of employees against

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(30) For the impact of the tax system under inflation upon wage differentials see Wilkinson and Turner (1972) and Brown et al.(1975).

non-employees, and under-employment in the labour market'.[31]

(4) There remain three alternatives which might yield significant economic explanations of the observed differentials. First, the fact that the supply 'price' of labour includes non-wage costs and benefits which may balance the wage differentials; second, differences in hiring standards and/or levels of skill acquired within the plants together with differences in skills utilised and effort expended undermine comparisons between workers classified to the same group in different plants; and thirdly, economic forces do determine inter-plant wage differentials but they are the forces operating in product markets not competitive labour markets. MacKay et al. were unable to show that the first two factors were decisive and thus concluded that the 'limits set to wage differentials by [labour] market forces are not, then, very narrow'.[32] It is therefore to the product market situations of firms we should look for further explanatory hypotheses.

These points suggest that the observed differentials represent real differences in efficiency wages between plants. As with mobility however it is important to associate what is happening in the external market with the situations in internal labour markets. Once again we turn to the MacKay study. It is important to know whether intra-plant skill differentials respond to conditions in the local labour market and how far there are features common to most plants, but overlaying these matters is the impact of the different payment procedures to be found in engineering. In particular the inter-plant differentials

(31) Op. cit., p.98.

(32) Ibid., p.98.

analysed in the above study and our own broad industry comparisons used averages covering workers contracted under different wage payment systems. We shall not go into explanations of how certain systems evolved, how they operate and how they are inter-related.[33] The resulting pattern of incentives to be found and its impact upon the allocation of labour is of prime interest.

A difficulty with most investigations into plant wage structures is that they are rarely concerned with the complexity of the wage system from the individual employee's point of view. Although much information is provided by them, their findings fail to enumerate the constraints and parameters facing the supply decision-maker with regard to choice of payment system and control over hours worked and rate of output. Thus we are told how many workers are engaged on piecework and timework and why these systems tend to be associated with different types of production technology and that timeworkers usually do more overtime than pieceworkers but we are not told for the plants studied how much individuals are able to transfer to different payment systems and the scope they have for choosing levels of overtime. This is an area where the lack of research is a distinct handicap to the prediction of supply responses to changes in the structure of incentives.[34] A fact which is all the more critical because a satisfactory econometric measurement of supply response is precluded by the peculiar identification problems accompanying the analysis of markets where prices are only partially influenced by resource imbalances and by lack of data.

With these qualifications in mind the points to be noted from the evidence on intra-plant wage structures are as follows.[35]

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(33) See references given in fn.(26).

(34) See however Goldthorpe et al. (1970).

(35) See MacKay et al (1971), Chapter 5.

(1) If indeed 'the primary reason for internal wage differentials is to induce a sufficiently large number of people to undertake the costs of training or to accept the more taxing content of skilled work'[36] then this is compatible with observed wage differentials only if the two main payment systems are regarded separately.

(2) Although earnings tend to increase with skill within each payment system, the wage structures overlap to such an extent that

> 'It does not appear unusual for semi-skilled, or even unskilled, pieceworkers to earn more than skilled timeworkers, especially where wages are measured by standard weekly earnings.'[37]

(3) Across plants, internal occupational differentials vary sufficiently to be regarded as unique to each plant.

(4) Intra-plant differentials generally seem to be unresponsive to changes in the relative supply and demand situations for different skills. Thus secondary wage drift tends to offset the effect of primary drift leaving the wage structure undisturbed.

(5) An analysis of the variation in changes in occupation-plant earnings revealed that changes in inter-plant differentials were more significant than changes in intra-plant differentials, much more so in the case of Glasgow.[38] Nonetheless movements in intra-plant differentials were substantial and, whilst point (4) may be qualified with caveats about possible lagged adjustment, the most convincing theory is that wage payment systems in most

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(36) Ibid., p.100.

(37) Ibid., pp.129-130.

(38) The period of change was taken as 1959-66. Ibid., pp.124-125.

> British engineering plants are poor instruments by which to repond selectively to external labour market pressures. Thus although these pressures may well provide the initial impulse for changes to wage differentials, the operation of wage bargaining through payment systems which have developed by an accumulation of ad hoc reactions to previous events is such as to frustrate what original economic rationale there may have been.

Under the above circumstances it is not surprising to find that management is reluctant to attempt to deal with labour shortages by initiating changes in wage relativities. Not only is it uncertain that supply will respond appropriately but also that the internal wage structure emerging from the system will in fact resemble the one intended.

Reviewing these results from the MacKay study we have attempted to look behind the comparisons of skilled and semi-skilled earnings in Table 2.20 based on national data. Of course the choice of gross average weekly earnings for all employees in a skill category will yield different figures from those comparing, say, the standard weekly earnings of skilled timeworkers with semi-skilled pieceworkers. The figures given however probably reflect best the relative earnings in 'average job opportunities' in those skill categories and industries.

Thus we have discussed both the extent of mobility affecting the employment of skilled men in engineering and their pay relative to semi-skilled men in the same industry and in motor vehicles. Since the wage structures and the mechanisms by which they evolve suggest a certain lack of competitive edge in the labour market for skilled craftsmen, it would be difficult even if sufficient time series observations were available, to sort through the disequilibrium stocks and flows to obtain measures of the various supply-flow responses to wage relatives. At the moment only fairly basic flows are amenable to analysis. This is not usually conducted in terms of modelling supply flows.[39] Before progress in this area can be made three main developments are required. Future local labour market studies need to build on the work of MacKay et al and American authors, first by investigating the conditions under which labour is and would be supplied with special concern for the decision-making situation of the individual, second, by going into the characteristics of those product markets which affect the operation of plants in the locality and, third, by relating shifts in labour demands and relative wage positions to changes in recruitment at the plant level.[40]

2.5.2 Wages in engineering relative to other industries

Flows of skilled men between engineering and other industries are only available from the EITB survey of craftsmen and the National Training Survey.[41] From the MacKay study about 72 and 85 per cent of all recruits to engineering plants in Birmingham and Glasgow respectively whose previous jobs were in skilled or

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(39) A cross-sectional analysis of the relationship between plant quit rates and wage levels yields a negative but weak association. In the tight Birmingham labour market a more significant determinant of cross-sectional variation in quit rates was recruitment in the previous période. Thus MacKay et al. support the hypothesis that differentials affect quit rates less in tight labour markets because suppliers of labour to a plant include a larger proportion of recent joiners whose responses to inter-plant wage differentials will be dominated by other considerations (producing the familiar log-normal profile of the completed length of service distribution of a given cohort of recruits). This does not mean that the net supply to the plant is unaffected by its wage position though.

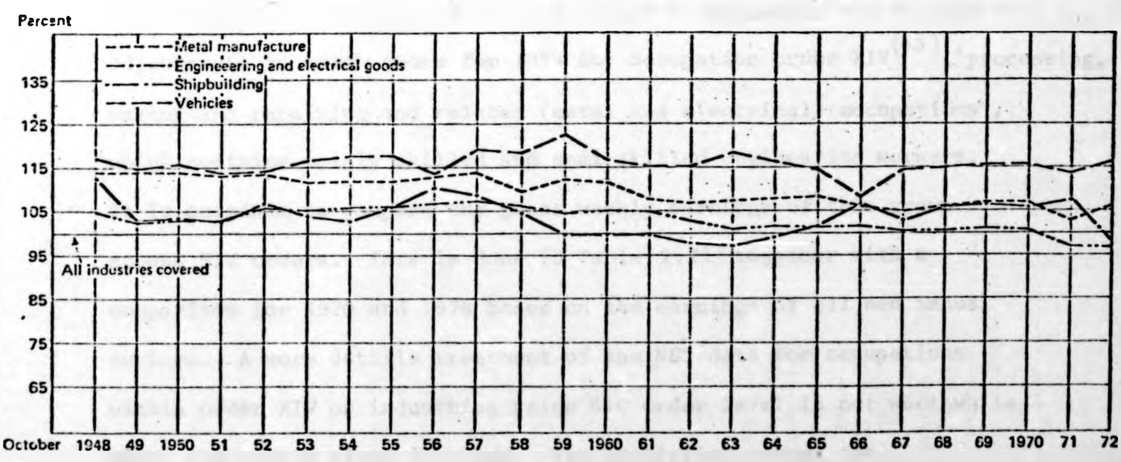
(40) The MacKay study investigates cross-sectional labour turnover and wages independently from a time-series analysis of aggregate market turnover and employment conditions (i.e. vacancies and unemployment). Ibid., Chapters 6 and 7.

(41) It is not possible to obtain them from the 1971 census returns. Sample sizes for the New Earnings Survey are too small to warrant classification of flows by industry and occupation.

semi-skilled engineering work came from other engineering plants. Thus although engineering employment in Birmingham grew by only 3.4 per cent between 1959 and 1966 and in Glasgow declined by 19 per cent, almost 30 per cent of recruits in the former case and 15 per cent in the latter case came from non-engineering plants. The extent of inter-industry mobility of job changers is therefore by no means insignificant.

As shown in Figure 2.2 during 1948-72 engineering industries provided manual work for men with average earnings generally above the national average. Vehicles is clearly the highest paying industry of the four metal orders of the 1958 SIC. The earnings enquiry identifies only one other SIC order, paper, printing and publishing, showing regularly (from 1958 onwards) a differential above the average of more than 15 per cent.(42) Earnings in shipbuilding have fluctuated quite widely falling below average between 1959 and 1964. Earnings

Figure 2.2
Average weekly earnings of men manual workers as percentages of average for all industries covered by the Department of Employment's October inquiry



Note For the period October 1948 to October 1958, inclusive, the indices for Engineering and electrical goods and Vehicles are based on estimated figures of average weekly earnings.

Source: Department of Employment (1973a), Figure 4, p.444.

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(42) See Department of Employment (1973a).

in engineering and electrical goods declined from a flat peak of seven per cent above average in 1957 to hover near the average from 1963 to 1970. Of non-engineering industries which employ relatively large groups of skilled engineering craftsmen, only chemicals and allied industries, paper, printing etc., and bricks, pottery etc. among the rest of manufacturing have been consistently above average; in coalmining average weekly earnings kept well above the national average for most of the period but declined from almost 35 per cent above in 1952 to just average in 1970. An industry which overtook engineering and electrical goods towards the end of the nineteen-sixties was transport and communications.

Covering as they do all men manual workers the above statistics can only give a rough indication of trends in industrial relativities for skilled and semi-skilled workers. For more recent years the New Earnings Surveys provide a better guide to both trends and absolute differentials. Beginning in 1968 they suffer among other things, from a break in the series for 1969 and changes in occupational classification. Taking the results for 1970 and making the necessary adjustments to match those for 1974 for occupation order XIV[43],'processing, making and repairing and related (metal and electrical) occupations', which contains mainly skilled and semi-skilled engineering workers, it is possible to compare the gross weekly earnings of this group across SIC orders. This is done in Table 2.21 together with a comparison for 1970 and 1974 based on the earnings of all men manual workers. A more details treatment of the NES data for occupations within order XIV or industries below SIC order level is not worthwhile given the sample sizes involved. The statistics reveal the

(43) See Appendix 3.

Table 2.21 Industrial wage differentials for men, 1970 and 1974: average weekly earnings

Industry (1968 SIC)	NES occupation XIV (on 1974 basis): Industry median as percentage of overall median		NES occupation XIV (on 1974 basis): Industry average as percentage of overall average		All men manual workers: Industry average as percentage of overall average	
	1970	1974	1974	Sample size	1970	1974
Agriculture	-	-	-		75,8	87.2
Mining and quarrying	96.3	114.2	116.7	323	97.8	113.5
Food, drink and tobacco	110.8	104.9	106.2	356	99.6	100.5
Coal and petroleum products	-	-	-	-	113.4	115.4
Chemicals etc.	110.0	101.3	100.6	360	108.2	101.2
Metal manufacturing	108.9	102.2	101.7	1,456	111.2	106.0
Mechanical engineering	104.5	99.6	99.1	2,491	107.5	102.1
Instrument engineering	99.3	89.8	91.0	189	97.4	95.0
Electrical engineering	101.1	96.0	94.9	1,193	103.0	98.2
Shipbuilding and marine engineering	105.2	106.9	107.9	465	108.6	108.9
Vehicles	115.6	108.7	106.0	2,112	117.5	110.5
Metal goods n.e.s.	104.5	100.2	100.0	1,301	105.6	103.0
Textiles	97.3	96.7	96.8	283	92.5	93.8
Leather etc.	-	-	-	-	-	-
Clothing etc.	-	-	-	-	88.4	89.5
Bricks etc.	104.1	106.2	107.1	242	103.0	106.7
Timber, furniture etc.	91.1	-	-	-	93.7	97.5
Paper, printing etc.	110.8	110.9	-	236	117.5	112.4
Other manufacturing	104.8	100.2	100.2	206	104.5	101.4
Construction	91.8	100.0	104.1	1,152	100.4	103.2
Gas, electricity and water	92.6	98.0	99.8	524	97.0	104.8
Transport and communications	104.8	98.4	98.3	1,473	106.3	103.9
Distributive trades	87.4	86.2	86.5	472	84.7	85.1
Insurance, banking finance etc.	-	-	-	-	85.5	86.2
Professional services	88.9	86.0	-	171	83.6	81.2
Miscellaneous services	85.5	82.0	82.7	710	81.7	79.4
Public administration	82.5	82.4	84.4	182	79.9	82.1

pre-eminence of vehicles within engineering as expected. The wider industrial comparison, however, confirms what was partly indicated by the earnings of all men manual workers discussed above, that the rest of the engineering sector also falls below certain other industries. For this specific occupational group, food, drink and tobacco and other manufacturing must be added to those other industries mentioned earlier (chemicals; metal manufacturing; bricks, pottery etc.; paper, printing etc. and transport and communications). Between 1970 and 1974 the position of the engineering sector deteriorated but so also did those of food etc., chemicals, metal manufacturing, other manufacturing and transport. Mining, construction and gas etc. increased their relative positions very considerably, the first of them taking the lead from vehicles.

These earnings statistics do not correspond directly with the earnings obtained in different industries by skilled engineering craftsmen as defined in the L7A survey. Some semi-skilled and some non-engineering workers are included. On the other hand, they do reflect earnings differentials between jobs which those trained in engineering trades might well move into and young people considering alternative occupations might choose to enter rather than join the engineering sector. To return to the general discussion about the relevance of wage differentials at the beginning of the present section, two points need to be emphasised; (i) the skill-industry differentials within engineering seem to be producing an inefficient distribution of skilled labour among engineering industries and (ii) during the last decade or so engineering industries, except motor vehicles, paid their skilled and semi-skilled workers little more than average for these occupations and significantly less than certain other manufacturing industries.

A final matter relates to the use of gross weekly earnings in the national comparisons made in this subsection. The argument for using standard weekly earnings purged of the effects of fluctuations in hours worked is that trends in these reflect the long-term development of relativities. On the other hand the measurement of differentials at a point in time as they are taken into account by the supplier of labour is rather more complicated. The overtime opportunities available to the potential skilled timeworker play an integral part in the income prospects attached to such jobs. On balance if one requires a single, convenient measure of the financial attractiveness of an occupation, it has been assumed that individuals, deciding within the bounds of the hours of work usually available, pay more attention to gross weekly earnings than to standard weekly earnings or average hourly earnings.[44] The availability of jobs, the stability of work in them and the continuation of current conditions of employment (pay, hours, fringe benefits etc.) should, nonetheless, be taken into account when considering the effects of what appear, at least from the point of view of conserving and utilising skilled engineering craftsmen, to be unfavourable wage structures. Some indication of demand conditions will be given in Chapter 3 where we look at the changes in employment and training taking place within the engineering sector between 1963 and 1973.

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(44) Note that with standard weekly earnings there is the problem of whether or not to alter the standard weekly hours figure used to calculate them when standard hours are renegotiated, as in the case of engineering in 1947, 1960 and 1965. This is in fact done but then standard weekly earnings fall relative to industries not similarly affected and what is an improvement in conditions of employment appears as an absolute and relative deterioration.

2.5.3 Econometric studies of wage differentials

Changes in wage differentials by firms could fail to balance the labour market either because they do not reflect relative shifts in supply and demand or because supply would not respond to such changes in any case or because of a combination of both situations.

The discussion of section 2.5.1 shows how the influence of labour market forces can be undermined by the process of wage bargaining. It also suggests that whilst aggregate wage differentials may have followed a medium-term trend (such as the widening of the skilled worker to labourer differential between 1951 and 1966) which was compatible with general movements in relative excess demand for the skills concerned, the size of the differential could have been quite inadequate even at its maximum to effect the necessary switch in supply. This applies with special force to the skilled versus semi-skilled differential across different engineering industries. Thus in time-series econometric work the impact of excess demand upon wage differentials may turn out to be strong but this does not prove that the market is operating effectively. One then turns to the product market and other structural factors dealt with in cross-sectional studies to provide explanations of persistent underlying absolute differentials across firms etc. The empirical synthesis of time-series and cross-sectional analysis faces problems particularly relating to the lack of time series measures of structural change in markets.

The determinants of times series variations in British skill differentials have not been the subject of much econometric analysis. Most studies have compared changes in differentials with simple indicators of excess demand or supply in the markets concerned and have usually concluded that, at best, only a weak relationship exists between the two series. Evans (1974) goes further than most previous authors in specifying, at the occupational level taking the engineering sector as a whole, regression equations linking a measure of the skill differential (or change in differential) to measures of relative excess demand using vacancies and/or unemployment data. His overall conclusion (p.114) from the analysis of the period 1963-69, in six-monthly intervals, looking at separate occupational differentials within regions and between regions as well as at broad skill groups for the whole economy was that:

> 'There does not seem to be much evidence to suggest that these changes in occupational differentials have much to do with the relative excess demand for certain skilled occupations in the short run, although other results reported in this section suggest that they might do in the longer term.'

Inevitably there are many qualifications to be attached to such simple tests of neoclassical market adjustment, as Fisher (1971) would be quick to point out. But there is something lacking when a theory's main defence seems to be an attack upon the validity of tests which purport to refute it rather than the presentation of results which lend it unequivocal support. Nonetheless the lack of data does prevent us from proceeding to a satisfactory conclusion on the basis of econometric analysis: it is the additional local labour market evidence explaining how the operation of the market can be circumscribed that, in the absence of econometric evidence to the contrary, points to failure in the mechanism.

Econometric evidence from studies of different occupations, industries and geographical regions, even countries, is often cited to buttress the use of an assumption in a model applied to a labour market for which adequate data is not available. This is a particularly hazardous procedure when it involves the impact of market structures upon relative prices, usually investigated through cross-sectional analysis. Until recently, had we wished to assess the possible effects of market imperfections upon wage determination we should have had to refer to, say, Weiss (1966), Masters (1969) and Haworth and Rasmussen (1971) for the United States (apart from the detailed labour market studies already cited where such factors are suggested as possible explanations of persistent differentials, for example, Lerner and Marquand (1963) and MacKay et al.(1971)). Now, there are three British studies available, all of which look at the structure of average hourly earnings of male manual workers in U.K. manufacturing industries at MLH level: Sawyer (1973), Hood and Rees (1974) and Wabe and Leech (1976). The last paper also presents results for a cross-section of 33 engineering MLHs.

The main theoretical considerations behind all the studies mentioned above are:

(i) imperfect product markets could yield a situation in which some firms can reap supra-normal long-run profits;

(ii) certain circumstances could lead firms to share these profits with labour, e.g. (a) management may genuinely adopt a non-profit maximising objective once an acceptable level had been reached, (b) trade unions could bargain away part of the monopoly rent.

This implies that in addition to the normal welfare loss attributed to product markets in which price diverges from marginal cost, there also results a misallocation of resources in the labour market. A major difficulty with testing the importance of the latter is the extent to which one is able to take into account not only concentration in the domestic market but also the overall product market situation faced by domestic producers - the demand elasticities they face incorporating the threat of competing imports. This is not dealt with directly in any of the studies cited, all of which specify regressions in which average hourly earnings are explained by variables to represent (i) market power, (ii) trade union power and (iii) personal characteristics of the work force. Weiss (1966), whose work is not really comparable with that of the other two American studies, concluded that unionisation was only a weakly significant determinant, at best, of wage differentials with the concentration ratio showing no significant influence at all. This implies that monopoly rent arising from these sources is not a dominant feature of labour markets; differences in types of labour (sex, skill and colour) and regional location provide the bulk of the explanatory power. However, there are problems with disentangling relationships between independent variables cutting across the three main categories. This is most clearly indicated when Masters (1969) introduces plant size as an additional variable. He confirms the weakness of the market power effect but plant size is highly significant. This could reflect the 'facts' that large plants (a) tend to require a more disciplined labour force, (b) employ usually less skilled workers than do small plants and (c) are more vulnerable, on balance, to trade union pressure. Since (a) and (b) will act in opposite directions it is (c) that, for Masters, clinches the a priori hypothesis in favour of a positive relationship between average hourly earnings and plant size. Note, however, that the significance of plant size in his regression results is only a reflection of a monopoly rent situation because of the presence of union power. The more stringent requirements placed upon workforce behaviour and the less severe skill standards would suggest merely that efficiency wages could be the same even if actual wages are not. But why should large plants per se have excess profits to share with the workforce? In competitive industries these would come from economies of scale; in non-competitive industries they would comprise monopoly rent as well as any benefits from scale economies.

Large plants also affect the potential trade union power effect. As Masters argues, large plants are usually relatively capital-intensive and the cost of capital tied up in strikes strengthens the trade unions. In addition, despite the fact that large plants may belong to firms with large resources, management is unlikely to exploit this because it wishes to 'preserve the bargaining relationship'. Finally, even if large plants avoid trade union organisation they will have to pay well to do so, especially since trade union organisation is easier to develop in concentrated work establishments.

The impact of large plants upon the influence of labour force 'quality' upon average hourly earnings obviously operates through the requirements of the production technology as well as through the complexities brought about by organisational size. Hence to (a) above one should add the requirement for highly responsible although not necessarily skilled workers to operate machinery where mistakes could be costly.

Haworth and Rasmussen (1971) take Masters' use of plant size a step further by supporting it with a theoretically preferable measure of the capital-labour ratio, a variable representing human capital employed and variables to take into account race and the presence of women in the labour force as well as regional disparities. Once again industrial concentration turns out to be insignificant but so now is unionisation; plant size is highly significant as are the human capital index, the capital-labour ratio, regional dummy and the proportion of males in the labour force. About 70 per cent of the variation in hourly earnings is explained as in Masters' analysis.

These American authors do not comment on multicollinearity between independent variables. Nor do they pin down the effect of plant size upon wages via the demands made upon the labour force for particular qualities (which in competitive theory would yield an equilibrium efficiency wage structure but not equal actual wages) and via the imperfections in either product or labour markets which large plant size helps to facilitate.

Sawyer (1973) was the first to follow the American approach using

British data and particularly tried to establish why, as with U.S. data, plant size should be so influential. He concludes (p.153) that

> '... size of plant still remains significant, and in economic terms this remains something of an enigma. Unless working in a large factory per se has a definite disutility which has to be compensated for by higher earnings, there would seem to be no other economic reason why size per se should give rise to higher earnings.'

His analysis is marred by a proliferation of regression equations in which sub-sets of variables are tested together as determinants of average hourly earnings. The final equations do, however include most relevant variables such as those to represent the effects of payments systems, skill, labour turnover, recent employment growth, hours worked, concentration, as well as plant size. Unionisation and 'size of market effect' (a somewhat contrived concept ignoring the way in which local labour markets and industrial complexes evolve together), neither of which Sawyer is able to measure, are invoked as possible explanations of the robustness of the plant size coefficient accompanied by significant coefficients on variables supposedly covering the main effects for which plant size was thought to be a proxy.[45]

(45) Sawyer's inclusion of both labour turnover (stability) and skill variables requires some explanation. Plants face (i) direct labour costs (ii) training costs and (iii) recruitment costs. Management may attempt to reduce unit labour costs by raising (i) to cut (ii) and (iii). Greater labour force stability will not only cut (ii) and (iii) but may also raise productivity because longer lengths of service may lead to greater learning by doing and hence acquired skill. High wage plants will then be those aiming to reap these benefits. However they may also be those simply wishing to combat the exceptional disutility of working in them. In both cases labour stability will be positively related to wages. If the recruitment and training costs and disutility of working in large plants are relatively high, these plants will be using above average profits to offset these disadvantages. The worker only shares in monopoly rent to the extent that the recruitment and training costs, which could reflect diseconomies of administrative scale, are not partly borne by him. The most plausible example is his benefit from the barriers to entry into his occupation set up at the expense of the firm in providing specific training. There is a range of indeterminancy within which the firm and individual are both better off relative to the competitive solution. Thus skill structure variables may explain variations in average hourly earnings but this does not necessarily justify the sizes of the skill differentials within or between industries. Furthermore if union bargaining has raised wages, management may react by raising hiring standards unnecessarily so that a superfluous relationship between labour quality and earnings emerges. Quality is not tested independently from skill structure in British work. Haworth and Rasmussen try an adjusted schooling variable which is significant but their skill index (wages of craftsmen, operators and labourers relative to labourers, weighted by employment proportions), which performs better, will suffer from similar deficiences to those of the usual skill proportions adopted in the British studies.

Hood and Rees (1974) obtain rather different results from Sawyer although they achieve a similar level of overall explanatory power (R^2 being about 0.7). They view the plant size variable as a 'dimension of market structure' reflecting 'possible capital cost and scale economies barriers to entry'.[46] The other dimension is that of actual competition and is represented as usual by a concentration index. The variables they add to these are similar to those used by Sawyer in his final equation but their treatment is really more akin to the American one. In particular they include variables representing the capital-labour ratio,[47] the extent of closed-shop agreements, strike activity (supposedly to reflect the threat of withdrawing labour), skill, recent employment growth, shift work premia, regional variation and the possibility of female substitution for male workers. The authors conclude (p.182) from their regression analysis that

> '... due to the very high degree of collinearity between the variables, (r = .72), only one of our two market structure variables will be significant at any time... However because we have suggested other reasons why plant size may affect wages, apart from acting as a proxy for entry barriers, we cannot be conclusive about the relationship between market structure and wage levels. We feel our results are nevertheless at least suggestive of a positive relationship between market structure and wages and that there may be some important resultant resource misallocation implications over and above the normal welfare loss due to monopoly.'

And there we should be happy to leave it were it not for the recent working paper by Wabe and Leech (1976), who are highly critical of the equations specified by other authors and by the loose interpretation of coefficients. They begin with an accounting identity:

$$AHE_j = \sum_i p_{ij} \; AHE_{ij}$$

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(46) Hood and Rees (1974), pp.172-3.

(47) However they note that in terms of the profit maximising hypothesis this variable and wages are jointly determined and hence the additional theoretical justification for including it given by Masters and Haworth and Rasmussen does not really apply.

where AHE_j is the overall average hourly earnings of male manual workers in industry j, AHE_{ij} is the same variable for occupation i and p_{ij} is the proportion of the manual labour force of industry j in occupation i. Three occupations are defined: skilled, semi-skilled and unskilled.

The identity is first broken by replacing the unknown AHE_{ij} by AHE_i the unknown 'competitive market rate' for occupation i. There follow a series of multiplicative adjustments to compensate for the divergence of the set $[AHE_{ij}]$ for each j from the competitive set $[AHE_i]$ due to features of payment systems (overtime, shift work and payment by results), non-wage value - added per man, recent employment growth, percentage of female manual workers in total manual labour force, trade union power measured by the proportion of male manual workers covered by collective agreements, proportion of the labour force in the high wage South-East and Midland regions and finally, concentration and average employment size in establishments with 25 or more employees. All variables relate to 1968 except concentration which corresponds to 1963, prior to the spate of merger activity taking place during the middle 1960s.

Of course some of these variables could be seen as extensions of the accounting identity; the multiplicative adjustment for overtime payments is an example.(48) However these extensions do not necessarily apply to each of the three skill groups in the same way. Wabe and Leech press their argument too far when they claim their specification to be more rigorous simply because they present a non-linear equation which is estimated by non-linear methods. Once a string of additional explanatory variables, supposedly exhibiting proportional effects upon AHE_j by

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(48) With the overtime rate factor β, the same for all skills, $AHE_j = \left[\sum_i p_{ij}\ AHE_i\right]\left[1 + \beta(1-H_j/40)\right]$ where 40 is an approximation to normal hours. Estimates of AHE_i (i=1, 2, 3) and β can be obtained by non-linear regression methods based on data for AHE_j, p_{ij} and H_j.

analogy with the payment system variables, is included in the regression there is no reason to expect coefficients on the skill proportions to accord with observed average skill differentials. This is because part of the observed differentials could be accounted for by trade union power, product market power and other variables. It is the 'competitive' skill differentials that are estimated.

Despite the fact that the authors find that the market power and trade union variables make no sustained significant contribution to explaining average hourly earnings across manufacturing MLHs and across the sub-set of engineering MLHs, some doubts remain about these results: (i) the correlation matrix is not examined, (ii) the variable representing plant size is not very satisfactory[49], (iii) skill structure and aspects of payment systems are themselves the outcome of bargaining processes, (iv) other, equally valid, complex functional forms are not tested and (v) the comparison of coefficient estimates for skill differentials and payments premia with total average effects derived from actual observations is incorrect.

On balance, given the supporting evidence of the local labour market studies, the above quoted conclusion of Hood and Rees would seem to be the most acceptable one (although they do not give results for engineering MLHs alone). As in the case of time series econometric analysis, although there is scope for more rigorous empirical work subject to improvements in data, it remains that the relationship between wage differentials (and changes in wage differentials) and relative scarcity of skills is a tenuous one. Even if supply were highly responsive to wage adjustments, the process of wage determination in engineering is such as to discourage the use of this device to eradicate shortages within

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(49) Plant size is taken as average establishment size among those establishments with 25 or more employees.

the period of a trade cycle.

2.6 Conclusions

The three main concerns of this chapter have been as follows:

(i) to explore the potential value of manpower stock-flow accounts in modelling labour markets and to identify problems in designing and constructung accounts for engineering craftsmen;

(ii) to review the evidence on the deployment of engineering craftsmen using where possible the accounting framework and to consider the relationship between changes in wages and resource flows;

(iii) to identify the scope for model-building, given the data currently available and bearing in mind the focus of manpower policy.

Some concluding remarks have been made at the end of each previous section and so only the most important general points will be made here under the three items given above.

2.6.1 The accounting framework and data

The notion of a set of manpower accounts is a simple one but there are problems in defining appropriate population states and then estimating the corresponding stocks and flows between them which are by no means trivial. In Chapter 7 we shall find that there are additional conceptual difficulties to be faced before using the accounting system in cost-benefit analysis. For the present, however, we conclude that the construction of an accounting system puts the analysis of a labour market on a more rigorous level. Not every item identifed in the system need be the subject of extensive data collection to improve the current estimates or requires detailed research on its determinants. The accounts provide an invaluable guide as to where both these activities should concentrate bearing in mind the difficulties of obtaining reliable flow statistics and the direction of manpower policy. As a base for formal model-building the accounting system inevitably provokes ideas for estimating simple statistical models of manpower flows. A priori the stability of the parameters for major parts of the Population Accounting Matrix and the Engineering Craftsmen Matrix is open to question. So also is their economic significance. This suggests that for the engineering craft labour market it would be best to focus upon particularly important flows for which we have data and study the determinants of these econometrically rather than seek to simulate the pattern of stocks and flows by using a mechanistic model. Certain parts of the system will no doubt always be dealt with by using parameters set in the light of past ratios of flows to stocks but the objective is to reduce their number to a minimum compatible with the balance of approximation in other areas of modelling work.

2.6.2 Features of the engineering manpower flow system

It is not possible to construct a set of demographic accounts in which flows of people into, within and out of the engineering industry are cross-classified by occupation and whose variations can be analysed over, say, a ten year period. However, in the case of the labour market for skilled engineering trades there is a host of information which can be used to form an overall view of the working of the market. This information is not generally available to the same extent and in the same form for other industries, nor for engineering does it contain many long statistical time-series amenable to econometric analysis.

What emerges from the occupational mobility data, available at the time the analysis was conducted, is the great difficulty in obtaining real insights, which will help in modelling flows, from a collection of ad hoc surveys. The information is of interest; it may highlight, as in the case of the much more detailed MacKay study, what appears to be a significant malfunctioning of the labour market, but in order to appreciate the way in which the market is truly evolving there is a desperate need for a regular mobility survey adopting consistent classifications. Static impressions of the mobility pattern during an ad hoc period or aggregating across many years, as in the collection of training and work histories, could alone lead to a misreading of the situation.

The three sets of manpower accounts constructed in section 2.3 effectively summarise our knowledge of national flows affecting the labour market for engineering craftsmen. Using EITB data we have managed to put some flesh on the bones of the accounting skeleton presented in section 2.2. Differences in flow magnitudes and stability led to questions about the determinants of flows and the impact of manpower policy on the flow system. These were explored in the light of local labour market evidence on mobility and wages, and national data on wage relativities and econometric studies of the wage structure. In seeking an explanation of the phenomenon of downward occupational mobility we concluded that product market features need to be taken into account when studying differences in wages between plants and industries and that the operation of wage bargaining will tend to diffuse changes to the wage structure initiated by responses to imbalances in the labour market for skilled labour. Thus if wages are insensitive to relative demand and supply, the supply responses observed in the market will reflect perpetual disequilibrium against a background of broad cyclical fluctuations.

If higher-paying plants, especially found in vehicles but also in other sectors, are absorbing skilled men from other parts of the industry and yet not employing them as skilled then an industry-wide misallocation of manpower resources is produced. It is doubtful whether the benefits to those firms from employing 'overqualified' people outweight the costs to the industry as a whole but we have no means of assessing this adequately.

As regards the potential mobility of skilled workers between engineering and the rest of the economy, the wage structure again seems not to be particularly favourable from the point of view of attracting skilled men into major parts of engineering or retaining them once employed there.

Combined with other information about the earnings of men manual workers over a longer period, the figures for skilled men suggest that for the past decade or so the engineering sector except for vehicles has paid its skilled workers a bit above average but significantly less than have certain other manufacturing industries.

On the basis of these remarks about mobility and the wage structure it might appear that we are poised ready to support a policy of allowing wage differentials to widen in favour of the skilled craftsmen relative to semi-skilled in engineering. From the point of view of supply management this is not necessarily desirable however. In this respect the problem with the engineering wage structure may derive more from the existence of large inter-plant differentials than from too small intra-plant skill differentials. This raises important issues of government policy towards wages in recently nationalised or partly rescued engineering firms. On the one hand, wages in mechanical and electrical engineering are not particularly high relative to the rest of the economy so reducing wages in higher-paying plants (notably in vehicles) may lead to a net loss of skilled supply to engineering as a whole because the gain from a better allocation within engineering is offset by the loss of men to other industries. On the other hand if there were to be a net gain, it is not self-evidently fair to workers employed outside government supported plants, that some of these plants should continue to pay high wages previously sustained by collective bargaining against a background of buoyant, oligopolistic product markets dominated by domestic suppliers.

The need for altering relativities, however difficult this may be in practise, does not follow then merely from the fact that skilled labour is being misallocated. It depends on the state of demand for labour. Since 1966 craft employment in engineering has declined. In other words, just as the EITB was getting into gear the labour market situation began to change very significantly. Had demand remained at fairly high levels, the consequences of the pattern of mobility described above could have been most peculiar. In effect, the EITB would have found itself encouraging the industry to train its way out of a major problem caused by the structure of wages. Some would say it is doing this anyway. The review of evidence on management decision-making given in the following chapter suggests that the state of manpower planning has left much to be desired. So we find that firms are reluctant or unable both to use the wage structure to influence the supply of skilled labour and to plan sufficiently far ahead to solve the shortage problem by investing heavily in apprentice training.

2.6.3 The present scope for model-building

The importance of apprentice recruitment as seen in the responses of manpower agencies and firms to the market situation outlined above and the fact that we are fortunate enough to have regular annual estimates of recruitment flows for different engineering industries suggest that this is probably the most fruitful area in which to begin the modelling of the manpower flow system. This does not imply an acceptance of the view that this is the only flow which manpower agencies need bother to control. It reflects the feeling that, whilst other flows are important and should not be ignored, if the recruitment of new trainees _is_ the preoccupation of policy-makers, then given the scope for more rigorous empirical work on the market determinants of this flow and the lack of previous analysis it would be worthwhile to concentrate our model-building activity upon this area.

Supported by the review of studies of the wage structure given in section 2.5, we shall assume degrees of short-run exogeneity of wages relative to the markets for engineering craftsmen and apprentices which enable us to pursue the estimation of resource flow equations rather than price equations. This does not rule out future work on the wage structure but, given the data problems and the poor performance of models previously estimated at this level of aggregation, the development of such models and their integration, where appropriate, within a simultaneous system is given a lower priority.

Finally there arises the matter of the regional dimension. Here also we shall leave a major topic for future research. The data at the regional level is now more abundant and existing data sources are receiving more attention.[50] Nonetheless it is still the case that the manpower stock and flow data used in this chapter is not generally available cross-classified by region. Nor would the comparisons of earnings from the New Earnings Surveys bear a disaggregation by region as well as occupation and industry. Some steps have been taken to investigate the operation of the skilled labour market in different regions but they suffer from lack of data particularly on employment levels by skill and yield somewhat inconclusive results based only upon statistics on vacancies, unemployment and earnings relativities.[51]

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(50) See, for example, the estimates of engineering earnings and hours for fitters and labourers during the period 1914-68, constructed by Hart and MacKay (1975) from the records of the Engineering Employers' Federation.

(51) See, for example, Evans (1974).

CHAPTER 3 MANPOWER DECISION-MAKING AND THE CRAFT EMPLOYMENT SITUATION IN ENGINEERING

3.1 Introduction

The previous chapter investigated the evidence available at the national and local labour market levels on the mobility and deployment of engineering craftsmen. It was decided to concentrate subsequent analysis upon the determinants of the flow of young people into apprenticeships in the engineering industry. Before doing so however we wish to assess the state of economic decision-making by firms and its impact upon labour market responses and the operation of active manpower policies at the national level. We review the evidence on firm decision-making in section 3.2.

Having studied the manner in which firms attempt to coordinate decisions about different resources, especially manpower, we turn to the experience of the industry as regards output, investment and employment since 1963, the first year for which we have the L7A occupational survey giving numbers of skilled craftsmen employed. The econometric analysis of section 3.3 captures not only the outcomes of decisions by engineering firms but the full market response to changes in demand, in so far as supply fluctuations are also an important determinant of employment changes. The section deals first with the general trends in output, investment and craft employment, then with a formal but simple model of demand for craftsmen and finally with the relationships between the employment of craftsmen and craft apprentices and the recruitment of new apprentices.

The market outcome, in terms of the pattern of shortages and surpluses generated during the past two decades, is reviewed in section 3.4 at least as far as the data on vacancies and unemployment will permit. The question of the importance of shortages of manpower in limiting output as opposed to shortages of materials, plant capacity or finance and the state of product demand is taken up in section 3.5. Some concluding comments are made in section 3.6.

3.2 Economic Decision-Making and Active Manpower Policies

In the course of the late 1950s and early 1960s there was much discussion about the inadequacies of both the quality and quantity of industrial training.(1) This situation in so far as it contributed to shortages of manpower and low productivity was considered to be an important factor in the poor growth of British industry. Furthermore the lack of satisfactory training opportunities, through which the aspirations of school-leavers might find their expression in employment fully suited to their abilities, was also seen as cause for concern.(2) 'The resulting situation has been admitted on all sides to be unsatisfactory but not to have within it the seeds of its own solution.'(3) The pace of technological change was expected to require the continual development of new skills. Existing facilities for and the organisation of training and retraining would prove to be increasingly inadequate both in terms of securing an appropriate skill mix in the supply of labour to industry and in providing individuals with opportunities to adapt to changing employment conditions. The imminent increase in school-leavers (due to the sudden post-war increase in births) requiring first jobs in the early 1960s, despite the mitigating effects of the expansion of full-time educational opportunities, was a further spur to action.

In contrast to a certain amount of general agreement prior to the introduction of the 1964 Training Act (which occurred near to the beginning of the boom leading up to 1966), in recent years there has been considerable

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(1) See, for example, Williams (1957); 'Industrial Training: Government Proposals'. Cmnd. 1892, H.M.S.O. (1962); Williams (1963) and Wellens (1963).

(2) 'Training for Skill' (Carr Report), Ministry of Labour, H.M.S.O. (1958).

(3) Marsh (1965), p.174.

criticism by industries saddled with poorly organised Training Boards, by firms (especially small ones) feeling that the levy-grant system affects them unfairly and by educationalists who saw the influence of industrial training upon technical colleges and colleges of further education as tending to undermine their broader educational purpose. Some economists have also taken a particularly jaundiced view of the developments. For example, McCormick and Manley (1967) and Lees and Chiplin (1970) argue that the Industrial Training Act ignored the important economic distinction between specific and general training made by Becker (1964) and the implications it has for the financing of training and particularly for the sharing of costs between firms and individuals.

Much of the criticism from economists has been motivated by a fairly competitive view of how the labour market could work, even if it does not actually do so. They take as read the actual features of decision-making by participants in the labour market but assume levels of information, analysis and economic rationality which appear to contradict the few thorough research studies available and the bulk of casual observation. The justification for such assumptions is that the situations they desire are achievable if not currently operative. The force of argument against centralised manpower agencies has been that they have tended not to create the appropriate environment for optimum economic decision-making but rather have attempted to coerce the market into achieving outcomes which the agencies thought desirable. Hence they have interfered in decision-making directly. The coercion in the British context has been achieved by altering the balance of financial incentives at the firm level in favour of more expenditure on training than would otherwise have occurred. Whether or not firms have responded to this change is arguable in some industries and for some types of firm and training but the aggregate effect has undoubtedly been to raise the level of training expenditures (and, it is also claimed, the effectiveness or quality of training given). Aside from these apparent effects of training policy, Hartley (1976) is extremely septical about the reasons for the existence of training boards. He explores the possible ways in which past and present government training policies may have been sub-optimal. However, his willingness to entertain these hypotheses is in striking contrast to his reluctance to judge whether or not they are really likely to be important. This can be explained by the fact that he seems to have no model of the actual behaviour of the labour market in mind but only a neoclassical abstraction together with a certain number of recognised 'problem areas' such as imperfect capital markets. Finding no clear economic rationals for the present system he explores, rather loosely, some possible models from the economics of politics and bureaucracy by which the birth and continuation of the training boards can be explained.

Those who support the setting up of the training boards argue that the creation of the appropriate decision-making environment could not have been done merely by propaganda revealing to firms wherein their best interests lay. The experience of the 1950s was an adequate testimony to that. There was a need for shock therapy. In the business environment the most easily administered shocks are essentially financial. However the intention was not to impose yet another arbitrary burden upon management. The system should seem to offer (indeed genuinely offer) rough justice at least. Justice was to be administered in the national interest and hence that of the nation's business enterprises to those who trained badly and above all to those who simply 'poached'. The last expression embodied one of the most dubious concepts to gain currency throughout industry and government circles and was enshrined in the Industrial Training Act of 1964 as the third of its major objectives: the equitable distribution of training costs among firms. Devoid of economic content as this notion is, its association with the real economic effects of under-training <u>in general</u> gave to an essentially moral judgement a pseudo-economic guise. The natural reaction to the question how do we make industry train more, was to make those who don't train at all or very little do their 'fair share'. Among those who favoured this attitude were understandably the large companies who were supposed to be training for themselves and the poachers.

Thus the perfectly respectable economic arguments for some interference in the labour market were submerged in the argument about the basis on which this interference should take place. This was still apparent from the discussion document <u>Training for the Future</u> (Department of Employment, 1972a) and the White Paper, <u>Employment and Training: Government Proposals</u>, leading to the 1973 Employment and Training Act.

If firms persistently run into periodic shortages then there are likely to be three main causes:

(i) firms fail to plan ahead;

(ii) firms plan badly and had they been able to predict their supply and demand situations more satisfactorily they would have augmented recruitment and training to some extent;

(iii) firms forecast future supply quite well but find it uneconomic to meet the full extent of the expected shortages through training.

Policies aiming to avoid future manpower bottlenecks will respond to the first two situations by promoting manpower planning as a desirable activity for each firm. They may also provide better information about national and local labour market situations in the form of aggregate supply and demand forecasts based on the most likely development of the economy and through advanced warning to firms in the local labour market of impending expansion or contraction of local firms, the entry of new firms and changes in population and educational trends etc.

The essential economic rationale for an active manpower policy (implying interference in the operation of the labour market in a more direct way than by simply providing information and advice) derives from the third case above. Investment in training as an <u>economic</u> decision is subject to the same basic considerations as other forms of investment made by firms. From the firm's point of view it may therefore be a relatively poor investment in certain situations. Thus the forward-looking firm may quite rationally choose not to avoid an expected shortage. However from an industry-wide or national point of view the sum of many rational decisions by firms may not amount to an optimal policy.[4] The problem is to determine when this is likely to be the case and, under such circumstances, to what extent the relevant manpower agency should adjust the supply of labour through the various means at its disposal. Much needed cost-benefit

(4) This will arise for example if firms curtail training due to the likelihood of trained employees leaving the firm to work elsewhere. A vicious circle may result due to the fact that as firms reduce training the liklihood of losing the employees they do train will increase - this further discourages training because of the risk of loss of investment. Other factors of course tend to mitigate this effect. Economists would normally distinguish between 'specific' and 'general' training in analysing training investment and the mix of the two received by the indiviual will affect his job changing. Thus potential mobility as perceived by firms, bearing in mind such factors as geographical location, pension rights and family circumstances, may affect their decisions about financing the general training of employees (Oatey, 1970). Similarly an 'investment history' of specific training might justify supporting general training since the employee's incentive to collect the continuing returns of his specific skills will probably be high.

analysis would shed light on these questions but currently the data on labour costs preclude satisfactory work in this area for many skills.

In Britain the situation reflects all three elements: a failure to plan, poor planning and the existence of externalities. Various pressures led to the Industrial Training Act in 1964 and the economic rationale, then as now, for the system of industrial training boards was not particularly clear from government statements. Nonetheless there was a consensus about the need to improve management systems handling the decisions to train and training itself. The extent to which most non-economists distinguish between the benefits to be gained from firms being encouraged to follow their own best interest (by showing them where this lay) and the broader interests of the industry or the national economy appears to have been restricted to the attitudes towards 'poachers'. If particular firms refused to do what was for their own good as perceived by training board assessors then they would be penalised for not doing their duty by the industry. The idea of grant as carrot and levy as stick was much vaunted because at least there was a carrot and carrots were good for you. However the paternalistic justification for the system begins to wear a little thin if there is a persistent refusal to take the carrot. By far the most audible scream of anguish came from small firms and was magnified via the Bolton committee, reporting in 1971.

Managerial theories of the firm suggest that planning and decision-making are complex activities which are not costless and various managerial utility functions may be advanced to explain why some firms appear not to aim to maximise recognisable function of profits. There is presumably always some sense in which any planning failure may be thought to stem from perfectly rational activity, albeit based on a rather singular utility function or exceptionally distorted information.

Following the managerial theories are behavioural theories which almost complete the slide from apparently testable statements such as 'firms act to maximise profits' into metaphysical assertions such as 'firms consist of collections of satisficing individuals'. Although these theories do yield rich insights, the approach taken below may be described as following a 'common sense model' in which the fact that firms complain readily of shortages is taken to imply that they would prefer to avoid them (although not always if it means raising wages to do so). Thus, whether or not departmental managers act as cogs in a profit maximising machine or satisfice on several fronts, the procedures which they adopt in planning recruitment and training are of interest and caveats about the possible rationality of a lack of planning will be omitted.

In the remainder of this section we review the evidence available on certain features of current decision-making on the demand side of the labour market, with special reference to the engineering sector and to the recruitment of young entrants to employment.

Decision-making by the firm

As regards the decisions made by firms we are fortunate in that studies by the Ministry of Labour (1965), MacKay et al.(1971) and the EITB (1971, 1972) deal largely with the engineering industry.

Not until the later part of the 1960s is there evidence of firms undertaking 'manpower planning' in response to the experienced shortages. 'On the one hand there is a persistent shortage of skilled workers; on the other a hand a dearth of facilities for training a new supply.'[5] In 1965, a survey conducted by the Ministry of Labour reported that

(5) Williams (1957), p.189.

in the metal industries

> 'less than one in four of all firms approached said they had some sort of manpower forecast for more than two years ahead, and only about one in forty said that this covered all categories of workers. In all, about half of the firms said they did some kind of forecasting but in the majority of cases, this was merely a one-year look ahead.'[6]

With regard to a small survey of firms with less than one thousand employees the Department of Employment concluded that 'no example was

(6) Ministry of Labour (1965), p.20.

found of comprehensive planning, with consideration given to future demand and supply of manpower.'(7) In their study of 66 engineering plants during 1959-66 MacKay et al (1971, p.329) report that 14 made no manpower forecasts, 30 did so for periods of less than one year (18 of which related to three months or less), 14 forecast for one year ahead and 8 plants for three years or more. Finally, in discussing the results of a survey(8) of 99 engineering firms who did not provide off-the-job training for all their first year craft trainees in 1968-69, Lee (1972, p.252) comments that

> 'the formalized training schedules of the Training Boards imply that the industrialist possesses, or should be encouraged to develop, something called a "long-term manpower policy". An entrepreneurial style is taken for granted with which our respondents seemed unfamiliar or which they judged inappropriate.'

Such partial evidence indicates simply that the practice of making even short-term manpower forecasts was not widespread. Information about the quality of manpower forecasting and the uses to which the forecasts are put, and about the relationship between manpower and other aspects of business planning is even more limited.

MacKay et al (1971, p.332) found that

> 'there was a less direct relationship between forecasting and recruitment than might have been expected .... Normally .... the personnel officer did not appear to initiate advanced recruitment action primarily on the basis of manpower forecasts, as distinct from .... other personnel records and the current notifications of labour requirements from production departments.'

In practice 'plants with manpower forecasts tended to postpone recruitment action until near the time when additional labour needs arose, and it is

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(7) D.E.P. Gazette, July 1970. The results of a further survey of firms 'known to be practising manpower planning to some extent' were considered to be 'encouraging' however.

(8) The survey was conducted by the Engineering Industry Training Board.

difficult to find any major difference in behaviour on the part of those units which did not attempt any manpower forecasting.'(9) As regards the factors taken into account in preparing forecasts,

> 'The forward period over which manpower forecasts ran was usually determined by the length of the order book' .... 'Relatively few plants attempted to predict product demand beyond this point by reference to past trends and/or by explicit consideration of developments in the economy as a whole' .... 'The forecasts usually assumed that current levels of labour productivity would hold in the future and did not make explicit adjustment for technical change and rationalisation' .. 'A further weakness in the preparation of forecasts was that little account was taken of labour wastage, Usually the forecasting took the form of estimating the future level of employment rather than calculating the recruitment necessary to achieve that level'.(10)

On the links between manpower and other plans, in a survey of 'major employing organisations in Britain' conducted by the Institute of Manpower Studies during 1970 it was noted that 'Manpower planning did not generally figure largely in the general business plan. More often, it was seen as a subsidiary calculation designed to ensure that the business plan could, in fact, be supplied with sufficient employees.'(11)

In the case of apprentice recruitment MacKay et al conclude that

> 'few plants made manpower forecasts over a long enough period to relate current apprentice-training to expected future needs. Moreover, those plants which did not use these to decide current intakes of apprentices [and the number recruited was] usually decided on the basis of some conventional rule-of-thumb or in response to conditions currently ruling in the labour market or in the plant itself.'(12)

This last statement leads us to consider what the main influences were if the decision to recruit apprentices has not usually been the result of a formal process of manpower forecasting and planning. Before doing so,

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(9) Ibid, p.343.

(10) Ibid, pp. 343, 329 and 331.

(11) Purkiss (1971) p.11.

(12) Op. cit. pp.340 and 327 respectively.

however, we should point to major changes in the organisation and financing of craft and technician training which took place in the later part of the 1960s.

Of particular relevance to this discussion is that the Engineering Industry Training Board, established under the Industrial Training Act of 1964, proceeded to develop a scheme to encourage off-the-job training for first year craft and technician trainees. The scheme became fully operational in 1966-67 and from then onwards we would expect some changes in behaviour on the part of firms in assessing their recruitment needs. It is difficult to establish the amount of full-time off-the-job training of first year apprentices which took place prior to 1966, the fragmented evidence suggests that it was much less than in the later period.(13) For example, Lee (1972, p. 243) notes that in an enquiry conducted by him in 1961-62, involving day release students taking engineering courses at a Midlands technical college, out of eighty-seven firms, 'forty-six trained boys completely on production work, allowing their experience (or lack of it) to be regulated more or less by the flow of work coming into the firm.' Only twenty of the remainder had off-the-job training facilities. It has been estimated(14) that there were about 14,000 places for off-the-job

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(13) See for example Williams (1957), Beveridge (1963), Marsh (1965) and Lee (1972). Statistics on the provision of day-release opportunities for apprentices are also limited prior to the collection of information by the E.I.T.B. Beveridge (1963) reports that the Engineering Employer's Federation claimed that about seventy per cent of apprentices under eighteen were subject to day release.

The percentage of all insured boys under eighteen employed in the engineering industry who were given day release rose from 50.6 in 1961 to 57.5 in 1965; (Statistics of Education, 1961 and 1965; Department of Education and Science). This is an indication of the likely trend between those years in day release for apprentices (who form between fifty and sixty per cent of young male entrants recruited by the engineering industry). Later statistics, however, should be interpreted in the light of increases in off-the-job training for apprentices.

(14) Engineering Industry Training Board. Report and Statement of Accounts for the period ended 31st March 1967. pp. 3-4, H.M.S.O. (1967).

training in the engineering industry during 1965 compared to 24,000 places by September 1966 and some 30,000 in 1968-69. The numbers of first year craft trainees under different training schemes are given in Table 3.1 for 1966-67 to 1973-74. A further innovation by the EITB has been the introduction during 1969-70 of the module training pattern to follow full-time off-the-job training. This and the eventual extension of the scheme to include the re-training of existing craftsmen in additional skills will have a far-reaching effect upon the labour market for skilled manpower. Especially relevant in the context of this section is the redistribution of the costs and benefits of training over time for firms and individuals. Approximately 85 per cent of the 16,230 certificated craft trainees completing first year off-the-job training in 1969-70 commenced module training.(15)

Not withstanding these important institutional developments it is reasonable to assume that full-time off-the-job training was received by a minority of new apprentices for most of the period 1951-65. Firms therefore benefitted from contributions to production during the first year of the recruit's training. Reference above has been made to the influence which current production and the present state of the labour market appear to have on the recruitment decision. In the survey conducted by the E.I.T.B. among 99 firms who did not provide off-the-job training for all first year craft trainees in 1968-69 and a further survey of 50 firms (of similar size to the 99 firms) who did so, the reasons given for recruiting trainees included 'As production demands'. Whilst there is probably some ambiguity(16) in the interpretation of

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(15) E.I.T.B. Report and Accounts 1970-71, p.14.

(16) As indicated by the fact that one of the firms who did provide off-the-job training for all first year craft trainees claimed to recruit according to 'As production demands'; Surveys of First Year Craft Training 1971, Part II, Table 4, E.I.T.B. (1971)

Table 3.1 Craft trainees: estimated numbers completing the first year of training, 1966-67 to 1973-74

	1966-67	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74
Number following the Board's recommended first-year course of off-the-job training and further education	17,554	20,072	19,768	19,724	19,364	14,923	11,768	12,129
Number given other approved training	884	213	186	220	200	155	111	139
Number given day or block release only	11,164	8,012	6,330	5,563	4,744	3,193	2,851	2,810
Total Trainees qualifying for grant	29,602	28,297	26,284	25,507	24,308	18,271	14,726	15,066
Total reported as completing first year training[1]	35,512	30,632	27,687	26,392	24,949	18,624	14,973	15,303

(1) The total number reported includes numbers not given day release and therefore not qualifying for grant from the Board. It is possible that numbers reported have been falling without a corresponding fall in the total numbers entering the industry, because employers are no longer reporting those who do not qualify for grant.

Source: E.I.T.B. Report and Accounts 1973-74, Appendix B, Table 9 for 1966-72. Data for the later years were provided by the E.I.T.B. Research Planning and Statistics Department.

this and other reasons given such as 'To maintain number of craftsmen' and 'To meet company needs (expansion)', 15 of the 88 respondents in the larger group of firms claimed to recruit according to short-term production requirements. There appears to be little statistical information about the contributions to production made by apprentices in the course of their training. Indeed, the lack of estimates of the costs and benefits associated with apprentice training, conducted mainly on-the-job during the first fifteen years of the period, makes it impossible to use any other proxy for an index of apprentice costs than some measure of the wages paid to apprentices.[17] No doubt the contributions to production vary from firm to firm according to the organisation of training and the system of production. In a recent study of the costs of training, the E.I.T.B. report that the contributions made by trainees on craft modules, measured as a percentage of the work of a skilled craftsman, ranged from nil to 60 per cent in their second

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(17) 'No estimates are available of the 'net costs' of employing apprentices, and the difficulty the investigator experienced in getting any information on this point leads to the belief that few firms have attempted to calculate in any adequate way the relationship between the apprentice's output during the five years of training and the expense incurred by the employer.' (Williams, 1957, p.189).

The belief that 'it is only during the last year or two that the apprentice makes a net contribution to production, so that these in a sense compensate for the losses incurred during the first three years....' led many employers'....to support the long period of apprenticeship, rather than any conviction that a boy could not learn the skills in a shorter time.' (Ibid, p.190).

As a result of their investigations, however, the Donovan Commission concluded that 'in very many cases training plays only a secondary part in apprenticeship. What happens in practise is that those engaged as apprentices are put on to "skilled" work after a few weeks' elementary training, and from then on they are doing "skilled" work just as much as any other skilled worker'. Royal Commission on Trade Unions and Employers' Associations, 1965-58. Report; pp.87-88; Cmnd. 3623, H.M.S.O. (1968).

year and 25 to 85 per cent in their third year.[18]

In addition to the current demand for skilled workers, MacKay <u>et al</u> found that apprentice recruitment also took place on the basis of a 'conventional rule-of-thumb'. At the same time, they point to the slight account taken of labour wastage. On the other hand the more recent E.I.T.B. surveys quoted above indicate that 'the main factor dictating the rate and level of recruitment of craft trainees is the need to maintain the existing skilled labour force at a given level in the face of normal wastage.'[19] It would seem to be the case that where the expected loss of craftsmen does influence recruitment, only that part of it associated with 'normal' turnover and retirements is taken into account, firms generally being over-optimistic about the availability of additional supplies of manpower in the future. It is most likely that in view of the limited information kept by firms about their employees, estimates of normal wastage are seldom up-dated and the 'conventional rule-of-thumb' is established. Statistical models of the relationship between wastage and the completed length of service distribution of employees in a firm have

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(18) See <u>The Costs of Training: A Preliminary Report</u>, E.I.T.B. Occasional Paper No.2 (1972), p.18. The Board has now initiated research to compare the module system of training with the traditional system.

Whether any notion of the productive work done by apprentices lies behind the consolidated time rates of junior male workers established in the engineering <u>Handbook of National Agreements</u> (1949) is open to investigation. These rates were based upon that of the adult male fitter according to the age of the junior worker. Two flat rate increases to the resulting junior scale since 1952 raised these rates and the agreement of 1964 brought the 1949 percentages up to three or four per cent above the then de facto ratios (see Marsh,1965, pp. 149 and 312.).

Age	15	16	17	18	19	20	21
1949 agreement	22½	27½	32½	45	52½	62½	}
1965 (1949 plus flat rate increases)	26.9	32.6	39.1	54.1	63.9	75.75	full rate
1965 agreement	30	35	42½	57½	67½	80	

(19) Op.cit., p.17.

been developed[20] but during 1966-67 52 per cent of craftsmen were employed in firms having fewer than 1,000 employees and with averages of 21 craftsmen and 73 employees. For those employed in firms between 100 and 999 employees (32 per cent of all craftsmen) the average number of craftsmen (per firm employing craftsmen) was 68 with an average number of employees of 292 (taken over all firms in the size group). Firms with 1,000 or more employees averaged 614 craftsmen per firm employing craftsmen; a more promising sample on which to base a statistical analysis of turnover.[21]

This review of some of the studies and surveys which have touched upon the practice of manpower planning in industry and, more particularly, in engineering firms would seem to justify a model of apprentice recruitment which adopts the following behavioural assumptions as being valid for the major part of the two decades.

(i) If firms forecast their demands for craftsmen, it is rarely sufficiently far ahead for them to adjust the recruitment of apprentices in accordance with expectations about demand conditions in the early part of the period when those apprentices begin to work as fully trained craftsmen.

(ii) Current labour shortages appear to play a role in recruitment policy but this may be due to either the ability of apprentices to contribute to current production or to a longer term view of training and the resulting net benefits to the firm. Not only have tight labour markets and high productive activity tended to focus attention upon the limits to growth

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(20) See Bartholomew (1967), Chapter 6.

(21) Report and Accounts 1967-68, E.I.T.B., Appendix C, Tables 4 and 5.

due to skill bottlenecks but at such times optimistic expectations about future levels of activity are likely to create the environment in which training is seen as more profitable and, furthermore, cash flow problems are less likely to be a restriction upon the manpower budget.

(iii) Where labour turnover is monitored, a notion of 'normal wastage' will influence the recruitment in firms having sizeable groups of craftsmen. The circumstances surrounding the employment of individual crafstmen will aggregate to more stable turnover patterns and moreover the recruitment of apprentices is more likely to be a regular exercise.(22)

A further factor in the recruitment of apprentices to which frequent reference is made is the operation of trade union restrictions upon the ratio of apprentices to journeymen. Marsh (1965, p.104) notes that under the relevant Engineering Procedure the ratio of apprentices to journeymen 'in any workshop or district is not to be subject to specific determination', 'although "recognised" proportions do exist by custom and

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(22) 'The intermittent demand for recruits is, of course, a reflection of the manpower structure of the firms themselves .... An employer's need for trainees depends on the overall 'establishment' of craftsmen which he tries to maintain .... over a long period. When this number exceeds a certain "threshold", problems of normal replacement caused by retirement, wastage etc., begin to arise fairly frequently. It makes sense, although it may not necessarily be seen that way, to think in terms of a regular intake of trainees.' Lee (1972), p.247.

In the E.I.T.B. survey mentioned above, 48 out of 99 firms who did not provide off-the-job training for all first year craft trainees, did not recruit each year; of the 50 firms sampled who had adopted the Board's scheme, 18 did not recruit annually (op. cit. Part 2, Table 3).

practice, in some areas of the country.' As in the case of union reaction to the employment of dilutees[23] it is extremely difficult to generalise about the existence of local restrictions upon recruitment during the period under study and whether or not the intake of apprentices was significantly limited in practice by union pressure. Certainly the ratio of apprentices to craftsmen in plants varies considerably and a major aim of the Industrial Training Act was to 'spread the burden' thought to be implied by an uneven distribution of apprentices among firms. In comparing the apparent effects of the 1964 Act upon apprentice recruitment in engineering plants located in Birmingham, Glasgow and three other Scottish areas, MacKay et al show that the number of apprentices employed by all the Birmingham plants as a percentage of the number of skilled workers employed in those plants rose from between 7.0 and 9.5 during 1959-63 to 11.9 in 1964 and 21.0 in 1966. This would involve considerable increases in the ratios of apprentices to skilled workers in some plants and it is clearly unlikely that union restrictions upon recruitment were operative in the earlier period. Moreover, a comparison with the experience of plants in other areas leads them to investigate, firstly, the influence of differences in union policy with regard to dilution, and the effects of local labour market conditions, internal wage structures and occupational structures required by the technology of production, in determining the extent of upgrading semi-skilled workers to skilled jobs in different plants; and secondly, the effect of such internal mobility upon apprentice recruitment, quite apart from the existence of union restrictions upon apprentice ratios per se. However, 'the volume of internal mobility is limited, there is a port of entry at every level of skill,

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(23) See, for example, Hall and Miller (1971) and MacKay et al (1971, Chapters 10-11).

and such internal mobility as does occur is subject to few formal rules. Nor is there any indication that managements'prerogatives in this field are being seriously challenged by unions.'[24] From the study of the above labour markets it appears to be the case that union restrictions are not important determinant of apprentice recruitment by the engineering industry. Williams (1963, pp.4-5) reaches the conclusion that

> 'contrary to widely held views, the shortage of skilled workers is not due either to the reluctance of boys to train, nor to the embargo put by trade unions on the number of apprentices a firm is allowed .... though unions retain their right to ration the number of apprentices if they think the employment situation warrants it, this right is now rarely used.'

With regard to short-run increases in the supply of skilled labour through upgrading semi-skilled workers, MacKay et al conclude that even in the case of the Birmingham area, where there were acute shortages of skilled labour, upgrading occurred infrequently and this probably stemmed from a wage-structure favourable to semi-skilled workers (and a cause of downward occupational mobility among skilled workers) and the 'inability of on-the-job training systems to train semi-skilled workers for most skilled jobs,'[25] rather than from institutional restrictions.

The supply of skilled workers therefore appears to be largely determined by the training of apprentices and the scope for increasing the supply in the short-run through upgrading is extremely limited.

Finally we consider the relationship between current manpower shortages and the pace of capital-skill substitution. In Chapter 5, it will be assumed that the rates of labour-saving technical progress and capital accumulation are exogenously determined. American evidence

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(24) Op. cit., p.323.

(25) Op. cit., p.322.

at the plant level[26] suggests that where wage costs were taken into account in making investment decisions, this was usually in terms of a standard wage rate unadjusted for differences in the skill required to operate alternative types of capital equipment. In assessing the output per unit of operating time, standard learnings curves were used (if at all) and productivity calculations based upon an 'ideal worker' tended to over-estimate the capacities of the ordinary production worker. As regards maintenance and repair costs these were usually only estimated for large projects and took no account of shortages of skilled men required. Thus in those cases where wage standards were employed, these did not differentiate according to skill and varying labour market conditions. The institutional aspects of the process of search for innovation and the discovery of new techniques (i.e. movements along the existing production function and shifts in the production function respectively) tended to diffuse the potential influence of relative labour scarcities upon investment decisions. In particular where the innovative process was governed by the manufacturer rather than the user of capital goods, the results were less affected by specific labour market conditions due to the manufacturer being less well informed about such matters and the need to standardise equipment across firms, industries and regions.

Turning to this country there is very little published evidence on the relationship between technological change and labour market behaviour. The only studies of direct relevance would seem to be those conducted for the E.I.T.B. by the Science Policy Research Unit at the University of Sussex, primarily into the effects of changing

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(26) Piore (1968).

technology upon manpower requirements. In their first report they conclude that

> 'the research team has accumulated a considerable amount of non-reproducible "evidence" to suggest that over the long-run the reverse of this assumed relationship may be equally important .... new manufacturing technologies are conditioned to an unknown extent by the current and expected future supply conditions in the labour markets.'[27]

On the other hand a second study concluded that:

> "During the course of our recent discussions in the UK engineering industry, only one case where the diffusion of a technological change had been stimulated by labour-market conditions was mentioned: this was the stimulus given to the use of press forgings as a substitute for hammer forging in the Second World War arising from the shortage of skilled male hammer operators and the availability of women workers, who could reasonably be trained for the less skilled and less fearsome work of press forging.'[28]

Whether or not, on closer examination, we find a similar situation to that reported by Piore in which only rather general labour market trends affect the pattern of technical change has obvious implications for manpower forecasting.

A further point is that economic studies of investment behaviour at the firm and industry level have not usually attributed much importance to the treatment of the labour market in formulating econometric models. Where labour cost variables have been included, the statistical significance achieved has been poor.[29] Nor has the estimation of inter-related factor demand systems by Briscoe and Peel (1974), using U.K. manufacturing data, yielded significant coefficients on factor price relativities in the capital equations.

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(27) Bell (1972), p.92.

(28) Senker and Huggett (1973). Further research also supported by the E.I.T.B. is in progress.

(29) See Jorgenson (1971).

3.3 The Employment and Training of Craftsmen in Different Engineering Industries.

3.3.1 Output, investment and employment trends.

A detailed analysis of the performance of the British engineering sector particularly since 1963 is given in Wabe (1977). In this sub-section we shall just summarise the growth patterns of output, capital investment and craft employment occurring between 1959 and 1973 in the 15 groups of industries comprising the sector.(30)

Fitting exponential trends to the output series gives the results shown in Table 3.2. The fastest growth rates recorded for the period 1959-73 were those for electronics (7.3 per cent per annum), insulated wires and cables (6.4), instrument engineering (5.3) and other electrical goods (5.0). All trends were significant at the one per cent level with the exception of machine tools, aircraft and hand tools, bolts etc. The trend for other vehicles (which includes motor cycles and railway stock) was strongly negative. As regards the evenness of production growth, the $\bar{R}^2$ statistics for the trend regressions of 9 of the 15 industry groups were 0.8 or more.

Occupational data has only been available from 1963 so production trends to compare with the figures on craft employment have been estimated for 1963-73. During this period the leading industry, electronics, has expanded even more rapidly but for most other groups growth has been about the same (EIGs 2, 4 and 10) or rather less (EIGs 3, 5, 6, 9 and 11) than that recorded for 1959-73. Electrical machinery and other metal goods join the industries with rather weak trends. Aircraft declined more rapidly and other vehicles less so.

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(30) See Appendix 4.

Table 3.2 Output, investment and craft employment growth in different engineering industries.

(percentage compound growth rates)

EIG	Output growth				Investment growth				Craft employment growth	
	1959-73		1963-73		1958-72		1963-72		1963-73	
	Rate	$\bar{R}^2$	Rate	$\bar{R}^2$	Rate	$\bar{R}^2$	Rate	$\bar{R}^2$	Rate	$\bar{R}^2$
1 Metal working machine tools	1.28+	.20	0.15	-	5.86**	.70	1.97	.09	-1.88+	.25
2 Industrial machinery	4.12**	.94	4.29**	.89	1.39	.12	1.61	-	-1.95**	.72
3 Other non-electrical machinery	2.11**	.79	1.42**	.53	5.59**	.79	3.11*	.37	-1.32*	.38
4 Industrial plant and steelwork	3.53**	.79	3.55**	.59	2.48**	.53	2.39+	.26	1.54+	.27
5 Other mechanical engineering	4.08**	.93	3.36**	.90	1.45*	.28	2.45*	.38	-0.90	.05
6 Instrument engineering	5.27**	.94	4.20**	.87	8.46**	.95	7.63**	.88	-0.91	.10
7 Electrical machinery	2.51**	.63	1.28	.13	-2.02**	.44	-3.67**	.56	-4.84**	.80
8 Electronics	7.30**	.95	8.20**	.96	9.19**	.89	6.00**	.67	0.73*	.38
9 Insulated wires and cables	6.43**	.95	5.26**	.89	2.92*	.33	-2.03+	.28	-0.85	.01
10 Other electrical goods	5.02**	.91	5.38**	.81	7.30**	.83	3.36*	.52	-0.32	-
11 Motor vehicles	3.89**	.87	2.58**	.83	5.38**	.46	2.30	-	0.48	-
12 Aircraft	-1.09+	.15	-2.39**	.33	3.67+	.15	2.82	-	-3.62**	.90
13 Other vehicles	-4.19**	.90	-2.90**	.85	-5.10**	.41	-3.38	-	-8.46**	.94
14 Tools, bolts, wire and cans	0.77*	.23	0.35	.07	1.94*	.29	1.05	-	-1.18**	.54
15 Other metal goods n.e.s	1.45**	.49	0.71	.06	3.78**	.70	3.74**	.68	-1.65**	.68

The role of the craftsman in the production of engineering goods during 1963-73 declined markedly. Where employment in a particular sector increased, as in industrial plant and steel work, electronics and motor vehicles, the growth in skilled labour force was only a fraction of the growth in output. In electronics the rate of increase of craftsmen was less than a tenth of the production growth rate. Skilled employment in industrial machinery, whose output grew relatively strongly, suffered a sustained decline of about 2 per cent per year. The three industries with faster rates of reduction of skilled manpower than this were electrical machinery (with no significant output trend) and the two main declining industries aircraft and other vehicles, the last recording a rate of -8.5. Employment trends were generally less significant than the corresponding production trends with $\bar{R}^2$ reaching 0.8 in only three cases (the three fastest declining groups).

Why did these developments in craft employment take place despite an expansion of engineering output which, whilst not impressive by international standards, was nonetheless significant? Increases in labour utilisation and the substitution of capital for labour are the general phenomena usually advanced to explain such changes. Substitution between different types of labour using the same capital has received much less attention. Fully satisfactory measures of these are extremely difficult to construct at the EIG level of aggregation. Taylor (1974) has been the most thorough of the authors who have attempted to estimate rates of labour utilisation but his 'peak to peak' method is suited only to a short-run, i.e. cyclical, treatment. There are no methods of estimation which measure changes in labour utilisation independently of strong assumptions about the labour-saving extent of new investment and the rates of capital usage observed at peaks in the output per man time-profile. Without freezing the technology of an industry this would indeed be impossible. Added to these problems there is, at the detailed level, too little disaggregate occupational, investment and capital stock data on which to base even a 'peak to peak' method of estimation. Attempts have been made by Evans (1974) on the basis of the output-employment profile for different skills from 1963 to 1971 but this was only a very tentative exercise.

It is therefore almost impossible to sustain the distinction between increases in labour utilisation and capital-labour substitution in present empirical work: we can however investigate what has been happening to the capital employed. Bosworth (1974, p.189) has described the construction of MLH estimates of capital stock based on disaggregating the perpetual inventory estimates for 'engineering and allied industries' according to MLH proportions of total fuel consumption for the group. They were then used in cross-sectional analysis of production functions for engineering MLHs. Comparison of the results for different periods was achieved by adjusting the aggregate capital stock figure, before the MLH allocation was made, by the capital usage series (based on fuel consumption) constructed by Heathfield (1972a). Apart from the obvious objection that the resulting figures measure an output of capital services by one of the inputs to that process, the fuel consumption data do not in fact refer to production alone. Nor are there fuel consumption figures for each year; in fact annual MLH proportions of all fuel consumed by the aggregate group were based on the census of production figures for 1963 and 1968, interpolated and extrapolated linearly. For a time series analysis these and other defects (of which Bosworth is fully aware) are sufficient to reject the use of the data. Thus we are left with no adequate series on capital stock and capital usage at the MLH level. There are however sample and full censuses of investment which provide a basis for the construction of investment series at the detailed level. The ones we shall use were estimated by Bosworth (1975) and used by him primarily in pooled time series and cross-sectional analysis of production functions at the MLH level. This data is described briefly in Appendix 5. There are some major inadequacies relating to (i) the use of inter-censal interpolation between 1958, 1963 and 1968 for the final disaggregation of investment for seven groups of industries into figures for the 15 EIGs used in this study and (ii) the splicing together of full and sample census results. However we shall pursue our analysis with the help of these statistics simply because they shed a little more light upon what has contributed to the decline in craft employment. We would expect investment in plant and machinery to be most relevant.

The generally weaker trends in plant and machinery acquisitions compared with output are to be expected. The greater fluctuations observed are indicated by the $\bar{R}^2$ statistics which exceed 0.8 in only three cases for 1958-72 and one case for 1963-73 (see Table 3.2). For the latter period investment activity was less than the average for the full period. This applies especially to machine tools and vehicles. Given their output performances it is not surprising to find that electronics and instrument engineering increased investment most strongly with investment by instruments rising the more rapidly during 1963-72. Sustained investment declines were recorded only for electrical machinery and other vehicles (for 1958-72), the two industries which reduced their skilled labour forces most rapidly. By the latter criterion it is relevant to observe that investment by industrial machinery and aircraft showed no significant trend in contrast to declining skilled employment, whereas other metal goods n.e.s ranked third among EIGs for its rate of investment. There are clearly no obvious associations between investment and employment changes which suggest themselves simply on the basis of a comparison of growth rates. In the following sub-section the connections between output, skilled employment and investment will be explored at a more formal level intended to yield greater insight than does a perusal of Table 3.2.

3.3.2 The demand for skilled craftsmen.

The above figures are for acquisitions of plant and machinery and thus refer to gross investment. In so far as this reflects the acquisition of new machinery embodying the latest technologies then it is important to distinguish this as a whole rather than simply deal with net investment by subtracting disposals. On the other hand the latter do represent a diminution of the capital stock with which employees work. The specification of an appropriate production function from which to derive a demand function for labour has had a central place in the work of Bosworth (1976). Without necessarily investing functional forms with the same theoretical significance as he does it is worth sketching out the following analysis which is rooted in his approach.

An *ex post* vintage production function is inverted to produce a demand equation of the following type.

$$L_t = \sum_v g_v K_{vt} U_{vt} \qquad \text{.................... (1)}$$

The summation is over all vintages of capital with labour-capital ratios distinguished according to vintage (g_v) and the utilisation of capital (U_v) specified independently of capital stock (K_v).

Wishing to exploit the use of the available investment data in the absence of reasonable estimates of capital stock, first differences of equation (1) must be taken. This produces what Bosworth describes[31]

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(31) Bosworth (1976), Chapter 6. The notation adopted in the present study identifies vintages according to the year in which they were first installed. Thus for the latest vintage v = t and for the oldest currently used vintage v = t - x + 1 if the latest x succesive vintages are held by the firm in each period. It is assumed that all machines installed during a given year are of the same technological standard.

as a 'fairly realistic looking equation' but to the present author appears to be a less elegant, equally tautological, version of equation (1), the significance of which is solely dependent upon our ability to extract investment as an independent variable with the minimum of unrealistic assumptions.

The assumption made by Bosworth in order to conduct his cross-sectional analysis boil down to the following:

(a) machines of the latest x successive vintages only are retained by each production unit;

(b) changes in utilisation of vintages common to both successive periods are negligible (in fact he makes a stronger assumption - that vintages common to both periods are fully utilised);

(c) different engineering MLHs (and firms) are on the same set of <u>ex post</u> vintage production functions utilising their newest and oldest vintages to the same extent.

This produces (for cross-sectional analysis over all industries $j = 1 \ldots m$) the following equation:

$$\Delta L^j_{t+1} = g_{t+1}\, K^j_{t+1,\, t+1}\, U_{t+1,\, t+1} - g_{t-x-1}\, K^j_{t-x-1,\, t}\, U_{t-x-1,\, t} \quad \ldots (2)$$

Note that $K^j_{t+1,t+1}$ is gross investment (GI) by industry j in period t+1 and $K^j_{t-x-1,t}$ is the corresponding amount of scrapping (S).

Bosworth estimated three equations linking craftsmen to investment in plant and machinery, choosing a five year period to minimise the impact of short-run adjustments of labour to capital.(32)

$$\text{(i)}\quad \Delta L^j_{t+1} = \alpha + \beta(GI^j - S^j)_{t+1}$$

$$\text{(ii)}\quad \Delta L^j_{t+1} = \alpha + \beta(GI^j - S^j)_{t+1} + \gamma\Delta U^j_{t+1}$$

$$\text{(iii)}\quad \Delta L^j_{t+1} = \alpha + \delta GI^j_{t+1} + \theta S^j_{t+1}$$

The results of (i) and (iii) are given in Table 3.3. The variable ΔU_{t+1} representing changes in usage of plant and machinery

(32) See footnotes to Table 3.3.

of all vintages (measured by electricity consumption data as mentioned above) made no significant improvement to the explanatory power of (i). The separation of gross investment and scrappage has a significant impact but the parameter estimation is marred by the correlation between these two components of net investment (the correlation coefficient varies between 0.7 and 0.8 depending on the time period).

Equations (i) and (ii) are not rigorously developed from the theory whereas equation (iii) corresponds to equation (2) above with a constant term added (which was significantly different from zero in one case only). Roughly speaking the results for equation (iii) suggest that θ is at least 20 times the value of δ and both are significant. This implies an exceptional difference in the labour requirements of old and new capital only if one assumes a simlar rate of utilisation. Some doubt must be cast on the assumption of a (0,1) uniform distribution for the utilisation of capital vintages held by the firm until they are scrapped. However, probably more important, is Bosworth's observation that the relative prices of new and second-hand machines when used to deflate acquisitions and disposals at current prices will yield constant price series which do not reflect properly the relative volumes of machines acquired and disposed of. The same price index is used to deflate both series so apart from the peculiarities of price determination in the second-hand market, if prices of new machines have increased faster than second-hand prices this will also tend to cause a relative bias downwards in the constant price disposals figures and hence θ will be biased upwards.

Table 3.3 Cross-sectional analysis of changes in craftsmen employed and investment in plant and machinery.

Dependent variable ΔL_{t+1} (1) / Period (t+1)	Constant	Independent variables (2): $GI_{t+1}-S_{t+1}$	GI_{t+1}	S_{t+1}	$\bar{R}^2$
1963-7	2.3210	0.0432			0.02
1964-8	-0.3692	0.0127			-
1965-9	-0.2940	0.0144			-
1966-70	-3.5816	0.0222			-
1967-71	-7.5991*	0.0873**			0.20
1963-7	0.6576		0.0118	0.9250	0.02
1964-8	1.6550		0.0613†	-1.3585†	0.04
1965-9	2.1543		0.0605†	-1.4221†	0.06
1966-70	1.4904		0.0978**	-2.5488**	0.31**
1967-71	-0.0441		0.2208**	-4.1882**	0.53**

Source: Bosworth (1976), Chapter 6, Tables 6.2 and 6.5.

(1) ΔL_{t+1} corresponds to the change in employment between the May surveys of the first year of and the year following the time period specified in the table.

(2) GI_{t+1} and S_{t+1} are the summations of all gross investment and scrapping respectively occurring during the calender years encompassed by the time period. Thus a lag of at least five months is allowed for between investment and achieving desired manning as a natural consequence of the timing of the employment surveys.

Another feature of Bosworth's results is their increasing statistical significance as the period of analysis moves over the 1965 [illegible] cyclical peak in engineering output and employment and into the subsequent recession from which employment has yet to recover. A major retrenchment was undertaken by firms during the five years or so straddling the turn of the decade: skilled labour was dishoarded, old capital equipment was scrapped and investment in both training and up to date technology was severely curtailed.

In order to conduct a time series analysis for each industry group based on equation (2) it is necessary to replace (c) with assumptions which deal with the vintage profile of productivity and utilisation over time rather than across industries. We shall not take the formal analysis further since to produce equations which are amenable to estimation requires an uncomfortable amount of trading between alternative simplifying assumptions in the absence of reliable information about capital usage over time and labour-saving technical progress and the problem of valuing second-hand capital goods. Let us reduce equation (2) to the following.

$$L(t+1)-L(t) = \beta_1 GI(t,t+1) - \beta_2 S(t,t+1) \quad \ldots\ldots\ldots (3)$$

The t values now correspond to moments of time so $GI(t,t+1)$ is the gross investment occurring between times t and t+1. The superscript j has been omitted for convenience. Equation (3) with a constant term added has been estimated for each EIG over the period 1963-72. The results are given in Table 3.4. The constant term is included to pick up any trend in the manning requirements of new capital relative to old (and hence is a crude device to accommodate trends in β_1 and β_2). It is expected to be negative. This much reduced version of the vintage model turns out to explain employment changes very poorly. A majority of the coefficients when significant do possess the expected signs but the results for industries 5 and 11 are anomalous. In no case are β_1 and β_2 significant together so it is not possible to compare their relative magnitudes in a meaningful way, the underlying hypothesis having been rejected. A relevant sidelight on these results is the correlation between gross investment and scrapping, given as $r(GI,S)$ in the table. There seems to be no pattern to these correlations seen in the context of the output, investment and employment growth rates shown in Table 3.2. The main explanation for this and the

Table 3.4 The relationship between changes in craft employment and gross investment and scrapping, 1963-72.

Dependent variable: L(t+1) - L(t)

EIG	Constant[1]	GI(t,t+1)	S(t,t+1)	R^2	$\bar{R}^2$	DW	r(GI,S)
1	4,883	140	-6,173	.5970*	.4818	1.821	0.32
	(9,052)	(507)	(1,973)**				
2	11,327	-264	-3,380	.0581	-	2.140	-0.66
	(19,709)	(440)	(5,647)				
3	5,927	97	-4,818	.4977	.3542	2.056	0.56
	(11,885)	(436)	(2,094)*				
4	-4,389	673	-3,187	.1831	-	2.017	0.53
	(11,260)	(104)	(2,545)				
5	20,265	-768	338	.3007	.1009	1.051	0.22
	(13,070)†	(449)	(3,092)				
6	-7,442	439	527	.5812*	.4615	2.571	0.79
	(2,390)**	(248)†	(3,012)				
7	-12,381	730	248	.2103	-	1.689	0.74
	(10,285)	(910)	(1,675)				
8	-1,822	60	108	.0578	-	2.451	0.00
	(3,483)	(95)	(605)				
9	-7,386	357	172	.2451	.0293	1.213	0.45
	(5,727)	(304)	(546)				
10	-3,127	164	-264	.0473	-	2.391	0.26
	(5,604)	(282)	(1,050)				
11	-15,165	37	4,700	.4772	.3278	2.684	0.01
	(9,256)†	(77)	(1,897)*				
12	-19,302	1330	-5,604	.0852	-	3.078	0.61
	(34,076)	(1724)	(8,546)				
13	-3,605	662	-4,638	.4108	.2425	1.791	0.48
	(2,149)†	(558)	(2,103)*				
14	3,251	-183	71	.0686	-	2.178	-0.09
	(5,293)	(259)	(1,305)				
15	10,932	-459	1,631	.2169	-	1.847	0.56
	(10,360)	(355)	(5,500)				

(1) Coefficients significantly positive or negative as appropriate at the 10, 5 and 1 per cent levels are denoted by †, * and ** respectively. The significance of a regression as a whole is indicated at the 5 or 1 per cent level by a similar convention attached to the R^2 statistic.

above results probably lies in the fact that changes in the utilisations of capital (new and old) over the cycle have not been accounted for and an analysis based on short time series is particularly vulnerable to its effects. Suitable data are not available for us to remedy the deficiency.[33] However the qualifications expressed above in connection with the cross-sectional model also apply, namely that extremely stong assumptions have been made about the profile of vintage utilisation and changes in manning requirements from vintage to vintage.

An alternative production function approach to that embodied in (1) would be to bypass the labour-capital and capital-output relationships by linking labour to output directly. The well-worn employment function in which desired is assumed to equal actual

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(33) The adoption of a five year period for cross-sectional analysis does of course blow over the impact of the trade cycle upon, especially, the utilisation of capital <u>and</u> labour. The cyclical aspect is particularly intrusive when attempting a time series analysis based on equation (3). Typically the investment cycle peaks after the output cycle by about 12-18 months by which time the economy is moving into recession and the hoarding of skilled labour is at its highest. Depending on the depth and length of the recession, hoarded labour will eventually be made redundant. It is not until output growth revives that the effect of dishoarding plus the earlier installation of new investment really bears on the observed level of productivity. In estimating equation (3) we are looking for a <u>positive</u> relationship between gross investment and craft employment over and above the rise in productivity engendered by that investment. If the latter is adequately covered by the constant term in equation (3) and labour hoarding is accommodated by a linear adjustment mechanism in which actual employment adjusts to desired employment (L^*) with a lag, then we obtain:

$$L(t+1) - L(t) = \lambda[L^*(t+1) - L(t)] \quad \text{with } 0 < \lambda < 1$$

$$\therefore \quad \Delta L(t,t+1) = \lambda\, \Delta^* L(t,t+1)$$

Thus no alteration to the estimated equation is involved but the interpretation of coefficients is such that if adjustment is very slow λ is close to zero and this will reduce the significance of all regression coefficients (since each is multiplied by λ). This still presumes however that there is not a major problem of cyclical usage to be taken into account. With the small number of observations it is not possible to test the theory on the basis of accumulated investment and scrapping between points corresponding to productivity peaks in the trade cycle. A simple lagging of the investment series so that investment is linked to changes in employment in a subsequent period where it is most likely to be operated at full capacity not surprisingly produces no significant improvement in the results. Nor does the use of a composite lag where the investment for the current period is averaged with that in the previous two periods.

employment and the effects of labour-saving technical progress and net capital formation are represented by an exponential time trend yields an equation of the form

$$L_t = \alpha\, e^{\gamma t}\, Y_t^{\beta} \qquad \text{............ (4)}$$

The subscript t now denotes a time period during which average employment (provided by the annual observation from the L7A survey) has been L_t and output Y_t. The results of estimating this equation are given in Table 3.5. We expect $\gamma < 0$ and $\beta > 0$. Multicollinearity is a problem with a majority of the equations as indicated by the $\bar{R}^2$ statistics for the production growth rate regressions in Table 3.2 This does not explain however the case of EIG 6 (instrument engineering) where the signs of γ and β are the reverse of the expected. All other significant coefficients are consistent with the theory. More than 50 per cent of the variation in craft employment during the decade is explained in 10 of the 15 industries; more than 75 per cent is explained in four. If it were not for the uneasy reliance upon a time trend proxy for labour-saving technical progress etc. these results might seem to provide a promising base for development, certainly compared with the results using the crude version of the vintage model (referring to the significance of coefficients and not the $\bar{R}^2$ statistics which are not comparable).

Given the deficiencies of the investment data at this level of aggregation and the short length of time series on which the estimation has relied in both cases, and given the simple versions of the two competiting employment-production theories expressed in equations (3) and (4), one cannot reject the vintage in favour of the neoclassically-based theory. Indeed equation (4) can easily be derived from a vintage theory.[(34)] It must also be said that the vintage theory (especially in the hands of Johansen, 1972) seems to provide a much more realistic view of the engineering production unit than

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(34) See Heathfield (1972b).

Table 3.5 Simple employment functions for craftsmen in engineering industries, 1963-73

Dependent variable: log L_t

EIG	$t^{(1)}$ (per cent p.a.)	log Y_t	R^2	$\bar{R}^2$	DW
1	-1.972 (0.765)*	0.6514 (0.3113)*	.5654*	.4570	1.396
2	-1.679 (1.275)	-0.0626 (0.2821)	.7515**	.6894	1.174
3	-2.017 (0.731)*	0.4919 (0.3905)	.5363*	.4204	1.144
4	0.526 (1.137)	0.2846 (0.2537)	.4351	.2938	0.946
5	-4.312 (2.175)*	1.0178 (0.6170)†	.3613	.2016	1.187
6	2.502 (1.417)†	-0.8107 (0.3160)*	.5549**	.4436	1.945
7	-5.896 (0.426)**	0.8268 (0.1555)**	.9602**	.9502	2.378
8	-2.165 (1.179)†	0.3536 (0.1413)*	.6871**	.6089	2.250
9	-4.269 (2.416)†	0.6492 (0.4358)†	.3026	.1282	1.525
10	-1.799 (1.338)	0.2744 (0.2269)	.1845	-	1.803
11	0.870 (1.246)	0.5246 (0.4447)	.2292	.0365	1.035
12	-3.693 (0.513)**	-0.0295 (0.1348)	.9114**	.8893	1.393
13	-8.764 (1.900)**	-0.1036 (0.6101)	.9482**	.9353	0.832
14	-1.149 (0.356)**	-0.0982 (0.2059)	.5937*	.4922	1.775
15	-1.589 (0.401)**	-0.0815 (0.2245)	.7154**	.6443	1.102

(1) Significance levels are indicated as for Table 3.4.

does any micro-neoclassical theory. Unfortunately from the forecasting point of view we appear to be in a situation where the easiest formulation to use, because of the lags in the availability of data and its reliability, is some direct relationship between employment and output; circumstances in which the short-term employment function has had a field day. Nothing more will be said on this subject since Bosworth (1974 and 1976) explores at length the vintage and neoclassical theories of production and Roberts (1974 and 1976) describes and tests several versions of the short-term employment function. Both authors use data on the British engineering sector for their empirical work although neither investigates time-series relationships at the detailed industry level.

One simple extension of equation (4) is to add a multiplicative adjustment process which incorporates lags in the adjustment of actual to desired employment levels due to a variety of decision and implementation problems. The literature on this is voluminous as indicated in Killingsworth (1970) and the details of the rationalisation for adding the adjustment will not be discussed here. To accommodate the log-linearity of the regression equivalent of equation (4) we adopt,

$$\frac{L_{t+1}}{L_t} = \left[\frac{L^*_{t+1}}{L_t}\right]^{\lambda} \qquad 0 \leq \lambda \leq 1$$

Substituting for L^*_{t+1} gives

$$L_{t+1} = \alpha^{\lambda} \, e^{\gamma\lambda(t+1)} \, Y_t^{\beta\lambda} \, L_t^{1-\lambda} \qquad \ldots\ldots\ldots \; (5)$$

The results of estimating this equation are given in Table 3.6.

The presence of log L_{t-1} results in a loss of significance of the coefficient on log Y_t for EIGs 5 to 7 and a gain for EIGs 11 and 12. The $\bar{R}^2$ statistics rise considerably for EIGs 1, 3 and 5 and fall for EIGs 6, 8 and 14. The adjustment parameters are close to

Table 3.6 Simple employment for craftsmen using lagged adjustment, 1964-73.

Dependent variable: log L_t

EIG	t	log Y_t	Log L_{t-1}	R^2	$\bar{R}^2$	DW
1	-0.014 (0.006)*	0.562 (0.228)*	0.999 (0.261)**	0.8759**	0.8138	2.513
2	-0.024 (0.012)*	0.363 (0.391)	0.796 (0.538)†	0.8338**	0.7507	2.205
3	-0.015 (0.007)*	0.366 (0.406)	0.750 (0.356)*	0.7565*	0.6347	1.545
4	-0.006 (0.011)	-0.153 (0.322)	1.007 (0.457)*	0.6163	0.4244	1.644
5	-0.029 (0.014)*	0.414 (0.458)	1.392 (0.291)**	0.8664**	0.7996	2.047
6	0.004 (0.015)	0.092 (0.515)	0.629 (0.432)†	0.4978	0.2466	2.166
7	-0.047 (0.015)*	0.359 (0.340)	0.303 (0.318)	0.9752**	0.9628	2.917
8	-0.022 (0.014)†	0.358 (0.165)*	-0.005 (0.316)	0.6562	0.4843	2.186
9	-0.049 (0.025)*	0.905 (0.484)†	0.464 (0.344)	0.4610	0.1915	2.307
10	-0.003 (0.017)	0.122 (0.257)	0.288 (0.400)	0.1695	-	2.339
11	-0.021 (0.012)†	1.071 (0.467)*	0.659 (0.327)*	0.5633	0.3450	2.285
12	-0.018 (0.018)	-0.397 (0.207)†	0.839 (0.533)†	0.9408**	0.9113	2.344
13	-0.022 (0.037)	0.060 (0.529)	0.628 (0.328)†	0.9629**	0.9444	1.857
14	-0.014 (0.008)†	-0.218 (0.293)	-0.075 (0.462)	0.5989	0.3984	1.885
15	-0.023 (0.010)*	-0.561 (0.514)	-0.329 (0.731)	0.8468**	0.7701	1.929

(1) Significance levels are indicated as for Table 3.4.

zero in several cases and for EIG 5 a negative value is obtained. Only for EIGs 1 (machine tools) and 11 (motor vehicles) does the addition of the adjustment mechanism really contribute to the economic explanatory power of the model in the way envisaged a priori. Even then, for the first industry the adjustment parameter is remarkably small (0.001).

3.3.3 The employment of craftsmen and apprentices

During the period 1963-73 craft employment was generally in decline. For the engineering industry as a whole a one per cent change in craft employment (including apprentices) was associated with a 2.8 per cent change in the employment of apprentices and a 3.4 per cent change in apprentice recruitment. Table 3.7 shows the log-linear regression results for each EIG linking apprentices and craftsmen, apprentice recruits and apprentices, and apprentice recruits and craftsmen. The inter-industry variation is very considerable. We would expect the coefficients β_1, β_2 and β_3 to be positive and indeed none are negative and significant at the 5 per cent level. The greatest consistency, perhaps not surprisingly is in the β_1 coefficients only one of which is not significant at the 5 per cent level; the corresponding numbers for β_2 and β_3 are five and six respectively.

In the mechanical engineering sector (EIGs 1 to 5) the relationship between the employment of apprentices and all those engaged on skilled work whether fully trained or not is a strong one although varying in the extent to which apprentice employment is adjusted. Somewhat weaker is the response of apprentice recruitment to apprentice employment in total. With the exception of other mechanical engineering, where for every one per cent net change in apprentice stock there is a

Table 3.7 Regression results relating the employment of craftsmen (C_t), all apprentices (A_t) and apprentice recruits (AR_t) : Engineering Industry Groups, 1963-73[1]

	$\log AR_t = \alpha_1 + \beta_1 \log A_t$			$\log A_t = \alpha_2 + \beta_2 \log C_t$			$\log AR_t = \alpha_3 + \beta_3 \log C_t$		
EIG	β_1	R^2	$\bar{R}^2$ DW	β_2	R^2	$\bar{R}^2$ DW	β_3	R^2	$\bar{R}^2$ DW
1 Metal working machine tools	1.1209 (0.1885)**	0.7571**	0.7745 1.70	1.7837 (0.1843)**	0.9123**	0.9026 0.75	1.9663 (0.4256)**	0.7034**	0.6705 1.22
2 Industrial machinery	0.8208 (0.2545)**	0.5360*	0.4845 1.00	2.5416 (0.4677)**	0.7664**	0.7405 1.88	2.6984 (0.6065)**	0.6974**	0.6527 1.24
3 Other non electrical machinery	0.8465 ** (0.2940)	0.4807*	0.4230 1.17	2.2836 (0.4284)**	0.7595**	0.7328 1.27	2.6989 (0.5774)**	0.7085**	0.6759 1.46
4 Industrial plant and steelwork	0.9754 (0.4214)*	0.3732*	0.3035 1.24	1.2665 (0.3062)**	0.6553**	0.6170 0.95	1.3168 (0.7076)*	0.2779	0.1976 0.77
5 Other mechanical engineering	1.4777 (0.2799)**	0.7559**	0.7288 1.47	1.7986 (0.1528)**	0.9290**	0.9322 2.06	2.6951 (0.5466)**	0.7298**	0.6998 1.25
6 Instrument engineering	1.0624 (0.3205)**	0.5496**	0.4998 1.49	-0.4536 (0.5694)	0.0659	- 0.92	-0.6878 (0.7905)	0.1229	0.0255 0.32
7 Electrical machinery	1.0969 (0.1372)**	0.8766**	0.8629 1.95	1.7536 (0.0888)**	0.9775**	0.9750 1.85	1.9908 (0.1986)**	0.9178**	0.9087 1.89
8 Electronics	0.8862 (0.2941)**	0.5022*	0.4469 1.30	-2.0306 (1.3581)†	0.1990	0.1100 0.60	0.5996 (1.6871)	0.0111	- 0.62
9 Insulated wires and cables	0.4209 (0.2777)†	0.2033	0.1148 1.66	1.6289 (0.8857)*	0.2732	0.1924 1.10	0.2857 (0.9649)	0.0096	- 0.98
10 Other electrical goods	1.8496 (0.6946)*	0.4407*	0.3785 1.45	0.2492 (0.4991)	0.0270	- 1.21	-1.1665 (1.3550)	0.0761	- 0.39
11 Motor vehicles	1.5989 (0.4189)**	0.6181**	0.5757 2.71	-0.6562 (0.5773)	0.1255	0.0284 1.13	-1.5921 (1.1377)†	0.1787	0.0874 1.52
12 Aircraft	0.7891 (0.2509)**	0.5236*	0.4707 0.97	1.5700 (0.2448)**	0.8204**	0.8004 0.76	1.1989 (0.4871)*	0.4023*	0.3359 0.66
13 Other vehicles	0.5812 (0.1722)**	0.5586**	0.5095 0.72	1.2494 (0.0615)**	0.9787**	0.9763 0.96	0.6740 (0.2361)**	0.4710*	0.4122 0.62
14 Tools, bolts, wire and cans	1.8241 (0.3367)**	0.7120**	0.6800 1.36	1.7962 (0.8223)*	0.3465	0.2739 1.01	3.3137 (1.9013)†	0.2523	0.1693 0.64
15 Other metal goods n.e.s.	1.0875 (0.2089)**	0.7506**	0.7229 1.88	1.2010 (0.6951)†	0.2491	0.1657 0.67	1.9570 (0.7670)*	0.4155*	0.3553 0.95
All engineering	1.2358 (0.1936)**	0.8114**	0.7905 1.57	2.7954 (0.3581)**	0.8650**	0.8500 1.23	3.4111 (0.7720)**	0.6845**	0.6494 0.83

(1) Significance levels are indicated as for Table 3.4.

1.5 per cent change in recruitment inflow, recruitment changes proportionately with total employment of apprentices. The resulting relationship between apprentice recruitment and all craft employment emerges as significant (although weak for EIG 4) but below the average for the engineering industry as a whole in the extent of the recruitment response.

Three EIGs outside mechanical engineering also display close associations between apprentice and all craft employment; these are electrical machinery, aircraft and other vehicles. The first also shows a particularly strong equiproportionate link between apprentice recruitment and employment. The final direct relation between apprentice recruitment and craft employment then explains 92 per cent of the variation in the former by variation in the latter. Aircraft and other vehicles are joined by other metal goods n.e.s. as a group of three industries for which the direct link is significant at the 5 per cent level; the explanatory power for four mechanical engineering groups and electrical machinery reaches significance at the 1 per cent level. Most of the significant β_3 coefficients are well above unity but that for other vehicles is only 0.7. For the sector as a whole β_3 is significant and is well in excess of any individual EIG coefficient.

How do these figures relate to those on the growths of output, investment and craft employment during 1963-73 (Table 3.2)? The dominant picture is one of declining craft employment which is most likely due to a fall in demand for craftsmen. Had this been due to craftsmen leaving for other jobs in engineering or outside, we would have expected to see firms attempting to increase the numbers of apprentices. Whether or not this leads to an actual increase in apprentice numbers via net recruitment depends on the supply of young people and this will to some extent be influenced by the same considerations causing craftsmen to leave. However should firms be successful at boosting apprentice numbers one would expect a weak if not negative relationship between apprentice recruits and craft employment, providing the situation is dynamically sustained over the decade studied. That is, dynamic excess demand for craftsmen arises through a shifting supply schedule generating increased apprentice recruitment which does not catch up with demand because of the training lead-times involved together with perhaps a small shift outwards in the demand schedule because product demand is growing slightly faster than productivity. Instead, of course, we obtain significant positive relationships between apprentice recruitment and craft employment and not only do both decline over this period but apprentice recruitment declines by much more than does craft employment. This would only occur if the supply of apprentice recruits was either falling through shifts in or moves along the supply schedule or, at the opposite extreme, if the profile of craft employment (and apprentice recruitment) was not in fact supply determined but demand determined. In the first case, the fact that apprentice recruitment was changing much faster than craft employment would be due to a greater tightening in the labour market for apprentice recruits than in that for adult craftsmen (given appropriate assumptions about the shapes of supply and demand schedules). In the second case, this observation would follow if demand adjustments fall more upon the recruitment margin of a firm's craft labour force and especially upon the recruitment margin of a firm's trainee craft group.

From the vantage point of the middle 1970s, given the discussion in Chapter 2, the second explanation above is clearly more likely to be the correct one following the peak of craft employment in 1966. The employment of craftsmen and apprentices (and hence apprentice recruitment) would seem to have been demand determined. There is however a third main alternative. In the short-run, craft employment could have been supply determined and apprentice recruitment demand determined. This would arise if firms, seeing the loss of craftsmen, decided to cut back on apprentice recruitment because they were unwilling to take the risk of loss of investment returns should newly trained men leave after only a short period with the firm as a fully qualified craftsmen. This may be characterised as 'cleft stick myopia'. The industry's reluctance to stem the tide of craftsmen leaving skilled jobs by altering the wage structure is combined with a reluctance to train its way out of the problem. One or other must be done in the short to medium run. The only possible option is to seek skill-saving capital investment. In some circumstances the lead-times for new capital to be installed may well be shorter than for training but there is also the accompanying problem of dealing with manning and redundancy where output growth envisaged is below the resulting productivity growth. This inevitably leads on to the wider issues involved in a consideration of Britain's relatively poor economic performance. These, we shall not pursue. Instead we turn to the apparent outcome in the labour market for skilled craftsmen generated by the changes in output, investment and labour demand, and supply responses or adjustments to the situation through mobility and training.

3.4 Shortages and Surpluses of Engineering Craftsmen

The measurement and interpretation of vacancies and unemployment are subjects about which much has been written by economists. The discrepancies between the principles underlying the statistical series available and the theoretical constructions employed in neo-classical economics are numerous and have persisted for some time. A review of the attempts to create acceptable proxies for excess demand using the vacancies statistics is given in Appendix 6, concluding that the vacancies series compiled by the Department of Employment generally understate vacancies recognised by firms, the degree of understatement increasing as the labour market tightens. The data will not fully reflect current shortages perceived by firms ex post or shortages anticipated in the near future i.e. ex ante. Indeed such are the mechanics of data collection and manpower decision-making by firms it is unreasonable to distinguish between these two concepts of shortage. The vacancies series gives an ordinal measure of the extent to which manpower is beginning to act as a binding constraint on the output growth of firms, equipped and managed as they are. Attempts such as those in a NEDO report (Anderson, 1974) to re-define the shortage problem according to the extent to which the employing orgainisation is efficiently managed serve only to emasculate the concept of shortage itself. The adjustments applied by Dow and Dicks-Mireaux (1958) are felt to be too contrived and unreliable.

British unemployment statistics suffer from a measurement problem in which the unregistered unemployed are estimated only through censuses (and, since 1972, through the General Household Surveys) whereas there is a continuous monthly series on those registered at labour exchanges. For skilled occupations dominated by males it can be argued that the problem is of limited importance, although the ratio of unregistered to total unemployment appears to decline with increasing unemployment and so the bias will not be constant. Note that the 'added worker' and 'discouraged worker' effects as defined via neoclassical theory of labour supply do not bear on the issue of short-run supply measurement where the data do not suffer from the British registration problem. They do influence judgements about the availability of additional manpower resources when anticipating an economic recovery in the medium-term but in the case of skilled occupations dominated by male workers their effects will probably be small relative to adjustments required for labour hoarding. With British data the labour market status of the added and discouraged workers, being somewhat 'marginal', leads them to be associated with the unregistered group but again, in the case of skilled occupations such as engineering, this will involve a minor modification of the picture sketched above.

As with the vacancies series we cannot justify any sophisticated manipulation of the registered unemployment series for skilled and semi-skilled workers but whereas the former can only be used as an ordinal measure of short-run excess demand, indicating probably between about a third and a half of the actual level, the latter will be accepted as a rough cardinal measure of short-run excess supply.

In presenting vacancies (V) and unemployment statistics (U) the ratio of the two is often used as a convenient summary indicator of the pressure of demand in the labour market. A consequence of the previous comment is that this procedure as well as the more involved one used by Dow and Dicks-Mireaux is inappropriate. One series is an ordinal measure of short-run excess demand and the other is a cardinal measure of short-run excess supply. Even had they both been cardinal measures the use of the ratio obscures the fact that V and U are separate disequilibrium phenomena despite the obvious connections between the two via the dynamics of the labour market. With a cardinal measure of vacancies one might well wish to express vacancies as a percentage of the relevant section of the employed labour force (E), indicating the extent of the shortage in relation to currently satisfied demand. With the statistics of unemployed skilled men we might similarly express the shortage of jobs as a percentage of the currently satisfied demand for jobs (which equals the currently satisfied demand for labour). Apart from the convenience of using the same denominator in both cases this means that the shortage of resources and the waste of resources respectively are couched in terms of the percentage additional output which would be delivered if the corresponding (marginal) increases in employment were accompanied by average increases in output.[35]

Figure 3.1 shows the unadjusted vacancies and unemployment series for skilled, semi-skilled and all engineering trades, taking males only. From 1956 up to 1966 vacancies and unemployment for the semi-skilled display in a small way, the kind of balanced counter-cyclical relationship between the two which led Dow and Dicks-Mireaux and others to accept the notion of a labour market in medium-run equilibrium with perhaps some underlying change in maladjustment (in this case, increasing over time). The patterns for skilled and all engineering trades are much less in accordance with this view, however much one adjusts for constant proportionate mis-statement of vacancies. The corresponding statistical movements for males in all occupations in the British economy are even more dramatically out of kilter, as shown in Figure 3.2. Note that we have argued for regarding the unadjusted vacancies data as providing an ordinal index which would require grossing up by a factor of two or more before it indicated the general level of short-run excess demand. By far the most significant feature shown by the statistics is the very considerable increase in unemployment between 1966 and 1972. The changes in the aggregate vacancies series and for the different engineering groups are all compatible with a dishoarding of labour in the cyclical downturn after 1965 which

(35) Adopting V/(E+U) and U/(E+U) makes little difference. The latter is used to calculate official unemployment rates.

Figure 3.1

Vacancies and Unemployment in Engineering Occupations:

Males in Great Britain 1956-74

(Thousands)

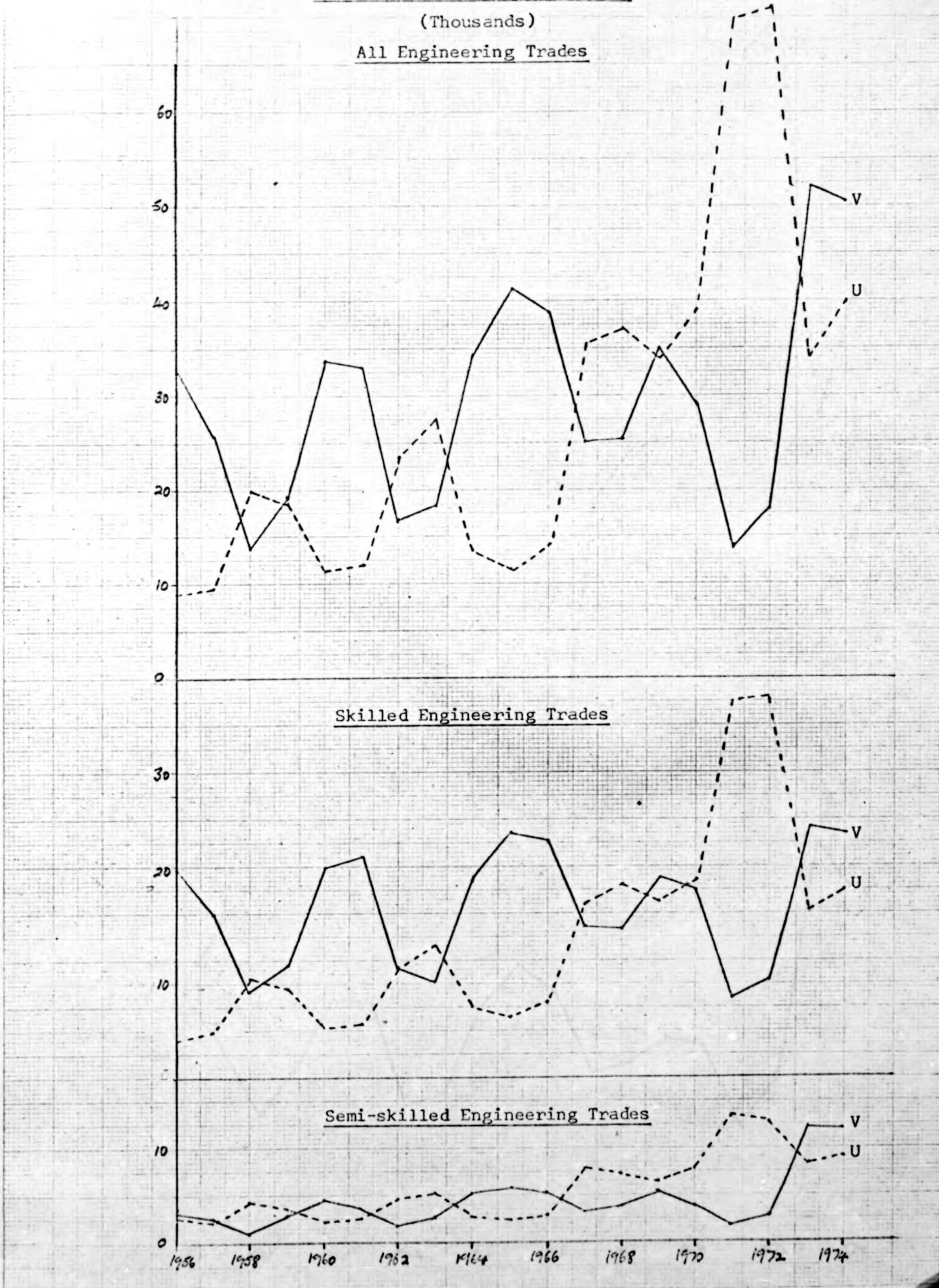
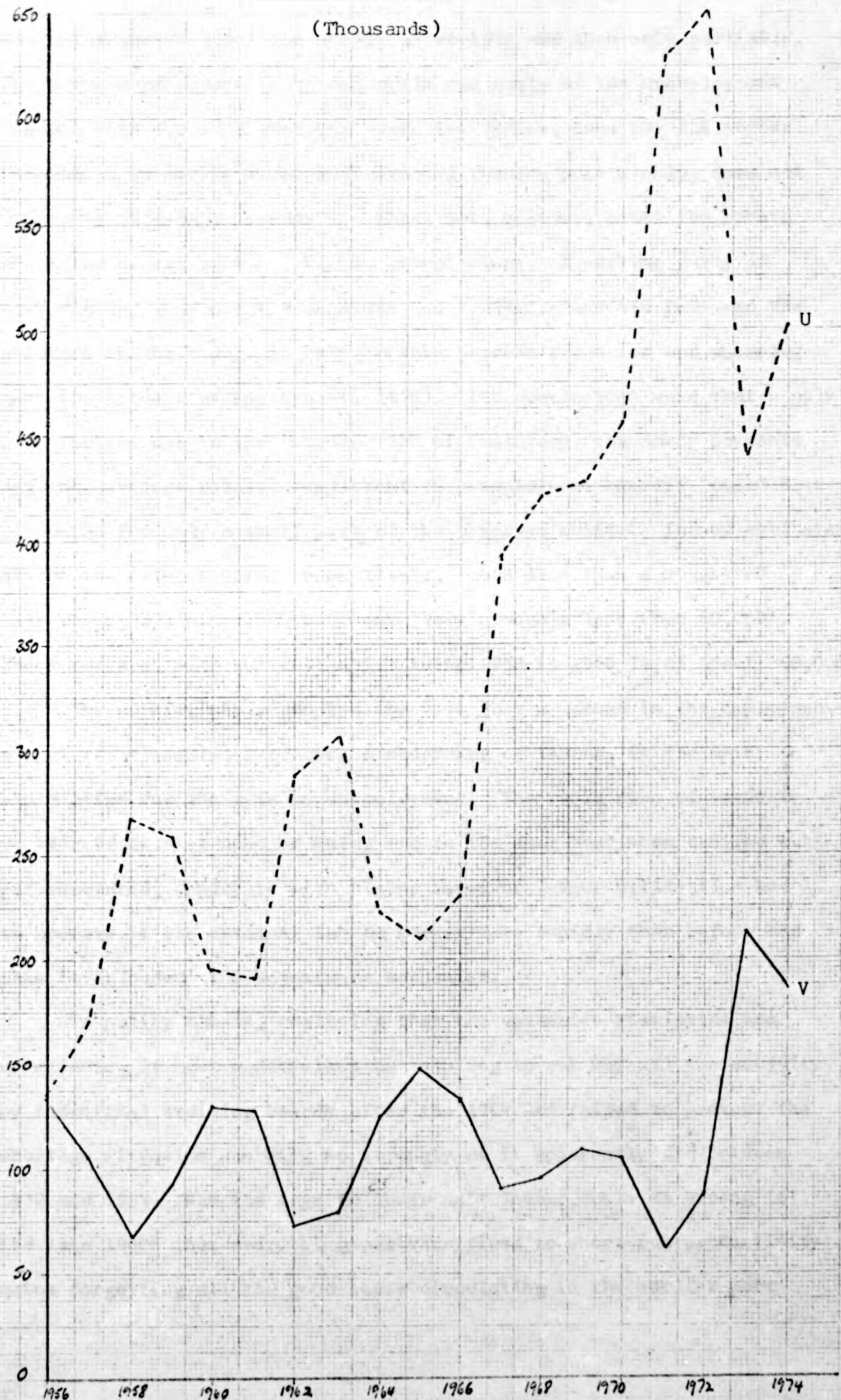


Figure 3.2

Vacancies and Unemployment in All Occupations:

Males in Great Britain 1956-74

(Thousands)



was not reversed until the upturn after 1971 and then only partially. The problem of course is to reconcile the scale of the unemployment changes with the fact that the vacancies series, even for the purist determined to use it as an indicator of turning points only, does not undergo such a major shift. We shall not, however, enter the debate about the causes of this rise in unemployment. A working party of academic and government economists and statisticians has reviewed the evidence on the change in relationship between vacancies and unemployment (Department of Employment, 1976). Its conclusions were that supply side factors due to the introduction of statutory redundancy payments and the earnings related supplement to unemployment benefit 'could have accounted for only a small part of the observed shift.' Indeed estimates of the two effects were, respectively, 'much less than a suggested extreme upper limit of 20,000' and 'very probably less than 50,000'. These compared with the full shift identified in 1966-74 of about 300,000.

The working party adopted the view that a change in the employment-output relationship, producing dishoarding of labour, is the main explanation for the rise in unemployment. The rapid rise of vacancies in 1972-73 is then seen as being due to the fact that, when desired output recovered, employers with higher rates of labour utilisation had to operate in the external labour market more rapidly than before and this 'overloaded' the adjustment mechanism.

To policy makers, realising that the vacancies statistics are unreliable, it must nonetheless be tempting to ask why all the activity by industrial training boards after the 1964 Act failed to prevent the shortage situation emerging so strongly as it apparently did between 1972 and 1973. Was the urge to lower unit labour costs so strong in the late 1960s that everything was sacrificed to short-run productivity gains forgetting all the good sense circulating in the earlier part of the decade about manpower planning and training for the future? Moreover, was the short-run management of manpower so bad that even with high unemployment among skilled men firms were unable to resort effectively to the external labour market after having reduced the supply of internally trained people? For many firms it would seem so.

3.5 The Relative Importance of Manpower Shortages

The theory of the trade cycle is much concerned with the cause of a cyclical down-turn in the economy. A manpower constraint or 'ceiling' is frequently invoked to explain the onset of a recessionary period. Whilst it can be argued that labour and land are in principle the only real long-term constraints on growth, there is much room for other factors to limit the growth of output. The CBI Industrial Trends Survey has, since 1960, recorded the percentages of responding firms who believe that their output is likely to be limited by (i) a lack of orders or sales, (ii) skilled labour, (iii) other labour, (iv) materials or components, (v) plant capacity and (vi) credit or finance.[36] Firms are asked to indicate the most important factor or factors and so the percentages may sum to more than 100. Responses are not weighted by the extent of shortages anticipated. Firms are in effect asked for predictions of their _ex post_ experience in the various markets. What assumptions they make about action intended to mitigate the effects of anticipated shortages one does not know. Expected shortages may cause management to initiate successful remedial measures which would not normally be used and may be costly. Do they then report no shortage anticipated? Given the difficulties of planning and forecasting it is most likely that the expectations reported in the CBI survey are heavily dependent upon current experience. Where considerations of the future influence responses it is most likely to be in terms of _ex ante_ expectations. Management will say that skilled labour is going to be a factor _likely to limit_ output even if firms then take exceptional steps to avoid the anticipated shortage. This is partly because they will be uncertain about the success of the measures to be taken, and partly because planning limitations are such that most firms will

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(36) See, for example, Confederation of British Industries (1972). About 1,400 companies responded.

experience current shortages before they predict future ones and even rapid and effective remedial action will take time to lift the constraint on production during the forecast period.[37]

The percentages of firms reporting that the various factors were likely to limit production in the short-run are given for 1960-75 in Figure 3.3. Whilst one can only interpret the results in a rough and ready fashion they do serve to underline the importance of other factors than labour in constraining production in the short-run. First, taking the survey methodology as it stands, the lack of product demand is generally the most important limiting factor. This was the case even in the 1965-66 period. Second, only very rarely is the shortage of skilled labour replaced as the second most frequently quoted factor likely to limit output, namely, in the 1963 and 1971 recessions by plant capacity and in the 1973-75 downturn by material and component supplies. Third, there is a slight tendency for the skilled labour indicator to peak after the plant capacity indicator and to <u>follow</u> the output cycle of the economy. The latter also applies to vacancies and unemployment statistics, both of which lag GDP by about six months.[38] Whilst such evidence does challenge simple theories which attribute a loss of economic momentum primarily to the lack of skilled manpower, the inter-connections between inter-industry transactions, resource usage, price movements and expectations are too extensive to deny to manpower shortages a significant role.[39] For example, the

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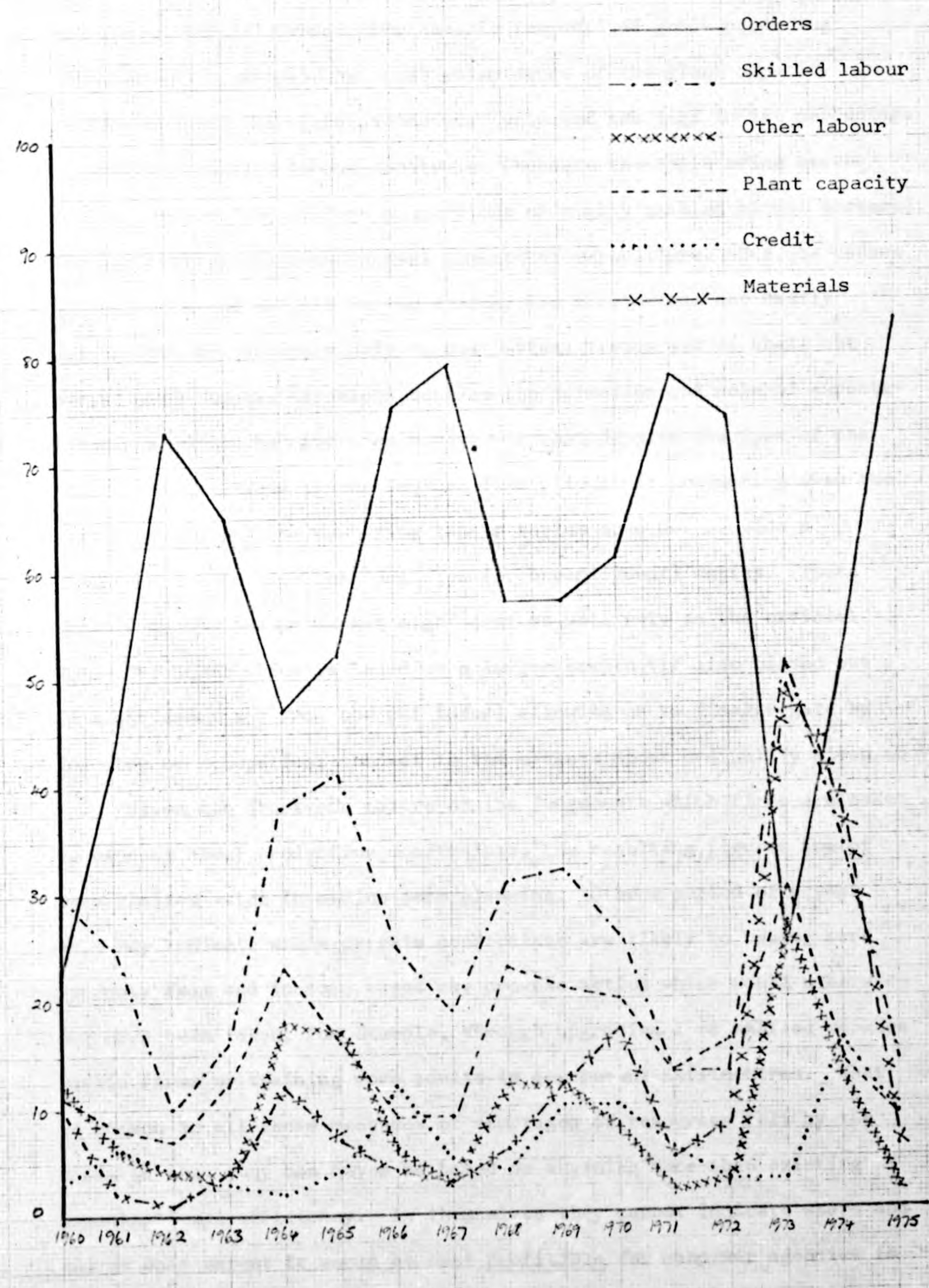
(37) We are assuming that firms do not attempt to convey to government officials and others what firms would like them to believe rather than their genuine impressions of future prospects.

(38) See O'Dea (1975).

(39) A recent internal government report, noting the same phenomenon, states 'whatever interpretation is put on this lag it certainly suggests that factors other than shortages of skilled labour are crucial in understanding the causes of downturns'.

Figure 3.3 Percentage of firms reporting certain factors as constraints on production



volume index for orders on hand held by engineering industries lags behind GDP by about 10 months and actual investment in plant and machinery by 15 months. Delays in fulfilling belatedly placed orders for new plant because of skilled labour shortages in the capital goods producing industry would explain the rough coincidence of the plant capacity constraint with the aggregate output cycle and the lags in the percentage reporting a skilled labour constraint (because the engineering sector employs higher than average proportions of highly skilled manual workers), in engineering orders and actual investment expenditure. But the causes of downturns and upturns in the economy are nonetheless not easily established by reference only to statistical series and we shall not pursue more complex questions such as the formation and role of expectations. What can be concluded however is that despite the form of the CBI Survey questions on the factors likely to limit production over the next four months, the resulting labour series does not provide a significant lead over the vacancies (or unemployment) series. Those monitoring the labour market might just as well rely on the official vacancies index which is based on a larger sample (if also biased but in a different way from the CBI index) allowing us to disaggregate by industry or occupation, subject to the caveats about ordinality given above.

Given the short-run nature of the judgements which firms are asked to express about production constraints, the resulting figures are of very limited value in medium-term planning. Over a period of a year they may indicate where certain constraints are likely to become more severely felt and in some cases may provoke action which would otherwise not have been taken, for example, through upgrading less skilled workers within firms or training more adults in government Skillcentres. What is common to all these measures of shortages of resources felt by the firms is that they can never be based on anything more than existing organisational efficiency. In themselves they cannot indicate where and and to what extent it would be most <u>profitable</u> for manpower agencies to help eradicate shortages. They simply suggest where to start looking.

3.6 Concluding Comments

A recent report by Anderson (1974)[40] of the National Economic Development Office provides a useful backdrop for some general comments on the matters discussed in this chapter. The report has generated much interest and some controversy by questioning the value of meeting alleged shortages of skilled labour. Its main conclusion after a pilot study of eighteen engineering firms is that most skill shortages could probably be eradicated by better management of production and industrial relations rather than increased recruitment and training.

> 'Any perception of the true dimensions of the problem cannot here be more than a general estimation, based roughly upon an assessment of the position in which a normally organised and efficient Company - not to be taken for granted on this survey - might expect to find itself after having explored the policy opinions available. Too many Companies on this survey were too easily prepared to take too many factors as being beyond their control, or outside their concern; it was perhaps therefore asking too much to discuss Hertzberg earlier, when some of these managers seem not yet to know about Elton Mayo.'[40]

These conclusions are however less surprising than the response to them. Committees were subsequently set up to discuss the implications of the project findings most of which had already been underlined ad nauseam by a variety of books and reports published during the nineteen-sixties, for example Shanks (1961), P.E.P. (1965), the National Plan (1965), Jones and Barnes (1967), Ulman (1968) and the Donovan Commission Report (1968) quite apart from the many N.E.D.O. reports of the period. Perhaps this was something of a reaction to realising that despite the 'shake-out' and the current high level of unemployment, which together might have suggested that firms in the nineteen-seventies were more efficient and facing plentiful supplies of skilled labour, firms were in fact still incapable of

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(4)) Anderson (1974), p.62.

organising their manpower affairs 'properly'.

In previous sections we indicated that management decision-making in operating in the external labour market left much to be desired. The NEDO study suggests that even if they attempted more tenaciously to plan to avoid expected shortages, even if they signalled their current and future vacancies for skilled men and trainees carefully and comprehensively to the Department of Employment, so long as these plans are based on the present inefficient use of manpower within firms then national manpower agencies will pursue inappropriate policies. They will concentrate upon augmenting the supply of labour rather than upon improving its utilisation.

However, two main points need to be investigated before we can conclude that, for example, the recently published government plans to increase expenditure on training represent further misapplied effort.

(i) Changing management attitudes and abilities is a longer problem than perhaps envisaged in the 'sixties and the managerial and industrial relations environment in which efficiencies can be achieved is unlikely to be created very quickly and without significant 'transaction costs'.(41)

(ii) Even if the findings of the pilot study are generally applicable to the engineering industry during autumn of 1974, the government is attempting to raise the level of economic activity and this could produce extensive shortages albeit in 'reality' (i.e. à la NEDO) less than actually perceived by companies.

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(41) i.e. the costs of achieving 'X-efficiencies'. See Leibenstein (1966).

Esentially the dilemma is to decide upon the acceptable balance of risks between:(42)

(a) misallocating resources in the interim by producing craftsmen who cannot subsequently find employment in their trades;

(b) failing to maximise growth 'when it comes' because of skilled labour shortages.

Assessing the situation in turn leads on to questions about the the reliability of forecasts of

(a) the future state of the economy;

(b) technical changes which promote labour-saving innovations;

(c) social changes which create conditions in which the efficiency of the labour force (including management) may be improved and the greatest benefit obtained from the advance of technology.

There is a possible danger that during severe recessions, the pressures for reducing unemployment will be transformed into pressures for raising the amount of training well above the level justified by a counter-cyclical manpower policy aiming to reduce the likelihood of bottlenecks to future growth. Training which has only a slight impact upon the individuals productivity in jobs likely to be available in the future might be regarded simply as a short-run welfare alternative to unemployment. However where it is conducted to such an extent that it raises significantly the risk of high unemployment among those skills which could be involved in major reorganisations of manning and production methods in certain industries, then training could indirectly

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(42) This presumes an absence of the illusion that training is one of those major technical devices which will provide a solution to Britain's unemployment problem. Clearly it will not, but, for example, the Manpower Services Commission has had to remind commentators repeatedly to avoid this misconception.

further slow down the achievement of basic improvements in efficiency. This raises many social questions some of which have only to be asked to indicate just how much the state of the labour market has changed since the nineteen-fifties (for example: Is it better for people to have the opportunity to be trained in skills for which they will probably never find proper employment rather than be left with unemployment as the only option until the economy slowly revives?). These broader issues are important but will not be discussed in this study. What should be explained is that the argument about better manpower utilisation versus training cannot proceed without crucial evidence missing from the NEDO survey of engineering companies. That is, some notion of the feasible speeds of adjustment attached to the options theoretically open to management. The NEDO pilot study has stated the problem but without a more detailed set of research studies of the economic and industrial relations aspects of manpower utilisation and technical change, there can be no insight into potential solutions. At the moment one is left with a vague impression that firms could reduce their skilled shortages by employing thrusting, working class ex-shop stewards imbued with the spirit of cooperative enterprise (but not ownership?) and thoroughly trained in modern management methods as mangers of innovation. Unfortunately they too seem to be in short supply.

The NEDO pilot study implies that too much attention has been focussed upon adjustments to supply rather than to demand but further that the supply adjustments have been of the kind to cause an outward shift of the supply schedule rather than a movement along it. In other words the NEDO study partly confirms the results reported by MacKay <u>et al</u> (1971) and discussed in the previous chapter that the wage-structure is tending to encourage downward occupational mobility. This suggests that serious consideration should be given to raising skilled wages relative to the rest since the short-run supply elasticity is likely to be significantly positive. Such action by firms would involve violating the conditions of the current incomes policy. When research begins to throw up these problem areas surrounding those attempting to devise 'active manpower policies' (which hitherto have been carefully pursued so as not to encroach upon the sovereignity of firms' demands for labour and above all upon the preserves of 'industrial relations policies'), it is clear that, especially in present political and economic circumstances, the difficulties of assessing alternative national manpower strategies are considerable. They are made worse by the limited information we have about labour costs for the training and employment of different skills, by imperfections in the evidence indicating that the current industrial and occupational wage-structure is not wholly compatible with an optimal allocation of the available skilled manpower, and by the extreme uncertainties attached to Britain's medium-term growth. These factors mean that the margins for error in the price parameters and resource distributions required for a calculation of the relevant opportunity costs are exceedingly large. At the same time there has been little econometric research done on the nature of the responses which the market itself throws up independently of any action by manpower agencies. We need to construct models of labour markets which provide a basis for investigating the effects of different policies. The present study is mainly intended to be a contribution to the development of such models rather than to the problems of then applying cost-benefit analysis to the outcomes of alternative policies as predicted by the models. No attempt will be made to deal directly with the question of potential improvements to the organisation of internal labour markets nor with the cost-benefit analysis of introducing labour-saving technologies. Despite strictures about ignoring the efficiency of the internal operation of the firm, it is felt that significant insights can be still be gained by analysing the behaviour of firms as observed in the external labour market.

CHAPTER 4 THE SUPPLY OF APPRENTICE RECRUITS TO ENGINEERING

4.1 Introduction

In the previous chapter the entry of young people into apprenticeships was identified as the main point at which engineering firms attempt to regulate the new supply of skilled labour. The recruitment of apprentices is also the only manpower flow in the skilled labour market for which there is regular statistical information available. The present chapter will consider the supply determinants of the flow of young entrants into engineering with particular reference to those taking up apprenticeships. First, we shall deal very briefly with some sociological perspectives on occupational choice. Second, we discuss the demographic and educational trends which will have influenced the supply of school-leavers to the labour market during 1951-71. Third, alternative labour market situations affecting the employment and earnings of apprentices and other school-leavers are assessed. Finally, we specify and estimate supply models for apprentice recruits and all school-leavers entering the engineering industry.

4.2 Sociological Studies of Initial Occupational Choice

This is not the place to survey the extensive literature on occupational choice. Butler (1968) and the collection of articles edited by Williams (1974, especially the introductory essay by Sofer) cover most of the work relevant to the British situation including the major American studies of which those by Ginzberg et al. (1951, 1964), Super (1953, 1964) and Blau et al. (1956) have strongly influenced the theoretical approaches of British studies. The multidisciplinary research strategy adopted by Blau et al. has most affinity with the treatments of occupational choice provided by economists following hard on the heels of developments in the theories of human capital and consumer behaviour. However the link between this earlier study and the work of Becker (1964, 1965), Fisher (1971) and most recently, Ghez and Becker (1972) is mainly in terms of a methodological similarity. Blau and colleagues, unlike Ginzberg and Super, distinguish sharply between the formation of occupational preferences by the individual and his actual entry into a particular occupation. Occupational choice is then a process influenced by the individual's hierarchy of preferences and his expectations of how successful he will be in attaining jobs in those different occupations. Sofer (1974, p.32) interprets this process as involving 'a descent in a hierarchy of preferences...which comes to an end, at least temporarily, by being selected for an occupation'. Economic and sociological as well as psychological variables are expected to determine the outcome of this process and Blau et al. believe that having used their framework to guide the selection of relevant variables, it is an empirical question as to which turn out to be most important in different circumstances. In contrast Ginzberg et al. (1951) concentrate upon occupational choice as the formation of preferences whilst Super (1953) is much more inclined to widen the definition to include the whole process of entry into an occupation during which the development and modification of preferences cannot be distinguished from the compromises made by the individual when his preferences are confronted by limited opportunities. Thus Super would object to the notion that preferences are in a sense 'unconstrained' and act as a set of criteria by which to evaluate alternatives selected from a choice set open to the individual. There is thus a fundamental difference between Super and Blau, Becker, Fisher etc., which is only further increased when one begins to consider more rigorously their implicit or explicit treatments of information, uncertainty and risk, and the rationality of occupational choice.

British research displays similar differences in the definition of occupational choice and the scope of studies into the phenomenon.

However, Butler (1968, p.2) concludes from his review of literature up to the middle nineteen-sixties that

> 'British research in this field is not commonly based on the empirical testing of hypotheses which derive from, and can be related to, sociological or psychological theory. There are exceptions...but because of the absence of general theoretical structures there is much duplication and little comparability. The selection of variables for study tends to be random; question wording varies; the significance of many results is missed; sample size is not optimised on the basis of expected standard errors (which are rarely computed in any case); and other detailed criticisms could be listed. In particular, the methods of data analysis used in sociological studies of occupational choice commonly consist of a series of cross-tabulations, and they frequently miss useful leads that might come from more powerful forms of analysis. In general, investigations conducted in this field by psychologists have employed more imaginative and more fruitful analytical techniques.'

Some of the more recent contributions collected together in Williams (1974) seek to correct this lack of theoretical perspective but the weakness of quantitative analysis is still present in those which include empirical results. The latter means that, however much these exchanges between soliologists may lead us to probe and challenge aspects of economic theories of occupational choice, one must doubt the usefulness of many of the findings of studies which start from sociologically more satisfactory theories. To narrow the discussion to the problem of quantitative modelling we might, for instance, look to empirical soliology for insight into the following aspects of entry into employment:

(i) the determinants of general occupation preferences;

(ii) the decision-making situation governing the way in which general preferences are compromised to produce occupational choices which guide the individual in the medium run;

(iii) the translation of occupation choice into short-run job search activity;

(iv) the major constraints upon decision-makers in (i)-(iii);

(v) the adequacy of information on which general preferences are formed, strategic choices are made and job search proceeds;

(vi) the positions of the main information feedback loops which allow for modification of decisions;

(vii) the rationality of preferences, choices and search activity;

(viii) the degree of explicitness and continuity in the decision-making processes including the formation of general occupational preferences.

The last two points indicate that the clear-cut terms in which decision-making tends to be discussed by economic theorists may be quite inappropriate. This particularly applies to those adopting, effectively, a utility theory of the most tautological form which provides an all embracing theoretical framework allowing the economist to absorb without surprise most sociological theories.(1) We shall however side-step this important aspect which is put forceably (arguing against other sociologists and psychologists) by Super (1953) and, in a rather different context, by Haystead (1971). Turning then to aspects (i)-(iii) it will be observed that the concept of time scale has been introduced when distinguishing three stages in the process of entry into employment. Thus it may not be possible to influence the supply of young entrants to a certain occupation in the medium-run by changing general occupational preferences. These are determined by personality traits such as 'interests, values, attitudes, abilities (intellectual, social and physical), beliefs (including religious beliefs) and knowledge.'(2) In circumstances where it is believed that children are subjected to influences which bias them against skilled manual work in engineering the modification of biased information (i.e. knowledge) may be insufficient to affect general preferences significantly because at this level, for example, attitudes and abilities acquired are more

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(1) This tradition is long and has undermined scientific progress in the application of economic theory to the labour market.

(2) Butler (1968, p.6.).

important and these are more difficult to change. Nor is altering the structure of the education system so as to inculcate a greater interest in science and technology and to provide greater opportunities to acquire basic skills, likely to have a medium-term inpact on the supply of young entrants to technical occupations. Unless one can predict job opportunities further ahead than that it is also arguable whether or not such a policy is justifiable. The strongest position to have been adopted has really been based on the assumption of a dynamic excess demand for people in technical occupations varying from skilled craftsmen to professional technologists (with admitted fluctuations in the mix) together with the belief, not that the education system is failing to bias children sufficiently in favour of the relevant subjects and occupations, but that it is not giving science and technology its fair due in the general educational process. Thus a particular view of the state of the post-war labour market is combined with an objection in principle to unbalanced education.[3] The latter becomes especially important when, as has been argued by some sociologists, attainment is a more important determinant of subject choice than is interest.[4]. If pupils/parents choose subjects with a view to batting from strength then the information on which strength is judged needs to correct for differences in the effectiveness and intensity of teaching given.

It is beyond the scope of this chapter to do justice to the variety of sociological theorising about the formation of what we have described as 'general occupational preferences'. Different taxonomies of concepts appropriate to analysing their determinants also tend to modify the concept of preference itself. This applies especially to the relationship between values and occupational preference. However it has been argued by Ford and Box (1967, p.112) that

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(3) For a neo-classical attack on this position, see Gannicott and Blaug (1969).

(4) See Butler (1968, p.7).

> 'in order to test a general theory of occupational choice it is sufficient to take value orientations as given and explore no further the process by which they are acquired. Indeed, even if it were our aim to develop procedures to enable practitioners to predict the occupational choices of specific individuals it would still be adequate to treat values as an independent variable.'

This view has much in common with the economist taking 'tastes' as given but, of course, ignores all circumstances in which the purpose of prediction is to see whether action should be taken to alter the expected outcome by trying to change values/tastes as well as other factors such as information and the situation as regards constraints (points (iv) and (v) above). Similarly it leaves to one side research into the legitimate means by which and the time-scale on which such changes in general occupational preferences may be significantly achieved.

The choice process has been split into three parts, the second of which involves the specification of occupational areas in which job search activity is eventually planned and executed. This stage crystallises out of the first stage by virtue of the need to take decisions about education and training not directly connected with a particular job. These decisions require the individual to stipulate the strategic position which he wishes to adopt from which to launch his job search. Hence it is necessary to translate general occupational preferences into terms which help to cope with the complexity of decision-making, relating both to information search and the process of evaluation. The perception of a need to make these intermediate choices at certain stages prior to labour force entry is highly influenced by the structural factors imposed upon the individual. It would seem impossible to distinguish a time-profile of decisions which would arise untrammelled by the very powerful channelling imposed by the education system from the one which actually occurs. Most research has understandably concentrated upon establishing where the main constraints operate, giving rise to choices with virtually irreversible consequences, rather than to the alternative decision sequences which might otherwise have been preferred by young people. We shall come to the question of constraints in a moment. As regards the process by which occupational choices are made, several sociologists have described it in terms similar to those of modern labour economics. Ford and Box (1967, p.113) put forward the following theory:

> '1. In choosing between alternative occupations, a person will rank the occupations in terms of the relation between his values and the perceived characteristics of the occupations; the higher the coincidence between the characteristics and his values the higher the rank
>
> 2. The higher a person perceives the probability that he will obtain employment in the higher-ranked occupation, the more likely he is to choose that occupation.'

This sort of reasoning applies especially to cases where the occupational choice must, by virtue of the intervening education and training, take place well in advance of seeking a job. Where an occupational choice is rapidly followed by job search because the relevant qualifications have already been acquired it is necessary to replace this theory with one which deals adequately with the information-job search process where the medium-run probability of finding employment in the occupation chosen is replaced by the short-run probability of obtaining a better job than the one just offered. On the other hand, because the consideration of occupations and jobs involves some evaluation of the likely stability of employment opportunities in an occupation and of the likely security of employment in a particular job, respectively, the treatment of job search activity still requires explicit recognition of the uncertain tenure in a job which has actually been offered as well as the uncertainty attached to the offering of another job.

Little detailed work seems to have been done by sociologists on the process of job search either for its own ends or as a means to studying the way in which occupational choices are revised with additional information about the labour market. In contrast recent contributions by economists appear to have concentrated upon this area as part of the evolving interest in the short-run dynamics of the labour market.[5] They have, however, ignored its connection with occupational choice.

The very nature of such sociological enquiry has led to findings which relate to the interaction of preferences or choices and the limitations placed upon the individual by the social and economic structure. The lack of British cohort studies in which the individual's decision-making is closely followed through time renders it almost impossible to distinguish unconstrained choice from the actual outcome except in certain specific short-run decision situations. Without some attempt to do so (and the concept of 'unconstrained choice' is itself a question-begging notion open to several philosophical and sociological objections) it is difficult to see what the effects of actual or possible structural constraints are likely to be. The mere fact that the enforced choice among school subjects is sometimes made with only limited regard for the implications it has for future employment does not indicate how much a more considered choice or a reduction in the need for limiting options at a particular stage will affect future labour supply to, say, technical occupations. The identification of constraints is however a first step towards an evaluation of the effects of their removal. The main type of constraint which has been investigated by economists is, of course, the demand for labour. A raising of the demand schedule-constraint when the market is in equilibrium is precisely a case where the supply of labour is unaffected unless the wage is also increased. The whole theoretical framework of price theory is built on the distinction between demand and supply by introducing the concept of the schedule.

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(5) See Fisher (1971).

The acquisition of information to guide the preference-choice-search process has been studied by sociologists but the distinction between general information about occupations, specific information about jobs and the associated measures of the probability of obtaining secure employment has not always been sustained. These studies have covered the operation and influence of the alternative channels of information both formal (through schools and the Youth Employment Service) and informal (through the family and peer group) rather than the adequacy of information transmitted.(6) Nor does the evidence presented on the latter point always justify the inferences drawn from it. For example Liversidge (1962, p. 74) concluded that for his sample of secondary school children in fifth and sixth forms,

> 'The general picture that emerges from this study is one of startlingly accurate appraisal of life chances by the children, and a shrewd appreciation of the social and economic implications of their placing within the educational system. They know at what age they will marry, the best type of job they can get, and the best wage they can hope to earn at that job.'

However, the respondents were asked to rank occupations according to prestige in the community and the similarity in their median rankings to those of adults was cited as evidence for children having not only 'a pretty clear idea of the social structure of the community in which they live', but also of 'the position they will occupy in that community when they leave school'. It is not clear how the second statement follows at all from perceptions of prestige. Liversidge's analysis of the accuracy of knowledge about the wage structure adopts a very crude measure of accuracy and really only shows that children in grammar schools were less likely to exaggerate earnings prospects in an occupation than those who attend secondary modern schools. Boys in the latter were especially prone to overestimate earnings. No attempt was made to compare the <u>relative</u> earnings in different

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(6) See Butler (1968, pp. 14-17) and Timperley and Gregory (1971).

occupations as anticipated by these children. Most economists would probably regard the claims of 'startlingly accurate appraisals' as ludicrous given the highly aggregate occupational classes and the limitations of the statistical design. Keil et al. (1966, p.79) nonetheless simply report that 'investigations agree that while knowledge of wages and hours is very accurate, knowledge of work content and training requirements is slight'. Sofer (1974, pp. 34-5) is rather more aware of the outstanding deficiencies which need to be remedied before such strong conclusions as those of Liversidge can be justified.

> 'It is evidently a matter for further empirical research to discover what proportions of school leavers can be specific (and are subsequently proved correct) about the first job they will secure, what proportions are wrong and in what direction they err, and what proportions are simply unable to specify. Within this design one could test various notions about the causes (or at least the obvious possible correlates) of accuracy, vagueness, pessimism and optimism.'

Thus whilst the quotation from Liversidge given above may be music to the ears of economists wishing to relate changes in the supply of young school-leavers to changes in employment conditions (notably wage relativities) and prospects, more thorough research is required before its claims can be accepted. It may seem no longer to be 'sociologically naive' to assume a reasonable degree of adequate information about employment opportunities; certainly young people are not completely ignorant, but the presence of a significant aggregate association between apprentice recruitment and a relative earnings variable (as shown below) cannot be accepted as reflecting a supply influence without more than the usual scrutiny.

4.3 The Impact of Demographic and Educational Trends

Notwithstanding changes in tastes and information which affect the occupational choices of young people, when the entry into employment of those under eighteen years is seen in the aggregate, undoubtedly the two major influences upon the numbers in that age-group joining the labour force are the variations in the size of the population group and the expansion of educational opportunities available beyond the compulsory stage.

The decision to leave full-time education will be influenced by the opportunities for further full-time study on the one hand and the availability of jobs on the other, both with their associated costs and benefits. The resulting activity rates for males and females aged fifteen to nineteen in Great Britain are given in Table 4.1. The drop in activity rates for males between 1951 and 1961 averaged 0.9 per cent per year compared to an average of 0.8 per cent between 1961 and 1966, and 1.9 per cent between 1966 and 1971. For females the corresponding average annual reductions were 0.8, 0.9 and 2.1 per cent respectively. The numbers economically active peaked however between 1961 and 1966. Supplementing the census data by inter-censal estimates of the changes in size of the cohort of school-leaving age we find there have been marked fluctuations in the potential supply of school-leavers requiring employment. Table 4.2 gives the de facto population aged fifteen years for the United Kingdom. Important features are the reduction to 623 thousand in 1956, a sudden increase from 767 thousand in 1961 up to 987 thousand in 1962, followed by a decline to 755 thousand in 1967 and the recent increase from 756 to 800 thousand between 1970 and 1971.

The impact of the state of the labour market and the level of educational provision upon the decision to leave full-time education is difficult to assess given the incompleteness of the statistics on numbers in full-time education for the earlier years (especially those in further education), the need for an adequate measure of the capacity of the education system as opposed to its utilisation and the problems of constructing indicators of the demand for education and of the costs of undertaking it. The outcome has been dominated by educational expansion. For England and Wales the percentages of young people aged

Table 4.1 Activity rates of young people in Great Britain

		Males aged 15-19	Females aged 15-19	Total
Economically active (thousands)	1951	1265	1229	2494
	1961	1350	1256	2606
	1966	1467	1337	2804
	1971	1155	1011	2166
Population (thousands)	1951	1508	1558	3066
	1961	1809	1765	3575
	1966	2077	2011	4088
	1971	1896	1810	3706
Activity rates (per cent)	1951	83.8	78.9	81.3
	1961	74.6	71.1	72.9
	1966	70.6	66.5	68.6
	1971	60.9	55.9	58.4

Source: Census of Population 1951, 1961, 1966 as published in Table 109. British Labour Statistics, An Historical Abstract, 1886-1968. Census of Population 1971.

Table 4.2 De facto population aged 15 years. United Kingdom (thousands)

	Males	Females	Total
1951	272	330	602
1952	285	332	617
1953	328	334	662
1954	338	333	671
1955	333	323	656
1956	316	307	623
1957	343	328	671
1958	373	359	731
1959	392	375	768
1960	389	370	759
1961	392	375	767
1962	505	482	987
1963	458	440	898
1964	428	406	834
1965	411	391	801
1966	395	377	772
1967	387	368	755
1968	388	373	761
1969	392	374	766
1970	387	370	756
1971	410	390	800

Source: The relevant Annual Abstracts of Statistics. Figures prior to 1956 are based on the numbers aged 16 to 20 years in 1956. Due to rounding errors the sum of male and female population figures does not always equal the total figure given.

Table 4.3 The trend in remaining at school (England and Wales)

	Percentages of boys and girls of each age group attending school in January	
	16 years	15 years
1954	15.8	31.5
1955	16.9	32.7
1956	17.7	33.9
1957	18.7	35.1
1958	19.3	36.6
1959	20.7	38.4
1960	21.5	39.8
1961	22.0	40.0
1962	21.9	42.3
1963	24.4	44.4
1964	24.9	58.9*
1965	26.4	61.5
1966	28.2	63.7
1967	29.9	65.6
1968	32.2	68.7
1969	34.2	70.4
1970	35.1	71.2
1971	35.8	72.7

* From 1963 onwards, those pupils who reached school-leaving age (15) during the Autumn Term and wished to leave, were required to remain until the end of the Easter Term.

Source: 1954-67 Layard et al (1969), Tables A4 and A5
1968-71 Statistics of Education for the relevant years.

Table 4.4 The trend in continuing full-time education after leaving school (England and Wales)

Academic Year	Percentages of all School-leavers of each age continuing in full-time education: 16 years	15 years
1960-61	12.5	5.7
1961-62	13.9	6.1
1962-63	13.8	5.8
1963-64	14.1	5.5
1964-65	14.4	3.7
1965-66	15.0	4.3
1966-67	16.5	4.7
1967-68	16.6	4.4
1968-69	17.7	4.6
1969-70	17.5	8.3
1970-71	17.9	8.9

Source: The relevant volumes of Statistics of Education fifteen and sixteen years who were attending school in January 1954 were 31.5 and 15.8 per cent respectively: these had risen to 44.4 and 24.4 per cent respectively by 1963. From 1963 onwards, those pupils who reached school-leaving age during the Autumn term and wished to leave, were required to remain until the end of the Easter term. This causes a considerable discontinuity in the series for fifteen year olds (see Table 4.3). The annual average increase up to 1963 was 1.3 per cent compared with 1.7 per cent between 1964 and 1971, calculated on the new series. The series for sixteen year olds is largely unaffected by this change and reaches 35.8 per cent in 1971. Given the increasing proportion of school-leavers entering further and higher education, the aggregate supply of young people aged about sixteen years (the usual age for entering an apprenticeship) will have diminished even more than is indicated in Table 4.3. The proportions of school-leavers extending their full-time education rather than directly entering employment are given in Table 4.4 for leavers during academic sessions 1960-61 to 1970-71 inclusive.

The outcome of these trends is captured for those under eighteen by the statistics of first employment of young people collected by the Youth Employment Service. Since the extensiveness of coverage varies between regions, these cannot be taken as accurate estimates of all such young people entering employment from the education system. In so far as the coverage does not vary from year to year, these figures do provide an estimate of trends in the pattern of first employment of those under eighteen. In particular, this is the only source of information about the industries and categories of employment entered. One of the categories of employment relates to apprentices and learners.[7] It is not possible to separate the two groups and the combined series is assumed to reflect movements in apprentice recruitment for 1951-71. A further assumption is that recording by the Youth Employment Service of apprentices who are recruited after say a year of further education is no less comprehensive than that for school-leavers. This implies a negligible increase in unrecorded recruitment due to more young people taking up further education prior to entering the labour force.[8]

The total number of school-leavers entering employment in all industries in Great Britain and the de facto population aged fifteen in the United Kingdom for 1951-71 are shown together in Figure 4.1. The supply influence is clearly observed for 1962. A similar pattern results for the first employment of all apprentices and learners, but for the engineering industry the employment of both school-leavers in total and apprentices and learners alone are much less dominated by the size of the cohort of school-leaving age. For example, between 1956 and 1962 the number of fifteen year olds increased by 58.5 per cent, the first employment of all school-leavers and all apprentices and learners increased by 36.3 and 30.8 per cent respectively but for the engineering industry the intake of school-leavers increased by

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(7) The numbers of young first entrants to the labour force are cross-classified by M.L.H. industry and five main employment categories. According to the notes of guidance on the coding of occupations issued to Youth Employment Officers, 'apprentices and learners' should include all those entering an 'apprenticeship or learnership covering a specified substantial period, normally at least three years,,.... which will lead to recognition as a skilled craftsman, tradesman or technician.' Those entering pre-apprenticeship training where there is a firm understanding that it will lead to an apprenticeship proper are also included. Since the statistics arise from the need to issue National Insurance Cards to those starting employment, not all those leavers who have already obtained insurance cards for temporary or part-time work will be recorded, although careers officers try to ensure that their records are complete. Department of Employment Gazette, July 1972, pp. 620-26.

(8) As regards those who begin work before taking up an apprenticeship with the same or a different firm, it is not certain how many of these are recorded as apprentices by the YES. Since this group will have declined during the period it will compensate to some degree for the possible under-recording due to the extension of full-time education.

17.5 per cent and the recruitment of apprentices in fact declined by 4.3 per cent following a peak of recruitment in 1961 which was 5.4 per cent above the 1956 level.

The zero-order correlation coefficients[9] between the number of fifteen year olds in the population and the following variables have been calculated for 1951-71: the total number of young entrants to the labour force (0.451) the total number becoming apprentices or learners (0.816), the number entering the engineering industry (0.046) and the number entering the engineering industry as apprentices or learners (-0.325). Since the supply of all four groups of entrants would be affected by the expansion of higher education, the low association between the recruitment of apprentices by the engineering industry and both cohort size and, as will be shown, the total number of young entrants to employment is somewhat striking.

4.4 An Economic Model of the Supply of Apprentices

It is not intended to provide a fully specified economic theory of occupational choice as a basis for a model of supply. The discussion of section 4.2 underlines the need for an appropriate socio-economic theory if we are to tackle policy issues properly. It remains to be seen whether the development of elaborate neo-classical theories, such as the one put forward by Fisher (1971), will provide testable models which can be used in forecasting situations and policy simulation. A more tentative approach is taken here, perhaps more in keeping with the data presently available.

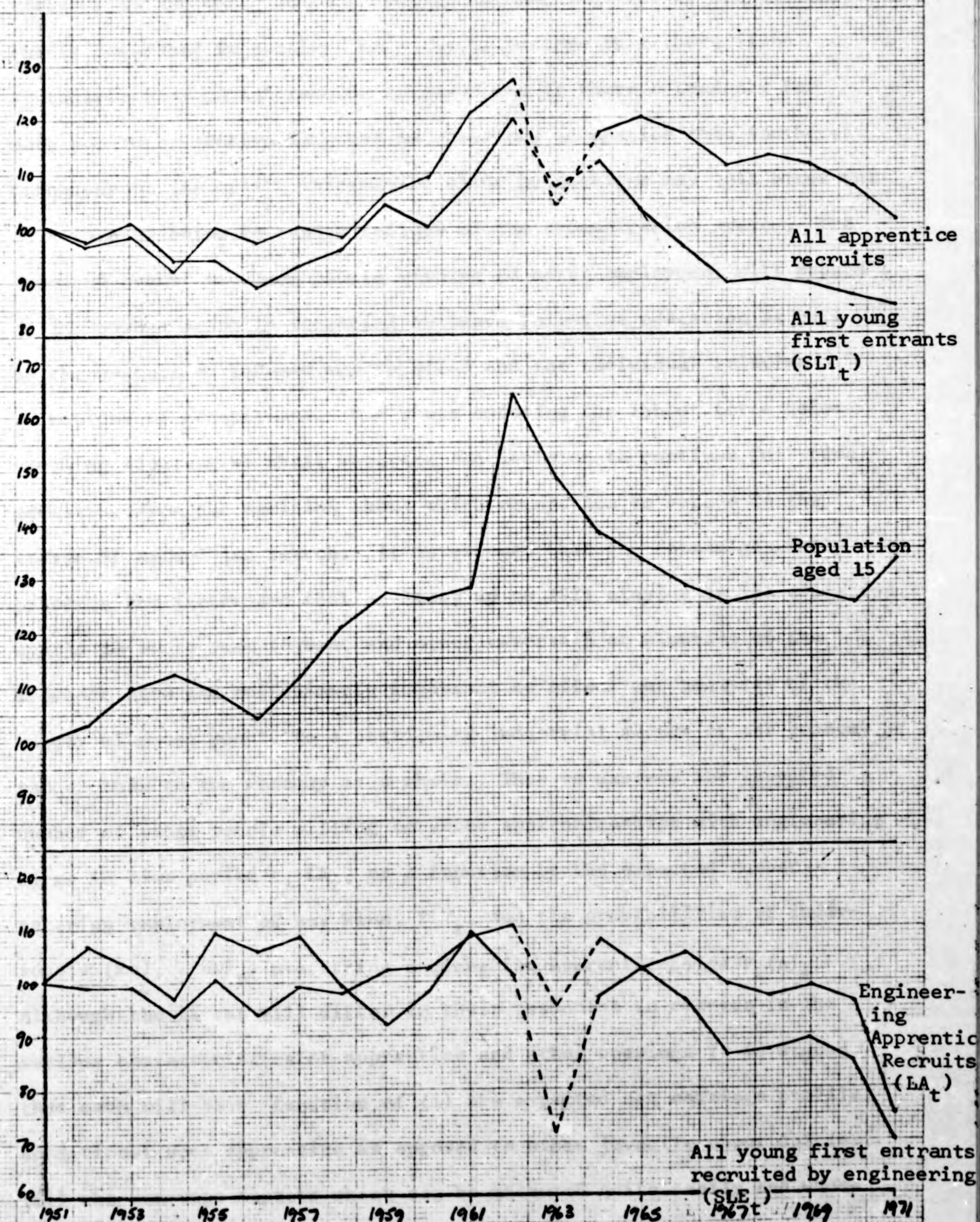
4.4.1 The model

The simple model presented below deals with the decision to enter an occupation-industry and not the choice of hours to be worked. We adopt a probabilitistic approach, positing a random event in which a random individual faced with information about a random occupation

(9) The variables were correlated in logarithmic form.

Figure 4.1

Index numbers (1951 = 100) for groups of young entrants to employment and the population aged 15



considers whether or not to seek such employment. The probability that he will choose an occupation is deemed to be a function of the probability that information is received about it in the first place and that this predisposes the individual to opt for that occupation rather than another. Cutting through the complexities of occupational choice described in section 4.2, let us presume that there is no systematic bias in information received nor is there a tendency for more people to receive information about one occupation than another. Erroneous or incomplete information about occupations may well occur but this is attributed to random failure of the communication system. The expected number of young people wishing to enter employment will depend on the number actually intending to leave full-time education as well as the pattern of information received and the individual relative valuations of occupations. For those entering the labour force before reaching eighteen we shall separate the decision to continue full-time education from the decision about which occupation to pursue in the course of actual job search. It is assumed that the former generally precedes the latter and that at least up to 1971 staying in the education system to avoid unemployment and other reversals or blurring of the sequence were not sufficiently important to affect our analysis of the supply of young people to a particular industrial sector of the economy rather than to the economy as a whole. Thus we express the <u>expected</u> number of young people willing to enter apprenticeships with engineering firms in time period t, LA_t, as a function of the expected number entering employment of any kind, SLT_t, and the probabilities of individuals ($k=1,...SLT_t$) preferring engineering apprenticeships $P_k(A)_t$. Although the latter will differ in their responses to changes in the various characteristics of apprentice and other openings it is argued that each will be a function of (i) the expected net earnings profile conditional upon apprentice as opposed to other juvenile opportunities, (ii) the non-wage aspects which can be measured quite easily <u>and</u> whose general directional influence upon labour supply can reasonably be predicted *a priori*, and (iii) the host of other facts in relation to which it is almost impossible to stipulate *a priori* a generally applicable individual supply response.[10] Denoting these characteristics by E_t, X_t and Z_t and using subscripts A and R to identify initial ports of entry as engineering apprenticeship and the rest, respectively, we can postulate a relationship between them and the mean of the $P_k(A)_t$.

$$\overline{P(A)}_t = g\left\{[E_t, X_t, Z_t]_A, \; [E_t, X_t, Z_t]_R\right\} \quad \dots \quad (1)$$

$$LA_t = SLT_t . \overline{P(A)}_t \quad \dots \quad (2)$$

Since the precise functional relationship g is unknown we shall collapse the comparison of profiles of characteristics associated with alternative ports of entry to the labour force into a set of relativities. Dropping the A and R subscripts, (1) and (2), yield

$$LA_t = SLT_t . \; f(E_t, X_t, Z_t) \quad \dots \quad (3)$$

where E_t, X_t and Z_t represent 'relative' measures. This step of course restricts severely the range of possible functions g compatible with f. Note also that g and f have been assumed to be independent of time. We have already indicated that tastes have not been the subject of very thorough investigation in relation to occupational choice. Since it is also not possible at this stage to find proxies for the main components of X_t and Z_t the relationship used as a basis for estimation is more appropriately written as

$$LA_t = SLT_t . f(E_t, e_t) \quad \dots \quad (4)$$

where e_t is a residual error term.

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(10) For example, whereas additional pension provision by the firm and reductions in hours of work are unlikely, *ceteris paribus*, to lower personal valuations of jobs offered by it, raising the temperature in the factory beyond 65°F and introducing piped music may well cause discomfort to as many as benefit by the new conditions.

The variable E_t is intended to represent the expected earnings profile obtainable via entry to an engineering apprenticeship relative to another category of employment. This encompasses the concept of security of employment in an occupation, not necessarily with the same firm or even industry.(11) Once this modification of the short-run supply model is introduced there arises an estimation problem tied to the measure adopted for relative security of employment. If the individual before looking for a job chooses as his best proxy for future employment prospects in different occupations some function of their relative levels of current unemployment then his supply response will be a function of the relative demands for labour. If further there is a negative correlation between the measure of relative security and the demand for apprentice recruits, then a very strong demand influence enters the estimation of the supply model via the unemployment proxy for relative security. This happens unfortunately in the case of the engineering industry which experiences recessions more heavily than other industries. In theory the relative levels of security of employment could be expressed as functions of past as well as or instead of current levels of unemployment but no experimentation with lag structures is attempted.

Before attempting to estimate this simple model it is necessary to look rather more closely at the labour market responses which will affect the extent to which one observes supply dominated fluctuations in apprentice recruitment.

4.4.2 Labour market responses

It will be useful to characterise the following labour market situations, bearing in mind the discussion in Chapters 2 and 3.

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(11) It is assumed however that most young people entering apprenticeships with engineering firms see their future jobs as being primarily in that industry as well as in the skilled trade chosen.

(i) Wages are slow to respond to relative shifts in demand and supply. Engineering firms have generally wished to recruit more apprentices than there were suitable candidates prepared to leave full-time education, at the market wage.

(ii) Wages offered to school-leavers are sensitive to demand and supply conditions and engineering firms have been able to recruit the numbers they require, given the market wage, but this has involved operating in the completely inelastic region of the supply curve for most of the period.

(iii) The intake of apprentices by the engineering industry was well within the effective supply limit implied by both (i) and (ii) and relative shifts in demand and supply did not lead firms to operate on the perfectly inelastic portions of their supply schedules. Variations in recruitment will then have been demand-determined in the short-run but long-run shifts in the supply schedule will affect the observed recruitment.

The supply and demand situations implied by (i) and (ii) above are represented in Figure 4.2. In the first case, the supply of potential apprentice recruits to an engineering firm is presumed to be highly elastic up to a limit beyond which the firm even by raising wages will not be able to increase recruitment. If the demand schedule shifts to the right of point C, there will exist a shortage CF. This is perhaps the situation normally held to be the case by employers who claim that there is a shortage of recruits. If firms do respond to shortages by raising wages for apprentices then no changes in recruitment will be observed unless the industry as a whole is faced by a supply curve which is not completely inelastic in the appropriate region. Individual firms may gain some advantage but the normal case will be the one indicated in Figure 4.2, in which wages are bid up whenever the demand schedule of the firm shifts beyond point C. From past experience firms may simply choose not to alter their wage structures in favour of apprentices since they anticipate that an increase in the wage bill will occur but

Figure 4.2 The supply of and demand for Apprentice Recruits : the Firm

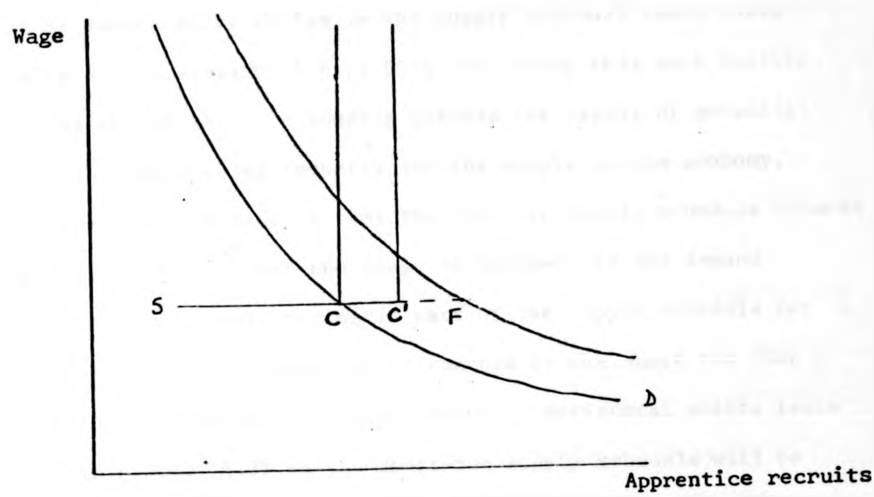
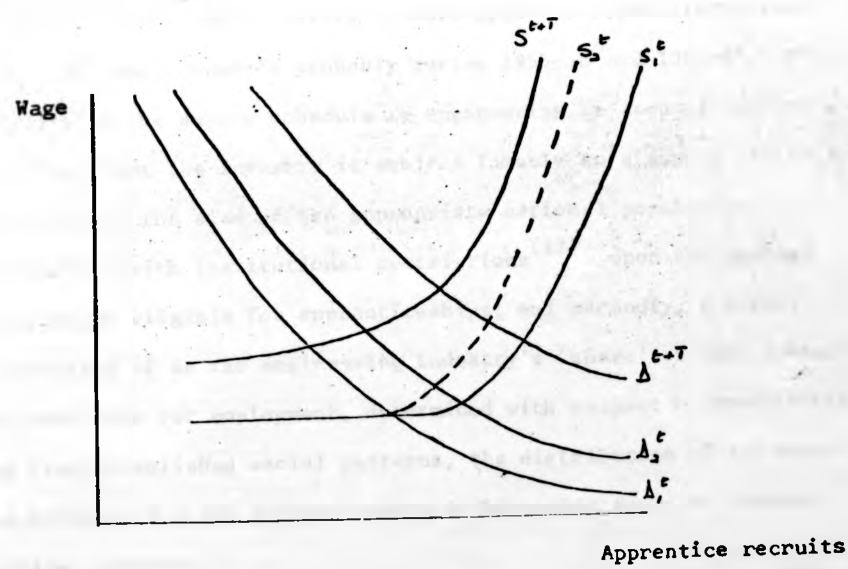


Figure 4.3 The supply of and demand for Apprentice Recruits : the Industry



attempts to increase recruitment will be frustrated. If such firms regularly prefer to operate to the right of point C, observed recruitment will be dominated by shifts in the supply schedule where these are normally of the horizontal type CC'. To pursue this much further we need to establish the relationship between the supply of potential recruits to the engineering industry and the supply to the economy. The critical assumption made is that the industry supply schedule behaves according to Figure 4.3 over the range of movement in the demand schedule. The increasingly inelastic part of the supply schedule for apprentice recruits for engineering is reached in the short-run when a change D_1 to D_2 in desired recruitment occurs. Horizontal shifts (such as S_1 to S_2 in Figure 4.3) in the short-run supply schedule will be caused by changes in demand from other industries. Long-run supply shifts for engineering may be regarded as shifts which are dominated by the demographic and educational trends. These have caused the national supply schedule for school-leavers to move upwards, especially between 1956 and 1962, and downwards probably during 1953-56 and 1962-67. The inelasticity of the supply schedule to engineering is assumed to stem from the fact that the industry is subject firstly to a supply limitation implied by the size of the appropriate national population cohort combined with institutional restrictions[12] upon the age-sex groups normally eligible for apprenticeships; and secondly, a supply limit conceived of as the engineering industry's 'share' of such school-leavers available for employment, determined with respect to immobilities arising from established social patterns, the distribution of industry and the difficulties for school-leavers in borrowing funds to finance geographical movement.

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(12) These of course are to some degree self-imposed and the cost-benefit considerations behind accepting their continuance in times when the supply constraint operates lead to a more complex treatment of decision-making by firms than is attempted here.

Given this view of the supply schedule facing the engineering industry, the situation for the firm will be assumed to be analogous. Hence in place of the extreme adopted in Figure 4.2 the situation for the firm is considered to be similar to that of the industry shown in Figure 4.3.

4.4.3 The available data

In addition to recruitment and population data already mentioned, the testing of the explanatory power of a supply model for observed recruitment requires information about the changes in the attitudes and abilities of school-leavers and in the job content of trades to which young people are apprenticed, and indices of the costs and returns for school-leavers considering different jobs. No time series information exists with which to chart changes in attitudes towards jobs. As regards both the abilities of school-leavers and the requirements of jobs, there is no statistical information which captures these effects satisfactorily and from which some series of the variations in 'quality' of labour supplied and demanded might be constructed. The obvious quality index available for supply for the latter part of the period would be some measure of examination attainment but there is probably no clear relationship between the number of C.S.E.s or 'O' levels an individual may have obtained and his potential performance as a skilled craftsman. Furthermore the apparently casual selection methods adopted in apprentice recruitment belie the concern with the quality of supply expressed by employers interviewed in the early part of the period.(13)

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(13) 'In many firms indeed, provided the boy looked reasonably fit physically and was obviously not mentally defective, this was all that was required.' Williams (1957, p.15). In the case of the engineering industry, 'firms with a very high reputation usually have more applications for apprentice vacancies than they can accommodate ... and take a fair amount of trouble to select on the basis of school records and interviews. But the majority seem to be very much more casual in their methods and trust to their belief that any boy who is obviously unsuitable will be picked out....' during the preliminary year from fifteen to sixteen prior to starting the apprenticeship proper (ibid., p.79).

Complaints by firms would seem to be as much a reflection upon their conditions of training and employment as upon the abilities of interested school-leavers. As a result of their survey, the E.I.T.B. report that 'Forty per cent of the firms amongst both those who did and those who did not provide off-the-job training in 1968-69 complained of difficulties in recruiting boys of the right calibre, e.g. boys who could show an acceptable level of interest and application to the job... The more self-critical firms recognised the comparatively poor conditions and limited training opportunities they had to offer as being the main cause of this problem and it is significant in this context to note that it was amongst the firms employing a hundred or fewer that complaints about recruitment problems were most frequently voiced.'[14] Small firms of course face particular difficulties associated, among other things, with irregular labour turnover and there has been considerable discussion about the development of more appropriate training schemes in which they might participate.[15]

For the costs and returns to school-leavers of different jobs the published data available for 1951-71 relate to wage rates and average earnings of young people and adults, regardless of skill. Since 1963 the Department of Employment has published[16] half-yearly, average earnings data for manual men in the engineering industry according to

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(14) Survey of First Year Craft Training 1971, Part II, p. 17, E.I.T.B. (1971). The Phelps Brown Committee reached broadly similar conclusions regarding the quantity and quality of the supply of boys willing to become apprentices in the construction industry. Report of the Committee of Inquiry into Certain Matters Concerning Labour in Building and Civil Engineering, 1968, pp. 49-51. Cmnd. 3714, H.M.S.O.

(15) See the Report on the Committee of Inquiry on Small Firms (Chairman J.E. Bolton) 1971, Chapter 14, Cmnd.4811, H.M.S.O.; Report on the Attitudes of Large and Small Firms to the Board's Proposals for New Levy/Grant Schemes 1969, E.I.T.B. (1970); and Lee (1972).

(16) See British Labour Statistics. Historical Abstract 1886-1968. Department of Employment and Productivity (1971), Table 60, H.M.S.O.

payment system and broad skill category (skilled, semi-skilled and labourers). Earlier data exist from surveys conducted by the Engineering Employers' Federation but this is based on a sample of federated firms only.(17) It is possible to link these series together but there are additional problems in constructing series for apprentices in engineering and for both skilled workers and apprentices employed outside the industry. We therefore rely on the earnings of youths and adult male manual workers in engineering, relative to the corresponding figures for all industries, to reflect the relative earnings prospects perceived by young people in considering whether to enter an apprenticeship in the engineering industry or to take any other job. A consequence of the availability of data on earnings is that we are unable to proxy the earnings of apprentices and skilled men in engineering relative to the earnings of other youths and men respectively in the industry. In the supply model tested in the following section the focus is upon the choice between an apprenticeship in engineering and any other job outside the industry. In particular it is not possible to consider, over the two decades, the specific choice between an apprenticeship leading to traditionally skilled employment and an initial job as a semi-skilled worker leading to semi-skilled or perhaps skilled work in adult life.

Problems with the use of unemployment figures to capture the perception of relative security in employment have already been mentioned. On the face of it the danger of introducing a demand variable can be reduced through the choice of an unemployment relativity which is dominated by the situation in the adult skilled labour market. However, as will be seen in the following chapter, the demand for apprentices is very strongly related to the state of the market for skilled craftsmen.

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(17) According to the Federation's Census of 1964, approximately two million workers were covered by its member firms out of an engineering labour force of about 3.4 million. Their earnings enquiries cover ninety to ninety-five per cent of the employment in their firms. (Marsh, 1965, pp. 2, 42 and 179-195).

A further point is that percentage unemployment rates cannot be used in the calculation of the relativity because prior to 1963 no annual series of observations on the numbers of skilled engineering craftsmen existed. Figure 4.4 presents the shifts in (a) the unemployment of skilled workers in engineering trades relative to the total wholly unemployed in Great Britain, $(U_c/U_T)_t$, (b) average weekly earnings of adult male manual workers in engineering relative to the earnings of the group in all industries (EM_t), and (c) average weekly earnings of youths in engineering relative to the earnings of youths in all industries (EY_t).

Bearing in mind previous comments on the problems of empirical analysis of the factors which influence the choice between entering the labour force and remaining in full-time education, the supply model estimated below deals only with a choice between alternative employment opportunities. The assumptions of the model and their relation to the data are summarised as follows:

(a) school-leavers in choosing whether or not they prefer an apprenticeship in the engineering industry to taking any job outside the industry are rational and sufficiently well informed to be responsive to changes in the characteristics of jobs and in expected security of employment;

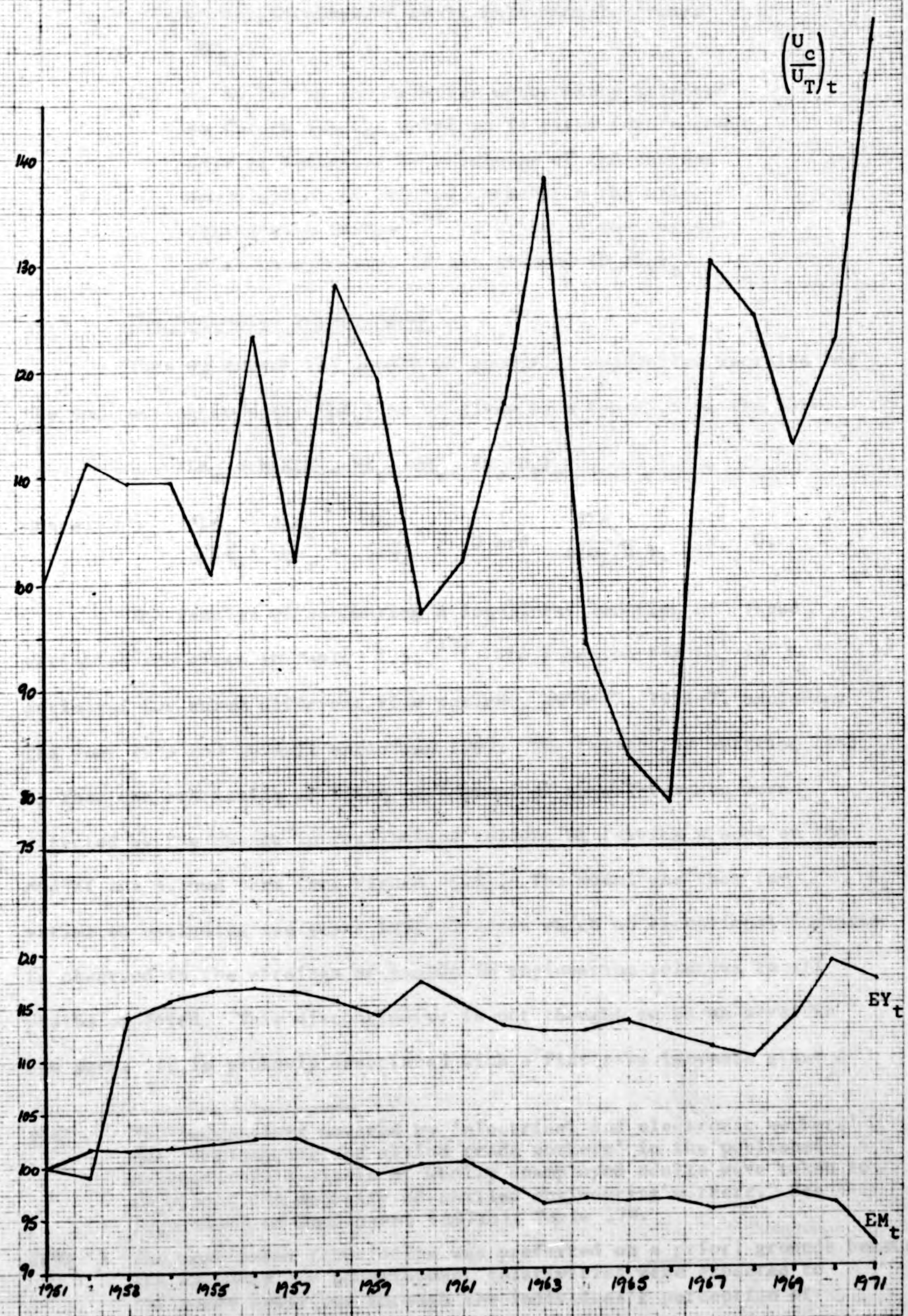
(b) shifts in the relevant supply schedule due to changes in the population of school-leaving age and in educational policy are assumed to be measured by the total numbers of school-leavers under eighteen entering employment (SLT).

(c) the time-profile of non-wage net benefits is highly correlated with the net earnings stream obtained from a job and/or constitutes a much smaller part of the return on the individual's investment;

(d) the main features of the net earnings stream from an engineering apprenticeship relative to the return from any job outside the engineering industry are captured by the average weekly earnings of youths in engineering

Figure 4.4

Index numbers (1951 = 100) for the relative unemployment and earnings variables



relative to those in the economy as a whole (EY_t) and by the corresponding relative average weekly earnings of adult male manual workers (EM_t);

(e) in so far as the relative uncertainty attached to future average earnings is taken into account, this is dominated by knowledge of the current unemployment of skilled workers in the main engineering trades[(18)] relative to the current total unemployment in the economy $(U_c/U_T)_t$.

4.5 The Estimated Supply Model

Thus we expect the supply of potential apprentice recruits for the engineering industry (LA_t) to be given by a function of the form,

$$LA_t = h(SLT_t, EY_t, EM_t, (U_c/U_T)_t)$$

where $$\frac{\partial LA_t}{\partial SLT_t}, \frac{\partial LA_t}{\partial EY_t}, \frac{\partial LA_t}{\partial EM_t} > 0 \text{ and } \frac{\partial LA_t}{\partial (U_c/U_T)_t} < 0.$$

The results of estimating a log-linear function of these variables are given in Table 4.5.[(19)] The equation for LA_t is estimated for three different time periods, 1951-71, 1951-71 excluding the year 1963 and 1953-71 excluding 1963. The reason for omitting 1963 is that the statistics of first employment of school-leavers were affected by the change in regulations concerning leaving school at the end of the autumn term (see Figure 4.1). The model was then re-estimated excluding the years 1951-52 after which an exceptional increase is observed in the earnings of youths in engineering relative to all youths employed. This discontinuity is not thought to be an error in the data. It is probably associated with a flat rate increase granted

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(18) The occupations covered by 'electrical and electronic workers' and 'engineering and allied trade workers' in the published occupational analysis of wholly unemployed adults were taken to represent the majority of skilled engineering workers. See Department of Employment (1971b), Table 174.

(19) The non-linear formulation was preferred on a priori grounds because the earnings and unemployment relativities were expected to influence behaviour through the individual's perception of proportionate rather than absolute changes.

to apprentices in a negotiated agreement but is clearly of such a different order of magnitude from other movements in the series that the estimation of the relationship excluding 1951-52 is of some interest.

In view of the fact that the earnings variables for engineering relate to manual workers and not to apprentices and craftsmen specifically, the equations have been re-estimated adopting as the dependent variable the total number of young people under eighteen entering the engineering industry for their first job. The relative unemployment variable chosen for the first set of regressions has been retained on the grounds that this will probably reflect the relative risks of unemployment perceived by young entrants to the labour force. The statistics of unemployment attributed to the engineering industry will follow closely those relating to the group dominated by skilled engineering workers.

The explanatory power of the model is greater for all young entrants to engineering, SLE_t, than for apprentices and learners alone, LA_t. In both cases, for all time periods, the adult earnings relativity and the unemployment ratio possess the expected signs and are significantly positive and negative respectively at the one per cent level. SLE_t is also significantly associated with the variable SLT_t representing all young entrants to the labour force. The coefficient is positive as expected and significant at the one per cent level for all periods of estimation. The coefficient on the earnings relativity for youths is not significantly positive in any of the equations estimated.

Variations in apprentice recruitment, in so far as they have been affected by changes in supply conditions only, appear to have been determined mainly by shifts in the supply schedule relating to changes in adult earnings and skilled unemployment rather than to shifts due to fluctuations in the aggregate number of young entrants to the labour force. In the case of all young entrants to the engineering industry,

Table 4.5: Supply Model Estimation

Dependent variable \ Independent variable	Constant	log SLT_t	log EY_t	log EM_t	log $(U_c/U_T)_t$	R^2	$\bar{R}^2$	DW
Period 1951-71								
log LA_t	11.267 ** (1.245)	-.1548 (.1675)	-.1022 (.3185)	1.7978 ** (.5193)	-.3400 ** (.0971)	.6776**	.5769	1.841
log SLE_t	7.467 ** (.567)	.7214 ** (.0763)	-.0268 (.1450)	1.4592 ** (.2364)	-.1993 ** (.0442)	.9354**	.9153	1.530
Period 1951-71 ex.63								
log LA_t	11.609 ** (1.292)	-.0336 (.1690)	-.1210 (.2967)	1.6441 ** (.4887)	-.2699 ** (.0979)	.6442**	.5256	1.592
log SLE_t	7.496 ** (.652)	.7181 ** (.0854)	.0273 (.1498)	1.4629 ** (.2468)	-.2013 ** (.0494)	.9355**	.9140	1.533
Period 1953-71 ex.63								
log LA_t	11.848 ** (1.261)	-.0929 (.1693)	-1.2257 (.7930)	2.0166 ** (.5467)	-.2576 ** (.0966)	.6996**	.5841	2.022
log SLE_t	7.590 ** (.670)	.6928 ** (.0900)	-.4247 (.4214)	1.6174 ** (.2905)	-.1942 ** (.0513)	.9411**	.9185	1.674

Standard errors are in brackets. Coefficients significantly positive or negative at the five and one percent levels are denoted by * and ** respectively. The significance of the overall relationship is similarly indicated.

significant shifts in the supply schedule also appear to have been caused by changes in the total number of young people entering employment.

As regards movements along the supply schedule, the coefficient of variation for the relative earnings of youths was 4.3 per cent. It is arguable whether or not this variation was sufficient over and above the variation expected as a result of shifts in the supply curve, to be associated with much movement along the curve and hence to identify the shape of the schedule. The estimation involves only twenty or so annual observations and the usual problems of timing are present when using flow variables such as output and recruitment and point observations of earnings and unemployment relativities. Thus the apparent inelasticity of the supply of both apprentices and all first entrants with respect to their immediate relative earnings prospects should be treated with some reservation.

We would expect the omission of 1963 to affect the equations for apprentices more than that for all young entrants. This is because the pattern of absorption into the labour force during a year is more skewed for apprentices than it is for other categories. SLE_t would therefore reflect the discontinuity in SLT_t more than would LA_t. However the coefficient on SLT_t for LA_t remains insignificant. Given that 1963 is also a major peak in the unemployment of skilled engineering workers relative to total unemployment, then it is not surprising to find that the coefficient on log $(U_c/U_T)_t$ is affected by omitting that year, changing in the expected direction from -0.34 to -0.27. There is also a reduction in the adult earnings elasticity. The goodness of fit of the model for LA_t drops and the Durbin-Watson statistic indicates the presence of positive autocorrelation.[20] The 'exploratory'

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(20) Note however that in calculating the statistic the omission of 1963 has been ignored, 1964 following 1962.

omission of the observations for 1951-52 in addition to that for 1963 revives the $\bar{R}^2$ statistic and removes the autocorrelation. The coefficient on log $(U_c/U_T)_t$ is not significantly affected but the elasticity of supply with respect to adult relative earnings rises from 1.64 to 2.02 as a result of shortening the estimation period to exclude the early 'break' in the relative earnings series for youths. The coefficient on this last variable is still insignificantly negative.

The coefficients on SLT_t, EM_t and $(U_c/U_T)_t$ in the equations estimated for all young first entrants (SLE_t) to engineering are significant and stable with respect to changes in time period except for an increase from 1.46 to 1.62 in the adult relative earnings elasticity when the observations for 1951-52 are excluded. Negligible changes in $\bar{R}^2$ but some reduction in positive autocorrelation accompany the removal of observations for 1951-52 and 1963 from the estimation. The coefficients on EM_t and $(U_c/U_T)_t$ for SLE_t are of the same order of magnitude as those for LA_t.

It is a matter for further enquiry whether more information about earnings relating directly to apprentices and craftsmen can be obtained. Unfortunately the relative earnings as well as unemployment variables will capture shifts in demand. The choice of average weekly earnings, on the grounds that young entrants are most influenced by their expected earnings from one source of employment, incorporates shifts in relative demand through changes in the overtime component. In view of the moderate explanatory power of a supply interpretation of fluctuations in apprentice recruitment (approximately 70 per cent of the observed variation at best) and the ambiguity attached to the role of the explanatory variables, it is clear that the single-equation model of supply is inadequate by itself.

The markedly better performance of the equation for all young first entrants, explaining about 94 per cent of the observed variation, points to the influence of the 'pool of school leavers' upon the size of the total intake to the engineering industry.

The final comments on the supply of school-leavers to the engineering industry concern the timing of explanatory variables and the presence of lags in the response of individuals to changes in economic conditions. The entry of school-leavers to employment is concentrated at the end of the spring and summer terms. In the model above we have chosen as our dependent variable the relevant number of young people joining the labour force during a calendar year. Monthly or quarterly data are not available for the earlier half of the period. With any flow variable there arises the problem of simultaneity between it and the earnings variable within the period over which the flow has been aggregated. In addition there exist only half yearly observations of the earnings of young people in industry. Here, whatever simultaneity exists between the entrant flows and the earnings variables has been ignored. Furthermore, since the earnings relativities for youths in April and October were so highly correlated, no interpolation of the figures has been attempted; observations from the October enquiry have been adopted on the marginal grounds that this month is closer on balance to the major period of recruitment. The unemployment relativity corresponds to September.

A major problem of testing for the presence of lags in adjustment in single equation models of supply or demand is the fact that the estimated adjustment parameters will probably reflect a mixture of demand and supply effects. Our knowledge of the information which school-leavers have about alternative job opportunities and how they make decisions is rather limited. The use of simple lags of six months or one year in the earnings and unemployment relativities makes little difference to the results shown in Table 4.5. Other sources of lagged adjustment exist however in addition to those which correspond to a combination of the delay in the communication of information about changes in earnings and risks to school-leavers and the time taken for this to affect actual supply. For example, the number of school-leavers interested in engineering apprenticeships this year may be influenced by the number entering such jobs last year, through whom they may receive information and encouragement. Without further rationalisation we postulate an adjustment process of the type,

$$\frac{LA_t}{LA_{t-1}} = \left[\frac{LA^*_t}{LA_{t-1}}\right]^{\lambda} \qquad 0 \leq \lambda \leq 1$$

where desired supply $LA^*_t = h(SLT_t, EY_t, EM_t, (U_c/U_T)_t)$ and similarly for SLE^*_t. This is of course equivalent to a distributed lag in which successive weights are geometrically distributed. Adding the required lagged dependent variable to the supply equation and re-estimating the model, we find that the previous coefficients and overall explanatory power are not significantly affected and that λ is not significantly different from unity. A rather different situation arises when such an adjustment process is added to single equation models of demand.

4.6 Conclusions

This chapter set out to explore in aggregate the supply determinants of apprentice recruitment by the engineering industry. There remain lingering doubts about the presence of demand effects in the independent variables employed in the estimation of the model. What is most striking however is the lack of a significant relationship between the total number of school-leavers entering the labour force and the recruitment to apprenticeships in engineering. Had there been supply problems running through most of the two decades to such an extent that changes in earnings could not have been expected to increase the supply of suitably qualified recruits very effectively, then one would have expected to see engineering firms stepping in to take advantage of the large increase in school-leavers in the early nineteen-sixties. As it turned out there would seem to have been a much greater relative shortage of manpower planners than adequately qualified school-leavers willing to enter engineering apprenticeships. The notion of an engineering industry trying to overcome the unbalanced view of skilled manual employment presented to young people by the education system and the lack of proper qualifications among young leavers is not a credible one. Bias may occur, tastes may well have changed and alternative employment and educational opportunities have certainly increased for those who would have previously aimed at a skilled manual trade. But the absence of medium-run planning of manpower resources in order to anticipate short-run supply inelasticities would seem to be the main cause of supply problems at this level.

Monitoring the potential supply of apprentice recruits is nonetheless an important function. It may not have been the main constraint upon apprentice recruitment in the past but it probably has limited the extent to which management has been able to make up belatedly for errors and omissions and is always a potential constraint upon recruitment activity in the future. In this respect there are strong arguments for the systematic study of attitudes among schoolchildren to skilled manual trades in the kinds of working environment provided by the industry. Enquiries repeated at intervals, using the same basic design, would help to establish changes which have taken place and to indicate where improvements in the reality, not just the image, of engineering apprenticeships might be possible. Such enquiries would cover the economic as well as sociological variables which affect occupational choice. In conjunction with the development of quantitative models they would provide a much firmer base for policy-making than presently available.

Finally, to return to the Engineering Craftsmen Matrix described in Chapter 2, the (calendar year) flow into first year apprentice training has been measured by the DE young entrants statistics. This series begins in 1950 whereas the various EITB training series used in Tables 2.11 and 2.12 begin much later, in 1966. Furthermore the DE statistics can be disaggregated into the separate industry groups identified in Chapter 3. This will be exploited in Chapter 6. The analysis of apprentice recruitment presented in this chapter investigated whether or not fluctuations in observed recruitment can be explained mainly by movements along and shifts in the supply schedule. Relative earnings are treated as exogenous and a situation of excess demand is assumed to exist during the period although there may be significant shifts in the demand schedule.

CHAPTER 5 THE DEMAND FOR APPRENTICE RECRUITS BY THE ENGINEERING INDUSTRY

5.1 Introduction [1]

The purpose of this chapter is to investigate the demand determinants of apprentice recruitment by the engineering industry during the period 1951-71. We are not directly concerned with whether or not the recruitment response of firms has been optimal from the point of view of the industry as a whole or the national economy. One might expect however that the development of an economic model of past recruitment may contribute to the discussion of this question and of the problems associated with establishing economic criteria for adjusting levels of skilled labour supply in pursuit of an 'active manpower policy'. Furthermore such a model would provide a basis for the development of models to forecast future recruitment. These forecasts should be relevant to policy makers concerned with the employment opportunites likely to be open to future school leavers and, more generally, with the efficient operation of the labour market for skilled manpower. For example, the provision of forecasts up to three years ahead, as opposed to enquiries of firms' recruitment intentions within a year of the actual recruitment taking place,[2] would assist a Training Board or other manpower agency to plan future expenditure relating to craft trainees.

A single equation model of the supply of apprentice recruits has been described in the previous chapter. Here we concentrate upon a single equation model of demand although an adjustment process, introduced to accommodate lags in the response of demand to changes in

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(1) This chapter is a slightly extended version of the article cited as Lindley (1975b).

(2) Such surveys are presently conducted by the Engineering Industry Training Board.

economic conditions, will capture supply influences upon the extent to which desired recruitment is achieved. A simultaneous treatment of demand and supply is not attempted in this chapter.

The determinants of desired recruitment which seem to dominate in practice have been discussed in Chapter 3. After reviewing the published research throwing light upon the major factors influencing firms in reaching manpower decisions, especially those relating to the recruitment of craft trainees or apprentices by the engineering sector, it was suggested that a model of desired recruitment could reasonably adopt certain behavioural assumptions as being valid for the major part of the period 1951-71. These amount to assuming that recruitment policy is sensitive to the current state of the labour market rather than to the results of manpower forecasting exercises which imply an investment view of apprentice recruitment. There is however an important caveat to this in that coinciding with current labour shortages may occur optimistic expectations about future product demand together with an ability to pay for investment in human as well as physical capital. The contribution which a new apprentice can make to current production may then be less important than the availability of funds especially when sales revenues are buoyant.

As regards the relationship between current manpower shortages and the pace of capital-skill substitution our review of the evidence available (see Chapter 3) leads us to assume that the rates of labour-saving technical progress and capital accumulation are exogenously determined; the models developed are thus concerned with short-run adjustments in labour demand given that firms decide upon production levels in accordance with the available capital services.

The following section presents a treatment of demand based upon the assumption that the contribution to current production which apprentices make is largely responsible for variations in levels of recruitment. Whilst maintaining the current production hypothesis, section 5.3 introduces further considerations relating to the influence of supply, the production of skilled labour services, the representation of technical progress, and the objective function of the firm. In section 5.4 we investigate a modified demand hypothesis which includes the effects of variations in expected future production levels as well as current production upon the recruitment of apprentices.

5.2 Recruitment for Current Production

In this section we consider firstly a constrained output-current cost minimising model of the firm's decision to recruit apprentices and craftsmen in perfectly competitive labour markets. This model is then adapted to allow for shortages of craftsmen but not of the skilled labour services required to produce the planned output; thus we continue to assume that actual output equals desired output. Adjustments in the mix of apprentices and craftsmen to minimise the cost of providing skilled labour services at a new level are considered to be instantaneous until, in part 5.2.3 we allow for a lag in the adjustment process and hence for a period of sub-optimal operation in which planned output might still be achieved but not at minimum cost. However there exists an inconsistency in the specification of the resulting model which allows the possibility of a failure to comply with production plans. This aspect of the model is taken up later, in section 5.3.4.

5.2.1 Perfectly Competitive Markets for Craftsmen and Apprentices

The following assumptions are made about decision making within the firm and the co-operation and substitutibility between factors of production.

(i) Firms fix levels of current production which are compatible with the capital services at their disposal and in accordance with developments in their product markets.

(ii) Capital stock is fixed in the short-run and its long-run development is unaffected by current difficulties in securing the required labour services to operate capital at the desired level of utilisation.

(iii) Labour of three broad types is employed; skilled craftsmen, apprentices and other employees. Only substitution between the first two groups is possible in the short-run and they are the sources of skilled labour services.

(iv) Capital-labour substitution cannot occur in the short-run.

Assumptions (i) and (ii) imply that neither production plans nor long-run capital formation are affected by the state of the labour market. In particular firms do not alter the time profile of output in accordance with expected changes in the relative prices of labour factors.

Assumptions (iii) and (iv) imply that desired output uniquely determines the required capital services and the amounts of skilled labour and 'other' labour required to operate the capital stock at the appropriate level of utilisation. The combination of apprentices and craftsmen is chosen with respect to the production function for the provision of skilled labour services and the supply situations in the markets for apprentices and craftsmen; the preferred combination is independent of the market for 'other' labour.

As regards the factor markets, given that capital formation is assumed to be exogenous to the determination of employment, we are only concerned with those for labour. It is assumed that,

(v) the market for 'other' labour is perfectly competitive, each firm facing a perfectly elastic supply schedule;

(vi) in minimising costs firms normally operate in the highly elastic part of the supply curve for apprentice recruits defined with respect to immediate earnings prospects (see section 5.3.1 below).

Initially we also assume that the supply of craftsmen to each firm is highly elastic at the market rate. Given this last assumption no shortages of any type of labour will arise and so actual output (Y_t) will equal desired output (Y_t^*).

We now cast the above system of production into specific functional forms. The required capital services (K_t^*) are related to desired output through

$$K_t^* = Ae^{-\alpha t}(Y_t^*)^{\theta} \quad \text{......................... (1)}$$

where α is the exponential rate of capital-saving technical progress and θ is the short-run elasticity of demand for capital services with respect to output. We expect $\alpha \geq 0$ and $\theta > 0$ and assume both to be constant throughout 1951-71. In not adopting the normal putty-clay model in which $\theta = 1$ and the capital services-output ratio is fixed in the short-run, the preference for (1) arises from the view taken of capital usage and economies of scale in the short-run. Firstly the choice of which vintage of capital stock to lay-off when not running at full capacity will involve a change in the observed aggregate capital services-output ratio due to differences in the (fixed) capital services-output ratios of different vintages. Secondly there exist economies of scale in the short-run which derive from the fact that there are some capital services which do not vary proportionately to changes in other capital services. These two influences may have opposite effects upon the determination of θ.

The demand for skilled labour services (LS_t^*) to operate the capital stock at the required level of utilisation is represented by

$$LS_t^* = Be^{-\beta t}(K_t^*)^{\phi} \quad \text{..................... (2)}$$

where β is the rate of labour-saving technical progress and $\emptyset$ is the elasticity of demand for skilled labour with respect to capital utilised; we expect $\beta \gtrless 0$ and $\emptyset > 0$ and assume both to be constant through time.

Assuming for the moment that the hours worked per employee cannot be varied, skilled labour services are obtained by the firm through the employment of combinations of apprentices and craftsmen. A Cobb-Douglas production function is taken to represent the relationship between the employment of apprentices LA_t and craftsmen LC_t and the skilled labour services they provide. Most generally we might identify apprentices of one to five years' standing LA_{1t}, ... LA_{5t} and craftsmen of one to ℓ years' experience LC_{1t}, ...$LC_{\ell t}$ where ℓ is the normal length of adult working life.

$$LS_t = De^{\gamma t} \prod_i LA_{it}^{a_i} \cdot \prod_j LC_{jt}^{c_j} \qquad \text{..................} \; (3)$$

where γ allows for an exponential trend in the efficiency of utilisation of apprentice and craftsmen labour in producing skilled labour services and a_i and c_j are their respective elasticities. Thus improvements in utilisation are assumed to be neutral with respect to the types and vintages of factor inputs.

In practice it is necessary both to aggregate the labour inputs and to aggregate across firms because of the form in which the statistics are available. In fact the number of new apprentice recruits LA_{1t} is the only class of labour identified in equation (3) for which a continuous annual statistical series exists for the full period 1951-71. From 1965 onwards two sources of statistics on skilled craftsmen in the engineering industry provide annual series of the total number of craftsmen $LC_t = \sum_j LC_{jt}$ and trainees $LA_t = \sum_i LA_{it}$. Bearing this in mind, consider the following aggregation of labour inputs at the firm level.

$$LS_t = De^{\gamma t} LA_{1t}^{a_1} \overline{LC}_t^{\,c} \; . \quad \ldots\ldots\ldots\ldots\ldots (4)$$

$\overline{LC}_t$ denotes $\sum_j LC_{jt} + \sum_{i \neq 1} LA_{it}$ and c is the elasticity of skilled labour services with respect to this aggregate input. If the firm minimises costs subject to producing Y_t^* then the required skilled labour services are given by substituting Y_t^* for K_t^* in equation (2), giving

$$LS_t^* = A^{\emptyset} Be^{-(\alpha\emptyset+\beta)t} (Y_t^*)^{\theta\emptyset} \quad \ldots\ldots\ldots (5)$$

and if wa_{1t} and wc_t are the unit costs of employing new apprentices and the composite factor respectively, then the firm will minimise

$$LA_{1t}\, wa_{1t} + \overline{LC}_t\, wc_t$$

subject to

$$De^{\gamma t} LA_{1t}^{a_1} \overline{LC}_t^{\,c} = A^{\emptyset} Be^{-(\alpha\emptyset+\beta)t} (Y_t^*)^{\theta\emptyset}.$$

The first order conditions determine the expansion path for the provision of labour services required to produce Y_t^*.

$$\text{i.e.} \quad \frac{LA^*_{1t}}{\overline{LC}_t^*} = \frac{wc_t a_1}{wa_{1t} c} \quad \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Setting $A^{\emptyset}BD^{-1} = F, \alpha\emptyset + \beta + \gamma = \delta$ and $\theta\emptyset = \psi$, LA_{1t}^* and LC_t^* are related through the production function expressed as,

$$(LA^*_{1t})^{a_1/c}\, \overline{LC}_t^* = \left[Fe^{-\delta t} (Y_t^*)^{\psi}\right]^{1/c}$$

Hence substituting for LC_t^* using equation (6), and letting $b = a_1 + c$,

$$LA_{1t}^* = \left[F\left(\frac{a_1}{c}\right)c\right]^{1/b} e^{-\delta t/b} (Y_t^*)^{\psi/b} \left[\frac{wa_{1t}}{wc_t}\right]^{-c/b} \quad \ldots\ldots (7)$$

With perfectly elastic supply schedules for new apprentices and the composite skilled labour factor, the demand for new recruits is given by the above equation. Depending on the values of δ and ψ and the rate of growth of desired output, the firm will move along its expansion path for skilled labour, increasing or decreasing the employment of LA_{1t} and $\overline{LC}_t$. The path itself may shift according to changes in relative factor prices $\frac{wa_{1t}}{wc_t}$.

The choice of aggregation in the production function[3] of equation (4) was determined by the lack of data on the simple aggregates LA_t and LC_t and their components, with the exception of LA_{1t}. The theoretical problems associated with the aggregation of different types of capital, labour and output and across firms are beyond the scope of this chapter.[4] The conditions for rigorous aggregation are invariably not met in the construction of the factor input series and we proceed by analogy with the microeconomic setting of the discussion so far to adopt the above equations as the corresponding macroeconomic relationships. However in addition to the general question of aggregation there is a structural problem in using $\overline{LC}_t$ which requires elaboration. This composite factor includes apprentices in their second year and above and qualified craftsmen. Apprentices are not normally hired and fired in the labour market and whilst those in later years of the formal apprenticeship period may be close substitutes for craftsmen, this is not the case for younger apprentices. In the context of forecasting apprentice recruitment the aggregation $LC_t = \sum_i LC_{jt}$ is of lesser importance, notwithstanding different standards of training and changes in productivity over the individual's lifetime due to learning by experience, obsolescence of skills,

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(3) Given that the elasticity of substitution between the two factors must be unity for a Cobb-Douglas production function it would be preferable to adopt a C.E.S. production function. This however leads to a term involving relative factor prices which would require a non-linear estimation procedure for the equivalent of equation (7) above. It is intended to pursue this formulation in later research.

(4) See for example Fisher (1969).

re-training and ageing. An indication of the weight attached to apprentices in the aggregate $\overline{LC}_t$ is given in Table 2.12. Taking the number of second and third year apprentices as a proportion of all apprentices in their second year and above plus all craftsmen as a measure of the real weight attached to 'non-craftsmen' in $\overline{LC}_t$, gives 0.078 in 1966-67 and 0.072 in 1970-71. For the same periods the ratios of the first year apprentices to all other apprentices plus craftsmen are 0.052 and 0.040 respectively. Given these magnitudes and the fact that the labour cost ratio wa_{1t}/wc_t must be proxied(5) by the wage ratio for youths and adult males in engineering instead of that for first year apprentices and craftsmen plus other apprentices, the following are held to apply:

(vii) fluctuations in the employment and labour costs of apprentices included in $\overline{LC}_t$ are negligible relative to changes associated with the employment of craftsmen;

(viii) changes in the cost of recruiting and employing new (i.e. first year) apprentices are adequately reflected in the series of average hourly earnings for youths employed in engineering;

(ix) changes in the unit costs of employing craftsmen are highly correlated with the movements of average hourly earnings of adult males in engineering.

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(5) The available earnings data are described in Appendix 5 and relate to manual workers.

The results of estimating equation (7) are shown in Table 5.1.[6] Two measures of the first year apprentice labour services recruited by the industry are adopted, the number of apprentices and learners recruited (LA_{1t}) and the same series adjusted for the average hours worked by youths in the engineering industry (LAS_{1t}). The change of dependent variable to account for variations in the hours worked by apprentices improves the fit of the model (the $\bar{R}^2$ statistic increases from 0.49 to 0.70) but causes no marked change in the coefficients. Both the coefficients on the time trend and output are significantly negative and positive respectively at the one per cent level as expected but the relative wage costs variable is not significant although possessing the anticipated sign. The imprecision of the last coefficient may be due to the presence of multicollinearity. The zero order correlation coefficient between log Y_t and t is 0.991 and between log (wa_{1t}/wc_t) and t is 0.938. No significant autocorrelation is present in either equation, the DW statistic is close to 2 in both cases.

5.2.2 Shortages of Craftsmen

With perfectly competitive markets for apprentice recruits and craftsmen a cost minimising firm will maintain a position on its expansion path. In a market characterised by training lags, poor information and short-run wage rigidities, firms may experience shortages of skilled labour services at the market wages and in the interests of achieving their production targets move off the expansion path to some extent. It is more likely that shortages of skilled craftsmen will arise than shortages of apprentice recruits. The evidence of the previous chapter suggests that even if the supply of apprentice recruits is unresponsive to changes in the immediate earnings prospects, it is

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(6) The sources of data are given in Appendix 5.

Table 5.1 **Demand Model Estimation (1952-71 excluding 1963-64)** (1)

Independent Variables / Dependent Variables (in logarithms)	Constant	t	$\log(\frac{wa_{1t}}{wc_t})$	$\log Y_t$	$\log U_t$	Lagged Dependent Variable	R^2	$\bar{R}^2$	$DW^{(2)}$
(1) LA_{it}	1.889 (2.472)	-.06453 (.01960)**	-.7397 (.5168)†	1.8649 (.5526)**			.6029**	.4894	2.036
(2) LAS_{it}	5.390 (2.399)*	-.07578 (.01902)**	-.6349 (.5017)	1.9665 (.5364)**			.7641**	.6967	2.009
(3) LA_{it}	8.328 (4.689)*	-.00350 (.04274)	-.9886 (.5154)*	.5483 (.9820)	-.1330 (.0838)†		.6673**	.5393	2.133
(4) LAS_{it}	10.349 (4.712)*	-.02877 (.04295)	-.8266 (.5179)†	.9525 (.9867)	-.1024 (.0843)		.7882**	.7067	2.012
(5) LA_{it}	8.697 (1.252)**		-1.0023 (.4697)*	.4699 (.2605)*	-.1392 (.3520)**		.6671**	.5720	2.126
(6) LAS_{it}	13.383 (1.279)**		-.9396 (.4799)*	.3074 (.2110)†	-.1533 (.0360)**		.7809**	.7183	1.900
(7) LA_{it}	-2.380 (5.918)	-.02817 (.03770)	-1.0085 (.4382)*	1.2586 (.8837)†	-.1135 (.0717)†	.7313 (.2987)*	.7781**	.6671	2.260
(8) LAS_{it}	-3.066 (6.121)	-.04264 (.03511)	-.9602 (.4218)*	1.5264 (.8244)*	-.0840 (.0685)	.7580 (.2706)**	.8719**	.8079	2.235
(9) LA_{it}	1.252 (3.319)		-1.1096 (.4096)**	.6141 (.1890)**	.1613 (.0319)**	.6716 (.2829)*	.7678**	.6784	2.232
(10) LAS_{it}	2.160 (4.433)		-1.1162 (.4091)**	.5544 (.2011)**	-.1589 (.0303)**	.7117 (.2727)*	.8562**	.8009	2.084

(1) Observations of the dependent variable for 1963-64 are omitted because of the change in school-leaving regulations affecting the statistics for 1963.

Standard errors are in brackets. The significance of coefficients is denoted by †, * and ** for the ten, five and one per cent levels respectively using a one tail 't' test. The significance of the overall relationship is denoted by ** for the one per cent level.

(2) In equations involving lagged dependent variables the Durbin-Watson statistic is biased in favour of accepting the null hypothesis in tests for the presence of autocorrelation. On the basis of asymptotic tests proposed by Durbin (1970) for use in this situation, no significant autocorrelation was detected. No adjustments were made for the discontinuity in the time series but the effects of this upon the outcomes of the tests would not be critical.

however responsive to adult earnings differentials which apply after training. Furthermore when shortages of skilled craftsmen in the engineering industry do occur then any increases in adult earnings to attract further supply will also make the recruitment of apprentices easier. Given the longer lags in the recruitment and training of craftsmen than in the recruitment of apprentices and the absence of a general binding constraint upon the supply of suitable apprentice recruits, we therefore assume that shortages of craftsmen will arise more readily.

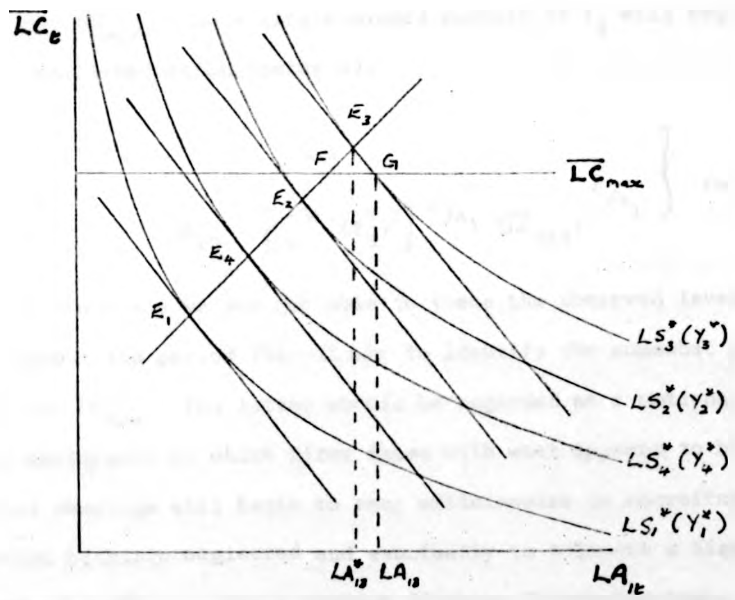

Figure 5.1 The provision of labour services by craftsmen and apprentices

With reference to Figure 5.1 suppose that the desired production profile for periods 1 to 4 is Y_1^* to Y_4^* (i.e. rising from Y_1^* to Y_3^* then declining to Y_4^*). Early expansion meets no problems with regard to combining $\overline{LC}_t$ and LA_{1t} to minimise the cost of providing the required labour services LS_1^* and LS_2^* to produce Y_1^* and Y_2^* as formulated in equations (4), (5) and (6). The labour services isoquants LS_t^* are also labelled with the corresponding output Y_t^* since they are uniquely related through equations (1) and (2) to the desired level of output. Having proposed a cost-minimising objective function subject to fulfilling desired output plans here we consider to what extent the cost minimising aspect is frustrated by short-run constraints on the supply of craftsmen. Desired output is still assumed to be achieved.

If in expanding from E_2 with the intention of reaching E_3 (for which the provision of the necessary inputs of capital and other labour services is in hand) the firm reaches a constraint on the supply of craftsmen $\overline{LC}_{max}$, then a single-minded pursuit of Y_3^* will require a sub-optimal combination (point G),

$$\left.\begin{aligned} \overline{LC}_3 &= \overline{LC}_{max} \\ LA_{13} &= \left[F_e^{-3\delta}\ (Y_3^*)^{\psi}\right]^{1/a_1} (\overline{LC}_{max})^{-c/a_1} \end{aligned}\right\} \quad \text{for } \overline{LC}_3^* > \overline{LC}_{max}$$

Unfortunately we are not able to trace the observed levels of $\overline{LC}_t$ throughout the period 1951-71 nor to identify the somewhat artificial construction $\overline{LC}_{max}$. The latter should be regarded as a notional level of craft employment at which firms faced with what appears to be a persistent shortage will begin to reap efficiencies in recruitment and utilisation hitherto neglected and eventually to tolerate a higher unit cost of craftsman labour through directly increasing wages, raising the level of overtime above normal, lowering hiring standards (i.e. incurring additional training costs and/or production costs), incurring greater costs of search etc. In practice lowering hiring standards may involve the upgrading of semi-skilled men and a re-allocation within $\overline{LC}_t$ in which apprentices are employed on more skilled work than is usual, in addition to changes in standards in recruiting from the external labour market. In section 5.3.2 we note the limitations to short-run upward mobility on the part of semi-skilled workers which may stem from unfavourable wage structures and the lack of suitable training arrangements. If indeed the wages of craftsmen relative to semi-skilled workers were increased then this may also lead to an increase in the supply of skilled workers previously attracted to semi-skilled jobs.

Such measures will raise the supply of skilled men and cause a pivoting of the iso-cost line in favour of substituting apprentices for craftsmen. The ultimate outcome of such changes could be a 'bending' of the craftsmen 'constraint' and a reduction in demand which, between them lead to a feasible optimal combination of LA_{1t} and $\overline{LC}_t$ at the new wage relativity. If this happens rapidly then the explanatory power of equation (7) subject to the accompanying qualifications about the proxy variables used should be high, since all observations of LA_{1t} will correspond to points on a (shifting) expansion path.

If changes in wages and/or supply responses to those changes occur slowly, then the tighter the labour market for craftsmen, the more likely will firms move off their expansion paths, employing more apprentice recruits than is optimal at current relative wages. Note that the amount of substitution of apprentices LA_{1t} for the composite group $\overline{LC}_t$ is not envisaged as being anything other than very marginal. The proportion of LA_{1t} to $\overline{LC}_t$ employed in practice was earlier seen to be of the order of four per cent (see Table 2.12). Furthermore we expect the elasticity for craftsmen (c) to be considerably greater than for first year apprentices (a_1). Thus small changes in the provision of skilled labour services will result from relatively large fluctuations in employment of new apprentices. As regards the way in which substitution might take place, either new apprentices may be given the less skilled aspects of the craftsman's job to do directly or may substitute for the work done by older apprentices who then substitute for parts of the craftsman's job.

A measure of the tightness of the skilled labour market in which engineering firms mainly operate is the level of unemployment (U_t) among the main skilled occupational groups employed in engineering (see Appendix 3). The lower the level of unemployment the closer will the industry be to the point at which a move off the expansion path is required to achieve the desired output. On the other hand when the demand for skilled labour services is decreasing (from LS_3^* to LS_4^* in Figure 5.1), beyond a certain level of unemployment further increases in U_t will make no difference to the observed mix of craftsmen and apprentices (because the firm is then free to reduce production along its expansion path) unless it is accompanied by a change in relative wages. Since we cannot obtain a satisfactory series for $\overline{LC}_t$ for 1951-71, the construction of a supply model for craftsmen (as opposed to apprentices) which specifies the link between unemployment and wages (and would also improve our treatment of the craftsmen constraint) is not attempted. Furthermore if rising craft unemployment does cause wages to fall, then the response of the firm is predicted by the demand model in any case. It was because of delays in wage movements in <u>tight</u> labour markets that the firm was forced to move off the expansion path.[7] If we modify our prediction of the demand for apprentices using equation (7) assuming that the craftsman constraint has continuously resulted in sub-optimal combinations of LA_{1t} and $\overline{LC}_t$ then we would expect

$$LA_{1t} = \left[F\left(\frac{a_1}{}\right)^c\right]^{1/b} e^{-\delta t/b} . (Y_t^*)^{\psi/b} \left[\frac{wa_{1t}}{wc_t}\right]^{-c/b} U_t^d \quad \ldots\ldots (8)$$

where d < 0.

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(7) Since the expansion path is defined with respect to actual factor prices, either these will change bringing the expansion path into the feasible region or the firm must move off the expansion path to achieve planned output.

The goodness of fit of this equation will be a matter of the degree to which the levels of craft unemployment observed during 1951-71 have not exceeded the point at which the firm is free to cost minimise. With an otherwise perfect specification we should expect the coefficient d to be significantly different from zero if firms in the engineering industry have generally operated off their expansion paths.

On the other hand an extremely slack labour market will introduce a distortion of its own which may mitigate the detrimental effect of the above mis-specification upon the goodness of fit. With increasing unemployment as the industry moves away from the craft 'constraint', the short-run opportunity costs of training change quite radically (see section 5.3.2 below). In this situation we suggest that the industry may indeed move off its expansion path but in the opposite direction to that taken when craftsmen are in short supply. Thus the unemployment variable will tend to capture these two extreme movements away from optimal employment combinations; the first in favour of employing relatively more apprentice recruits and the second in favour of hoarding craftsmen rather than recruiting new apprentices.

The introduction of U_t as a multiplicative term U_t^d allows for the fact that the effect is probably non-linear and accommodates the log-linear regression estimation of the equation as before. The results are given in Table 5.1, (3) and (4), and prove to be disappointing. Minor improvements in explanatory power are gained at the expense of the significance of coefficients on t and log Y_t. Only the coefficients on log (wa_{1t}/wc_t) retain similar orders of magnitude to the corresponding coefficients in (1) and (2) of Table 5.1. The coefficients on log U_t possess the expected sign but are also insignificant. Again we might note the presence of multicollinearity and if the time trend (which is both the main source of multicollinearity and the least significant of the variables in (3) and (4))is omitted some improvement occurs. In Table 5.1, (5) and (6), the coefficients on log U_t and log (wa_{1t}/wc_t) are significantly negative at the one and five per cent levels respectively and for log LA_{1t} as the dependent variable, the coefficient on log Y_t is significantly positive at the five per cent level. However the magnitudes of the coefficients on log Y_t have dropped considerably in both (5) and (6), and in the latter the coefficients on log (wa_{1t}/wc_t) and log U_t show marked increases. Some increase in the $\bar{R}^2$ statistic for the equation for log LA_{1t} is obtained. The situation with regard to autocorrelation is not significantly affected.

5.2.3 The Adjustment of Actual Recruitment

The moderate explanatory power of equation (8) suggests that we possess a model of apprentice recruitment which is still incompletely specified quite apart from problems of multicollinearity.

We now consider a supplementary hypothesis relating to the adjustment of the actual employment of new apprentices and craftsmen to the desired levels implied by the solution of the constained cost minimising problem.

When firms wish to alter the combinations of LA_{1t} and $\overline{LC}_t$ they may do so by altering hours worked and/or the numbers of workers employed.

In estimating equations (7) and (8) the more satisfactory specification of LA_{1t} in terms of hours of labour services provided (LAS_{1t}), as opposed to numbers of new apprentices employed, significantly improves the explanatory power of both models. At this stage, no more complex treatment of the wage cost function is attempted.

The lag in the adjustment of actual recruitment to changes in relative wages and the supply situation for craftsmen will be composed of:

(i) a lag in the re-assessment of required recruitment by firms in response to changing labour market conditions;

(ii) a lag in the implementation of the decision to alter recruitment.

In the first case firms may be poorly informed about the state of the labour market and some time may elapse before the information which might lead to a change of policy is available to the appropriate decision maker; firms may then wish to delay a decision until say present shortages of craftsmen are seen to persist and the agreement of several departments within the firm (for example those responsible for production and financial control in addition to the personnel function) may be required before appropriate action is initiated. In the second case the rapid implementation of a decision to increase recruitment may involve changes to the organisation of recruitment and training in addition to the actual search for suitable recruits.

A decision to decrease the employment of first year apprentices will involve some delay, owing to the job security normally granted to apprentices, until cuts in their employment are effectively achieved by not recruiting replacements for those who leave and reducing future recruitment.

The resulting adjustment process is likely to be asymmetric with respect to increases and decreases in employment. The speed of adjustment will also be a function of the costs of adjustment and the supply situation. We assume however a symmetric and stationary multiplicative adjustment process[8] by which the actual rate of change in recruitment is a function of the desired rate of change according

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(8) This amounts to a distributed lag in which successive weights are geometrically distributed.

to,

$$\frac{LA_{1t}}{LA_{1,t-1}} = \left[\frac{LA^{*}_{1t}}{LA_{1,t-1}}\right]^{\lambda} \qquad 0 \leq \lambda \leq 1.$$

Substituting for desired recruitment using equation (8), we obtain

$$LA_{1t} = \left[F(\frac{a_1}{c})^c\right]^{\lambda/b} e^{-\delta\lambda t/b} (Y^{*}_{t})^{\psi\lambda/b} \left[\frac{wa_{1t}}{wc_t}\right]^{-\lambda c/b} U_t^{\lambda d} \left[LA_{1,t-1}\right]^{1-\lambda} \quad \ldots (9)$$

The results of estimating this equation in log-linear form are given in Table 5.1, (7) and (8). A marked increase in explanatory power is obtained; the $\bar{R}^2$ for LA_{1t} increases from 0.54 to 0.67 and for LAS_{1t} from 0.71 to 0.81. The coefficient on the lagged dependent variable in each case is significantly positive at the five per cent level, implying that λ is significantly less than unity. The values of λ obtained were 0.37 and 0.34 for LA_{1t} and LAS_{1t} respectively suggesting that the adjustment of actual recruitment to desired recruitment is rather slow, only about thirty-five per cent of the desired adjustment taking place within the corresponding year. The difference between the speeds of adjustment is not statistically significant; we would have expected the adjustment of hours to be faster than the adjustment of employment.

The significance of the other coefficients shows some improvement compared to the situation in (3) and (4). The coefficients on log Y_t for LA_{1t} and LAS_{1t} are now significantly positive at the ten and five per cent levels respectively and take higher values than before. The coefficients on log (wa_{1t}/wc_t) are now both significant at the five per cent level. Note that despite the increases in the coefficients on output and slight changes in those on the wage relativity and unemployment variables, all coefficients should be divided by the estimate of λ before being compared with the estimates in (3) and (4). Once again the time trend is insignificant. When however this variable is omitted from the estimation, all remaining coefficients become highly significant with large changes in magnitudes occurring for log Y_t (decreasing) and log U_t (increasing). Relative to (5) and (6) the coefficients show exceptional increases after adjusting for λ.

5.3 Further Analysis Retaining the Current Production Hypothesis

Within the rationale of the current production hypothesis this section discusses certain qualifications which stem from the treatment of the supply of apprentice recruits, the production of skilled labour services, technical progress and the objective function of the firm.

5.3.1 The Supply of Apprentice Recruits

In adopting equation (7) to represent the corresponding industry relationship, it has been assumed that supplies of apprentice recruits and craftsmen were perfectly elastic. This assumption was retained only for the former in deriving equations (8) and (9). The discussion of a single equation model of the supply of young recruits given in Chapter 4 suggests that a more appropriate supply schedule would incorporate a highly elastic section turning quite rapidly into a highly inelastic section.(9) Although it was expected that the demand schedule would intersect the highly inelastic section of the supply schedule only infrequently in the course of relative shifts between them, the empirical results indicated a supply elasticity insignificantly different from zero. Furthermore the variable intended to capture shifts in the supply schedule for apprentice recruits due to demographic and educational trends, the

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(9) See page 4.22.

total numbers of young entrants entering employment in Great Britain, proved also to be insignificant. The explanatory power of the supply model, which was about seventy per cent of the observed variation, was attributed to the adult earnings relativity and the unemployment of engineering craftsmen relative to all males in the economy. If these and other omitted effects caused shifts in the supply schedule (defined with respect to the immediate, juvenile earnings relativity between engineering and the rest of the economy) to dominate movements along the schedule, then the apparent inelasticity of supply with respect to juvenile earnings should be treated with some reservation. Bearing in mind the sociological studies discussed in Chapter 4 the econometric estimate is not accepted as sufficient evidence for a highly inelastic supply schedule.

However if we accept that the supply of apprentice recruits is influenced more by perceptions of future relativities when fully trained and the likelihood of unemployment than by immediate earnings prospects, then it should be noted that the industry would find that an increase in the earnings of craftsmen would, *ceteris paribus*, increase the supply of apprentice recruits and also, on the basis of the current production hypothesis, increase demand.[10]

In the presence of a shifting, inelastic supply curve the initial interpretation of the lagged adjustment mechanism incorporated by the demand model becomes unsatisfactory. The estimation of the adjustment parameter will capture supply effects in addition to lags in demand responses to changing conditions. Indeed it is possible to rationalise the use of a similar adjustment process in the supply model to represent lags in supply responses but in that case we found

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[10] The unit elasticities obtained directly from results (7) - (10) of Table 5.1 compare with supply elasticities of between 1.6 and 2.0 if the distinction between hourly and weekly earnings is ignored. Thus the response of the supply of recruits to an increase in craft earnings exceeds that of demand. The functional forms estimated constrain these elasticities to be constant of course.

that the previous coefficients and explanatory power are not significantly affected and the parameter λ is not significantly different from unity.(11)

One way of introducing the supply influence would be to allow λ to be a function of the excess supply of apprentice recruits. Roberts (1974) uses such a device in the context of estimating employment functions for the engineering industry. Unfortunately a high degree of multicollinearity enters the estimation procedure since all explanatory variables are effectively multiplied (in logarithmic form) by the excess supply variable; the results were insignificant. Another ad hoc method of turning the demand model into a model of actual recruitment would simply be to add the excess supply term (for apprentice recruits) to equation (9). However these steps do not distinguish a supply response to changes in wages and rule out the re-adjustment of demand and supply through the price mechanism. The evidence of the single equation treatment of supply and demand suggests that although both respond to shifts in the wage structure, they are influenced by different aspects of it. It would seem worthwhile to pursue a simultaneous formulation in subsequent research to see whether any tendency to resolve supply and demand through a more complicated price mechanism can be represented analytically.

5.3.2 The Production of Skilled Labour Services

In section 5.2, combinations of apprentices and craftsmen provide the skilled labour services required. The substitution of 'other' labour for these two groups is assumed to be negligible in the short-run. Skilled men who have opted for higher paid

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(11) See Chapter 4 , p.4.36.

semi-skilled jobs cannot be induced to return to skilled work because of the rigidities of the wage structure and upgrading of semi-skilled workers in the short-run is limited by inappropriate training systems and the time required for learning skills even under ideal conditions. However the dominance of apprentice training in controlling the supply of labour does not of course justify the assumption that short-run substitution is infeasible, merely that it occurs infrequently. The potential for upgrading and job re-design in response to shortages of skilled manpower has received little investigation and it is difficult to judge how important these alternatives could be and how far they have been rejected explicitly by firms on cost-benefit grounds.

Apprentice training schemes vary considerably in the contribution to current production made by apprentices at different stages of training and the extent to which training responsibilities reduce the productivity of qualified craftsmen. As regards the contribution to current production, we concluded in Chapter 3 that full-time off-the-job training was received by a minority of new apprentices for most of the period 1951-65 prior to the introduction of the Training Board's scheme for first year off-the-job training which became fully operational in 1966-67. However there appeared to be little statistical information about the contributions to production made by apprentices in the course of their training (section 3.2). An important problem in measuring the opportunity cost of training is to account for the pattern of incidence of the work load and hence the fluctuations in alternative costs which the firm would incur if it wished to produce the apprentices' output using fully skilled labour employed directly or if the main option involved sub-contracting to other firms.

5.3.3 The Treatment of Technical Progress

Given that the estimation is bedevilled by multicollinearity we now consider the implications for our maintained hypothesis of omitting the time trend. According to equations (1), (2) and (4), this amounts to,

$$\delta = \alpha\emptyset + \beta + \gamma = 0$$

The results[13] of estimating equation (1) directly are given in Table 5.2. It is found that the rate of capital-saving technical progress (α) is significantly different from zero and negative (-0.028) at the five per cent level. Thus the production of a given level of output has required an increasing input of capital services during 1951-71. The output elasticity (θ) is found to be positive (0.624) as expected and significantly different from zero at the five per cent level; it is not however significantly different from unity. The $\bar{R}^2$ statistic is high but the significant positive autocorrelation implies that the standard errors of the above coefficients are understated.

Table 5.2 Estimation of Equations (1), (2) and (5)
(1951-71)

Dependent Variable \ Independent Variable	Constant	t	log Y_t	log KS_t	R^2	$\bar{R}^2$	DW
log KS_t	3.666 (1.141)**	.02750 (.00997)*	.6243 (.2741)*		.9889**	.9867	.364
log MS_t	6.687 (.956)**	-.03172 (.00769)**		.7867 (.1526)**	.8387**	.8119	.621
log MS_t	8.027 (1.013)**	-.02346 (.00885)*	.8622 (.2433)**		.7647**	.7255	.672

Standard errors and statistical significance are indicated as before except that the significance of coefficients now relates to the two-tailed test.

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(13) The measure of capital services used was based upon the capital usage figures given in Heathfield (1972a) and the gross capital stock series given in the relevant volumes of National Income and Expenditure and in Pyatt (1964).

Without a precise measure of LS_t it is not possible to estimate equation (2). We can however investigate a similar relationship between the input of labour services of all male employees (MS_t), of which craftsmen constitute about thirty-five per cent, and the input of capital services. In that case the parameters β and $\emptyset$ are significantly positive as expected with values of 0.032 and 0.787 respectively. Combining these estimates with that of α above, $\alpha\emptyset + \beta = 0.010$ compared to 0.023 which is the figure obtained when $\alpha\emptyset + \beta$ is estimated directly by substituting for K_t^* between equations (1) and (2) and estimating the equivalent of equation (5). The latter estimate is significantly different from zero but not from 0.010.

Taking these estimates of $\alpha\emptyset + \beta$ together with the fact that $\delta\lambda/b$ is not found to be significantly different from zero in estimating equation (9), there is clearly some ambiguity attached to the signs of α and δ. Unfortunately we cannot estimate γ directly in equation (4); the above estimates of α, β, $\emptyset$ and δ imply that $\gamma < 0$ and hence that there has been a reduction of efficiency in providing skilled labour services during 1951-71. It must be remembered however that the direct estimates of β, $\emptyset$ and $\alpha\emptyset + \beta$ were obtained using MS_t in place of LS_t as the dependent variable in equation (5).

If instead of substituting Y_t^* for K_t^* in the derivation of equation (7) we retain K_t^*, equation (9) becomes

$$LA_{1t}^* = \left[D^{-1}B\left(\frac{a_1}{c}\right)^c\right]^{\lambda/b} e^{-(\beta+\gamma)\lambda t/b} (K_t^*)^{\emptyset\lambda/b} \left[\frac{wa_{1t}}{wc_t}\right]^{-\lambda c/b} U_t^{\lambda d} \left[LA_{1,t-1}\right]^{1-\lambda} \qquad \text{............ (10)}$$

The results of estimating equation (10), without the exponential trend, using gross capital stock (K_t) and the constructed series for capital services (KS_t) as alternative measures of K_t^* are given in Table 5.3, (1) - (4). The results as regards the significance of the coefficients and the explanatory power of the relationship are similar to those for output. The use of KS_t has slight impact upon $\bar{R}^2$ but is accompanied by marked changes in coefficients on log U_t and the capital variable. The presence of the time trend reproduces the effects discussed in the case of output as the independent variable; the results of estimating the full equation (10) are not therefore given in Table 5.3.

Rather than pursue the comparisons of alternative estimates for coefficients α, β, γ and δ we would simply note that the exogenous specification of the effects of technical progress in this and other frequently estimated models using exponential time trends to measure the concept, leaves much to be desired. The effects of capital-labour substitution in addition to capital-saving technical progress will be captured in the observed capital-output relationship and, over the period studied, the substitution of capital for labour would appear to have been the dominant influence (assuming that changes in quality of both capital and output are adequately represented in the statistics). The omission of the time trend from the model on the basis of the revised expectation and the fact that in practice it seems only to thrive in the absence of explanatory variables with which it is highly correlated and whose influence can be more directly specified, is therefore ad hoc but not unreasonable at this stage of research. At the same time, indicators of technical progress which are less mechanistic than the exponential time trend need to be investigated (see Bosworth, 1973).

5.3.4 The Objective Function and the Adjustment Mechanism

In the demand model of equation (8) it is assumed that planned output is always achieved, since no shortages of apprentices occur. This ignores the fact that the firm may become more aware of the

Table 5.3 — Demand Model Estimation (1952-71 excluding 1963-64)[1]

Dependent Variables (in logarithms) \ Independent Variables	Constant	t	$\log(\frac{wa_{1t}}{wc_t})$	$\log K_t$	$\log KS_t$	$\log GCP_t$	$\log U_t$	Lagged Dependent Variable	R^2	$\bar{R}^2$	DW[2]
(1) LA_{lt}	4.248 (3.044)†		-1.1386 (.4622)*	.7634 (.2640)**			-.2033 (.0423)**	.5329 (.2865)*	.7439**	.6455	2.134
(2) LAS_{lt}	5.598 (4.033)		-1.0919 (.4627)*	.6416 (.2762)*			-.1960 (.0413)**	.5774 (.2716)*	.8390**	.7770	1.950
(3) LA_{lt}	2.792 (3.218)		-.9501 (.3954)*		.4060 (.1364)**		-.1688 (.0346)**	.5452 (.2839)*	.7498**	.6535	2.092
(4) LAS_{lt}	4.618 (4.250)		-.9251 (.3981)*		.3356 (.1429)*		-.1662 (.0337)**	.5704 (.2695)*	.8400**	.7785	1.925
(5) LA_{lt}	6.687 (2.017)**		-.9071 (.2331)**			.4285 (.0799)**	-.1136 (.0219)**	.3380† (.2013)	.8691**	.8187	2.308
(6) LAS_{lt}	8.155 (2.675)**		-.9545 (.2449)**			.3740 (.0832)**	-.1257 (.0225)**	.4205 (.1901)*	.9107**	.8764	2.085
(7) LA_{lt}	7.613 (2.234)**	-.01099 (.01130)	-.6655 (.3410)*			.5508 (.1491)**	-.0761 (.0444)†	.2295 (.2306)	.8786**	.8179	2.122
(8) LAS_{lt}	11.379 (3.091)**	-.02153 (.01229)†	-.5127 (.3395)†			.6026 (.1516)**	-.0597 (.0430)	.1688 (.2276)	.9289**	.8934	2.000

(1) Observations of the dependent variable for 1963-64 are omitted because of the change in school-leaving regulations affecting the statistics for 1963.

Standard errors are in brackets. The significance of coefficients is denoted by †, * and ** for the ten, five and one per cent levels respectively using a one tail 't' test. The significance of the overall relationship is denoted by ** for the one per cent level.

(2) In equation involving lagged dependent variables the Durbin-Watson statistic is biased in favour of accepting the null hypothesis in tests for the presence of autocorrelation. On the basis of asymptotic tests proposed by Durbin (1970) for use in this situation, no significant autocorrelation was detected. No adjustments were made for the discontinuity in the time series but the effects of this upon the outcomes of the tests would not be critical.

diminishing returns to increasing apprentice recruitment off the expansion path and eventually may choose to sacrifice production. In effect the shadow price on the craftsmen 'constraint' increases with apprentice recruitment in times of shortages of craftsmen, subject to the shifting of the expansion path in accordance with changes in relative prices. If a possible decision to lengthen order books or build up stocks then enters the calculation this complicates the current production model and points to the existence of trade-offs in the short-run as well as the long-run between output, costs of recruiting and training apprentices, and costs of recruiting and employing qualified craftsmen.

The specification of the objective function of the firm has received much attention in the development of investment and short-term employment functions. In addition both types of model suffer to some extent from the problem of rationalising the inevitable introduction of a lagged adjustment mechanism. Essentially the need for such a device stems from an incompletely specified objective function and by incorporating some lag function the explanatory power is normally improved considerably. The difficulty then is to identify what exactly the adjustment parameters represent. We have already referred to the impact of supply effects upon the recruitment of apprentices and the interpretation of the adjustment function in the demand model. In this final part of section 5.3 the focus is upon the consistency between the two sets of assumptions underlying the chosen objective function and the rationalisation of the adjustment process given in section 5.2.3.

We begin by noting that, notwithstanding the improvement in explanatory power, the introduction of the adjustment mechanism gives rise to a contradiction between two of the assumption made initially, namely that desired output is achieved and hours of work are fixed (given that capital-labour substitution is ruled out in the short-run).

If indeed hours per apprentice recruit (HA_t) and hours per craftsman (HC_t) are fixed at HA_o and HC_o respectively, there should be no need to adjust the number of apprentices recruited by the hours of employment as a preferable measure of labour services. In the estimated equations the ratio HA_o/HC_o may be regarded as part of the constant term since relative variations in labour costs per man are fully reflected in the hourly labour costs term.(14) In fact actual average hours per man for both groups have varied during the period and the estimation of the equations using LAS_{1t} in place of LA_{1t} is equivalent to treating the firm's decision problem as one of choosing the combination of total hours worked by apprentice recruits and craftsmen irrespective of the choices of employment levels and average hours per man.(15)

In either case the dependent variable is intended to reflect fully the input of labour services from apprentice recruits. If adjustments of this input are not instantaneous, desired output can only be achieved generally if the hours and employment of craftsmen may be altered temporarily whilst the optimum input of labour services from apprentice recruits is gradually approached. This

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(14) If $LA_{1t}\ HA_o\ wa_{1t} + \overline{LC}_t\ HC_o\ wc_t$ is the wage cost function incorporating fixed hours of work, where wa_{1t} and wc_t are now the relevant unit costs per hour per man, the cost minimising level of recruitment of apprentices is given by multiplying the term,

$$\left[\frac{wa_{1t}}{wc_t}\right]^{-c/b} \text{ by the constant } \left[\frac{HA_o}{HC_o}\right]^{-c/b}$$

in equations (7) - (9). This does not affect the estimation procedure.

(15) In this case we simply return to the intial formulation, interpreting $\overline{LA}_{1t}$ and $\overline{LC}_t$ as total hours of labour services rather than employment levels for each group, and wa_{1t} and wc_t as unit costs per hour rather than unit costs per man employed.

seems only plausible to the extent that craftsmen currently employed may do 'extra' overtime - it is unlikely that firms would go to the lengths of recruiting additional craftsmen only to make them redundant as the labour services from apprentice recruits nears the cost minimising level.

However, in section 5.2, shortages of craftsmen were envisaged from which would arise a sub-optimal demand for apprentice recruits at the relative labour costs prevailing. In section 5.3 we introduced a distortion in meeting this demand caused by imperfections in information and decision-making (together with lags in implementation) within the firm rather than in the labour market for apprentices. Thus in the very situation where craft shortages have caused particular increases in desired apprentice recruitment it is implied that temporary increases in, say, overtime worked by craftsmen will make up for the delay in reaching the desired level of apprentice recruitment. Consequently there are two main situations in which the skilled labour services are unlikely to meet demand in the short-run and production will be curtailed. The first corresponds to where output increases sufficiently to require the firm to increase its already sub-optimal employment of young recruits or to move off its expansion path for the first time. The second relates to a shift in the supply of craftsmen, lowering the constraint in Figure 5.1 and rendering the previous position infeasible. In each case the firm will only be able to alter its employment of labour services from apprentice recruits by a proportion of the desired adjustment as indicated above. In other situations such as the reduction of desired output, changes in relative wages and the raising of the craftsmen constraint, the desired level of output will be compatible with currently available labour services and so may be achieved although not at minimum cost immediately.

Note that in situations where an increase in apprentice recruitment is desired but the industry is well within the feasible region, a temporary increase in labour services supplied by craftsmen, beyond the optimal, whilst the apprentice adjustment takes place, presumes of course that similar lags in the adjustment of the labour input by craftsmen do not exist.

In those short-term employment functions which assume (a) a cost minimising objective function, (b) actual output equals desired output and (c) an adjustment of the type given above, the degree of freedom which ensures that desired output is achieved is the variation in hours. With only one labour factor and an exogenously determined input of capital services Ball and St. Cyr (1966), for example, postulated a quadratic relationship between the effective wage rate per hour and hours worked. Optimal employment (not labour services) is then determined with respect to this hourly wage cost function and the production function. Actual employment is however thought to adjust to the optimal level taking into account the various unspecified costs of changing the level of employment and uncertainties about future desired employment. So by exploiting temporarily the ability to vary hours worked per man about the level which would minimise the effective hourly wage rate, the long-run optimal level of employment is approached without loss of output. Our model is more complex because of the presence of two labour factors and hence in principle four methods of adjusting labour services; hours worked per apprentice recruit and craftsman and the numbers of each employed. Furthermore the employment of one of the factors is subject to a notional supply constraint in the short-run.

If we were to accept the rationale behind the type of wage cost function introduced by Ball and St. Cyr, the compatibility of the adjustment mechanism and the achievement of desired output is most likely in the case of adjustment of the level of recruitment with hours worked per recruit providing the degree of freedom. A rationalisation of the adjustment mechanism applied to the input of labour services from recruits (i.e. recruitment times hours worked per recruit) requires some means whereby labour services from craftsmen compensate temporarily for the delay in increasing recruitment.

Thus quite apart from any doubts we may have about this simple form of single period labour adjustment, focussing upon proportionate changes, there are difficulties in reconciling the treatment of the adjustment mechanism with that of the cost and objective functions, especially where two labour factors and an imperfect market are involved. The literature on investment functions and short-term employment functions provides similar examples of conflict between the specification of the objective function and the adjustment mechanism. For example both Jorgenson (1965) and Dhrymes (1969) introduce ad hoc adjustment functions which violate their respective assumptions that optimal capital stock and opt' labour services are achieved. A common element is the fact that because the objective functions chosen are limited in their consideration of the costs and benefits which actually impinge upon the decison-making unit, the 'desired' levels approached through the adjustment procedures introduced are not 'desired' with respect to all the aspects of the choice to be made. The costs of adjustment are those usually ignored in the formal specification.

5.4 Recruitment for Future Production

The demand for skilled labour services is assumed to derive from the need to operate capital stock at the required level to produce desired output. In considering future production plans bearing in mind developments in product markets and the current capital available, together with investment which will be installed in the course of the planning period, firms may also note that these preparations have implications for their future demands for labour with perhaps the likelihood of shortages of skilled workers. The evidence presented in Chapter 3 suggests that a minority of firms during the period of study undertook this kind of assessment and either expectations about future demand and supply were dominated by current experience because of the lack of more sophisticated forecasting methods, or the inclination to look ahead was very much tempered by the need to attend to the more immediate problems of the firm. Having adopted an extreme hypothesis that the desired recruitment is largely determined by current production and labour market situations because firms discount the future very heavily, we must recognise that if firms adopt present situations as their best estimates for the future then it is possible to place an investment interpretation upon the result obtained. Furthermore with the increase in off-the-job training in the later part of the period it is implausible to maintain the current production hypothesis to the complete exclusion of an investment view of the observed behaviour of firms. Throughout the period it also seems more realistic to allow for the availibility of funds to finance the expansion of training budgets but we shall make no attempt to identify the impact of this factor separately.

Expectations about future demand will reinforce or counteract present tendencies to adjust the level of recruitment of apprentices for two reasons. Firstly, as apprentices now and in the near future their contribution to production will be valued especially if shortages of skilled manpower are expected to persist and secondly, they provide the means whereby these shortages can be reduced by increasing the supply of skilled craftsmen in approximately four years time.

In Chapter 3 we noted that firms rarely forecast sufficiently far ahead to enable them to adjust recruitment closely in accordance with expected supplies of fully trained craftsmen. However, if indeed current output, unemployment and wage relativities strongly influence firms' expectations about the future we may arrive at a more loosely specified function analogous to equation (8) and, adopting the same adjustment process as before, to equation (9). The estimated equations are not therefore incompatible with an investment view of apprentice recruitment in which expectations about the future are dominated by current experience. In order to specify formally an investment model for apprentice recruitment it would be necessary to distinguish the different contributions to output made by the various groups of apprentices and craftsmen and the stock-flow situation pertaining to each. In the short-run model implied above the productivity of recruits in, say, the second and third years of training (in addition to the initial year) is thought to influence the recruitment decision. At this stage no attempt is made to construct surrogate series for the employment of these trainees. On the other hand having dropped the extreme current production hypothesis we might now consider the relationship between the desired recruitment of apprentices and plans for investment in capital equipment. The decision to invest will embody a view of future capital stock and utilisation, given expectations about product demand. Gross fixed capital formation should therefore be related to desired production now and in the future. Thus we might expect that, compared to current output (Y_t), gross fixed capital formation deflated by the price of capital goods (GCF_t) would be a better indicator of the composite pressure of current production and planned production over, say, the next three years, upon the decision to recruit apprentices.

Substituting GCF_t for Y_t in equation (9) the model has been re-estimated subject to the above qualifications about the interpretation of coefficients. The results, given in Table 5.3, (5) - (8), should be compared to those of Table 5.1, (7) - (10). With the time trend excluded, the $\bar{R}^2$ statistic rises from 0.68 to 0.82 for LA_{1t} and from 0.80 to 0.88 for LAS_{1t} when Y_t is replaced by GCF_t. Except for the constant terms (which increase markedly in both size and significance) all coefficients decrease in size, particularly those relating to the output or capital formation variables and the lagged dependent variable. The significance of the latter for LA_{1t} drops to the ten per cent level. With the time trend included, the effects of replacing Y_t by GCF_t are very similar to those above but for the fact that the significance of coefficients is once more disrupted by the time trend. Indeed the lagged dependent variables for GCF_t are no longer significantly positive and the time trend for LAS_{1t} is significantly negative at the ten per cent level. This did not occur for the equations employing Y_t, K_t, and KS_t, the coefficients on the lagged dependent variables being more robust than those on the time trend.

In the revised model of desired recruitment (excluding the time trend), the speed of adjustment increases by about 50 per cent and, adjusting for the different values of λ, the 'GCF-elasticities' are approximately one third those for output. Once again the adjustment of LAS_{1t} is less rapid than that of LA_{1t}.

In addition to the improvement in explanatory power, there is a further consequence of adopting gross fixed capital formation to reflect changes in expectations about product demand and hence the desired demand for skilled labour services, over a period of one to three years ahead. The theoretical reconciliation of the objective and adjustment functions is now less troublesome, providing current capital formation is independent of the current state of the labour market; we no longer assume that actual output is a proxy for desired output. The argument then moves to the validity of our assumptions about capital formation (discussed in sections 5.1 and 5.2.1).

Finally, in view of the relatively sudden change in the opportunity cost of training craftsmen which took place with the advent of the levy-grant scheme administered by the E.I.T.B., it would be of interest to know whether this produced any shift in demand relative to those effects already embodied in the two main models. If we assume that the impact of the scheme simply caused a multiplicative shift relative to the proxy used for the labour costs ratio, in favour of recruiting apprentices, then this may be written as $\eta \frac{wa_{1t}}{wc_t}$ where $\eta = 1$ for $t = 1951, \ldots, 1965$ and $0 < \eta = \eta_o < 1$ for $t = 1966, \ldots, 1971$. The addition of a dummy variable, taking the values zero up to and including 1965 and unity thereafter, when estimating equation (9) and the equivalent equation involving the variable for capital formation, should identify this shift. In the case of equation (9) the coefficient on the dummy variable will be $\left[-\frac{\lambda c}{b} \log \eta_o\right]$ and since $\log \eta_o < 0$, we expect the coefficient to be positive. In fact it is insignificantly different from zero for both LA_{1t} and LAS_{1t} regardless of whether the time trend is included or not. The impact upon other previously significant coefficients is marginal and altering the year of change-over to 1965 or 1967 causes no significant improvement. This also applies to the model using the capital formation variable.

The results are not surprising bearing in mind that the introduction of the off-the-job training scheme for first year craft trainees and the early experience of the so-called 'shake-out' (see Bowers et al, 1972) also cover the 1966-67 period. The unravelling of their effects upon apprentice recruitment is unlikely to be achieved given the lack of satisfatory data on labour costs.

5.5 Conclusions

We began with a model of the demand for apprentice recruits by the engineering industry which focussed upon their contribution to current production. The model incorporated a constrained-output, cost-minimising objective function, a putty-clay view of the technology of production (with exogenous capital formation) and a neo-classical treatment of the production of skilled labour services. Certain short-run substitution possibilities were ruled out tentatively on the basis of the available studies of decision-making by firms, in the areas of manpower and investment. Given the different technologies and methods of organising production and training in the engineering industry, the specification of an industry demand model is obviously beset by problems of aggregation. However, notwithstanding these limitations, in the case of the current production model accounting for shortages of craftsmen and lags in adjustment the coefficients are statistically significant and conform to our a priori expectations about their signs. The overall explanatory power is reasonable but improves considerably when the dependent variable is adjusted for changes in average hours worked; the R^2 statistic rises from 0.77 to 0.86.

Whilst retaining the current production hypothesis, section 5.3 stressed elements of the model which warranted improvement. The assumption of a perfectly elastic supply curve for potential apprentice recruits was questioned on the basis of the results of Chapter 4 using a single equation model of supply. If at least some degree of inelasticity with respect to immediate earnings prospects was present during the period and significant shifts in the supply schedule took place due to changes in adult relativities and in relative risks of unemployment, the interpretation of the lagged adjustment parameter estimated in the demand model becomes unsatisfactory; the estimation will have captured supply effects. We suggest that a simultaneous approach would be worth investigation.

The treatment of the production of skilled labour services is necessarily rudimentary in view of the lack of data on the productive work done by first year apprentices but is generally supported by the institutional studies cited.

The lack of significance of the time trend in the fully specified model and the presence of multicollinearity, largely due to its high correlation with output and relative wages, led us to investigate the relationship between capital services, labour services and output more directly. On the basis of this the use of the time trend as an indicator of the effects of capital-saving and labour-saving technical progress was abandoned and the time trend was omitted from the model.

Sections 5.3 and 5.4 continue the analysis focussing on different but related aspects of the model. In the former we note the possible conflict which may arise between the assumption that desired output is always achieved and the introduction of an adjustment mechanism. This depends on the treatment of other factor adjustments in the model. Furthermore it opens up the question of whether other short-run objective functions might be preferable to cost minimisation subject to fulfilling production plans. The extensive literature on short-run employment functions suggest several possible improvements within the limitations of the current production hypothesis, for example, a more sophisticated treatment of the adjustment costs involved in choosing between hours per man and employment levels which would lead us to a version of the interrelated factor demand model. As regards the objective function itself, Solow (1968) for example adopts a model which minimises labour costs over a planning period during which desired output is predetermined. No mechanistic adjustment process is involved in his specification. In so far as firms are influenced by future considerations this would also be a desirable theoretical development of the demand model of apprentice recruitment presented in this chapter.

Section 5.4 takes a first step in recognising that expectations about future labour market and product market situations will influence desired recruitment to some extent. Furthermore, if these expectations are determined by current experience, the results of section 5.2 are consistent with a simple investment hypothesis. It is argued that changes in capital formation will reflect variations in expectations about product demand as well as in the present buoyancy of the market. Thus we no longer assume that desired output is adequately represented by actual output, the main object of criticism in section 5.3.4. Adopting a less formal specification than that of equation (9) the explanatory power of the current production model is improved markedly by replacing current output by gross fixed capital formation; the R^2 statistics for LA_{1t} and LAS_{1t} increase from 0.77 to 0.87 and from 0.86 to 0.91 respectively.

No attempt to develop a formal investment model of apprentice recruitment has been made in thischapter. Section 5.4 introduced a simple modification involving short-run expectations but without specifying the various adjustments costs and a suitable objective function. However the two main models presented here do provide a level of insight and explanatory power which form a useful basis for further research.

CHAPTER 6 APPRENTICE RECRUITMENT BY DIFFERENT ENGINEERING INDUSTRY GROUPS.

6.1 Introduction

In the two previous chapters we have used single equation models of supply and demand in an attempt to analyse the fluctuations in the recruitment of young people by the engineering sector as a whole. As with all fairly aggregate studies, the results may obscure important differences between constituent industries. These may turn out to be mainly in the values taken by nonetheless significant coefficients, the aggregate analysis having successfully anticipated the modelling of recruitment patterns at the disaggregate level. The differences in coefficients might then provide further insight but generally within the initial conception of the aggregate model. Less satisfying is the situation in which the significance of coefficients and the explanatory power of the model vary somewhat from industry to industry.

We shall disaggregate the engineering industry progressively, beginning in section 6.2 with an application of supply and demand models to each of the three industry orders: engineering and electrical goods, vehicles and metal goods n.e.s. For these three groups the estimation of the models is conducted for two periods 1952-71 and 1960-71, in order to check the stability of the estimated coefficients. The additional results also provide a better basis for comparison between aggregate and disaggregate models since complete data for the individual industry groups in only available for the shorter period. The results of the disaggregate analysis are discussed in section 6.3. The specification of supply and demand models is the same as described in the previous two chapters. In section 6.4 forecasts for 1972 and 1973 are evaluated at all three levels of aggregation. The concluding section discusses possible improvements to the models and indicates which ones would be particularly worthy of future research.

The significance of coefficients is indicated as in Chapter 5 by the use of one-tailed 't' tests.

6.2 Results for the Three Engineering Orders.

6.2.1 Supply model

Estimates of the supply model parameters derived from data for 1951-71 and the sub-period 1959-71 are given in Table 6.1 for engineering and electrical goods, vehicles and metal goods n.e.s. The results for the longer period will be discussed first for all industries. Engineering and electrical goods accounts for about two thirds of apprentice recruitment by the engineering sector so we would expect the results for this group of industries to be closest to the aggregate outcome. This is the case if we ignore the weak negative significance of EY_t but the elasticity on EM_t, although positive as expected, almost doubles, increasing from 1.6 to 2.9. The coefficient on relative unemployment falls slightly to -0.25 and once again SLT_t makes no significant contribution to overall explanatory power. The R^2 statistic is much higher for the order, 0.79 compared with 0.64. Once again the introduction of the adjustment process makes no significant impact upon the coefficients and overall explanatory power.

Vehicles and metal goods differ from the above mainly in the poverty and perversity of the significance of their coefficients. Taking first the vehicles results excluding the lagged dependent variable, we find that the coefficient on relative unemployment is significantly negative as expected but so is the coefficient on relative youths earnings and that on relative adult earnings is not significant at all. The introduction of the lagged dependent variable almost doubles the unemployment coefficient, disturbs the EY_t elasticity completely, raises the $\bar{R}^2$ statistic but also produces a small negative estimate of the adjustment parameter which is not significantly different from zero. This is theoretically incompatible with the presence of another significant coefficient. From Chapter 4 we have

Table 6.1 Supply Model Estimation: the three engineering orders

Dependent Variable: $\log LA_{1t}$

Industry and Period of Estimation		Constant	$\log SLT_t$	$\log EY_t$	$\log EM_t$	$\log (U_c/U_t)_t$	$\log LA_{1,t-1}$	R^2	$\bar{R}^2$	DW
Engineering and Electrical goods (VI) 1952-71, excl.1963-64	(1)	6.9756 (2.1574)**	-0.0951 (0.1791)	-1.0976 (0.7825)†	2.8829 (0.5745)**	-0.2483 (0.0974)*		0.7927**	0.7289	2.015
	(2)	5.6323 (2.9609)*	-0.1033 (0.1833)	-0.9166 (0.8425)	2.5500 (0.7645)**	-0.2784 (0.1089)*	0.1945 (0.2863)	0.8003**	0.7172	2.017
1960-71, excl.1963-64	(3)	6.0362 (3.5885)†	-0.0283 (0.2886)	-1.2443 (0.9222)	3.1598 (1.5388)*	-0.2047 (0.1373)†		0.8263**	0.6874	2.145
	(4)	-2.9507 (6.9795)	-0.3137 (0.3266)	-0.6345 (0.9334)	3.8698 (1.4746)*	-0.2263 (0.1251)†	0.7725 (0.5311)	0.8864**	0.7444	2.014
Vehicles (VIII) 1952-71, excl.1963-64	(5)	10.8575 (4.2012)*	-0.0862 (0.3074)	-0.7762 (0.5061)†	0.6488 (1.2407)	-0.3440 (0.1788)*		0.4905	0.3337	1.455
	(6)	0.7937 (5.6527)	-0.3639 (0.2716)	0.2465 (0.5596)	1.2293 (1.0378)	-0.6145 (0.1770)**	1.0357 (0.3809)**	0.6847**	0.5533	1.923
1960-71, excl.1963-64	(7)	11.4043 (8.7293)	-0.2016 (0.5436)	-2.8459 (2.7907)	2.4991 (2.4873)	-0.2203 (0.3076)		0.4703	0.4646	1.728
	(8)	3.2276 (7.2065)	-0.7017 (0.4469)†	-1.7320 (2.0737)	0.9272 (1.9193)	-0.5055 (0.2533)†	1.6156 (0.6867)*	0.7781	0.5008	1.392
Metal Goods n.e.s. (IX) 1952-71, excl.1963-64	(9)	14.3999 (7.8761)*	0.6104 (0.4876)	4.2660 (3.1271)†	-7.3846 (2.0061)**	-0.4746 (0.3063)†		0.5419*	0.4009	0.745
	(10)	-11.0755 (6.4155)†	-0.1315 (0.3043)	1.9004 (1.7985)	2.6463 (2.1537)	-0.0052 (0.1914)	1.0760 (0.1973)**	0.8682**	0.8134	2.297
1960-71, excl.1963-64	(11)	5.0690 (3.8259)	-0.1718 (0.2695)	1.0173 (2.2674)	1.0090 (1.7077)	-0.1337 (0.1461)		0.6090	0.2961	2.468
	(12)	-9.6560 (4.4298)*	-0.4500 (0.1606)*	2.7792 (1.2864)*	2.6809 (1.0064)*	0.0023 (0.0853)	0.8727 (0.2337)*	0.9128*	0.8039	2.470

$$\frac{LA_{1t}}{LA_{1,t-1}} = \left[\frac{LA^*_{1t}}{LA_{1,t-1}}\right]^{\lambda} \qquad 0 \leqslant \lambda \leqslant 1$$

$$\therefore \; LA_{1t} = LA^{*\lambda}_{1t} \left[LA_{1,t-1}\right]^{1-\lambda}$$

i.e. $LA_{1t} \rightarrow LA_{1,t-1}$ as $\lambda \rightarrow 0$

A similar situation occurs with metal goods. Without the adjustment process both earnings variables have significant coefficients but for EM_t it is strongly negative; the unemployment coefficient is only weakly significant. Once $LA_{i,t-1}$ is included the earnings coefficient loses significance whilst that on EM_t also reverses sign. As with vehicles, the coefficient on $LA_{1,t-1}$ implies an adjustment parameter which is not significantly different from zero. Thus for each industry, the increase in $\bar{R}^2$ (from 0.33 to 0.55 for vehicles and from 0.40 to 0.81 for metal goods) is accompanied by switches in coefficient significance and an estimate of λ which together shed doubt on the validity of the model with or without the adjustment hypothesis.

For the shorter period 1960-71 the estimation of an equation containing five or six parameters cannot be entirely satisfactory. However the data available at the industry group level restricts the estimation to this period except that the problem of short time series has been exacerbated by saving the two most recent observations (1972-73) for the forecasting evaluation.

At the order level the supply results for 1960-71 do nothing to buttress the extreme supply explanation of observed recruitment, that is, fluctuations in apprentice recruitment are largely due to movements along and shifts of the supply schedule. Even the results for order VI are undermined, with a partial loss of significance by coefficients on EM_t and $(U_c/U_t)_t$. However the coefficient estimates without the lagged dependent variable are quite close and the $\bar{R}^2$ for the two periods are of similar magnitudes. With order VIII no coefficients are significant in the absence of $LA_{1,t-1}$ and whilst the inclusion of this variable does produce results more compatible with those for the longer period the estimate of λ is now large and negative although once again not significantly different from zero. The increase in $\bar{R}^2$ for vehicles with $LA_{1,t-1}$ is modest by comparison with the case of metal goods. There the equation is transformed, the $\bar{R}^2$ rising from 0.3 to 0.8 and both earnings variables being significantly positive. However SLT_t is significantly negative and $(U_c/U_T)_t$ is not significant. Once again λ is close to zero. Thus there are some marked differences between equations estimated for different periods for vehicles and metal goods. The results do not justify the sophistication of testing this hypothesis formally. The main point is that for these two industries $LA_{1,t-1}$ plays a significant role but one which drastically affects the equation and lends no confidence in the basic model being tested.[1]

6.2.2 Demand model

The demand results for engineering and electrical goods, vehicles and metal goods n.e.s. are given in Tables 6.2, (a) - (c). They correspond to those for the engineering sector as a whole in Table 5.1. No attempt has been made to estimate the equivalent of equation (5.10), which employs the capital stock variable, on the grounds that this equation performed less well than equation (5.9) which bypasses the capital-labour relationship to use net output directly and also because we are ultimately disaggregating further than the three orders and complete measures of capital stock are not available at the EIG level. Hence the estimation of the demand models has been confined to variations on

(1) Tests for first-order autocorrelation at the 5 per cent level for all three industries in the equations without lagged dependent variables and for the longer period prove to be inconclusive. As noted in the previous chapter the DW statistic is biased in favour of accepting the null hypothesis when a lagged dependent variable is included. The modified test coping with this case really applies only to samples with n $\geq$ 30 and so has not been conducted for each equation with the lag present. For the small samples involved in the short period estimation the DW statistic is not strictly defined. In both these cases the statistic is given simply to indicate roughly the probably existence of extreme autocorrelation only. This applies to all the results given in this chapter for both demand and supply models.

Table 6.2(a) Demand Model Estimation: Engineering and Electrical Goods (VI) 1952-1971, excluding 1963-64

Dependent Variables \ Independent Variables		Constant	$\log \frac{wa_{1t}}{wc_t}$	$\log Y_t$	$\log GCF_t$	$\log U_t$	Lagged Dependent Variable	R^2	$\bar{R}^2$	DW (1)
$\log LA_{1t}$	1	6.0429 (3.1878)*	-0.9486 (0.9086)	0.3007 (0.2325)		-0.1527 (0.0443)**	0.3250 (0.3293)	0.7246**	0.6399	1.918
	2	8.7017 (1.7023)**	-1.3187 (0.8268)†	0.3302 (0.2303)†		-0.1398 (0.0435)**		0.7040**	0.6406	2.021
$\log LA_{1t}$	3	8.1252 (2.7752)**	-0.9015 (0.6551)†		0.2381 (0.1241)*	-0.1180 (0.0433)**	0.2089 (0.3190)	0.7578**	0.6833	1.754
	4	9.8688 (0.7655)**	-1.1574 (0.5150)*		0.2608 (0.1167)*	-0.1073 (0.0392)**		0.7498**	0.6962	1.845
$\log LAS_{1t}$	5	8.5475 (4.2087)*	-1.1030 (0.8759)	0.2433 (0.2240)		-0.1522 (0.0417)**	0.3367 (0.3075)	0.8349**	0.7841	1.949
	6	12.7836 (1.6673)**	-1.4831 (0.8098)*	0.2406 (0.2256)		-0.1451 (0.0415)**		0.8197**	0.7810	2.035
$\log LAS_{1t}$	7	11.2090 (3.6213)**	-1.2947 (0.6735)*		0.2290 (0.1178)*	-0.1221 (0.0391)**	0.1805 (0.2934)	0.8604**	0.8175	1.939
	8	13.3895 (0.7278)**	-1.5717 (0.4896)**		0.2484 (0.1110)*	-0.1168 (0.0373)**		0.8564**	0.8256	2.049

(1) The hypothesis of zero autocorrelation is not rejected at the 5 per cent level in any of the equations 2, 4, 6 and 8.

equation (5.9) only plus once again the testing of the explanatory contribution made by the gross-fixed capital formation variable.

To simplify our discussion of the results we should note that the insignificance of the time trend coefficient reappears at the order level. Given the comments made about the role played by the time trend in sections 5.3.1 and 5.3.3, it seems reasonable to concentrate upon the estimated equations which exclude it. One might add that for all three orders the time trend is highly correlated with the relative wages and output variables and, for orders VIII and IX, with the investment variable. The multicollinearity remaining after excluding the time trend is still a problem however, particularly that involving the relative wages variable with output and investment as appropriate.

<u>Order VI</u>. In view of its high relative weight in the aggregate sector, it is not surprising to find that the results for order VI conform most closely to those for all engineering. On the other hand, for this order, the lagged dependent variable is not significant and the output variable is only just significant in one case. When $LA_{1,t-1}$ and $LAS_{1,t-1}$ are excluded the coefficients on log (wa_{1t}/wc_t) with log Y_t are significant at the ten and five per cent levels respectively. The investment variable is generally more robust, retaining its significance throughout accompanied by the wage relativity. The LAS_{1t} specification again provides greater explanatory power than the use of apprentice recruits unadjusted for hours worked. As regards the values taken by coefficients when t and the lagged dependent variable are excluded those on log (wa_{1t}/wc_t) are higher and those on log Y_t or log GCF_t are lower relative to the corresponding aggregate results whereas the unemployment elasticities are about the same. The overall explanatory power of the relationships is better for order VI alone relative to all engineering when log Y_t is employed but not in the case of log GCF_t; for example for LAS_{1t} with log Y_t the R^2 statistic rises from 0.78 to 0.82 whereas

Table 6.2(b) Demand Model Estimation: Vehicles 1952-71 excluding 1963-64.

Dependent Variables	Independent Variables	Constant	$\log \frac{wa_{1t}}{wc_t}$	$\log Y_t$	$\log GCF_t$	$\log U_t$	lagged Dependent Variable	R^2	$\bar{R}^2$	DW(1)
$\log LA_{1t}$	1	3.2166 (3.2854)	0.1905 (0.3220)	0.1165 (0.1919)		-0.1723 (0.0491)**	0.7812 (0.3574)*	0.6384**	0.5589	1.940
	2	9.9465 (1.2914)**	-0.0907 (0.3326)	-0.0257 (0.2034)		-0.1320 (0.0513)*		0.5387*	0.4399	1.365
$\log LA_{1t}$	3	6.3574 (2.6923)*	-0.2867 (0.4162)		0.2814 (0.1611)	-0.1282 (0.0493)*	0.3570 (0.3667)	0.7190**	0.6326	1.623
	4	9.0922 (0.5987)**	-0.6060 (0.2557)*		0.3673 (0.1346)**	-0.1043 (0.0426)*		0.6985**	0.6339	1.493
$\log LAS_{1t}$	5	4.6442 (4.5439)	0.0204 (0.3729)	0.0993 (0.1975)		-0.1571 (0.0486)**	0.7130 (0.3562)*	0.7588**	0.6846	1.838
	6	13.4163 (1.3238)**	-0.3962 (0.3406)	-0.0144 (0.2085)		-0.1383 (0.0526)**		0.6845**	0.6169	1.359
$\log LAS_{1t}$	7	8.4144 (3.9183)	-0.4758 (0.4558)		0.2728 (0.1592)	-0.1267 (0.0468)**	0.3842 (0.3507)	0.7995**	0.7378	1.587
	8	12.6510 (0.6325)**	-0.8795 (0.2701)**		0.3533 (0.1422)*	-0.1115 (0.0450)*		0.7810**	0.7340	1.460

(1) Tests of the hypothesis of zero autocorrelation are inconclusive (equations 2,4,6 and 8).

with log GCF_t the order level R^2 statistics are inferior.

Order VIII. The initial specification of the demand model using net output proves to have significant overall explanatory power when applied to the vehicles order but lacks significant coefficients on output. Replacing log Y_t by log GCF_t yields coefficients on all three explanatory variables which are significant at the five per cent level at least and possess the expected signs. The R^2 statistics are however somewhat lower than for the whole sector and order VI. The best result which uses LAS_{1t} and log GCF_t achieves an R^2 of 0.78 compared to 0.86 for order VI. For order VIII, the coefficient on log (wa_{1t}/wc_t) turns out to be lower than in the aggregate case giving an elasticity almost half the figure for order VI. The 'GCF elasticities' for these two orders are in the region of one quarter to a third and their unemployment elasticities are near to one eighth. When $LA_{1,t-1}$ or $LAS_{1,t-1}$ is included it makes a significant contribution only in the presence of Y_t but the $\bar{R}^2$ does not reach the level associated with GCF_t. The wage variable loses significance.

Order IX. The results for metal goods n.e.s. run counter to those for the sector and orders VI and VIII in that first, the LAS_{1t} specification is accompanied by a reduction in explanatory power and the wage coefficient is positive when significant. The overall explanatory power is however higher, equation for equation, than that achieved for order VIII. Thus multicollinearity which is present in all three sets of data seems to affect particularly the estimation of the models for metal goods. The coefficients on GCF_t and U_t are significant throughout, taking values which are somewhat higher and lower respectively than corresponding estimates for the other two orders. The addition of $LA_{1,t-1}$ or $LAS_{1,t-1}$ raises the $\bar{R}^2$ statistics considerably in all cases. With Y_t the λ values are similar to those for vehicles.

Whilst the precision of coefficient estimates obviously suffers,

Table 6.2(c) Demand Model Estimation: Metal Goods n.e.s. 1952-71 excluding 1963-64

Dependent Variables	Independent Variables	Constant	$\log \frac{wa_{1t}}{wc_t}$	$\log Y_t$	$\log GCF_t$	$\log U_t$	Lagged Dependent Variable	R^2	$\bar{R}^2$	DW(1)
$\log LA_{1t}$	1	-1.1756 (5.0218)	-0.4844 (1.3742)	0.7315 (0.5078)†		-0.0856 (0.0530)	0.7934 (0.2961)**	0.8339**	0.7828	1.610
	2	9.5091 (3.6655)*	2.2488 (1.1057)*	0.2717 (0.5738)		-0.0841 (0.0637)		0.7422**	0.6869	0.868
$\log LA_{1t}$	3	4.2660 (2.5270)†	-0.4951 (0.9544)		0.4228 (0.1681)*	-0.0795 (0 0465)†	0.5787 (0.2477)*	0.8705**	0.8306	1.351
	4	9.8544 (0.9353)**	0.7305 (0.9154)		0.4673 (0.1918)*	-0.0659 (0.0529)		0.8161**	0.7767	0.724
$\log LAS_{1t}$	5	-1.5580 (6.1330)	-0.8875 (1.3518)	0.7939 (0.5213)†		-0.0785 (0.0549)	0.8348 (0.3050)**	0.7668**	0.6950	1.753
	6	12.8723 (3.7914)**	1.7575 (1.1437)†	0.3111 (0.5936)		-0.0990 (0.0659)†		0.6323**	0.5535	0.848
$\log LAS_{1t}$	7	6.0153 (3.4979)†	-0.8506 (0.9061)		0.4616 (0.1725)**	-0.0782 (0.0467)†	0.5445 (0.2551)*	0.8228**	0.7682	1.319
	8	13.2721 (0.9242)**	0.0260 (0.9045)		0.5334 (0.1895)**	-0.0782 (0.0523)†		0.7606**	0.7093	0.737

(1) The null hypothesis is rejected at the 5 per cent level in fabour of positive autocorrelation in equations 2,4,6 and 8.

multicollinearity need not be a source of forecasting error unless the correlations between explanatory variables are expected to break down in the future. In section 6.4 we shall see how forecasts for 1972-73 compare with the actual observations. Meanwhile some indication of the stability of the model with respect to the period from which its parameters have been estimated may be obtained by comparing the results given in Tables 6.3(a) - (c) for the period 1960-71 with the above results for 1952-71.

Order VI. Parameter estimates for the shorter period are comparable with those for the two decades. Coefficients on log (wa_{1t}/wc_t) and log U_t are particularly close whereas those on log Y_t and log GCF_t are somewhat higher. As with the longer period, none of the coefficients on the lagged dependent variable for 1960-71 is significant. Comparing $\bar{R}^2$ statistics those for LA_{1t} are similar but those for LAS_{1t} are roughly 0.05 lower. For the shorter period GCF_t as well as Y_t barely makes a significant contribution. However the results for 1960-71, despite some loss of significance for individual coefficients, generally correspond to those for the full period.

Order VIII. Without the lagged dependent variable none of the coefficients (except GCF_t at 10 per cent) is significant and nor is overall explanatory power. The introduction of the lagged dependent variable raises the $\bar{R}^2$ statistic in all four cases to about 0.66, with a corresponding R^2 of about 0.81. There is nothing to choose between equations; all imply negative adjustment parameters of roughly unity and hence inconsistent with the adjustment hypothesis advanced in Chapter 5. In addition to the significant coefficients on the lagged dependent variable those on log U_t are significantly negative as expected but at least double previous estimates. The other variables make no theoretically consistent, significant contribution to the explanation of recruitment fluctuations. Quite clearly these results amount to a break-down of the

Table 6.3(a) Demand Model Estimation: Engineering and Electrical Goods, 1960-71 excluding 1963-64

Dependent Variables \ Independent Variables		Constant	$\log \frac{wa_{1t}}{wc_t}$	$\log Y_t$	$\log GCF_t$	$\log U_t$	Lagged Dependent Variable	R^2	$\bar{R}^2$	DW
$\log LA_{1t}$	1	4.3169 (4.6071)	-1.2859 (1.0629)	0.4542 (0.3500)		-0.1786 (0.0637)*	0.4271 (0.5114)	0.8053	0.6496	1.991
	2	7.7507 (2.0266)**	-1.7111 (0.9092)†	0.5294 (0.3296)†		-0.1685 (0.0616)*		0.7782*	0.6673	2.447
$\log LA_{1t}$	3	4.7472 (4.2393)	-1.0769 (0.8139)		0.3938 (0.2380)†	-0.1188 (0.0575)*	0.5270 (0.4613)	0.8318*	0.6973	1.893
	4	9.4171 (1.1505)**	-1.4581 (0.7610)†		0.4190 (0.2429)†	-0.0968 (0.0553)†		0.7879*	0.6819	2.408
$\log LAS_{1t}$	5	6.6877 (7.5635)	-1.3936 (1.0684)	0.3869 (0.3492)		-0.1723 (0.0655)*	0.4222 (0.5587)	0.8449*	0.7208	1.911
	6	12.1690 (2.0673)**	-1.7441 (0.9274)†	0.3765 (0.3362)		-0.1676* (0.0686)*		0.8272*	0.7408	2.359
$\log LAS_{1t}$	7	6.2031 (7.0753)	-1.2201 (0.8575)		0.3629 (0.2508)	-0.1174 (0.0564)*	0.5418 (0.5324)	0.8638*	0.7549	1.790
	8	13.3035 (1.1706)**	-1.5997 (0.7743)*		0.3153 (0.2471)	-0.1155 (0.0565)*		0.8356**	0.7534	2.356

Table 6.3(b) Demand Model Estimation: Vehicles, 1960-71 excluding 1963-64

Dependent Variables \ Independent Variables		Constant	$\log \frac{wa_{1t}}{wc_t}$	$\log Y_t$	$\log GCF_t$	$\log U_t$	Lagged Dependent Variable	R^2	$\bar{R}^2$	DW
$\log LA_{1t}$	1	-0.6943 (5.1288)	2.9466 (1.6906)†	-0.1613 (0.6705)		-0.3327 (0.1022)*	1.8356 (0.5526)*	0.8129*	0.6632	1.355
	2	8.4111 (7.0859)	-0.6373 (2.1275)	0.1531 (1.0850)		-0.1061 (0.1244)		0.4000	0.0999	1.204
$\log LA_{1t}$	3	-4.7589 (5.2756)	4.2548 (2.3448)†		-0.2552 (0.3246)	-0.4275 (0.1599)*	2.4597 (0.9687)*	0.8315*	0.6967	1.875
	4	8.1642 (1.9181)**	-1.2331 (1.2560)		0.4408 (0.2403)†	-0.0633 (0.0975)		0.6143	0.4214	1.007
$\log LAS_{1t}$	5	-4.3446 (7.2278)	4.1294 (2.2579)†	-0.4011 (0.7554)		-0.3351 (0.1148)*	2.0489 (0.6823)*	0.8135*	0.6642	1.290
	6	11.8751 (7.3422)†	-1.0878 (2.2045)	0.1157 (1.1243)		-0.1010 (0.1289)		0.4770	0.2154	1.204
$\log LAS_{1t}$	7	-6.0213 (8.7712)	3.3698 (2.7343)		0.0013 (0.2962)	-0.3104 (0.1505)*	1.9634 (0.9687)	0.8029	0.6453	1.372
	8	11.4336 (2.0537)**	-1.7117 (1.3448)		0.4272 (0.2573)†	-0.0582 (0.1044)		0.6410	0.4615	1.030

Table 6.3(c) Demand Model Estimation: Metal Goods n.e.s., 1960-71 excluding 1963-64

Dependent Variables	Independent Variables	Constant	$\log \frac{wa_{1t}}{wc_t}$	$\log Y_t$	$\log GCF_t$	$\log U_t$	Lagged Dependent Variable	R^2	$\bar{R}^2$	DW
$\log LA_{1t}$	1	2.4955 (4.7550)	0.9297 (1.2008)	0.5597 (0.3848)		-0.0956 (0.0494)+	0.4253 (0.3580)	0.6357	0.3443	2.572
	2	7.2819 (2.6104)*	0.2343 (1.0838)	0.4006 (0.3729)		-0.0884 (0.0510)+		0.5329	0.2993	2.004
$\log LA_{1t}$	3	6.9447 (3.3198)*	0.6659 (1.2090)		0.3949 (0.3301)	-0.0936 (0.5192)+	0.2631 (0.3534)	0.5969	0.2744	1.487
	4	9.2804** (1.0467)	0.4072 (1.1142)		0.3837 (0.3173)	-0.0846 (0.0495)+		0.5522	0.3283	1.254
$\log LAS_{1t}$	5	5.5196 (7.6512)	1.2570 (1.3135)	0.5416 (0.4519)		-0.0928+ (0.0563)	0.3432 (0.4656)	0.6797	0.4234	2.531
	6	10.7577** (2.7261)	0.8280 (1.1318)	0.3941 (0.3894)		-0.0999+ (0.0533)		0.6449	0.4673	2.200
$\log LAS_{1t}$	7	11.0960 (5.2568)*	1.2278 (1.2289)		0.4491 (0.3459)	-0.0965 (0.0594)+	0.1214 (0.4100)	0.6916	0.4449	1.518
	8	12.6159 (1.0494)**	1.1696 (1.1171)		0.4442 (0.3181)	-0.0969 (0.0496)		0.6862	0.5293	1.4564

theoretically more acceptable equation for vehicles. The R^2 can only be resuscitated by recourse to an <u>ad hoc</u> autoregressive structure.

Order IX. For the full period, the overall explanatory power of equations for metal goods was quite good but the coefficient estimates were poorly determined due to the presence of multicollinearity. For 1960-71, the $\bar{R}^2$ statistics are low. Only U_t makes a significant contribution with coefficients similar to those for the full period. The lagged dependent variable is not significant.

6.3 Results for the Fifteen Engineering Industry Groups

In this section the supply and demand models are re-estimated for each industry group within each order. Engineering and electrical goods is split into ten groups, vehicles into three groups and metal goods n.e.s. into two groups.

6.3.1 Supply model

The estimation of the supply model at the EIG level further undermines our confidence in the supply hypothesis as the underlying explanation of fluctuations in apprentice recruitment. This however is a matter of relative rather than absolute judgement and we shall deal with it after describing the disaggregated results for both supply and demand models.

Table 6.4 (a) to (c) contains the results of estimating the supply model without the lagged dependent variable. The overall explanatory power of the equation is significant at the 5 per cent level in only 6 out of 15 EIGs. Of these, five belong to the engineering and electrical goods order; they are metal working machine tools, industrial machinery, instrument engineering, electrical machinery and insulated wires and cables. The sixth was aircraft manufacturing.

At the EIG level the SLT_t coefficient is significantly positive at the 5 per cent level in two cases, EIGs (1) and (2), but in the second of these the coefficient is very high implying that for a 1 per cent increase in all young persons entering employment there is a 6 per cent increase in recruitment (supply) of apprentices to industrial machinery. In two other industries, EIGs (4) and (8), the coefficient is significantly negative whilst for EIG (9) it is positive but significant only at the 10 per cent level.

The significance of earnings variables in the supply models reflects the results at the SIC order level. When the EY_t elasticity is significant it is usually negative (EIGs 3, 7, 8 and 12 but not 11) and when the EM_t elasticity is significant it is usually positive (EIGs 1, 2, 5, 6, 7, 12 and 14). Values of the EM_t elasticities lie between 2.4 and 8.4. It is probable that the results for EY_t indicate the influence of demand via the depressing effect which increases in the earnings of youths will have had upon their recruitment (EY_t captures the rise in engineering earnings relative to the substantial rise in the earnings of all youths employed in Great Britain and will understate the change in real labour costs affecting firms during the period). It is possible that the significance of the EM_t elasticities is consolidated by a demand effect acting in the same direction as the expected supply effect. The demand effect would follow from two influences.

(i) The earnings relativity EM_t tends to follow the cycles of output in the economy because engineering suffers the extremes of cyclical activity and hence EM_t is a weak proxy for engineering output and labour demand in most manual occupations.

(ii) EM_t will also partly reflect fluctuations in real adult labour costs just as does EY_t for the case of youths. With EY_t in the same regression equation, EM_t will thus represent the price of adult labour relative to EY_t and the higher this is the more likely will firms recruit young people. To put it another way, the higher are adult skilled earnings relative to apprentice earnings the more likely will firms make short-run decisions to recruit apprentices at times of labour shortage.

Only for aircraft (12) is the unemployment coefficienc significantly positive. Of the twelve for which the sign is as expected, three coefficients are significant (EIGs 7, 9 and 10). As with EM_t above, demand factors may penetrate the estimation of a supply relationship, tending to support the expected supply effect since fluctuations in $(U_c/U_T)_t$ are negatively correlated with those in engineering sector output. The poor results cannot then be attributed to the presence of a demand

Table 6.4(a) Supply Model Estimation: Engineering Industry Groups. 1960-71 excl. 1963-64

Dependent variable: $\log LA_{1t}$

Engineering Industry Group	Independent variables Constant	$\log SLT_t$	$\log EY_t$	$\log EM_t$	$\log(U_c/U_t)_t$	R^2	$\bar{R}^2$	DW
1) Metal working machine tools	-0.2442 (2.0056)	0.4545 (0.2176)*	-0.1839 (0.7088)	2.4166 (0.6162)**	-0.1377 (0.1172)	0.9522**	0.9139	2.426
2) Industrial machinery	-7.8517 (6.2967)	0.5970 (0.2768)*	-0.0915 (0.9292)	5.1651 (1.7758)*	-0.1614 (0.1483)	0.8588*	0.7458	1.609
3) Other non-electrical machinery	11.3493 (3.9861)*	-0.2595 (0.3591)	-1.3349 (0.9017)†	1.1709 (1.7309)	-0.2235 (0.7978)	0.5168	0.1303	2.162
4) Industrial plant and steelwork	11.2989 (4.6884)*	-0.8120 (0.4098)†	0.6933 (1.5004)	0.2204 (2.6283)	-0.1165 (0.2151)	0.4899	0.0818	2.240
5) Other mechanical engineering	3.7190 (4.0875)	-0.0708 (0.3228)	-1.5696 (1.1300)	3.3848 (1.7000)†	-0.0130 (0.1706)	0.6945	0.4500	1.718

Table 6.4(b) Supply Model Estimation: Engineering Industry Groups. 1960-71 excl. 1963-64

Dependent variable: $\log LA_{1t}$

Engineering Industry Group	Independent variables							
	Constant	$\log SLT_t$	$\log EY_t$	$\log EM_t$	$\log(U_c/U_T)_t$	R^2	$\bar{R}^2$	DW
6) Instrument engineering	-7.5714 (3.8279)*	0.2067 (0.2160)	0.5163 (0.9887)	4.7097 (1.1723)**	0.0423 (0.1166)	0.9077**	0.8339	3.505
7) Electrical machinery	0.9960 (2.8921)	0.2967 (0.4139)	-2.1429 (1.2990)†	4.6767 (1.7408)*	-0.4061 (0.1840)*	0.9497**	0.9095	3.258
8) Electronics	15.9253 (9.0238)†	-0.9594 (0.4369)*	-4.0362 (2.3151)†	2.6640 (2.1951)	0.1246 (0.2462)	0.8031†	0.6455	2.864
9) Insulated wires and cables	4.4910 (6.1269)	1.0856 (0.5718)†	0.8788 (0.9869)	-1.3124 (2.8044)	-0.9403 (0.1767)**	0.9274**	0.8694	2.7999
10) Other electrical goods	1.3930 (5.2618)	0.2383 (0.6669)	-0.5974 (2.0514)	3.1547 (2.8607)	-0.5160 (0.3176)†	0.7405	0.5330	2.1230

Table 6.4(c) Supply Model Estimation: Engineering Industry Groups. 1960-71 excl. 1963-64

Dependent variable: $\log LA_{1t}$

Engineering Industry Group	Independent variables							
	Constant	$\log SLT_t$	$\log EY_t$	$\log EM_t$	$\log(U_c/U_T)_t$	R^2	$\bar{R}^2$	DW
11) Motor vehicles	-5.0073 (8.8890)	1.2552 (0.9335)	3.7165 (2.2250)†	-1.1266 (2.0844)	-0.5182 (0.3947)	0.4398	-	1.270
12) Aircraft	-10.3385 (2.4967)**	-0.1666 (0.2393)	-1.9289 (0.3505)**	8.3509 (0.9766)**	0.4371 (0.1262)**	0.9570**	0.9225	3.380
13) Other vehicles	-9.3104 (16.7364)	1.2739 (1.5474)	2.8631 (3.7037)	0.7918 (5.4961)	-0.2013 (0.6337)	0.6727	0.4109	1.347
14) Tools, bolts, wire and cans	-4.0228 (11.6179)	0.3955 (0.5903)	-2.3566 (3.2843)	6.1179 (2.8837)†	-0.1793 (0.3603)	0.7754	0.5957	1.4990
15) Other metal goods n.e.s.	11.4658 (5.3166)	-0.1248 (0.4115)	0.2720 (2.9643)	-0.8766 (2.8049)	-0.2313 (0.2154)	0.2071	-	1.5246

effect counteracting a supply effect.

Although the Durbin-Watson statistic is not strictly defined for the small sample of observations used here, the DW statistics are given to indicate the presence of extreme cases such as EIGs (6) to (9) and (11) to (13).

The introduction of a lagged dependent variable (for which the results are not shown) makes a significant contribution in only one case; other vehicles, where the $\bar{R}^2$ rises from 0.41 to 0.97. Accompanying this is a gain of significance by $(U_c/U_T)_t$ with the expected sign but also by SLT_t and EM_t with negative signs; the coefficient on the lagged dependent variable itself exceeds unity. For other industries, the $\bar{R}^2$ statistics are affected only marginally and generally speaking coefficients, previously significant, remain so. The main exception is electrical machinery where the inclusion of the new variable disturbs the pattern of significance all round.

6.3.2 Demand model

The results for the demand hypothesis turn out to be more economically meaningful than those for the supply hypothesis at the disaggregate as well as aggregate level. The number of alternative demand equations tested is greater than in the case of supply. To simplify discussion we shall deal with the results for four basic equations to which may be added the time trend as a proxy for technical progress and/or the lagged dependent variable as a means of allowing for an adjustment process. The time trend was excluded from the start at this level of disaggregation; this leaves the lagged dependent variable which in 13 of the 15 EIGs proved to have a negligible impact upon the significance of coefficients and overall explanatory power. Only the lagged results for the other two EIGs will be mentioned with those of the four basic equations for all industries.

Table 6.5(a) Demand Model Estimation: EIGs (1) to (3), 1960-71 excluding 1963-64

Industry and dependent variable	Constant	log wa_{1t}/wc_t	log Y_t	log GCF_t	log U_t	R^2	$\bar{R}^2$	DW
(1) Metal working machine tools								
LA_{1t}	5.6813 (1.9778)*	-1.4072 (0.5792)*	0.6142 (0.3522)†		-0.1984 (0.0536)**	0.8758**	0.8138	2.126
	8.8388 (1.2575)**	-1.0431 (0.7700)		-0.0218 (0.1834)	-0.1876 (0.0682)*	0.8133*	0.7200	2.374
LAS_{1t}	9.8134 (2.2190)**	-1.7356 (0.6498)*	0.5257 (0.3951)		-0.2242 (0.0602)**	0.8876**	0.8314	1.967
	12.7530 (1.2863)**	-1.2837 (0.7876)†		-0.8760 (0.1875)	-0.2078 (0.0698)*	0.8595**	0.7893	2.381
(2) Industrial machinery								
LA_{1t}	5.9006 (3.0307)*	-1.6486 (1.2657)	0.5448 (0.5058)		-0.1839 (0.0810)*	0.6720	0.5083	2.013
	2.1165 (2.4008)	-3.4141 (1.0846)**		1.1565 (0.3845)*	-0.0517 (0.0594)	0.8440**	0.7660	1.832
LAS_{1t}	9.9465 (3.0483)**	-1.8242 (1.2731)	0.4642 (0.5087)		-0.1905 (0.0815)*	0.7378*	0.6067	2.071
	5.6733 (2.2690)*	-3.7699 (1.0250)**		1.1642 (0.3634)**	-0.0633 (0.0562)	0.8898**	0.8348	2.183
(3) Other non-electrical machinery								
LA_{1t}	2.9283 (1.7081)†	-1.0240 (0.5041)*	1.2850 (0.3352)**		-0.1272 (0.0462)*	0.7557*	0.6336	2.397
	7.2595 (1.0151)**	-0.9811 (0.6156)†		0.4276 (0.1492)*	-0.0972 (0.0531)†	0.6442	0.4663	2.160
LAS_{1t}	7.6597 (1.7819)**	-1.1502 (0.5259)*	1.0790 (0.3497)*		-0.1403 (0.0482)*	0.7647	0.6462	2.351
	11.3163 (1.0127)**	-1.1041 (0.6142)†		0.3539 (0.1489)*	-0.1146 (0.0530)*	0.6858	0.5287	2.156

Table 6.5(b) Demand Model Estimation: EIGs (4) to (6), 1960-71 excluding 1963-64

Industry and dependent variable	Constant	log wa_{1t}/wc_t	log Y_t	log GCF_t	log U_t	R^2	$\bar{R}^2$	DW
(4) <u>Industrial plant and steel-work</u>								
LA_{1t}	7.0450	1.6593	0.3490		-0.0642	0.7152*	0.5727	2.056
	(1.8347)**	(1.0221)†	(0.2967)		(0.0585)			
	8.1212	2.1495		0.2741	-0.0328	0.6872	0.5309	2.230
	(1.3275)**	(0.8663)*		(0.3221)	(0.0496)			
LAS_{1t}	11.7909	1.7258	0.1855		-0.0807	0.6161	0.4240	2.140
	(1.8324)**	(1.0208)†	(0.2963)		(0.0584)			
	2.5337	2.0613		0.0895	-0.0615	0.5965	0.3947	2.225
	(1.2970)**	(0.8465)*		(0.3148)	(0.0484)			
(5) <u>Other mechanical engineering</u>								
LA_{1t}	4.5109	-2.0827	0.5454		-0.0722	0.5566	0.3350	2.146
	(2.8040)†	(1.2534)†	(0.4197)		(0.0735)			
	10.7703	0.2920		-0.5260	-0.08967	0.5095	0.2643	2.247
	(3.3252)**	(1.4343)		(0.5395)	(0.0839)			
LAS_{1t}	8.7869	-2.1586	0.4081		-0.0732	0.6302	0.4454	2.039
	(2.8833)*	(1.2888)†	(0.4316)		(0.0755)			
	13.3054	-0.4441		-0.3645	-0.0805	0.6050	0.4070	2.133
	(3.3619)**	(1.4501)		(0.5455)	(0.0848)			
(6) <u>Investment engineering</u>								
LA_{1t}	8.0958	-0.6287	-0.2336		-0.0690	0.8383*	0.7574	2.493
	(2.0681)**	(1.0977)	(0.2707)		(0.0560)			
	7.6144	-0.4860		-0.1616	-0.0807	0.8395**	0.7592	2.421
	(1.5515)**	(1.2095)		(0.1813)	(0.0544)†			
LAS_{1t}	12.5399	-0.5496	-0.3612		-0.0750	0.8793**	0.8189	2.366
	(2.1360)**	(1.1337)	(0.2796)		(0.0578)			
	11.7924	-0.3318		-0.2494	-0.0931	0.8811**	0.8217	2.260
	(1.5960)**	(1.2442)		(0.1865)	(0.0560)†			

Table 6.5(c) Demand Model Estimation: EIGs (7) to (9), 1960-71 excluding 1963-64

Industry and dependent variable	Constant	log wa_{1t}/wc_t	log Y_t	log GCF_t	log U_t	R^2	$\bar{R}^2$	DW
(7) Electrical machinery								
LA_{1t}	8.1976 (1.9168)**	-1.8976 (0.8857)*	0.2526 (0.2755)		-0.3206 (0.0670)**	0.9314**	0.8971	2.583
	5.3585 (2.3850)*	-1.8064 (0.6748)*		0.7912 (0.4067)*	-0.1214 (0.1115)	0.9520**	0.9280	1.459
LAS_{1t}	12.3033 (1.8698)**	-2.1282 (0.8640)*	0.1263 (0.2687)		-0.3161 (0.0653)**	0.9423**	0.9135	2.643
	9.0794 (2.2224)**	-2.2016 (0.6288)**		0.7340 (0.3790)†	-0.1359 (0.1039)	0.9632**	0.9448	1.697
(8) Electronics								
LA_{1t}	1.4777 (2.4114)	-3.5236 (1.2140)*	0.9495 (0.3978)*		-0.1269 (0.1256)	0.6303	0.4454	2.287
	2.3445 (1.6599)	-3.2640 (0.8703)**		0.5239 (0.1578)**	0.0871 (0.0870)	0.7460*	0.6190	2.102
LAS_{1t}	5.5674 (2.3442)*	-3.5008 (1.1801)*	0.8356 (0.3867)*		-0.1085 (0.1221)	0.6685	0.5027	2.347
	6.3039 (1.6592)**	-3.2869 (0.8699)**		0.4649 (0.1577)*	0.0805 (0.0869)	0.7592*	0.6388	2.097
(9) Insulated wires and cables								
LA_{1t}	9.7761 (1.7425)**	0.0617 (0.7862)	0.0811 (0.2633)		-0.3992 (0.0902)**	0.8815**	0.8223	2.267
	10.3380 (1.6824)**	0.2581 (0.6212)		-0.0350 (0.2539)	-0.3938 (0.0905)**	0.8800**	0.8200	2.162
LAS_{1t}	13.7819 (1.6622)**	-0.0901 (0.9500)	-0.0169 (0.2512)		-0.3904 (0.0860)**	0.9102**	0.8653	2.330
	14.2627 (1.5624)**	-0.0816 (0.5769)		-0.1194 (0.2358)	-0.4068 (0.0840)**	0.9138**	0.8708	2.199

Table 6.5(d) Demand Model Estimation: EIGs (10) to (12), 1960-71 excluding 1963-64

Industry and dependent variable	Constant	$\log wa_{1t}/wc_t$	$\log \bar{Y}_t$	$\log \overline{GCF}_t$	$\log \bar{U}_t$	R^2	$\bar{R}^2$	DW
(10) Other electrical goods								
	9.8097	-0.4785	-0.2558		-0.1915	0.8369**	0.7553	1.855
	(2.3391)**	(1.1382)	(0.3220)		(0.0852)*			
LA_{1t}	10.0020	0.1071		-0.2112	-0.2264	0.8423**	0.7634	1.529
	(2.2778)**	(1.5144)		(0.2277)	(0.0860)*			
	13.6788	-0.7366	-0.3404		-0.1851	0.8623**	0.7934	2.011
	(2.3875)**	(1.1617)	(0.3287)		(0.0870)*			
LAS_{1t}	14.0105	0.0947		-0.2907	-0.2325	0.8723**	0.8085	1.570
	(2.2766)**	(1.5136)		(0.2276)	(0.0860)*			
(11) Motor vehicles								
	11.3025	-1.6056	-0.1239		-0.1627	0.6005	0.4007	1.808
	(2.1700)**	(0.7834)*	(0.3102)		(0.0624)			
LA_{1t}	10.2673	-1.3598		0.0577	-0.1453	0.6006	0.4009	2.021
	(11.1815)**	(0.4678)*		(0.1434)	(0.0741)*			
	15.3952	-1.5913	-0.2330		-0.1562	0.5333	0.2999	1.954
	(2.2629)**	(0.8170)*	(0.3235)		(0.0651)*			
LAS_{1t}	13.7611	-1.1441	0.0513	-0.1394		0.5054	0.2581	2.006
	(1.2005)**	(0.5022)*		(0.1539)	(0.0796)†			
(12) Aircraft								
	12.3501	-4.0513	-0.1488		-0.1325	0.7511*	0.6266	1.731
	(3.9521)*	(1.2370)**	(0.9220)†		(0.0772)†			
LA_{1t}	7.1902	-1.4517		0.2101	-0.1571	0.6954	0.5432	1.665
	(1.5832)**	(1.3890)		(0.2066)	(0.1029)†			
	17.8673	-4.3806	-0.1831		-0.1797	0.7929*	0.6894	1.648
	(3.8783)**	(1.2139)**	(0.9048)*		(0.0757)*			
LAS_{1t}	11.1411	-1.6070		0.1761	-0.1847	0.6834	0.5251	1.587
	(1.7368)**	(1.5234)		(0.2267)	(0.1128)†			

Table 6.5(e) Demand Model Estimation: EIGs (13) to (15), 1960-71 excluding 1963-64

Industry and dependent variable	Constant	$\log wa_{1t}/wc_t$	$\log Y_t$	$\log GCF_t$	$\log U_t$	R^2	$\bar{R}^2$	DW
(13) <u>Other vehicles</u>								
	-1.7194 (2.7956)	-1.2746 (1.6104)	1.7861 (0.3067)**		-0.0723 (0.0895)	0.9371**	0.9057	2.466
LA_{1t}	11.000 (3.3793)**	3.2995 (3.7919)		0.6244 (0.5041)	-0.2834 (0.1966)†	0.6670	0.5006	1.984
	1.7939 (2.8393)	-1.1982 (1.6356)	1.8692 (0.3115)**		-0.0841 (0.0909)	0.9418**	0.9127	2.500
LAS_{1t}	15.1723 (3.5566)**	3.5081 (3.9908)		0.6241 (0.5306)	-0.3130 (0.2070)†	0.6689	0.5034	0.986
(14) <u>Tools, bolts, wire and cans</u>								
	2.8442 (4.1794)	-2.7203 (1.0954)*	0.9240 (0.7549)		-0.1992 (0.0903)*	0.8309**	0.7463	1.600
LA_{1t}	7.4683 (3.1715)*	-2.3019 (1.3461)†		0.0468 (0.7036)	-0.2147 (0.1014)*	0.7888*	0.6832	1.135
	6.5394 (4.2356)†	-3.1108 (1.1101)*	0.9172 (0.7650)		-0.2176 (0.0915)*	0.8573**	0.7859	1.723
LAS_{1t}	10.8865 (3.1960)**	-2.7579 (1.3564)*		0.1084 (0.7090)	-0.2313 (0.1022)*	0.8238*	0.7357	1.192
(15) <u>Other metal goods n.e.s.</u>								
	8.4405 (3.5352)*	1.0916 (1.6478)	0.2557 (0.4497)		-0.0710 (0.0751)	0.3126	0.3105	1.480
LA_{1t}	9.7487 (3.5187)*	1.4243 (2.2706)		0.0854 (0.5062)	-0.0889 (0.0691)	0.2790	-	1.329
	11.9639 (3.5458)**	0.4819 (1.6528)	0.2278 (0.4510)		-0.0787 (0.0753)	0.2884	-	1.641
LAS_{1t}	12.4925 (3.4829)**	0.3981 (2.2475)		0.1760 (0.5010)	-0.0920 (0.0684)	0.2731	-	1.481

Tables 6.5 (a) to (e) show the results for five groups of three industries each. Table 6.6 compares the $\bar{R}^2$ statistics achieved by the supply model with those achieved by the four demand models. This shows that for 6 out of 15 EIGs the supply explanation of recruitment fluctuations was statistically superior to one or both demand explanations (unadjusted for hours worked: demand equations (1) and (2)). Note especially the results for aircraft (12). In terms of the coefficients estimated Table 6.6 also summarises the pattern of significance at the 5 per cent level or less. The results seem to favour the demand model; this is supported by the figures given in brackets which are the numbers of coefficients possessing at least the expected sign if not necessarily the requisite significance. With the exception of EY_t the explanatory variables in both supply and demand models tend to take the expected signs. This suggests that significant coefficients do not occur merely as random events and that the apparently better performance of the demand models is also therefore unlikely to be a random phenomenon. Nonetheless one can hardly be satisfied with the general state of the demand results.

A perusal of Table 6.6 in conjunction with Table 6.5 indicates that the differences between industries are on balance more marked than the differences between alternative demand hypotheses, although for industrial machinery (2), equations (2) and (4) yield much higher $\bar{R}^2$ statistics than do equations (1) and (3), and for other vehicles (13) the reverse is the case. The industries for which the demand models provide both significant explanatory power <u>and</u> acceptable coefficient estimates in the main are metal working machine tools (1), other non-electrical machinery (3), electrical machinery (7) and tools, bolts etc. (14). Combining forces, the demand equations yield significant explanatory power for LA_{1t} in 12 out of 15 industries, and for LAS_{1t} in 11 out of 15.

Table 6.6 Comparison of $\bar{R}^2$ statistics: supply and demand models at EIG level.

EIG	Supply equation	Demand equations (1) (LA_{1t}, Y_t)	(2) (LA_{1t}, GCF_t)	(3) (LAS_{1t}, Y_t)	(4) (LAS_{1t}, GCF_t)
1	0.91**	0.81**	0.72*	0.83**	0.79**
2	0.75*	0.51	0.77**	0.61*	0.83**
3	0.13	0.63*	0.47	0.65*	0.53
4	0.08	0.57*	0.53	0.42	0.39
5	0.45	0.34	0.26	0.45	0.41
6	0.83**	0.76**	0.76**	0.82**	0.82**
7	0.91**	0.90**	0.93**	0.91**	0.94**
8	0.65	0.45	0.62*	0.50	0.64*
9	0.87**	0.82**	0.82**	0.87**	0.87**
10	0.53	0.76**	0.76**	0.79**	0.81**
11	-	0.40	0.40	0.30	0.26
12	0.92**	0.63*	0.54	0.69**	0.53
13	0.41	0.91**	0.50	0.91**	0.50
14	0.60	0.75**	0.68*	0.79**	0.74*
15	-	0.31	-	-	-

Variables significant as expected at the 5 per cent level (with expected sign regardless of significance).

SLT	2(9)	-	-	-	-
EY	0(6)	-	-	-	-
EM	5(12)	-	-	-	-
U_c/U_T	2(12)	-	-	-	-
wa_1/wc	-	6(11)	3(8)	6(12)	4(11)
Y	-	3(11)	-	3(10)	-
GCF	-	-	4(10)	-	3(10)
U	-	8(15)	5(14)	9(15)	5(14)

The addition of a lagged dependent variable makes a significant contribution to overall explanatory power only for electrical machinery (7), the $\bar{R}^2$ for equations (1) to (4) rising to 0.94, 0.96, 0.96 and 0.96 respectively, and other vehicles (13), the $\bar{R}^2$ rising to 0.95, 0.94, 0.94 and 0.93 respectively. In the first case the presence of the lagged dependent variable disturbs the significance of the wage variable and in the second case the same occurs for the output variable.

Finally, it is extremely important to emphasise that the output data and, especially, the investment data on which these regression results are based are subject to sizeable errors at this level of disaggregation. For industries with relatively small levels of output and investment this point is particularly applicable. The results are therefore only generally indicative of the success to be expected with more reliable data.

6.4 The Forecasts

Conditional forecasts at the SIC order and EIG levels are compared with actual observations for 1972-73 in Table 6.7. All are based on equations omitting the lagged dependent variable. Results for 1973 using the GCF variable are not given because, at the time this analysis was conducted, the investment data was not available. The year 1973 is also associated with another problem: the raising of the school-leaving age to sixteen years. Given the specification of the supply variable SLT_t as the number actually entering employment one might expect the supply model (as well as the demand models) to take 1973 in its stride. However, both supply and demand models have been estimated with respect to patterns of change in the data against which the impact of the raising of the school-leaving age might be regarded as an exogenous non-marginal shock to the labour market for young persons. It would be surprising if the models did not over-predict apprentice recruitment in 1973.

Percentage forecasting errors for the order level models, estimated with and without the lagged dependent variable, are shown in Table 6.7. The forecasts are conditional upon known independent variables and so the errors are free from forecast errors in these variables. Several general statements can be made about the pattern of errors.

(i) With certain exceptions, all the models are over-predicting and, as expected, the prediction errors are much greater for 1973.

(ii) Contrary to expectations the presence of the lagged dependent variable makes a significant impact, cutting the errors obtained without it by considerable amounts except in the case of the vehicles forecasts for 1972 based on the 1960-71 data.

(iii) The use of the shorter base period 1960-71 produces generally lower errors for engineering and electrical goods and metal goods.

(iv) Without lags the use of the GCF_t variable in place of Y_t (demand equations 2 and 4 in the table) does usually reduce forecast errors, although only for vehicles is the improvement very great; with lags, however, the errors increase for vehicles and metal goods.

(v) Adjustment for hours of labour services (demand equations 3 and 4) yields only a relatively small reduction in forecast error.

(vi) The supply model does not perform systematically worse than all demand models. Although specified in a way which one would expect to cope with the raising of the school-leaving age, the supply model if anything performs worse than the demand models.

(vii) Despite the sizes of the errors only one in eight are statistically significant from zero and these relate especially to 1973 without the lag.

Turning to the results for EIGs excluding lags, summarised in Table 6.8, the above features re-appear to some extent, except that (ii) and (iii) do not apply. The disaggregate models also over-predict, the use of GCF_t in place of Y_t now improves the forecasts only in the case of vehicles, the adjustment for hours of labour services only affects the forecasts marginally, the supply model predictions are no worse than those of the demand model and the proportion of forecasting errors which are significant now rises to one fifth. Comparing the effective aggregate forecasts derived from EIG results with those obtained directly from order level models using no lag and based on 1960-71 (see the third and seventh columns of Table 6.7), there is little to chose between the two sets of results using the demand specification which includes Y_t or the supply model. However, forecasts from the order level demand models employing GCF_t are better than the corresponding aggregated EIG forecasts for each of the three orders, strikingly so in the case of vehicles.

Table 6.7 Percentage forecasting errors[1] for 1972-73; order level models

			1972				1973			
			Model base 1952-71		Model base 1960-71		Model base 1962-71		Model base 1960-71	
			No lag	lag	No lag	lag	No lag	lag	No lag	lag
(VI) Engineering and electrical goods										
Demand	LA_{1t} Y_t	(1)	24*	14	20	7	47**	32	46*	23
	LA_{1t} GCF_t	(2)	20	14	15	-1	-	-	-	-
	LAS_{1t} Y_t	(3)	23*	12	20	6	43**	26	41*	20
	LAS_{1t} GCF_t	(4)	17	12	16	-2	-	-	-	-
Supply LA_{1t}			19	13	19	-8	54	43	46	22
(VIII) Vehicles										
Demand	LA_{1t} Y_t	(1)	35*	1	33	-26	61**	16	51	-1
	LA_{1t} GCF_t	(2)	4	-3	-2	-39	-	-	-	-
	LAS_{1t} Y_t	(3)	33	3	31	-29	56**	16	44	1
	LAS_{1t} GCF_t	(4)	4	-4	3	-28	-	-	-	-
Supply LA_{1t}			32	-12	29	-31	70	25	74	20
(IX) Metal Goods										
Demand	LA_{1t} Y_t	(1)	47	2	22	6	151	38	78**	43
	LA_{1t} GCF_t	(2)	31	5	19	10	-	-	-	-
	LAS_{1t} Y_t	(3)	43	-3	18	6	139	28	66*	41
	LAS_{1t} GCF_t	(4)	26	3	14	10	-	-	-	-
Supply LA_{1t}			40	-5	23	1	43	37	101	89

(1) Prediction minus observed value as a percentage of observed value. Predictions which are significantly different from observed values at the 5 and 1 per cent levels are denoted by * and ** respectively.

Table 6.8 Percentage forecasting errors[1] for 1972-73: EIG level models

EIG	1959-73 Mean recruit-ment	1972 Demand models (1)	(2)	(3)	(4)	1972 Supply model	1973 Demand models (1)	(3)	1973 Supply model
Order VI									
1	2070	8	27	4	22	27*	26	19	9
2	2347	22	-20	21	-21	22	55*	6	
3	4357	5	12	5	11	11	62**	52**	85
4	840	55**	59**	56**	59**	38	101**	105**	200*
5	2464	37	50*	33	46*	37*	54*	51*	74
6	787	19	18	19	18	4	37	36	3
7	1902	30	38**	33**	37**	42*	45	45*	24
8	1408	28	36*	25	32	8	15	9	96
9	409	18	19	18	16	22	21	16	-41
10	1052	25	38	21	39	31	35	29	30
Total (via aggregation)		20	23	19	21	22	48	43	56
Order VIII									
11	2398	31	24	31	25	25	73	71	69
12	1683	19	5	23	6	-9	44	54	3
13	759	9	5	9	6	58	23	23	-13
Total (via aggregation)		24	15	26	16	17	57	60	37
Order IX									
14	956	9	19	6	14	28	41	33	25
15	3279	27	27	24	22	16	102*	89*	90
Total (via aggregation)		24	26	21	20	18	91	79	79
All Engineering		21	22	21	20	21	56	52	56

Note (1) Prediction minus observed value as percentage of observed value. Predictions which are significantly different from observed values at the 5 and 1 per cent levels are denoted by * and ** respectively. Significance tests have not been applied to the predictions derived from aggregating individual EIGs.

Forecasts using models estimated with the lagged dependent variable were not carried out for all EIGs. On the basis of the regression results this was thought only to be worthwhile for EIGs 1, 6, 13 and 15 in the case of supply and EIGs 2, 7, 9, 12 and 13 in the case of demand. In fact, just for EIGs 7 and 9 is there a general reduction in forecast error and then relatively modest in comparison with the reductions recorded for the order level results. However this does not particularly justify the exclusion of the lagged dependent variable any more than the order level results justify its inclusion. Taking each basic equation specification in turn, the differences between forecasts with and without the lagged dependent variable are generally insignificant. Nonetheless, at the order level the overall impression gained is that taking into account the adjustment process does seem to produce smaller forecasting errors.

This rather anomalous result can be explained in terms of the procedure adopted for forecasting using models with lags. Each model has been given access to all actual observations on exogenous variables. Thus when forecasting 1972 and 1973 the actual values of recruitment in 1971 and 1972 are supplied because we are testing its conditional forecasting performance. In the case of a model with a lagged dependent variable one could also test its performance by requiring it to use the estimated value of 1971 as a base for forecasting 1972 (even though when forecasting in real situations one would have an actual observation for 1971) and the estimated value of 1972 for forecasting 1973. This would not necessarily yield a very different set of forecasts from those using the method adopted here but in this particular case it would have done so. The reason is that the drastic fall in recruitment occurred in 1971 and reached levels not experienced by the engineering sector in the last two decades. Figures for 1968-73 are given in Table 6.9. In effect the model has already begun to over-estimate recruitment in 1971 and the treatment of the lag in the course of forecasting 1972 and 1973 allows that version to re-base its forecast very quickly. The lagged model would have been no more successful than the basic model in anticipating the fall in 1971 had we been forecasting from 1970 nor would its forecasts of 1972 and 1973 have been as good had the actual values for 1971 and 1972 been denied to it. For short-term forecasting this is both the strength and weakness of models incorporating a lagged adjustment mechanism. Where a significant shift in behaviour (relative to the factors captured in the model) occurs, the lagged model accommodates it, in effect, by automatically adjusting its constant term but the basic model continues to over-predict or under-predict as the case may be. On the other hand the long-run relationship may not have shifted in such a simple fashion and there may be a greater delay in realising that some factor previously not very influential upon the dependent variable has become important, or that the range of experience captured in the estimation period has been exceeded by one or more of the variables already known to be significant but perhaps now requiring a change in functional form.

Table 6.9 Recruitment of Apprentices 1968-73

(Males plus females: thousands)

	Engineering and electrical goods	Vehicles	Metal goods n.e.s.
1968	18.4	5.6	4.6
1969	19.1	5.4	4.7
1970	18.6	4.9	4.8
1971	13.8	3.7	3.8
1972	11.9	3.3	3.4
1973	10.9	3.0	2.5

Source: See Appendix 5.

Recalling the discussion of labour market behaviour during 1972-73 in section 3.4, the forecasts may be reconciled with actual observations as follows. The exceptionally high levels of unemployment among those with skilled engineering trades (see Figure 3.1) experienced during 1971-72 caused firms to cut back apprentice recruitment even more severely than would have been estimated by the demand models. The recovery of the economy in 1973 led to the rapid re-employment of craftsmen but not without some delay which under normal circumstances might have led to an upsurge in apprentice recruitment. However, the raising of the school-leaving age in 1973 created circumstances in which many firms found themselves pushing against a supply constraint in the market for apprentice recruits at the same time as they were facing difficulties in the market for craftsmen.

6.5 Concluding Comments

This chapter set out to examine the performance of supply and demand models at the disaggregate level. In empirical terms this boils down to investigating (i) the goodness of fit of regression equations estimated and the plausibility and significance of their coefficients and (ii) the conditional forecasting errors reported for 1972-73.

The general conclusion is that whilst in certain cases the explanatory power of the supply models proves to be superior to that of the corresponding demand models, a study of coefficient estimates and the susceptibility of the supply equation to demand influences leads one to support the demand explanation of fluctuations in apprentice recruitment. This applies to all three levels of aggregation at which the models have been tested. However, the results at EIG level must be regarded as very tentative given the unreliability of data on output and capital formation at this level of disaggregation and problems of multicollinearity. No advantage is obtained in forecasting at the order level by summing separate EIG forecasts.

The fact that all models tend to over-predict for 1972-73 suggests that further thought should be given to functional forms as well as to the possible effects of omitted variables. Ad hoc additions of non-linear terms might well improve the explanatory power and forecasting performance but the most attractive prospect is in the development of the expectations version of the demand model. The GCF_t variable is intended to reflect the combined influence of current and expected future production upon recruitment. There are however two series on investment intentions dating from the early 1960s which could be exploited in constructing better measures of expectations for use in the model for short-term forecasting.

Where equilibrium in the market can be assumed to hold for most of the estimation period, the use of O.L.S. regression to identify structural coefficients directly is likely to lead to estimates which are biased and inconsistent. However, as the equilibrating forces and the degree of price endogeneity with respect to the current period weaken so do the arguments in favour of a simultaneous equation approach. The evidence on the determinants of wage differentials presented in Chapter 2 suggests that our assumption that the wage structure variables EM_t, EY_t and (wa_{1t}/wc_t) may be treated exogenously, and hence independently of the dependent variables LA_{1t} or LAS_{1t}, is a reasonable one. In the light of alternative market situations discussed in Chapter 4, single equation models of supply and demand were then estimated. In effect they provide two competing hypotheses about the short-run determinants of the flow of apprentice recruits and we find that the demand hypothesis is by far the more convincing one. On the other hand, as emphasised in Chapter 4, the rather poor results for the supply model do not imply that in a forecasting situation the supply of apprentices can be disregarded. Our discussion of forecasts for 1973 underlines this qualification. Taking the behavioural and econometric evidence as a whole we conclude that during the post-war period there may have been occasions when demand exceeded supply at the market wage but that this was the exception rather than the rule. Moreover, even when firms have found difficulty in recruiting apprentices, any impact this may have upon the juvenile wage structure is delayed and partly diffused by other considerations of the bargaining process. In these circumstances the lack of significance of the EM_t elasticity should not be attributed to simultaneity biasing down the coefficient.

Despite this disequilibrium view of the labour market for apprentice recruits the research findings do point to lines of further enquiry which would lead to links between short-run models of resource flows and models of the wage structure, incomes policies notwithstanding. The first, is to move away from apprentice recruitment by engineering firms and to tackle the entry of young people into employment. This aggregate phenomenon has been regarded as exogenous to the recruitment of apprentices and yet there may be an interdependence between SLT_t and LA_t. A study of the determinants of SLT_t would undoubtedly yield insights into the factors influencing the juvenile wage structure and flows into specific areas of employment. The second development would be to look at the connection between wages in skilled and semi-skilled occupations and the pattern of entry of young people. In the case of engineering craftsmen it was not possible to explore the relationship between wage differentials and apprentice recruitment to the extent of distinguishing between jobs in skilled and semi-skilled occupations as well as employment in engineering and other industries. Both of these suggestions for further research present data difficulties not least because whilst the New Earnings Survey is beginning to provide a continuous picture of changes in the wage structure along various dimensions (subject to small sample problems), we find that the series on young entrants to employment has been discontinued. Plans to replace it have yet to materialise.

CHAPTER 7 COST BENEFIT ANALYSIS AND MARKET BEHAVIOUR

7.1 Introduction

The analysis of the preceding chapters has provided a view of the labour market for skilled engineering craftsmen. The picture is by no means complete but it would now seem worthwhile to investigate the treatment which this labour market has received in studies attempting to evaluate the costs and benefits of policies which interfere in the normal running of the market.

The empirical contributions which use British data are those by Ziderman (1969, 1973, 1975) and Ziderman and Driver (1973) at the national level, and Thomas et al (1969) and Woodward and Anderson (1975) at the level of the firm. All the studies involving Ziderman concentrate upon Government Training Centres, Thomas et al deal with operative training in a clothing establishment and Woodward and Anderson with apprentice training in a shipbuilding company. So far there seems to have been no published cost-benefit analysis of training through the organisation of an Industrial Training Board. Woodward and Anderson report that they originally intended to conduct such an evaluation of the Shipbuilding Industry Training Board's first year off-the-job apprentice training but in the absence of 'a suitable sample of trainees' they abandoned this objective. The EITB (1972) restricted itself to estimating the net costs of training craftsmen, technicians and technologists under different schemes but adopted the viewpoint of the firm and included benefits only in so far as they offset the costs of training during the training period. The introduction to the last study does however reveal an appreciation of the greater scope for cost-benefit analysis.

> 'So far the studies have examined only the net cost to the firm, taking account of the costs of providing the

> training and the resulting benefit to the firm during the training period. They have not examined the costs and benefits to the individual being trained, nor have they examined the much wider question of the costs and benefits to the industry, or to society as a whole. This last point is particularly important to stress because the craftsman, technician, technician engineer, or technologist is equipped for his job not only by the skill training given in industry, but also by the knowledge acquired through the education he received before undertaking training, or the complementary further education which accompanies his training. Nor do the studies examine the benefits to the industry and to society of a more highly skilled and more mobile labour force, with the ability to adapt to technological change by up-dating or additional training at a later career stage. In other words, the work has so far been restricted to 'cost effectiveness' from the point of view of the firm.'[1]

The project directed by Adrian Ziderman is the only one to yield estimates of the social returns to training in Britain. His methodology is worth examining in detail bearing in mind the assumptions it makes about the operation of the labour market and the extent to which out findings suggest alternative perspectives.

In American research the measurement of benefits and resource costs of training has normally involved the use of control groups. Since the role of the GTCs encompasses the training of people coming direct from jobs as well as the unemployed it is especially important to deal with the indirect benefits and costs of training. The use of control groups alone would not take this factor into account. In the U.S., manpower programmes are dominated by schemes for the unemployed so it might be argued that the likelihood of there being important replacement and displacement effects is much less than for the U.K. Ziderman's methodology attempts to tackle the problem of representing what would have happened to people had they not

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(1) E.I.T.B. (1972), p.7.

entered training by means of a stochastic model of work experience. He explores the possible importance of replacement and displacement effects through the choice of a range of parameter values.

Adopting the notation in Ziderman (1975) the social benefits and costs of investment in training can be expressed as follows.

$$B_t = (e'Wa)_t - (eWs)_t \qquad t = 1, \ldots T$$

$$C_o = (eWs)_o + K_o$$

B_t - the monetary benefit obtained during periods t = 1, ... T following training.

C_o - the direct costs of training during the training period t = 0.

Wa - the marginal product of a trained worker when employed.

Ws - the marginal product which would have been produced by the same worker in the absence of training.

e' - probability of trained worker being employed.

e - probability of the worker being employed if training had not occurred.

K_o - resource cost per occupied training place.

Ziderman takes account of replacement and displacement effects by introducing four parameter adjustments.

$$B_t = (e'Wa)_t - (1-r)\,(eWs)_t - \{pd + (1-p)\hat{d}\}\,(e'Wa)_t$$

$$C_o = (1-r)\,(eWs)_o + K_o$$

r - fraction of jobs which would have been filled by trained workers had they not been trained which are filled by engaging unemployed workers.

p - proportion of employed trained men using their new trades.

d - proportion of employed trained men using their new trades who have obtained jobs at the expense of other qualified workers.

$\hat{d}$ - proportion of employed trained men not using their new trades who have obtained jobs at the expense of other qualified workers.

No distinction is made between the marginal products achieved in jobs requiring the newly acquired skills and in those not doing so nor in the probabilities of obtaining these jobs. The third term comprising B_t might otherwise have been expressed as

$$-\{pd\ (e'Wa)_t + (1-p)\ \hat{d}\ (\hat{e}'\hat{W}a)_t\}.$$

In addition to replacement and displacement effects there are complimentarity effects which arise when the employment of newly trained labour removes constraints on the employment of other skills (where the effects are mainly intra-firm this implies technologies of production with rather low short-run substitution possibilties between skills, and where the effects are cross-firm or cross-industry the implication is that the technologies of customer producing units are rigid with respect to inputs of goods and materials and import substitution is difficult in the short-run).

Two further aspects of training programmes are their non-economic externalities (notably via their possible effects on crime rates, health and general satisfaction with lifestyles) and their macroeconomic effects. The former have yet to be considered in British work but Borus (1972) includes relevant contributions in the American context. The latter are regarded by Ziderman as being only marginal given the relatively small scale of training in this country. Certainly taken as yet another expenditure programme stimulating aggregate demand even the levels envisaged in 1978[(2)] will have slight impact. From the point of view of the unemployment - inflation trade-off, the case for a macroeconomic effect is less easily dismissed in circumstances where skill bottlenecks to growth are severe and a country is already experiencing balance of payments difficulties. However, Thirlwall (1969, pp.1004-5) is especially pessimistic about our ability to evaluate both non-economic and macro-economic benefits:

'Short of a laboratory experiment – denying manpower

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(2) Training Services Agency (1974).

> policies to a particular part of the country, and comparing the situation with a control area - it would seem wellnigh impossible to attach a precise money value to even the most tangible of benefits of certain manpower policies, let alone the intangible.'

He advocates the adoption of a 'minimum impact' approach so that

> '.. where the empirical measurement of benefits is hazardous, [it is best] to establish what the <u>minimum</u> impact must be for the discounted benefits to exceed the costs, and then to make a considered judgement whether the necessary minimum impact of policies is feasible?'

Ziderman adopts a rather more positive approach in which, whilst ignoring non-economic externalities, macroeconomic effects and (more limited) complementarity effects,(3) he sets up a model to structure the application of 'considered judgement' making explicit which assumptions and estimates most influence the evaluation of returns. Thus he simulates the results of applying alternative replacement and displacement parameters r, d and $\hat{d}$ and alternative estimates of the 'work experience' probability, e. All other variables in his model are single-valued. One of our main criticisms will relate to the choice of the latter but we shall deal first with the estimation of e using a model which, Ziderman (1975, p.227) states, 'represents a methodological contribution for cost-benefit studies in this field, and occupies a central role in the present analysis'.

7.2 The Stochastic Simulation of Trainee Work Experience

The method adopted revolves around the definition of five states of unemployment and two states of employment between which movement

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(3) Intuitively we would expect these three jointly to yield positive rather than negative returns.

of members of the labour force takes place according to a Markovian transition matrix, P.

$$
P = \begin{array}{c|ccccccc}
 & U^1 & U^2 & U^3 & U^4 & U^L & E^b & E^c \\
\hline
U^1 & 0 & 1-p_{1b} & 0 & 0 & 0 & p_{1b} & 0 \\
U^2 & 0 & 0 & 1-p_{2b} & 0 & 0 & p_{2b} & 0 \\
U^3 & 0 & 0 & 0 & 1-p_{3b} & & p_{3b} & 0 \\
U^4 & 0 & 0 & 0 & 0 & 1-p_{4b} & p_{4b} & 0 \\
U^L & 0 & 0 & 0 & 0 & 1-p_{Lb} & p_{Lb} & 0 \\
E^b & 1-p_{bb} & 0 & 0 & 0 & 0 & p_{bb} & 0 \\
E^c & 1-p_{cc} & 0 & 0 & 0 & 0 & 0 & p_{cc}
\end{array}
$$

U^1, U^2, U^3, U^4 and U^L correspond to the states of having been unemployed for 1, 2, 3, 4 and 5 or more periods respectively. E^c is a state of having been continuously employed and E^b is a state of being currently employed but with work experience previously broken by at least one spell of unemployment. By distinguishing E^b from E^c Ziderman is able to treat the probability of unemployment arising for someone who has been unemployed before $(1-p_{bb})$ as different from that for a person so far continuously employed $(1-p_{cc})$. This he justifies on the grounds that longer service employees are less likely to be made redundant than those who have been re-employed so $(1-p_{bb})$ will be significantly higher than $(1-p_{cc})$. The consequences of this device need to be examined a little further however. Note, first, that a 'closed system' model is being used in which the possibility of joining and leaving the labour force is denied to the trainee group. Second, those who are attributed to state E^c at the beginning of the training period will not all be long-service employees. Some will be younger workers with shorter lengths of company service than many of those initially attribted to E^b. The importance of these points depends on the characteristics of the sample of trainees but they ought to be taken into account. Third, the definition of 'continous employment' seems, on first sight, to be applied only to the simulated period since no person is allocated to state E^b to begin with. It is possible but unlikely that none of those joining the GTC course directly from employment had been previously unemployed but this is what is implied from Ziderman's initial employment status vector (L_0) classifying the 259 trainees studied by him. A partial explanation is that in the model actually estimated he effectively divides E^c as given above into two states: E^c, now representing only those continuously employed <u>since the initial period</u> and not facing redundancy and E^r, those currently employed but facing redundancy. This modification is introduced to allow for the fact that

> 'a large number of trainees in employment immediately prior to training, were nevertheless under the threat of imminent redundancy; it was thought that the stochastic process described would not be applicable to the movement of these workers from employment to unemployment.'

It may, fortuitously, have been the case that all the employed who had previously experienced unemployment were among this group in high risk of redundancy. Assuming that to be so it is also necessary to omit the phrase 'since initial period' in the definition of E^c, the numbers in state E^c at time t, as given by Ziderman (1973, p.5); 'number in time t, of those continuously employed since initial period and not known to be facing redundancy.' Otherwise E^c_t might include some of those initially in E^b but who experienced no subsequent unemployment. The transition probability which would technically accommodate this has been set to zero in the version of P given by Ziderman, suggesting that this revised definition is the one intended. It would not in any case make sense to define a state in terms of work experience dated only from when the training course began, since the model is intended to simulate work experience in the <u>absence</u> of training.

The specification of E^r is such that those believed to be facing imminent redundancy are dealt with completely outside the stochastic model until they are rendered unemployed. They enter the unemployment state U^1 according to the time-profile (R_t) of redundancies estimated from the survey information. All are routed through U^1 and hence those facing redundancy followed immediately by another job are presumably classified to E^c rather than E^r..

The transition probabilities were estimated as follows.

$\underline{p_{1b}, p_{2b}, p_{3b}, p_{4b}}$ Two sources were used. (i) A steady state analysis of the unemployment register using the method described by Fowler (1968) and updated for 1967-70. The probability (p_{ib}) of becoming emplgyed after i months on the register is related to the percentage of unemployed obtaining jobs after i months on the register (f_i) via the equation

$$p_{ib} = \frac{f_{i+1} - f_i}{1 - f_i} .$$

The method applies to a situation in which the aggregate level of unemployment is constant. (ii) The post-redundancy experience of a group of midland engineering workers as reported by MacKay (1972). Estimates were obtained using the above equation once again but there is no accompanying presumption of a steady-state unemrloyment situation.

$\underline{p_{Lb}}$ The value chosen to match the above estimates based on Fowler's analysis 'was set intuitively at 30% per three month period'. To match the MacKay data, a figure of 15 per cent was adopted without comment.

$\underline{p_{bb}, p_{cc}}$ 'Guestimates' of 0.030 and 0.015 repectively were obtained for the probabilities of becoming unemployed from the re-employed and continuously employed states, yielding 0.97 for p_{bb} and 0.985 for p_{cc}.

Table 7.1 The transition matrices governing simulated work experience and the initial state vector (L_o).

		U^1	U^2	U^3	U^4	U^L	E^b	E^c	E^r	L_o
	U^1	0	0.20	0	0	0	0.80	0	0	68
	U^2	0	0	0.47	0	0	0.53	0	0	19
	U^3	0	0	0	0.58	0	0.42	0	0	6
P (Fowler) =	U^4	0	0	0	0	0.66	0.34	0	0	11
	U^L	0	0	0	0	0.70	0.30	0	0	20
	E^b	0.03	0	0	0	0	0.97	0	0	0
	E^c	0.015	0	0	0	0	0	0.985	0	85
	E^r	0	0	0	0	0	0	0	1	50

	U^1	0	0.42	0	0	0	0.58	0	0	68
	U^2	0	0	0.55	0	0	0.45	0	0	19
	U^3	0	0	0	0.54	0	0.46	0	0	6
P (MacKay) =	U^4	0	0	0	0	0.66	0.34	0	0	11
	U^L	0	0	0	0	0.85	0.15	0	0	20
	E^b	0.03	0	0	0	0	0.97	0	0	0
	E^c	0.015	0	0	0	0	0	0.985	0	85
	E^r	0	0	0	0	0	0	0	1	50

Source: Ziderman (1973).

These values were used in both transition matrices otherwise formed from the two different sets of probabilities given above.

The resulting matrices are given in Table 7.1. The numbers of trainees who would have been in each state are traced out by means of the standard recurrence relationship, adjusted for anticipated redundancies r_t during period (t,t+1)

$$L'_{t+1} = R'_t + L'_t P$$

R'_t is defined as $[r_t, 0, 0, 0, 0, 0, 0, -r_t]$ and the initial state vector for the 259 Scottish entrants to GTCs[4] studied by Ziderman was

$$\begin{array}{rccccccccc} & & U^1 & U^2 & U^3 & U^4 & U^L & E^b & E^c & E^r \\ L'_o & = & 68 & 19 & 6 & 11 & 20 & 0 & 85 & 50\ . \end{array}$$

At time t, the probability of a randomly selected member of the trainee group being in employment (e_t) is given by a weighted sum of the stochastic profiles followed by the trainees under simulated work experience. This amounts to

$$e_t = (L_t^b + L_t^c + L_t^r)/L'_t.i$$

where i is the column unit vector and $L'_t.i = 259$ for all t.

Under certain conditions, satisfied by the P matrices in this study, the vector L_t will tend to a limit $\overline{L}$, describing the steady state distribution of trainees. The structure of the P matrix is such that $\overline{L^c}$ will be zero and the separate treatment of those initially in E^r will also cause $\overline{L^r}$ to be zero assuming that all those expected to become redundant are actually made so. In effect E^c and E^r can both be regarded as transient states, the first being fully specified within the stochastic model and the second being handled exogenously, setting $p_{rr} = 1$ throughout, rather than allowing it to vary (the other elements

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(4) Those not completing the course are excluded.

remaining constant) using,

$$p_{rr}^{t} = 1 - \frac{r_t}{L_o^r - \sum_{j=1}^{t-1} r_{t-1}} \qquad t > 0$$

$$p_{rr}^{o} = 1 - \frac{r_o}{L_o^r}$$

The two different transition matrices were used to explore the sensitivity of the cost-benefit calculations to changes in the various probabilities given the same initial vector (L_o) which describes the trainees according to employment status just prior to entering training. Depending on the transient characteristics of the stochastic process relative to the length of training period, the cost-benefit results could also be highly sensitive to the choice of L_o. It may not be of paramount importance to optimise the employment status mix of the intake of trainees but it would seem to be worth investigating how much the returns to training vary with changes in that mix. This aspect is not pursued by Ziderman. A second source of variation not covered in his study relates to the values chosen for p_{bb} and p_{cc} which are common to both matrices. One would have thought that the likelihood of remaining employed in states E^b and E^c would also change significantly according to the state of the labour market. The main reason for testing for the impact of changes in P is to establish how widely, in practice, the returns to training are likely to vary and to give some indication to policy makers of how critical is the <u>timing</u> of their decisions (especially with respect to the trade cycle). It is difficult to locate the matrices of Table 7.1 in the spectrum ranging from very tight markets apparently exhibiting manpower bottlenecks to situations of high unemployment affecting even the skilled manual trades for which skillcentres provide training. From the treatment of the probabilities of leaving unemployment the use of Fowler's method applied to the period 1967-70 and adjusted for Scotland (see Ziderman and Driver, 1973 p.415) covers three years of fairly stable unemployment followed by a marked increase for 1970. Relatively speaking the fluctuations are somewhat less than those during 1961-65 for which Fowler conducted his analysis. The MacKay study of the West Midlands covers the period 1959-66 but the transition data came from a specific group of redundant workers. The unemployment rates in the two areas (Scotland and the West Midlands) which correspond roughly to the periods for which the probabilities have been derived were of the order 4 and 1.5 per cent respectively. Under these rather different labour market situations it would seem to be inappropriate to retain the same probabilities of remaining in employment. A further indication of this stems from the steady state vectors $\bar{L}$ (Fowler) and $\bar{L}$ (MacKay). They actually imply 'long-run' rates of unemployment of 4.3 and 6.5 per cent respectively in the (closed) markets concerned, reversing the ranking of observed rates because of the special characteristics of the redundant workers.(5) Bearing in mind also the impact of the transient stage of the process, one is automatically wary of Ziderman's conclusion (1973, p.13) that the cost-benefit results 'are not particularly sensitive to the values of the transitional probability sets used'.

The difficulty of assessing the applicability of transition estimates stems from not having an adequate model of manpower flows. The combination of separately produced estimates and 'guestimates' yields little feel for which labour market situation they might jointly represent and for how far two such transition sets might mark the range of plausible impact upon the cost-benefit calculation.

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(5) These figures are obtained by solving the set of equations $\bar{L}' = \bar{L}'P$. The complete state vectors, given in proportionate terms (π), yield

$$\pi(\text{Fowler}) = [0.029,\ 0.006,\ 0.003,\ 0.002,\ 0.003,\ 0.957,\ 0,\ 0]$$

$$\pi(\text{MacKay}) = [0.028,\ 0.012,\ 0.006,\ 0.004,\ 0.015,\ 0.935,\ 0,\ 0]$$

7.3 The Parameter Simulations

Again we have the problem of deciding what are the plausible ranges of parameter values and whether or not the choice of fixed value for one parameter perhaps ignores an effect which is potentially of equal importance to those due to the parameters allowed to vary. In this case, p, the proportion of employed trained men using their new trades, is held constant at 0.65 whilst d and $\hat{d}$ the displacement factors for trainees engaged and not engaged, respectively, in their new trades, and r, the replacement factor, are varied between 0 and 1. Ziderman (1973, p.17) argues that r and $\hat{d}$ can be allowed to vary together 'on the assumption that similar market situations are likely to prevail in the two cases.' Whether or not the assumption is justified is another matter. A view of the association between r and $\hat{d}$ may be obtained from Figure 7.1. This indicates that a large excess supply in other trades will lead to high r and, if employers discriminate in favour of qualifications (i.e. raise hiring standards unnecessarily), including those obtained by GTC trainees, to high $\hat{d}$. Presumably this is the line of thought which led Ziderman to adopt the assumption. However it does ignore the dynamics of manpower flows to assume that r and $\hat{d}$ are not only positively correlated but also roughly equal. Ziderman believes that the most plausible alternatives lie within the ranges $0.25 \leq r, \hat{d} \leq 0.75$ and $0 \leq \hat{d} \leq 0.25$. The low range for d is adopted because most training is in trades for which skills are in short supply. Ziderman is obviously very much aware of the need to obtain a rather more specific view of the labour market.

> 'The advantage of this seemingly irresolute approach lies not only in giving the reader the opportunity of making his own assumptions with regard to these parameters, but also in demonstrating the sensitivity of the results, to the particular assumptions made.'[6]

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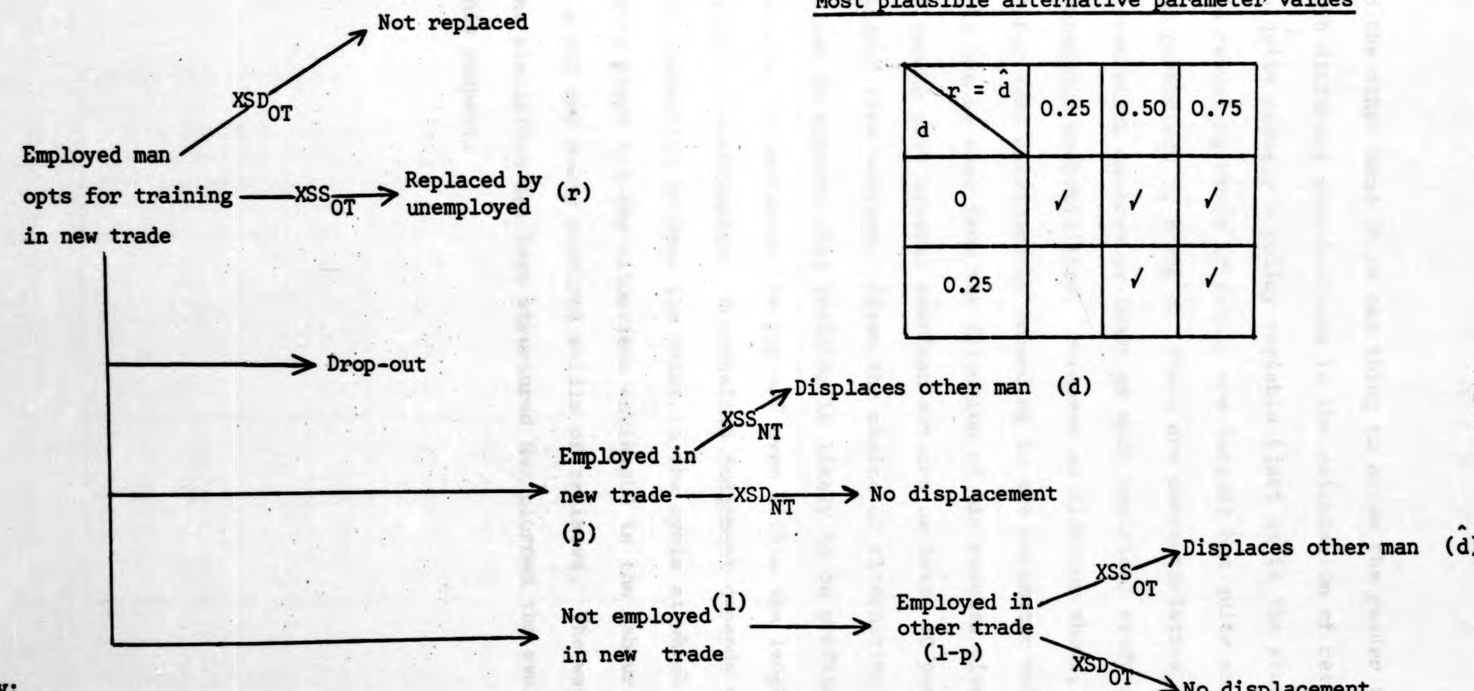
(6) Ziderman (1975), p.13.

Figure 7.1 A schematic view of the impact of GTC trainees on the labour market.



Most plausible alternative parameter values[2]

d \ $r = \hat{d}$	0.25	0.50	0.75
0	✓	✓	✓
0.25		✓	✓

Key:

XSS - excess supply

XSD - excess demand

OT - other trade (including old trade)

NT - new trade

(1) It is assumed that trainees will be employed at some stage following training so unemployment may be regarded as falling within 'employed in other trade' to which (1-p) relates.

(2) According to Ziderman.

On the other hand it is one thing to allow the reader to experiment with different time horizons in the calculation of returns since this is quite clearly a policy variable (just as is the standard by which the resulting rates of return are judged) but quite another to vary the parameters r, d and $\hat{d}$. These are characteristics of the labour market which deserve at least as much empirical study as do the transition probabilities. Moreover as Ziderman shows, the results differ very considerably according to the parameter values chosen. This can be seen from the selection of his results given in Table 7.2. In common with several American authors he takes 10 years as the maximum time horizon. Given the choice of alternative parameter values it appears that training is likely to be profitable. Under certain circumstances the pay-off even within the length of a trade cycle is considerable. Nonetheless judgement depends very much upon the connection between the point in the cycle at which training takes place and the situations envisaged in the labour markets for the old and newly acquired skills of trainees. The way in which the simulation has been structured has blurred the evaluation in this respect.

Table 7.2 Estimates of social rates of return and net present values (i=10%) on GTC training in Scotland 1968/69.

Time horizon from start of training (years)		P(Fowler)						P(MacKay)					
	$\hat{r}$,d	0.25		0.50		0.75		0.25		0.50		0.75	
	d	0	0.25	0	0.25	0	0.25	0	0.25	0	0.25	0	0.25
1½	Social rate of return	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0	<0
2½		<0	<0	<0	<0	32.4	1.6	<0	<0	3.9	<0	36.3	6.2
5		2.2	<0	30.6	2.8	62.2	34.2	10.4	<0	36.3	8.8	65.6	37.5
10		17.9	<0	41.1	18.4	68.7	44.2	24.5	<0	46.0	23.2	71.8	47.0
1½	NPVs (£)	-703	-905	-429	-631	-155	-357	-621	-823	-374	-576	-127	-329
2½		-533	-862	-146	-475	240	-88	-419	-748	-70	-399	279	-50
5		-173	-771	452	-145	1078	480	347	-588	1082	-24	1817	541
10		335	-642	1296	319	2258	1281	613	-364	1482	505	2351	1374

Source: Ziderman (1973) Tables 2 and 4. Further results using only one transition matrix similar to P(Fowler) are given in Ziderman (1975). These are based on a much larger sample of post-training job histories and identify the returns to training in three separate trade groups.

7.4 The Estimation of Single-Valued Elements

Finally we come to the choice of values for e'_t, Wa_t, Ws_t (for $t = 1, \ldots T$) and C_o. The parameter p has already been discussed.

$\underline{C_o}$ The resource costs of providing training include capital and material costs plus an estimate of the opportunity cost of employing personnel to run courses (equated to production foregone as measured by salary costs). They exclude allowances paid to trainees since these are simply transfer payments. No adjustment for underutilisation is made and hence C_o is the average and not marginal cost.

$\underline{Ws_t}$ Production foregone per trainee assuming he would have been fully employed throughout the course was estimated from average weekly earnings figures of labourers in certain production industries and the length of the course. This is subsequently modified by the results of the simulation analysis of work experience to obtain $Ws_t\ e_t$. Given that the valuation was retrospective, Ws_t was partly available from historical series and was assumed to grow in real terms at 3 per cent annually.

$\underline{Wa_t, e'_t}$. Production contributed per newly trained man was valued according to actual earnings in the first 3 years after training, thus giving a direct estimate of the product $Wa_t\ e'_t$. This was extrapolated in real terms at 3 per cent per annum implying that between the third and tenth year percentage differentials between the GTC trained person and the average labourer remained constant.

The choice of wage variables to represent the social marginal products of employed people raises the usual questions about the competitiveness of labour, product and capital markets. These will not be pursued here. Some reference to the competitiveness of labour and product markets in engineering was made in Chapter 2. We shall confine comment to the contrasting structural treatments of prices and resource flows.

Mention has already been made of the significance of the structure of the initial state vector L_o in relation to the transient period of the Markov process. L_o and P are defined with respect to Markov states distinguished by continuity of employment experience if employed and duration of unemployment if unemployed. Manpower flows between these states are not therefore distinguished by the characteristics which might be thought to determine work experience but simply by actual experience. The schematic view of the impact of trained people on the labour market given in Figure 7.1 indicates the relevance of skill in the determination of p, r, d and $\hat{d}$. One would also expect the skills and other characteristics of people prior to entering training to affect the transition probabilities. In connection with the duration of unemployment Cripps and Tarling (1974) point out that there need be no causal significance in the observation by Fowler (1968) and others that the longer a person remains on the unemployment register the less likely he is to leave it. They test an alternative hypothesis that the individual's probability of leaving the register during a certain period is independent of the duration of unemployment but can be explained by reference to the structure of inflows to unemployment according to such factors as age, sex, skills, location, etc. Their results, which only deal with the age and regional disaggregations, suggest that the analysis of aggregate duration of unemployment has dwelt too much on the earlier statistical model and more consideration should be given to one stressing (on the supply side) personal characteristics rather than unemployment experience.

The above conclusion applies especially to the use of the Markov model devised by Ziderman. On the one hand we have a method of evaluation which ignores skill in the choice of Markov states prior to simulating work experience and on the other hand uses the resulting time profiles of employment status to produce expected earnings streams incorporating a simple skill criterion: Ws_t is proxied by the earnings of labourers rather than some weighted function of the prices of labour most relevant to the group of people accepted for training.

7.5 Future Developments

The general conclusion reached is that in order to apply cost-benefit analysis to training it is necessary to have a model of those sections of the labour market involved. Hedging the simple calculation of rates of return on the basis of direct costs and benefits with adjustments for replacement and displacement effects leaves too much room for rather arbitrary guesswork in judging the simulation results. The use of a stochastic process to model alternative work experience provides an interesting alternative to the use of the control group.[(7)] However a more appropriate definition of Markov states is required to take into account personal characteristics which relate directly to the structure of labour demand and supply. Moreover the use of a stochastic model should not be limited to the role of replacing the control group. It should embrace the determination of other flow parameters through a non-stationary treatment of manpower movements in the relevant labour markets. In the context of inter-industrial mobility, Lindley (1974, and 1976a) has explored the main deficiencies of stationary stochastic models and some of the conceptual problems involved in developing and estimating non-stationary models embodying a satisfactory economic rationale for variations in parameters. There are considerable difficulties but until these are resolved the use of the models for cost-benefit evaluations would appear to be premature.

Ziderman's studies are all ex post evaluations. For planning purposes it is necessary to conduct ex ante analyses. These will require predictions of all variables contained in the cost-benefit calculation. In these circumstances the control group cannot in any case be used and nor can the trainee group be observed in subsequent

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(7) There seems to be no further example of its use other than the paper by Smith (1971) cited by Ziderman.

employment. Thus one must adopt a model of the labour market from which to derive predictions of price variables (Wa_t and Ws_t) and resource variables (e'_t, e_t, r_t, p_t, d_t, $\hat{d}_t$). Note that the stochastic flow model would be used to determine all the resource parameters for the whole period up to the cost-benefit horizon. Even Ziderman's <u>ex post</u> evaluation involves the forecasting of variables beyond 3 years after the end of training (the time constraint due to the date of the follow-up survey of trainees). The development of more comprehensive flow models would then also contribute to the quality of <u>ex post</u> studies.

The connection between the partial flow model, implied by Ziderman's transition matrix and supplementary flow parameters, and models based on the sort of manpower account discussed in Chapter 2 may be seen by referring to Figure 7.1 and Tables 2.4, 2.11 and 2.12. The social rates of return on investment in government training corresponds to the return on maintaining stocks of trainees in GTCs (now Skillcentres). These stocks (ECV_{18}) are associated with recruitment flows into training (recorded in column 18 of Tables 2.4 and 2.11) and outflows of completers and drop-outs. Suppose a person employed in ROI enters a Skillcentre for engineering training ($E_{14,18}$).[8] The parameter r in Figure 7.1 corresponds to the probability of this inducing a flow from unemployment ($E_{16,14}$) to fill the vacated job. During training some will drop out. Ziderman bypasses this group by dealing only with <u>ex post</u> evaluation of completers, calculated K_o as the average direct training cost per completer.

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(8) As noted in Chapter 2, Skillcentre courses normally last less than one year and some information about the flows through this state is lost in annual period accounts. Thus we have also recorded the total annual outflow (in Table 2.12). It would be preferable for this part of the training system to have six-monthly accounts but in the discussion given here this problem will be ignored together with the fact that some trained in engineering trades could be employed in their trade in industries outside engineering.

In <u>ex ante</u> studies the proportion completing would have to be predicted in addition to all the other flow parameters listed earlier.(9) Some of the completers will enter engineering as craftsmen ($E_{18,1-4}$: related to p) and this may cause a reduction in flows from unemployment into that area of employment ($E_{15,1-4}$: related to d) especially when the economy is still in recession. Other completers will not in fact follow their new trades but will find employment in other occupations perhaps displacing a flow from unemployment into those jobs ($E_{15,12-14}$: related to $\hat{d}$).

Replacement and displacement effects are clearly connected in the above to the probability of unemployed workers obtaining employment again. In the Engineering Craftsmen Matrix, which reflects available data, the unemployment state is split into two according to skill but aggregates across unemployment duration. Ziderman's matrix P reverses this procedure giving prominence to unemployment duration. The simulation he wished to perform was on the work experience of those without engineering skills although the data used for P is only intended to be indicative of the range of response. Seen in the light of the manpower accounts it is desirable to relate P, r, d and $\hat{d}$ together explicitly on the basis of an accounting framework similar to ECM, especially when turning to <u>ex ante</u> evalauation. Seen in the light of the specification of P, r, d and $\hat{d}$, the paramerisation of a flow model based on ECM along the lines of the fixed outflow proportions used in educational modelling (see section 2.2) is quite unsatisfactory because these proportions do not take into account the potential links among them via changes in the levels of certain stocks and flows. This applies particularly to those

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(9) Our accounts are deficient in this respect by not distinguishing flows out of training which cover completers who do not enter craft jobs from those covering drop-outs who, one assumes, cannot enter craft jobs. This has to be dealt with in supplementary tables.

which can be affected directly by policy, such as the expansion of Skillcentres.

It is tempting to disregard completely the problem of simultaneity. From a purely forecasting point of view, manpower flow propensities estimated assuming that price variables are exogenously determined might well prove to be adequate. From the cost-benefit analysis point of view the relationship between price and resource movements, certainly in the medium or long-run, cannot be assumed away without destroying the theoretical basis of the analysis itself. Thus the contrast between the actual wage structure and its short-run or medium-run shadow wage structure is crucial when conducting a cost-benefit analysis with a time horizon of little more than two trade cycles. Recent work on the determinants of the inter-industry wage structure have improved the level at which debate can be conducted with reference to the British economy but is by no means conclusive.[10] Earnings data at a sufficient level of occupational and industrial disaggregation is not available to provide suitable estimates of how influential are labour and product market structures upon the determination of wages of different skills. Piecemeal evidence on wages and mobility assembled for the engineering sector suggest that there may be significant misallocations of labour in the event of economic recovery but without a more complete model of the labour markets concerned one cannot reach stronger conclusions.

(10) See Chapter 2.

7.6 Labour Market Control, Cost-Benefit Analysis and Model-Building

It must be clear from our detailed discussion of Ziderman's methodology that the application of cost-benefit analysis to the evaluation of national training policy is in a very early stage of development. Ziderman's contribution has been to provide those all important initial studies from which a more specific understanding of the theoretical and empirical difficulties may be obtained in the British context. However, improvements to the present methodology lead away from a simple application of cost-benefit analysis (if there is such a thing) towards what amounts to the synthesis of competing methodologies much sought-after by economists interested in educational planning. The use of the terms 'naive manpower forecasting'or 'manpower requirements approach' have come to imply a very mechanistic or, at best, a behaviourally very simple, model of labour demand. However the epithet 'naive' applies to both sides of the 'rate of return analysis versus manpower forecasting' debate. In practice rate of return studies bear the marks of an inadequate behavioural model being forced upon inadequate data just as much as do manpower forecasting studies. In particular, both pay little attention to the determinants of the supply of labour despite the fact that the signals they provide to planners primarily concern its control. Manpower policies are mainly executed by operating flows of manpower and too much research has tended to treat the system of flows as a black box. Attempts to move away from naive variants of cost-benefit analysis and manpower forecasting have initially aimed at using the techniques as complementary aids to planning if not at synthesis of the methods themselves.
Layard (1972) has examined the relationship between the two methods and the relative roles they might play in educational planning. He suggests that 'rate of return analysis is a method of evaluating the base from which a forecast is made and adjusting it to eliminate the effect of current imbalance.'[11] The relative importance of correcting for current

(11) Layard (1972), p. 128.

imbalances as opposed to anticipating future shifts in demand depends on the supply lead times and demand elasticities. The higher the former and the lower the latter the greater is the need for forecasting. Note that Layard is referring to 'naive' rate of return analysis based on cross-sectional data only, in which no attempt is made to calculate expected future, marginal cost and income streams as required in a full cost-benefit analysis. Thus 'current imbalance' refers to the perpetuation of the same sub-optimal equilibrium position (A) with supply and demand schedules fixed, as in Figure 7.2. At A the supply of skilled manpower

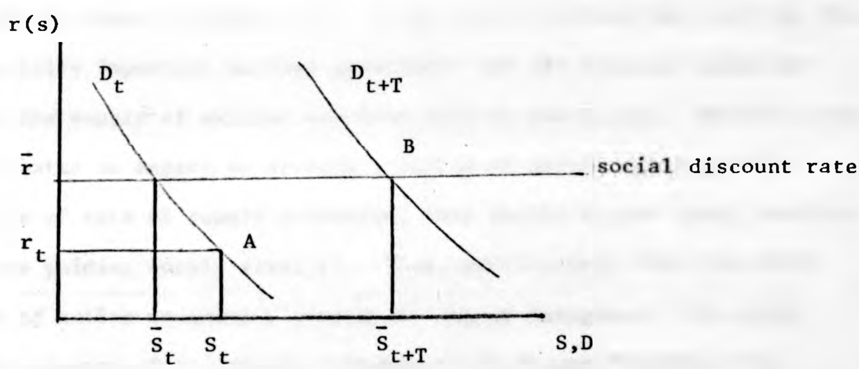

Figure 7.2 The rate of return and labour market control

S_t has been expanded beyond the point at which further training would be socially profitable. If demand were static then S_t would be allowed to decline, say, through retirement until reaching $\bar{S}_t$, the point of indifference between a marginal investment yielding $\bar{r}$ and no investment. When demand shifts to D_{t+T} during a period T the target level of supply will be $\bar{S}_{t+T}$. If T >> L where L is the supply lead time some decline in S_t will probably be desirable prior to the eventual increase to $\bar{S}_{t+T}$. This will depend on the costs involved in making downward adjustments to supply. However, the demand schedule may not simply be moving to a new position of stability, D_{t+T}. A whole set of demand shifts may be envisaged up to and beyond the planning horizon.

When applying the above analysis to industrial training the assumption of an administered supply which is highly inelastic in the short-run without government intervention is less appropriate than in the case of education , where at least government controls the capacity of the system, if not its utilisation beyond the school-leaving age. Even so, as Armitage et al (1969) show, modelling the flows through and out of the education system is a complex task. Whether or not planners rely more upon calculations of rates of return than upon manpower forecasts to indicate what is the optimal stock of skilled manpower they should be aiming for, they need a model of what determines the pattern of supply in order to affect it. In the case of industrial training this is especially important because government and its manpower agencies control the supply of skilled manpower only at the margin. Whilst it may be optimistic to expect to develop a series of models which provide forecasts of sets of supply schedules, this should be the ideal technical objective guiding supply research. Thus, particularly from the point of view of active manpower planning or 'supply management' the shape and determinants of the supply schedule S_t in Figure 7.2 should be explored by, first, investigating the changes in flows which give rise to changes in actual stocks in order to move closer to the supply phenomenon itself rather than employment levels resulting from the joint effects of demand and supply. The most important flows then need to be analysed econometrically to ascertain how they are determined. This has been the approach of the present study concentrating as it has in Chapters 4 to 6 upon the main flow by which government has tried to influence S_t: the recruitment of apprentices.

A justifiable criticism of naive manpower forecasting has been the lack of research devoted to testing the usual assumption of negligible factor substitution. More recently, attempts have been made to estimate substitution elasticities,[12] to develop the theories of production from which labour demand functions are derived and to distinguish more carefully between ex ante and ex post concepts in modelling the relationship between current capital, employment and output, and investment in human and physical capital.[13] These studies face numerous methodological and data problems. Only by considering the econometric results together with findings of research into production technologies at the micro level will they eventually yield useful insights.

Whether or not naive rate of return analysis or naive manpower forecasting is the lesser of the two evils is of little relevance given the options open to researchers. Improvements to both methods may be sought via the study of demand and supply responses to developments in labour markets. A set of forecasts of demand and supply schedules is the only way of providing the material from which a satisfactory cost-benefit analysis may be conducted. From this it follows that the construction of forecasting models and the development of the rate of return methodology are both necessary conditions for improving the economic analysis of alternative investments in training. The first is required in order to anticipate the impact of different policies in terms of their effects upon future resources and prices and the second, in order to evaluate these outcomes for the purposes of comparison with each other and with opportunities for other types of social investment.

7.7 Conclusions

In this chapter we have investigated the way in which recent

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(12) These have met with varying degrees of success. See, for example, Layard et al. (1971) for a study based on an industrial cross-section and Fallon and Layard (1975) for one using an international cross-section.

(13) See Bosworth (1976).

British cost-benefit analyses of training have been conducted. It was argued that the treatment of the control group and 'resource parameters' comes close to the very kind of mechanistic approach which supporters of rate of return analysis have criticised in manpower forecasting. The degree of judgement required in assessing the rates of return is such as to involve a large arbitrary element some of which could probably be reduced by giving more attention to the manpower flow system.

The connection between different labour markets and the flows between different employment states in these markets is asserted as a reason for dealing jointly with the problem of the alternative work experience of those entering training and the problems of adjusting the cost-benefit calculation for replacement and displacement effect. A further impetus for constructing a more satisfactory model of the labour market flows is the need for ex ante as well as ex post evaluations. However, the requirements of cost-benefit analysis show that the present Engineering Craftsmen Matrix, restricted as it is by existing data, will need to be extended before it is able to provide a base for modelling the flow parameters required in the evaluation.

Finally we observed that applications of the 'naive' versions of rate of return analysis and manpower forecasting suffer from much the same disregard for the supply side of the market. This is an especially acute criticism in the context of planning training and in order to tackle supply more thoroughly one is led to modelling and forecasting manpower flows. Since 'manpower forecasting' has come to be associated with the manpower requirements approach as usually contrasted with cross-sectional rate of return analysis we have chosen to describe the practice which ought to govern future research strategies as the 'model-building approach'. This is wholly compatible with the need for forecasting as well as the need for cost-benefit evaluation. It stresses the desirability of explicitly modelling the operation of the market concerned as a basis for both activities.

CHAPTER 8 EMPLOYMENT LINKAGES BETWEEN ENGINEERING INDUSTRIES

8.1. Introduction

In Chapters 4 and 5 single equation models of supply and demand were estimated for the recruitment of apprentices by the engineering sector as a whole. In Chapter 6 the same models were estimated for different industries within engineering. We wished to investigate whether or not the explanatory power achieved at the aggregate level is maintained at a more detailed level distinguishing industries which face different product markets, use different technologies of production and whose participation in the several sub-markets for labour of different skills varies as indicated roughly by the occupational structures of their labour forces.

Chapter 3 pointed to the differences between industries in their apprentice recruitment activity and Chapter 2 examined the pattern of relative earnings between skill groups within and across industries in the engineering sector. Suppose that one particular industry is able to pay high wages basically because of a favourable market power situation but does not engage in training skilled men to the extent that others do. High wages should enable it to attract the skilled labour it requires although there will be lags in supply response. In a steady growth situation these lags may be unimportant but where the industry is highly cyclical it may find that its boom period is too short-lived for its wage position to be fully effective in raising supply. However, suppose further that such is the structure of the economy that this industry tends to be in the vanguard of cyclical recovery regardless of whether or not consumption, investment or export growth 'leads to the boom'. Then the industry can also take greatest advantage of its wage position by being one of the first to expand.

The allusion is of course to the motor vehicle industry and the factor we have left out but will discuss below for the whole sector is the problem an industry might face in achieving adequate component supplies and sufficiently rapid installation of new machinery from other industries less well placed in the labour market for skilled manpower. The lack of training by one industry may manifest itself mainly as a shortage experienced by another but could ultimately rebound upon its own production plans. The same applies to the impact of a skilled versus skilled or semi-skilled versus skilled differential across the two industries.

However our intention is not to cast one particular industry as the villain of the piece but to investigate the possible extent of the manpower linkages between engineering industries and between this sector and the rest of the economy. Section 8.2 presents the basic model and defines the employment effects matrix, section 8.3 estimates linkages at the aggregate level regardless of skill, section 8.4 estimates engineering craft linkages and section 8.5 takes the theoretical approach a step nearer to dealing explicitly with manpower bottlenecks and the balance of trade. It is in this context that we discuss the treatment of complementarity and macroeconomic effects associated with a major effort to raise the supply of skilled manpower above what it would otherwise be. The problem of estimating these effects in cost-benefit analysis of training was mentioned in the previous chapter.

8.2 Manpower Implications of Intermediate Transactions between Engineering Industries

In the analysis below we shall assume that prices are fixed exogenously. The following notation is required:

- D - matrix of intermediate transactions of domestic outputs between domestic production activities
- M - matrix of imports classified by importing and by using domestic production activity (assumed to be diagonal)
- A - matrix of technical coefficients relating to D

B - matrix of technical coefficients relating to M

q^m - vector of imports by production activity

q^d - vector of domestic gross outputs by production activity

f^d - final demand vector for domestic output

f^m - final demand vector for imported products

N - vector of labour input by production activity

g - vector of labour input per unit of gross domestic output in each production activity.

We have

$$A_{ij} = \frac{D_{ij}}{q_j^d} \ , \ B_{ij} = \frac{M_{ij}}{q_j^d} \ \text{(but } M_{ij} = 0 \text{ for } i \neq j\text{) and } g_j = \frac{N_j}{q_j^d} \quad ..(1)$$

for i,j = 1, ...k where k is the number of production activities. Partitioning the usual balance equations, assuming non-competitive imports, we may write

$$\left[\begin{array}{c|c} I - A & 0 \\ \hline -B & I \end{array}\right] \cdot \begin{bmatrix} q^d \\ q^m \end{bmatrix} = \begin{bmatrix} f^d \\ f^m \end{bmatrix} .$$

Hence

$$\begin{bmatrix} q^d \\ q^m \end{bmatrix} = \left[\begin{array}{c|c} [I - A]^{-1} & 0 \\ \hline B[I - A]^{-1} & I \end{array}\right] \cdot \begin{bmatrix} f^d \\ f^m \end{bmatrix} . \qquad ...... (2)$$

It is now possible to calculate the total employment effect of meeting an increase in a particular category of final demand through domestic production only, keeping constant all other final demands for domestically produced goods and all final demands for imports. Clearly the <u>gross</u> outputs of domestic sectors and <u>intermediate</u> imports will change to some extent depending on the linkages between production activities.

A fixed coefficient production function relating domestic employment to domestic output yields the following matrix of direct and indirect effects upon the demand for labour contingent on a unit increase in domestic final demand.

$$X = [\hat{g}]\,[I - A]^{-1} \qquad \ldots\ldots (3)$$

$\hat{g}$ is a diagonal matrix containing the vector g along the diagonal. Labour inputs have been measured by the number of people employed in the activity (i.e. by man-years). The results contain the implicit assumption that the degree of labour utilisation changes proportionately with output.

X_{jj}, a diagonal element of X, is the 'direct' employment effect from meeting an expansion of final demand for the j^{th} product by £1 million through increasing domestic output in the j^{th} production activity. The effect includes the impact of additional demands arising upon the initiating sector itself from other activities expanding to meet its input requirements. The off-diagonal elements in the j^{th} column of X are the increases in labour demands in the rest of the production activities which result from meeting the input requirements of activity j.

The use of input-output analysis to calculate the employment effects of alternative changes in the pattern of final demands has long been recognised. Leontief (1944), following his seminal contribution to equilibrium analysis of the American economy, observed that direct and indirect employment effects may be obtained in the manner described above. Burtle (1952) provided a non-technical exposition of the method and its potential usefulness: 'This technique has practical value in a field which is of considerable concern to the International Labour Organisation - that of manpower supply and full employment'.(1) More recently Parikh (1974) has produced some results for the United Kingdom and the present author has analysed the X matrix for Sri Lanka as part of a wider study of that economy.(2) Parikh (1975) also investigates the significance of adopting

(1) Burtle (1952) p.600.

(2) See Lindley (1975a).

various proxies for the domestic coefficients matrix (A) as a guide to the choice among the major alternatives open to the planner in countries where a direct estimate of the matrix is not available.

We shall use the X matrices computed by Parikh for the United Kingdom and derived from the appropriate domestic coefficients matrices.[3] The section of the X matrix most relevant to this study corresponds to the square sub-matrix at the intersection of the rows and columns relating to the engineering industries identified in the official input-output tables.[4] In addition we have retained other industries with which engineering has strong employment linkages whilst aggregating all other industries. Part of the resulting X matrix for 1963, transformed by dividing column elements by column totals and expressing figures as percentages is given in Table 8.1.

To return to a comment in the introduction, it should be emphasised that the employment effects matrix has been derived on very strict assumptions about foreign trade. All intermediate imports are collected under the industry of first destination and treated as complementary. Since many imports compete strongly with British products it would be preferable to adopt the treatment recommended in the United Nations handbook, A System of National Accounts (1968), which distinguishes between complementary and competitive commodities. The latter are then routed through the sector in which that good is the principal product, yielding an inter-industry transactions matrix reflecting technology independently of trade except in so far as complementary imports cannot

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(3) I am most grateful to Dr. Parikh for generously providing me with copies of his estimates of the E matrices for 1963 and 1968.

(4) See Central Statistical Office (1970). Twenty separate industry groups cover the engineering sector in the 1963 table. For 1968 this was increased to twenty-six. Matters of classification are dealt with in Appendix 4.

Table 8.1 Employment Effects Matrix (percentages) for United Kingdom, 1963

	Input-output industry	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	40	41	42
22	Agricultural Machinery	49.04	0.06	-	0.05	-	0.04	-	0.03	0.21	-	-	0.01	-	0.01	0.01	0.01	0.01	0.02	0.01	0.02
23	Machine tools	0.21	64.18	0.28	0.45	0.18	0.23	0.17	0.33	0.23	0.35	0.05	0.21	0.16	0.09	0.18	0.23	0.20	0.23	0.32	0.20
24	Engineering small tools	0.44	0.23	72.13	0.70	0.34	0.46	0.90	0.37	0.41	0.62	0.22	0.34	0.41	0.26	0.40	0.60	0.52	0.54	0.32	0.33
25	Industrial engines	1.11	0.26	0.06	46.61	0.06	1.40	0.10	0.25	0.19	0.03	0.04	0.48	0.04	0.09	0.08	0.06	0.05	0.09	0.06	1.96
26	Textile machinery	0.11	0.04	-	0.07	57.92	0.06	-	0.06	0.10	0.01	0.01	0.03	0.02	0.04	0.03	0.01	0.03	0.04	0.02	0.04
27	Construction mech. hand equip.	0.21	0.09	0.06	0.14	0.11	49.25	0.10	0.17	0.38	0.04	0.01	0.10	0.08	0.07	0.11	0.11	0.12	0.15	0.06	0.08
28	Office machinery	-	-	-	-	-	0.03	69.79	0.02	0.02	0.03	-	0.02	0.01	0.01	0.02	-	0.01	0.01	0.01	-
29	Other non-electrical machinery	1.38	0.88	0.35	1.73	0.70	1.20	0.82	58.89	2.79	0.39	0.26	0.52	0.52	0.32	0.71	0.61	0.44	0.64	0.72	0.60
30	Industrial plant & steelwork	1.47	0.30	0.17	0.38	0.22	0.76	0.24	0.56	50.32	0.10	0.12	0.75	0.18	0.14	0.21	0.31	0.21	0.27	0.17	0.26
31	Other mechanical engineering	3.55	2.91	1.08	3.69	4.19	3.56	6.06	4.54	3.71	68.50	0.85	1.75	1.07	2.04	3.23	0.90	0.47	1.24	0.53	2.52
32	Instrument engineering	0.26	0.30	0.21	0.63	0.50	0.41	0.08	0.44	0.75	0.16	73.15	1.18	0.18	3.59	1.10	0.10	0.13	0.33	1.87	0.16
33	Electrical machinery	1.14	1.36	0.35	1.16	1.11	1.96	1.29	1.60	0.87	0.29	0.90	65.81	0.52	1.01	1.18	0.36	0.32	0.82	0.49	1.56
34	Insulated wires & cables	0.09	0.16	0.09	0.27	0.11	0.25	0.18	0.20	0.14	0.14	0.19	0.91	42.94	0.38	0.62	0.10	0.21	0.29	0.19	0.17
35	Electronics & tele-communications	0.23	0.35	0.25	0.38	0.54	0.28	0.18	0.30	0.29	0.14	1.46	0.99	0.30	63.08	0.91	0.11	0.15	0.36	1.37	0.23
36	Other electrical goods	0.30	0.31	0.23	0.37	0.44	0.40	0.19	0.34	0.33	0.14	1.16	0.39	0.30	0.39	53.59	0.32	0.31	2.32	0.36	0.67
37	Cans & metal boxes	0.03	0.02	0.01	0.02	0.02	0.04	0.01	0.03	0.02	0.02	0.02	0.02	0.08	0.03	0.04	42.15	0.07	0.06	0.02	0.02
38	Other metal goods	5.49	3.48	1.65	6.14	5.75	5.80	1.69	2.71	2.27	1.77	1.36	2.17	9.96	2.56	2.71	1.22	59.42	5.63	4.39	2.07
40	Motor vehicles & tractors	0.52	0.27	0.29	0.72	0.29	1.00	0.21	0.33	0.37	0.12	0.14	0.25	0.31	0.19	0.26	0.38	0.29	45.02	0.21	1.07
41	Aerospace equipment	0.03	0.02	0.08	0.10	0.02	0.09	0.02	0.06	0.07	0.06	0.04	0.19	0.04	0.05	0.04	0.03	0.07	0.09	69.85	0.13
42	Other vehicles	0.35	0.22	0.13	0.38	0.21	0.34	0.23	0.30	0.35	0.25	0.08	0.21	0.27	0.14	0.22	0.54	0.31	0.41	0.17	63.30
	Sub-total engineering	65.96	75.44	77.42	63.99	72.71	67.56	82.28	71.53	63.82	73.16	80.06	76.33	57.39	74.49	65.05	48.15	63.34	58.56	81.14	75.39
3	Coal-mining	1.93	1.72	1.39	2.36	1.61	1.98	1.20	1.71	2.28	2.04	0.88	1.54	2.19	0.95	1.56	3.88	2.29	2.32	1.19	2.05
19	Iron & steel	7.54	6.57	4.99	7.89	4.74	7.99	3.04	5.87	9.66	5.47	1.19	4.48	2.88	1.48	3.29	21.98	8.56	8.36	2.83	5.65
66	Road & rail transport	3.25	2.29	1.66	3.34	1.88	3.00	1.28	2.51	3.21	2.08	1.20	2.02	3.64	1.36	2.34	6.20	3.30	2.97	1.18	1.94
69	Distributive trades	5.24	4.31	2.92	6.06	4.14	5.96	2.41	4.25	5.95	3.80	2.93	3.74	5.89	4.51	4.11	5.88	6.33	6.46	3.95	4.07
70	Miscellaneous services	5.80	2.31	4.84	2.83	5.84	3.09	2.15	4.12	5.15	3.41	3.33	2.29	6.12	5.93	7.49	3.08	4.47	4.63	2.05	1.74
	Sub-total	23.76	17.20	15.80	22.48	18.21	22.02	10.08	18.46	26.25	16.80	9.53	14.07	20.72	14.23	18.79	41.02	24.95	24.74	11.20	15.45
	All industries listed above	89.72	92.64	93.22	86.47	90.92	89.58	92.36	89.99	90.07	89.96	89.59	90.40	78.11	88.72	84.44	89.17	88.29	83.30	92.34	90.84
	Other industries	10.28	7.36	6.78	13.53	9.08	10.42	7.64	10.01	9.93	10.04	10.41	9.60	21.89	11.28	15.56	10.83	11.71	16.70	7.66	9.16

be routed though a domestic industry and so embody an extension of the technical structure involving 'complementary foreign industries'. This would then make way for a treatment of domestic employment effects which could take into account a behavioural model of import responses recognising price effects and incorporating an appropriate balance of payments constraint. We shall not attempt to be so thorough. The partitioning of total supplies into domestic outputs and imports along the lines given above yields an approximate view of domestic employment generation which will do for our purposes, namely, an examination of the basic structure of the employment effects matrix. As it stands then, the model implies that competitive as well as complementary intermediate imports move in proportion to the output of the using domestic industry.

The notion of manpower linkages has been presented in terms of most relevance to a situation where certain changes in final demands are being anticipated and it is desirable that their full employment effects should be considered. These expected changes may be based on evolving consumer demands, public expenditure plans, a forthcoming investment boom etc. or they may be more specifically associated with exploring the employment effects of alternative changes in the pattern of final demands prior to settling the way in which the government should try to steer through the unemployment-inflation-balance of payments difficulties faced by it. However, as indicated by our treatment of imports, we shall not be looking at the problem of modelling in a formal way the impact of manpower bottlenecks which threaten to unbalance the growth of an economy running at near full capacity or to block the achievement of a major economic revival.

8.3 The Structure of the Employment Effects Matrix (X)

The purpose of this section is first to use the X matrices for

1963 and 1968 in order to investigate aggregate employment effects without distinguishing different occupational groups and second, to derive and analyse matrices of skilled employment effects (X_s) only.

8.3.1 <u>Aggregate Employment</u>

The impact of a change in final demand for domestic output upon employment in different industries is captured by the matrix of employment effects. Tables 8.2 - 8.4 summarise the information to be gleaned from the X matrices for 1963 and 1968. Other parameters of relevance to a discussion of manpower linkages between engineering industries are included in Table 8.2. The employment effects act in the same direction as do unit changes in final demand and, since the underlying model is linear, accumulate in proportion to those changes. Increases in prices and productivity make a comparison between the absolute elements of the X matrices for 1963 and 1968 of less interest for our purposes than a comparison of the structure of employment effects by dividing all the elements of the X matrix by their corresponding column totals (the total employment effects of a unit increase in final demand) and expressing the resulting figures as percentages (see Table 8.1). It is revealing to compare three quantities which relate to the impact of a change in final demand upon the demand for labour.

(i) Labour input per unit of gross output.

(ii) Direct employment effect of unit change in final demand.

(iii) Total employment effect of unit change in final demand.

The first coefficient is simply a measure of the employment impact of a unit change in intermediate or final demand disregarding <u>all</u> further effects upon the economy. The third coefficient takes into account the full ramifications of inter-industry transactions as captured in the model. The second coefficient adds to the first only those further

Table 8.2 Employment effects and output statistics for engineering industries 1963

Input-output industry	Labour-output (gross) coefficients[1]	Employment effects[2]				£lm as % of gross output	Value-added as % of gross output[3]
		Direct	Total	(3) as % (4)	(2) as % (4)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
22	334	346	705	49	47	1.59	41.8
23	428	460	716	64	60	0.64	57.2
24	443	562	780	72	57	0.98	59.5
25	273	291	624	47	44	0.82	44.8
26	423	447	772	58	55	0.90	46.0
27	325	344	699	49	46	0.41	42.3
28	460	491	704	70	65	1.69	54.4
29	372	423	719	59	52	0.15	51.0
30	315	366	727	50	43	0.28	42.1
31	485	524	764	69	63	0.21	55.7
32	497	580	793	73	63	0.42	59.0
33	514	553	840	66	61	0.25	50.6
34	237	245	570	43	42	0.46	29.9
35	430	501	795	63	54	0.16	52.9
36	397	403	753	54	53	0.23	41.2
37	271	324	768	42	35	1.06	27.1
38	339	425	716	59	47	0.09	44.6
40	188	294	652	45	29	0.06	38.2
41	368	539	771	70	48	0.02	58.2
42	523	543	858	63	61	0.50	45.2

Source: Central Statistical Office (1970) and Parikh (1974).

Notes:
(1) Labour-output coefficients are in units of man-years per £lm gross output excluding intra-industry consumption.

(2) Employment effects are per £lm final demand.

(3) Gross output excluding intra-industry consumption.

demands which fall upon the initiating sector. In Table 8.2 these three coefficients are shown in columns (2) - (4) and compared in columns (5) and (6) for 1963. The unit of output, £1 million, as a percentage of industry gross output will obviously depend on the industry. This means that the coefficients shown in the tables obviously do not represent employment responses to the same percentage increases in final demand. The cross-sectional differences are partly due to variations in value added per man-year (a measure of labour 'productivity') and in the ratios of value added to gross-outputs as well as to the inter-industry structure. An indication of just how different are the scales of operation and value added proportions among industries is given in columns (7) and (8).

If one were to look at the labour to gross output ratios for evidence on those engineering industries in which the employment effect of a given absolute change in final demand would be greatest then electrical machinery (33) and other vehicles (42) lead the field. In both cases however the estimated impact would only amount to 61 per cent of the total effect. Industries in which the estimated impact using the first method appear to be very low are insulated wires and cables (34) and motor vehicles (40). In these cases though, the estimates prove to be even less relative to total effects than those of the two leading industries. In motor vehicles the use of the labour to gross output ratio indicates an employment response which is only 29 per cent of the total response. A perusal of Table 8.2 shows significant changes in the ranking of industries according to employment impact as one moves from column (2) to (4). More important is that absolute and proportionate cross-sectional differences also change considerably. The relation between direct effects and labour to gross output coefficients is indicative of the extent of feedback to the initiating sector. Variations in its importance between industries can be seen by subtracting column (6) from column (5). Its significance ranges from almost zero up to 16 per cent. Industries with relatively high manpower feedback are engineering small tools (24), instrument engineering (32), other metal goods (38), aerospace equipment (41) and, largest of all, motor vehicles (40).

It is of interest to look at the distribution of total employment effects among other engineering industries relative to non-engineering industries. Table 8.3 summarises Table 8.1 for 1963. The extent to which the manpower linkages cause engineering to be a closed system is shown in column (4). With the exception of cans and metal boxes (37) at least half of the total employment effect for an industry falls on the engineering sector. Office machinery (28), instrument engineering (32) and aerospace equipment (41) all generate just over 80 per cent of the total effect within the engineering sector. A group of five industries - coal mining (3), iron and steel (19), road and rail transport (66), distributive trades (69) and miscellaneous services (70) - generally absorb a major proportion of the remaining employment generated.

Between 1963 and 1968 some changes occurred in the structure of the employment effects coefficient matrix. Table 8.4 summarises the position for 1968. In four cases (25, 28, 34 and 40) the differences between the elements of columns (4) for 1963 and 1968 just exceeded five percentage points. Otherwise the structure of the X matrices for 1963 and 1968 were similar. Of course differences in the <u>levels</u> of employment generated will be due to several factors but short of listing them below nothing further will be said about them.

(i) Price changes which mean that the unit change in final demand (£1m) actually represents a different level of physical output (usually less because of inflation) in 1968.

(ii) Changes in the domestic input coefficients (A) and import coefficients (B).

(iii) Changes in labour productivity (g).

Table 8.3 Summary of the distribution of total employment effects for engineering industries among select groups of industries (in percentages). 1963.

Input-output industry (1)	Initiating industry (2)	Other Engin-eering industries (3)	All Engin-eering (4)	Industries:(3) (19), (66), (69), (70) (5)	Rest of industry (6)	Whole economy(1) (7)
22	49.0	16.9	66.0	23.8	10.3	100.0
23	64.2	11.2	75.4	17.2	7.4	100.0
24	72.1	5.3	77.4	15.8	6.8	100.0
25	46.6	17.4	64.0	22.5	13.5	100.0
26	57.9	14.8	72.7	18.2	9.1	100.0
27	49.3	18.3	67.6	22.0	10.4	100.0
28	69.8	12.5	82.3	10.1	7.6	100.0
29	58.9	12.6	71.5	18.5	10.0	100.0
30	50.3	13.5	63.8	26.3	9.9	100.0
31	68.5	4.7	73.2	16.8	10.0	100.0
32	73.2	6.9	80.1	9.5	10.4	100.0
33	65.8	10.5	76.3	14.1	9.6	100.0
34	42.9	14.5	57.4	20.7	21.9	100.0
35	63.1	11.4	74.5	14.2	11.3	100.0
36	53.6	12.1	65.7	18.8	15.6	100.0
37	42.2	6.0	48.2	41.0	10.8	100.0
38	59.4	3.9	63.3	25.0	11.7	100.0
40	45.0	13.6	58.6	24.7	16.7	100.0
41	69.9	11.2	81.1	11.2	7.7	100.0
42	63.3	12.1	75.4	15.5	9.2	100.0

Source: Table 8.1

Note: (1) Elements in columns 2, 3, 5 and 6 sum to 100.0 along the rows subject to rounding errors.

Table 8.4 Summary of the distribution of total employment effects for engineering industries among select groups of industries (in percentage). 1968

Input-output industry (1)	Initiating industry (2)	Other Engin-eering industries (3)	All Engin-eering (4)	Industries: (3) (19), (66), (69), (70) (5)	Rest of industry (6)	Whole economy[1] (7)
22	53.9	15.8	69.7	20.6	9.7	100.0
23	61.8	13.1	74.9	17.2	7.9	100.0
24	70.5	6.2	76.7	15.9	7.4	100.0
25	54.2	16.3	70.5	17.8	11.7	100.0
26	57.7	16.0	73.7	17.2	9.1	100.0
27	47.2	20.1	67.3	21.2	11.5	100.0
28	59.3	16.6	75.9	13.2	10.9	100.0
29	64.2	9.4	73.6	16.6	9.9	100.0
30	51.1	14.6	65.7	24.1	10.2	100.0
31	64.8	6.2	71.0	17.6	11.5	100.0
32	73.4	7.8	81.2	9.6	9.2	100.0
33	64.3	13.1	77.4	12.9	9.8	100.0
34	48.5	14.2	62.7	17.5	19.8	100.0
35	66.8	10.9	77.7	11.7	10.7	100.0
36	55.4	13.1	68.5	16.7	14.9	100.0
37	43.8	6.2	50.0	21.0	29.0	100.0
38	60.4	4.5	64.9	23.5	11.6	100.0
40	50.6	13.3	63.9	20.2	16.0	100.0
41	67.8	14.5	82.3	10.1	7.7	100.0
42	65.4	11.9	77.3	13.6	9.1	100.0

Source: As for Table 8.1

Note: Elements in columns 2, 3, 5 and 6 sum to 100.0 along the rows subject to rounding errors.

8.3.2 Skilled Employment

The X matrix aggregates all occupations but subject to providing the necessary demand functions the approach can be extended to a set of occupational groups into which employment in all input-output industries can be divided. With a fixed coefficient model of labour demand (again via gross output not net output) in which ℓ_s becomes a diagonal matrix of skill input per unit of output in each industry, the expression for the skill effects matrix relating to skill s is simply,

$$X_s = \ell_s(I - A)^{-1} \qquad \ldots\ldots (4)$$

Thus the inter-relatedness of industry demands may be analysed for each skill in turn. Leaving aside the well-rehearsed objections to using fixed coefficient labour demand functions, there is an empirical problem in applying this model to investigate the manpower linkages for skilled engineering craftsmen. The most satisfactory statistics on employment in the relevant trades are from the L7A survey (see Chapter 2) but this covers only the manufacturing sector. Rather than use census of population statistics as presented in Table 2.1, we have restricted the analysis to the engineering sector alone. Thus the total employment effects initiated by one engineering industry and falling within the sector as a whole are derived for the occupation, skilled engineering trades. To obtain a rough estimate of the additional demands for this skill falling upon non-engineering industries, we can take about 7 per cent of all employment generated outside engineering compared with about 35 per cent on average of all employment generated within engineering.[5] The skilled engineering employment effect will then on average be five times larger per 100 jobs generated in engineering than per 100 jobs generated elsewhere. Only in industries (34) and (37) where the proportions

(5) The figures given are based not on the L7A definition of skilled engineering trades but on the definition of 'skilled engineering occupations' given in Ministry of Labour (1967). Both percentages will be higher than ones based on the former definition.

of skilled engineering trades in total employment and the engineering sector's share of the total employment effect are relatively low is the skilled employment generated outside engineering more than 15 per cent of the total skilled employment effect (each being about 30 per cent). The figures for five other industries (25, 35, 36, 38 and 40) lie between 10 and 15 per cent. These estimates, which are very approximate, are given in full in Table 8.5, column (4).

The distribution of skilled employment effects is also summarised in Table 8.5 where the direct employment effects are given as percentages of the total within-sector effects. Thus, depending on the industry, between 51 and 94 of every 100 jobs generated for engineering craftsmen within engineering arise in the initiating sector. Only insulated wires and cables (34) retains as small a percentage as 51; all other industries retain at least 70 per cent and 12 of the 20 retain 80 per cent or more.

The final column of Table 8.5 is a very rough measure of the extent to which each industry, by expanding to meet an increase in final demand, will generate skilled labour demands confined to its own establishments. The larger the percentage direct effect the less likely is the industry to find itself competing for labour with other industries actually expanding solely to provide it with the inputs required to produce the additional gross output. A comparison between Table 8.5, column (6), and Table 8.2, column (5), indicates the more confined nature of the skilled effects relative to the aggregate employment effects. Industry (34) is the only exception to this general observation but there is a wide range in the extent of the difference shown by other industries. Note that part of the direct effect will arise from the industry acting so as to facilitate the production of these other industries by supplying them in turn with inputs.

Table 8.5 Skilled employment effects for engineering industries 1963

Input-output industry (1)	Skilled labour as % of all labour (1) (2)	Skilled labour-output coefficient (2) (3)	Engineering employment effects: Skill effect falling outside engineering as % total skill effect (4)	Direct skill effect as % skill effect falling within engineering (5)	Direct skill effect as % total skill effect (6)
22	37.70	126	8	80	74
23	49.30	211	4	89	85
24	40.87	181	4	94	90
25	31.70	87	10	77	69
26	44.47	188	5	84	80
27	41.78	136	6	76	71
28	29.37	135	4	76	73
29	36.85	137	6	89	84
30	35.76	113	9	79	72
31	33.55	163	6	92	86
32	31.06	154	5	92	87
33	28.83	148	6	84	79
34	8.84	21	34	51	34
35	18.05	78	10	79	71
36	18.53	74	15	73	62
37	16.48	45	28	78	56
38	27.24	92	11	92	82
40	29.84	56	12	81	71
41	37.83	139	4	87	84
42	39.84	208	5	88	84

Source: Columns (3) - (5) were derived from column (2) and Table 8.2 (see text).

Notes: (1) Unpublished data on skilled employment by M.L.H was available from the L7A Survey of the Department of Employment. Although there were some uncertainties connected with the use of the occupational classification in the first year of the survey, (1963), these figures have been used as best available estimates for 1963 in preference to the 1964 figures.

(2) Units are skilled man-years per £lm gross output.

The above analysis is attractively simple but it can only be used as a starting point for studying manpower linkages. How 'rough' are the measures of these linkages provided in Table 8.5? Undoubtedly they are over-estimates given the existence of labour hoarding and stock holding. Replacement of the labour-output ratios by incremental labour-output ratios appears to reduce the fit of crude manpower models at about this level of aggregation for engineering industries.[6] Changing to a non-linear employment function of the kind shown in Table 3.5 introduces output elasticities below unity; indeed, only 5 out of 15 were significantly greater than zero implying that in the short-run changes in output would not be accompanied by changes in employment. If these functions replaced the average labour-output ratios used in forming the skilled employment effects matrix, only in the cases of input-output industries 23, 24, 31, 33, 34 and 35 would the direct effect probably be significant. This will tend to distort the employment effects matrix considerably, generally increasing the ratio of direct to indirect effects for these industries and decreasing it for other industries, approaching zero for metal goods (37 and 38), aircraft (41) and other vehicles (42). Supplementing this with differences in stock holding behaviour, it is quite clear that the employment effects matrices do not provide a direct guide to the manpower linkage effects in the short-run.

However, the employment effects matrix for a base year may be used as a benchmark in the following way. If the purpose is to consider what demands for skilled manpower are likely to be generated in which sectors if the pattern of final demands is changed in a particular way without altering import ratios then a diagonal matrix of changes in

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(6) See Bosworth et al. (1974).

final demand from the base year can be multiplied by X_s to obtain the absolute employment effects. Summing these along the rows gives an estimate of the hypothetical change in labour requirements of an industry and taken together with the implied gross output change a judgement about how much to scale down the average response can be made. This will involve consulting any available information about labour hoarding and stocks of intermediate goods held. The resulting rough adjustment can then be made to all elements in that row. Econometric evidence on short-run output elasticities and possible productivity increases due to major institutional change can also be incorporated in the adjustment exercise for which the initial set of employment effects provides a useful starting point.

Having followed this procedure for each row, attention is then switched to the columns. Industries which appear to be expanding rapidly to meet increases in final demands can be selected with a view to checking whether or not they are likely to generate much pressure on the external labour market for skilled manpower themselves and which industries responding to meet their input requirements might add significantly to that pressure.

8.4 Bottlenecks and Balance of Trade - A theoretical note

The existence of employment linkages between industries makes for a situation in which 'complementarity effects', mentioned briefly in the last chapter, could become significant depending on the stock positions of industries and/or their ability to substitute imports for domestic goods in short supply. In the latter case, whilst the technological problem of a lack of suitable inputs may be solved, this could have a significant macroeconomic effect via its impact on the balance of payments. The modelling of short-run adjustments to bottlenecks is extremely difficult because of the lack of information about stocks and about vacancies cross-classified by occupation and industry. However, our main interest is in the medium-term balance of the economy, given a certain growth path, and the extent to which this could be upset by manpower shortages. In that sense the perspective adopted is similar to the one underlying the static Cambridge model as described in Barker (1976, editor). Furthermore, in what follows we shall not incorporate the potential complementarity effect between relieving supply constraints in the current period and employment effects in a future period (arising through the greater investment allowed in the current period), nor shall we analyse the complementarity effect arising from the lack of substitution between skills within the same production unit. For the latter, the degree of ex post substitution between engineering craftsmen (including apprentices) and others was assumed to be zero in Chapter 5. The fixed coefficients employed in equations (3) and (4) above imply the more severe restriction that the output elasticity is unity.

Consider a three sector model in which the subscripts 'e', 'r' and 'o' denote a specific engineering industry, the rest of engineering and all other industries respectively. If x, h and m refer to exports, other final demands for domestically produced products and all imports respectively, retaining the framework of equations (1) and (2) in which all imports are treated as complementary, we have:

$$q = Aq + h + x \qquad \text{......} \ (5)$$

$$m = Bq \qquad \text{......} \ (6)$$

$$h + x = f \qquad \text{......} \ (7)$$

$$N = \hat{g}q \qquad \text{......} \ (8)$$

Assume that it is intended to achieve f_e*, f_r* and f_o* in some target year. If a labour supply constraint (S_e) affects q_e* required to produce f* then let the constraint upon q_e* be $q_e^* \leq \bar{q}_e$. New equilibrium flows of goods and services might be achieved according to the following objectives:

(i) achieve proportions p_e, p_r and p_o of f_e*, f_r* and f_o* respectively

(ii) achieve f_r* and f_o* then maximise q_e and hence f_e

(iii) achieve f_e and then $\bar{p}f_r$ and $\bar{p}f_o$, maximising $\bar{p}$

(iv) maximise i'f

(v) maximise i'N

(vi) maximise w'N where w is a vector of average wages.

Constraints upon all these objectives are

(a) $f = \hat{p}f^* = (I - A)q$

(b) $q \leq \bar{q} = \hat{g}^{-1}S$

(c) $N = \hat{g}q$

(d) $q, f \geq 0$.

A, $\bar{q}$ and $\hat{g}$ are matrices or vectors of exogenous technical parameters. Elements in f, q and S may be set at certain magnitudes or subject to inequality constraints depending upon the form of the optimisation problem.(6)

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(6) The maximisation problems can only be stated formally but the solutions to (i) and (ii) are as follows:

(i) $q=(I-A)^{-1}\hat{p}f^*$ which is feasible providing $\hat{p}f^* \leq (I - A)\hat{g}^{-1}S$.

(ii) $q_e = \dfrac{S_e}{g_e}$, $\begin{bmatrix} q_r \\ q_o \end{bmatrix} = \begin{bmatrix} I-A_{rr} & -A_{ro} \\ -A_{or} & I-A_{oo} \end{bmatrix}^{-1} \begin{bmatrix} f_r^* + A_{re}q_e \\ f_o^* + A_{oe}q_e \end{bmatrix}$

and $f_e = (1 - A_{ee})q_e - \begin{bmatrix} A_{er} & A_{eo} \end{bmatrix} \begin{bmatrix} q_r \\ q_o \end{bmatrix} \neq f_e^*$

The form of analysis given above ignores the impact of the solution upon imports and exports and hence the balance of trade. A simple extension of the approach would be to limit the total import bill ($\bar{m}$) to a level compatible with a balance of trade objective based upon a view of the proportion of output to be devoted to exports. Thus we would add

(e) $i'Bq^* \leq i'm = \bar{m}$ (a scalar)

and this may in fact over-ride some of the labour supply constraint inequalities (i.e. the shadow prices on the supply constraints may fall to zero in the optimal solutions to problems (iv)-(vi)).

Other problems may be posed within this initial framework but the importance of the balance of trade in economic management suggests that this should be incorporated explicitly rather than be used 'off-stage' to derive the total import constraint $\bar{m}$. At the same time our highly restrictive assumption that all imports are complementary will be dropped.

Replacing the strict partitioning of domestic and imported intermediate supplies into D and M with corresponding coefficient matrices A and B respectively, Stone and Brown (1962) split imports according to whether they are competitive or complementary.[7] If A is redefined to represent a technology matrix unaffected by changes in foreign trade, all competitive commodities are then routed through the domestic industries of which they are the principal products. If we collapse B to a vector (b) of aggregate complementary commodity import coefficients and if m_1 and m_2 are competitive and complementary intermediate imports respectively and h_1 and h_2 are the corresponding final demand vectors we have:

$$m_1 + q = A_q + h_1 + x \qquad \text{......} \; (9)$$

(7) The empirical criterion adopted was whether or not more than 50 per cent of the supply of a commodity was obtained from a domestic source.

$$m_2 = \hat{b}q + h_2 \qquad \ldots\ldots (10)$$

Constraining the balance of trade to a value β in constant prices and specifying a set of competitive import functions relating individual imports to total imports, we obtain two further equations

$$\beta = i'(x - m_1 - m_2) \qquad \ldots\ldots (11)$$

$$m_1 = a_1 + c_1 i' m_1 \qquad \ldots\ldots (12)$$

Solving for q we have:

$$q = \left[I - A + c_1 b\right]^{-1} \left[h_1 + x - a_1 - c_1(i'x - i'h_2 - \beta)\right] \ldots\ldots (13)$$

So for a given balance of trade target, exports and other final demands for domestically produced goods (h_1) and complementary imports (h_2), equation (13) yields the domestic gross output requirements and hence labour demands.

It is now possible to deal directly with the balance of trade constraint upon the achievement of such objectives as (i)-(vi) given above. The constraints (e) and (a) are replaced by

$$(a') \quad f_1 = h_1 + x = \left[I - A + c_1 b\right] q + a_1 + c_1(i'x - i'h_2 - \beta)$$

Thus if one is maximising total employment, the shadow prices on constraints (b), reflecting limited supplies of labour in at least one industry, indicate the complementarity effect (measured in terms of additional employment) which would be achieved for marginal increases in supplies of labour to those industries taken one at a time. The shadow prices do however take into account the satisfaction of a macro-economic constraint placed upon the system - a target balance of trade. Without it, equation (13) reduces to

$$q = (I - A)^{-1} (h_1 + x - m_1). \qquad \ldots\ldots (14)$$

Clearly in this case any f_1 may be achieved since now there are competitive imports to fill the gap between domestic supply and final demands (whereas under the earlier model there existed only complementary imports which could not be substituted for domestic products) and the balance of payments situation is being ignored. The economy would necessarily achieve full employment because any lack of domestic intermediate inputs due to labour shortages in certain industries would be made up through imports. Such a state of affairs could not of course be sustained for long but it indicates that even when the balance of trade target is being satisfied the model assumes that 'competitive' imports are determined as a residual. Stone and Brown explore alternatives to the above, for example by adopting a different relation for competitive imports in which they are directly related to output and replacing the exogenous exports assumption by the simple form (12) used initially for imports. Thus the solution for exports rather than imports is obtained as a residual via the balance of trade.

Barker (1972) points out however that in the context of medium-term projection the balance of trade constraint expressed in constant prices may be inconsistent with an independent forecast of the terms of trade. Furthermore, it is desirable to allow imports and exports to be price sensitive.

The classification of imports is changed to include all as competitive except for those where domestic output is extremely small. Barker specifies the following import and export functions where p_q, p_m, p_x, p_f and θ are, respectively, domestic output and import prices, prices of our exports and competing foreign products and the exchange rate.

$$(m + q)^{-1}m = \hat{b}_o (\hat{m} + \hat{q})^{b_1} (\hat{p}_q^{-1} p_m)^{b_2} \qquad \text{...... (15)}$$

$$x = \hat{c}_o (\theta^{-1} \hat{p}_f^{-1} p_x)^{c_1} \qquad \text{...... (16)}$$

The trade balance in current prices is

$$\beta = p'_x x - p'_m m \qquad \text{...... (17)}$$

Thus an iterative solution for outputs, imports, exports and the balance of trade can be found given a set of prices, exchange rate and domestic final demands.[8]

In the second case above, stemming from equation (13), no balance of payments effect can be derived, of course, through shadow price valuations since β is just a constraint, not part of the maximand. However in, say, maximising total income (i'f) or employment (i'N) the sensitivity of the shadow price on a labour supply constraint (Ps_i) to changes in the trade target could in principle be explored. One would obtain a relationship between β, Ps_i and the maximand.

In the third case we have the balance of trade as part of the solution so that the effects of supply constraints could be investigated by varying S_i and noting the resulting β and maximand values. One then obtains a relationship between the same three variables but this time the value of β should be consistent with relative price changes affecting the volume of import and export movements.

This section has taken us some way from the simple analysis of employment linkages in previous sections. The notions of 'complementarity and macroeconomic' effects of large scale training policy have been explored in terms of the choice of maximand and constraints which define related optimising problems. The solutions to these would convey some indication of the aggregate employment and balance of payments effects resulting from labour supply constraints on different industries. There is no need to specify all possible aggregate industry supply constraints. It is only necessary to specify those constraints such as the supply of certain skills in different industries which are most likely to affect output, providing the production function incorporates the appropriate

(8) See Barker (1972) p.118 for the complete iterative sequence based essentially on equations (15) to (17) and balance equations of the form (9) and (10). More recent specifications of export and import functions are described in Barker (1976, ed.), Chapters 6 and 7.

skill input requirements per unit of output.

In principle then the use of a mathematical programming model could yield some idea of the magnitude of complementarity and macroeconomic effecrs. However, as in the case of the simple employment effects model given in the previous section, the role envisaged for this sort of approach is strictly circumscribed by the validity of strong assumptions made about the technology of production, the operation of market mechanisms and the way in which the shortage problem presents itself. The potential value of the programming model is most likely to emerge in the following circumstances. Assume that aggregate output is being maximised subject to balance of trade and labour supply constraints. The shadow prices on the latter are then scrutinised bearing in mind that the labour markets concerned might actually anticipate the programming solution by setting in train changes to wage differentials which would, to some extent, relax the supply constraints. This would raise the question of links between supply constraints as seen through the manpower flow system. Thus, rather than accept them uncritically as the appropriate price parameters (taking into account macroeconomic effects) for the manpower cost-benefit calculation, shadow prices no less than the simple employment effects matrix would provide only a guide to further analysis.

Clearly the empirical application of the scheme outlined above raises very difficult problems particularly in the specification of supply constraints and the technology of production. The purpose of this theoretical aside has been to sketch out formally one approach to incorporating macroeconomic effects of manpower programmes, showing how these effects may be important but equally how difficult it is to take them into account even at a theoretical level. On the other hand some experimentation along the lines suggested might eventually yield useful insights.

8.5 Conclusion

This chapter has explored some aspects of the manpower linkages among engineering industries and between them and other sectors of the economy. The intention was to provide a sense of the potential magnitudes of these linkages taken directly from average coefficient matrices rather than a detailed analysis of them. The latter would require a more sophisticated treatment of imports, the use of comparable data on the skill structure of non-engineering industries, the analysis of changes over time in the components used to estimate the employment effects matrices and a study of the dynamic adjustment processes involved in the generation of employment including the impact of bottlenecks.

The estimates of direct and indirect employment effects at the aggregate and craftsmen levels assume that import coefficients remain constant. Taken at face value the ranking of engineering industries changes considerably when moving from a labour per unit of gross output criterion to the total employment effect. The importance of employment generation via inter-industry linkages is apparently greatest of all in the case of motor vehicles in which the labour to gross output coefficient is barely a third of the total effect; the direct effect is less than a half. Most labour to gross output ratios however lie between about 45 and 65 per cent of the total effect. Shares of total employment effects falling within engineering vary between 48 and 82 per cent but 12 of the 20 lie within the range 60-75 per cent; between 1963 and 1968 these components of the X matrix did not change very significantly. As regards the skilled employment effects only in 5 industries did the shares falling outside engineering exceed 10 per cent. The restriction of the skill effect to the industry initiating the expansion lay between 70 and 85 per cent in the main. Thus, according to X_s , there are sizeable skilled manpower linkages between engineering industries making for the transmission of effects of shortages among them. This would place a premium upon the efficiency of the labour market in allocating skilled labour so as to smooth out imbalances in relative supply and demand situations facing different industries.

The empirical analysis does not deal with the role of imports in employment generation. Nor does it incorporate the impact of employment changes upon incomes, leading to changes in final demands and thence to employment, since final demands are taken to be exogenous. This requires a general equilibrium model of the kind described in Barker (1976, ed.) and, preferably, progressing towards a dynamic treatment as indicated in Barker (1976). The theoretical note to this chapter had a more modest purpose, namely, to express complementarity effects (those arising through inter-industry linkages) and macroeconomic effects (those relating to the balance of trade) in formal terms within the basic input-output framework. This suggested that it might be possible to take the empirical analysis of these selected effects a little further than hitherto implied by those attempting cost-benefit analysis of manpower programmes.

CHAPTER 9 CONCLUSIONS

This thesis has explored the problems of modelling a labour market. The conclusions of the study are in four parts. First, there are some empirical results for the labour market for skilled engineering workers. These have been summarised already at the end of each chapter but the main findings will be reiterated briefly below. Second, the various components of labour market behaviour which have been analysed separately will be brought together in order to show the nature of the model which is beginning to evolve for the skilled engineering labour market. Third, some suggestions for future research will be made, standing back from the detailed matters of model development considered in earlier chapters. Finally, whilst we have concentrated upon one particular market, several general points about modelling a labour market seem to have emerged and these are stated.

9.1 Empirical Findings

Great stress has been placed upon the synthesis of the findings of local labour market studies with those of aggregate statistical and econometric analysis. The notion of the 'crucial test' is notoriously difficult to apply in this and other areas of economics but especially so when the theory being tested is microeconomic and the test methodology is based on aggregate econometric estimation. This applies particularly to the evidence presented in Chapter 2 where the deployment and mobility of craftsmen was investigated. From the simple manpower accounts the loss of skilled engineering workers to other jobs within engineering and the loss of trainees during training were shown to be of comparable magnitudes to the inflow of new craft trainees or apprentices. Relying heavily on the study by MacKay and his colleagues for a set of initial hypotheses about how the market is operating, the relationship between labour mobility and supply and the wage structure was explored, leading on to the question of the determinants of the wage structure in engineering. This brought us to the econometric evidence which, whilst failing to resuscitate the neoclassical view of the labour market, was generally inconclusive. However, on balance there seemed to be enough evidence to suggest the importance of product market power in settling the inter-industry wage structure and that combined with the diffuse relationship, at best, between skill differentials and relative shortages, a situation likely to undermine the allocative function of the market during periods of economic recovery had arisen in the engineering industry.

Faced with this environment how has management attempted to cope with the job of recruiting manpower? Adopting apprentice recruitment as their main instrument for adjusting skilled labour supply managers seem to have used it extremely short-sightedly. In circumstances where trade union restrictions on apprentice recruitment appear to be unimportant if not non-existent the scenario is one of recruiting when skilled labour is already in short supply, causing extreme cyclical fluctuations. From the econometric analysis, models used to estimate demand functions for craftsmen did not discriminate between the vintage and neoclassical approaches. This was not surprising given the limitation of data. The simple employment function continues to have its usual attractions of superficially reasonable explanatory power (but not for all industry groups) and ease of estimation given the availability of statistics on output as opposed to gross investment and scrapping. The sharpness of the apprentice recruitment response to a tightening craft labour market is shown in the high elasticities of the former with respect to craft employment. For engineering in total a value of 3.4 was obtained but there is a wide range of estimates at the industry group level (6 of the 15 are not significantly different from zero). As regards the summary statistics used to indicate the state of the labour market and especially the difficulties which firms were facing in recruiting labour, we concluded that given the circumstances in which these statistics are collected the unadjusted vacancies and unemployment series were to be preferred to series which combine the two measures and to the information provided by the CBI Industrial Trends Survey.

The main empirical work concerned a detailed analysis of the apprentice inflow to engineering. Single equation supply and demand models have been presented, in Chapters 4 and 5 respectively, as competing hypotheses about the determinants of recruitment fluctuations in the period 1951-71. This contrast should not be pressed too far. Qualifications to both supply and demand results are discussed. The evidence favours the demand explanation partly because it is felt that demand influences which reinforce supply effects are likely to have contributed to the explanatory power of the supply model and partly because the coefficients estimated for the demand model are much more acceptable. On the supply side one should note the lack of significance of the 'cohort-size' variable in the case of apprentice inflows - a variable which is highly significant in the supply equation estimated for all young entrants to engineering. The elasticities of supply with respect to immediate (youths) and future (adult) relative earnings prospects were not significantly different from zero in the first case and about 2 in the second. However there was some doubt over the scope for identifying the former given the small variation in the relative earnings variable. On the supply side two points were emphasised: first, had the supply of apprentice recruitments been a major determinant of apprentice inflows then one might have expected firms to take advantage of the large rise in school-leavers in the early 1960s but this did not happen and, second, since the demand for recruits is very sharply related to the imbalance between supply and demand, the absence of medium-run manpower planning in order to anticipate short-run supply inelasticities is the main cause of supply problems at the apprentice level rather than the presence of bias against skilled manual work, poor qualifications and competition from other expanding employment opportunities.

On the demand side the main theoretical construction is the use of a constrained-output, cost-minimising objective function with a putty-clay production technology except that the provision of labour services to the production process admits of short-run substitution possibilities between trained craftsmen and apprentices and hence, at the margin, apprentice recruits. The model relating recruitment via the apprentices' contribution to current production yields robust coefficient estimates and reasonable explantory power. Adjustments for hours of work increase the latter considerably. Replacing output by capital stock and then capital services through the medium of the vintage hypothesis we found that neither modification improves upon the direct link between employment and output. Several caveats accompany the demand results. The implicit treatment of supply, the problem of accounting for technical progress and the consistency between objective functions and the adjustment mechanism are all discussed but the consideration which leads to an alternative specification and estimation of the demand model is that of the influence of expectations about future output. By replacing current output by gross fixed capital formation to reflect the combined effect of current output and future expectations, the explanatory power improves and coefficients maintain their significance. Whilst no attempt is made to produce a formal model of investment in apprentice training the results suggest that this would be worth exploring. What we do have is a demand model which explains 90 per cent of the variation in the inflow of apprentices to engineering and accords with expectations about the signs of coefficients. The treatment of wages as an exogenous variable to both supply and demand models is partly justified by the findings of Chapter 2 but there is room for further work in this area particularly on the determinants of the wages of youths relative to adults and the differential between the skilled and semi-skilled.

In Chapter 6 the supply and demand models were tested at a disaggregate level. In the case of the 15 engineering industry groups the data base is much less reliable and the results are only generally indicative of the performance of the models. Multicollinearity is evidently a problem and support for the demand hypothesis as opposed to the supply hypothesis is not as strong as in the case of the aggregate models. Thus it must be said that several developments are envisaged before these models can be pressed into the service of forecasting the recruitment response of industry, so that we can anticipate what the industry will do over, say, a planning period of about three or four years ahead. We have nonetheless conducted an evaluation of 'forecasts' for 1972 and 1973 using the present models. The peculiar state of the economy in this period, the raising of the school-leaving age (in 1973) and changes in certain data series all conspire against an adequate testing of the models. Basically we find that they are over-predicting. If the models correctly captured the determinants of recruitment in the period up to 1971, then there has been a significant change in behaviour of firms, their recruitment dropping in 1972 by more than one would expect on the basis of previous recessions. Put another way, if the models whilst adequately explaining pre-1972 behaviour, omitted some aspect which subsequently comes to the fore, then it may be possible to see where this occurred and correct the models. Obviously our treatment of expectations of firms is very crude but there is also much concern about the data question. However, we now have a working model which can be used as a benchmark for tentative predictions and further development. It should perhaps be stressed that models of investment in physical capital have also been over-predicting in recent years. These have been used for some time by national forecasting teams. In effect this study has attempted to lay a foundation on which to base forecasts of investment in human capital through the recruitment of apprentices. As with models of physical investment one expects these models of recruitment to go through a continual process of improvement.

Chapter 7 presents no empirical findings but in the light of earlier chapters assesses the methodology of cost-benefit analysis as applied in recent British evaluations of training. Its conclusions lend further support to the idea of modelling skilled labour markets and their links with other markets through supply flows. At present the application of the Markov chain model to the problems of simulating the work experience of a control group is thought to be premature.(1) The integration of the flow model concept as part of the cost-benefit methodology, in place of the fairly arbitrary selection of parameter adjustments to take account of displacement and replacement effects, would involve changes to the Engineering Craftsmen Matrix requiring additional data. However as a research objective this would begin to bring together the modelling of the flow system's reaction to changes initiated by manpower agencies and the evaluation of the costs and benefits of training policy. This has relevance for the way in which other manpower policies (e.g. the use of employment subsidies) also affecting labour market stocks and flows should be assessed.

Since the main reason usually given for active manpower policies is to avoid supply bottlenecks to growth it is unfortunate that cost-benefit analysis has tended, in practice, to regard complementarity and

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(1) See section 9.4 below.

macroeconomic effects as beyond the scope of estimation. A superficially attractive model for use in studying the potential importance of such effects is based on input-output analysis. The employment effects matrix estimated in Chapter 8 would, subject to strong assumptions, provide rough estimates of the employment linkages by which output changes in one industry generate output and hence employment changes in other industries. According to this crude model, the extent to which employment effects fall outside the engineering sector declines very much when the aggregate linkages are replaced by those for skilled craftsmen. However there remain sizeable skilled manpower linkages between engineering industries. For 9 of the 20 input-output industries at least 20 per cent of the skill effect falling within the sector impinges upon industries other than the one initiating the change. Given the assumption of fixed technical coefficients (including stock-holding ratios) and complementary imports such a model provides only a benchmark for a procedure which would involve scrutinising the validity of each of the main fixed coefficients. In the case of engineering the short-run output elasticities are clearly not all unity (see Chapter 3) and the employment effects initially estimated would need to be modified considerably. By the same token the procedure implied by the theoretical treatment of macroeconomic effects, relaxing import complementarity, is also seen only as an initial step in the rough analysis of these potential economic benefits to training. However, it remains to be seen how feasible the approach outlined in Chapter 8 turns out to be in practice and how much real insight is obtained into the significance of complementarity and macroeconomic effects. At present we are far from having a means of estimating 'cross-elasticities' between supply and demand for engineering craftsmen in different industries.

9.2 A Summary of the Evolving Model

Obviously we do not have a complete model of the labour market for engineering craftsmen. However several components of market behaviour have been modelled directly or indirectly in the course of the previous chapters and it is worthwhile bringing them together to make the shape of the evolving overall model explicit.

The formal summary given below includes a set of behavioural relationships and a set of accounting identities and constraints. A list of exogenous variables completes the system but not in the sense of providing an equilibrium path as a result of solving the model. The essence of the model is that disequilibria arise in both the sub-markets for craftsmen and apprentice recruits, especially in the former case. The outcome is determined by the solution to the bottleneck problem discussed in Chapter 8 in conjunction with the demand and supply functions. The statement of the model is highly schematic and is left in terms of its structural equations without, in the main, giving the functional forms by which the dependent and independent variables are related.

For clarity of presentation some simplifications are made in the sub-models discussed in the relevant chapters. A disaggregate model is given in which different occupations and industries are indicated by subscripts i and j respectively. Where notation differs from that given in the chapters because of the disaggregation this is explained.

Behavioural equations

(a) Supply of craftsmen to industry j (SC^t_{cj}):

$$SC^t_{cj} = SC_{cj}\left\{ SQC^t , \left[E^t_{ij}\right] , \left[PU^t_{ij}\right] , \left[D^t_{hk}\right]\right\} \qquad \ldots (1)$$

$$\left.\begin{array}{l} i = 1, \ldots n \\ j = 1, \ldots m \end{array}\right\} \text{hk all ij except cj}$$

SQC^t total number of people in the labour force with craft skills

SC^t_{ij} number of qualified craftsmen willing to supply labour in occupation i in industry j

E^t_{ij} present value of expected earnings of those in employment in (i, j)

PU^t_{ij} composite probability of underemployment and unemployment associated with (i, j) as perceived at time t

D^t_{hk} demand for people working in occupation h by industry k

(b) Demand for craftsmen by industry j (D^t_{cj}):

(i) Desired employment

$$D^{*t}_{cj} = D^{*}_{cj} \left\{ TP^t_j , Y^t_j , \left[\frac{W_{aj}}{W_{cj}}\right]^t \right\} \quad \ldots (2)$$

(ii) Short-run demand function

$$D^t_{cj} = \left[D^{*t}_{cj}\right]^{\lambda} \left[D^{t-1}_{cj}\right]^{1-\lambda} \qquad 0 \leqslant \lambda \leqslant 1 \quad \ldots (3)$$

TP^t_j technical progress adjustment to skilled labour services requirement per unit of value added Y^t_j

(c) Inter-related demand structure (matrix notation):

(i) All imports complementary

$$q = (I - A)^{-1} f \quad \ldots (4)$$

(ii) Competitive imports and balance of trade incorporated

$$q = (I - A + c_1 b)^{-1} \left[h_1 + x - a_1 - c_1 (i' x - i' h_2 - \beta)\right] \quad \ldots (5)$$

(iii) Value added - gross output relation

$$Y = \hat{v} q \quad \ldots (6)$$

(iv) Demand for labour

Simple fixed coefficients $\quad D_c = \hat{g}_c q \quad \ldots. (7)$

More complex case $\quad$ Solution via (2) and (3) using (6) with (4) or (5).

$\hat{g}_c$ diagonal matrix of skilled labour input per unit of gross output coefficients

$\hat{v}$ diagonal matrix of value added to gross output ratios

D_c vector of demands for craftsmen by industry D_{cj}

All other variables and parameters are as given in equation 8.3. The time superscript has been dropped for convenience.

(d) Supply of apprentice recruits to industry j (S^t_{aj}):

$$S^t_{aj} = S_{aj}\left\{ SLT^t ; \left[EJ^t_{i'j'}\right], \left[PJU^t_{i'j'}\right], \left[DJ_{h'k'}\right] ; \left[E^t_{ij}\right], \left[PU^t_{ij}\right], \left[D_{hk}\right]\right\} \quad \ldots (8)$$

$\left.\begin{matrix} i' = 1, \ldots r \\ j' = 1, \ldots s \end{matrix}\right\}$ h'k' all i'j' ≠ aj. $\left.\begin{matrix} i = 1, \ldots n \\ j = 1, \ldots m \end{matrix}\right\}$ hk all ij ≠ cj

EJ, PJU and DJ are analogous to E, PU and D but correspond to juvenile employment opportunities. This notation splits the two aspects of the earnings stream represented by a single variable (E) in equation 4.4. The presence of E and PU captures expectations about the adult section of the earnings and employment time profile. Career profiles in fact limit the relevant combination of ij with i'j' but this is not shown above.

(e) Demand for apprentice recruits by industry j (DJ_{aj})

(i) Desired demand

$$DJ^{*t}_{aj} = DJ^*_{aj}\left\{ TP^t_j , Y^t_j , \left[\frac{w_{aj}}{w_{cj}}\right]^t , U^t_c \right\} \quad \ldots (9)$$

(ii) Short-run demand function

$$DJ^t_{aj} = \left[DJ^{*t}_{aj}\right]^\theta \left[DJ^{t-1}_{aj}\right]^{1-\theta} \quad \ldots (10)$$

Accounting identities and constraints

(f) Wage and hours functions

$$E^t_{ij} = \sum_{\tau=t}^{t+T} w^\tau_{ij} H^\tau_{ij}/(1 + r)^{\tau-t} \quad \ldots (11)$$

$$HD_{ij} = H_{ij} D_{ij} \quad \ldots (12)$$

HD_{ij} demand for hours of adult labour in (ij) given short-run demand D_{ij}

H_{ij} hours worked in (ij) - assumed to be exogenous to the determination of desired employment D^*_{ij} in the simplified case above (see Chapter 5)

Similar functions apply to EJ and HDJ.

(g) Aggregate manpower account

$$SQC_t = \sum_j \sum_{\tau=t-L}^{t-1} LA_j^{\tau} P_t^{\tau} \qquad \ldots (13)$$

L length of working life

P_t^{τ} proportion of those recruited as apprentices at time τ who are still able to work as craftsmen at time t

The profiles p_t^{τ} summarise the results of failure to complete training, depreciation of skill, and death in one set of parameters which may themselves be functions of economic conditions. Adult training and migration are ignored. Note that all apprentices with more than one year's experience are aggregated with craftsmen (hence the summation up to t-1; see Chapter 5 for the treatment of demand in this respect).

(h) Observed employment of apprentice recruits (LA) and craftsmen (LC) must satisfy the following inequalities at least (plus non-negativities):

$$\sum_j LA_j^t \leq \sum_j S_{aj}^t \leq SLT^t$$

$$\sum_j LC_j^t \leq \sum_j SC_{cj}^t \leq SQC^t$$

$$LA_j^t \leq S_{aj}^t \;,\; DJ_{aj}^t \qquad \text{all } j$$

$$LC_j^t \leq SC_{cj}^t \;,\; D_{cj}^t \qquad \text{all } j$$

These yield a further identity

$$U_c = \sum_{ij} (SC_{ij} - LC_{ij})$$

LC_{ij} is the employment of craftsmen in occupation i and industry j. Where the first subscript is omitted as in the above inequalities only craftsmen employed in craft jobs in industry j are included.

Exogenous variables

W_{ij}^t, H_{ij}^t, SLT_t, P_t^{τ}, TP^t, U_T^t; PU and PJU (both preferably based on past experience rather than current unemployment relativities as in Chapter 4); f or h_1, x and h_2; D_{ij}^t and DJ_{ij}^t for all j and $i \neq c$, a.

Adjustment and other parameters shown in equations (4) to (6) and implied by the unspecified functions are also exogenous. Of the sections of the model given above no empirical analysis has yet been attempted for equations (1) and (13).

The data problems associated with craftsmen supply and mobility were described in Chapter 2. The Engineering Craftsmen Matrix records actual flows rather than the potential flows which are the theoretical counterpart of labour supply. ECM also fails to retain information about those qualified as engineering craftsmen who are working in other occupations. Thus ECM records LA_j and LC_j but not necessarily S_{aj} and SC_{cj} and certainly not SQC. Equations (1) and (13) have been specified so as to emphasise the importance of the total population of qualified craftsmen to the supply management problem. Ideally ECM should be extended to record the distribution of skilled men amongst all occupations but the available data prevents this. If this were possible, the aggregation of selected states of ECV (row or column totals of ECM) would yield SQC and the matrix entries linking the relevant elements of ECV (t) to ECV (t+1) would show the composition of flows giving rise to the shift from SQC^t to SQC^{t+1}. ECM would also show as it does now the composition of flows giving rise to changes in the observed employment of craftsmen in engineering craft jobs, from LC^t to LC^{t+1} (using the notation of Chapters 4 to 6 rather than the ECM notation of Chapter 2). Were demand and supply functions for each employment state of ECV specified above, a fourth set of accounting identities based on ECM and ECV would replace the single unemployment equality in (h).

9.3 Further Research

The most constructive light in which to consider future research is that of the work of the manpower agency most concerned with the skilled engineering labour market, the Engineering Industry Training Board. Taking a broader view of the research activity and the EITB's role, one particular issue comes to the fore: our conception of the supply problem. The legislation on training boards operates through the Boards' relations with firms of their industries. The whole apparatus tends to emphasise the situation of the firm as the prime context in which training matters should be discussed. Only recently in circumstances of extremely high unemployment has the position of the individual in relation to training rivalled that of the firm, mainly in connection with the expansion of Government Training Centres, job creation and emergency training schemes operated by the Manpower Services Commission. This is not the place to enter into a discussion of the institutional and financial arrangements most suited to deal with the training of manpower in Britain. What can be said however is that the present arrangements focus attention too much on the features of decision-making by firms on employment and training matters rather than by the suppliers of labour. To a great extent this research has followed this emphasis because, in the case of engineering craftsmen, it is the decisions of firms which so dominate changes in future supply. Nonetheless as we have seen in previous chapters, there is much more involved than simply fixing the level of apprentice recruitment.

The Engineering Industry Training Board is essentially concerned with 'supply management'. Its actions initiate changes to the numbers being trained and the quality of their training. It may be felt that the Board has also promoted the efficient use of manpower within the firm partly through generally pressing for manpower planning but specifically through the impact of better training upon the individual's job efficiency and the minimisation of distortions to the preferred occupational structure caused by shortages of skills. Manpower agencies in Britain have not involved themselves in the debate about alternative technologies or in challenging the demands for labour as they are expressed by firms on the grounds that firms are failing to develop or choose technologies which employ the skills and aptitudes which are available. So without wishing to suggest that Board staff are unconcerned about these broader issues, it is clear that the very considerable practical problems associated with supply management dominate their strategy.

The term 'supply management' has been used to indicate the manipulation of the various instruments available to training boards in order to produce outcomes in the labour market which would otherwise not occur. The prime example is the boosting of counter-cyclical training to avoid the all too familiar skill shortages when the economy moves out of recession. Manpower agencies intending to act in this way require the following information:

(i) forecasts of demand,

(ii) forecasts of supply assuming the agency does not interfere (or does not interfere more than 'usual'),

(iii) forecasts of how the labour market will respond to alternative agency proposals,

(iv) estimates of the relative values of acting so as to ameliorate one anticipated shortage rather than another or as opposed to other forms of public expenditure (for example, incentives for investment in physical capital).

This thesis has concentrated upon the problems of developing models which will help with the first three items but the work on both demand and supply has very strong implications for the validity of certain methods of evaluating alternative training investment decisions in (iv), as we saw in Chapter 7.

In order to forecast changes in supply we need to establish how supply is presently distributed among activities (including unemployment), how likely suppliers of labour are to change their activities during the forecast period and how the level and distribution of additional labour supply expected from those likely to enter the labour market during the period will vary. Clearly estimates of demand and supply need to be broken down into different occupations and, ideally, according to geographical location. However, the development of flow models even at this level of detail does not lead to a straightforward 'input' to the planning process. Many other considerations arise to undermine the confidence we would have in the meaning to be attached to a statement such as 'our supply model(s) indicate that there will be shortages of so many skilled men in mechanical engineering trades in the period 1978-80'. In order to react rationally to this statement a manpower agency needs to know what factors are contributing to the expected shortage and what methods of avoiding the shortage are available. This requires a more intimate knowledge of the particular labour market in question and its institutions than is implied by the operation of a set of national manpower flow models even dealing with different occupations and regions as well as industries.

In our underlying approach to engineering labour supply we distinguish between the following.

(i) The situation facing the individual in the process of making an initial choice of occupation involving (a) no further training or (b) further training.

(ii) The situation facing someone who has already acquired work experience and is (a) contemplating a change of occupation which will involve some training or (b) considering alternative jobs involving no significant retraining either because the individual would remain in the same occupation and would require only a certain amount of induction training, or because although changing occupation he or she would need only a sub-set of previously acquired skills.

(iii) Involuntary search for work leading to (ii), caused (mainly) by redundancy.

The potential responses of workpeople to these three basic situations determine the size and composition (age, sex, education, training, work experience) of labour supply. Depending on the length of time it takes for the individual to cope with these decision situations and the subsequent time needed for training or education (through firms, GTCs and educational establishments) we may define supply at appropriate points along the short-run to long-run continuum. In addition, variations in the characteristics of occupations, especially (a) pay and other conditions of employment, (b) structure of work tasks and (c) envisaged security, will cause shifts in supply previously defined with respect to a particular set of these characteristics.

Finally, from time to time demographic and economic changes will alter the numbers of people primarily facing one of the three situations listed above. For example, an increase in the cohort of school leaving age will raise the numbers under (i) and a fall in the demand for labour outside engineering will raise the numbers under (ii) and (iii) looking towards opportunities within engineering.

Thus, in the research on engineering craftsmen we have covered (i) from the point of view of both the supply of recruits and the supply of training (i.e. demand for recruits), concluding that changes in the latter have in the main determined the future supply of newly qualified skilled labour. We have covered (ii) only by piecing together several sources of partial information some of which relates to the last period of high labour demand ending in 1966. There seems to be a strong case that the supply of training (i.e. the ability of training systems to cope with upgrading) is the major limitation on raising supply through attracting people in situation (iia) but there is the question of overlapping payment systems within the same plant which may discourage workers from accepting training for upgrading. The individual may also look outside engineering. As regards (iib) the firmest evidence applies to those leaving skilled for better paid semi-skilled work especially in motor vehicle plants but again the loss of people moving to skilled (or switching to semi-skilled) occupations in other industries is likely to be significant.

Future research on the supply side should therefore aim to examine in more detail the circumstances of the main groups potentially in a position to supply labour. This study has focussed on the supply of skilled craftsmen but the scheme applies in principle to all groups. Recent Board surveys have concentrated upon the extent of mobility rather than its cause and upon enquiring about those who are in skilled jobs, technician jobs etc. rather than about where those with engineering craft and technician skills are employed, and why. The matter of the potential response of labour supply to changes in pay and other conditions of employment places much more stress on survey design and organisation. A knowledge of these responses is however just as important as firms' views of alternative training proposals and their habits of manpower decision-making.

On the question of an annual mobility survey, raised in Chapter 2, this would allow the Board to monitor what is happening to the major flows of manpower within the engineering labour market and between the sector and the rest of the economy. Since training policy impinges directly upon these flows we would press for an information system which is adequate enough to monitor the flow system. It is a matter of significance beyond mere research interest that such a regular survey should include information about individual pay, working hours etc. The understanding of job decision-making by workpeople acquired from both the more detailed studies and the limited regular mobility surveys would more than repay the effort involved. Future research would then concentrate upon moving through ECM (to which the categories of the mobility surveys should be closely related) selecting flows for analysis according to their importance for the craftsmen labour market. As data accumulates more sophisticated models than those described for apprentice recruitment can be entertained. This applies particularly to the analysis of the market in simultaneous terms or at least to the estimation of wage structure equations for which the lag in response of wages to market imbalances is shorter than the forecasting horizon envisaged in this work: at most four to five years.

9.4 General Points on Modelling a Labour Market

The importance of establishing which are the main stocks and flows of manpower led to the use of a set of aggregate manpower accounts. The inadequacy of using rules of thumb which focus too much on one particular flow, typically the inflow of new recruits to training programmes relative to the stock of trained people, was illustrated by the case of engineering craftsmen. Manpower accounts which identify the major elements of resource movement also provide a framework for the collection and presentation of manpower statistics.

The fact that not all people who are qualified to work in certain occupations despite the fact there is an excess demand for their skills suggests that we should distinguish firmly between the skills embodied in the population and their deployment among occupations. This needs to be recognised as an extension of the manpower accounting system so that we are able to pick up the continuous misallocation of skilled manpower and begin to question why it is happening.

The manpower account should be regarded as a basic research tool to be used in the analysis of labour supply. In a similar but not exactly analogous fashion, the input-output matrix embedded in a Social Accounting Matrix provides an important device by which we can begin to examine interrelationships between industries via intermediate demands. One could of course invert sets of coefficient matrices based on the manpower accounts and use them as a 'fixed coefficient' supply model. However it is not for this mechanistic purpose that the proposal is made for extensive use of manpower accounts. With reference to the engineering craftsmen market it has been argued that a much more effective information system would result from the specification of an accounting system within which to organise the development of manpower stock and flows statistics and on which to base model-building. Quite a number of statistical series are produced by official bodies but the lack of a systematic relationship between them leads to an unnecessary loss of information and probably a waste of resources in the data collection activity. The categories identified within the accounts also have implications for the form in which potential explanatory variables, such as earnings and hours of work, should be collected so as to match the statistics on manpower resources.

At a more aggregate level the case above applies with even greater force. The inconsistencies between population census data and Department of Employment data on the labour force are well known and the gaps left between official education and employment statistics have already been pointed out in Chapter 4. The Population Accounting Matrix presented in Chapter 2 and described in more detail in Lindley (1976c) has been developed with the aim of providing the necessary data framework within which statistics on population, employment, education and training can be fitted together for the purpose of studying labour supply. Its use raises questions of government strategy in the collection of statistics; for example, on the need for a regular national mobility survey and the role of the population census and related samples in providing key information at, say, five year intervals at a more detailed level than otherwise possible with sample surveys. The part to be played by longtitudinal surveys in monitoring certain sectors of the accounting system is a further important issue.

The evidence presented on the inflow of apprentices to engineering indicates that there is scope for modelling individual flows but of course it remains an empirical question whether or not similar levels of explanatory power can be achieved for flows of young entrants into other occupations and industries and especially for the mobility flows of those already in the labour force. In the latter case, however, it will be some time before satisfactory time series data is available.

The difficulty of estimating economically meaningful, general stochastic models of population flow systems is well illustrated by the application of a Markov model to the fairly specific area of industrial mobility. The discussion given in Chapter 2 and Appendix 1 showed the interplay between 'accounting problems' such as the presence of multiple movement and activity and the choice of stochastic representation of the flows. In the case of engineering craftsmen it is not possible to test such models but from the study of aggregate inter-industry mobility it is clear that much further work needs to be done before stochastic models of parts of the flow system can be slotted into pointed out in Chapter 4. The Population Accounting Matrix presented in Chapter 2 and described in more detail in Lindley (1976c) has been developed with the aim of providing the necessary data framework within which statistics on population, employment, education and training can be fitted together for the purpose of studying labour supply. Its use raises questions of government strategy in the collection of statistics; for example, on the need for a regular national mobility survey and the role of the population census and related samples in providing key information at, say, five year intervals at a more detailed level than otherwise possible with sample surveys. The part to be played by longtitudinal surveys in monitoring certain sectors of the accounting system is a further important issue.

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Thus, the objections made to the sort of cost benefit analysis procedure adopted by Ziderman do not stem simply from an aversion to accepting the equality between observed wages and social marginal products. They run to the heart of the way in which these 'price' parameters are connected by 'resource flow' parameters used to evaluate the full impact of policy, including ripple effects produced by attempts to increase the flow of manpower along one part of the flow system. The model-building activity is as much a prerequisite for cost benefit analysis as it is for manpower forecasting. Indeed it provides for the only possible synthesis of the two approaches, replacing the confrontatation of straw theories about how labour markets work with more direct attention to the market mechanism itself. Of course there remains the question of how labour markets should work - a matter of great social and political importance. This thesis has addressed itself to the technical problems of modelling one particular labour market. How much more difficult it is to anticipate the economic consequences of major changes in the organisation of the labour market on a national scale. On the other hand the purpose of constructing economic models is to reduce the need for potentially wasteful social experimentation. The notion of a 'model' of the national labour market, comprising a set of linked models of sub-markets, may sound too ambitious. But without a more clearly articulated view of the present system, it is impossible for those within the various government departments and agencies responsible for controlling the economy to produce coherent policies, whether or not they involve large scale institutional change as has taken place in the labour market over the last decade.

APPENDICES

APPENDIX 1 INTER-INDUSTRY MOBILITY OF MALE EMPLOYEES IN GREAT BRITAIN 1959-68[1]

A1.1 Introduction

With reference to the discussion of manpower flow accounts and models in Chapter 2, the statistical analysis presented in this appendix should be seen as a necessary part of the work preparatory to the development of models to forecast the flows of manpower in the economy and the resulting industrial distribution of labour.

In the following section a demographic accounting framework is established for the manpower flows taking place within the labour force. In section A1.3 the preferred structure of the accounts is modified because of the limitations of the data in order to give central place to the industrial mobility of members of the employee labour force and to the external flows linking this group with the rest of the population. Section A1.4 presents a particular type of manpower flow model which may be derived from the demographic accounts, namely, a Markov model of inter-industry mobility. There are however some strong a priori objections to the use of such a model to represent the mobility process and these are also noted. In section A1.5, Markov transition matrices are estimated for the period 1959-68, the effects of the missing flows data are investigated in relation to forecasting the industrial distribution of labour and the significance of variations in the estimated mobility matrices is tested over the period under study. Section A1.6 concludes the appendix.

A1.2 The General Statistical Framework

In this section we briefly introduce a simple demographic accounting framework which specifies the links between the labour force, which is the focus of our attention, and the rest of the population. In Table A1.1 a set of basic demographic accounts is presented in matrix form. Adopting the notation as defined below the matrix, the body of the matrix relates the stock totals corresponding to the labour force and the rest of the population at

(1) This appendix has been published in article form, cited as Lindley (1976a) in the references.

DOMESTIC DEMOGRAPHIC ACCOUNTS : GREAT BRITAIN

Table A1.1

		GB		ROW	Total
		Labour Force	ROP		
GB	Labour Force	$n_{ll}(t)$	$n_{lr}(t)$	$d_l(t)+e_l(t)$	$L(t)$
	ROP	$n_{rl}(t)$	$n_{rr}(t)$	$d_r(t)+e_r(t)$	$R(t)$
ROW		$i_l(t)$	$b(t)+i_r(t)$	0	$b(t)+i(t)$
Total		$L(t+1)$	$R(t+1)$	$d(t)+e(t)$	

$n_{ll}(t)$ Numbers in the labour force at time t who were also members at time t+1

$n_{rr}(t)$ numbers in the rest of the population at time t who were also there at time t+1

$n_{lr}(t)$ numbers in the labour force at time t who had joined the rest of the population by time t+1

$n_{rl}(t)$ the reverse flow to $n_{lr}(t)$

$i_l(t)$ and $i_r(t)$ immigrants who entered the labour force and the rest of the population respectively during the period (t, t+1) and were in these categories at time t+1

$e_l(t)$ and $e_r(t)$ members of the labour force and the rest of the population respectively at time t who had emigrated by time t+1

$d_l(t)$ and $d_r(t)$ deaths among the labour force and the rest of the population respectively during period (t, t+1)

b(t) and d(t) aggregate births and deaths in the population during period (t, t+1)

e(t) total numbers of the population at time t who had emigrated by time t+1

L(t) the numbers in the labour force at time t

R(t) the numbers in the rest of the population at time t.

Table A1.2(a)

			GB					ROP	ROW	TOTAL
			Labour Force							
						U				
			HMF	SE	EE	CU	UU			
GB	Labour Force	HMF								HMF(t)
		SE								SE(t)
		EE			$n_{ll}(t)$			$n_{lr}(t)$	$d_l(t) + e_l(t)$	EE(t)
	U	CU								CU(t)
		UU								UU(t)
	ROP				$n_{rl}(t)$			$n_{rr}(t)$	$d_r(t) + e_r(t)$	R(t)
	ROW				$i_l(t)$			$b(t) + i_r(t)$	0	$b(t) + i(t)$
TOTAL			HMF(t+1)	SE(t+1)	EE(t+1)	CU(t+1	UU(t+1)	R(t+1)	d(t) + e(t)	

Table A1.2(b)

	Labour Force: Industrially classified employees only (EE+CU) 1 - - - - - - H	ROP: Retirement only	Residuals from LF (HMF, SE and UU) and ROP plus ROW	Total
Labour Force Industrially classified employees only (EE+CU) 1 - - - H	n(t)	x(t)	l(t) - x(t)	N(t)
ROP: First entrants from education only	y'(t)	0		
Residuals from LF and ROP plus ROW	h'(t) - y'(t)			
TOTAL	N'(t+1)			

time t to those totals at time t+1 through the major flow components affecting the stocks during the period. Thus the size of the labour force at time t+1 is determined (in the accounting sense) by the stock at time t, deaths and emigration among members of the labour force, flows into the rest of the population and in reverse, and immigrants joining the labour force directly.

$$\text{i.e.} \quad L_{t+1} = L_t - \left[d_1(t) + e_1(t)\right] - \left[n_{1r}(t) - n_{r1}(t)\right] + i_1(t)$$

If we further disaggregate the classification to identify separately the self-employed, employees in employment, the unemployed and those in non-civilian employment (HM forces and women's services), the matrix of Table A1.2(a) is obtained. Finally if we wish to disaggregate the labour force and related flows according to the industry of employment then, before expanding the table by replacing SE, EE and U by appropriate row and column vectors with elements corresponding to each industry, it is necessary to distinguish those members of the unemployment pool who are classified by industry (CU) from those who are not (UU), as shown in Table A1.2(b).

The resulting matrix is of similar structure to that of Table A1.2(a) in which all elements in the SE, EE and CU rows and columns are either (1xH) or (Hx1) vectors or, at their intersection, (HxH) Matrices where H is the number of industries. The statistics available to match the stocks and flows identified in the accounts will be discussed in the following section. Some general problems of the scope and definition of aspects of labour market behaviour captured in the accounts need to be dealt with before doing so however.

(1) The distinction between domestic and national concepts in defining the population covered by the accounts clearly requires us to identify migrants and visitors separately. This involves classifying those leaving or entering the country according to whether they intend to migrate or not.

(2) The time period adopted for the accounts will depend partly on the peculiarities of currently available statistics, for example, the most satisfactory estimates of stocks of manpower are those for mid-June and the industrial flows data relate to the June to June annual period. The accounting period preferred also depends on the extent to which the demographic accounts are expected to correspond to the calendar year national economic accounts. Stone (1971, p.19) notes that by establishing demographic accounts across the calendar year this

would provide a mid-year estimate of the labour force. This raises our third point.

(3) Demographic accounts are normally discussed in terms of flows of individuals and not, in the case of the labour force, in terms of flows of labour services. The valuations of the latter for a calendar year for each industry correspond to the value added component attributed to labour in the economic accounts. A more direct correspondence to the economic accounts would be possible if the accounting periods coincided and if sub-period point observations of stocks were available.

(4) The notion which now arises is the possibility of valuing a flow of an individual from one activity to another in terms of the hours being transferred. This obviously raises the question of how to deal with full-time, part-time and spare-time employment[2] and more generally the problem of multiple activities and changes in the mix of activities in which an individual participates. At this stage it is infeasible for flows to be valued in hours and for accounts to be defined in terms of the most common multiple activity combinations.

(5) We should distinguish between multiple activity and multiple movement during the accounting period. Since we shall adopt an annual accounting period, multiple activity may reasonably describe employment each week in more than one job. If the combination of jobs held were changed in the course of the period this would constitute a change of (multiple) activity in the more complex accounts referred to in point (4). In accounts which classify the individual by principal employment only a change of activity would only be recorded if the principal job were changed. Multiple movement arises when the individual changes activity (or combination of activities defined in multiple activity accounts) more than once during the sample period. Only the first and last activity of the period are recorded by the stock-flow accounts.[3]

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(2) Stone (1971, p.58).

(3) The combination of highly seasonal demands for labour (and hence multiple movement) and multiple activities makes for particular difficulty in avoiding undue simplification in constructing accounts for developing countries.

(6) The definition of productive activity raises the familiar problems encountered in national economic accounting. Such activity is defined as involving the production of goods and services for the market. Productive activity does not normally include additional value added within the household but is extended to include well-defined and economically measurable activities of government and other institutions not market-orientated. Those engaged in activities which span the 'production boundary' create certain problems since some are examples of multiple movement within the accounting period between the basic sectors of the demographic accounts rather than multiple activity, for example, students in full-time education working during vacations.

(7) The use of a classification according to employment status in the tabulation of population and labour force statistics usually involves allocating the individual to one of the following groups: (a) employers and self-employed, (b) employees in employment, (c) unpaid family workers, (d) the unemployed, (e) the economically inactive (i.e. the disabled, sick, permanently retired and the remainder of the population not elsewhere classified). Labour statistics published by the U.K. Department of Employment on the basis of the annual counts of national insurance cards simply disregard (c) and classify the unemployed according to the criterion of registration at labour exchanges; all those not registered are deemed not to be members of the labour force and hence are classified under (e) along with unpaid family workers. Part-time workers and those temporarily absent from their jobs through sickness, industrial stoppage, short-time arrangements etc. are considered to be 'in employment'.

A1.3 Statistics Available for the Male Population of Great Britain

A1.3.1 The Main Sources of Data

Annual estimates of the stocks of manpower identified in Table A1.2(a) are published regularly for the armed forces (HMF), employees in employment (EE) and the classified (CU) and unclassified (UU) unemployed. Estimates of the self-employed (SE) are obtained only from the population census of 1961 and sample census of 1966 during the 1959-68 period. Annual estimates of the rest of the population (R) and of the flows of births (b) and deaths (d) are also available by reference to the relevant reports of the G.R.O. To complete the items identified in the 'Total' row and column, we require estimates of aggregate immigration (i) and emigration (e) both of which are available from 1964 onwards from the International Passenger Survey but correspond to the United Kingdom not to Great Britain.

Moving into the body of the matrix we now take the 'ROW' row and column. Flows between the 'rest of world' and the labour force can be separated from the aggregate population flows (i and e) on the basis of the occupational classification of the migrants interviewed in the International Passenger Survey. For example in 1968 this classification distinguishes members of the armed forces, professional and managerial workers, manual and clerical workers, students, no occupation and occupation 'not known', and children under 15 years. The classification refers to previous occupation rather than intended occupation and does not identify employees and the self-employed separately. No industrial classification is attempted[4] and so it is not possible to disaggregate i_1 and e_1 by industry. Although deaths are disaggregated by age, they are not classified according to whether the person was a member of the labour force when death occurred.

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(4) The numbers of commonwealth citizens holding Ministry of Labour vouchers are given in Commonwealth Immigrants Act 1962, Control of Immigration Statistics, 1962-3, and subsequent issues. Those holding 'A' vouchers which specify a particular job are disaggregated by industry groups for 1968, but these account for 2889 of the 8120 voucher holders in total. The total number of male immigrant workers (including foreigners) for that year was 63.3 thousand (Statistical Review of England & Wales 1968, Part II, Table 52. General Registrar's Office (1970)).

A1.3 Statistics Available for the Male Population of Great Britain

A1.3.1 The Main Sources of Data

Annual estimates of the stocks of manpower identified in Table A1.2(a) are published regularly for the armed forces (HMF), employees in employment (EE) and the classified (CU) and unclassified (UU) unemployed. Estimates of the self-employed (SE) are obtained only from the population census of 1961 and sample census of 1966 during the [illegible] period. Annual estimates of the rest of the population (R) and of the flows of births (b) and deaths (d) are also available by reference to the relevant reports of the G.R.O. To complete the items identified in the 'Total' row and column, we require estimates of aggregate immigration (i) and emigration (e) both of which are available [illegible] onwards from the International Passenger Survey but correspond to the United Kingdom, not to Great Britain.

Moving into the body of the matrix we now take the 'ROW' row and column. Flows between the 'rest of world' and the labour force can be separated from the aggregate population flows (i and e) on the basis of the occupational classification of the migrants interviewed in the International Passenger Survey. For example in 1968 this classification distinguishes members of the armed forces, professional and managerial workers, manual and clerical workers, students, no occupation and occupation 'not known', and children under 15 years. The classification refers to previous occupation rather than intended occupation and does not identify employees and the self-employed separately. No industrial classification is attempted[a] and so it is not possible to disaggregate i_1 and e_1 by industry. Although deaths are disaggregated by age, they are not classified according to whether the person was a member of the labour force when death occurred.

(a) The numbers of Commonwealth citizens holding Ministry of Labour vouchers under the Commonwealth Immigrants Act 1962 are given in Commonwealth Immigrants Act 1962, Control of Immigration Statistics, 1962-3, and subsequent issues. Those holding 'A' vouchers which specify a particular job are disaggregated by industry groups for 1968, but these account for 2889 of the 8120 voucher holders in total. The total number of male immigrant workers (including foreigners) for that year was 68.8 thousand (Statistical Review of England & Wales for 1968, Part II, Table 52. General Registrar's Office (1970)).

Referring to the 'ROP' row and column, the elements not yet covered are the flows between the rest of the population and the labour force (n_{lr} and n_{rl}). Aggregate information on these gross flows is not published. In more detailed accounts we would certainly split the rest of the population or non-labour force group into those activities included under full-time education and the remainder.(5) The main component of the flows between the labour force and the education system is the entry of young people under 18 into the labour force. The published statistics capturing this group are disaggregated by industry. Of the remaining components only the first employment of university graduates is covered by regular statistics (beginning in 1962); these are also disaggregated by industry. The most important omission in the statistics of flows between the labour force and the education system is the lack of information about the destinations of students leaving the further education sector. Furthermore the statistics of university graduates and young entrants refer to the industry of <u>initial</u> employment only, not that of the individual at the end of the period in which he enters the labour force.(6) An indication of our ignorance of the initial employment of those not entering employment directly from secondary school is that of the 312.1 thousand boys leaving school in England and Wales during the academic session 1960-61, it can be shown (Lindley, 1976a) that ten per cent are not covered by statistics of first employment. By 1967-68 this proportion had risen to approximately fifteen per cent. The minor flows from the labour force to the education system (part of n_{lr}) are not documented.

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(5) A more sophisticated conception of the whole accounting system has been suggested by Stone (1971, pp 20-21). This introduces the notions of 'active' and 'passive' life sequences. 'While flowing through their "active" sequence, individuals also flow through a "passive" sequence, in the sense of a succession of socio-economic groupings to which they belong at different times of their life; ....' The 'active' sequences reflect the fact that people progress through periods of learning, earning and retirement. The detail given in this appendix relates only to earning activities of the active sequence and the other two types of activity are combined under the rudimentary classification, 'ROP'.

(6) The statistics for graduates refer to their first destination between the point of graduation and 31st December thereafter, those for young entrants record the issue of national insurance cards by Youth Employment Service careers officers. For details of the limitations of coverage see, for example, University Grants Committee (1969) and Department of Employment (1972b).

Whilst the statistics on flows from the education system to industry are by no means complete, the major deficiency lies in the flows between the labour force and the inactive population. Time series of industrial retirement rates, for example, (part of n_{1r}) are not available, notwithstanding some cross-sectional evidence of the incidence of retirement (Ministry of Pensions, 1954) and the age distributions of employees by industry published annually (see the Department of Employment, 1970b). In the addendum we describe the estimation of retirements by industry from the employee age distributions and these estimates are used in Section A1.5. Statistics of temporary retirement from the labour force due to ill-health, pregnancy etc. are not collected; this will be particularly important in the case of married women. The same is true of the corresponding flows into the labour force. Note that we are only concerned with male members of the population in this appendix.

Finally we come to flows within the labour force itself, involving changes of status and industry. The statistics of flows between industries on a regular annual period basis relate only to employees (EE and CU) and there are no compatible statistics on changes of employment status.(7)

The statistics of inter-industry mobility derive from a sample of National Insurance Cards taken annually by the Department of Health and Social Security (see Department of Employment, 1970a). Those unemployed for over a year when exchanging cards lose their industrial classification. The unclassified group of unemployed people also includes new entrants who have registered as unemployed. The inter-industry flows data take no account of whether the employee is actually employed or not. We are faced strictly with flows between industries of attribution. This enables someone unemployed at both ends of the 'insurance year' to be counted as a flow providing that in each year preceding the moment of classification, he spent at least one week of insured employment in different industries. The statistics simply measure flows between industries and do not provide estimates of those employed in the same industry at the beginning and end of a period.

(7) See however the recently published statistics of monthly flows on and off the unemployment register (Department of Employment, 1973a) and the fragments of information available on movements between self-employed and employee status (Lindley, 1976a).

A1.3.2 A Simplified Classification

Since we wish to establish the numerical significance of the unknown flows in relation to the major stocks and flows, let us adopt a classification which suits the data currently available in the detail required to match the identification of industries of employment in the labour force sector of the accounts. This data comprises:

(i) the employment stocks (HMF, SE, EE, CU and UU).

(ii) flows of employees (EE + CU) between SIC orders.

(iii) young people under 18 entering the labour force as employees in employment by SIC order.

(iv) estimated retirements of employees (EE + CU) from each order.

The corresponding accounting matrix is given as Table A1.2(b). The matrix n(t) denotes the flows of male employees between industries and is covered by the industrial flows statistics except for the leading diagonal. The column vectors x(t) and [l(t) - x(t)] represent retirement flows and all other flows, respectively, leaving the industrially classified employee labour force. The row vectors $y'(t)$ and $[h'(t) - y'(t)]$ represent young first entrants and all other entrants to the employee labour force respectively. N(t) and $N'(t+1)$ are the column and row vectors of stocks of employees by industry at times t and t+1. Those entries left blank in the accounts do not directly concern the labour force. We have treated the industrially unclassified group of unemployed workers as part of the inactive population.(8) The consolidation of the ROW account with the residual ROP account amounts to assuming that immigration and emigration occur through the inactive population. A final point of classification is that, in the absence of data on changes of employment status and the infrequent observations of the stocks of employers and self-employed workers, we have focussed upon employees, and

(8) Flows linking the unclassified pool of unemployment to the classified employee labour force are difficult to estimate by industry because of the absence of duration analyses of unemployment by industry. In June 1966 and 1968 this group numbered 17.8 and 32.3 thousand respectively corresponding to male wholly unemployed totals of 200 and 429 thousand. (Department of Employment, 1971b, Tables 129 and 166). Flows relating to this group would cause extremely small adjustments however; since estimates would have to be based simply on net changes in the industrial distribution of the classified unemployed and the statistics of unemployed school leavers, the refinement would also be somewhat arbitrary.

flows between these two main groups are also effectively channelled through the inactive population. The various stocks and flows in the jth row and column, corresponding to the jth industry, are related via the basic stock-flow equation given below.

$$N_j(t+1) = N_j(t) + \{\sum_{\substack{All \\ i \neq j}} n_{ij}(t) - \sum_{\substack{All \\ K \neq j}} n_{jk}(t)\} + h_j(t) - l_j(t) \qquad \ldots(1)$$

The variables are defined as follows:

$N_j(t)$ the number of employees in industry j at time t

$n_{ij}(t)$ the number of employees in industry i at time t who have moved to industry j by time t+1

$h_j(t)$ the number of people in the employers and self-employed group, the education system or the inactive population at time t who have joined industry j by time t+1.

$l_j(t)$ the number of employees in industry j at time t who have left the labour force to join the employers and self-employed group, the education system or the inactive population by time t+1.

i,j,k denote one of the H industries into which the economy is divided

Of the various components of $h_j(t)$ and $l_j(t)$ we have identified respectively young entrants $y_j(t)$ and retirements $x_j(t)$ separately in the accounts because these are the only external flows for which annual series may be directly estimated for each SIC order. The other major flow between the employee labour force and the rest of the population which is probably amenable to estimation is deaths.

The estimation of retirement flows using the age-structure of the labour force might suggest a similar procedure for calculating mortality rates for each industry. However the published age-specific mortality rates do not distinguish between the active and inactive populations.(9) Given also the different conditions of employment in industries, the estimation of both deaths and temporary retirement because of ill-health for each industry, is left for later research.

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(9) According to these rates, approximately 90 thousand male employees aged 15-64 died during 1967-68; this estimate assumes that males in the inactive population are no more in risk of death than those working, leading to an over-estimate of deaths in the working population particularly for the age-group 45-64 (76 thousand out of the total of 90 thousand). For employees aged 65 and over the large proportion of the population who are inactive (76.5 per cent of the age group 65-84 according to the 1966 sample census) makes the application of an aggregate death rate most unreliable. See Annual Abstract of Statistics, 1969, Table 33.

A1.4 A Stochastic Model of Manpower Flows

We now move away from the social accounting considerations of sections A1.2 and A1.3 and take up the question of the type of model one might construct on the basis of the accounts. The model most frequently used in conjunction with national economic accounts is the input-output model relying on the input coefficients estimated from the accounts. Whilst similar models may be used with demographic accounts (see Stone, 1971 and 1972), the flow models most suited to forecasting movements among the population rely on the calculation of transition proportions equivalent to outflow coefficients. Furthermore the similarity between the stock-flow equations of the deterministic transition model and the expected value relations of a Markov chain model suggest that it might provide further insight to treat the system of manpower flows explicitly in terms of Markov states and transition probabilities. Additional complexity may be introduced, such as increasing the order of the Markov chain or representing the flows by a Markov Renewal Process, but a wary use of the properties of the simple first order Markov model is usually all that is possible with the available data.

Blumen, Kogan and McCarthy (1955) used different versions of the stationary Markov model to reproduce the inter-industry mobility of a sample of insured employees in the United States. They concentrated upon testing the stationarity and seasonality of transition patterns and the extent to which different sex-age groups differed in mobility characteristics. The cross-sectional variations observed were not related to labour market conditions and no time-series analysis was attempted. Nevertheless their exhaustive statistical exercise indicated how useful the simple Markov model might be as a starting point in the study of labour mobility.

In representing the system of inter-industry mobility as a Markov process equation (1) is re-written as follows:

$$N_j(t+1) = \sum_{i=1}^{H} \{N_i(t) - l_i(t)\}\, m_{ij}(t) + h_j(t) \qquad \ldots (2)$$

$m_{ij}(t)$ corresponds to the probability of an individual in industry i at time t joining industry j by time t+1, conditional upon his being in the labour force at time t+1. $\sum_{j=1}^{H} m_{ij}(t) = 1$, and the matrix M(t) of the probabilities $m_{ij}(t)$ is the Markov transition matrix for inter-industry mobility. The education system and inactive population have not been made integral parts of the Markov model in equation (2) by defining them as states of the system. Whilst with a disaggregation of the population by age groups this may be conceptually preferable, the aggregate model is probably best limited to identifying only industries as Markov states. The education system and the inactive population (for male employees) would approximate to transient and absorbing states respectively in the enlarged model. The flows linking them to the industrial system are associated with rather narrow age-groups of the population and despite variations according to the state of the economy, they are governed by strong social convention. As states of the aggregate stochastic model they are not really comparable with industrial destinations as outcomes of the same stochastic process, and their inclusion would emphasise the inhomogeneity of the population of the model.

Having suggested the use of the above flow model we must consider the suitability of the stochastic representation in more detail, quite apart from the question of whether or not the available data will enable us to estimate the Markov model of equation (2) for past years and if so whether we are able to develop explanatory relationships in order to forecast future values of the mobility matrix and the external flows.

In this particular appendix we are not concerned with forecasting the mobility parameters and external flows but with the statistical form which gives rise to the parameters and identifies the important external flows. However our ability to forecast both components will depend upon the stochastic representation adopted.

The limitations of the first order Markov model when applied to the mobility of labour

The main inadequacies of a Markov model of mobility relate to:

(a) the inhomogeneity of the population;

(b) multiple movement within the model period and the problem of multiple activities;

(c) the crude model of job turnover implied;

(d) the inter-dependence of mobility flows themselves and of those flows with the external flows.

(a) The aggregation of individuals with very different mobility propensities is clearly unsatisfactory, but a more complex treatment must await further data. The mover-stayer model estimated by Blumen et al.(1955) was based on the multiple period transitions available from their longitudinal data(10) but, in the absence of such observations, the proportion or category of the labour force designated as 'stayers' may be assessed only roughly, having regard to the age structure of the labour force in each industry and the conglomeration of research studies into the mobility experience of particular groups. Whilst probably a useful exercise, such estimates will not be attempted here. Apart from dividing the population into male and female employees no further disaggregation of the flows data is possible. In replacing the crude mover-stayer distinction by a more sensitive classification according to the propensity to change jobs, details of flows by age and occupational groups would be required.

(b) As regards multiple movement within the model period, if one accepts the notion of a 'decision point' at which the individual considers changing his job and assumes the outcome of the decision is to be governed by a first-order Markov transition matrix, inter-industry movement (as observed by recording jobs held at fixed intervals) will only be first-order Markovian if decision points occur at fixed intervals or if the intervals between decisions are independently and

(10) Goodman (1961) discusses the problems of estimating parameters of the model and testing associated hypotheses. Blumen et al. showed that predictions of the multiple period transitions of individuals (i.e. the proportion in industry i at time t who are in j at time t+T) using the simple Markov model systematically over-estimated the proportion of individuals who had moved to a different industry. The introduction of the mover-stayer model improved the fit of the model, increasing the predicted diagonal elements of the multiple period transition matrix.

exponentially distributed (see Bartholomew, 1967). Where the individual is engaged in multiple activities, or Markov states as defined in the accounts, the Markov model can only be applied to his principal activity unless the state space is widened to include the main combinations of activities explicitly as Markov states; the data do not permit this however.

(c) Labour economists and industrial relations specialists have provided many studies (see Hunter and Reid (1968) and Parnes (1970)) of the behaviour of firms and individuals in the labour market and from these certain features emerge which need to be incorporated into a stochastic model of manpower movements. One such aspect, labour turnover, has been subjected to statistical analysis relating length of service and the probability of leaving a particular job (described for example in Lane and Andrew (1955) and reviewed and extended by Bartholomew (1967)). An aggregate manifestation of this relationship would be second-order Markov behaviour in which mobility in the future depends on the current industry and the previous industry of employment (at least to the extent that the previous industry differs or not from the present one). In his review of the stochastic formulations used in models of various types of mobility, Ginsberg (1971) argues that the use of the Semi-Markov or Markov Renewal process simplifies many of the problems which arise from imposing a Markov chain model on systems clearly displaying such non-Markovian properties as so-called 'cumulative inertia' and 'push and pull' effects. For example, the expansion of the state space to cope with the influence of duration of stay upon the probability of movement ('cumulative inertia') by using 'duration specific' transition probabilities, would make the model cumbersome to operate and involve extensive estimation of parameters when the purpose is to forecast inter-industry mobility among several industries. Whilst the estimation of a Semi-Markov model requires more data than is currently available, the choice of prefered formulation is relevant to the collection of new statistics.

(d) The distinction between the propensity to move and actual mobility has been emphasised in conventional studies of employment changes (Parnes, 1970). In the context of a stochastic flow model the author (1974) has shown the same distinction to be indispensable to a meaningful application of the Markov model. The propensity to move from industry i to j is deemed to be Markovian but the observed movement among industries will reflect barriers to the enactment of desired moves due to imperfections in the labour market and in related markets, for example, those for housing and personal loans to cover the costs of moving. In fact the observed flows will only be Markovian when the market is in equilibrium or at least the demands for labour in each industry exceed supply. The more a situation of excess supply for one or more industries arises the less a Markov model of observed mobility will be appropriate. In that case the independence of transition probabilities determining mobility outcomes is clearly violated since movement from industry i to j depends partly on the 'push and pull' effects influencing employees in industry i relative to j but also upon the general presence of other employees competing for the same jobs to which industry i's employees are attracted.(11) Similarly the external flows and internal mobility flows are not stochastically independent.

These then are all compelling reasons why we should regard the Markov model as an unsatisfactory representation of the mobility of labour. It would nonetheless seem worthwhile to do some empirical work on the available data, accepting the limitations of the model, but recognising that at present more sophisticated treatments are ruled out.

Thus in the next section we face the problems of estimating transition matrices, we investigate the effects of ignoring external flows and finally we test whether the observed variations in the transition matrices over time suffice to reject the hypothesis that the inter-industry mobility of labour is a stationary Markov process.

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(11) See Lindley (1974) for a discussion of the relevance of the non-stationary Markov model in these circumstances.

A1.5 Empirical Results

A1.5.1 The estimation of transition matrices for 1959-68

If $\alpha_i(t)$ is the proportion of employees $N_i(t)$ who have left the labour force by time t+1, then equation (2) becomes,

$$N_j(t+1) = \sum_{i=1}^{H} (1 - \alpha_i(t))\, N_i(t)\, m_{ij}(t) + h_j(t) \qquad \ldots (3)$$

Since $m_{ij}(t)$ is the probability that an employee in industry i at time t has joined industry j by time t+1, conditional upon his being in the employee labour force at t+1, estimates of $\alpha_i(t)$ are required in order to estimate $m_{ij}(t)$ from the inter-industry flows data. The statistics simply measure flows between industries and do not provide estimates of those employed in the same industry at the beginning and end of a period. Given the full information, the maximum likelihood estimates of $m_{ij}(t)$ for $i \neq j$ and $m_{ii}(t)$ would be respectively

$n_{ij}(t)/\{N_i(t) - l_i(t)\}$ and $\{N_i(t) - l_i(t) - \sum_{j \neq i} n_{ij}(t)\}/\{N_i(t) - l_i(t)\}$.

Denoting the estimates obtained assuming that $l_i(t) = 0 = \alpha_i(t)$ by $m^*_{ij}(t)$ and $m^*_{ii}(t)$, they are related to the actual values $m_{ij}(t)$ and $m_{ii}(t)$ through,

$$m^*_{ij}(t) = (1 - \alpha_i(t))\, m_{ij}(t) \qquad i \neq j \text{ and } i,j = 1, \ldots H$$

$$m^*_{ii}(t) = (1 - \alpha_i(t))\, m_{ii}(t) + \alpha_i(t) \qquad i = 1, \ldots H$$

The diagonal elements of the mobility matrix are therefore over-estimated and the off-diagonal elements underestimated, the former proportionately less than the latter since for most industries $m_{ii}(t)$ and $\alpha_i(t)$ will be of the order of .90 and .02 respectively. Note that the <u>relative</u> values of the off-diagonal elements are independent of $\alpha_i(t)$ and so direct estimates of these may be obtained from the flows data.

Using estimates of $\alpha_i(t)$ which are based upon approximate retirement flows, the percentage bias in the $\hat{m}_{ii}(t)$ for the two extreme periods 1959-60 and 1967-68, range from .1 to .3 per cent. The retirement flows are those calculated assuming a 'normal' retirement process solely dependent upon the age structure of the labour force. In addition to the inter-industrial differences, this leads to an increase from 1.2 to 1.6 per cent between 1959 and 1968 in the estimated proportion of the labour force retiring. The retirement flows take no account of conditions in the labour market which might be expected to influence them, in particular the level of unemployment and incidences of large scale redundancy in certain industries. Details of their estimation are given in the addendum.

In addition to retirements, there are grounds for recognizing other groups of leavers who make up the flow $l_i(t)$ but the calculation of annual estimates of these would be unduly approximate given the present data. For the moment these further sources of potential loss (and gain) for the employee labour force will be ignored.

The complete mobility matrices for 1959-60 and 1967-68 based on retirement estimates of $\alpha_i(t)$ are given in Table A1.3. The main features are the dominance of the diagonals, which range from .85 for metal goods to .94 for rest of service industries plus agriculture for the period 1959-60, and a reasonable stability over time. In relation to the normal extent of movement in the labour force the shifts observed in the matrix are not insignificant however. These will be discussed at the end of this section. Compared to metal goods, outflows for the other parts of the engineering industry (engineering and electrical goods, and vehicles) are about ten per cent of the labour force. Figures denoted by 'R.H.' in Table A1.3 are those which would have been observed if the outflows from

TABLE A1.3 Inter-Industry Transition Matrices

Industry \ Industry		V	VI	VII	VIII	IX	XVI	XVII	XIX	XX	XXIII	RPI	RSI
V	1959-60	0.9190	0.0238	0.0014	0.0052	0.0103	0.0010	0.0105	0.0036	0.0054	0.0022	0.0139	0.0055
	1967-68	0.9037	0.0199	0.0010	0.0060	0.0104	0.0017	0.0127	0.0030	0.0072	0.0035	0.0214	0.0073
	R.H.	0.9045	0.0107	0.0015	0.0051	0.0025	0.0013	0.0102	0.0035	0.0093	0.0051	0.0229	0.0153
VI	1959-60	0.0078	0.9064	0.0014	0.0144	0.0022	0.0021	0.0120	0.0050	0.0030	0.0053	0.0195	0.0031
	1967-68	0.0062	0.9055	0.0021	0.0078	0.0035	0.0036	0.0134	0.0044	0.0024	0.0060	0.0194	0.0137
	R.H.	0.0040	0.9042	0.0016	0.0055	0.0027	0.0014	0.0111	0.0103	0.0101	0.0056	0.0243	0.0135
VII	1959-60	0.0072	0.0212	0.9574	0.0034	0.0046	0.0023	0.0250	0.0102	0.0027	0.0049	0.0185	0.0125
	1967-68	0.0016	0.0222	0.9116	0.0016	0.0057	0.0021	0.0164	0.0035	0.0042	0.0037	0.0154	0.0073
	R.H.	0.0041	0.0122	0.8895	0.0058	0.0028	0.0015	0.0116	0.0107	0.0105	0.0069	0.0254	0.0191
VIII	1959-60	0.0026	0.0278	0.0024	0.9579	0.0077	0.0020	0.0073	0.0059	0.0055	0.0065	0.0102	0.0105
	1967-68	0.0017	0.0258	0.0010	0.9181	0.0051	0.0016	0.0047	0.0070	0.0053	0.0100	0.0123	0.0065
	R.H.	0.0036	0.0105	0.0015	0.9004	0.0024	0.0013	0.0100	0.0092	0.0090	0.0069	0.0218	0.0164
IX	1959-60	0.0205	0.0410	0.0003	0.0174	0.8454	0.0034	0.0183	0.0070	0.0107	0.0060	0.0211	0.0054
	1967-68	0.0119	0.0427	0.0011	0.0101	0.8437	0.0069	0.0133	0.0069	0.0098	0.0090	0.0224	0.0093
	R.H.	0.0058	0.0169	0.0024	0.0061	0.8477	0.0020	0.0161	0.0149	0.0145	0.0096	0.0354	0.0255
XVI	1959-60	0.0047	0.0237	0.0018	0.0113	0.0059	0.8542	0.0077	0.0093	0.0125	0.0071	0.0433	0.0365
	1967-68	0.0025	0.0257	0.0005	0.0030	0.0036	0.8581	0.0111	0.0060	0.0131	0.0221	0.0567	0.0125
	R.H.	0.0057	0.0166	0.0023	0.0079	0.0039	0.8487	0.0159	0.0146	0.0143	0.0094	0.0347	0.0261
XVII	1959-60	0.0071	0.0172	0.0039	0.0054	0.0059	0.0028	0.9510	0.0054	0.0136	0.0063	0.0318	0.0177
	1967-68	0.0036	0.0103	0.0017	0.0035	0.0053	0.0015	0.9239	0.0052	0.0108	0.0083	0.0301	0.0193
	R.H.	0.0048	0.0141	0.0020	0.0057	0.0033	0.0017	0.8232	0.0084	0.0122	0.0080	0.0295	0.0221
XIX	1959-60	0.0034	0.0094	0.0020	0.0056	0.0016	0.0014	0.0085	0.9194	0.0117	0.0083	0.0173	0.0111
	1967-68	0.0021	0.0073	0.0008	0.0043	0.0017	0.0017	0.0097	0.9259	0.0089	0.0058	0.0165	0.0115
	R.H.	0.0031	0.0061	0.0013	0.0045	0.0021	0.0011	0.0086	0.9242	0.0078	0.0052	0.0192	0.0142
XX	1959-60	0.0042	0.0151	0.0013	0.0061	0.0057	0.0027	0.0164	0.0133	0.8679	0.0154	0.0359	0.0160
	1967-68	0.0026	0.0158	0.0007	0.0035	0.0030	0.0035	0.0162	0.0150	0.8504	0.0154	0.0454	0.0175
	R.H.	0.0057	0.0167	0.0023	0.0080	0.0039	0.0020	0.0159	0.0147	0.8502	0.0095	0.0349	0.0262
XXIII	1959-60	0.0035	0.0141	0.0011	0.0106	0.0042	0.0024	0.0148	0.0153	0.0240	0.8591	0.0243	0.0256
	1967-68	0.0021	0.0163	0.0005	0.0066	0.0051	0.0030	0.0129	0.0129	0.0203	0.8757	0.0230	0.0230
	R.H.	0.0052	0.0153	0.0021	0.0073	0.0035	0.0019	0.0145	0.0135	0.0132	0.8574	0.0320	0.0240
RPI	1959-60	0.0055	0.0103	0.0029	0.0042	0.0026	0.0038	0.0149	0.0059	0.0125	0.0059	0.9246	0.0067
	1967-68	0.0039	0.0110	0.0006	0.0032	0.0032	0.0032	0.0146	0.0071	0.0139	0.0080	0.9210	0.0106
	R.H.	0.0037	0.0108	0.0015	0.0051	0.0025	0.0013	0.0102	0.0095	0.0093	0.0061	0.9231	0.0159
RSI	1959-60	0.0022	0.0063	0.0009	0.0020	0.0012	0.0007	0.0129	0.0044	0.0083	0.0052	0.0131	0.9539
	1967-68	0.0012	0.0056	0.0002	0.0012	0.0010	0.0009	0.0115	0.0034	0.0067	0.0069	0.0120	0.9514
	R.H.	0.0027	0.0076	0.0011	0.0036	0.0018	0.0009	0.0273	0.0067	0.0266	0.0043	0.0159	0.9415

Note: All rows sum to unity subject to rounding. The first row for each industry contains the distribution of employees among industries in June 1960 given that they were employed in that row industry in June 1959. The second row refers to the period 1967-68. The third row (R.H.) corresponds to the random hypothesis that employees leaving industries during 1959-68 joined other industries with probabilities according to the relative sizes of their employee labour forces. The diagonal elements are the average diagonal elements $\bar{m}_{ii}$ of the nine matrices for 1959-68 of which the first and last are given in rows one and two; the off-diagonal elements are taken from the average June manpower distribution $\bar{w}_i$ for the years 1959-67, i.e. the elements r_{ij} of the third row for industry i are given by $\bar{w}_j (1-\bar{m}_{ii})/(1-\bar{w}_i)$ where $i \neq j$.

The industrial classification is based on the 1958 S.I.C. The 'engineering sector' covers engineering and electrical goods, vehicles and metal goods n.e.s., orders VI, VIII and IX respectively. Metal manufacture (V), construction (XVII), transport (XIX), distribution (XX) and miscellaneous services (XXIII) have been identified separately because of their importance in the mobility inflows and outflows associated with the engineering sector. Shipbuilding (VII) and other manufacturing (XVI) have also been isolated because of the relatively large share of their inflows and outflows attributed to engineering. Furthermore, orders VII and XVI are of particular interest in the comparative analysis (not discussed here) of secular and cyclical changes in sources of labour supply for different industries.

All other manufacturing industries (orders III, IV and X-XV) together with mining (II) and gas, electricity and water (XVIII) have been aggregated to form 'Rest of Production Industries' (RPI). Agriculture (I) has been grouped with the remaining service industries (XXI, XXII, XXIV) to form 'Rest of Service Industries plus Agriculture' (RSI). These two groups are a little more homogeneous than their total would be. (In particular they separate the remaining production industries from the service sector, and agriculture has been allotted to the aggregate group whose flows with the individually identified industries are most similarly distributed to those between agriculture and these industries).

Sources: Unpublished flows data were provided by the Department of Employment. Adjustments for retirements are discussed in the text.

a particular industry were randomly distributed according to the relative distribution of manpower among other industries averaged over the period 1959-67. Flows are much higher than is compatible with this random hypothesis for movements between the engineering orders and between engineering and metal manufacture; flows from engineering to RPI and RSI are much lower than expected. (See also the discussion of Table A1.7 at the end of this section).

A1.5.2 Errors induced by ignoring the external flows

In forecasting the numbers of employees attributed to the various industries, there will always be minor flows with one or other group of the population which have not been accounted for. In so far as the industrial distribution associated with such flows will negligibly affect the forecasts, it is most convenient to regard the model as forecasting the proportions of total employees found in each industry; the total number of employees in the economy is then estimated taking account of the external flows explicitly treated by the model but dealing with other components in net flow terms, aggregating some of the sources of flow where necessary (typically through an appropriate activity rate). The projections made by the Department of Employment (1971c) are of the kind envisaged. These are based on projections of population, forecasts of full-time students above the minimum school-leaving age and assumptions about future activity rates.

Clearly the development of a model to forecast the distribution of manpower and the analysis of aggregate participation are related activities but we will assume that exogenous forecasts of the total employee labour force N(t+1) are available. If we were simply to ignore the external flows, treating the employee labour force as a closed population, then the expected proportion of employees in industry j at time t+1, $\hat{w}_j(t+1)$, is given by

$$\hat{w}_j(t+1) = \sum_{i=1}^{H} w_i(t)\,\hat{m}_{ij}(t) \qquad \ldots (4)$$

The approximation of equation (4) is best assessed simply by comparing the observed $w_j(t+1)$ and the $\Sigma\, w_i(t)\,\hat{m}_{ij}(t)$ using the sample estimates (i.e. uncorrected for $\alpha_i(t) \neq 0$) of $M(t)$ for the period 1959-68. Table A1.4 gives the percentage errors in the estimates of $w_j(t+1)$ making the closed system approximation, averaged over the years 1960-68.

From the distributions of positive and negative errors which lie behind the averages in Table A1.4 it can be seen that the shares of manpower of most industries are systematically either underestimated or overestimated throughout the period, the exceptions being orders V, VI, XVI, and RSI. Apart from the contribution of sampling errors, these errors are due to,

(i) the assumption that $l_i(t) = \alpha_i(t) = 0$, for all i and t, in the calculations of $m_{ij}(t)$ and hence that

$$\hat{m}_{ij}(t) = m^*_{ij}(t) = \frac{n_{ij}(t)}{N_i(t)} \text{ and } \hat{m}_{ii}(t) = m^*_{ii}(t) = 1 - \frac{\sum_{j\neq i} n_{ij}(t)}{N_i(t)}$$

and (ii) the closure of the system by adopting equation (4) which ignores the influence of external flows, setting $l_i(t) = h_i(t) = 0$ for all i and t.

If we calculated the elements of M(t) taking proper account of leavers and then simply adopted the closed system model, the percentage errors resulting would be very slightly affected. For example, with transition matrices which have been estimated taking into account retirements (those for 1959-60 and 1967-68 are given in Table A1.3) the percentage errors arising from the use of equation (4) differ only in the third decimal place from those shown in Table A1.4. The major effect of assuming no leaving is not due to the biased estimates of the $m_{ij}(t)$ obtained from the flows data but to the omission of the external flow itself.

Mean Percentage Errors in Industrial Shares of Total Manpower

Industry	(1) Closed Model	Mean percentage adjustments to column (1) when incorporating: (2) Young Entrants	(3) Retirements	(4) Adjusted Model
V	0.546	0.605	-0.160	0.101
VI	0.024	0.021	-0.246	0.249
VII	2.041	0.090	0.403	1.548
VIII	0.739	0.921	-0.232	0.050
IX	-1.110	-1.031	-0.140	0.061
XVI	-0.390	0.482	-0.081	-0.791
XVII	-0.400	-0.530	-0.497	0.628
XIX	0.857	1.239	0.178	-0.559
XX	-2.437	-1.712	-0.001	-0.724
XXIII	-1.068	-1.192	0.454	-0.330
RPI	0.898	0.394	-0.031	0.535
RSI	-0.015	0.176	0.311	-0.502
Mean Error	-0.026	-0.045	-0.003	0.022

Percentage Error $x_{n-1} \leq e < x_n$		Overall frequency distributions of percentage errors and adjustments			
4.0	∞	1			
2.0	4.0	6			7
1.5	2.0	11			3
1.0	1.5	13	13		9
0.5	1.0	12	14	4	17
0	0.5	14	38	36	22
-0.5	0	11	12	64	18
-1.0	-0.5	9	8	4	14
-1.5	-1.0	13	17		7
-2.0	-1.5	6	5		2
-4.0	-2.0	11	1		9
-∞	-4.0	1			

Note: These frequency distributions give equal weight to percentage errors regardless of the size of industry.

With an unbiased transition matrix the percentage errors in the goodness of fit may be split into two parts representing the omission of inflows and outflows. The absolute error in the estimated proportion of the labour force in industry j at time t+1 is given by

$$\hat{w}_j(t+1) - w_j(t+1) = \left[\hat{w}_j(t+1) - \frac{h_j(t)}{\sum_j h_j(t)}\right]\frac{\Sigma h_j(t)}{N(t+1)} - \left[\hat{w}_j(t+1) - \frac{\sum_i l_i(t) m_{ij}(t)}{\sum_i l_i(t)}\right]\frac{\Sigma l_i(t)}{N(t+1)} \quad .....(5)$$

The percentage error is obtained by multiplying throughout by $100/w_j(t+1)$.

Thus having determined the fit of the closed system model we now wish to know how much this will be improved by taking into account the two components of external flows for which reasonable flows estimates exist; young entrants to the labour force and retirements. For each industry the extent of the improvement will depend upon the difference between its estimated share of the labour force and its share of these aggregate flows. This is clear from equation (5).

The gross flows of retirements and young entrants between an industry and the 'outside world' are each between one and two per cent of the stock of manpower in the industry. In Table A1.5 the estimates of the industrial distribution of retirements during the two annual periods 1959-60 and 1967-68 are compared with the corresponding distributions of young entrants. In both periods the proportions of retirements leaving orders IX, XVII, and XX are markedly less than the proportions of young entrants joining these industries; the reverse applies to order XIX, RPI and RSI. The new entrants under 18 and the pensionable retiring employees are the major proportions of total numbers of male entrants ($h_j(t)$) and male leavers ($l_j(t)$) respectively. Whilst their industrial distributions differ significantly, the actual magnitude of these flows would require an exceptional relative skew to make much impact upon the distribution of total manpower. On the other hand the observed changes in manpower

TABLE A1.5 The Industrial Distribution of Young Entrants and Retirements

Industry -		1959-60 Young entrants	1959-60 Retirements	All male employees (1960)	1967-68 Young entrants	1967-68 Retirements	All male employees (1968)
Metal manuf.	(V)	.0260	.0328	.0380	.0267	.0333	.0355
Eng. & Elec. goods	(VI)	.1087	.0838	.1038	.1100	.0980	.1144
Shipbuilding	(VII)	.0150	.0226	.0176	.0133	.0160	.0127
Vehicles	(VIII)	.0315	.0422	.0551	.0294	.0382	.0489
Metal goods	(IX)	.0379	.0213	.0245	.0395	.0253	.0266
Other manuf.	(XVI)	.0100	.0117	.0127	.0101	.0136	.0147
Construction	(XVII)	.1155	.0597	.0970	.1351	.0752	.1067
Transport	(XIX)	.0340	.1136	.0978	.0367	.0980	.0922
Distribution	(XX)	.1800	.0889	.0943	.1646	.0912	.0902
Misc. Services	(XXIII)	.0875	.0787	.0573	.1085	.0801	.0643
Rest of Production Inds.	(RPI)	.1937	.2373	.2344	.1730	.2011	.2154
Rest of Service Inds. plus Agriculture	(RSI)	.1602	.2067	.1675	.1531	.2100	.1785
All industries		1.0000	.9998	1.0000	1.0000	1.0000	1.0001
Approximate flow total (thousands)		291	176		252	232	
Flow total as proportion of total employees at June 1960 and 1968		.0203	.0123		.0174	.0160	

distribution are themselves rarely more than five per cent per annum and average two per cent per annum during 1959-68.

The mean percentage errors in $\hat{w}_j(t+1)$ due to omitting young entrants and retirements are given in Table A1.4. Subtracting these errors from those of the closed system model we obtain the resulting fit of the model, modified to account for these flows with the non-industrial system. Column (4) of Table A1.4 gives the remaining discrepancies in the adjusted model. The goodness of fit corresponding to column (4) but based upon M(t) corrected for bias using the estimates of $\alpha_i(t)$, and upon the full retirement distribution (conditional upon 'remaining' in the labour force), that is $\sum_i l_i(t)m_{ij}(t)$ instead of the approximation $l_j(t)$ used initially, differs mainly in the third decimal places of the percentage errors.

Comparing the closed and adjusted models the overall mean absolute error is reduced by thirty per cent (from 1.285 to .923) when the two external flows are incorporated. The mean error turns positive from -.026 to .022, and the number of errors within one per cent increases from forty-six to seventy-one out of one hundred and eight. The frequency distributions of the errors and adjustments in Table A1.4 are shown directly below columns (1) to (4). The adjustments for young entrants and retirements are oppositely skewed as one might expect. For retirements the adjustments all fall within one per cent; those for young entrants are more volatile, thirty-six exceed one per cent.

Despite the improvement in fit there remain significant biases which would undermine the accuracy of the model when forecasting the distribution of labour based on forecasts of future mobility flows and young entrants and retirements. In particular, if the mean errors by industry for closed and adjusted models are compared, orders V, VII-IX, XIX, XX, XXIII and RPI show improvement but orders VI, XVI, XVII and RSI show an increased bias; the mean error for order VII is still exceptionally high and there remain some substantial isolated errors for other industries.

The mean absolute errors, sampling errors and mean absolute annual changes in manpower shares are given in Table A1.6. The thirty per cent reduction in overall mean percentage error has been noted previously; orders IX and XX are most affected, with reductions of 50 and 65 per cent respectively. Discrepancies increase by 26 per cent for order XVII and by 10 per cent for order XVI and RSI. The sampling standard errors of the gross flows on which the historical estimates of the $m_{ij}(t)$ are based are of the order of ten and three per cent for estimated flows of ten and a hundred thousand respectively. The gross flows into and out of a given industry average roughly ten per cent of the total manpower in the industry. The standard errors for the estimates of employee distribution from the closed system model, due solely to the sampling errors of the flows, were estimated approximately from these sampling errors assuming that those of the $N_i(t)$ are negligible.[12] The four industries with exceptionally large standard errors are the four smallest orders V, VII, IX and XVI; whilst those for the other industries are much less, they are still large in relation to the corresponding fit of the adjusted model. This would suggest that the effects of further adjustments may be masked by the sampling errors. The mean errors in Table A1.4 indicate however that some significant flows have been left unrecorded, significant that is, with respect to forecasting the industrial distribution of male employees.

Thus we find that before beginning to accumulate forecasting errors, the available past data on the flows linking the employee labour force to

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(12) The calculated standard error will therefore under-estimate the influence of sampling errors in the comparison of $w(t+1)$ and $\hat{w}(t+1)$. The numbers employed in each industry are based on a count of all national insurance cards exchanged in June-August each year, which virtually amounts to a 25 per cent sample of employees (the gross flows being a 4 per cent sample of these cards and therefore a 1 per cent sample of all employees holding cards). Department of Employment (1971b), p. 14.

Table A1.6 Goodness of fit, sampling errors and changes in manpower shares

Industry		Mean absolute percentage errors 1960–68		Closed model estimates $w(t+1)$: approximate standard errors induced by sampling errors of flows	Mean absolute percentage annual changes in manpower shares 1959–68
		Closed Model	Adjusted Model		
Metal manuf.	(V)	1.13	1.06	0.54	2.65
Eng. & Elec. Goods	(VI)	0.76	0.66	0.21	2.07
Shipbuilding	(VII)	2.05	1.59	0.65	4.29
Vehicles	(VIII)	1.28	0.80	0.38	1.84
Metal goods	(IX)	1.56	0.72	0.51	1.86
Other manuf.	(XVI)	1.43	1.55	0.89	2.44
Construction	(XVII)	0.51	0.64	0.20	1.63
Transport	(XIX)	1.14	0.76	0.30	1.20
Distribution	(XX)	2.44	0.86	0.26	1.12
Misc. Services	(XXIII)	1.49	1.08	0.33	1.76
Rest of Production Inds.	(RPI)	0.90	0.53	0.11	1.15
Rest of Service Inds. plus Agriculture	(RSI)	0.74	0.81	0.29	1.45
Overall mean		1.29	0.92	0.39	1.95
Overall mean excluding VII & XVI		1.19	0.79	0.31	1.57

the rest of the population leave sizeable discrepancies in attempts to account for the historical changes in the distribution of labour. This combination of sampling errors in the inter-industry flows and the incompleteness of external flows data provides an upper bound to the accuracy of forecasts whatever the explanatory relationships developed for the transition probabilities and external flows.

A1.5.3 The significance of variations in the inter-industry flows

Unfortunately the external flows data available do not provide very reliable estimates of the diagonal elements $m_{ii}(t)$ of the transition matrix. Whilst the uncertainty in relation to these particular elements will be of the order of 0.2 per cent this amounts to two per cent when considering the absolute values of the off-diagonal elements. Formal tests of stationarity of the full Markov matrix M(t) are therefore not given. However, we may distinguish between variations in the $m_{ii}(t)$ and variations in the relative values of the off-diagonal elements. The inter-industry flows data provide estimates of these relative values which themselves may be tested for stationarity. Thus we may consider,

$$m_{ij}(t) = om_i(t)\, p_{ij}(t) \text{ with } p_{ij}(t) = p_{ij} \text{ for all } t \text{ and } i \neq j$$

$$\sum_j p_{ij} = 1 \qquad p_{ii} = 0 \text{ for all } i.$$

$$\text{and } m_{ii}(t) = 1 - om_i(t) \qquad \ldots (6)$$

$om_i(t)$ is the probability that an individual in industry i at time t, whilst remaining in the labour force, has joined another industry by time t+1. The distribution of these leavers among the industries of destination $\{ p_{i1}(t), \ldots p_{i,i-1}(t), p_{i,i+1}(t), \ldots p_{iH}(t)\}$ is assumed to be constant.

Coefficients of variation for the estimated proportions corresponding to the $om_i(t)$ are shown in Table A1.7. Maximum likelihood estimates for P(t) may be obtained directly from the inter-industry flows data, assuming a multinomial distribution of outflows;

$$\hat{p}_{ij}(t) = \frac{n_{ij}(t)}{n_i(t)} \quad \text{for } i \neq j$$

where $n_i(t) = \sum_{j \neq i} n_{ij}(t)$ and the $n_{ij}(t)$ now denote the sample values.

By definition $p_{ii}(t) = 0$ for all i.

If $\bar{p}_{ij}$ is the maximum likelihood estimate for the conditional outflow probability p_{ij}, assumed to be constant over time, then,

$$\bar{p}_{ij} = \frac{\sum_t n_{ij}(t)}{\sum_t n_i(t)}$$

Given the level of aggregation all flows between industries are non-zero. Hence we may test the hypothesis,

$$H_o : p_{ij}(t) = \bar{p}_{ij} \text{ for all } j \neq i \text{ and } t = 1, \ldots T$$

i.e. that the conditional outflow process for industry i is stationary, by means of the following χ^2 statistics on (T-1)(H-2) degrees of freedom:

$$\chi_i^2 = \sum_t \sum_{j \neq i} \frac{(p_{ij}(t) - \bar{p}_{ij})^2 \, n_i(t)}{\bar{p}_{ij}}$$

The successive year tests (Table A1.7) indicate the significance of year to year shifts in the conditional outflow distribution. Two-thirds of the hypotheses rejected at the five per cent level or less relate to the first half of the period (25 out of 37) despite the exaggerated movement recorded for 1966-67. The shifts in outflow distributions observed for 1966-67 are considerably affected by the imposition of the Selective Employment Tax (which took effect in September 1966) and a reclassification of firms seeking exemption from the tax.

The most obvious conclusion to be reached from the χ^2 tests is that there are significant shifts in outflow distributions which if studied in the context of the trade cycle, the introduction of various government measures and major changes in the fortunes of certain industries, may fall into a more discernible pattern than in Table A1.7. It is worth noting that of the twenty-four industries in the disaggregated model eleven exhibit no more than one significant shift at the five percent level, nineteen industries exhibit no more than three significant shifts at the five percent level and only forty-seven out of 192 tests are significant at the five percent level compared with the thirty-seven out of ninety-six in the aggregated model. The twelve industry model used in this appendix emphasises the variation in outflow distribution because of its focus upon the more volatile engineering and related industries and because of the increased sample sizes involved in the aggregation of RPI and RSI.

Taking the first and last four years of the period the tests of stationarity of the underlying conditional outflow distribution are also given in Table A1.7. These emphasise the much greater changes in mobility patterns for the earlier period. The χ^2 statistics lead us to reject the stationary hypothesis at the five percent level for all industries for periods 1959-63 and 1959-68 and for six industries for 1964-68. Finally it is not surprising to find (in the last column of Table A1.7) that the hypothesis that employees, having left an industry, will distribute themselves among other industries according to the relative levels of employment at the beginning of the period, is rejected at well below the .1 percent level for all industries.

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A1.6 Conclusions

This appendix began with a discussion of the demographic accounting problems associated with establishing the flows within the labour force and between the labour force and the rest of the population. Given the data available on manpower flows it was necessary to simplify the stock-flow accounts in order to proceed with the estimation of a Markov model of mobility.

The absence of complete external flows statistics proved to be a significant source of error in the estimation of the Markov transition matrices. More important however than the biases in transition estimates were the effects of external flows when treating the employee labour force as a closed population and subsequently allowing for young entrants to employment and retirements. Even when these last adjustments had been made there remained sizeable errors in estimates of the industrial distribution of labour at the end of the period corresponding to the flows. Thus despite the fact that flows between the employee labour force and the rest of the population are relatively small, their industrial distribution must be taken into account when forecasting the aggregate industrial distribution of male employees.

To add to our theoretical objections to the Markov model of mobility, significant variations were observed in the transition probabilities estimated for the period 1959-68. With the exception of the non-stationary Markov model alternative stochastic models are ruled out by the absence of appropriate data. As regards the former it remains to be seen whether the estimation of explanatory relationships for the supply and demand for manpower could sustain the distinction drawn in section A1.4 between Markovian propensities to change industry and the Markov model applied to actual mobility.

ADDENDUM

1. The young entrants series

The construction of the series of young entrants to the labour force according to a 'June to May' year was based on the calendar year data published in the *Department of Employment Gazette* (usually in the May issue) together with unpublished statistics, provided by the Youth Employment Service, giving the monthly totals for young entrants aggregated across all industries. 'June to May' totals were obtained from the latter data and these were distributed among industries using a weighted sum of the two relevant calendar year distributions, the weights being the proportions of the 'June to May' year entrants contributed by each of the calendar years.

2. Retirement estimates

Direct measures of annual retirement flows by industry are not available. Estimates of retirement were based on age structure, assuming that the industrial distribution of retirements is identical to the industrial distribution of that part of the employee population deemed to be 'in risk' of retirement. Disregarding inter-industrial differences in the extent of the risk, the proxy for this section of employees was chosen from combinations of those relevant age groups into which the published age by industry statistics are aggregated (aged 60-64 inclusive, aged 65 and over). A government survey[13] of all employees retiring during the four weeks up to 11th October 1953, provides the most recent direct evidence of retirements by industry. Approximately 194 thousand reached the age of 65 during 1953 of which about 156 thousand were eligible for retirement pensions under the National Insurance scheme introduced in 1948. During October 9981 men took retirement pensions and these were distributed among industries of the 1948 S.I.C. as in Table A1,8. Ignoring seasonal effects and some under-representation of certain groups (especially among administrative, professional and technical workers), we take this distribution

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(13) '*Reasons given for Retiring or Continuing at Work*'. HMSO, 1954.

to be representative of that for retirement flows during 1953-4. From the industrial distribution of selected age-groups of employees the one which explained the largest proportion of the variance of the retirement distribution for 1953-4 was selected as the best proxy for the retirement flows distribution in the absence of flows statistics. The age structure data for June 1953 given in the Ministry of Labour Gazette, (June 1954) provided the independent variables in the estimation (14) of a linear regression equation relating the proportion (r_i) of total retirements occuring via industry i, to the proportion (g_i) of the chosen employee age-group employed in that industry.

$$r_i = \alpha + \beta g_i + u_i$$

The results are shown at the bottom of Table A1.8.

Given the change of industrial classification to the 1958 S.I.C. from 1959 onwards, the actual values of α and β are inapplicable to the period covered by the mobility model. On the rough and ready basis of maximising the correlation coefficient, the age-group chosen was 'aged 60 and over'. In generating the retirement flows, the industrial distribution of this group of employees at the beginning of the period was assumed to be identical to the industrial distribution of retirements occurring during the period (i.e. α and β were assumed to be zero and unity respectively). The estimates of total retirements in each annual period were made assuming that the equivalent of one fifth of the employee age group 60-64 inclusive, enumerated at the beginning of the period, retired within the year. No adjustments for changes in the pressure of demand for labour were made.

For the purposes of comparison, the industrial distributions of young male entrants to the labour force during 1953 and of all male employees in June 1953 are included in Table A1.8.

(14) Heteroskedasticity is present but is unlikely to make any significant difference to the inferences drawn from the exercise.

Table A1.8 Industrial distributions of retirements, young entrants and all male employees, 1953 (percentages)

Industry (1948 S.I.C.)		Men taking retirement pensions (October 1953)	Male young entrants (1953)	All male employees (June 1953)
Agriculture	I	6.7	9.3	4.7
Mining	II	6.8	4.5	6.3
Bricks, china etc.	III	1.4	1.6	1.9
Chemicals etc.	IV	1.8	1.2	2.5
Metal manuf.	V	3.3	2.3	3.6
Engineering etc.	VI-IX			
* Heavy Engineering		3.7	}24.7	3.4
Other Engineering		11.5		17.4
Textiles, Leather	X-XI	4.2	3.1	3.3
Clothing	XII	1.9	2.0	1.4
Food etc.	XIII	3.0	3.2	3.5
Wood, paper and other manuf.	XIV-VI	4.7	7.7	5.2
Building	XVII	8.0	11.1	9.4
Gas etc.	XVIII	2.4	0.8	2.5
Transport etc.	XIX	11.0	4.9	10.7
Distribution	XX	8.5	14.5	8.1
Insurance etc.	XXI	1.2	1.5	2.0
Public Admin.	XXII	10.7	2.5	7.2
Prof. services	XXIII	3.0	2.3	3.9
Misc. Services	XXIV	6.2	2.9	3.2

* 'Heavy engineering' covers MLHs 50, 51, 53, 58, 84 and 85. 'Other engineering' (other engineering, metal goods, precision instruments) covers MLHs 52, 54-7, 67-83, 86-103.

Sources: '<u>Reasons given for Retiring or Continuing at Work</u>', HMSO 1954, Table 29. 'Young Persons Entering Employment', <u>Ministry of Labour Gazette</u>, December, 1954, pp. 405-7.

Regression results:

Age group	α	β	Correlation Coeff.
60-64	-.407	1.073	.956
65 and over	.117	.979	.908
60 and over	-.199	1.035	.958
Men in sample reaching 65	-.242	1.033	.991

APPENDIX 2 THE ESTIMATION OF ECV AND ECM

This appendix describes the data sources and outlines the methods used to estimate the Engineering Craftsmen Vectors (ECV) for each year during the period 1967-75 and the Engineering Craftsmen Matrix (ECM) for 1972-73. The final estimates of the vectors and the matrix were discussed in Chapter 2 and presented in Tables 2.12 and 2.11 respectively.

Vector elements based on non-EITB data

Using the notation of sections 2.2.2 and 2.3.4 the sources of data for the following elements of ECV are as shown below and present no problems of adjustment.

Rest of Industry (ECV_{14}):

> Department of Employment (1971b), Table 121, and subsequent annual supplements. Includes all self-employed and equals the residual between the March estimates from the quarterly working population series and the EITB estimates of ECV_1 to ECV_{13} (see below).

Registered unemployment (ECV_{15} and ECV_{16}):

> Department of Employment (1971b), Table 165, and subsequent annual supplements, plus unpublished DE data for April unemployment among skilled engineering trades (males only but the number of females is very small).

Full-time training n.e.c. (ECV_{18} and ECV_{19}):

> Unpublished data from the Training Services Agency, corresponding to April. ECV_{18} includes all Skillcentre trainees in engineering trades - others in engineering training sponsored by TOPS through colleges and employers' establishments are omitted.

Vector elements based on EITB data

These elements are ECV_1 to ECV_{13}. Data on employment by occupation and training status are available from two main sources for engineering. First, the L7A survey conducted in April each year from 1963 by the DE and second, EITB returns (completed during the summer) giving figures for October and May of the past training year from 1966. The former corresponds directly with the SIC but excludes establishments with fewer than 11 employees; the latter excludes establishments normally classified to engineering MLHs (a) if they are deemed not to be within the legislative scope of the EITB and (b) if they did not claim grants by completing the S2/S3 return (this applies mainly to small firms). The Board compiles several sets of regular statistics as indicated in EITB (1976) but also maintains a register of craft trainees and conducts ad hoc manpower surveys of which the most relevant in the present context is the craftsmen survey (EITB, 1975).

The EITB returns would, in principle, provide two observations on occupational structure and training but there is some evidence that the two are not independent.(1) We shall assume that the figure for May is the main observation as this is closest to the point at which the returns are completed by firms and to the month (April) for which most firms will also be completing an L7A return for the DE. The final estimate given by the EITB involves grossing up the May occupational estimates according to factors calculated on the basis of the S1 return which is completed by all firms for April (but contains no occupational detail).

The choice of the EITB series on occupational employment for use in estimating ECV follows from the wish to relate employment to training. By far the richest source of training data on engineering craftsmen is collected by the EITB and this is classified in a similar way to the EITB's occupational stock data described above. However we must aggregate males and females because most of the training data does not distinguish the sexes. This means that all elements of the final ECV must also be given on this basis. There are however very few females

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(1) See Wabe (1977).

in the ECV states 1 to 11, covering the craftsmen group in engineering employment, and in states 15 and 18, covering unemployment among engineering craftsmen and Skillcentre trainees in engineering trades respectively.

ECV_3, ECV_{12} and ECV_{13} are obtained directly from the EITB annual reports (for example, EITB (1976), Table 3). The main statistical problem involves the disaggregation of all trainee craftsmen into the separate ECV training states. This is achieved using information on trainee flows and assumptions about the structure of training and the seasonal pattern of trainee flows. The data is given in EITB (1976), Tables 7, 8 and 9. The main assumptions are: (i) all those completing a stage of training continue with the next stage, (ii) no repitition of a training year occurs, (iii) everyone starts together in the first year and there are no other ports of entry to the engineering industry's training system (transfers between firms are allowed), (iv) all courses are continuous and of the same duration, (v) all fourth year completers who are on five year courses also complete the fifth year. These assumptions impose upon the training system certain regularities which are not entirely applicable. However given the strong seasonality due to the high late summer intakes of apprentices (August/September), the assumption of an approximate August to July training year is not unreasonable.

The seasonal pattern of loss during training is required in order to estimate backwards from numbers completing a training stage in 'July' to a stock in training in April for the vector estimate. We have assumed that losses during the first year are concentrated in the first six months and so first year course completers equal April trainee stocks. For subsequent stages losses are assumed to be even throughout the year, except for the fifth year, when they are zero.

The surrogate stock series for ECV_5 to ECV_{11} are then aggregated and subtracted from the estimate of total trainees obtained from the EITB's regular occupational returns (adjusted to April). Very small positive residuals are expected giving the numbers of qualified craftsmen doing supplementary training plus adult trainees. In fact the residuals are of the order of at most 3,000 and are negative in two years. Clearly the estimation of $ECV_1 + ECV_2 + ECV_4$ cannot be obtained reliably from this procedure and hence the residual group has been aggregated with ECV_3 in the estimated ECVs and ECM.

The development of the engineering industry's training system since the EITB was established will have affected the comparability of statistics. This particularly applies to the middle 1960s when approved off the job training was being promoted and to recent years when the module training scheme is coming into its own.(see EITB (1975), Appendix). Statements made in Chapter 2 have taken this into account and should not be significantly affected by it.

Matrix elements

The flow elements within the training sector of the matrix (rows and columns 5-11) follow directly from the method of estimating stocks in training. Flows into and out of craft employment in engineering have been obtained from unpublished data made available by the EITB. As noted in section 2.3.4 these estimates are grossed up from quarterly sample figures and hence assume away problems of multiple movement. For the skilled engineering worker it is unlikely that the resulting estimates will include a large upward bias due to the presence of more than one move per man in the grossed-up year. For unskilled workers we would expect this to be a more important source of error.

The representation of flows into and out of Skillcentres and other TOPS training courses generally lasting six months or less cannot be incorporated fully into the manpower accounts. For engineering trades, probably half the real number will be recorded as having moved between 'Training full-time n.e.c.' and the labour force. For the rest, flows into and out of this category will be lost as 'multiple moves' within the accounting period. Thus it is necessary to maintain subsidiary flow series for the full annual output of TOPS as shown in Table 2.12. These are calendar year estimates obtained from the Training Services Agency.

APPENDIX 3 COMPARISON OF OCCUPATIONAL CLASSIFICATIONS

The occupational data used has been based on two main sources: the censuses of population and the L7A surveys. The former cover people employed in all industries and relate to 1951, 1961, 1966 and 1971. The latter are conducted by the Department of Employment and between 1963 and 1968 covered all manufacturing industries and from 1969 onwards covered only the metal industries. There are many difficulties associated with comparing figures from these two sources. The most important one to affect our manipulation of figures for the skilled and semi-skilled engineering trades is that of matching the occupational classifications. Table A3.1 relates the Engineering Occupational Groups, describing skilled engineering trades as used in this study, to L7A occupations and census occupations. This has formed the basis for the estimation of the industrial distributions of skilled engineering tradesmen and growth rates in the aggregate skilled group.

Note to Table A3.1

(1) Foremen supervising crafts normally entered by apprenticeship or equivalent training (lines 14-24) are not included under the relevant craft in the L7A categories used in 1973 and subsequently. An adjustment is required for this when dealing with all craftsmen and comparing figures across the change of classification. The more troublesome comparisons for particular skills were fortunately not required in the empirical work reported here.

Table A3.1 Census and L7A occupations matched to Engineering Occupational Groups

(EOGs relate only to skilled engineering trades)

EOG	EITB condensation of L7A categories: EOG and EITB title	L7A categories (1964-72)	Line titles	L7A categories (1973-)(1)	Line titles	CODOT unit groups	Census occupations (1970): Census unit groups
(1)	Metal fabrication trades	14 15 17	Platers Pipe fitters and plumbers Sheet metal workers	19	Metal fabrication crafts	771-773	033,035,045,046
(2)	Welding trades	16	Welders	20	Welders (skilled)	775	036
(3)	Electrical engineering trades	11 13	Electrical fitters Electricians	17	Electrical/electronic engineering crafts-production	751,752 759,831	024-028,030
(4)	Mechanical engineering trades	7 8 9 10 12 19 22	Toolmakers and fitters Machine tool setters Setter operators, turners, Other skilled machine operators Other fitters Precision instrument makers Inspectors and markers off	16	Mechanical engineering crafts-production	721,722 731-739 741,799,831	034,037,038 040,041,043
(5)	Maintenance engineering trades	31 32 33	Maintenance workers Instrument mechanics Maintenance fitters and electricians	18	Maintenance engineering crafts-mechanical, electrical/electronic	741,744,749,761-763 769-799	042
(6)	Vehicle body building trades	20 21	Coach or vehicle body builders Coach trimmers	21	Coach and vehicle body building crafts	653,793,813,819	052
(7)	Apprentices taking general course	30	Apprentices taking general course	22	Apprentices on general courses	-	032
-	Foundry trades	18 23	Pattern makers Coremakers and Moulders	14	Foundry crafts	677,711-713,715-719	-
-	Iron and steel trades	24	Smiths, forgemen	15	Smiths and forgemen	714	
-	Construction trades	25 26 27 34 35	Carpenters, joiners Other woodworkers Bricklayers Bricklayers as classified under maintenance workers Carpenters and joiners as classified under maintenance workers.	23	Construction crafts (production and maintenance)	671-676, 679 811-814,861	-
-	Other skilled trades	29 36	Other skilled workers Other skilled workers as classified under maintenance workers	24	All other production crafts		-

APPENDIX 4 INDUSTRIAL CLASSIFICATIONS USED IN DISAGGREGATE ANALYSIS

Engineering Industry Group

The Engineering Industry Training Board divides the main part of its industry into 13 groups. There are also additional firms normally classified outside these groups in government applications of the SIC but falling within the scope of the EITB for levy-grant purposes. We have chosen to sub-divide two of the groups and to combine differently the MLHs belonging to two other groups.[(1)] The resulting 15 groups are referred to as Engineering Industry Groups (EIGs). Table A4.1 relates them to the 1958 and 1968 SIC and the EITBGs.

The matrix of inter-industry employment effects

The 1963 input-output table for the United Kingdom distinguishes 70 separate industrial groups of which 20 cover the three engineering orders of the 1958 SIC.[(2)] Eleven of the engineering industry groups (EIGs) used in the disaggregated part of this study may be derived directly from one or more of the input-output groups as shown in Table A3.2. The others cut across the input-output chassification and would have to be amalgamated to form two composite groups which might be called "wires, radio and telecommunications" (EIGs 8 and 9) and "metal goods n.e.s." (EIGs 14 and 15, equivalent to Order IX). The greater detail given in the 1968 input-output table,[(3)] disaggregating engineering into 27 industries, does not remove the need to aggregate the above groups when moving from the input-output classification to EIGs. We have chosen to retain the 1963 input-output detail in our analysis of the employment effects matrix.

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(1) One sub-division yields an EIG which is equivalent to the 1968 SIC Order VIII (instrument engineering) rather than the one used by Wabe (1974) which is preferable on grounds of combining industries of similar technologies and occupational structures but which, for our purposes, would have generated a number of statistical problems not arising in his study. Our treatment of EIGs 14 and 15 is however the same as that of Wabe.

(2) Central Statistical Office (1970), p.29.

(3) See Central Statistical Office (1973) p.27.

Table A4.1 Comparison of different engineering industry classifications

	EIG	EITBG (1)	SIC 1958	SIC 1968
1	Metal working machine tools	04	332-333	332,390
2	Industrial machinery	06	331,334-338	331,334-338
3	Other non-electrical machinery		339	333,339
4	Industrial plant and steelwork	07	341	341
5	Other mechanical engineering	08	342,349	342,349
6	Instrument engineering	09	351-352	351-354
7	Electrical machinery	10	361	361
8	Electronics	11	364	364-367
9	Insulated wires and cables	12	362-363	362-363
10	Other electrical goods		365,369	368,369
11	Motor vehicles	13	381	380,381
12	Aircraft	14	383	383
13	Other vehicles	15	382,384 385,389 (2)	382,384 385
14	Tools, bolts, wires and cans	16 and 17	391,393-395	391,393-395
15	Other metal goods		392,396,399	392,396,399

(1) The sub-divisions of engineering adopted by the EITB.

(2) 389 strictly belongs to EITGB 15 but has been excluded from our work because it cannot be identified separately from 399 in the 1968 SIC.

Table A4.2 Comparison of input-output industries and EIGs.

Input-output table: Industry or commodity groups. 1968	1963		1958 SIC MLHs	Engineering Industry Groups EIGs
30	22	Agricultural machinery	331	2(pt)
31	23	Machine tools	332	1
51	24	Engineers' small tools	333	
33	25	Industrial engines	334	2(pt)
34	26	Textile machinery	335	
35	27	Contractors' plant, etc.	336,337	
36	28	Office machinery	338	
32,37	29	Other non-electrical machinery	339	3
38	30	Industrial plant and steel work	341	4
39	31	Other mechanical engineering	342,349	5
40	32	Scientific instruments, etc.	351,352	6
41	33	Electrical machinery	361	7
42	34	Insulated wires and cables	362	9(pt)
43	35	Radio and telecommunications	363,364	9(pt),8
44,45	36	Other electrical goods	365,369	10
55	37	Cans and metal boxes	395	14,15
52-54, 56	38	Other metal goods	391 to 394, 396,399	
46	39	Shipbuilding and marine engineering	370	Not included
47,48	40	Motor vehicles	381	11
49	41	Aircraft	383	12
50	42	Other vehicles	382,384,385, 389	13

Source: Central Statistical Office (1970, p.29) and (1973, p.27).

APPENDIX 5 SOURCES OF DISAGGREGATE DATA

Average hours and hourly earnings of manual workers.

The data on average hours and average hourly earnings were taken from the October surveys of establishments conducted by the Department of Employment[1]. These statistics relate to the United Kingdom and cover all manual workers by MLH industry. Part-time female workers are defined as those working for not more than 30 hours a week. Part-time male workers are numerically insignificant in these industries and are excluded from the survey. For some industries girls also form too small a part of the labour force to justify the estimation of average figures. The earnings data are pre-tax and inclusive of bonuses (suitably pro-rated where necessary) and overtime payments. Hours worked include hours for which employees were available for work, although not working, and for which a guaranteed wage is payable. The series breaks in 1969 for the change of SIC. This was catered for by using the dual classification of data available for 1969 and weights based on total male employment figures. The weights were calculated for 1969 and 1974 but since they differed only slightly the same weights (those for 1969) were used for each of the years 1970-74 inclusive. Male employment weights were used for data corresponding both to men aged 21 and over and to youths and boys. It is not thought that this creates undue bias since, in those industries where weighting was required, cross-sectional employment differences were considerable, in which case differences in age structure between industries to be aggregated are unlikely to be of much significance.

Having obtained a consistent data series for 1959-74 on the 1958 SIC the engineering MLHs were aggregated to form the 15 industry groups at which level most of the time-series econometric analysis was conducted.

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(1) See Department of Employment (1971b).

Investment

Investment data at the MLH level for engineering is available from the production censuses for 1958, 1963 and 1968 and from the revised annual sample censuses of 1970-1972. In addition the earlier sample censuses provide investment figures by groups of industries: mechanical and instrument engineering, electrical engineering, motor vehicles, aircraft, other vehicles and metal goods n.e.s. Bosworth (1975) has used the latter to interpolate changes in investment by MLH between the full censuses. We have used his results for 'plant and machinery' acquisitions and disposals and overall net investment, based on the 1968 SIC, aggregating to the 1958 SIC.

Table A5.1 Aggregation of industries for sample census.

Sample census groups	MLH industries covered (1958 SIC)		EIGs covered	Net investment 1963 (full census)
Mechanical engineering[1]	331-349	Order VI	1-5	101.3
Scientific instruments[1]	351-352	Order VI	6	
Electrical engineering	361-369	Order VI	7-10	66.6
Motor vehicles	381	Order VIII	11	91.4
Aircraft	383	Order VIII	12	11.6
Other vehicles	382,384-389	Order VIII	13	1.8
Metal goods n.e.s.	391-399		14-15	50.9

(1) For 1962-67 the first two sample census groups were aggregated.

In years for which we have both sample and full census figures there are considerable discrepancies largely due, it is thought, to the sampling of 'business units' in the former and 'individual establishments' in the latter. From 1970 onwards the sample censuses have adopted the establishment as the basic sampling unit. Bosworth's method of interpolation is completed in two steps: (i) each sample census group figure is adjusted by the corresponding full census to sample census ratio interpolated linearly between the full census years, (ii) MLH figures are then obtained within each adjusted sample census group by interpolating between full census years proportions of the given group total attributed to its constituent MLHs and applying the resulting proportions to the totals from (i). Minor adjustments were required to ensure that the relevant proportions summed to unity. Further details are given in Bosworth (1975).

Production

Unpublished annual net output data by MLH for all engineering MLHs except ordinance and small arms (342) were obtained from the Central Statistical Office and the Department of Trade and Industry. Data was available for 1958-68 on the 1958 SIC using 1958 weights and 1963-74 on the 1968 SIC using 1963 weights. A continuous series based on the 1958 SIC and 1963 weights was produced by splicing at 1963.

Young entrants to employment

The flow of young entrants into employment is recorded at the MLH level and by categories of employment. The Department of Employment has retained annual summaries based on the basic monthly data returned by Youth Employment Officers and giving the requisite detail for 1957-73. Unfortunately the major change of industrial classification (from the 1948 to 1958 SIC) breaks this particular statistical series half way through 1959. Since to bridge this change for the purposes of analysis at the MLH level itself (as opposed to the order level) would require very crude proportionality assumptions we have chosen to work with the period 1959 onwards. For 1959, data for all other variables is available on the 1958 SIC so the young entrants data for the first half of that year (about one third of the annual intake) has been adjusted to match the later classification. For a discussion of general problems with the use of these statistics see Chapter 4.

APPENDIX 6 A NOTE ON MEASURING VACANCIES AND UNEMPLOYMENT

A6.1 The Measurement Problem - Vacancies

In the NEDO report (Anderson, 1974) referred to in Chapter 3 management was roundly criticised for failing to tackle shortages properly by acting on both supply and demand sides in order to reduce or eliminate the manpower constraint on output. We noted that whilst indeed there are many options theoretically available to management the important point is to establish how quickly they may be taken up. The report distinguishes between the shortages 'perceived' by companies and the 'true dimension' of the shortage problem. It is critical of the approach of the study into skilled engineering shortages in the Leicester area (Department of Employment, 1971a) for its naivety in asking companies to define their shortages to be 'the number of additional workers you would engage if suitable skilled men were available'.

> 'This is, of course, an "ideally desired" measure, and therefore producing exaggeratedly-high figures, which neglect such questions as - would productivity hold up? - would the market absorb the increased product? - would responses include an element of other people's employees (e.g. sub-contractors)? This present study chooses to use the "establishment" definition, in contrast. As pointed out above, it has its imperfections, but it has some greater proximity to reality. Ceteris paribus arguments are best confined to economics textbooks; in the real world, certain constraints do exist, other things are not equal, and policies cannot be made on any other assumptions.'(1)

Whilst economists might blanche at the confusion indicated by the last sentence and the Department of Employment might point out that sub-contracting was taken into account in their study, it is the weakness of the definition of 'establishment' level of manpower which gives the argument a really peculiar twist. A shortage is a 'shortfall from some notional "establishment" level of manning'. Both alternative standards will embody a production target of some kind calculated be methods of varying crudity and awareness of the company's operating position, but 'if an "ideally-desired" criterion is adopted, any shortfall will be greater than if a "realistically-desired"

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(1) Anderson (1974) p.17.

target is set'.(2) Some difficulty was found in keeping companies to the 'establishment' definition rather than the 'ideally-desired' definition. This is not surprising given the fact that when investigating the effects of perceived shortages the NEDO study relaxed the definition 'to allow companies to give their opinions on the effects of less-than-desired labour availability upon their future prospects'. It is hard to justify the force of the NEDO criticism of the DE's Leicester study when their own criterion was so elastic. The notions of 'establishment' and 'ideally-desired' levels of manpower both suffer from a lack of time-scale specified during which adjustment is allowed to take place. There seems to be no vacancy study in which firms were asked: 'How many additional workers would you engage within the next week, fortnight, month, six months and year if suitable skilled men were available at present rates of pay offered by your company and none, other than those retiring from work, were to leave in the intervening period?' If such a question were then followed by an investigation of the strength of the assumptions made about (i) internal utilisation of manpower (including minor job re-designing), (ii) sub-contracting, (iii) material and component supplies, (iv) investment, and (v) product market prospects, it would be possible to assess the likely effects of vacancies not being filled or at least the extent to which the estimates of firms were based on explicit consideration of these matters. One then moves to the problem of how to devise measures of vacancies without going through the same process of evaluation with each firm which would, of course, be out of the question in the production of a regular statistical series. The simplest approach appears to be to limit the time period for adjustment to, say, a fortnight or month. With present planning practices in industry a longer period would probably only be justified if supplementary information about the assumptions made in

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(2) This is no more a virtue of the 'realistically-desired' measure of vacancies than the fact that household-based unemployment surveys give higher estimates of unemployment than does the official register is a virtue of the survey method of collection. Both views simply beg important questions about the purposes of compiling these statistics.

(i)-(v) were also sought. Finally, there is the problem of actual collection. British vacancy statistics are based on vacancies reported to the Department of Employment, a practice which clearly leans heavily towards administrative convenience. The implication of the above discussion is that yet another survey is required. Is it likely that the results will be significantly more useful than the present official statistics?

The present statistics refer to reported vacancies remaining unfilled at monthly or, in the case of the occupational data, quarterly intervals. If vacancies are reported evenly throughout the period between counts then at least half of the vacancies reported will be at risk of being filled during an interval of at least half a period. Thus many vacancies will be reported and filled without being captured by the statistics. The nature of the series is such that in a fairly competitive labour market where supply and demand adjustments are rapid it will not be dominated by transient phenomena of little interest to policy makers but will tend to pick up emerging market imbalances. (In a highly competitive market, of course, the statistics would indeed be swamped by temporary fluctuations). With the transient effects filtered by the method of compiling the series what we have is an ex post measure of excess demand experienced by firms. The difference between this and the kind of ex ante measure advocated above depends on the foresight of firms in reporting vacancies. If in practice they only report 'currently felt' vacancies then at the time of the count of unfilled vacancies we are observing shortages, i.e. ex post vacancies. Since we have reason to believe that firms do not anticipate their manpower requirements very far ahead it must be doubtful, at this stage, that the difference between the short-run ex ante reporting of vacancies and present vacancy statistics will be very great. It seems reasonable to view the statistics as providing an ex post vacancies measure only slightly influenced by short-run ex ante considerations. This means we may regard the various official vacancies series as representing current shortages.

But what of criticisms of the kind made by NEDO? The following view is taken of the role of reported vacancies. A shortage is a signal about the current situation in which a firm believes itself to be. Unless there are changes which can be implemented quickly at slight cost simply by revealing to management opportunities they had missed then the shortage is still a shortage. The shortage perceived by a management which has done little to deal with the industrial relations aspects affecting manning is no less a shortage than the one perceived by a firm which is highly effective but has miscalculated its labour demand and/or supply. Every shortage indicates a failure of planning (i.e. of management) of one kind or another. Furthermore, since to investigate the reality of each shortage (as did NEDO) would itself use national resources and take time it would be better to accept that current shortages reported by managements[(3)] are indeed shortages. We simply emasculate the concept by distinguishing shortages according to whether they are perceived by firms, training boards, NEDO investigators or academics in ivory towers looking through binoculars. On the other hand the national planner's problem is the same. An attempt to calculate a shortage defined as 'that part of the difference between demands and supplies perceived by producing units which, in the national interest, should be met by special manpower programmes' is equivalent to an attempt to calculate that part of a shortage defined as 'the

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(3) Different managers are likely to have different perceptions of a labour shortage. Behavioural theories of the firm suggest that the 'firm' has no identity in the sense of being a decision-making unit and hence the choice, for example, between the views of the works manager and the sales manager may well be a real one. The only solution is to try to ensure that vacancies are reported by those organisationally responsible for recruitment. In this way, the information received will be more likely to represent the outcome of whatever conflicts over objectives exist within the organisation rather than the view of one particular department expressed in the course of internal discussion.

sum of reported shortages' which should be met through those same manpower programmes. It would however seem preferable to use the term shortage to relate to the short-run market signal from the firm rather than to the required extent of market interference by the manpower agency. This helps to distinguish clearly between the decision-making situations of firms and national planners - a distinction which is essential to the economic rationale of active manpower policies and which, ironically, has tended to be blurred by the optimistic and automatic association of the interests of the firm and nation.

Our aspirations for the vacancies data would therefore seem to be quite modest. We expect them to be the sum of current shortages as notified by firms (in labour markets which are not highly competitive). From them we wish to obtain a reliable measure of the short-run perceptions of firms. In effect, we wish to use them as indicators of the extent to which manpower is beginning to act as a binding constraint upon output growth in firms, equipped and managed as they are. Confidence in the vacancy statistics as collected by the Department of Employment has in fact depended very much upon a belief in the existence of a fairly stable relationship between vacancies and unemployment. Underlying this is the view that the labour market is in 'medium-term' equilibrium and the level of vacancies rarely rises sufficiently to eat in to the minimum frictional unemployment, and the level of unemployment minus its frictional component rarely exceeds the vacancies available. With the experience of the nineteen-thirties and ealier as a backcloth it is perhaps not surprising that economists in the post-war period assumed these conditions to be applicable. Only when a shift in the relationship between vacancies and unemployment statistics was discerned in 1966 and again in 1971 was the confidence in the basic data really shaken. Of course, before then it was well known that both series suffered from important deficiencies but within the limits of accuracy to which economic analysis and forecasting aspired it was generally thought that the signals transmitted by these statistics were not unduly distorted. However Evans (1975) has shown how inherently unstable the functional relationship between vacancies and unemployment has been throughout the period 1950-73. Indeed the whole episode is a cautionary tale against inadequate econometric analysis of data as well as too glib an interpretation of the data itself.

The most commonly cited reference on the use of British unemployment and vacancy statistics to measure excess demand for labour is Dow and Dicks-Mireaux (1958). In striking contrast to discussions about the interpretation of unemployment statistics provoked by the debate about the so-called 'shake-out',(4) these authors did not raise the conceptual problems associated with the unemployment statistics. They considered only the difficulties over the vacancies statistics.

> 'There are good prima facie reasons for distinguishing the statistics of unfilled vacancies since they neither record transactions nor register decisions, but represent a sort of queue. The size of a queue may be either more or less than the real unsatisfied demand: people may either duplicate orders or join several queues; or they may give up trying and not join a queue at all. The unemployment figures, in contrast, are "hard statistics": a person can register only once as unemployed and he has a financial reason for doing so.'(5)

Their fait. .. the unemployment statistics provided an essential benchmark against which to assess the vacancy statistics.

> 'But the more closely the behaviour of the vacancy statistics is compared with that of the unemployment figures, the clearer it seems that up to a point they are rather reliable indicators.'(6)

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(4) See, for example, Bosanquet and Standing (1972), Bowers (1973) and Department of Employment (1976).

(5) Dow and Dicks-Mireaux (1958), p.2.

(6) Ibid.

Visual inspection of the figures for 1946-56 showed an inverse relationship with some convergence (divergence in terms of the v and inverted u curves shown by Dow and Dicks-Mireaux) which was attributed to a decrease in labour force maladjustment rather than to a shift in the extent to which employers overstate or understate their vacancies as reported to employment exchanges. The statement ratios given by reported vacancies divided by 'true' vacancies were estimated for seven aggregate industry groups. From their discussion of their results Dow and Dicks-Mireaux evidently had few qualms about the concept of excess demand except to argue the case for collecting ex post statistics because product and labour do not respond quickly to imbalances. They do not elaborate upon the causes of mis-statement of vacancies and have no a priori view of the direction of the bias. Their estimation of statement ratios is based on the relative amplitudes of seasonal fluctuations in vacancies and unemployment (only for services, building and agriculture where seasonal changes were significant) and on the time series association between the two data sets in conjunction with information about trends in output and hours worked. The main weaknesses of their method are as follows.(7)

(i) The reliance on the concept of unemployment according to industry. These statistics could be as much a function of changes in demand elsewhere in the economy rather than of changes in the industry in which the unemployed were previously employed.

(ii) The effects of the 1945 and 1947 Control of Engagements Orders and the 1952 Notification of Vacancies Orders are uncertain. The authors argue (p.27) that although the 1947 and 1952 regulations undoubtedly increased the proportion of vacancies being notified to the exchanges, the impact upon the vacancies recorded in the statistics as unfilled was very limited. No evidence is cited for this last conclusion but they explain it nonetheless by saying that the vacancies most difficult to fill are the

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(7) One should also note that they applied their procedures to the rates of employment and vacancies and included females. No discussion of these points is given.

ones left on the records. The increase in notifications is mainly in vacancies which are filled very quickly. Even so such vacancies reported to exchanges just before the count will be captured in the statistics.

(iii) No stock-flow model is constructed against which to assess their adjustment method especially in relation to (ii).

Their results embody very considerable adjustments to the vacancy statistics by the statement ratios (the former are divided by the latter to obtain 'true' vacancies). The ratio for the metals industries combined was 1.3; the highest ratio was 2.0 for textiles, leather and clothing and the lowest ratio was 0.6 for services. Only for agriculture was it deemed likely that the ratio changed over time, increasing from 0.4 to 1.0. Aggregating across the seven industry groups produced a statement ratio of 1.0 for all industries. Thus whilst the effective adjustment at the aggregate level was negligible, the cross-sectional differences were marked.

Assuming a rectangular hyperbolic form for the unemployment-vacancy relationship, Dow and Dicks-Mireaux posit a measure of labour market maladjustment (m) by taking the point on the curve nearest to the origin, for which unemployment (u) will equal adjusted vacancies (v/s). They then derive a measure of net excess demand (d) such that

$$d = m - u \quad \text{for } u > v/s$$
$$d = v/s - m \quad \text{for } v/s > u \qquad \text{where } m = \sqrt{(uv/s)}.$$

To our doubts about the estimation of statement ratios we now add a sceptical note on the creation of this index. What does it add to our knowledge of the labour market beyong u and v/s, or in what sense does it synthesise the basic information into a form which yields greater insight?

The index is zero at a point defined as zero net excess demand (where v/s = u = m) and measures excess labour demand net of maladjustment. Frequently however in the course of their article (indeed, also in its title) the qualifying 'net' is dropped. The ambiguity is indicated by the following quotation (pp. 15-16).

> 'Our index is an index of net excess demand. Thus in 1956 unfilled vacancies amounted to 1.7 per cent of employees. Of these, vacancies corresponding to 1.2 per cent are treated as due to maladjustment, i.e. matched by kinds of labour in excess supply. Net excess demand is stated as 0.5 per cent. We do not know whether the kinds of labour which were in short supply were few or many. But if they could be aggregated, excess demand calculated as a percentage of the total supply of these kinds of labour would of course be higher than our percentages. This might be called an index of gross demand. In fact we do not have enough information to construct such an index; and even if we could, an index of net excess demand would remain convenient as a summary aggregate measure. The use of a net index does not imply that policy should ignore the maldistribution of labour. Ideally the amount of detail should certainly be extended beyond disaggregation into seven industry groups as given here.'

Surely Dow and Dicks-Mireaux have already constructed a series of gross excess demand by producing v/s. This series reflects the sum of reported shortages experienced by firms wishing to operate in the external labour market. An index of gross demand would include those in employment as well as vacancies although this is complicated by the presence of labour hoarding (see Taylor, 1974). The index d is presumably intended to show how far the economy is from reaching the level of unemployment or vacancies below which it cannot move very easily without significant improvements in allocative efficiency. However, since the measure of maladjustment is derived for each moment in time from ex post unemployment and adjusted vacancies, d is defined with respect to a possibly shifting view of maladjustment and, moreover, one very sensitive to the functional form adopted for the u-v curve and the estimated statement ratios. One would wish, therefore, to tabulate both d and m so that changes in m could be monitored.

The concept of maladjustment derived from the unemployment versus adjusted vacancies curve is a seductive one. However, we prefer to stick close to the basic data, avoiding the use of statement ratios and the net excess demand concept. The use of v and u rather than d and m involves no subsidiary calculations and begs fewer questions.

The dangers of using the net excess demand measure are well illustrated by Dow and Dicks-Mireaux themselves, and in a way which is highly relevant to the analysis of the labour market in the nineteen-seventies. Having constructed their indices they state (p.14, my emphasis)

> 'there is reason to believe that it gives a good idea of the order of magnitude of <u>excess demand</u> for labour (i.e. nearer to 1 or 2 per cent than to 10 per cent). Since this is probably smaller than most people would believe, it is an important conclusion.'

Certainly d is much less than v; for example, taking annual averages for all industries, d ranges from -0.3 to 1.0 whereas v ranges from 1.3 to 3.2. For textiles, which records the greatest range for d, d ranges from -3.6 to 1.9 and v from 2.1 to 7.5. Leaving aside the fact that Dow and Dicks-Mireaux do not actually cite others who believe that <u>net</u> excess demand (not just excess demand as in the above quotation) is of the order of 10 per cent rather than 2 per cent, only rarely does v itself exceed 3 per cent among the seven aggregate groups (except in textiles). So one really must expect more of d than an ability to discriminate between situations where net excess demand or excess demand was 2 per cent or 10 per cent. In fact their attempt to reconcile the low values of their index of net excess demand with 'commonsense impressions about the strength of demand' applies as much to the vacancies statistics themselves. The reconciliation is only in very general terms essentially pointing out the plausibilty of the view that apparently very high product demand conditions need not be completely transmitted to the labour market because other shortages may be binding on output, there may be legal or effective rationing or employers may be reluctant to contribute to a tightening of the labour market involving increasing wage costs. In these conditions ex post vacancies will only pick up short-run imbalances and in a medium-term planning context the vacancies statistics give little guidance in evaluating the extent of the manpower constraint on growth which would have arisen given certain conditions about say material supplies, investment and product demand which differed from those which were actually in force. Similarly in looking forward rather than studying the past the latest vacancy figures will at most help to evaluate the base period from which a medium-term assessment is being made, indicating where shortages exist and where they are likely to become significant quite quickly.

But there still lurks the problem of the statement ratio. Is it conceivable that this was approximately unity for the economy during the period of exceptionally low unemployment? Without this assumption v cannot be regarded as a reliable cardinal index of demand. Dow and Dicks-Mireaux apparently had no independent survey evidence at hand to check their estimates of statement ratios but MacKay et al (1971, Chapter 13) and the study by Whitehead (described in Department of Employment, 1974a) provide evidence for 1966 and 1973 respectively.[8] Both conclude that vacancies reported to employment exchanges considerably underestimate current vacancies identified by management and for which employees were being sought. For engineering plants in Glasgow, North Lanarkshire and New Town, the percentages of all manual

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(8) The Department of Employment (1971b) in their introductory notes to British Labour Statistics. Historical Abstract 1886-1968 state that apart from periods affected by statutory controls 'less than half of all vacancies are in fact notified'.

vacancies reported were 20, 12 and 41 respectively (16, 9 and 43 per cent for skilled vacancies only). In Whitehead's sample of companies in various industries and labour market areas, mainly covering manual occupations but some clerical, 32 per cent of vacancies were reported.[9] These figures sit rather uncomfortably with statement ratios of 1.3 for the metal industries and 1.0 for all industries (cf. 0.4 for New Town and 0.3 from Whitehead's study) obtained by Dow and Dicks-Mireaux. On the other hand the latter themselves say 'we know that in manufacturing industries a declining proportion of jobs becoming vacant are notified to the employment exchanges, and that the proportion may be as low as a third'.[10] They discuss this evidence by virtually assuming what they wish to prove - that their estimates of statement rates are reasonably constant and on average approach unity - and then reconcile their relatively high values with the previous statement by suggesting that 'it is the vacancies which are hardest to fill which are left on official records'. This implies a peculiar relationship between the incidence of vacancies previously not notified and the timing of counts of unfilled vacancies. A consideration of the stock-flow changes suggests that this is incorrect and that not only must one reject the application of constant statement ratios to the 1946-56 period, but the statement ratios were on average much too high. Notwithstanding the small sample sizes it must be concluded that the official vacancy statistics generally understate vacancies recognised by firms and the extent of the understatement is likely to vary cross-sectionally taking different industries, occupations and labour markets and through time.

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(9) About 20 per cent of all vacancies were in anticipation of net increases in labour demand (<u>ex ante</u> vacancies) but it is not stated what proportion of these were reported to exchanges.

(10) Op. cit., p.27.

Dow and Dicks-Mireaux were being modest but nonetheless optimistic when they concluded (referring to their d index, p.20):

> 'It may therefore be that the indices described here do not present a completely midleading impression of the extent of excess demand for labour, and that their evidence should not be rejected out of hand.'

MacKay et al (1971, pp.410-411) suggest very tentatively that, if anything, the degree of understatement increases as the labour market for the relevant group tightens. Thus we endorse their general conclusion:

> 'On the positive side, all we can say is that as a rough, ordinal measure vacancy statistics do indicate those types of labour in greatest demand in the market as a whole, and when used in conjunction with unemployment data will indicate the approximate nature of the employment conditions facing different occupational groups.'

A6.2 The Measurement Problem - Unemployment

The predominance of men in skilled engineering occupations suggests that those deficiencies normally recognised in the statistics of registered wholly unemployed are less important than when analysing excess supply in occupations including substantial numbers of women. In contrast to our difficulties over the vacancy statistics the unemployment data may be taken as an approximate cardinal measure of unemployed manpower seeking work on the external labour market. For Great Britain, Standing (1972, p.292) calculates that in 1966 (near to a peak of labour demand in 1965) only 49 per cent of male electrical and electronic workers (order VI) and 46 per cent of male engineering and allied workers (order VII) recorded as unemployed by the census were actually registered as such with the Department of Employment. He also shows that 27 and 32 per cent respectively of those unemployed in these groups were unregistered but sick. A more detailed breakdown of the aggregate male census unemployment figure, covering all occupations, is given below.

	Thousands
Registered	
Sick	20
Seeking work	153
Waiting to take up a job	47
	220
Unregistered	
Sick	120
Seeking work	60
Waiting to take up a job	43
	223

Source: Department of Employment (1971b) p.412.

This shows that 67 thousand, about a third, of those registered were either sick or had found jobs but a similar number of unregistered were seeking work. So as a rough measure of those still looking for jobs the male registered unemployment figures for April 18th 1966 giving 200 thousand were not far from the actual number seeking work, 213 thousand. Thus although total unregistered unemployment may equal registered unemployment for men, the existence of the sick and those waiting to take up jobs in both groups of figures means that registered unemployment for men may not be a bad proxy for the numbers still seeking work. Indeed the figures produce a small overestimate of about 3 per cent compared to an apparent underestimate of about 30 per cent obtained by ignoring as did Standing the presence of the sick among the registered and those waiting to take up a job among the registered and unregistered unemployed. There is a further factor namely that compared to the 220,000 given in the census, the Department of Employment report 234,000 wholly unemployed for April 1966. No explanation is given for this discrepancy.

There remains the question of how stable are the proportions attributed to each component of census unemployment over time. No data exists to allow us to compare results for different years. From regional cross-sections there appears to be a tendency for registration to fall with a rise in labour demand. This is mainly explained through the presence of voluntary leavers who receive no unemployment benefit for six weeks and hence lack a direct financial incentive to register and form a larger proportion of the unemployed the tighter the labour market. About 60 per cent of the variation in males registered as unemployed is explained by males unemployed but not registered. However when excluding the unregistered sick there is apparently no significant relationship.(11) Attempts to explore the relationship by using proxy variables of various kinds have failed to elucidate the measurement problem in a sufficiently reliable way (see Shepherd, 1968, and Bowers et al, 1972).

We must conclude that whether or not the relationship between registered and unregistered unemployment is stable enough to justify the kind of approximation suggested above and whether or not male registered unemployment is a reasonable proxy for the numbers currently seeking jobs, has still to be decided. However, since 1966 was near the peak of labour demand it is probably true that the numbers unregistered and either seeking work or waiting to take up a job were proportionately at their highest so one would not expect registered unemployment to understate the numbers currently seeking jobs by more than it did in that year. Since in fact there was a small overestimate of 3 per cent in 1966, years where demand was less will, if anything, tend to show male registered unemployment figures which overstate effective short-run excess supply by more than this. Note, however, that if people waiting to take up a job are to be excluded from the short-run excess supply measure, then the corresponding vacancies should be cancelled when the jobs are offered and accepted, not when they are taken up. It has been assumed that this is most likely to be the case but no information is available on this point.

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(11) Bowers (1975) p.5.

REFERENCES

REFERENCES

Ahmed, B. and M. Blaug (1973). (eds). The Practice of Manpower Forecasting. Amsterdam: Elsevier.

Anderson, A.V. (1974). 'Shortages of Skilled Craftsmen in Engineering'. London: National Economic Development Office. (mimeographed)

Armitage, Peter, Cyril Smith and Paul Alper (1969). Decision Models for Education Planning. London: Allen Lane The Penguin Press.

Ball, R.J., and E.B.A. St. Cyr (1966). 'Short Term Employment Functions in British Manufacturing Industry'. Review of Economic Studies.

Barker, T.S. (1972). 'Foreign trade in multisectoral models'. Input-Output Techniques. Eds. A. Brody and A.P. Carter. Amsterdam: North Holland.

_______ (1976). 'Towards Strategic Paths in Economic Planning'. Paper presented to the International Economic Association Conference on Econometric Contributions to Public Policy, Urbino, Italy. (mimeographed)

Barker, T.S. (1976). (ed.) Economic Structure and Policy. Cambridge Studies in Applied Econometrics 2. London: Chapman and Hall.

Bartholomew, D.J. (1967). Stochastic Models for Social Processes. London: John Wiley.

Becker, Gary S. (1964). Human Capital. New York: National Bureau of Economic Research.

_______ (1965). 'A theory of the allocation of time'. Economic Journal, 75 (September), 493-517.

Bell, R.M. (1972). Changing Technology and Manpower Requirements in the Engineering Industry. Engineering Industry Training Board, Research Report no. 3. Brighton: Sussex University Press in conjunction with the EITB.

Beveridge, A. (1963). Apprenticeship Now. London: Chapman and Hall.

Blau, Peter M. et al. (1956). 'Occupational Choice: A Conceptual Framework'. Industrial and Labor Relations Review, 9, no. 4, 531-43.

Blumen, I., M. Kogan and P. McCarthy (1955). Industrial Mobility of Labour as a Probability Process. Ithaca: Cornell University Press.

Borus, M.E. (1972). (ed.). Evaluating the impact of manpower programs. Massachusetts: D.C. Heath.

Bosanquet, Nicholas, and Guy Standing (1972). 'Government and Unemployment 1966-1970: A Study of Policy and Evidence'. British Journal of Industrial Relations, X (July), 180-92.

Bosworth, Derek L (1973). 'Changes in the Quality of Inventive Output and Patent Based Indices of Technological Change'. Bulletin of Economic Research, 25, no. 2, 95-103.

______(1974). 'Production Functions and Skill Requirements'. Problems in Manpower Forecasting. Ed. J. Stuart Wabe. Farnborough: Saxon House, D.C. Heath, 153-96.

______(1975). 'Estimated Investment by Type and Industry Within Engineering'. (mimeographed)

______(1976). Production Functions: A theoretical and empirical study. Farnborough: Saxon House.

Bosworth, D.L., G.J. Evans and R.M. Lindley (1974). 'Mechanistic Manpower Models'. Problems in Manpower Forecasting. Ed. J. Stuart Wabe. Farnborough: Saxon House, D.C. Heath, 61-84.

Bowers, J.K. (1973). 'Unemployment Statistics 1966-70: A Note'. British Journal of Industrial Relations, XI (July), 286-90.

Bowers, J.K. (1975). 'British Activity Rates: A Survey of Research'. Scottish Journal of Political Economy, XXII (February), 57-90.

Bowers, J.K. et al. (1972). 'Some Aspects of Unemployment and the Labour Market 1966-71'. National Institute Economic Review, 62 (November), 75-88.

Briscoe, G. and D.A. Peel (1974). 'The Value of Inter-related Factor Demand Models for Explaining Short Term Employment Behaviour in the U.K. Manufacturing Sector'. Research Paper 52, Centre for Industrial Economic and Business Research. Coventry: University of Warwick. (mimeographed)

Brown, C.V., E. Levin and D.T. Ulph (1975). 'Inflation, Taxation and Income Distribution'. Discussion Paper 33 in Economics, Finance and Investment. Stirling: University of Stirling. (mimeographed)

Brown, W.A. (1973). Piecework Bargaining. London: Heinemann.

Burtle, James (1952). 'Input-Output Analysis as an Aid to Manpower Policy'. International Labour Review, 65 (May), 600-25.

Butler, J.R. (1968). Occupational Choice. Department of Education and Science, Science Policy Studies no. 2. London: HMSO.

Central Statistical Office (1957). Annual Abstract of Statistics 1956. London: HMSO. (also for other years)

______(1970). Input-output tables for the United Kingdom 1963. Studies in Official Statistics No. 16. London: HMSO.

______(1973). Input-output tables for the United Kingdom 1968. Studies in Official Statistics No. 22. London: HMSO.

Confederation of British Industries (1972). CBI Industrial Trends Survey, 43 (January). London: Confederation of British Industries.

Cripps, T.F. and R.J. Tarling (1974). 'An Analysis of the Duration of Male Unemployment in Great Britain 1932-73'. Economic Journal, 84 (June), 289-316.

Crossley, J.R. (1970). 'Theory and Methods of National Manpower Policy'. Scottish Journal of Political Economy, XVII (June), 127-46.

Department of Education and Science (1962). Statistics of Education 1961. London: HMSO.

Department of Employment (1970a). Department of Employment Gazette, April. London: HMSO.

_______ (1970b). Department of Employment Gazette, July. London: HMSO.

_______ (1971a). Skilled Engineering Shortages in a High Demand Area. Department of Employment Manpower Papers no. 3. London: HMSO.

_______ (1971b). British Labour Statistics: Historical Abstract 1886-1968. London: HMSO.

_______ (1971c). Department of Employment Gazette, August. London: HMSO.

_______ (1972a). Training for the Future. London: HMSO.

_______ (1972b). Department of Employment Gazette, March. London: HMSO.

_______ (1973a). Department of Employment Gazette, May. London: HMSO.

_______ (1973b). Department of Employment Gazette, September. London: HMSO.

_______ (1974a). Department of Employment Gazette, March. London: HMSO.

_______ (1974b). Department of Employment Gazette, October. London: HMSO.

_______ (1976). 'Final Report of the Working Party on the Changed Relationship between Unemployment and Vacancies'. London: DE. (mimeographed)

Dhrymes, P.J. (1969). 'A Model of Short-run Labor Adjustment'. The Brookings Model: Some Further Results. Eds. J.S. Duesenberry et al. Amsterdam: North Holland, 110-50.

Doeringer, Peter B. and Michael J. Piore (1971). Internal Labor Markets and Manpower Analysis. Lexington: D.C. Heath.

Dow, J.C.R. and L.A. Dicks-Mireaux (1958). 'The Excess Demand for Labour: A study of conditions in Great Britain, 1946-56'. Oxford Economic Papers, 10 (February), 1-33.

Durbin, J. (1970). 'Testing for Serial Correlation in Least-Squares Regression when Some of the Regressors are Lagged Dependent Variables'. Econometrica, 38, no. 3, 553-77.

Elias, D.P.B. (1976). 'The derivation of employment and unemployment targets in the Cambridge Growth Project Model'. MRG RP20, Manpower Research Group, University of Warwick. (mimeographed)

Employment and Training: Government Proposals. (1973). Cmnd. 5250. London: HMSO.

Engineering Industry Training Board (1967). Report and Statement of Accounts for the period ended 31st March 1967. London: HMSO.

______(1970). Report on the Attitudes of Large and Small Firms to the Board's Proposals for New Levy/Grant Schemes, 1969. Watford: EITB.

______(1971). Survey of First Year Craft Training. Part II. Watford: EITB.

______(1971). Report and Accounts 1970-71. Watford: EITB.

______(1972). The Costs of Training: a preliminary report. EITB Occasional Paper no. 2. Watford: EITB.

______(1974). Report and Accounts. 1973-74. Watford: EITB.

______(1975). The Craftsman in Engineering: An Interim Report. Watford: EITB.

______(1976). Annual Report and Accounts 1975-76. Watford: EITB.

Evans, Graham J. (1974). 'The Labour Market Mechanism and the Hoarding of Manpower'. Problems in Manpower Forecasting. Ed. J.S. Wabe. Farnborough: Saxon House, D.C. Heath, 97-154.

______(1975). 'A Note on Trends in the Relationship between Unemployment and Unfilled Vacancies'. Economic Journal, 85 (March), 135-39.

Evans, G.J. and R.M. Lindley (1973). 'The Use of RAS and Related Models in Manpower Forecasting'. Economics of Planning, 13, no. 1-2, 53-73.

Fallon, P.R. and P.R.G. Layard (1975). 'Capital-Skill Complementarity, Income Distribution and Output Accounting'. Centre for the Economics of Education, London School of Economics and Political Science. (mimeographed)

Fisher, F.M. (1969). 'The Existence of Aggregate Production Functions'. Econometrica, 37, no. 4, 553-577

Fisher, M.R. (1971). The Economic Analysis of Labour. London: Weidenfeld and Nicolson.

Ford, Julienne and Stephen Box (1967). 'Sociological Theory and Occupational Choice'. The Sociological Review, 15 (November). Reprinted in Williams (1974), 111-24.

Fowler, R.F. (1968). Duration of Unemployment on the Register of Wholly Unemployed. Studies in Official Statistics, Research Paper no. 1. London: HMSO.

Gannicott, K.G. and M. Blaug (1969). 'Manpower Forecasting since Robbins: A Science Lobby in Action'. Higher Education Review, 2 (September), 56-74.

General Registrar's Office (1970). Statistical Review of England and Wales 1968, Part II, Table 52. London: HMSO.

Ghez, Gilbert, R. and Gary S. Becker (1972). 'The Allocation of Time and Goods over the Life Cycle'. Center for Mathematical Studies in Business and Economics, Report 7217. Chicago: University of Chicago, Department of Economics and Graduate School of Business. (mimeographed)

Ginsberg, R.B. (1971). 'Semi-Markov processes and mobility'. Journal of Mathematical Sociology, 1, 233-62.

Ginzberg, E. et al. (1951). Occupational Choice: An Approach to a General Theory. New York: Columbia University Press.

Ginzberg, E. et al. (1964). Talent and Performance. New York: Columbia University Press.

Goldthorpe, John H. et al. (1970). The Affluent Worker: Industrial Attitudes and Behaviour. Cambridge Studies in Sociology 1. London: Cambridge University Press.

Goodman, L.A. (1961). 'Statistical methods for the Mover-Stayer model'. Journal of American Statistical Association, 56, 841-68.

Hall, K. and Isobel Miller (1971). 'Industrial Attitudes to Skill Dilution'. British Journal of Industrial Relations, IX (March), 1-20.

Harris, Amelia I. and Rosemary Clausen (1967). Labour Mobility in Great Britain. Government Social Survey, SS 333. London: HMSO.

Hart, R.A. and D.I. MacKay (1975). 'Engineering Earnings in Britain, 1914-68'. Journal of the Royal Statistical Society, Series A, 138, Part 1, 32-50.

Hartley, Keith (1976). 'Training and Retraining for Industry'. Paper presented to the Conference on Fiscal Implications of Manpower Planning. University of Sterling. (mimeographed)

Haystead, Jennifer (1971). 'Social Structure, Awareness Contexts and Processes of Choice'. Sociological Review, 19 (February). Reprinted in Williams (1974), 171-86.

Haworth, C.T. and D.W. Rasmussen (1971). 'Human Capital and Inter-Industry Wages in Manufacturing'. Review of Economics and Statistics, 53 (November), 376-80.

Heathfield, D.F. (1972a). 'The Measurement of Capital Usage using Electricity Consumption Data for the U.K.'. Journal of the Royal Statistical Society, Series A, 135, Part 2, 208-20.

________ (1972b). 'Factor Substitution: Some Empirical Results for Six U.K. Manufacturing Industries'. Department of Economics Discussion Paper 7205. Southampton: University of Southampton. (mimeographed)

Hood, W. and R. Rees (1974). 'Inter-Industry Wage Levels in U.K. Manufacturing'. Manchester School, XLII (June), 171-85.

Hunter, L.C. and G.L. Reid (1968). Urban Worker Mobility. Paris: O.E.C.D.

Industrial Training: Government Proposals. Cmnd. 1892. London: HMSO.

Johansen, L. (1972). Production Functions - An Integration of Micro and Macro, Short-Run and Long-Run Aspects. Amsterdam: North Holland.

Jones, Glyn and Michael Barnes (1967). Britain on Borrowed Time. Harmondsworth: Penguin Books.

Jorgenson, D.W. (1965). 'Anticipations and Investment Behaviour'. The Brooking's Quarterly Econometric Model of the U.S. Eds. J.S. Duesenberry et al. Chicago: Rand MacNally.

______ (1971). 'Econometric Studies of Investment Behaviour: A Survey'. Journal of Economic Literature, IX (December), 111-47.

Keil, E., Teresa C. Riddell and B.S.R. Green (1966). 'Youth and Work: Problems and Perspectives'. Sociological Review, 14 (July). Reprinted in Williams (1974), 76-96.

Killingsworth, Mark R. (1970). 'A Critical Survey of "Neoclassical" Models of Labour'. Bulletin of the Oxford University Institute of Economics and Statistics, 32 (May), 133-65.

Knowles, K.G.J.C. and T.B. Hill (1954). 'The structure of engineering earnings'. Bulletin of the Oxford University Institute of Statistics. 16 (September and October), 272-328.

Knowles, K.G.J.C. and D. Robinson (1969). 'Wage Movements in Coventry'. Bulletin of the Oxford University Institute of Economics and Statistics, 31 (February), 1-21.

Lane, K.F. and J.E. Andrew (1955). 'A method of labour turnover analysis'. Journal of the Royal Statistical Society, Series A, 118, 296-323.

Layard, P.R.G. (1972). 'Economic Theories of Educational Planning'. Essays in Honour of Lord Robbins. Eds. M.H. Peston and B.A. Corry. London: Weidenfeld and Nicolson.

Lee, D.J. (1972). 'Very Small Firms and the Training of Engineering Craftsmen: Some Recent Findings'. British Journal of Industrial Relations. X, no. 2, 240-55.

Lees, Dennis and Brian Chiplin (1970). 'The Economics of Industrial Training'. Lloyds Bank Review, April, 29-41.

Leibenstein, Harvey (1966). 'Allocative Efficiency vs. "X-Efficiency"'. American Economic Review, LVII (June), 392-415.

Leontief, Wassily W. (1941). The Structure of American Economy, 1919-39. New York: Oxford University Press.

Lerner, S.W. and J. Marquand (1962). 'Workshop Bargaining, Wage Drift and Productivity in the British Engineering Industry'. Manchester School, 30 (January), 15-60.

_______ (1963) 'Regional Variations in Earnings, Demand for Labour and Shop Stewards' Combine Committees in the British Engineering Industry'. Manchester School, 31 (September), 261-96.

Lindley, Robert M. (1974). 'Manpower Movements and the Supply of Labour'. Problems in Manpower Forecasting. Ed. J.S. Wabe. Farnborough: Saxon House, D.C. Heath, 239-81.

_______ (1975a). 'The Sources and Distribution of Household Incomes in Sri Lanka'. (mimeographed)

_______ (1975b). 'The Demand for Apprentice Recruits by the Engineering Industry, 1951-71'. Scottish Journal of Political Economy, XXII (February), 1-24.

_______ (1976a). 'Inter-Industry Mobility of Male Employees in Great Britain, 1959-68'. Journal of the Royal Statistical Society, Series A, 139, Part 1, 56-79.

_______ (1976b). 'The Population Accounting Matrix'. MRG RP 24, Manpower Research Group, University of Warwick. (mimeographed)

_______ (1976c). 'Aspects of the Labour Market for Skilled Engineering Craftsmen'. (mimeographed research report, University of Warwick)

Liversidge, William (1962). 'Life Chances'. The Sociological Review, 10 (March). Reprinted in Williams (1974), 58-75.

MacKay, D.I. et al. (1971). Labour Markets under Different Employment Conditions. London: George Allen and Unwin.

MacKay, D.I. (1972). 'After the Shake-Out'. Oxford Economic Papers, 24 (March), 89-110.

Marsh, A. (1965). Industrial Relations in Engineering. London: Pergamon.

Masters, S.H. (1969). 'An Inter-Industry Analysis of Wages and Plant Size'. Review of Economics and Statistics, 51 (August), 341-45.

McCormick, B.J. and P.S. Manley (1967). 'The Industrial Training Act'. Westminster Bank Review, February, 44-56.

Ministry of Labour (1958). Training for Skill. London: HMSO.

_______ (1965). The Metal Industries. Ministry of Labour, Manpower Studies no. 2. London: HMSO.

_______ (1967). Occupational Changes 1951-61. Ministry of Labour, Manpower Studies no. 6. London: HMSO.

Ministry of Pensions (1954). Reasons given for Retiring or Continuing at Work. London: HMSO.

National Plan (1965). Cmnd. 2764. London: HMSO.

Oatey, M. (1970). 'The Economics of Training with respect to the Firm'. British Journal of Industrial Relations, VIII, no. 1, 1-21.

O'Dea, D.J. (1975). Cyclical Indicators for the Post-War British Economy. National Institute of Economic and Social Research, Occasional Paper no. 28. London: Cambridge University Press.

Office of Population Census and Statistics (1960). Classification of Occupations. London: HMSO.

_______ (for 1951, 1961, 1971). Census of Population. General Reports and Economic Activity Tables for these years. London: HMSO.

Organisation for Economic Cooperation and Development (1965). Wages and Labour Mobility, Chapter VI. Ed. P. de Wolff. Paris: O.E.C.D.

Parikh, Ashok (1974). 'An Analysis of Sectoral Employment in the U.K.'. Manchester School, XLII (December), 340-58.

_______ (1975). 'Estimation Error in Sectoral Employment Requirements in the Absence of a Domestic Coefficients Matrix in the Input-Output Analysis'. Paper presented to the World Econometric Congress, Toronto. (mimeographed)

Parnes, H.S. (1970). 'Labor force participation and labour mobility'. Review of Industrial Relations Research, 1, 1-78. Madison: Wisconsin Industrial Relations Research Association.

Piore, M.J. (1968). 'The Impact of the Labour market upon the Design and Selection of Productive Techniques within Manufacturing Plant'. Quarterly Journal of Economics, 82 (November), 602-20.

Political and Economic Planning (1966). Attitudes in British Management. A P.E.P. Report. Harmondsworth: Penguin Books.

Purkiss, C.J. (1971). 'A Review of Manpower Planning'. Institute of Manpower Studies Report. Brighton: University of Sussex, Institute of Manpower Studies. (mimeographed)

Pyatt, F.G. (1964). Capital, Output and Employment 1948-1960. A Programme for Growth, 4. Department of Applied Economics. University of Cambridge. Cambridge: Chapman and Hall.

Pyatt, F.G. and A.R. Roe with R.M. Lindley and J.I. Round et al. (1977, forthcoming). Social Accounting for Development Planning with Special Reference to Sri Lanka. London: Cambridge University Press.

Reddaway, W.B. (1959). 'Wage Flexibility and the Distribution of Labour'. Llyod Bank Review, 54, 32-48.

Report of the Committee of Inquiry under Professor E.H. Phelps Brown into Certain Matters Concerning Labour in Building and Civil Engineering (196[illegible]). Cmnd. 3714. London: HMSO.

National Plan (1965). Cmnd. 2764. London: HMSO.

Oatey, M. (1970). 'The Economics of Training with respect to the Firm'. British Journal of Industrial Relations, VIII, no. 1, 1-21.

O'Dea, D.J. (1975). Cyclical Indicators for the Post-War British Economy. National Institute of Economic and Social Research, Occasional Paper no. 28. London: Cambridge University Press.

Office of Population Census and Statistics (1960). Classification of Occupations. London: HMSO.

_______ (for 1951, 1961, 1971). Census of Population. General Reports and Economic Activity Tables for these years. London: HMSO.

Organisation for Economic Cooperation and Development (1965). Wages and Labour Mobility, Chapter VI. Ed. P. de Wolff. Paris: O.E.C.D.

Parikh, Ashok (1974). 'An Analysis of Sectoral Employment in the U.K.'. Manchester School, XLII (December), 340-58.

_______ (1975). 'Estimation Error in Sectoral Employment Requirements in the Absence of a Domestic Coefficients Matrix in the Input-Output Analysis'. Paper presented to the World Econometric Congress, Toronto. (mimeographed)

Parnes, H.S. (1970). 'Labor force participation and labour mobility'. Review of Industrial Relations Research, 1, 1-78. Madison: Wisconsin Industrial Relations Research Association.

Piore, M.J. (1968). 'The Impact of the Labour Market upon the Design and Selection of Productive Techniques within Manufacturing Plant'. Quarterly Journal of Economics, 82 (November), 602-20.

Political and Economic Planning (1966). Attitudes in British Management. A P.E.P. Report. Harmondsworth: Penguin Books.

Purkiss, C.J. (1971). 'A Review of Manpower Planning'. Institute of Manpower Studies Report. Brighton: University of Sussex, Institute of Manpower Studies. (mimeographed)

Pyatt, F.G. (1964). Capital, Output and Employment 1948-1960. A Programme for Growth, 4. Department of Applied Economics. University of Cambridge. Cambridge: Chapman and Hall.

Pyatt, F.G. and A.R. Roe with R.M. Lindley and J.I. Round et al. (1977, forthcoming). Social Accounting for Development Planning with Special Reference to Sri Lanka. London: Cambridge University Press.

Reddaway, W.B. (1959). 'Wage Flexibility and the Distribution of Labour'. Llyods Bank Review, 54, 32-48.

Report of the Committee of Inquiry under Professor E.H. Phelps Brown into Certain Matters Concerning Labour in Building and Civil Engineering (1968). Cmnd. 3714. London: HMSO.

National Plan (1965). Cmnd. 2764. London: HMSO.

Oatey, M. (1970). 'The Economics of Training with respect to the Firm'. British Journal of Industrial Relations, VIII, no. 1, 1-21.

O'Dea, D.J. (1975). Cyclical Indicators for the Post-War British Economy. National Institute of Economic and Social Research, Occasional Paper no. 28. London: Cambridge University Press.

Office of Population Census and Statistics (1960). Classification of Occupations. London: HMSO.

_______ (for 1951, 1961, 1971). Census of Population. General Reports and Economic Activity Tables for these years. London: HMSO.

Organisation for Economic Cooperation and Development (1965). Wages and Labour Mobility, Chapter VI. Ed. P. de Wolff. Paris: O.E.C.D.

Parikh, Ashok (1974). 'An Analysis of Sectoral Employment in the U.K.'. Manchester School, XLII (December), 340-58.

_______ (1975). 'Estimation Error in Sectoral Employment Requirements in the Absence of a Domestic Coefficients Matrix in the Input-Output Analysis'. Paper presented to the World Econometric Congress, Toronto. (mimeographed)

Parnes, H.S. (1970). 'Labor force participation and labour mobility'. Review of Industrial Relations Research, 1, 1-78. Madison: Wisconsin Industrial Relations Research Association.

Piore, M.J. (1968). 'The Impact of the Labour market upon the Design and Selection of Productive Techniques within Manufacturing Plant'. Quarterly Journal of Economics, 82 (November), 602-20.

Political and Economic Planning (1966). Attitudes in British Management. A P.E.P. Report. Harmondsworth: Penguin Books.

Purkiss, C.J. (1971). 'A Review of Manpower Planning'. Institute of Manpower Studies Report. Brighton: University of Sussex, Institute of Manpower Studies. (mimeographed)

Pyatt, F.G. (1964). Capital, Output and Employment 1948-1960. A Programme for Growth, 4. Department of Applied Economics. University of Cambridge. Cambridge: Chapman and Hall.

Pyatt, F.G. and A.R. Roe with R.M. Lindley and J.I. Round et al. (1977, forthcoming). Social Accounting for Development Planning with Special Reference to Sri Lanka. London: Cambridge University Press.

Reddaway, W.B. (1959). 'Wage Flexibility and the Distribution of Labour'. Llyods Bank Review, 54, 32-48.

Report of the Committee of Inquiry under Professor E.H. Phelps Brown into Certain Matters Concerning Labour in Building and Civil Engineering (1968). Cmnd. 3714. London: HMSO.

National Plan (1965). Cmnd. 2764. London: HMSO.

Oatey, M. (1970). 'The Economics of Training with respect to the Firm'. British Journal of Industrial Relations, VIII, no. 1, 1-21.

O'Dea, D.J. (1975). Cyclical Indicators for the Post-War British Economy. National Institute of Economic and Social Research, Occasional Paper no. 28. London: Cambridge University Press.

Office of Population Census and Statistics (1960). Classification of Occupations. London: HMSO.

_______ (for 1951, 1961, 1971). Census of Population. General Reports and Economic Activity Tables for these years. London: HMSO.

Organisation for Economic Cooperation and Development (1965). Wages and Labour Mobility, Chapter VI. Ed. P. de Wolff. Paris: O.E.C.D.

Parikh, Ashok (1974). 'An Analysis of Sectoral Employment in the U.K.'. Manchester School, XLII (December), 340-58.

_______ (1975). 'Estimation Error in Sectoral Employment Requirements in the Absence of a Domestic Coefficients Matrix in the Input-Output Analysis'. Paper presented to the World Econometric Congress, Toronto. (mimeographed)

Parnes, H.S. (1970). 'Labor force participation and labour mobility'. Review of Industrial Relations Research, 1, 1-78. Madison: Wisconsin Industrial Relations Research Association.

Piore, M.J. (1968). 'The Impact of the Labour Market upon the Design and Selection of Productive Techniques within Manufacturing Plant'. Quarterly Journal of Economics, 82 (November), 602-20.

Political and Economic Planning (1966). Attitudes in British Management. A P.E.P. Report. Harmondsworth: Penguin Books.

Purkiss, C.J. (1971). 'A Review of Manpower Planning'. Institute of Manpower Studies Report. Brighton: University of Sussex, Institute of Manpower Studies. (mimeographed)

Pyatt, F.G. (1964). Capital, Output and Employment 1948-1960. A Programme for Growth, 4. Department of Applied Economics. University of Cambridge. Cambridge: Chapman and Hall.

Pyatt, F.G. and A.R. Roe with R.M. Lindley and J.I. Round et al. (1977, forthcoming). Social Accounting for Development Planning with Special Reference to Sri Lanka. London: Cambridge University Press.

Reddaway, W.B. (1959). 'Wage Flexibility and the Distribution of Labour'. Llyods Bank Review, 54, 32-48.

Report of the Committee of Inquiry under Professor E.H. Phelps Brown into Certain Matters Concerning Labour in Building and Civil Engineering (1968). Cmnd. 3714. London: HMSO.

Report of the Committee of Inquiry on Small Firms (1971). Cmnd. 4811. London:HMSO.

Report of the Royal Commission on Trade Unions and Employers' Associations, 1965-68 (1968). Cmnd. 3623. London: HMSO.

Roberts, Colin J. (1974). 'The Demand for Manpower: Employment Functions'. Problems in Manpower Forecasting. Ed. J.S. Wabe. Farnborough: Saxon House, D.C. Heath, 197-238.

_______ (1976). A Demand and Supply Analysis of Aggregate Employment in the Engineering Industry. (mimeographed research report, University of Warwick)

Robinson, D. (1970). Local Labour Markets and Wage Structures. London: Gower Press.

Routh, Guy (1965). Occupation and Pay in Great Britain, 1906-60. National Institute of Economic and Social Research, Economic and Social Studies XXIV. London: Cambridge University Press.

Sawyer, M.C. (1973). 'The Earnings of Manual Workers: A Cross-Section Analysis'. Scottish Journal of Political Economy, XX (June), 141-57.

Senker, P. and C. Huggett (1973). Technology and Manpower in the U.K. Engineering Industry. Engineering Industry Training Board Occasional Paper no. 3. Watford: EITB.

Shanks, M. (1961). The Stagnant Society. Harmondsworth: Penguin Books.

Shepherd, J.R. (1968). 'Productive Potential and the Demand for Labour'. Economic Trends (August). London: HMSO, xxv-xxvii.

Smelser, N.J. (1963). 'The Sociology of Economic Life'. New Jersey: Prentice-Hall.

Smith, Ralph E. (1971). 'The Opportunity Cost of Paticipating in a Training Program'. Journal of Human Resources, VI, no. 4, 510-32.

Sofer, Cyril (1974). 'Introduction'. Occupational Choice. Ed. W.M. Williams. London: George Allen and Unwin, 13-57.

Solow, R.M. (1968). 'Short-run Adjustment of Employment to Output'. Value, Capital and Growth. Ed. J.N. Wolfe. Edinburgh: University Press.

Standing, Guy (1972). 'The Distribution of Concealed Unemployment in Great Britain'. British Journal of Industrial Relations, X, no. 2, 291-98.

Stone, Richard (1965). 'A model for the educational system'. Minerva, 3, no. 2, 172-86.

Stone, Richard (1971). Demographic Accounting and Model-Building. Paris: O.E.C.D.

_______ (1972). 'A Markovian education model and other examples linking social behaviour to the economy'. Journal of the Royal Statistical Society, A, 135, 511-44.

Stone, Richard and Alan Brown (1962). A Computable Model of Economic Growth. A Programme for Growth, 1. Department of Applied Economics, University of Cambridge. Cambridge: Chapman and Hall.

Super, D.E. (1953). 'A Theory of Vocational Development'. American Psychologist, 8, 185-90.

_______ (1963). Essays in Vocational Development. Quoted but not referenced by Sofer, Cyril (1974). 'Introduction'. Occupational Choice. Ed. W.M. Williams. London: George Allen and Unwin.

Taylor, J. (1972). 'The Behaviour of Unemployment and Unfilled Vacancies: Great Britain, 1958-71, An Alternative View'. Economic Journal, 82 (December), 1352-65. (mimeographed).

_______ (1974). Unemployment and Wage Inflation with Special Reference to Britain and the USA. Harlow: Longman.

_______ (1976). 'Unemployment in Britain: An Interpretation of the Last Twenty-Five Years (1951-75)'. Paper presented to British Association for the Advancement of Science, Annual Meeting, Section F. University of Lancaster.

Thomas, G. (c.1953). 'Labour Mobility in Great Britain 1945-49'. Government Social Survey Report. (mimeographed)

Thomas, B., J. Moxham and J. Jones (1969). 'A Cost-Benefit Analysis of Industrial Training'. British Journal of Industrial Relations, VII (July), 231-64.

Thonstad, T. (1969). Education and Manpower: Theoretical Models and Empirical Applications. Edinburgh: Oliver and Boyd.

Thirlwall, A.P. (1969). 'On the Costs and Benefits of Manpower Policies'. Department of Employment Gazette, November,1004-8.

Timperley, S.R. and A.M. Gregory (1971). 'Some Factors Affecting the Career Choice and Career Perceptions of Sixth Form School Leavers'. Sociological Review, 19 (February). Reprinted in Williams (1974), 187-206.

Training Services Agency (1974). A Five Year Plan. London: HMSO.

Ulman, Lloyd (1968). 'Collective Bargaining and Industrial Efficiency'. Britain's Economic Prospects. Ed. Richard E. Caves. London: George Allen and Unwin.

United Nations (1968). A System of National Accounts. Studies in Methods Series F, no. 2, Rev. 3. Statistical Office of the United Nations. New York: United Nations.

United Nations (1975). Towards a System of Social and Demographic Statistics. Studies in Methods Series F, no. 18. Statistical Office of the United Nations. New York: United Nations.

University Grants Committee (1968). First Employment of University Graduates 1968. London: HMSO.

Wabe, J.S. (1977). Manpower Changes in Engineering. Watford: EITB.

Wabe, J.S. and D. Leech (1976). 'Relative Earnings in UK Manufacturing - A Reconsideration of the Evidence'. Research Paper 70, Centre for Industrial Economic and Business Research, Coventry: University of Warwick. (mimeographed)

Weiss, L.W. (1966). 'Concentration and Labor Earnings'. American Economic Review, 56 (March), 96-117.

Wellens, J. (1963). The Training Revolution. London: Evans Brothers.

Wilkinson, R. (1962). 'Differences in earnings and changes in the distribution of manpower in the UK, 1948-57'. Yorkshire Bulletin of Economic and Social Research, 14, no. 1, 46-57.

Wilkinson, Frank and H.A. Turner (1972). 'The Wage-Tax Spiral and Labour Militancy'. Do Trade Unions Cause Inflation? Dudley Jackson, H.A. Turner and Frank Wilkinson. University of Cambridge, Department of Applied Economics, Paper in Industrial Relations and Labour 2. London: Cambridge University Press.

Williams, Gertrude (1957). Recruitment to Skilled Trades. London: Routledge and Kegan Paul.

_______ (1963). Apprenticeship in Europe. London: Chapman and Hall.

Williams, W.M. (1974). (ed.). Occupational Choice. London: George Allen and Unwin.

Woodward, Nicholas and Trevor Anderson (1975). 'A Profitability Appraisal of Apprenticeships'. British Journal of Industrial Relations, XIII, no. 2, 245-56.

Ziderman, Adrian (1969). 'Costs and Benefits of Adult Retraining in the United Kingdom'. Economica, 36 (November), 363-76.

_______ (1973). 'Cost-Benefit Analysis of Government Training Centres in Scotland: A Simulation Approach'. Paper presented to the Annual Conference of the Association of University Teachers of Economics, University of Warwick. (mimeographed)

_______ (1975). 'Costs and Benefits of Manpower Training Programmes in Great Britain'. British Journal of Industrial Relations, XIII, no. 2, 223-43.

Ziderman, Adrian and C. Driver (1973). 'A Markov Chain Model of the Benefits of Participating in Government Training Schemes'. Manchester School, 41 (December), 401-15.