EMPLOYEE PARTICIPATION AND ENTERPRISE PERFORMANCE : AN ECONOMIC ANALYSIS

by

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DECLARATION

Section 3 of chapter 1 and sections 2 and 3 of chapter 3 draw on the author's contribution to a working paper co-authored by Felix FitzRoy (Cable and FitzRoy, 1983). All other parts are the independent work of the author, carried out in the period October 1983 to October 1986. References to earlier collaborative work with Felix FitzRoy are given in the text where appropriate.

SUMMARY

This study investigates the relationship between employee participation in decision-making within production enterprises and their economic performance. Alternative forms of employee involvement such as profit sharing and employee ownership are also considered. A theoretical framework is developed in which the firm's structural and performance characteristics are seen as the outcome of a strategic game in which employers and workers can either seek to impose unilateral control or cooperate to maximise joint welfare. Two new theoretical insights are gained. The first is that a latent 'prisoners dilemma' may be inhibiting more widespread adoption of participatory production. The second involves an important distinction between two conceptually separate ways in which the hypothesized participation-performance relationship might operate. Problems of measuring the key, participation variable in empirical work are raised and solved. A test procedure is devised and applied to arbitrarily-weighted participation indexes of the kind used in previous econometric work. In all cases tested the indices are found to rest on unacceptably restrictive assumptions. This calls into question previous results and appears to present a barrier to further work. However alternative, Guttman scales of participation are proposed and found statistically valid for samples of firms in the West German and UK engineering industries. Incidentally these tests provide support for an existing hypothesis in the literature concerning the pattern of development of participation within the firm. When applied to subsamples of participatory and non-participatory firms in the West German database, significance tests of subsample means and discriminant analysis reveal no statistically significant differences in productivity. However significant differences in technology and labour-force characteristics are found, in particular indicating greater human capital development in participatory firms. OLS and 2SLS estimates of augumented production functions in general confirm these results. Implications for public policy measures to promote greater industrial democracy and profit-sharing are briefly considered.

I. INTRODUCTION

1.1 Controversial Developments in the Organisation of Work

Many western economies are witnessing a growth of alternatives to the traditionally run capitalist firm, in which operatives participate to a significant degree in ownership, in decision-making, or in the firm's financial surplus. Flourishing producer cooperative sectors are to be found in the Mondragon area of northern Spain, and in France and Italy, as well as under central planning in Poland (Estrin, Jones and Svejnar, 1984; Jones, 1983). Industrial cooperatives are also to be found elsewhere, (Estrin, 1986; European Commission, 1984) including Britain where, though cooperative organisation has historically been focussed on the distributive trades, some of the late nineteenth-century producer-cooperatives still survive (Jones, 1982), and a new wave of cooperative development has occurred in recent years (Wilson and Coyne, 1981).[1/] Co-determination laws have been extended in Germany in 1972 and again in 1976, and co-determination systems have also been introduced in Denmark, the Netherlands, Norway and Sweden, while industrial democracy has been on the political agenda of the EEC since the Vredeling proposal of 1972, and at the time of writing is opposed in principle only by Britain.

Alongside these formal developments there has also been a widespread development of diverse, voluntary schemes for worker-participation and profit-sharing (see e.g. Guski and Schneider, 1977; IDS, 1984) in part but not wholly prompted by tax concessions, of the kind currently mooted in Britain (HMSO, 1986). No-one knows

exactly how many workers are affected, though this undoubtedly far exceeds the number employed in cooperatives.[2/] Finally, as is well known, inroads have been made into many Western markets by goods made in Japan, many of them produced under a distinctive, consensus system of intrafirm organisation and decision-making; and American ("theory Z") firms like Eastman-Kodak, Hewlett-Packard, IBM, and others, who have adopted certain features of the Japanese managerial style, it is claimed, have generally been successful (Ouchi, 1982).

The development of these deviations from traditional organisation raises some searching questions about our assumptions on the nature of production enterprises, and has provoked sharp divisions of opinion in the economics literature. Sceptics of the new developments, including Furubotn (1976 a,b, 1985) Jensen and Meckling (1979), and Pejovich (1976, 1978), have argued that only the traditional firm can be efficient. These orthodox writers detect both economic justice and operating efficiency in the dual system of work organisation which rests on a functional division of task and income between capitalists and labour.[3/] Thus it is thought optimal that owners and their agents, management,[4/] receive profits (and salaries) in return for their coordination and control of production, while labour input is compensated by wages.

Profit-sharing or other forms of financial participation by workers is held inefficient on two counts. First, it means that the sole residual claimant is no longer the owner/agent, whose role as 'monitor' of productive inputs under team work is the raison d'etre of the firm (Alchian and Demsetz, 1972; Jensen and Meckling 1979)[5/]; as there is nothing apart from profit to monitor the monitor, it is

argued that dilution of his financial incentive will reduce the efficiency of his monitoring, and hence also of production. Secondly, Samuelson (1977), Meade (1972) and others have emphasized the free-rider aspect of profit-sharing, in that individuals receive only 1/n of any overall gain by the firm, but all the benefits of individual leisure on-the-job. Thus, like other group incentive schemes, profit-sharing encourages 'shirking' (thereby intensifying the monitoring problem).

The specific objections to worker participation in decision-making appear to be somewhat as follows: it offends against Smithian principles of specialisation, and leads to wrong decisions where workers lack expertise; it is a costly and protracted process due to problems of informing, convening and securing agreement among numerous decision-makers, and is prone to the supplanting of economic considerations by intra-firm political ones; it increases the risk of disclosing confidential information; and finally, it can lead to managerial shirking by reducing power, discretion and responsibility.

Thus, in the traditionalists' view, efficient work organisaiton requires preservation of the functional division of roles and rewards between capital and labour, an hierarchical internal structure with vertical supervision,/6 and can require the use of individual incentives such as piecework./7 This view accords in all important respects with the principles of scientific management (Taylor, 1947), which have been widely implemented (Leavitt, 1973). The required internal organisation structure takes the form of a Weberian ideal bureaucracy (McGuire, 1964).

Profit-sharing and participatory decision-making are also held to violate legitimate property rights. Since capitalists bear the risks of productive enterprise then, in accordance with Knight (1921), they should both receive the residual and control the policies on which it depends. By implication, workers are held to bear no risk, and are fully compensated for their skills and disutility of work via fixed, risk-free wages. Worker-ownership, it is argued, is not an acceptable variant of the traditional model, since this has other drawbacks. First, it is undesirable for workers with limited wealth to concentrate their risks in firms for which they also work (Jay, 1977; Mead, 1972);[8/] assuming risk-aversion, the inefficient portfolio distribution this produces will lead to lower commercial risk-taking, reinvestment and hence productivity than in firms owned under efficiently diversified portfolios.[9/] Secondly, Furubotn (1976a), in particular, predicts that control will be monopolised by an original group of owners, leading to purely political constraints on maximum employment, and to factor-utilisation decision resting on issues other than marginal productivity alone.

More sympathetic writers, on the other hand, including Vanek (1970, 1975), Horvat (1982 a,b), and Oakeshott (1978), contest the traditionalist arguments on efficiency and/or equity grounds. Most formal models of cooperation focus on full worker control in the Ward-Domar-Meade framework,[10/] and with few exceptions[11/] hold technology constant and abstract from differences in workers' incentives when comparing entrepreneurial and labour-managed firms (LMFs). As a result LMF theory has little to offer in predicting the productivity consequences of participation, and of course does not treat participation in firms which remain conventionally owned and

managed. Some general propositions can however be derived from an extensive informal literature (McCain, 1982).

The arguments predicting productivity gains from participation begin from factors which are allegedly neglected in the traditional view. Thus advocacy of scientific management is held to ignore social interaction at the workplace, i.e. the strategic, individual and collective responses of workers to the minute division of labour, deskilling and fragmentation which Taylorism entails (Braverman, 1974; Edwards, 1979). As well as to the political and social ill-effects of alienation (Espinosa and Zimbalist, 1978), this leads to well-documented economic costs arising from absenteeism, high labour turnover, poor work-motivation, production sabotage, slowdowns and stifled initiatives, the strategic withholding or distortion of information, reduced incentives to invest in human capital, and general failure to realise human potential. Similarly, the traditional economist's reliance on individual incentives to exact optimal effort ignores workers' incentive for 'rational collusion' in the form of rate-busting and peer-group pressures (Cable and FitzRoy, 1980).

Its critics claim the traditional argument is also flawed by an oversight of market frictions and the widespread immobility of labour and capital. Thus both workers with factory-specific skills and installed capital are intrinsically immobile (Mueller, 1976; Jonsson, 1978). 'Exit' now becomes a costly strategy on both sides, and if effective 'voice' is denied to labour (Hirschman, 1970; Freeman, 1976) the firm becomes a bargaining arena in which both sides

can inflict substantial damage without precipitating the other's withdrawal from the firm (Cable and FitzRoy, 1980).

Factor immobility is thus seen as an underlying cause of the traditional, adversarial situation described above, in which resources are expended on a zero-sum distributional struggle. Factor immobility also modifies the property rights issue. In particular, the worker with factory-specific skills faces significant unemployment risk, since his human capital is not marketable even in an otherwise frictionless labour market under full unemployment. Moreover, unlike shareholders, as the critics themselves argue, workers cannot mitigate their inherently lumpy risk by efficient portfolio management.

Finally, it can be argued that the traditional view takes no account of managerialism. Even in the principal-agent framework, corporate policy departs from shareholders' preferences by some (optimal) amount determined by the monitoring and other transactions costs of stockowner intervention (Jensen and Meckling, 1976). Thus with managerial goals and 'expense preferences' in play as analysed by Marris (1964) Williamson (1965) and others, factor utilisation decisions are no longer governed by marginal productivity considerations alone even in traditional (non-participatory) firms, which then are open to precisely the same criticism as are cooperative firms under Furubotn's previously mentioned 'alternative view'. Moreover, like factor immobility, managerial intrusion on decision-making, and hence on corporate risk, further undermines the traditionalist's property rights arguments; extending rights of information and choice to workers may be more a transfer from the

salariat to wage-earners, i.e. from one group of employees to another, than a net loss to shareholders.[12/]

This said, there is then broad agreement within the pro-cooperation camp over the channels through which efficiency gains are realised. Individually and in combination, joint decision-making, worker-ownership and profit-sharing are seen as capable of generating productivity gains that may be embodied in the productive skills of the labour force and their level of work effort, or disembodied improvements in the firm's organisational efficiency (Jones and Svejnar, 1982). In part the gains arise from the absence of restrictive labour practices - demarcation rules, output restrictions, resistance to new technology, etc. - that have their origin in the adversarial stance required by traditional organisation. Hence in a democratic environment where workers have 'voice' and the fear of exploitation is not predominant, static and dynamic flexibility is increased, so that the firm can more easily achieve optimal input combinations and introduce new products, technologies and work-methods. Secondly, the firm gains from reduced economic costs of alienation (strikes, quits, absenteeism, pilferage, etc.) due to the presence of better mechanisms for conflict resolution and consensual decision-making. Thirdly, supervision and training costs (for a given level of human capital stock) are reduced cet par, as peer-group pressure and 'horizontal monitoring' substitute for hierarchical supervision,[13/] and as average job tenure increases through reduced turnover. Fourthly, the firm is expected to benefit from better-informed decisions embodying workers' experience, and gained through improved information channels and reduced incentives for employees at all levels to withhold information to secure personal

advantage. Fifthly, the legitimacy of decisions is enhanced by their joint nature, and this favourably affects their execution. Sixthly, labour's contribution in all areas is expected to be enhanced by a higher average quality of the labour force, due to greater incentives to invest in training and human capital on both sides where expected job tenure is increased, and where work organisation seeks to maximise skill and job content (the reverse of deskilling). Finally, workers have greater direct, economic incentive for higher effort and work intensity, as well as higher non-material incentives deriving from increased group loyalty and identification with the firm. The effectiveness of work effort is then further enhanced in a high-trust environment, yielding high levels of job satisfaction through improved team spirit and morale, and improved functioning of work groups. In sum, the proponents of cooperation predict not only higher economic efficiency in a narrow sense - static production efficiency of capital and labour, product quality and technical progressiveness - but also greater social efficiency of work as an institution satisfying human aspirations for self-fulfilment and needs for social interaction.

1.2 Some unanswered questions and chapter outline

Though extensive, the literature reviewed in the previous section leaves a great many unanswered questions concerning worker participation and its effects, and its position and importance in the spectrum of alternative forms of work organisation. For example, at the theoretical level, is it possible for a variety of firm types to exist in equilibrium? If so, must they be equi-efficient, or could there be a multiple equilibrium of firms types that are not equi-efficient by conventional measures? If, on the other hand,

efficiency considerations dictate convergence to a single, dominant type, does the variety of developments currently being observed represent a move from an old to a new equilibrium, or are these temporary aberrations only, shortly to be corrected? If we are moving to a new equilibrium, why is this occurring now? More fundamentally, what is the underlying choice mechanism which determines the nature of production enterprises, and how does it operate?

On the empirical side, much doubt remains on the magnitude of productivity effects, and more evidence is needed to resolve the previously described a priori controversy on this issue. While there is a great deal of piecemeal and often case-study evidence (surveyed, for example, in Blumberg 1968; Espinosa and Zimbalist, 1978; and Hodgson, 1982, 1984), previous econometric evidence has focussed mainly on the effects of varying degrees of participation in the cooperative sector (Backus and Jones 1977; Conte and Svejnar, 1981; Jones 1982; Defourney, Estrin and Jones, 1985; Svejnar and Jones, 1982)or codetermination (Svejnar, 1982), with only isolated examples elsewhere (notably Cable and FitzRoy, 1980, and FitzRoy and Kraft, 1985, which, as we shall see, are flawed by measurement and other problems). Further unresolved issues are encountered in pursuing empirical work, notably concerning the specification of testable hypotheses, and the measurement of key variables, in particular the degree of direct employee participation in decision-making. Another open question to be confronted in empirical work is whether we should expect a continuous relationship between the degree of participation and its expected effects over a wide range, or whether there is likely to be some critical threshold level above and below which we will observe behavioural differences under alternative regimes.

An important question in current policy debate is whether different forms of worker participation - in decision-making, in ownership, and in profits - can be effective individually, or need to operate in conjunction. In particular, is profit-sharing, advocated by Weitzmann (1983, 1984) and others on macroeconomic grounds for its employment effects, tenable without participation in decision-making by employees, who now explicitly bear financial risk? If not, as Meade (1986) and Weitzmann himself argue, the favourable employment effects may not materialize, since workers under profit-sharing have an incentive to restrict employment in order to maximise individual shares. More generally, the degree of complementarity or 'synergy' that exists between different forms of participation, if any, is clearly an important consideration for practitioners and public policy makers alike in devising participatory schemes and measures to encourage them, if, indeed, encouragement is warranted by the evidence.

A complete resolution of all these unknowns and uncertainties is clearly beyond the scope of this or any other single study. The following chapters attempt to chip away at the zone of ignorance in the following way. Chapter 2 develops a theoretical framework in which both the firm's structural characteristics - including the degree of participation - and its performance are seen as the outcomes of a strategic game between workers and employers, in which each side can either strive for unilateral control or cooperate to maximise joint welfare. This analytical approach provides a new way of looking at participation and, more generally, the choice process among alternative modes of work-organisation. It offers a

framework within which a great deal of what we already know about participation can be accommodated, related and reconciled, and which also generates two major new insights. Firstly, it leads to a conceptual distinction between two alternative ways in which participation might yield productivity gains, namely as an 'efficient bargaining' institution, or as a means of opening up technological opportunities not available to traditional firms. This has direct implications for the focus of subsequent empirical work. Secondly, the analytical framework points to a possible prisoners' dilemma in the choice of work organisation, with the implication that, to the extent that participatory production has not become as widespread as might be expected (on the basis of observed performance data), this could be due not to the absence of potential mutual gains to workers and employers, as might otherwise be assumed, but to difficulties in realising them.

Subsequent chapters turn to empirical analysis, utilising a database for firms in the engineering industries in West Germany, described in the next section, and to problems associated with such analyses. The first obstacle is the problem of measuring a key variable, i.e. the degree of employee-participation in decision-making. Best practice in this regard in previous work has involved the construction of continuous participation indices from essentially qualitative basic data. However this requires the imposition of an unavoidably arbitrary weighting structure by the researcher. Chapter 3 spells out the assumptions implicit in such indices, and presents a suitable test procedure of the restrictions these entail in subsequent applications. Results for a number of previous cases overwhelmingly reject these restrictions. This brings some previously published

findings into question, and also seems to lead us to a barrier in the way of further useful work. However, Chapter 4 discoveres an alternative route forward, involving the use of Guttman scales, a measurement technique used widely in some areas of the social sciences, but only rarely in economics. These are found to meet standard statistical requirements when tested on a UK data set as well as the West German data used elsewhere in the present analysis, and the test results incidentally provide evidence in support of a previous hypothesis concerning the pattern of development of participation within production enterprises, which has direct implications for policy.

Chapters 5 and 6 present our main new empirical results. Chapter 5 focusses on the structural and performance characteristics of subsamples of participatory, profit-sharing and traditional firms. t-tests of subsample means and discriminant analysis reveal no significant productivity differences. However, the participatory subsample, that is, firms with participation in decision-making above a critical value on the relevant Guttman scale, display labour force and technological characteristics consistent with the theoretical framework in chapter 2, for the case where participation leads to predictable differences in technology. Profit-sharing firms, by contrast, do not, and in general appear to have relatively little in common with participatory firms, a finding which has direct bearing on the previously mentioned policy issues associated with the interrelatedness of alternative forms of participation.

Productivity effects are investigated further in chapter 6, where a structure of hypotheses is set up on the basis of chapter 2,

extended by a further theoretical consideration of the sequence in which work-organisation and enterprise performance are determined. Estimated production functions confirm that there is no unambiguous productivity gain from participation, but that participation does affect the production process interactively with input quality effects, in particular various dimensions of human capital in the labour force. Final conclusions and policy implications are drawn together in chapter 7, which also briefly outlines a number of avenues for future research.

1.3 Survey Data for the West German Metalworking Industries

The empirical analysis is based on survey data for 87 firms in three sectors of the West German metalworking (engineering) industries. Table 1.1 reports means and definitions for a pooled time-series, cross-section sample containing 128 observations for all those responding firms which provided complete or near complete responses for the last two years of the survey: 63 in 1977 and 65 in 1979. Minor gaps in the data were filled in by interpolation. In most of the empirical analysis reported in chapters 5 and 6 a slightly different sample was used, retaining only the 61 firms appearing in both the 1977 and 1979 cross sections, thus yielding 122 pooled observations. Mean values for this sample will of course be very similar to those in table 1.1. The largest firm in our sample had 6,867 employees and the smallest 10 and, as table 1.1 shows, total employment was on average 649.

In a number of areas, most noticeably labour-turnover for different skill levels, quantitative data should theoretically have

Table 1.1 Characteristics of Sample Firms

Variable	(Abbreviation)	Mean	Unit/Definition
Value-added	(V)	30,291.1	Thousand DM. Total revenue less labour and capital costs.
Capital stock	(K)	52,208.6	Thousand DM. Value of Capital (fixed and working)
Employment	(NET)	648.7	Total number employed
Capital per man	(KBYL)	67.5	Thousand DM
Output per unit capital	(VBYK)	0.96	Thousand DM
Output per man-hour	(VBYH)	0.027	Thousand DM
Participation	(GS4)		See text
Profits to Workers	(P1W2)	0.035	Ratio of profits paid to workers/wages and salaries
Workers' Capital	(M2)	0.339	Thousand DM. Capital owned by workers
Incentive Pay	(I2)	0.187	Ratio of performance-related pay to total wages and salaries
Intermediate Technology	(IT)	0.95	1 if intermediate technology used (see text) 0 otherwise
Job (production method)	(JO)	0.52	1 if Job production methods used, 0 otherwise
Batch (production method)	(BA)	0.76	1 if Batch production methods used, 0 otherwise
Flow (production method)	(FL)	0.20	1 if flow production methods used, 0 otherwise
Per cent male	(PCM9)	82.8	Percentage male employees
Skill mix	(SBYU)	1.60	Ratio of skilled to unskilled workers
Per cent unionised	(PWU9)	36.7	Percentage of union members in workforce
Workers Council	(WOCO)	0.89	1 if a Works Council exists, 0 otherwise
Hours worked	(TMHNEM)	700.6	Total hours worked per blue-collar man-year
Turnover: skilled	(ATS)	0.133	1 if high labour turnover of skilled workers, 0 otherwise
Turnover: unskilled	(ATU)	0.344	1 if high labour turnover of unskilled workers 0 otherwise
Training expenditure	(TREXP)	0.887	Thousand DM. Annual training expenditure per employee
Organisational concentration	(CS4)		Ratio of number of organisational levels/total employment
Urban/Rural	(UBYR)	0.50	1 for urban location, 0 for rural
Market Structure	(HERF)	0.141	Estimate of seller concentration Herfindahl (see text).

been available, but firms' responses were incomplete or only qualitative. As a result we had to construct dummy variables, which necessarily involved an element of judgement in classifying turnover rates as high or low. In the case of these and other dichotomous variables, the means can be interpreted as probabilities that a firm in the sample will possess the relevant characteristic.

Most of the variables in table 1.1 are straightforward and the characteristics of our typical firm are readily apparent by inspection. However the technology (IT), market structure (HERF), organisational concentration (CS4), and participation (GS4) variables require some explanation.

The raw technology data consisted of five dummy variables (T1 - T5) indicating the firm's use of different types of machinery according to a standard German classification for the metal-working industries. This ranges from simple hand tools (T1) to fully automated equipment (T5). When all five were included in initial regressions, significant coefficients were consistently obtained for the intermediate levels only. Subsequently an F-test procedure confirmed that a single IT variable with IT = 1 if T2 or T3 or T4 = 1, and zero otherwise, was an acceptable alternative to the original five dummies.

Attempts to construct conventional measures of seller concentration relevant to each firm in our sample were frustrated by problems of defining market boundaries at the highly disaggregated level necessary, and by the lack of sales data for competing firms not in our sample. The variable HERF is based on firms' perceptions of

the number of principal competitors in the relevant markets. Recalling that the Herfindahl index (H) depends on the number of firms (N) and the coefficient of variation of firm size (v^2),

$$H = (v^2 + 1)/N$$

ignoring inequality of firm size, and accepting the firms' estimates of the number of competitors N, we take the reciprocal of this number as an approximation to the true value of the relevant Herfindahl concentration measure (HERF). We make no exaggerated claims for the reliability of these data, which are best interpreted as a subjective indication of the intensity of competition as perceived by the firm.

A Herfindahl-type measure was also employed for the degree of hierarchy, or organisational concentration. The original data in this area yielded information on the number of hierarchical levels in the organisation, their description, and numbers employed at each level. Various alternative measures of the degree of hierarchy were experimented with, and an overall index eventually selected which took account of both the number of levels and employment in each:

$$CS4 = \sum_{i=1}^{n} S_i^2 ,$$

where S_i is the proportion of employees at the i'th hierarchical level and n is the number of levels. Note that CS4 is an inverse measure of hierarchy, taking unit value for a totally non-hierarchical firm (e.g. a small co-operative or partnership) and tending to zero as hierarchy increases. Results for this variable should again be

interpreted circumspectly, not only because CS4 is again calculated from respondents' perceptions of the number of hierarchical levels in the firm, but also because there is clearly scope for variation from firm to firm in what constitutes an 'hierarchical level'.

Participation responses from the firms took the form of statements describing workers' roles in each of four decision-making areas as 'none', 'prior information given', 'opinion sought' and 'full participation'. The four decision-making areas were investment/rationalisation, employment, wage-setting and job design. Managements' assessments were available for all firms in the sample, and independent assessments by workers and by works council representatives were available for sub-samples (with 77 and 64 observations respectively in the pooled sample of 128 firms). Table 1.2 sets out the response matrices in each case. The data may once again be interpreted as probabilities that the firm will be located in the column in question, each row summing to unity (subject to rounding error). Strictly speaking the matrices are not comparable, because the samples differ. However management responses were in fact remarkably constant across the three subsamples, with only one major discrepancy.[14/] Thus it is not unreasonable in practice to compare the alternative perceptions of participation as recorded in table 1.2.

On the whole these are surprisingly similar. Thus, summing over the four decisions, the mean responses of management and of workers indicate very close agreement over the level and forms of workers involvement. Works Council representatives consistently perceive a higher level of participation, but the differences are not unduly large. The fact that works council representatives judge the

TABLE 1.2: Participation Responses, Management, Workers and Works Council Representatives

(Proportion of firms with affirmative response in each row/column).

	None	Prior Information	Opinion Sought	Full Participation
Management (n = 128)				
Investment/ rationalisation	0.21	0.32	0.39	0.08
Employment	0.16	0.32	0.33	0.19
Wage setting	0.31	0.37	0.11	0.21
Job design	0.11	0.11	0.31	0.47
Mean (4 decisions)	0.20	0.28	0.29	0.24
Workers (n = 77)				
Investment/ rationalisation	0.23	0.35	0.29	0.13
Employment	0.17	0.38	0.35	0.10
Wage setting	0.43	0.32	0.06	0.18
Job Design	0.00	0.10	0.26	0.66
Mean (4 decisions)	0.21	0.28	0.24	0.27
Works Council (n = 64)				
Investment/ rationalisation	0.28	0.44	0.16	0.13
Employment	0.11	0.36	0.31	0.22
Wage setting	0.31	0.23	0.09	0.36
Job Design	0.03	0.00	0.36	0.61
Mean (4 decisions)	0.18	0.26	0.23	0.33

level of participation to be higher than other groups might be thought to arise from their own close involvement in the process. As we shall see, however, other evidence in fact casts doubt on the importance of formal machinery for effective participation.

In the field of employment decisions all groups agree that the workers' role tends towards either receiving prior information or having their views sought, in roughly equal proportions. A similar central tendency is suggested for investment/rationalisation decisions, though less strongly. Thus there is a higher incidence of firms with no participation in this area and also a noticeable discrepancy between the views of workers and, especially, works council representatives as against management; in a substantial number of cases workers and their representatives apparently see as the receipt of prior notification of decisions what managements believe to be the sounding of workers' views.

Interestingly, all groups agree that full participation is most prevalent in the area of job design. This category attracts the highest proportion of firms in any cell of all three matrices, and the proportion of firms with no participation in this decision-making area is very small. In the case of wage setting, by contrast, participation is either absent or limited to receipt of prior information in two-thirds or more of all firms according to both management and workers. Works council representatives, however, find this to be the case in only a half of the total cases, and, moreover, detect full participation over wage-setting in more than a third. It is primarily in this area that their overall perception of greater participation occurs.

Notwithstanding these individual differences, there is a broad congruence in the three independent assessments of the degree of participation, and in order to maximise the available sample size, subsequent analysis is based on management-response data only. As mentioned in the previous section, however, there are technical problems in moving from qualitative data of the sort summarised in table 1.2 to the quantitative measures of the overall degree of participation in a given firm required for empirical analysis. The variable GS4 refers to a Guttman scale as explained in chapter 4. Since this is an ordinal ranking of firms by degree of participation, table 1.2 in this case reports the GS4 value for the median firm, and indicates that this firm would have full participation in one of the four decision making areas surveyed.

FOOTNOTES

1/ The number of worker cooperatives in Britain has more than quadrupled since 1979, from around 300 then to more than 1,400 in 1986 (HMSO, 1986 p.4).

2/ A recent official estimate for profit sharing suggests that there are more than a thousand all-employee schemes in operation, covering more than 10,000 companies and in excess of 1.25 million employees. Of these, however, some 400,000 are in recently privatised, ex public sector firms (HMSO, 1986, p.4).

3/ By anology with parliamentary democracy, Clegg (1975) sees industrial democracy as present in the dual system as long as trade unions form an effective opposition, which their involvement in management may erode. But this analogy is false since workers are not enfranchised periodically to vote management out of control and unions in; only owners vote.

4/ The difficulty that otherwise would exist in recognising salaried management in the traditional view is removed by the 'principal-agent' framework of Jensen and Meckling (1976) and Fama (1980). Fama actually denies the existence of ownership in any real sense, but this seems to be mainly semantics.

5/ Teamwork essentially involves non-separability of the produciton function so that marginal products could not be observed and rewarded purely by market exchange.

6/ Alchian and Demsetz (1972) deny the existence of an authority relationship within the firm, on the grounds that there is continuous freedom to recontract. However, this depends crucially on the existence of a costless, frictionless labour market, and is not present in other orthodox views of the firm, e.g. Coase (1937).

7/ Though Bradley and Gelb (1983) see resort to individual incentives as evidence of a failure of hierarchical control.

8/ In tacitly recognising employment risk, the argument here conflicts with that on which the alleged legitimacy of traditional property rights rests; wages are still fixed, but they are not risk free.

9/ See Jones and Svejnar (1982). The argument of course ignores the multitudes of traditional firms which are owned by individuals or families, or are otherwise closely-held.

10/ See Ward (1958), Domar (1966), Vanek (1970), Mead (1972, 1974).

11/ E.g. Steinherr (1977), Backhaus and Furubotn (1985). For a survey of LMF theory see Ireland and Law (1982).

12/ Except indirectly via an effect on the transactions costs of stockholder-intervention.

13/ Jones and Svejnar (1982) cite Greenberg's (1978) evidence that while US cooperative plywood manufacturers used only one or two

supervisors per shift, comparable capitalist firms used six or seven.

14/ The figure for 'opinion sought' with respect to employment decisions is only 0.18 in the Works Council sub-sample, compared with 0.33 in the full sample and 0.25 in the Workers sub-sample.

APPENDIX 1.1: SURVEY METHOD

Data collection was financed by a grant of DM 135,000 from the Volkswagen Foundation, administered by Dr F.R. FitzRoy at the International Institute of Management of the Science Centre, Berlin. The survey instrument was designed by the author, Professor Paul Kleindorfer of the Wharton School, University of Pennsylvania, and Dr FitzRoy, building on an earlier, postal questionnaire designed by FitzRoy and Dr John Hiller. The survey was administered by interview with firms whose cooperation had previously been obtained, in response to a letter of approach.

Interviews were typically of 2-3 hours duration, and carried out by Dr Karl Niemann by prior appointment. The principal respondents and source of information were representatives of senior management, or often proprietors in the case of small firms. Other members of the management might be called upon to assist with the provision of factual and/or judgemental responses, but no attempt was made to elicit more than one independent, management response. Where firms would permit it, however, interviews were also carried out with a representative of the workforce and a spokesperson for the Works Council (Betriebsrat). These interviews were confined to the section of the survey instrument which asked for subjective assessments of the degree of employee participation, etc. A data sheet, asking for financial, performance and other quantitative information at two-yearly intervals from 1971 to 1979, was left with the firm to be filled in from company records and returned to

Dr Niemann. Follow-up enquiries were required in many cases to ensure its return.

Usable responses were eventually obtained from 87 firms, though approximately a quarter of these were too incomplete to be used in the main analyses. The omissions were mainly in the quantitative data section of the survey, and especially for the earlier years requested. In retrospect, it was a mistake to have asked for data at two-yearly intervals over a ten year period (our intention having been to gain some longitudinal perspective on individual firms while at the same time mitigating the burden of responding for them). In the event, most firms did not have records readily available for more than a few previous years, and more data might have been forthcoming had we asked for annual data for five consecutive years. (This seems to be confirmed by subsequent experience in a survey for the UK, referred to in chapter 4.)

The following samples were used in the present analysis. All 87 firms were included in the tests of the Guttman scales of employee-participation, for which only the qualitative participation data were required. A pooled sample of 128 observations, comprising overlapping samples of 65 firms in 1977 and 63 in 1979, and in which minor gaps in the quantitative data were filled by interpolation, was used for the overall means in chapter 1 and the cross-tabulations and discriminant analysis of chapter 5. A third sample, for technical reasons consisting of only the 61 firms appearing in both the 1977 and the 1979 cross-

sections, was used for the analysis of subsample means in chapter 5 and for the econometric work in chapter 6.

2. THEORETICAL FRAMEWORK

2.1 Introduction

Though blurred by a multiplicity of titles defining job status and function at the place of work, the fundamental distinction is between workers and employers: the 'two sides of industry'.[1/] Each can be seen as having two broad strategic options: to seek control over the work process in order to maximise sectional gains; or to cooperate with the other side to maximise joint welfare. With non-trivial frictions and transactions costs in factor and assets markets,[2/] the *two sides are effectively locked in* over a range of performance and distributional outcomes in a continuing employment relationship. The firm is then a bargaining arena, in which each side can inflict substantial damage on the other without inducing exit (Cable and FitzRoy, 1980). The firm's economic performance and distributional choices may thus be seen as the outcome of a two-person game in which, as we shall see, its structural characteristics are also determined.

Looking at the firm in this way, we find that participation may affect the firm's behaviour and performance in two conceptually distinct, though potentially additive ways. First, participation may provide an institutional mechanism permitting attainment of efficient bargaining outcomes, for a given technology. This case can be examined using simple, existing models in which the players' objective functions are mostly defined over just wages (w) and employment (L) for workers, and profits (π) for employers. Secondly, however, participation may be seen as affording access to additional,

human-capital intensive technologies that are not available to traditional (i.e. non-participatory) firms. To see this we require more complex specifications of the players' objective functions, and of the firm's underlying production relationship; the analysis gains in richness and insight, though at some expense of formal tractability.

In each of the two cases identified, it is argued, participation may be interpreted as a Pareto-optimum solution in a prisoners' dilemma (PD) game. However, whereas in the first case the participatory outcome would not necessarily surpass efficient bargaining outcomes achieved by other means (e.g. Nash-bargaining equilibrium via collective bargaining), in the second case the participatory outcome can in principle dominate even the efficient bargaining outcome in traditional firms.

Prisoners' dilemma games are notoriously unstable, with an incentive always to do other than at present; if there is a (non-cooperative) Nash-equilibrium it is worth cooperating to secure the Pareto-superior outcome, but under Pareto equilibrium there is an incentive to cheat (though in repeated games the possibility of retaliation must be taken into account). The theoretical analyses help to reveal the circumstances under which participatory arrangements within the firm are likely to succeed in achieving the Pareto-optimum solution to the PD game. They also provide a framework for subsequent empirical analysis, in particular by throwing light on the ways in which participation in the firm may affect its performance.

2.2 Participation as Efficient Bargaining

Our analysis of this case builds on three previous studies: MacDonald and Solow's analysis of wage bargaining and employment (MacDonald and Solow, 1981), McCain's model of codetermination (McCain, 1980), and Ben-Ner and Estrin's recent investigation of what happens when unions run firms (Ben-Ner and Estrin, 1985). While there are important differences in the detailed specification of objective functions and technological constraints, and over institutional setting and application, these analyses share a broadly similar theoretical framework. We begin with a very simple model where workers' utility (G) depends on employment (L) as well as earnings (w):

$$G = G(w,L), \tag{2.1}$$

and employers' interests in dividends and capital gains, etc., (V) are proxied by profits (π): thus

$$V = V(\pi). \tag{2.2}$$

The firm's production activity is governed by an orthodox, concave production function:

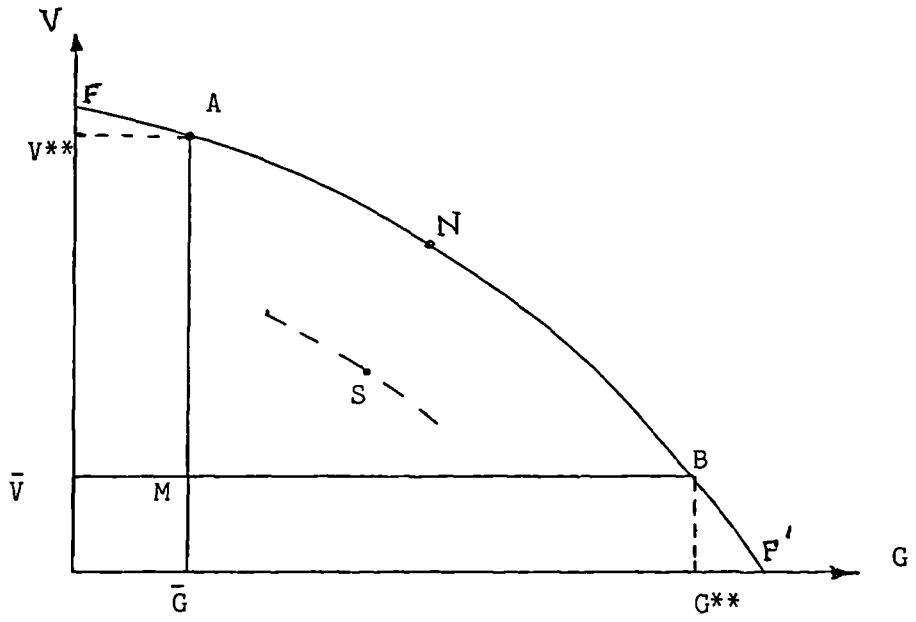
$$Q = Q(K,L), \tag{2.3}$$

where Q is physical output and K is the per-period flow of capital services.

Given the firm's demand constraints,[3] the underlying objective production function (2.3) determines all feasible utility vectors, which map through functions (2.1) and (2.2) into a set of utility pairs G,V bounded by the Nash-Zeuthen-Harsanyi efficient bargaining frontier FF' in figure 2.1.[4]

In a strictly orthodox, pure market model the only outcome would be at point M. Here workers' and employers' utility levels $\bar{G}$, $\bar{V}$) are set at exogenously given, market-alternative levels in the case of w and π, L is then endogenous, and each side is indifferent between working in the firm and elsehwere. Hence all utility pairings $(G, V) \leq (\bar{G}, \bar{V})$ are non-viable as one side exits, while any case where $(G, V) \geq (\bar{G}, \bar{V})$ will be eliminated via competition in capital, labour, and corporate control markets (i.e. due to entry and exit in response to excess reward, here calibrated in terms of G and V). Thus the bargaining set, bounded by FF' and containing all technically feasible $(G, V) \geq (\bar{G}, \bar{V})$, is empty.

Figure 2.1



Previous writers have, however, offered convincing arguments for the existence of non-empty intra-firm bargaining sets. Essentially a form of organisational rent is invoked, and the arguments primarily concern market frictions and the specificity of human and capital assets.

Aoki (1980), for example, argues:

> "The employees are considered to embody skills and knowledge more or less specific to the firm as a result of quasi-permanent association with it.[5/] The employees in cooperation with assets supplied by the stockholders, can produce some economic gains which would not be possible through mere casual combination of marketed factors of production. These economic gains accrue to the firm from the unique and lasting interaction of the organisational resources, both human and physical, and may be termed the organisational rent. Through the acquisition of firm-specific skills and knowledge, the employees may be able to exert implicit or explicit bargaining power over the disposition of the organisational rent" (emphasis added).

He then cites a similar observation from Alfred Marshall:

> "The point of view of the employer however does not include the whole gain of the business: for there is another part which attaches to his employees. Indeed in some cases and for some purposes, nearly the whole income of a business may be regarded as .... a composite quasi-rent divisible among the different persons in the business by bargaining, supplemented by custom and by notions of fairness ..." [p.626].

Further emphasis on the importance of firm-specific skills may be found in the recent literature on internal labour markets. Doeringer and Piore (1971) provide a particular graphic description, cited in Williamson, Wachter and Harris (1975):

> "Almost every job involves some specific skills. Even the simplest custodial tasks are facilitated by familiarity with the physical environment specific to the workplace in which they are being performed. The apparently routine operation of standard machines can be importantly aided by familiarity with the particular piece of operating equipment. ... In some cases workers are able to anticipate trouble and diagnose its source by subtle changes in the sound or smell of the equipment. Moreover, performance in some production or managerial jobs involves a team element, and a critical skill is the ability to operate effectively with the given members of the team. This ability is dependent upon the interaction skills of the personalities of the members, and the individual's work "skills" are specific in the sense that skills necessary to work on one team are never quite the same as those required in another." (pp.15-16)

Williamson et al also cite support from an unlikely quarter, containing an incidental reference to cooperation:

> "... practically every individual has some advantage over all others in that he possesses unique information of which beneficial use might be made, but of which use can be made only if the decisions depending on it are left to him or are made with his active cooperation. We need to remember only how much we have to learn in any occupation after we have completed our theoretical training, how big a part of our working life we spend learning particular jobs, and how valuable an asset in all walks of life is knowledge of people, of local conditions, and special circumstances." (Hayek, 1945, pp.521-522, emphasis added).

Williamson et al then proceed to classify job 'idiosyncracies' as arising in four main ways: (i) equipment idiosyncracies, (ii) process idiosyncracies, (iii) informal team accommodations, and (iv) communication idiosyncracies.

The increased productive potential due to job-specific capital, labour skills and information in the firm, above what a 'mere casual combination of marketed resources' would permit, is essentially

a public good. The associated quasi-rent is available for distribution among the firm's members, but participation rights are strictly non-portable. Thus, any who quit forego their claim, but at the same time reduce the total available to those who stay. (For example, the loss of one member of a team erodes the ability of all those remaining to work together or with a newcomer.) It is this which gives those associated with a firm both an incentive to stay and, as Aoki points out, their bargaining power within the firm, and it is probably this, rather than purely the more familiar search and other transactional costs of re-employment which, as stated earlier, effectively lock in employers and workers over a range of performance and distributional outcomes.[6/]

Given the existence of the bargaining set and its associated frontier FF', we can consider alternative reference outcomes in figure 2.1. As we have seen M may be interpreted as a market outcome, and as is now apparent this is the most that a 'mere casual combination of marketed resources' can yield. In Nash-bargaining terms M is also the mutual threat point, below which employers and workers will exit.

Points A and B, with utility pairs (V**, $\bar{G}$) and ($\bar{V}$, G**) are respectively dominant-employer and dominant-worker outcomes, where one side has 100 per cent bargaining power and the other zero. These are analogous to Stackelberg leader-follower outcomes in duopoly, where one player maximises own-utility subject to a low level opponent's reaction function, viz, in this case

$$\max (V|\bar{G})$$

in the case of point A, and

$$\max (G|\bar{V})$$

in the case of B. These are clearly, however, limiting cases which like their Stackelberg counterparts are not full but conditional equilibria, and are likely to be observed only in extreme circumstances.[7/]

Intermediate points such as N, on the other hand, are efficient bargaining outcomes, determined according to a model of the bargaining process e.g. Kalai and Smorodinsky (1975), Zeuthen-Harsanyi (1930, 1956), or (equivalently) Nash (1950, 1953). In the most familiar of these cases, (generalised) Nash-bargaining, N is obtained by maximising the weighted product of the differences between the players utility levels and threat points; $\max [G - \bar{G}]^{\delta} . [V - \bar{V}]^{\mu}$, where the parameters δ, μ denote relative bargaining strengths.

Interior points such as S represent inefficient outcomes. They occur whenever there is a failure to reach full agreement,[8/] for example as the outcome of a sequential game. In his model of codetermination, McCain (1980) focusses on suboptimization games where,

in the absence of an agreed bargain, certain variables $\underset{\sim}{P}$ are precommitted by player X, and the remaining free variables $\underset{\sim}{F}_x$, $\underset{\sim}{F}_y$ are then suboptimised by players X and Y given $\underset{\sim}{P}$ as data. The outcome is inefficient because (i) free variables can vary only over a restricted range determined by the values of the precommitted variables and (ii) $\underset{\sim}{P}$ may also be set suboptimally on the basis of expectations of opportunistic behaviour.

McCain defines workers' utility over earnings (w) and effort (E):

$$U_W = g\ (w,E), \tag{2.4}$$

and employers' utility, as before, over profits:

$$U_S = h\ (\pi). \tag{2.5}$$

The underlying production process is characterised by a function of factor inputs and variable effort

$$q = f\ (K,L,E). \tag{2.6}$$

where $E = \underset{\sim}{x}$ is a multidimensional vector of 'dimensions of work activity'. Suboptimisation occurs because in a world of incomplete labour contracts not all the x_i are specified. Codetermination is then presented as a potential source of mutual gains to workers and

shareholders, by shifting variables from the precommited set $\underset{\sim}{P}$ to the free set $\underset{\sim}{F}$; thus the commitment structure of the game is altered. In effect the frontier shifts from the broken line through S to the real frontier through N (figure 2.1).[9/] Essentially, codetermination works as an efficient bargaining institution.

Clearly the role of participation as an efficient bargaining mechanism need not be confined to the particular case of codetermination. McCain himself adds comments on the case of workers' management. More generally, it is the essence of any form of participatory arrangement that joint decision-making between workers and employers is extended over a broader range of decision variables in the firm than wages alone: employment, investment, job design, working conditions, supervisory arrangements, and so forth. Thus, generalising from McCain's model, consider the role of participation <u>in general</u> where the underlying production relationship is written

$$Q = Q\ (\underset{\sim}{K},\underset{\sim}{L},\underset{\sim}{Q},\underset{\sim}{m},\underset{\sim}{f},\underset{\sim}{e},\underset{\sim}{u},) \qquad (2.7)$$

where $\underset{\sim}{K}$ and $\underset{\sim}{L}$ are vectors of capital and labour inputs, $Q = Q\ (.)$ is a single-valued, concave function, and the remaining variables are all multidimensional vectors of organisational variables ($\underset{\sim}{Q}$), workers' effort ($\underset{\sim}{e}$), workers' strategic sanctions ($\underset{\sim}{u}$), employers' monitoring intensity ($\underset{\sim}{m}$), and employers' discretionary authority ($\underset{\sim}{f}$).

The organisation vector $\underset{\sim}{O}$ registers the firm's choice of job, batch or flow production methods, control spans, hierarchical structure, payments and communication systems, etc. Some areas of discretion over these matters may be assumed to exist, subject to technological limits, for a given product and capital labour inputs, though clearly $\underset{\sim}{K}$, $\underset{\sim}{L}$, and $\underset{\sim}{O}$ choices must be to some extent interrelated; for example, a given system of control-spans implies certain relative employment relationships within the $\underset{\sim}{L}$ vector and so forth. Workers' effort $\underset{\sim}{e}$ *resembles McCain's* E, *and the range of* workers' sanctions $\underset{\sim}{u}$ is familiar from the industrial relations literature: strikes, restrictive work-norms, demarcation rules, absenteeism, pilferage, non-communication, etc. Employers' monitoring ($\underset{\sim}{m}$) refers to vertical supervision, (as opposed to horizontal monitoring among peer groups of workers) and clearly may vary in intensity for a given control span. Finally, employers' authority ($\underset{\sim}{f}$) includes 'legitimate authority' under incomplete employment contracts, but is more especially intended to capture retaliatory actions such as threats and lockouts in the face of workforce militancy. In general terms, $\underset{\sim}{K}$, $\underset{\sim}{L}$ and $\underset{\sim}{O}$ determine the firm's technical inputs - its internal organisation structure and factor utilisation - whereas $\underset{\sim}{e}$, $\underset{\sim}{u}$, $\underset{\sim}{m}$ and $\underset{\sim}{f}$ define the way in which employers and workers behave towards each other.[10/]

Given this framework it is clear that in the traditional, non-participatory firm, employers typically precommit

$$\mathcal{P} = \{\underset{\sim}{K}, \underset{\sim}{L}, \underset{\sim}{O}\}$$

leaving the free variables

$$\mathcal{Y}_E = \{\underset{\sim}{m}, \underset{\sim}{f}\}$$

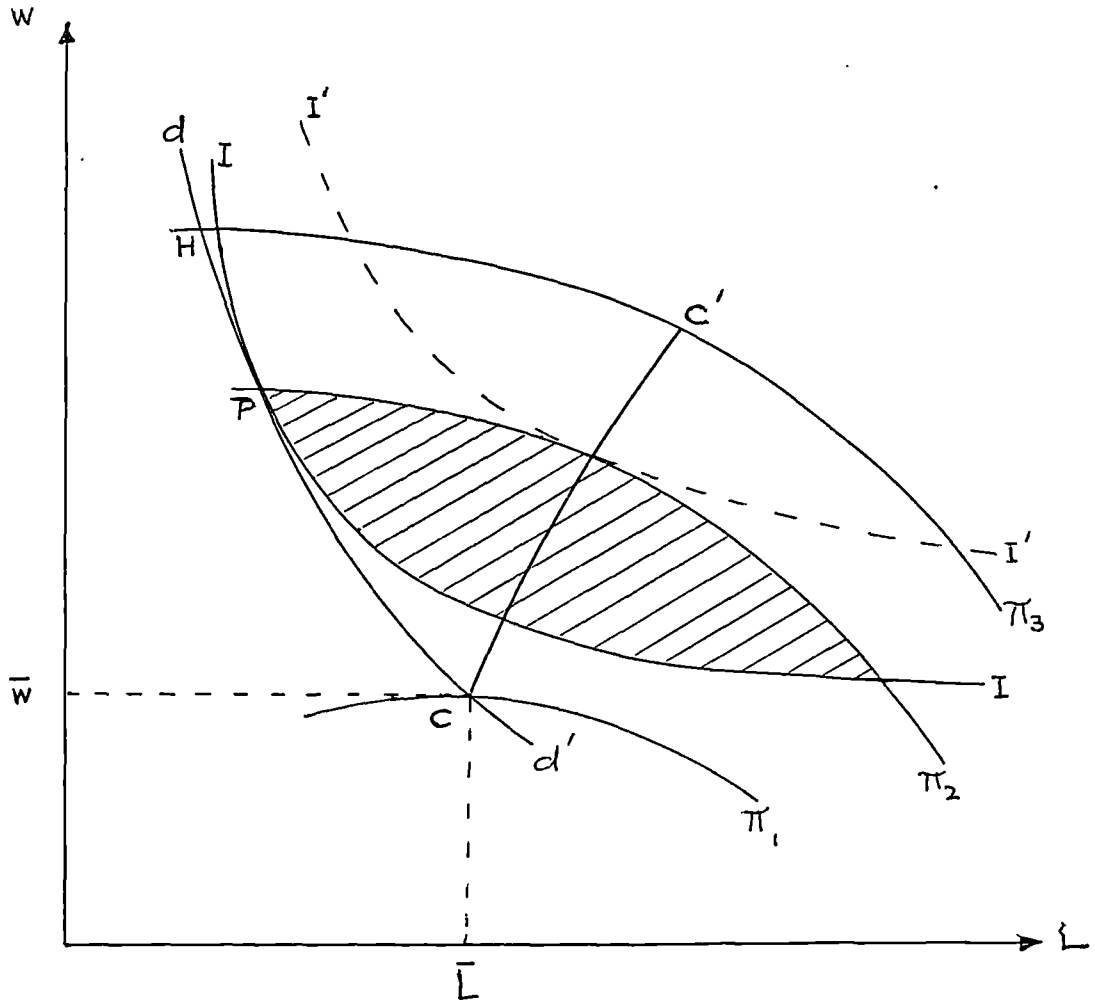
$$\mathcal{Y}_W = \{\underset{\sim}{e}, \underset{\sim}{u}\}$$

to be suboptimized by workers W and employers E. Just as in McCain's specific case of codetermination, any form of participation which enlarges the range of jointly-decided variables within the firm, shifting some or all of the $\underset{\sim}{K}$, $\underset{\sim}{L}$ and $\underset{\sim}{Q}$ variables from the precommitted to the free set, can be regarded as an efficient bargaining institution, capable in principle of moving the firm from interior point S in figure 2.1 towards the efficient frontier FF'.

Neat and insightful as this analysis based on McCain's model may be, it is incomplete in one important respect; there is no attempt to evaluate participation (codetermination) as an efficient bargaining institution against other institutional alternatives.[11/] Collective bargaining is the obvious candidate, and in a paper more or less contemporaneous with McCain's, McDonald and Solow (1981) demonstrate similar efficiency gains from extending the range of collective bargaining from wage determination alone.[12/]

With McDonald and Solow, we are back in a fixed-effort world where $V = V(\pi)$, $G = G(w,L)$ and $Q = Q(K,L)$. The case they consider has a profit maximising firm and a monopoly union supplier of labour. If there is wage bargaining only, equilibrium is on the labour demand curve dd' in figure 2.2, where the union indifference curve II is tangential to dd' at point P. But if bargaining is over wages and employment a set of Pareto preferred outcomes is available between the

Figure 2.2: Wage Bargaining and Employment (McDonald-Solow)



union's indifference curve II and the firm's iso-profit curve π_2 passing through P. The locus of tangencies betwen successive pairs of union indifference and iso-profit curves CC' is the set of efficient bargains. When transposed into utility space this corresponds to FF' in figure 2.1 The original wage bargaining outcome P is an interior point, and utilising McCain's framework we can see that the scope for efficiency gains depends on transforming employment (L) from a precommitted variable (which it is as long as the firm's labour demand curve is a constraint) to a free variable subject to union-employer negotiation.

The potential equivalence of participatory and union bargaining institutions is highlighted in the recent analysis by Ben-Ner and Estrin (1985). The authors compare Koor firms - the 150 or so firms owned and run by the Israeli trade union movement (Histadrut or General Federation of Labour), and accounting for about ten per cent of manufacturing employment - with unionised capitalist firms. In the latter, the firm is once again maximising $V = V(\pi)$ and the union $G = G(w,L)$ subject to the production function $Y = f(A,K,L)$, where π, w, L and K are defined as before and A is a technical shift parameter. Under efficient bargaining over w and L, the contract curve CC' in figure 2.2 is given by

$$-G_L/G_W = (1/L)\ (pf_L - w). \qquad (2.8)$$

Distribution of the surplus between owners and workers is assumed to

be the outcome of Nash-Zeuthen bargaining, maximising $N = [V-\bar{V}]^{\delta} \cdot [G-\bar{G}]^{\mu}$, the relative bargaining powers of agents δ, μ determining the position of equilibrium point along CC'.

Koor firms are seen as internalising the union-firm bargaining conflict, maximising

$$U = U(w,L,\pi) \tag{2.9}$$

with the function U(.) allocating weights that determine the division of the firms' economic surplus according to union preferences. However, in the present context we can clearly recognise the Koor firm as a participatory enterprise, by virtue of its joint welfare maximand. Now, as Ben-Ner and Estrin show, maximising U subject to π yields the first order conditions:

$$LU_{\pi} - U_{w} = 0 \tag{2.10}$$

and

$$U_{L} - U_{\pi}(w - pf_{L}) = 0, \tag{2.11}$$

which, when combined, yield exactly the contract curve for the unionised capitalist firm, mutatis mutandis. Thus, as Ben-Ner and Estrin stress, if the two kinds of firm face the same production, cost and demand parameters, and the same reservation wages $(\bar{w})$ and union preferences for w and L, they will have identical contract curves. The equilibrium point will then differ only to the extent that the

distribution parameters in the Koor (i.e. participatory) firm's maximand diverge from the bargaining power parameters δ, μ in the unionised capitalist firm.

In subsequent empirical work Ben-Ner and Estrin find that, in the Israeli context, (i) the contract curve CC' is positively sloped; (ii) there are no perceptible differences in union preferences over w and L as between Koor and union-bargaining firms; but (iii) there is a significant (40%) productivity-augumenting shift effect generated by union ownership and management (the Koor firms have more to distribute). The whole question of shift effects is taken up in the next section.[13/] The relevant point here is that the Koor firm maximand is an essentially participatory, joint-welfare maximising specification;[14/] and Ben-Ner and Estrin themselves cite other evidence that the situation in Koor firms amounts to "something very close to co-partnership between the workers' representatives and management" (Barkai, 1981). Thus, recognising the Koor model as a case of participation, the formal equivalence with efficient union-bargaining is clearly established.

2.3 Participation, Human Capital and Technology

In the foregoing analysis the role of participation is strictly limited. Essentially this is because participatory and traditional firms are assumed to make the same technological choices; the underlying true objective payoff frontier is the same for both (and hence also its transformation to the curve FF' in figure 2.1). In the simple models considered participation may be important for

whether the efficient frontier is reached, and hence for the size of the firm's economic surplus available for distribution, but effects on production methods, supervisory and control systems, job content, human capital development and the quality of working life are ignored. In public and policy discussion of participation, by contrast, potential effects such as these loom large. Thus an extension of the theoretical framework to encompass them is needed.

The central question at issue is whether employee participation in the control of an enterprise can open up a 'new world' of technical opportunities that are not available to non-participatory firms. The basic idea is simple; that in traditional firms the available technical choice set is constrained not only by technological knowledge, but also by the need to maintain control over the workforce. Thus, under traditional organisation only the subset of control-maintaining technical choices is available. Where control is shared, however, this second constraint is removed. Formally, we define the global set of technical opportunities $\mathcal{Y}$ associated with a given state of knowledge, the elements of which may be thought of as exhaustive input-output vectors $\underline{T}$. Control-maintaining technical choices are a subset of the global set: $\mathcal{Y}_c \subset \mathcal{Y}$ The twofold question at issue is (a) whether the complement $\mathcal{Y} - \mathcal{Y}_c$ in $\mathcal{Y}$ is economically speaking non-trivial, which involves questions concerning productivity and welfare, and (b) whether participation in any institutional guise can make it available.

The notion of control-constrained technology is well established in the radical economics literature. Edwards (1979)

provides a particularly good account. Introducing his discussion, Edwards observed:

> "Considerations of technical efficiency ... distinguish superior from inferior methods. Yet by themselves these types of technical considerations are insufficient to determine what technologies will actually be used.
>
> It is well known that most industries confront a variety of possible techniques, and that the relative costs of required inputs will influence which is chosen ... What is less well known is that there is also an important social element in the development and choice of technique. Firms confront a range of techniques that differ not only with respect to required inputs, but also in the possibilities for control over their workforces. A superior technology may be one that facilitates the transformation of the firm's labour power into useful labour, even if that technology entails a larger bill for other inputs or even a larger wage bill per hour of operation .
>
> While it remains true that capitalists undoubtedly seek those technologies that are the most profitable, we must now admit that there are several considerations that enter into the calculation of profitability. One is technical efficiency, the ratio of the physical outputs to the physical inputs; another is the cost of the various inputs and the value of the outputs; yet a third is the leverage in transforming purchased labour power into labour actually done" (pp.111-112).

Edwards then examines the nature of technical control, and documents with much illustrative detail its evolution in the 'capitalist era'. His analysis forms part of the radical critique of scientific management, or Taylorism, with its emphasis on deskilling, machine pacing, monitoring and hiring and firing, developed elsewhere by Braverman (1974), Gordon, Edwards and Reich (1982) and others.

In the game theoretic framework adopted here, the control-precluded technical options in the traditional firm would be those which, if chosen, give workers enhanced bargaining power. Thus

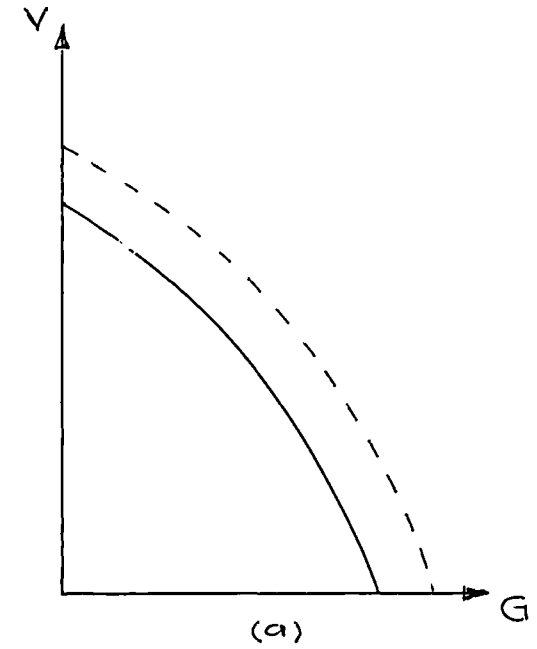
the significance of deskilling will be not merely to reduce the costs of hiring, training, and firing (with respect to marketable labour skills), but also to minimise the acquisition of firm-specific skills and knowledge through which, as we have seen, employees derive 'implicit or explicit bargaining power'. In abstaining from these choices the traditional firm stakes its chances on a control-oriented strategy. However it thereby foregoes the productivity and welfare gains which might be obtained by developing the potential human capital of its workforce. Thus, where participation does act to open the new world of technical opportunities, we would expect to observe significant differences in the characteristics of the workforce between participatory and traditional firms, along various observable dimensions of human capital.

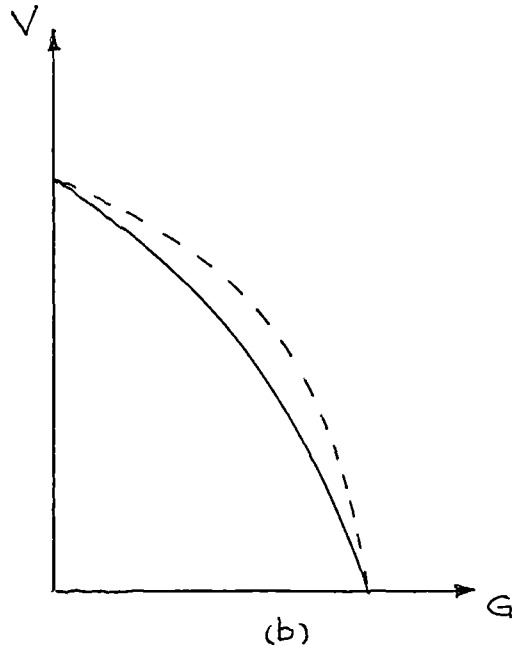
Once it is recognised that the firm's choice of production methods is being determined by strategic behaviour in the firm, as well as by 'laws of nature', it is evident that technology is not the wholly exogenous constraint it is assumed to be in orthodox theory. Nevertheless, the potential scope for participation to open up new technical opportunities will vary from industry to industry, according to technical limits which truly are exogenous; the boundaries of the relevant <u>global</u> technical opportunities sets. Oil refining, for example, probably offers rather limited opportunities, at least at the relative input prices ruling in developed and oil-producing economies. Suppose that, in a particularly restricted case, the new technical opportunities which participation offers lead only to an increased density of utility pairings below and to the left of point S in figure 2.1, and that S is the relevant, traditional alternative in

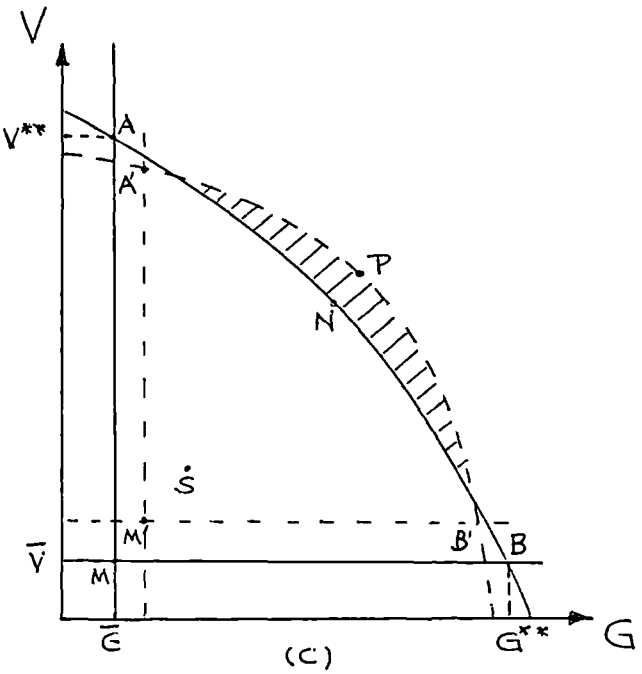
the firm in question: a suboptimal game outcome following the employers' original, control-oriented precommitment of $\underline{K}$, $\underline{L}$, and $\underline{Q}$ in equation 2.7. Clearly participation as the new world offers no additional welfare gains here (though it may of course still offer a potential for improvement towards the frontier FF' via efficient bargaining).

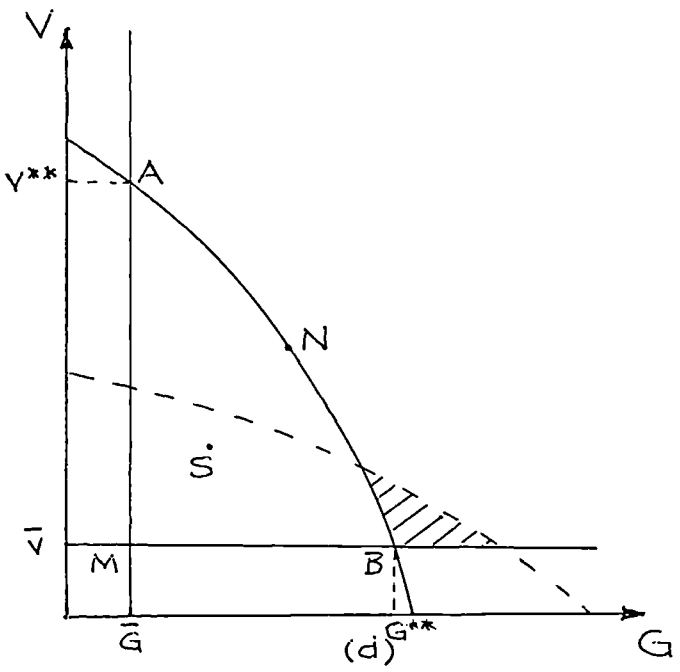
If, on the other hand, the newly available utility pairings lie above and to the right of S up to the frontier FF', participation offers dual scope for mutual gains, via 'new world' and efficient bargaining effects. But participation still offers no potential improvement over efficient outcomes arrived at by other means using restricted (non-participatory) technical choices. Finally, however, consider the case where the new technical opportunities underlying the utility frontier cause it to shift. Figure 2.3 shows a number of possibilities. Cases (a) and (b) are optimistic of participation's potential, involving shifts in the frontier along its entire length (excepting the end-points in the case of (b)). Case (d) extends the range of potential workers' utility G, but there is no mutual gain for employers. However, *in case (c)* there are mutual gains. Note that in this case the participation outcome P can be Pareto-preferred not only to S but also to the 'traditional' (i.e. non-participatory) efficient bargain N. Note also that in this case the one-side-dominant outcomes (A', B') now offer lower utility than the previous maxima (V**, G**). Moreover the mutual exit-threat point has risen to M', for example because increased non-specific skills raise the market alternative wage. These changes are of no consequence as long as the participatory

Figure 2.3: Technology Shifts









outcome is held. But they illustrate a form of no-return risk when entering participatory agreements that may fail.

The prospect of a frontier shift due to participation increases when we allow for the fact that the choice of production methods, job content, human capital development, etc. may enter directly into the players' utility functions, rather than affect welfare indirectly via financial rewards (w,π) and the mere fact of being employed (L), as in the formal models considered so far. How far it is useful to go in elaborating the relevant functions is an open quesiton. At minimum, perhaps, we might wish to consider

$$G = G(w,B_w,e,d_w,t_w) \tag{2.12}$$

for workers, and

$$V = V(s,\pi,B_m,d_m,t_m) \tag{2.13}$$

for employers, where $w = \bar{w} + w'$, and $\bar{w}$, w' are the workers' market-alternative wage and firm-specific supplements respectively; similarly $s = \bar{s} + s'$ is managerial salaries, e = workers' effort;[15/] d_w, d_m are levels of job security for workers and managers respectively (i.e. expected duration of employment), and t_w, t_m are corresponding indices of job-satisfaction derived from performing assigned tasks; B_w denotes non-pecuniary worker benefits; B_m represents managerial non-pecuniary benefits and discretionary expenditures; and π is profits.

The firm-specific supplements w' and s' correspond to Aoki's 'differential earnings': shares in the organisational rent

arising from quasi-permanent association within the firm, as well as premia for firm-specific skills and responsibilities under plant-level job evaluation schemes, etc. Workers' effort e is present, in part, to capture the level of disutility associated with a given intensity of labour input, according to whether this is volunteered or extracted via a supervision or authority system. The variables t_w and t_m are notional indices capturing the inherent interest or boredom associated with assigned tasks, the scope for creative work they offer, the nature and frequency of contacts with others in the place of work, and so on.[16/] These, in particular, will be sensitive to the extent to which the firm chooses to develop and utilise human capital in its workers. Non-pecuniary benefits include fringe benefits and the quality of working conditions for both workers (B_w) and managers (B_m), but in the latter case also reflect goal participation and the extent of discretionary expenditure as emphasised by managerial theorists (notably Baumol 1958, 1967; Marris 1964; Williamson, 1965). Finally profits (π) may be interpreted as capturing shareholders' and managers' interests in dividends, capital gains and retained earnings.[17/] Presumably G, V are increasing in all arguments except workers effort e; over some range workers may feel positively towards extra work, especially if they have volunteered or sanctioned it, but disutility of further effort must arise beyond some level.

Precisely how we might choose to augment the workers' and employers' objective functions is, for present purposes, a question of detail; the foregoing is merely an example. The more important, general point is that once the existence of direct utility effects of work organisation - the non-neutrality of transformations[18/] - is

recognised, the possibilties for participation-induced frontier shifts are enlarged. For the curve FF' in figures 2.1 and 2.3 is now a mapping from underlying utility vectors extended to include variables other than w, L and π, illustrated by equations 2.12 and 2.13, and capturing welfare effects that ex hypothesi are strong under participation and weak under traditional work organisation. Of course, the extent to which participants can trade-off non-pecuniary benefits against productivity and profit-enhancing factors will be limited in the face of competition from traditional firms; ultimately the limiting factor is the extent to which workers and employers are prepared to forego financial reward for increased quality of working life. At the same time, it does not follow that such tradeoffs are inevitable. There is no a priori certainty that traditional methods will dominate others on purely financial grounds- that participatory, human-capital-intensive production cannot match traditional organisation. Whether or not they do is an empirical question, to which we return in chapters 5 and 6.

2.4 Equilibrium in a Prisoners' Dilemma

The preceding arguments identify two potential roles for participation: as an efficient bargaining institution enabling the utility frontier to be reached for a given, underlying production technology; and as a means of shifting that frontier by enlarging technical opportunities available to the firm. We now show that participation may be seen in each case as the Pareto-optimum solution in a prisoners' dilemma (PD) game. Recall that workers' and employers' broad strategic options are to seek unilateral control (denoted as strategies W2, E2) or to cooperate (W1, E1). In figure

2.1, as we have seen, unopposed employers' and workers' control (E2, W1 and W2, E1) occur at points A and B respectively. Here the enterprise generates a high level of overall benefits, distributed asymmetrically in favour of the controlling side. Mutual cooperation (W1, E1) on the other hand, yields an efficient but more equitably distributed outcome N. Where, however, there is no full agreement and both players attempt to control (W2, E2), conflict will result, and the mutually damaging tactics reduce overall economic performance and benefits, as at interior point S.

With suitably calibrated axes, these outcomes conform to the payoff matrix in table 2.1. This is clearly a PD game: control is the dominant, individually rational strategy for both players, whatever the opponent chooses, yet the conflict (W2, E2) outcome is Pareto inferior to the cooperative (participatory) outcome E1, W1.

Table 2.1: Payoff Matrix

	EMPLOYERS	
	E1 (Co-operate)	E2 (Control)
W1 (Cooperate)	6,6 Participation	4,7 Autocratic Management
W2 (Control)	7,4 Dominant Workers	5,5 Conflict

Note that in this case no four efficient outcomes can satisfy the PD ordering; only when an inefficient outcome such as S is considered does a conforming pattern emerge and, as we have seen, participation will not necessarily surpass efficient bargaining outcomes arrived at by other means.[19/] However, where participation shifts the efficient

bargaining frontier, as in figure 2.3(c), points P, S, A and B again form a PD payoff structure, but in this case participation P offers potential mutual gains over not only the suboptimal outcome S but also over efficient bargaining with traditional production N.

In purely theoretical terms, we know that the conflict outcome in table 2.1 is the individually-rational (Nash) equilibrium in a one-shot game, and on the equilibrium path at every stage in a finitely repeated game.[20/] However prisoners' dilemma games are inherently unstable, with an incentive always to do other than at present; if there is Nash-equilibrium it is worth cooperating to secure the Pareto superior outcome (W1, E1) whereas under Pareto-equilibrium there is an incentive to cheat (though in repeated games the possibility of retaliation must be taken into account). Moreover experiments by Axelrod and Smale have produced results where, at least for some time, players cooperate and end up with payoffs strictly greater than under equilibrium play. Noting that in Axelrod's PD tournament, the "strikingly simple and quite natural strategy" of 'tit-for-tat' play[21/] emerged as the winner, Kreps, Milgrom, Roberts and Wilson (1982) show that such cooperation until the last few stages of a repeated game is consistent with rational, self-interested behaviour if either it is not common knowledge that the opponent is not 'tit-for-tat', or there is two-sided uncertainty over the stage payoffs (and hence of the opponents' incentive to renege).

Incomplete information of this kind is not unlikely in the complex production game under consideration. However, the cooperation it produces occurs only in the finitely repeated game, whereas the

production game is in practice most likely one-shot. Though production itself is obviously a repeated activity, workers and employers typically do not view determining the form of work organisation as a recurring issue, not least because of the high transaction costs involved. And while far-reaching organisational changes do occur from time to time, it is neither obvious nor very likely that they have been anticipated at the previous stage, as is required in a repeated game. Hence the reality may be a sequence of (infrequent) one-shot games rather than a single, repeated game. In any case the level of transactions costs is such that even in a genuine repeated game, the number of repetitions within the players' time horizons must be small, whereas the cooperation discussed by Kreps et al continues only until the last few plays, and is therefore of interest only in large, frequently repeated games.

Can we nevertheless envisage situations in which participation is chosen as the solution to a latent PD problem? The existence of such situations turns on the players' perceptions of (a) the probability that the opponent will renege on a participatory arrangement if established; and (b) the probability of achieving outright domination and maximising individual benefits under the relevant off-diagonal, Stackelberg leader-follower equilibria.

Ensuring that probability (a) is low enough is a matter of establishing adequate mutual trust and security in the design of participatory institutions and contracts. Here the distinction between producer cooperatives (PCs) and participatory 'schemes' may be important.[22/] Once the conflict between workers' and employers' interests has been internalised via large worker-ownership stakes, the

incentive to revert to sectional utility maximisation is removed; this is the argument put by Oakeshott (1978), Horvat (1982 a,b) and some other writers, that a substantial ownership stake by workers is essential to break down the traditional antagonism between labour and capital and support the required changes in working practices and social relations of production.[23] The point is of course strongest when all the workers in a PC are owner-members - with no distinct categories of member (e.g. the original founding group and others), no non-working members, and no contracted labour. Otherwise, internalisation is incomplete and the enterprise may begin to exhibit symptons of 'degeneracy' including the domination of some sectional interests or open conflict between them,[24] so that PC behaviour comes to resemble the other outcomes highlighted by the present analysis: (W1, E2), (W2, E1) or (W2, E2).

Thus while the 'pure' form of PC may offer a full solution to problem (a), not all PCs will be of this type. Moreover participation 'schemes' may also have trust-enhancing features. This is particularly true where they involve mutual release and sharing of each sides' strategic information. By so doing each side signals its willingness <u>not</u> to revert to sectional behaviour and, indeed, forfeits an important strategic advantage were it to attempt this. Similarly, profit-sharing schemes introduce a further element of 'bonding'. For example, if employers renege on a participatory cum profit-sharing arrangement, and succeed in maximising V, workers at least receive monetary compensation via their profit-sharing entitlements. Conversely, if workers defect the financial loss to employers is mitigated by reduced profits-to-workers payments. However, the strength of the bonding effect is clearly a function of the amount of

profit-sharing (more specifically the proportion of total income for which it accounts), which in practice is often small.

In sum, it appears that both PCs and participation schemes may be routes to the Pareto-superior outcome (W1, E1). But there is nothing automatic in this, and whether they are or not will depend on the institutional or contractual arrangements in specific cases.

With respect to (b), the perceived probability of one side achieving outright domination, it is important to recognise that in the real-world production game the availability to each player of a choice of strategy is not absolute, but a function of environmental factors. Thus the chances of worker domination will be perceived to be small and those of employers correspondingly large if there is heavy unemployment and acute domestic or international competition; if government policies curb union organisation and activity (e.g. by removing closed shops, restricting picketing, increasing unions' legal liabilities over disputes, enforcing 'contracting in' to political levies, and so forth) and at the same time reduce unemployment benefits and strikers' social security; and if social attitudes emphasize respect for material and private property and deference to hierarchical authority.[25/] Conversely, the opposite economic political and social environment will generate the opposite predictions.

These effects can be captured in the model by attaching the players' subjective probabilities to the payoffs in table 2.1, where these probabilities are then a function of the prevailing economic, political and social environment.[26/] When the probability of one

player being able to play his 'control' strategy falls below a certain level (in the limit zero), the game simply collapses to a single leader-follower outcome (W1, E2 or W2, E1), one side having no option but to comply.

In certain cases, environmental factors have an overriding influence in ruling out particular outcomes. For example, the pathological, low performance Nash equilibrium (W2, E2) may be viable only in a favourable economic climate, such as an economic boom, or under tariff protection or monopolistic advantage, and be driven out under economic adversity. Experience in the UK in the post-1979 recession is of interest here, showing evidence of a polarized response to the crisis - some firms reverting to strong managerial control but others, despite the presence of a government policy favourable towards reassertion of managerial prerogatives, seeking a participatory solution.[27/] Also, as we have already seen, technological imperatives may rule out an effective participatory solution in certain cases, most especially when they dictate giant plant size, extremes of machine-pacing, etc. (though as has also been seen, we should be wary of treating technology as truly exogenous, when the nature and direction of R & D effort may have been biased towards work-control enhancing technologies).

The upshot is that when naive theoretical predictions are tempered with practical and political considerations, none of the four outcomes in table 2.1 can be ruled out <u>in general</u>. When, however, we turn to a specific context, a balance of probabilities may be struck. The empirical analysis which is reported in chapters 5 and 6, for example, is concerned with West Germany in the late nineteen-seventies.

In this case it is highly improbable that, in the majority of firms, either side could achieve a unilaterally dominant position. Hence the off-diagonal leader-follower outcomes are unlikely to be encountered, except as occasional, observational outliers. Thus in an empirical sample we should expect to observe basically two firm types: participatory and traditional enterprises.

2.5 Conclusions

A simple game-theoretic approach helps to distinguish two conceptually separate roles which participation might play: firstly as a mechanism whereby workers and employers may reach 'efficient' bargains, within a given technology, maximising benefits to each side given the benefits received by the other; and secondly as a way of opening up access to technological choices which, though permitted by laws of nature, may be proscribed on considerations of strategic control in traditional firms. In each case participation can be seen as a solution to a latent prisoners' dilemma. In the first case the participatory outcome would not necessarily dominate efficient bargaining outcomes achieved by other means, e.g. collective bargaining; hence it may be observationally indistinguishable from them by reference to enterprise performance variables alone, though other, structural evidence should permit identification of the participatory case. In the second case, however, the participatory outcome could dominate even efficient bargaining in traditional firms. If so, participatory and traditional firms will differ systematically both in performance dimensions and in structural characteristics. The nature of these differences is elaborated in chapter 5, where empirical results for West Germany are also presented. Before turning

to the empirics, however, we consider in the next two chapters the problems which arise in defining and measuring 'participation' in the various senses of the term. The principal implication for participation measurement that arises from the present theoretical discussion, is the importance of the range of decision variables encompassed.

FOOTNOTES

1/ 'Employers' means owners and top management, and in large organisations may reach down to middle and junior management, at least to department heads. While generalisation over where to draw the line is hazardous, the distinction between employer and employed is usually straightforward in specific cases. The two sides of industry are treated 'holistically' throughout the analysis, i.e. as single-acting entities. Thus problems of goal-conflict and intra-group co-ordination are subsumed. In the case of employers, a transactions-cost efficient reconciliation of owners' and managerial objectives is assumed to have taken place within the agency framework developed by Jensen and Meckling (1976).

2/ Including not only the familiar transactions costs from job search but, in particular, rigidites arising from labour and asset specificity, discussed below.

3/ For simplicity, the firm is assumed to produce a single product and face market-determined prices. In later empirical work market structure variables and industry dummies are included to normalise for possible market power effects.

4/ As is customary we show FF' concave from below. We assume non-increasing returns in production and diminishing marginal utility over the relevant range in all utility arguments. As Bishop (1963) explains, the frontier is either linear or concave from below in all usual cases; "if it has any portions that are concave from above, or if it is initially discontinuous (for example consisting of just certain isolated points, as when the objects to be exchanged are indivisible), the orthodox prescription is to bridge those gaps with straight lines, reflecting the expected utilities implied by various probability deals".

5/ Freeman and Medoff (1979) put the average duration at 8 years or more.

6/ The existence of firm-specific quasi-rents also gives rise to asymmetric information in labour markets, in that outsiders (potential joiners) will know only the <u>average</u> rents to be expected in a firm of given size etc in a given industry, rather that the actual rent in a given firm, whereas for the firm's existing workers actual rent is known from experience.

7/ In the terminology of a different literature these outcomes may alternatively be seen as encapsulating the class struggle, except that even at B private capital remains as an institution. Following Bradley and Gelb (1983) we might envisage a further stage where stock values are reduced to zero via worker-controlled commercial and distributive policies, and capital is then 'bought out' at zero market price. On the question of whether A and B will be observed, see section 2.4 below.

8/ Bishop (1963, p.562) points out: "if bargainers cannot agree as to a particular point on their utility frontier, they are not going to reach it at all".

9/ McCain's frontier is defined in effort/productivity terms, not utility as here, but this does not affect the argument.

10/ With factor inputs entered as specific types or grades of capital and labour, technology may realistically be regarded as wholly embodied. Consequently, many kinds of production or X-inefficiency (Farrell, 1956; Leibenstein, 1966), i.e. departures from the maximum output technically derivable from given factor inputs, are allowed for explicitly here. However evidence of disembodied technology effects may appear in empirical work if, as is likely, employment levels of different grades of capaital and labour cannot be measured with complete accuracy. This may well have occurred in the results reported by Ben-Ner and Estrin (1985), discussed below.

11/ Except insofar as McCain explicitly rules out complete labour contracts, on feasibility grounds.

12/ C.f. also Freeman and Medoff's 'collective voice/institutional response' view of trade unions (Freeman and Medoff, 1979, 1984).

13/ The nature of the productivity-augumenting 'shift' in Ben-Ner and Estrin is not entirely clear: specifically, whether the shift is from some interior region (e.g. near S) towards the true frontier FF' in figure 2.1 (type I shift) or whether FF' itself shifts (type II shift). (This distinction is discussed further in the following section.) In our framework the first depends on players' behaviour (in terms of e, u, m and f) within a given choice set over the vectors $\underset{\sim}{K}$, $\underset{\sim}{L}$ and $\underset{\sim}{Q}$, whereas the second implies expanded $\underset{\sim}{K}$, $\underset{\sim}{L}$ and $\underset{\sim}{Q}$ choices and their associated behaviour. In their discussion Ben-Ner and Estrin refer to incentive and morale effects, and "reduced conflict between work and management [which] will have a positive influence on industrial relations and on productivity enhancing factors in particular" (p.5). This suggests a shift of the first type. However, in footnote 5, they also hint at human capital effects, flowing from increased worker incentives due to reduced labour turnover, and this suggests a type two shift, since the $\underset{\sim}{L}$ vector certainly, and the $\underset{\sim}{K}$, $\underset{\sim}{Q}$ vectors possibly may now change. Technically, the problem is that only disembodied technology shifts are allowed for, whereas there may be observationally indistinguishable from variations in the 'quality' of inputs, when K, L are entered in an aggregated way.

14/ However it appears that the Koor firms may be participatory only in this highly abstract sense, as Ben-Ner and Estrin observe: "Ownership rights of these firms are vested in the Histadrut and therefore diffused throughout the unions' membership, so the possibility for direct workers' ownership and control at the enterprise level are small. In fact, Koor firms are run by union-nominated managers in a fairly traditional way. These managers are required to operate with union preferences in mind

for the benefit of Koor firms' employees and of union membership at large." (Ben-Ner and Estrin, 1985, p.4).

15/ Managers' effort is assumed to be captured elsewhere, in variables such as control span and monitoring intensity (see below). Effects on managerial utility then feed back via t_m. These are discussed in detail in section 2.3 below.

16/ Under complete labour contracts t_w, t_m would become redundant since there would be no variation in tasks and duties associated with a given wage or salary.

17/ As previously noted, a transaction-cost efficient reconciliation of owners' and managers' objectives is assumed to have taken place within the agency framework developed by Jensen and Meckling (1976).

18/ In axiomatic production theory neutrality of transformations entails that any two transformations are indifferent if their inputs are indifferent and their outputs are indifferent. That is consumer-workers judge transformations solely by their inputs and outputs, and the processes or activities as such do not give rise to preferences. Walsh (1970) observes that this axiom may be interpreted as an assumption that all transformations are, so to speak, morally and aesthetically 'clean'. He adds "need I point out (again) that in the world we live in this is most notoriously not so?" (p.227).

19/ Though in practice collective bargaining appears to be primarily, if not overwhelmingly, over wage issues only.

20/ The logic is similar to Selten's backwards induction in the chain-store game. By contrast, in an infinite game, 'any average payoff vector in the intersection of the positive orthant and the convex hull of the four possible stage payoff vectors can be achieved through a perfect equilibrium" (Kreps, Milgrom, Roberts and Wilson, 1982).

21/ 'Tit-for-tat' play requires cooperation at first, which is then continued only if the opponent also cooperated at the previous stage.

22/ In the case of a PC it may seem at first sight that the game-theoretic framework is inappropriate since there are no longer two players; workers also own the enterprise. But a strict separation between owners and workers is in fact not possible under any of the four outcomes; there is nothing to prevent workers buying shares in the most autocratic or conflictual companies, if they wish. Moreover, the interests of workers qua owners and workers qua workers have still to be reconciled in a producers' cooperative. Thus the fact that workers play a dual role does not fundamentally change the structure of the game; what really happens is that in the PC case the trade-off between workers' and owners' interests is internalised. We should therefore expect to observe open conflict (W2, E2) or exploitive domination of either workers' or owners' interests (W2, E1) and (W1, E2) only in cases of PC

degeneracy, as, for exmaple, in the case where Furubotn (1976) considers domination by an original, founding group of members. In practice, by no means all PCs have 100 per cent owner-membership. Thus internalisation of the worker-owner tension may be incomplete, and this will affect the behaviour and performance of PCs. Variables used in empirical work which capture the proportion of worker-members, the importance of members' loans in the capital structure, etc., (Estrin and Jones, 1983; Jones and Svejnar, 1984) may be interpreted as proxying the degree of internalization which has been achieved.

23/ This is not, however, a universally held view, and in principle there is no reason why similar results should not be achieved by agreement between separate goups of workers and employers, just as in principle colluding oligopolists can achieve the results of a multi-plant monopolist. Problems of trust and potential chiselling are, of course, to be reckoned with, but problems also exist in securing agreement and loyalty within PCs. This is not, however, to say that exactly identical outcomes are to be expected from PCs and from conventionally-owned participatory firms. An important difference arises from the fact that individual PC member-workers are likely to have much higher exit costs, and correspondingly lower exit propensity, than are either workers or owners in conventional firms; because of their dual role, their exit costs are the sum of those of a worker and an owner. On the one hand this may be expected to result in a greater incentive to secure agreement within the cooperative, and prevent the necessity for exit. At the same time it may mean that the minimum values to which particular worker and owner benefits can be driven before exit occurs will be higher for participatory firms than for PCs. Consequently, the balance between owners and workers interests may have to be found within a narrower range of payoff-values in the participatory firm, and this could mean that in empirical work we will observe higher levels of physical productivity and financial performance than in PCs, whose scope to trade these off for increased worker benefits is less tightly constrained by the need to prevent employers from abandoning either the firm as a whole or, at least, the cooperative stance required to sustain a participatory agreement.

24/ As, for example, in the case where Furubotn (1976) considers domination by an original, founding group of members.

25/ There are now two kinds of uncertainty in the model, one concerning rival's behaviour and one (mutual) uncertainty about stage payoffs (c.f. Kreps et al).

26/ The outstanding example of political impact is perhaps the case of Chile under the short-lived Allende government (see Espinosa and Zimbalist, 1978). Striking examples of politico-social influence are also to be seen in developing countries. Current policies to 'liberalise labour markets' in the US and UK offer further, in this case negative, illustrations.

27/ Source: spokesman for West Midlands Engineering Employers Federation. The opinion is substantiated by empirical data collected by Nick Wilson for the UK Work Organisation project.

3. THE MEANING AND MEASUREMENT OF PARTICIPATION: SOME TESTS OF EMPLOYEE PARTICIPATION INDICES

3.1 The Nature of Participation and the Measurement Problem

The term 'participation' has so far been used in a broad sense, covering situations that range from full workers' control in producer cooperatives over varying degrees of participation under informal participatory 'schemes' in conventionally owned firms. This rather loose usage is characteristic of the existing literature, where 'participation' is capable of various meanings and can be a source of some confusion. For example, it is not always clear whether collective bargaining and grievance procedures would or would not fall within the definition in a given context.[1/]

More precise definitions and measures are required for effective empirical work. First, we may usefully separate two functionally distinct types of participation: financial participation, in the form of profit or value-added sharing by workers, worker-ownership, or worker provision of debt capital; and participation in control or, as Espinosa and Zimbalist put it: "the ability of workers to directly influence or form the management and work process in an enterprise" (1978, p.2). Essentially, participation in control captures the nature and degree of employee involvement in the decision-making process.[2/] While both types of participation may be important from a motivational, human capital utilisation and group behaviour viewpoint, participation in control is clearly the more closely related to the theoretical framework developed in the preceding chapter. Unfortunately, however, whereas

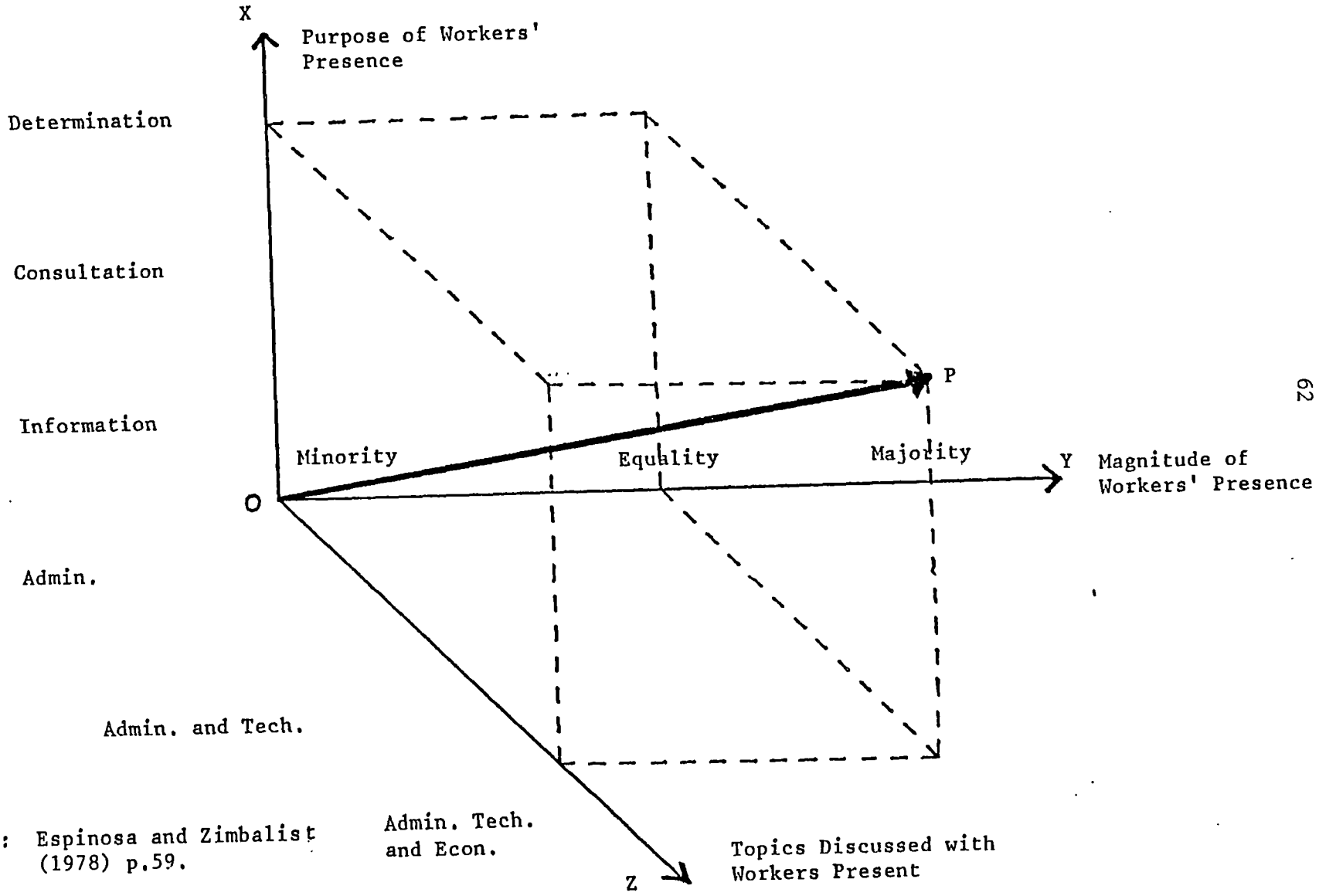
financial participation raises no unusual measurement problems (i.e. problems beyond the commonly encountered difficulties of non-standard accounting definitions and practices etc), measuring participation in control encounters problems of a totally different order.

The essence of the problem is that participation in control is a qualitative, multi-dimensional phenomenon, whereas for many research purposes an overall, quantitative measure of the degree of workforce involvement is needed. The solution mostly commonly applied in past work has been to compile an index of participation. Espinosa and Zimbalist's (1978) early work on Chilean cooperatives under the Allende government remains one of the most detailed and carefully constructed examples. Their index takes account of the range of the firm's activities over which workers have influence; their role in the decision making process; and the degree of influence they are able to exert. Conceptually, the derivation of their index may be seen as calibrating the vector OP in figure 3.1.

In the Chilean circumstances, considerable variation was to be expected up to high values of the Y axis of figure 3.1 (the magnitude of workers' presence). In surveys of conventionally-owned firms, however, we might expect to observe relatively slight variation in this dimension, at a comparatively low value. In any case, survey responses will often at best be able to reveal the type or form of worker involvement in making certain, specified decisions.

Thus the raw data is typically in the form of qualitative information on the XZ plane of figure 3.1. Participation responses

Figure 3.1



Source: Espinosa and Zimbalist (1978) p.59.

Table 3.1 Participation Data Matrix

	CATEGORY						
	1	2	3	.	.	.	m
1	0	1	0	.	.	.	
2	0	0	0	.	.		
3	0	0	1				
Area .	.	.					
.	.						
.							
n							

to survey questions might, for example, permit firms to be classified at participation category $j = 1, 2,...m$, in decision area $i = 1, 2,...n$. The data for each firm can then be represented by an $n \times m$ matrix of binary variables in which each element p_{ij} has unit value if the firm is classified in the j'th category for the i'th decision and zero otherwise, as in table 3.1. The index method then awards points based on a weighting structure for each level and decision, and sums over levels and decisions, yielding an index value

$$P_t = \sum_{i=1}^{n} \sum_{j=1}^{m} w_{ij} p_{ijt}$$

where the w_{ij} are the weights and $t = 1, 2,...v$ denotes a sampled firm.

Such indices are open to two main objections. Firstly, the researcher must impose an arbitrary weighting structure w_{ij}. Thus subsequent analysis becomes part observation and part introspection, and there is an obvious danger that researchers may unwittingly have imposed the relationships they subsequently find. Secondly, the measures are not derived from or readily related to any theoretical model.

Where arbitrarily-weighted indices are subsequently incorporated in regression models (e.g. Cable and FitzRoy, 1980; FitzRoy and Kraft, 1985), the assumptions implied by the weighting structure can be spelt out as linear, homogenous restrictions and tested directly. In this way the technical validity of a given index can be evaluated. A suitable test procedure is outlined in the next section. In the present case, unlike some other areas of economics, restrictions do not come naturally from theory. Hence the natural way to proceed is to start from the least restrictive form permitted by the data and then gradually impose reasonable restrictions to see what the data support. In section 3.3 the procedure is carried out in three cases for which the relevant data is available. The concluding section 3.4 summarises the test outcomes and discusses their implications for further research.

3.2 A Test Procedure

Suppose that participation data in the form of table 3.1 are to be included in a regression analysis. The least restricted available model would include dummy variables for each element in (all

but one column of) the participation data matrix.[3/] For example, in an analysis of the participation-productivity relationship we would have

$$V_t = \sum_{h=1}^{\ell} \alpha_h X_{ht} + \sum_{i=1}^{n} \sum_{j=2}^{m} \beta_{ij} p_{ijt} + u_t, \qquad (3.1)$$

where V_t is, say, log value-added for firm t, and $\underset{\sim}{X}_t$ is a vector of other explanatory variables called for by the relevant theory.[4/]

The implied assumptions when an arbitrarily weighted index P_t is substituted for the terms $\sum_{1=1}^{n} \sum_{j=2}^{m} \beta_{ij} p_{ijt}$ can be best illustrated by reference to previous work. For example, Cable and FitzRoy (1980) and FitzRoy and Kraft (1985) used a linear weighted system with weights 0, 1,...3 for 'no participation', 'prior information given', 'workers consulted' and 'full participation', and gave each decision equal (unit) weight. With, say, four decision areas, firms would then be placed on an integer scale with a P-score of between zero and 12. The implied assumptions are that:

A (i) all decision areas are equally important;

A (ii) the impact of having a higher degree of participation is the same across all decision areas;

A (iii) the appropriate index has a specific, arbitrarily imposed gradient of unity.

These are typical of the index-building assumptions which we wish to test. With no loss of generality we continue to consider a case with four participation levels and four decision areas. Working

from the unrestricted model (3.1) we can identify and test the parameter restrictions implied by A(i) - A(iii) as follows.

First, the constant incremental weights assumption (A(ii)), which is widely used in constructed indexes, requires $\beta_{i3}/\beta_{i2} = \lambda$, $\beta_{i4}/\beta_{i2} = \mu$, for all i, where λ and μ are constants. Imposing only this restriction we write

$$V_t = \sum_{h=1}^{\ell} a_h X_{ht} + \sum_{i=1}^{4} \beta_{i2}(p_{i2t} + \lambda p_{i3t} + \mu p_{i4t}) + u_{2t} \quad (3.2)$$

Non-linear estimation is required to yield the separate 'base' coefficients for each decision $\hat{\beta}_{i2}$, and the constant incremental weights $\hat{\lambda}$ and $\hat{\mu}$.

Next we can impose the additional constraint that all decisions are equally important, i.e. $\beta_{i2} = \phi$ for all i, obtaining:

$$V_t = \sum_{h=1}^{\ell} \alpha_h x_{ht} + \phi\left(\sum_{i=1}^{4} p_{i2t} + \lambda \sum_{i=1}^{4} p_{i3t} + \mu \sum_{i=1}^{4} p_{i4t}\right) + u_{3t}. \quad (3.3)$$

If non-linear estimates of ϕ, λ and μ are obtained, likelihood ratio tests are then available to test the restrictions in (3.3) and (3.2), against the unrestricted equation (3.1).

Finally, we can test all three assumptions A(i) - A(iii), the 'Kyklos' assumptions used in Cable and FitzRoy's (1980) pilot study, by imposing $\lambda = 2$, $\mu = 3$ on equation (3.3) to give

$$V_t = \sum_{h=1}^{\ell} \alpha_h X_{ht} + \gamma\{ \sum_{i=1}^{4} p_{i2t} + 2 \sum_{i=1}^{4} p_{i3t} + 3 \sum_{i=1}^{4} p_{i4t} \} + u_{4t} \quad (3.4)$$

where the bracketed term $\{.\}$ reduces to a scalar participation index, denoted P_t. Since OLS may be used to estimate both (3.4) and (3.1), an F-test may be used in this case.

3.3 Results

(i) VW Sample (Cable-FitzRoy 1983)

Tables 3.2 and 3.3 report the relevant coefficients and summary statistics from empirical estimates of equations (3.1) - (3.4). The twelve participation-dummy coefficients in the unrestricted equation (3.1) display a mixed sign and significance pattern that is not readily susceptible to interpretation (table 3.2). However, a significant overall participation effect is present; testing $H_o : \beta_{ij} = 0, \forall_{i,j}$ yields $F_{12,91} = 3.23 > F^{.05} = 1.88$.

Each of the restricted equations (3.2) - (3.4) is rejected (table 3.3). In the case of equations (3.2) and (3.3) the likelihood ratio test yields $LR = 16.41 > \chi^2_6 = 12.6$ and $LR = 36.97 > 21.7$ respectively at the 5 per cent level. An F-test similarly rejects equation (3.4) yielding $F_{11,93} = 5.82 > F^{.05} = 1.91$. Thus, as Cable and FitzRoy report, the P_t index is incompatible with the data in this case.

TABLE 3.2 p_{ij} Coefficients (Cable-FitzRoy, 1983)

	Prior Information	Opinion Sought	Full Participation
Investment/ rationalisation	0.2088*	0.3155**	0.3302
Employment decisions	-0.0399	-0.1456	0.2399
Wage setting	0.2542**	-0.1922	-0.4122**
Job design	0.4548**	0.1202	0.1962

Note: * denotes significant at 10 per cent or better.

** " " " 5 " " " " .

TABLE 3.3 , OLS and LSQ Estimates, Equations (3.1)-(3.4) Cable-FitzRoy, 1983.

(Cob-Douglas specification, substituting for participation dummies P11, P12,...,P43)

Equation / Coefficient	(3.1)	(3.2)	(3.3)	(3.4)
$\hat{\beta}_{12}$		0.031 (0.366)		
$\hat{\beta}_{22}$		-0.087 (-0.851)	0.112* (1.917)	
$\hat{\beta}_{32}$		0.272** (3.057)		
$\hat{\beta}_{42}$		0.586** (2.943)		
$\hat{\lambda}$		0.217 (1.273)	0.099 (0.231)	
$\hat{\mu}$		0.230 (1.330)	0.069 (0.159)	
P_t				-0.0162 (-1.191)
R^2	0.9585			0.9590
F	104.39			100.50
LLF		-27.6992	-37.9707	

Note: t values in parentheses

*) denotes significance at (10 per cent or better
**) (5 " " " "

TABLE 3.4 p_{ij} Coefficients (FitzRoy-Kraft, 1984)

	Prior Information	Opinion Sought	Full Participation
Investment/ Rationalisation	0.0173 (0.141)	0.1041 (0.769)	-0.0698 (-0.351)
Employment	-0.0553 (-0.386)	0.0029 (0.020)	-0.0444 (-0.231)
Job Design	0.2547 (1.189)	-0.0730 (-0.500)	0.0011 (0.008)

(ii) VW Sample (FitzRoy and Kraft, 1985)

FitzRoy and Kraft report a further analysis of the VW database using an index based on the above weighting structure. However, since their specification of the $\underset{\sim}{X}$ vector differs slightly from Cable and FitzRoy, and since they also delete survey responses relating to wage-setting (decision area III) the foregoing results do not automatically carry over. Thus a further test is required, modifying the $\underset{\sim}{X}$ vector, deleting $p_{3j}, \forall_j$ from equation (3.4), and testing against a correspondingly truncated equation (3.1) in which the $\beta_{3j}, \forall_j$ are constrained to zero. FitzRoy-Kraft themselves report no test outcomes, and the following results were obtained from reestimations.

At first sight, deleting the data seems to have done the trick. Testing with the modified versions of (3.4) and (3.1) described above yields $F_{8,93} = 0.80 < F^{.05} = 2.04$, so that the restrictions embodied in the index are apparently valid. However, further investigation reveals that in the modified unrestricted equation none of the individual participation dummies are significant (table 3.4). Thus the index restrictions appear acceptable only because the 'true' values of the relevant unrestricted coefficients are zero. An F test confirms that there is no jointly significant effect of the participation dummies as a group in the FitzRoy and Kraft model; the hypothesis $H_o : \beta_{ij} = 0$ (with $i = 1,2,4$, and $j = 2,3,4$) is not rejected ($F_{9,93} = 0.74 < F^{.05} = 2.01$).

TABLE 3.5 p_{ij} coefficients (Cable-FitzRoy, 1980)

	Workers involved as		
	Observers	Advisers	Active Participants
Investment	-0.1205 (-1.334)	0.1718** (1.992)	-0.0021 (-0.024)
Price	-0.0314 (-0.584)	-0.0458 (-0.568)	-0.2381 (-1.555)
Product design	-0.1963** (-3.177)	-0.0076 (-0.067)	-0.0492 (-0.614)
Advertising	0.0812 (0.971)	0.1027 (0.917)	-0.1011 (-0.984)
Wage system	-0.0316 (-0.397)	-0.0401 (-0.308)	0.2801** (3.422)
Production methods	0.1510 (0.719)	-0.2209** (-2.416)	-0.2192** (-2.427)
Job design	0.2292 (0.9846)	0.1415 0.876)	0.1282 (0.878)
Piece rates	0.2033** (2.274)	0.0321 (0.628)	0.1074** (2.051)

Note: t values in parentheses

*) denotes significance at (10 per cent or better
**) (5 " " " "

TABLE 3.6 OLS and LSQ Estimates: Equations (1)-(4) (Cable-FitzRoy, 1980)

Equation / Coefficient	(1)	(2)	(3)	(4)
$\hat{\beta}_{12}$		.0280 (0.951)		
$\hat{\beta}_{22}$		-.0928 (-1.639)		
$\hat{\beta}_{32}$		.0125 (0.603)		
$\hat{\beta}_{42}$		.1050 (1.643)	-.0053	
$\hat{\beta}_{52}$		.0583 (1.611	(-0.399)	
$\hat{\beta}_{62}$		-.0152 (-0.645)		
$\hat{\beta}_{72}$		-.0596 (-1.307)		
$\hat{\beta}_{82}$		-.0028 (-0.141)		
$\hat{\lambda}$		1.826** (2.363)	-4.352 (-0.374)	
$\hat{\mu}$		2.997** (2.136)	-4.544 (-0.3866)	
P_t				.0165*** (4.487)
R^2	.995			.991
F	490.6			404.8
LLF		73.93	69.33	

Note: t values in parentheses

**) denotes significance at (5 per cent or better
***) 1 " " " "

(iii) Pilot Sample (Cable and FitzRoy) 1980

In this early pilot study the weighting structure is as in the two preceding cases, but the survey-response data covered eight decision areas; investment, price, product-design, advertising, wage-system, production methods, job-design, and piece rates. Participation dummy coefficients for an unrestricted model corresponding to equation (3.1) are set out in table 3.5. Once again signs and significance levels follow an erratic pattern, as in the VW analysis (c.f. tables (3.2) and (3.4).

Once again, tests of assumptions A(i) - A(iii) produce the same outcomes. Thus, testing for constant incremental effects (A(ii)) alone with a modified equation (3.2) yields an LR statistic of 27.59 which compares with a critical χ^2 value of 23.7 at the 5 per cent level. When A(i) and A(ii) are tested together using a modified equation (3.3), we obtain LR = 42.6 > χ^2_{21} = 38.9, while the F test inevitably rejects the combined index assumptions, yielding $F_{23,89} = 4.82 > F^{.05} = 1.68$. Relevant coefficients and summary statistics are set out in table (3.6). Finally, as in Cable and FitzRoy though not FitzRoy and Kraft, we find that though the index is unreliable, there is a significant overall participation effect; testing the restrictions $B_{ij} = 0, \forall_{ij}$ in the pilot study case yields $F_{24,89} = 5.37 > F^{.05}_{24,\ 89} = 1.66$.

(iv) Subindices

In the preceding test sequence the constant incremental weights assumption (A(ii)) appears to violate the data less than the

equal weights assumption (A(i)). This suggests that it may be useful to experiment with participation subindices for groups of decisions falling within broader decision-making areas. Having the most decision areas, the pilot study data lends itself most readily for this purpose.

Two experiments were carried out. For the first, individual decisions were grouped according to an ILO classification scheme thus:

Area	Description	Decisions	
I	Social, administrative and personnel	Wage system Piece rates	(5) (8)
II	Technical and production	Product design Production methods Job design	(3) (6) (7)
III	Economic and financial management	Investment Price Advertising	(1) (2) (4)

Subindices for each area were then formed, imposing equal weights for decisions within a given area ($\beta_{i2} = \beta_{j2}$ for all ij within the area), but allowing different weights as between areas ($\beta_{i2} \neq \beta_{j2}$ for any i, j in separate areas). The estimating equation for this experiment was accordingly

$$V_t = \sum_{m=1}^{n} \alpha_m X_{mt}$$
$$+ \gamma_1\{(p_{52}+p_{82}) + \lambda(p_{53}+p_{83}) + \mu(p_{54}+p_{84})\}$$
$$+ \gamma_2\{(p_{32}+p_{62}+p_{72}) + \lambda(p_{33}+p_{63}+p_{73}) + \mu(p_{34}+p_{64}+p_{74})\}$$
$$+ \gamma_3\{(p_{12}+p_{22}+p_{42}) + \lambda(p_{13}+p_{23}+p_{43}) + \mu(p_{14}+p_{24}+p_{44})\} + u_{5t} \quad (3.5)$$

where $\gamma_1 = \beta_{52} = \beta_{82}$, $\gamma_2 = \beta_{32} = \beta_{62} = \beta_{72}$, and $\gamma_3 = \beta_{12} = \beta_{22} = \beta_{42}$, and the bracketed terms $\{.\}$ are the three area subindices embodying identical but non-imposed, constant incremental weights γ and μ.

The second experiment followed a similar procedure, but utilised a simple dichotomy between 'strategic' and 'job-related' decisions. Strategic decisions were taken to include investment, price, product and advertising decisions, and the job-related category was thus wage systems, production methods, job-design and piece rates. The estimating equation for this case was then

$$V_t = \sum_{m=1}^{n} \alpha_m x_{mt} + \delta_1\{\sum_{i=1}^{4} p_{i2} + \lambda \sum_{i=1}^{4} p_{i3} + \mu \sum_{i=1}^{4} p_{i4}\}$$
$$+ \delta_2\{\sum_{i=5}^{8} p_{i2} + \lambda \sum_{i=5}^{8} p_{i3} + \mu \sum_{i=5}^{8} p_{i4}\} + u_{6t} \quad (3.6)$$

Non-linear procedures were again used to estimate equations (3.5) and (3.6) to permit likelihood-ratio tests of the restrictions embodied in them against the unrestricted equation (3.1'). The LR statistic values were found to be 39.9 and 35.8 for equations (3.5) and (3.6) respectively, compared with critical χ^2 values of

30.1 and 31.4 at the 5 per cent level. Thus, at the conventional level neither set of participation subindices is compatible with the data.

3.4 Conclusions and Implications for Further Work

A broad distinction may usefully be drawn between financial participation, and participation in control of the enterprise. Whereas financial control presents no unusual measurement problems, measuring the degree of employee participation in the control of the enterprise does.

Previous researchers have resorted to arbitrarily weighted indices. These have no theoretical underpinnings. Moreover, when they are subsequently used in regression models, the parameter restrictions imposed in index construction are found to be statistically unacceptable. These results cast doubt on previously published estimates, in particular of the productivity-participation relationship. They also call into question the suitability of such measures for future work. In any event, tests of the underlying assumptions should be carried out. Ideally it would be useful to test simultaneously restrictions on the β_{ij}s and α_h (i.e. the implied P-index and production function parameters), since different restrictions on α_h may lead to a different choice of restrictions on the β_{ij}. However the procedure is very cumbersome, since any index test is itself valid only for the model in which it is carried out. Hence, strictly, the test should be repeated for every respecification or change of estimation method.[5/]

More generally, adoption of the approach outlined here may be useful in empirical work on self-management and participation in order to learn more about the sensitivity of different data sets to standard restrictions. Meanwhile, in view of the problems which clearly attend the index measurement method, there would also seem to be a strong case for exploring alternative measurement techniques, one of which - Guttman Scales - is considered in the next chapter.

FOOTNOTES

1/ Elliott (1984) draws a distinction between representative industrial democracy - 'employee participation in national, industrial and company affairs through representative organisations' and shopfloor democracy: "industrial democracy in its broadest sense of giving workers a share in the control of their places of employment". The distinction is of course vital when the role of trades unions is a central focus of the analysis. This is not the case here, and for the present no distinction will be made as to whether participation in control is effected via direct individual employee involvement or their representatives. Later, however, unionisation variables will be entered alongside measures of the degree of participation in the relevant empirical models.

2/ The term 'participation in control' is preferred to the alternative 'non-material participation', which occurs in the literature, due to the latter's unfortunate altruistic and also inconsequential overtones.

3/ The column vector $\sum_{i=1}^{n} \beta_{i1} p_{i1t}$ is dropped to avoid singularity problems in estimation, since otherwise the sum of the row vectors $\sum_{j=1}^{m} \beta_{ij} p_{ijt}$ is unity for all i. Thus the β_{ij} coefficients capture deviations from the base (no participation) observation.

4/ Augmented production function models are now the normal method of investigating the productivity effects of participation. See, for example, Backus and Jones (1977); Jones (1982); Jones and Svejnar (1984); Defourney, Estrin and Jones (1985); Cable and FitzRoy (1980, 1983); FitzRoy and Kraft (1985). However, not all utilise participation indices. In particular, studies of worker-cooperative samples have used other measures of participation, such as membership and members' loans, in order to capture, or proxy, the degree of participation.

5/ Some researchers have sought to justify their arbitrarily weighted indices with the claim that their results are "insensitive to the choice of weights". But this tells us very little. In the first place the range of variation of imposed values is often not given. Secondly, the statement may merely reveal that one set of arbitrarily chosen weights is just as bad as any other. Thus all 'equally good' sets of arbitrary weights may be rejected in a test against the unrestricted equation (3.1); this is the correct standard of comparison for any given weighting structure, not some other, equally arbitrary alternative.

4. PARTICIPATION MEASUREMENT II: GUTTMAN SCALE TESTS OF THE ESPINOSA-ZIMBALIST HYPOTHESIS

4.1 Participation as a cumulative process

In their pioneering study of Chilean cooperatives under the short-lived Allende government, Espinosa and Zimbalist (1978, pp.57-70) advance support for an evolutionary hypothesis concerning employee participation. Specifically they claim that, as hypothesized, participation tends to begin in areas close to workers' knowledge and experience (in terms of their categories, 'social administrative and personnel problems'), and gradually spreads to other areas which are increasingly remote in this respect ('technical and production problems' and 'economic and financial problems').[1/]

In fact their evidence is by no means overwhelming. Formalising their hypothesis, Espinosa and Zimbalis predict $\bar{P}_1 > \bar{P}_2 > \bar{P}_3$, where $\bar{P}_i$ is mean participation across the sample in area i, and i increases with 'remoteness'. While their predictions are in general borne out by the data, there are discrepancies when participation is considered at different hierarchical levels (with a tendency for $\bar{P}_2 > \bar{P}_1$ at lower levels). Moreover the comparison of sample means may conceal numerous individual patterns contrary to the hypothesis that cancel out in the mean values, and evidence on the relative incidence of individual 'error' cases is required.[2/] Finally, the reliability of the evidence may be questioned on the grounds of its reliance on an arbitrarily weighted (though highly

intricate) participation index, of the kind found wanting in the previous chapter.

Nevertheless, the hypothesis is a priori appealing, and gains credence from the existence of many parallels in behavioural science. For example, it displays a strong family likeness to the principle of 'local search' in the behavioural theory of the firm.[3/] Moreover, if validated, the hypothesis would have important policy implications. In particular it would militate against 'top-down' reforms in the extension of industrial democracy, for example those which begin by extending worker representation into top-level decision making at board level. For if the natural development of participation, unforced by legislative or other outside intervention, is found to be essentially a 'bottom-up' process, then clearly top-down reforms must be seen as working against or short-circuiting nature, and therefore less likely to succeed.

At the very least, therefore, the Espinosa-Zimbalist hypothesis is worthy of further investigation. Moreover it turns out that, if the hypothesis is valid, an alternative way forward opens up allowing us to circumvent the problems of measuring the degree of employee participation which, as we have seen, arbitrarily-weighted indices do not satisfactorily resolve. The reasoning here is as follows. Under the hypothesis in question, participation is essentially a cumulative phenomenon. Thus, we would expect that a firm which has participatory decision making over, say, investment decisions will also be participatory in the determination of job-design, but that the reverse would not necessarily follow. More generally, we would predict a stable and predictable ordering of

decision areas by remoteness from employees' direct work experience, so that firms with participatory procedures for high-order decisions will also be participatory over low-order decisions, but not vice-versa. Now if progressivity of this kind is present in the data, participation may be measured with the aid of Guttman scales - a technique that has been widely used in some areas of the social sciences, but only in isolated examples by economists. And since the standard tests of validity of Guttman scales are essentially tests of the cumulativeness of the phenomenon under scrutiny, their outcomes simultaneously provide further evidence on the validity of the Espinosa-Zimbalist hypothesis and also indicate whether or not Guttman scales can legitimately be used to measure participation in empirical work.

The nature of Guttman scales is briefly described in the following section. Section 4.3 then reports statistical tests of their validity in measuring participation, using the VW data set for West Germany as described in chapter 1, and also a comparable database for the UK. Section 4.4 once again summarises the test results, and considers the strengths and weaknesses of Guttman scales in the context of research on participation.

4.2 Guttman Scales

Named after their inventor (Guttman 1944, 1950) the mathematical pioneer of scalogram analysis,
Guttman scales have been widely used in some areas of the social sciences, notably in psychometrics as a method of measuring attitudes. One of the earliest and best known studies created social distance or

prejudice scales (Bogardus, 1958). Only isolated applications are, however, to be found in economics, notably in the measurement of disability and medical need in health economics (Williams, 1983; Williams et al 1976; Culyer 1978).

In principle, however, Guttman scales can be applied to a wide range of phenomena, provided that they are (a) unidimensional and (b) cumulative. Unidimensionality implies that the movements measured must be towards or away from the same single object or position which is, of course, a requirement for a vast range of measures. The cumulativeness condition, however, is a special feature of Guttman scales which distinguishes them from almost all others. As we have seen, this requires that there must be a stable and predictable ordering of items or characteristics by degree of 'difficulty' or 'intensity' (according to the application in question), so that subjects possessing a higher-degree characteristic will also possess lower-degree characteristics, but not vice-versa. In a (simplified) medical dependency example, for instance, the observer might evaluate a patient's ability (i) to get out of bed, (ii) to move about indoors, and (iii) to move about outside. Anyone capable of (iii) should also be capable of (ii) and (i); anyone capable of (ii) but not (iii) should also be capable of (i); but anyone incapable of (i) will be incapable of (ii) and (iii) also. Once the relevant ordering of 'items' is established, subjects may then be ranked according to the number of characteristics they exhibit; that is, by establishing the ordering sequence, one can then say that a subject is further on, or less far on, in regard to that sequence.

In the case of the Espinosa-Zimbalist hypothesis concerning the spread of participation in a firm, we have seen that the expectation is that a firm which has participatory decision making over, say, investment decisions, will also be participatory in the determination of job-design, but the reverse is not necessarily true. More generally, consider a case where there are four decision-making areas, ranked A to D in descending order of 'remoteness' from workers' direct, shop-floor experience. If participation were cumulative as hypothesised, and if all firms conformed exactly to the sequence, every firm would exhibit one or other of the patterns shown in table 4.1 (a), where units indicate the presence of participation in a given decision area, and zero otherwise. In a perfect Guttman scale, only the five patterns shown would be observed, and the number of unit responses in each scale type is then the scale score, or category number, for each observation.

In practice, of course, we expect some deviant observations, or 'errors' as in Table 4.1 (b). In these cases the pattern of unit entries does not correspond to that of the scale-consistent observations for a given score. E.g. cases (i), (ii) and (iv) in table 4.1(b) all score 2, but do not correspond to the admissable scale type 2 in table 4.1(a). Thus when using Guttman scales the first step is to test the validity of the scale, by reference to the incidence of error cases. Two principal test statistics are used.[4/] One is the coefficient of reproducibility (CR), defined as

$$CR = 1 - e/n$$

where n is the total number of observations, and e is the number of error cases - observations with one or more differences in the pattern of unit entries, compared with the admissable pattern for the same scale score. As a general guideline $CR > 0.9$ is considered to

TABLE 4.1 (a): Guttman Scale Types

Scale Type (and score)	Decisions			
	A	B	C	D
4	1	1	1	1
3	0	1	1	1
2	0	0	1	1
1	0	0	0	1
0	0	0	0	0

(1 = participatory, 0 = non-participatory)

(b) Error Patterns

Error Case	Decisions				Scale Score
	A	B	C	D	
(i)	0	1	1	0	2
(ii)	0	1	0	1	2
(iii)	1	0	0	0	1
(iv)	1	0	1	0	2
etc.					⋮

indicate a valid scale. However it is possible to obtain a high CR value simply because observations are 'predicting' the most commonly possessed characteristic. A second test statistic due to Menzel (1953) takes account of this, recognising that CR cannot be less than the ratio of the sum of majority responses to each item to the total number of responses. Thus the coefficient of scalability measures the proportion of non-majority cases correctly predicted by the scale. In this case CS > 0.6 is regarded as confirming the existence of a valid cumulative and unidimensional Guttman scale. Though the levels of acceptable error are based on mathematical and statistical analysis of the scalogram technique, they do not have an interpretation in sampling terms. The conventional view is that the critical CR and CS values are set at a 'fairly stringent' level (Williams, et al, 1976).

4.3 Empirical tests

West Germany

Guttman scales of employee participation were constructed and tested for the sample of 85 firms in the West German metalworking industries described in chapter 1, using subprogram GUTTMAN SCALE of SPSS (Nie et al, 1975).[5/] Due to data limitations, effective sample size was limited to 64, and to avoid further loss of observations, the analysis utilised only the managerial assessments of the role of workers in each of four decision areas. As will be recalled, this data conforms to the general pattern of table 3.1, with four participation categories ('none', 'prior information given', 'opinion sought', and 'full participation'), and four decision areas

(investment/rationalisation, employment, wage-setting, and job-design.)

Subprogram GUTTMAN SCALE enables the researcher either to impose an ordering of 'items' (here, decision areas) according to theory or prior belief, or to allow an 'optimal' ordering to emerge by experimentation. In the present case no ordering was preimposed, but technically valid scales were subsequently reviewed for the a priori plausibility of the ordering which actually emerged, in the light of the Espinosa-Zimbalist hypothesis.

The subprogram also provides for up to three 'cutting points' for converting continuous or ranked variables (here, the degree of participation), into the binary form of table 4.1 which is required for scaling purposes. This proved highly convenient in the present case, where we have just four participation categories; the dividing line (cutting point) between 'participation' and 'non participation' for any firm and decision could be set experimentally in any one of the three possible positions, thus:-

	Cutting Point			
	1 ↓	2 ↓	3 ↓	
Participation Category	None	Information Given	Opinion Sought	Full Participation

With four unordered decision areas and a choice of three cutting points in each area a total of 81 scales were processed. Of these, sixteen met the required acceptance levels in terms of CR and CS prior to rounding, and a further 5 after rounding CR and CS

to two decimal places. A further three scales were close to the acceptance limits. Full details are reported in appendix table A.4.1.

However, several of the valid scales involved a priori implausible rankings of the decision areas in terms of the Espinosa-Zimbalist hypothesis, while others did well only because the cutting point was set 'high' (i.e. at level 3) for the most difficult item, and then sharply reduced for 'less difficult' items, thus increasing the probability of valid scale being found. Accordingly all scales were rejected which did not meet one or other of two orderings considered a priori plausible (namely investment - employment - wage-setting - job-design; or investment - wage-setting - employment - job-design), and the degree of 'tapering' of the cutting points was recognised as a further criterion in evaluating Guttman scales.

A small set of 'best' scales was then identified from those remaining, containing all those not dominated by any other scale in terms of CR and CS values, and the degree of 'tapering' of cutting points. Details of these four scales are given in table 4.2. GUTSCAL 4 has minimum 'tapering'. setting the cutting point at full participation in all areas, but only just meets CR and CS requirements. GUTSCAL 2 has maximum CR, and GUTSCAL 3 maximum CS. GUTSCAL 1 is the single 'best' scale for the decision ordering A, B, C, D and is not dominated by any other scale, having higher CR than GUTSCAL 3 and 4, higher CS than GUTSCAL 4, and less tapering than GUTSCAL 2. The intercorrelations among the four scales are given in table 4.3.

TABLE 4.2 Four Best Guttman Scales (Germany)

	Order(1)				Cutting Points(2)				CR	CS
GUTSCAL 1	A	B	C	D	3	3	2	2	.9360	.6812
GUTSCAL 2	A	C	B	D	3	2	1	1	.9477	.6897
GUTSCAL 3	A	C	B	D	3	3	2	2	.9302	.7037
GUTSCAL 4	A	C	B	D	3	3	3	3	.9070	.6049

Note (1) A = investment; B = employment; C = wage setting; D = job design

(2) 1 = 'prior information' or more;

2 = 'opinion sought' or more;

3 = 'full participation'.

TABLE 4.3 Correlation Matrix of Alternative Guttman Scales (Germany)

	GUTSCAL 2	GUTSCAL 3	GUTSCAL 4
GUTSCAL 1	.83	.86	.84
GUTSCAL 2		.76	.63
GUTSCAL 3			.79

UK

The UK data was collected by similar interview-questionnaire methods to those used in West Germany, from firms in the UK engineering industry.[6/] Sample size in this case is 61 firms. Again, the assessments of workers' roles in decision-making came from management representatives. Translating the German participatory categories into the UK context, we have four corresponding levels: management control, information, consultation, negotiation. The only significant difference between the UK and German data sets is that the former has five decision areas rather than four: rationalisation (capital investment, introduction of new products), manning levels, job design (work organisation, environment), pay issues (wages and bonuses), and welfare (health and safety, pensions). Other things being equal, the greater the number of 'items', the less likely it is that a valid Guttman scale will be found. Thus in this sense the UK test is marginally more rigorous that its German predecessor.

With five decision areas and three cutting points, the number of scales to be processed rises to 243 (3^5 as opposed to 3^4). After processing, 46 scales were found to pass CR and CS criteria before rounding. Details of all these scales are set out in appendix table A.4.2.

Using the same criteria as for the German tests (maximum CR and CS, minimum tapering, and decision orderings ABCDE or ABCED only) three scales dominate all others (table 4.4). Scale No.438 has the same (maximum) CR as two others (Nos. 60 and 384, table A.4.2) and the maximum CS of all. Scale No.492 has zero tapering, with the

Table 4.4: Three Best Guttman Scales (UK)

Scale No.	Order[1]					Cutting Points					CR	CS
438	A	B	C	E	D	3	3	3	3	2	.9733	.7500
492	A	B	C	E	D	3	3	3	3	3	.9573	.7241
168	A	B	C	D	E	3	3	3	3	1	.9467	.6078

Note (1) A = rationalisation; B = manning; C = job design;

D = pay issues; E = welfare.

cutting point set at full negotiation in all areas. All these scales order the decisions ABCED. Scale No.168 is the only scale with acceptable CR and CS values and the other a priori acceptable ordering ABCDE. As can be seen, the CR and CS values are substantially better in the UK tests, especially for scales 438 and 491 (c.f. tables 4.4 and 4.2), implying fewer errors in the measured degree of participation in control.

4.4 Conclusions

Empirical tests on data for the West German and British engineering industries revealed relatively large numbers of statistically acceptable Guttman scales of employee participation in decision-making. Since the essential requirement for a valid Guttman scale is the cumulativeness of the phenomenon measured, this provides much stronger evidence than was hitherto available in support of Espinosa and Zimbalist's hypothesis that participation tends to develop from decision-making areas close to workers' knowledge and experience to areas increasingly remote in this respect. If participation is thought to merit encouragement via public policy, it would therefore seem that policy measures to foster shopfloor initiatives would have the advantage of working with a natural development process, whereas legal requirements for worker representation at board level could be working against this. The fact that positive results were obtained for both the UK and German data is particularly telling. While the coefficients of reproducability and scalability (plus additional selection criteria as described in the text) permit evaluation of any given Guttman scale in its own right, it is generally accepted that the acid test of the appropriateness of

Guttman scales in any given context is whether, as here, satisfactory results can be replicated from sample to sample (Nie et al, 1975).

The discovery that Guttman scales may validly be used to measure participation simultaneously promises a way round the problems in empirical research on the nature, causes and effects of self-management and participation that derive from the lack of reliable alternative measures, as described in the previous chapter. Their theoretical appeal in this context is considerable. In particular, in reflecting the number and range of decision areas (variables) which are subject to participation within the enterprise, they satisfy the prime theoretical requirement of a participation measure emerging from chapter 2. But they are more than a simple count, since they also take account of the pre-required ordering of items (decision areas), under the cumulative participation hypothesis.

In practical terms, each valid, individual scale is a candidate measure of participation in empirical work. As might be expected alternative scales prove quite highly correlated. But they are not so interrelated as to be near-perfect substitutes (with simple correlation coefficients among the four German scales ranging from 0.63 to 0.86). The implication for research is that more than one scale may need to be used for any given data set.

The main limitation of Guttman scales is that only an ordinal rather than a cardinal ranking is produced with, moreover, relatively few steps: one more than the number of 'items' (decision areas).[7/] This inevitably restricts their usefulness, but the scales remain adequate for a wide range of research purposes. For example,

as we shall see in the fcllowing two chapters, Guttman scales can successfully be used to partition a sample into high and low participation subsets for separate analysis. With relatively few participation categories, Guttman scales may also be used as dependent variables in multinominal logit equations. Alternatively, Guttman scales lend themselves to dummy independent variable structures. In short the cost of obtaining a theoretically relevant, technically valid participation measure, in terms of empirical flexibility, is relatively modest. A signal advantage vis-a-vis participation indices is that the validation tests are not model-specific, and hence do not have to be repeated for every respecification or change of estimation method in empirical work.

FOOTNOTES

1/ The three categories used by Espinosa and Zimbalist are elaborated from the scheme set out in the previous chapter and comprise

AREA 1: Social, administrative and personnel problems

Hiring and firing; work rules and systems of internal discipline; creation and maintenance of social services; educational and vocational training; labour relations; system of participation; new wage scales, forms of remuneration; job evaluation, promotion, incentives, etc.

AREA 2: Technical and production problems

Improvement in work conditions, problems of industrial hygiene and safety; transfers, job rotation and job enlargement; changes in work organisation and administration; maintenance of machinery and equipment; quality control; raw materials supplies; sales and commercialization policy, inventories and stocks; research and development of new products; selection and modification of technology, specific and general (methods, movements, time, etc); information and communication system within the firm.

AREA 3: Problems of economic and financial management

Investment and growth of the enterprise; production planning - lines of production and quantities; financial situation of the firm: assets-debits; profits-losses situation; pricing policy; wage and salary policy (level, not internal structure); financing of investments.

2/ As is provided in Guttman scale tests (see below).

3/ In behavioural theory, organisational search for problem-solutions begins close to current symptoms and old solutions, spreading to more distant areas only as satisfactory new solutions fail to be found. See Cyert and March (1963).

4/ For a full discussion see Togerson (1958).

5/ Regrettably GUTTMAN scale is not available under SPSSX (SSPS Inc, 1986).

6/ Data collection was carried out by Nick Wilson under a research grant from the ESRC awarded jointly to the author and Wilson.

7/ To form a Guttman scale, observations are ultimately classified on the basis of the number of items processed or passed (i.e. the number of unit entries in the binary row vector characterising the firm in question). Thus, a Guttman scale groups observations

into (n + 1) categories, where n is the number of items (decision areas in the present case). No cardinal significance can of course be attached to the scale scores; Guttman scales can provide only ordinal group rankings. Observations which exhibit error patterns are customarily still classified according to the number of items possessed, even though their binary row pattern is 'wrong'. Clearly an element of measurement error is thereby introduced, but the proportion of error types in a given sample is directly observable in the CR statistic, and may be taken into account by the researcher in deciding whether to proceed with an empirical analysis using the scales. In practice, Guttman participation scales may display not much less variation than some arbitrarily-weighted indices. For example, the FitzRoy and Kraft index is an integer scale with only nine points, (and Cable and FitzRoy is little better with 12). Thus, even if valid these scales would also exhibit limited variation across the sample, and possibly concentration on certain values (e.g. zero), calling for restricted choice of, and corrective measures in, model specification.

TABLE A.4.1: VALID GUTTMAN PARTICIPATION SCALES (GERMANY)

Scale Ref. Number	Order	Division Points	CR	CS
12	A B C D	3 1 1 1	.9419	.6364
18	A B C D	3 2 1 1	.9186	.6500
30(1)	A C B D	3 2 1 1	.9477	.6897
32	C B A D	2 2 1 1	.9012	.6383
36	A C B D	3 2 2 1	.9244	.6867
38	B C A D	3 2 1 1	.9477	.7429
40	B C A D	3 2 2 1	.9186	.6957
84	A C D B	3 2 2 1	.9302	.6471
90	A C B D	3 2 2 2	.9186	.6989
92	B C A D	3 2 1 2	.9070	.6000
96(3)	A B C D	3 3 2 2	.9360	.6812
108(3)	A C B D	3 3 2 2	.9302	.7037
120	A D C B	3 3 1 1	.9070	.6404
156	A C D B	3 3 3 1	.9070	.6000
168	A B C D	3 3 3 3	.9012	.5802
170(4)	A C B D	3 3 3 3	.9070	.6049

Note: 1 = GUTSCAL 2
2 = GUTSCAL 1
3 = GUTSCAL 3
4 = GUTSCAL 4

} cf. Table 3.9

APPENDIX A.4.2: VALID GUTTMAN PARTICIPATION SCALES (UK)

Scale Ref. Number	Order	Division Points	CR	CS
28	A C B E D	2 2 1 1 1	.9147	.6190
30	A C B E D	3 2 1 1 1	.9253	.6410
40	B A C E D	3 2 2 1 1	.9520	.6727
42	A B C E D	3 3 2 1 1	.9573	.6735
44	C A B E D	3 1 1 1 1	.9200	.6250
46	C A B E D	3 1 1 1 1	.9360	.6250
48	A C B E D	3 3 2 2 2	.9467	.6552
54	A C B E D	3 3 2 1 1	.9573	.6981
56	B C A E D	3 3 1 1 1	.9520	.6471
58	B C A E D	3 3 2 1 1	.9680	.6571
60	A B C E D	3 3 3 1 1	.9733	.6552
82	A C B E D	2 2 1 2 1	.9093	.6136
84	A C B E D	3 2 1 1 2	.9200	.6341
94	B A C E D	3 2 2 1 2	.9467	.6610
96	A B C E D	3 3 2 1 2	.9520	.6604
98	C A B E D	3 1 1 1 2	.9147	.6190
100	C A B E D	3 2 1 1 2	.9307	.6176
102	A C B E D	3 3 1 1 2	.9413	.6452
108	A C B E D	3 3 2 1 2	.9520	.6842
110	B C A E D	3 3 1 1 2	.9467	.6364
112	B C A E D	3 3 2 1 2	.9627	.6410
114	A B C E D	3 3 3 1 2	.9680	.6364
164	B C A D E	3 3 1 3 1	.9253	.6164
166	B C A D E	3 3 2 3 1	.9413	.6140
168	A B C D E	3 3 3 3 1	.9467	.6078
202	B A C E D	3 2 2 2 1	.9360	.6364
204	A B C E D	3 3 2 2 1	.9413	.6333
216	A C B E D	3 3 2 2 1	.9413	.6563
218	B C A E D	3 3 1 2 1	.9413	.6452
220	B C A E D	3 3 2 2 1	.9680	.7391
222	A B C E D	3 3 3 2 1	.9680	.7000
256	B A C E D	3 2 2 2 2	.9307	.6286
258	A B C E D	3 3 2 2 2	.9360	.6250
270	A C B E D	3 3 2 2 2	.9360	.6471
272	B C A E D	3 3 1 2 2	.9360	.6364
274	B C A E D	3 3 2 2 2	.9627	.7200
276	A B C E D	3 3 3 2 2	.9627	.6818
346	B A E C D	3 2 3 1 1	.9413	.6333
348	A B E C D	3 3 3 1 1	.9520	.6667
372	A C E B D	3 3 3 1 1	.9360	.6308
382	B C A E D	3 3 2 3 1	.9627	.6667
384	A B C E D	3 3 3 3 1	.9733	.7222
436	B C A E D	3 3 2 3 2	.9627	.6957
438	A B C E D	3 3 3 3 2	.9733	.7500
490	B C A E D	3 3 3 3 2	.9467	.6875
492	A B C E D	3 3 3 3 3	.9573	.7241

5. PARTICIPATORY vs TRADITIONAL FIRMS

5.1 Introduction

In the prisoners' dilemma model of employee participation and enterprise performance outlined in chapter 2, both the firm's structural characteristics and its performance are seen as the outcome of a strategic game between workers and employers, each faced with the alternatives of seeking to impose unilateral control over the firm, or to cooperate to maximise joint welfare. In this chapter we seek to identify the structural and performance characteristics of the firm under the traditional (Nash) and participatory (Pareto) outcomes, which are those we expect to observe empirically. This entails a consideration of the detailed tactics associated with each of the players' strategic options. We then examine subsamples of firms in the West German data set, described in chapter 1, to test their conformity to one or other of the two equilibrium patterns.

Our first concern in the empirical analysis is with subsamples formed according to the degree of participation-in-control which, as we have seen, is a priori most relevant to the theoretical framework of chapter 2. For this purpose we partition the sample into participatory (P) and traditional or non-participatory (T) firms using the Guttman scales tested in chapter 4. It is however also of interest to compare these results with those from a comparison based on a profit-sharing/ non profit-sharing dichotomy, in order to see whether, despite obvious superficial differences, financial participation and participation in control have an essentially similar underlying economic function, role and effect, as is commonly inferred

in both academic discussion and public debate when the term 'participation' is used generically to embrace both.

In order to carry out the relevant comparisons we test for significant differences in subsample means of key variables pinpointed by the analysis. We also employ discriminant analysis to test whether the variables highlighted by the theory are also statistically important in separating the subsamples. Recalling the arguments of chapter 2, if P and T firms are found to be structurally similar but P firms outperform T firms, we would interpret this as evidence of participation acting as an efficient bargaining mechanism within a given technology, and hence with negligible effects on the nature of production and work organisation within the firm. However, if P firms differ structurally from T firms in ways consistent with the a priori arguments, and if they also outperform T firms, then we detect evidence of participation shifting the efficiency frontier by enlarging the firm's effective technological opportunities. This presupposes that participation raises firm performance. If, on the contrary, participation has a neutral or negative performance effect, this will also be registered in the results.

5.2 Enterprise characteristics under Nash (traditional) and Pareto (participatory) equilibrium

In order to spell out the specific structural and performance characteristics which are predicted in participatory and traditional enterprises, we consider the tactics available to each of the players in pursuing the broad strategic options outlined in chapter 2, i.e. to seek to impose unilateral control or to cooperate

in maximising joint welfare.

The techniques of employer-control are traditionally associated with the principles of scientific management, and extensively documented in the literature deriving both from Taylor (1947) and from his latter-day radical opponents (notably Braverman 1974; Edwards, 1979; and Gordon, Edwards and Reich, 1982). The principal elements are deskilling via fine division of labour, precise job descriptions, and close control of work effort through machine-pacing or hierarchical supervision. Human capital development is minimised, the cost of replacing untrained labour is low, and 'hire and fire' policies may be practised or threatened. The choice of technique and direction of R and D effort are governed by implications for control over the workforce as well as purely technical considerations, and piecework earnings or similar individual incentives may be used to motivate workers.[1/]

In recent years, however, some of the traditional employer-control tactics appear to have been discarded in favour of more subtle methods. In particular, modest levels of profit-sharing or value-added bonus systems have sometimes been substituted for individual incentives, and found to be more effective because they are less prone to manipulation by workers (see below). Similarly, firms have found that 'human relations management', and even a measure of participation, can be useful in increasing the acceptability of employer control. However, in the case of participation where employer control remains the aim, care will be taken to ensure that there is no serious erosion of management's prerogatives over

confidential, strategic information, which is central both to their capacity to control and to their status.

The tactical methods by which workers can control production are familiar from the industrial relations literature: unionisation (or an equivalent form of collective organisation) and any or all of the various forms of industrial action - strikes, slow-downs, working to rule, etc. Managerial policies for division-of-labour and incentive payments systems can be frustrated by demarcation rules and by strategic manipulation of work effort ('rate-busting') on a group basis. Labour's share of (potential) corporate product can be raised via on-the-job leisure and pilferage. Bargaining power can be cultivated by the strategic withholding of information of potential value to management, gained through shop-floor experience, and so on.

Given the tactics outlined above, non-participatory or traditional firms are expected to have a 'Tayloristic' structure, production methods and control apparatus. Thus, subject to truly exogenous technological limits,[2/] the stereotype traditional firm will have a tall managerial hierarchy, narrow control spans and either a capital-intensive, machine-paced technology or a high ratio of supervisors to operatives. Both the ratio of skilled to unskilled workers and training investment will be low, for a given technology. Jobs will be non-rotating and narrowly defined with little variety. The firm's payment system will rely on time rates only if effective control can be established by supervision alone, or otherwise feature individual or group incentives including profit and value-added sharing according to strategy. A facade of worker participation in decision-making may exist, but the firm will not be genuinely

participatory. Thus in reality workers will either not be involved in decision-making at all, or involved the minimum degree possible; the Works Council will be either ineffectual (dealing with peanut issues) or non-existent; there will be no formal participation scheme, little informal participation, and minimum disclosure of information about the company's position and prospects to the workforce.

The performance characteristics of traditional firms, however, may conform to one of three possible types:-

(i) In the extreme case of unopposed employer control, the firm will exhibit high productivity and financial performance as the theoretical benefits of scientific management or its modern equivalent are realised. Product quality will likewise be high, and technical innovations (of a control-enhancing kind) will be unimpeded. Workers will not volunteer effort, but effective supervision and control by management will extract an optimally high work-rate. Disputes and stoppages will be infrequent, though labour turnover may be high. In brief, we observe a high-performance, low-conflict firm.

(ii) Alternatively, high performance and conflict resolution may be achieved via efficient union-firm bargaining. Observationally case (ii) should be distinguishable from (i) by means of evidence on the bargaining process (in particular, the degree of unionisation and the scope of collective bargaining agreements) and on the degree of

parity or asymmetry in the distribution of the firm's surplus.

(iii) Thirdly, in the dysfunctional, conflictual case the firm will exhibit low performance, high conflict indicators. Thus productivity will be low due to mutual obstruction, and the retention by each side of information that might lead to efficiency gains but would be of strategic importance to the other side. The level of disputes and stoppages will be high, as will other indicators of labour alienation - absenteeism, pilfering, low quality of work, and so on.

The directly observable structural and performance characteristics of traditional firms are summarised in the right hand column of table 5.1.

It was argued in chapter 2 that, in participatory firms where participation plays the role of efficient bargaining, the firm's internal structure, behaviour and performance will be essentially the same as in the traditional firm with efficient bargaining. Indeed, as previously argued, the only distinction between these two cases lies in the institutional form which bargaining takes: producer cooperative status or participatory schemes as opposed, most likely, to formal, union-firm collective bargaining.

Where, however, participation has more fundamental effects, opening up access to resources and technologies that would otherwise not be utilised because of their implications for control in an adversarial situation, the stereotype participatory enterprise will be

run quite differently from the traditional firm. Production methods, control structure, and decision-making apparatus will be chosen so as to encourage human capital formation and utilisation. 'Negative collusion' to frustrate managerial control will give way to 'positive collusion' between workers and employers to increase the total available for distribution (Cable and FitzRoy, 1980). Potentially high aggregate benefits are then partly inherent in the form of work organisation chosen (benefitting mainly workers via increased human capital development and improved non-monetary benefits), and partly the result of productivity-enhancing effects as described in the literature.[3/] These include the realisation of human capital potential - a resource underutilised in traditional organisation; the release by both sides of strategic information, leading to improved communication and full utilisation of workers' and managers' experience in decision-making; the reduction of time lost in disputes through the use of superior methods of conflict resolution; reduced supervision and alienation costs as peer-group pressure and 'horizontal monitoring' replace 'vertical' monitoring and control by supervisors[4/]; greater informal training and mutual assistance among the workforce which is elicited in a high trust, co-operative work environment; and the higher productivity (as well as lower disutility) of work effort which is volunteered, rather than squeezed out by a controlling employer. The left-hand column of table 5.1 summarises the structural and performance characteristics of participatory firms in which these more fundamental effects are felt.

Table 5.1 Enterprise Characteristics under Alternative Outcomes (Representative Firms)

	Participatory (E1, W1)	Conflict (E2, W2)
Participation		
(i) Decision-making	Genuine worker involvement. Information shared.	Workers excluded. Information withheld.
(ii) Ownership	Up to 100% (co-ops).	Neglibible for workers. Share-options confined to management.
(iii) Profit-sharing	Entailed by ownership or participation agreement.	Negligible; used as group incentive only.
Human capital/technology		
Training investment	High	Low on average; confined to 'elite' employees
Job design	Broad	Narrow
Job variety	High	Minimal
Technology	Intermediate; biased to human capital utilisation and worker satisfaction.	Extremes of high and low-technology, choice biased to control of work-process.
Supervision/incentives		
Control system	Predominantly horizontal self-monitoring or peer-group pressure.	Tight. Predominantly vertical, narrow control span, tall hierarchy, and/or machine-pacing.
Incentives (payment by results)	No	Yes, unless control system makes redundant.
Workforce		
Skill-mix	High average skills	Low average skills; perhaps polarized (majority semi or unskilled, minority highly-skilled).
Unionisation	Uncertain	High
Working days lost	Low	High
Turnover	Low	High
Effort	'Voluntary'; optimum for joint welfare max.	'Forced'; low
Performance		
Productivity	High	Low
Profitability	Moderate? (Special rules for co-ops.)	Low
Innovation	Unimpeded; human-capital biased.	Contentious
Morale: workers	High	Low
employers	High	Low

5.3 Sample and subsamples

The basic sample used in the empirical analysis reported in this chapter and the next consists of all 61 firms in the West German database described in chapter 1 for which complete financial and performance data were available for both 1977 and 1979, as well as the undated survey data which had also been collected. At different points in the analysis this sample was treated alternatively as (i) a single, 61-firm cross-section containing the survey data plus averages over the two years for variables with separate 1977 and 1979 observations; (ii) a 122-firm pooled time-series, cross-section sample using separate yearly observations where available and replicating survey data values where not; and (iii) separate, 61 firm, crosssections for 1977 and 1979. Information on which of these alternatives was employed in a particular part of the analysis is given with the results, where this affects their interpretation.

Dividing the sample according to participation in control called first for selection of a single Guttman scale from the four 'best' scales identified in the previous chapter, and secondly for a critical, discriminating value on that particular scale. Experimenting over all combinations of scale and scale value in preliminary t-tests of subsample means showed that best results were obtained using scale GS4 with a critical value of $GS4 \geq 1$ for high participation (P) firms.[5/] In effect this divided the sample in an intuitively plausible way between those having 'full participation' in at least one decision-making area (typically job-design) and others, and was used in all subsequent analyses.

When partitioning the sample according to profit-sharing (PIW2, the ratio of profit paid out to workers over total wages and salaries), alternative divisions were made at critical values of zero (any profit-sharing vs none) and one per cent. For identification purposes the profit-sharing subsamples are hereafter denoted ΠS0 and ΠS1 respectively. Use of the higher criterion (which reduces the proportion of firms classed as profit-sharing from 0.48 to 0.30), is in recognition of the fact that, as observed in section 5.2, low levels of financial participation may occur as an employers' control tactic rather than as genuine participation, and hence may be ambiguous discriminators. Though the higher critical value of one per cent is necessarily arbitrary, inspection of the frequency distribution of firms with respect to profit-sharing suggests that it may serve reasonably well to demarcate firms seriously committed to profit-sharing from the rest. On average, profit-sharing amounted to 7.2% and 11.5% of employee remuneration in the ΠS0 and ΠS1 subsamples respectively.

5.4 Empirical Findings

(a) Evidence on the coincidence of participation and profit-sharing: Cross-tabulations

Table 5.2 shows the proportion of firms in the high participation (P) and profit-sharing (ΠS0, ΠS1) categories, together with those in which there is employee-ownership of the firms' capital - an alternative index of financial participation.[6/] The table also shows in matrix form the proportion of firms in a given 'high

participation' category (i.e. each row) which appear in each other high participation category (i.e. each column).

Table 5.2 Cross-Tabulations, Participation in Control and Financial Participation (Number of firms in each row category which also belong to the respective column category; n=128)

	Participation in Control	Profit Sharing		Employee Ownership
		(i) Greater than zero	(ii) Greater than 1%	
Participation in Control	76	39	27	22
Profit sharing (i) Greater than zero		62	38	28
(ii) Greater than 1%			38	13
Employee Ownership				30

Clearly participation in control (as measured by GS4) is more common across the sample than is financial participation. Thus nearly 60 per cent of observations are in the P-firm category, whereas just under half the sample have some profit-sharing (the S0 group) and in only 30 per cent of cases (the S1 category) does this exceed one per cent. Least common of all is employee-ownership, which is reported in less than a quarter of all cases. Clearly, from these figures, the various forms of participation by no means always go

hand-in-hand. For example, only half the observations with high participation in control also have profit-sharing and less than 30 per cent have employee-ownership. Even the two forms of financial participation are only loosely interrelated; under half of all profit-sharers report employee-ownership although, necessarily, virtually all employee-ownership firms have profit-sharing.

(a) Evidence from sub-sample means : t-tests

Significance tests on differences in subsample means were carried out using all three alternative versions of the basic sample described in the previous section. They were also carried out for corresponding samples confined to observations within the metal-manufacturing and processing sub-industry (ID3). This was as a safeguard against possible distortions arising from the uneven distribution of subsamples across sub-industries though, as can be seen in table 5.3, differences in the proportions of the various subsamples falling into industry subdivisions (ID1, ID2, ID3) are not statistically significant. Only the metal-manufacturing subindustry sample contained sufficient observations for separate analysis in this way. For ease of presentation only the results for the 61-firm, 'average' sample will be presented in detail, important differences in other sets of results being mentioned where appropriate. This sample is arguably the most appropriate for the task in hand, utilising the separate data for 1977 and 1979 where available, yet taking no liberties over the degrees of freedom.[7/]

Table 5.3 reports mean values of 43 structural and performance variables for the previously described subsamples of

Table 5.3: t tests: Participatory and Profit Sharing Firms vs Others[1]

	PARTICIPATION IN CONTROL			PROFIT-SHARING Greater than zero			Greater than 1%		
	MEANS			MEANS			MEANS		
	P firms	Others	t	Π>0 firms	Others	t	Π>1 firms	Others	t
	n = 36	n = 25		n = 30	n = 31		n = 19	n = 42	
PARTICIPATION									
GSD	-	-	-	0.60	0.58	0.15	0.68	0.55	1.00
M2	0.48	0.21	1.11	0.53	0.22	1.30	0.67	0.24	1.47
P1W2	0.05	0.01	1.26	-	-	-	-	-	-
LABOUR FORCE									
SBYU	2.09	0.88	2.32**	0.91	2.25	-2.27**	0.87	1.92	-2.29**
APP	0.15	0.09	2.12**	0.10	0.15	-1.33	0.11	0.13	-0.65
CERT	0.81	0.75	0.64	0.80	0.78	0.27	0.86	0.76	0.97
HIED	0.16	0.16	0.00	0.15	0.16	-0.24	0.15	0.16	-0.09
TREXP	1.03	0.69	1.82*	0.74	1.04	-1.41	0.68	0.99	-1.73*
WBYB	0.36	0.31	1.35	0.35	0.33	0.53	0.39	0.31	1.38
PCM9	86.89	75.24	1.90*	76.47	87.58	-1.83*	70.74	87.26	-2.07**
SAET	47.04	44.01	0.68	45.19	46.39	-0.27	41.23	47.87	-1.42
TMHNEM	1712.8	1695.9	0.17	1654.2	1755.9	-1.04	1694.4	1711.0	-0.16
REMUNERATION									
MANW	28.90	26.00	1.30	28.83	27.12	0.54	29.16	27.06	0.68
AVSAL	39.01	38.25	0.36	40.28	37.18	1.51	41.14	37.60	1.60
AVIN	3231.8	3298.1	-0.49	3398.9	3123.6	2.14**	3447.1	3173.9	1.65
EUE	1198.9	1130.3	1.70*	1199.1	1143.4	1.38	1190.2	1162.0	0.54
ETE	1451.8	1411.4	1.11	1463.4	1408.0	1.55	1460.6	1423.8	0.83
CONTROL									
CS4	0.74	0.81	-2.12**	0.80	0.74	2.05**	0.79	0.76	1.07
I2	0.10	0.12	-0.59	0.13	0.09	0.77	0.07	0.13	-1.17
VOICE AND EXIT									
PWU9	32.31	40.60	-1.14	39.43	32.10	1.02	30.37	38.12	-1.17
PWU1	28.22	37.92	-1.42	32.57	31.84	0.11	22.89	36.40	-2.31**
WOCO	0.75	0.80	-0.45	0.87	0.68	1.77*	0.79	0.76	0.23
ATS	0.11	0.16	-0.55	0.17	0.10	0.80	0.21	0.10	1.23
ATU	0.19	0.56	-3.14***	0.50	0.19	2.62**	0.42	0.31	0.84
TECHNOLOGY AND FINANCE									
JO	0.67	0.28	3.16***	0.47	0.55	-0.63	0.47	0.52	-0.36
BA	0.81	0.72	0.77	0.80	0.74	0.53	0.79	0.76	0.23
FL	0.11	0.36	-2.23**	0.30	0.13	1.64	0.32	0.17	1.31
IT	0.97	0.96	0.26	1.00	0.94	1.41	1.00	0.95	0.96
KBYL	67.48	74.58	-0.86	72.14	68.69	0.42	79.71	66.17	1.57
GEAR	0.53	0.48	0.62	0.52	0.50	0.21	0.56	0.48	0.79
INVEST	0.13	0.16	-0.75	0.12	0.16	-1.00	0.13	0.15	-0.28
MARKET AND INDUSTRY									
HERF	0.12	0.17	-1.02	0.14	0.14	0.20	0.16	0.13	0.63
MSE	26.47	34.08	-1.19	27.67	31.40	-0.60	29.47	29.64	-0.02
PS5	47.77	41.75	0.88	42.76	47.76	-0.74	46.44	44.79	0.23
PS10	66.69	69.07	-0.33	71.79	63.67	1.17	73.18	65.17	1.06
ID1	0.08	0.16	-0.92	0.17	0.06	1.24	0.21	0.07	1.34
ID2	0.22	0.32	-0.84	0.20	0.32	-1.08	0.21	0.29	-0.61
ID3	0.69	0.52	1.38	0.63	0.61	0.16	0.58	0.64	-0.47
LOCATION AND AGE									
UBYR	0.50	0.48	0.15	0.43	0.55	-0.89	0.42	0.52	-0.73
YEAR	1932	1920	1.33	1932	1921	1.21	1937	1922	1.74*
SIZE									
NET	473	925	-1.35	872	452	1.40	818	587	0.59
PRODUCTIVITY									
VBYL	49.83	47.15	0.56	51.93	45.63	1.24	52.96	46.82	1.11
VBYK	1.12	0.75	1.47	0.90	1.03	-0.43	0.91	1.00	-0.29

Note (1) *, **, *** denote significance at 10%, 5% and 1% respectively.

high-participation (P) and profit sharing (ΠS0, ΠS1) firms. All variables are defined in Appendix 5.1. The accompanying t-values relate to tests on the mean differences between the subsamples in question and appropriately defined 'other firms'. The t-statistics are calculated using pooled or separate variances according to a prior F-test for equality of subsample variables, with the aid of the relevant SPSSX sub-routine.

As is to be expected with the relatively small sample available, mean differences between the subsamples in many of the variables analysed are not statistically significant. There are nevertheless some striking results bearing on the theoretical propositions of chapter 2. The main features of the results as a whole may be summarized as follows.

(i) The average productivity of both labour (VBYL) and capital (VBYK) is higher in participatory (P) firms than elsewhere, though the differences are not statistically significant (table 5.3). In the corresponding analysis using the pooled data set, however, the capital productivity difference was just significant at the 5% level. Thus, while it can reasonably be said that, on this evidence, participation is not a source of productivity loss, any stronger claim would be hazardous. Profit sharing (ΠS) firms, by contrast, exhibit mixed results, with higher average labour productivity but marginally lower capital productivity than non-profit sharing firms. In this case the differences remain statistically nonsignificant in the results from pooled data, as well as in table 5.3.

(ii) This pattern of (weak) productivity differences between participatory and profit-sharing firms, as compared with their respective 'other firm' groups, is consistent with the observed pattern of capital intensity (KBYL) differences - lower than elsewhere for P firms, higher for ΠS firms - though the differences are again consistently non-significant. The fact that to the extent real differences do exist, it is capital productivity which is higher in P firms, and labour productivity which is higher in ΠS firms, may be significant. For as we shall shortly see, there is evidence of capital and labour-augmentation in P and ΠS firms respectively, arising from systematic differences in labour force quality and production technology, which would be consistent with the pattern of productivity differences shown.

(iii) The existence of only a weak association between participation in control and profit-sharing, as revealed in the cross-tabulations of table 5.2, is confirmed in tables 5.3. Thus there are no statistically significant mean differences indicating higher profit-sharing (PIW2) in P-firms,[8] or significantly higher participation in control (GSD) among ΠS0 or ΠS1 firms. More surprisingly in the light of table 5.2, ΠS firms do not have significantly more employee ownership (M2), though the mean differences are large and, in the pooled data analysis, achieve significance at better than 1%.[9]

(iv) Striking differences between P and ΠS firms do, however, emerge in respect of the human capital and technological characteristics of the firm, emphasized in the theoretical framework of chapter 2. P-firms exhibit significantly higher skill,

apprenticeship and training ratios (SBYU, APP and TREXP respectively, the latter at 10% only); operate significantly more 'job' (JO) and significantly less 'flow' (FL) production processes; and (at the 10% level) employ a significantly higher proportion of male workers (PCM9). By contrast, these effects are entirely lacking in the ΠS firms, where there is contrary evidence of significantly lower skill ratios and male employment (at the 10% level), and the mean differences for JO, FL, APP and TREXP are all of opposite sign, though non-significant.[10/] No significant differences are recorded in the utilisation of intermediate technology (IT), however, which appears to predominate in all subsamples.

(v) How far the inter-group differences in production implied by these results are associated with differences in firm size is difficult to say, since the subsample variances in size (NET) must be very large. For though P firms are only half the size of 'others' in terms of employment, while ΠSO and ΠS1 firms are respectively 93% and 39% larger, none of these differences is statistically significant.

(vii) The foregoing differences in P and ΠS firms may contribute to a number of other features of the results. In particular, the significantly smaller control spans (CS4) in P-firms could largely reflect the smaller work-group characteristics of job-production.[11/] and, though less certainly, the significantly higher spans in ΠSO firms a higher incidence of machine-pacing under flow production. Secondly, the previously noted differences in the sex composition of the workforce of P and ΠS firms may at least partially explain the results for (unskilled) labour turnover (ATU)

which tends to be lower in the former, and higher in the latter. As is well known, turnover is for various reasons generally higher among female workers, who are also predominantly unskilled. Bearing in mind also the usual sex differentials in pay, the higher proportion of male workers in P-firms presumably also contributes towards the higher unskilled earnings (EUE) observed there.

(viii) On the evidence presented, participation-in-control clearly does not depend strongly on union organisation. For unionisation tends to be lower in P-firms than elsewhere and, though the differences are generally not statistically significant, this result is more remarkable in view of P-firms' high ratio of male workers, whose propensity to unionise is generally higher than women's. Similarly, as measured in this study, participation-in-control does not seem to have much to do with Works Councils (WOCO); again the mean difference for P-firms is negative, though highly non-significant, whereas if Works Councils were central to the participatory process, a significant positive difference might be expected.

(ix) Among variables not so far discussed, there are no significant inter-group differences in hours of work (TMHNEM), the ratio of white to blue collar workers (WBYB), the incidence of workers with educational qualifications (CERT) and higher education (HIED), skilled earnings and turnover (ETE, ATS), length of service (SAET), the use of individual incentives (I2), wages and salaries (MANW, AVSAL) market environment (HERF, MSE), product longevity (PS5, PS10), and gearing and investment ratios (GEAR, INVEST). The remaining statistically significant results indicate, in the case of ΠSO firms, higher incomes for foremen, etc. (AVIN) - which could possibly

be associated with greater emphasis on hierarchical supervision - and a weak suggestion of more works' council activity (WOCO), and in the case of ΠS1 firms, (i.e. those most committed to profit sharing), stronger evidence than elsewhere of low training (TREXP), unionisation (PWU1) and male employment (PCM9).

In other, unreported comparisons, mean differences were tested for subsamples of firms which met both participatory and profit-sharing criteria - the intersections of the P and ΠS0 or ΠS1 subsets. Few of the foregoing results were repeated and, in the few cases where significant differences were found, both significance levels and, occasionally, signs tended to vary according to whether comparison was made with all other firms, or with firms in neither the P nor ΠS subsamples. This is not unexpected if, as the general tendency of the results suggests, participation in control and financial participation are essentially different phenomena, typically used by different kinds of firms in different circumstances; they may well not mix.

(c) Discriminant Analysis

In the light of the foregoing differences in subsample means, we may reasonably expect that, taken together, the structural and performance variables at hand would discriminate successfully among firms in the sample, and jointly predict with some accuracy to which subsample a firm should belong, given its observed characteristics. Discriminant analysis was employed (a) to confirm this and (b) to see whether those variables attracting most weight in the relevant discriminant functions were also variables highlighted by

theory as hallmarks of participatory, profit-sharing and traditional firms. The discriminant analysis was carried out using SPSSX and again focussed on the three prior divisions of the sample - participation in control and two levels of commitment to profit sharing - used in the preceding section.

Initially, five sets of variables were entered in stepwise fashion by all five methods available on SPSSX, using the pooled time-series, cross-section sample described in section 3.[12/] Identical results were obtained by each method, and further analysis was therefore confined to the method of minimising Wilks' λ, a measure of group discrimination. The sets of variables were

(a) all variables listed in the appendix, and used in the previously reported t-tests;

(b) all variables except performance, broadly defined (to include capital and labour productivity, together with voice/exit indicators of alienation (ATU, ATS and PWU9));

(c) selected firm-structural variables (including labour force characteristics, training, control, incentives and technology, (see below);

(d) performance variables (defined as under (b)); and

(e) productivity (capital and labour).

Table 5.4 reports summary statistics for each set of variables and division of the sample. The eigenvalue and Wilks' λ ($0 < \lambda < 1$) both reflect the discriminating power of the function (Wilks' λ inversely).[13/] Significance levels are based on chi-square tests. The percentage of classification 'successes' shows the power of the function to predict the group to which an observation belongs, by reference to its structural and/or performance characteristics; in two-group examples such as those under consideration, the figures shown should be compared with a random expectation of 50% success.

Table 5.4 shows that in each case significant results were obtained for variable groups (a) to (d), but not for group (e). In unreported analyses, 'other performance' variables (ATS, ATU and PWU9) also yielded, on their own, non-significant results. Hence the first result from discriminant analysis is that, by themselves, productivity (and other 'performance' variables, ATS, ATU and PWU9) do not distinguish the subsamples in a statistically significant way. But if we use all performance variables together, and *a fortiori* all structural and performance variables together, we can successfully distinguish the high and low participation groups. Thus the evidence is consistent with the proposition that it is possible to organise production in the firm in different ways (in particular according to participatory or non-participatory regimes) with *at least* no sacrifice of productivity, and this confirms the earlier evidence from subsample means.

Secondly, we can see that a set of firm structural variables selected for their *a priori* theoretical relevance (set (c)) contribute importantly to overall discriminating power. This set of variables

Table 5.4 Discriminant Functions, Summary Statistics

Variables	Eigenvalue	Wilks' λ	χ^2	Significance Level	% Correctly Classified
HIGH VS LOW PARTICIPATION (GS4>1)					
a All	.84	.54	71.43	0.00	83.59
b All except performance	.72	.58	64.47	0.00	81.25
c Structural (selected; see text)	.52	.66	50.83	0.00	75.78
d Performance	.20	.84	22.25	0.01	70.31
e Productivity	.02	.98	2.82	9.30	42.97
PROFIT-SHARING VS NON PROFIT-SHARING (PIW2>0)					
a All	.85	.54	71.90	0.00	82.81
b All except performance	.59	.63	54.46	0.00	72.66
c Structural (selected; see text)	.31	.76	33.14	0.01	69.53
d Performance	.09	.92	10.42	0.55	64.84
e Productivity	.01	.99	1.84	17.51	53.91
HIGH PROFIT SHARING VS OTHERS (PIW2>0.01)					
a All	.77	.57	67.97	0.00	79.69
b All except performance	.70	.59	63.48	0.00	83.59
c Structural (selected; see text)	.47	.68	46.82	0.01	75.00
d Performance	.10	.91	11.42	9.60	60.16
e Productivity	.02	.98	2.37	12.40	62.50

focusses on the characteristics of firms which are most closely related to their human capital utilisation (the quality and composition of their labour forces, and training intensity), their internal control and incentive system, their location[14/] and their production methods and technology. Compared with variable group (b) (which like (c) excludes performance variables), the omissions mainly concern firm size, industrial and market environment, finance and investment pattern, and pay. These are less central in the theoretical framework developed in chapter 2 than are the variables retained in set (c). Yet, with ten fewer variables, set (c) still classifies 79% of observations correctly when the sample is split according to participation in control (GS4 1), and 72-75% in the case of the two profit-sharing divisions. This compares with a maximum success rate of just over 86% for any discriminant function.

Table 5.5 reports the standardised coefficients for individual variables in the set (c) functions. Ignoring signs, the coefficient values indicate the relative contribution of the associated variables to the function; interpretation is analogous to that of beta coefficients in multiple regression. At the same time the coefficients can be used, as in factor analysis, to identify the dominant characteristic they measure. In the case of the high vs low participation-in-control dichotomy, (GS4 1), job production (JO) and skill ratio (SBYU) are outstandingly the dominant characteristics. In the two splits based on profit-sharing, by contrast, the most important single factor is workers' capital (M2); these, it appears, are both "ownership" functions. In both cases, however, M2 is much less dominant over other variables than are JO and SBYU in the first function; there are four variables with intermediate

TABLE 5.5

STANDARDISED DISCRIMINANT FUNCTION COEFFICIENTS(1)

VARIABLE	DIVISION		
	GS4≥1	PIW2>0	PIW2>0.1
	(1)	(2)	(3)
GS4D	-	0.36	0.55
PIW2	0.37	-	-
M2	0.23	0.71	0.66
SBYU	0.68	-0.26	
APP			
TREXP	0.28	-0.30	-0.38
HIED	-0.37		
CERT	0.23		
WBYB	0.33		
PCM9			-0.45
CS		0.55	
I2	0.29	-0.26	-0.46
JO	0.76		
BA	0.28		-0.23
FL	-0.21	0.50	0.59
IT		0.46	
KBYL		-0.44	0.23
UBYR			-0.20

Note (1) Missing values indicate a variable not retained in stepwise analysis. The default value (F to enter = 1.0) is set so that "almost any variable with discriminatory power is chosen and retained for the analysis" (Nie, et al (1975) p.448).

values (in excess of 0.40) in each of the ownership functions (though the identities of the variables are different as between the two functions). In order to confirm this interpretation, further discriminant analyses were carried out for the three prior classifications, retaining only JO and SBYU in the first (participation-in-control) analysis, and M2 only in the second and third (profit-sharing) analyses. Highly significant results were obtained in each case, and despite the omission of all variables but these, the functions still classified correctly no less that 70.49%, 63.11% and 74.59% of cases in the respective functions, compared with 75.78%, 69.53% and 75.00% using the original, full specifications as shown in table 5.4.

Finally, the discriminant analysis results confirm the evidence of the sub-sample means, that a partitioning of firms according to participation-in-control identifies a subsample with very different characteristics from that which emerges when the partitioning is based on profit-sharing; participatory and profit-sharing firms are by no means the same. Thus in table 5.5 there appears to be very little correspondence between the vectors of discriminant function coefficients in column 1 and either columns 2 or 3; in fact the simple correlation coefficients (assigning zero values for variables not retained in a given function) are very low: $r_{12} = 0.22$ and $r_{13} = 0.19$.[15/] The most important differences of detail are also confirmed, in particular the contrast between participatory firms' tendency towards high skill, job production methods and profit-sharing firms' tendency towards average or low skill, low training, and flow production technologies.

5. Conclusions

On the evidence of the database on firms in the West German metalworking industries described in chapter 1, there are striking differences in the characteristics of firms which, on the one hand, involve workers in decision-making and, on the other hand, practice some degree of profit sharing. In particular, firms which practice participation-in-control score significantly more highly in human capital related dimensions of the labour force, and tend to employ a mixture of 'job' and 'batch' production methods, rather than a mixture of 'batch' and 'flow'. Indicators of conflict, such as unionisation and labour turnover do not all show significant differences but, where they do, are lower under participation. On the performance front, labour and capital productivity is at worst no less than in other firms, and there are weak indications that capital productivity may be significantly higher. Profit-sharing subsamples, by contrast, exhibit low indicators of embodied human capital and a propensity to more repetitive, machine-paced 'batch' and 'flow' production methods in larger enterprises. In general, profit-sharing, which appears to be associated with limited levels of share ownership, appears also to be more a matter of substituting group for individual incentives in certain categories of traditional production, rather than a mark of firms which are pursuing more genuinely participatory forms of work organisation.

Thus the evidence from cross-tabulations, t-tests of mean differences, and discriminant analysis presented in this chapter indicates that, judged by the characteristics of the firms which adopt them, profit-sharing and participation in control are emphatically not

the same thing, as they are not infrequently inferred to be in both academic discussion and policy debate. Moreover, while the characteristics of firms practicising participation in control in general conform to a considerable degree to the pattern predicted in participatory outcomes by the theoretical framework of chapter 2, profit-sharing firms do not.

FOOTNOTES

1/ Bradley and Gelb (1983), however, argue that resort to payments-by-results represents a failure of the supervisory aspect of scientific management.

2/ Recall the distinction between 'ultimate' and 'effective' technology drawn in chapter 2.

3/ For a review see e.g. McCain (1982).

4/ For formal analysis see FitzRoy and Kraft (1985), and Reich and Devine (1981).

5/ See table 4.2 for details of this scale.

6/ Table 5.2 is based on the pooled sample described in section 5.3. Results with the 61-firm 'average' sample are almost identical, slight differences occuring only where individual firms fell into different profit-sharing and workers' capital categories in 1977 and 1979. Replication of the participation (GS4) data in this case does not distort the results, which are based only on relative frequency counting and do not involve degrees of freedom.

7/ In this case use of the pooled data sample, involving replication of survey data values for each twice-entered firm, would affect the results by overstating the true degrees of freedom.

8/ Though the P1W2 difference is significant at 8.3% using pooled data.

9/ Which underlines the dangers of relying exclusively on pooled data samples when testing mean differences.

10/ In fact, the FL difference for ΠSO firms only narrowly misses significance at 10% (it is significant at 10.6%). Moreover, in the analysis for the metal manufacturing industry (ID3) only, both the JO and FL differences are significant (negatively and positively respectively).

11/ Recall that the organisational Herfindahl CS4 is an inverse measure of hierarchy, taking unit value for a totally non-hierarchical firm (e.g. a small cooperative or partnership) and tending to zero as hierarchy increases. As previously indicated, the results should be interpreted with caution since CS4 is calculated from respondents' perceptions of the number of hierarchical levels in the firm, and clearly there is scope for variation from firm to firm in what constitutes an 'hierarchical level'.

12/ Respectively these are: minimise Wilks' λ (WILKS); maximise Mahalonobis distance between the two closest groups (MAHAL); minimise the smallest F between pairs of groups (MAXMINF); minimise residual variation (MINRESID); and maximise Rao's V, a generalised distance measure (RAO). Similar results were obtained using annual cross-sections for 1977 and 1979 separately, in which replication of survey data is avoided. Thus no serious distortion appears to have been introduced by the replication procedure.

13/ In general, discriminant analysis involves solving for $\underset{\sim}{u} = W^{-1}\underset{\sim}{d}$, where $\underset{\sim}{d}$ is a vector of mean differences between groups for a set of discriminating variables and $\underset{\sim}{u}$ is a vector of the weights attaching to each variable in the discriminant function. For a description of the method see, for example, Lindeman, Merenda and Gold (1980), chapter 6.

14/ The urban/rural variable is included on the hypothesis that participation and profit-sharing may have more positive effects ceteris paribus in non-urban settings, where workers are more likely to be known personally to each other, and where the fortunes of individual firms loom larger in the local community.

15/ Whereas the equivalent correlation between the two profit-sharing vectors is $r_{23} = 0.44$. When all variables are forcibly retained in the function (discriminant analysis METHOD = DIRECT), the coefficients are respectively $r_{12} = 0.17$, $r_{13} = 0.38$, and $r_{23} = 0.40$.

APPENDIX 5.1 List of Variables used in the Analysis

Participation

GSD	Participation-in-control dummy (1 if participatory (GS4 ≧ 1)).
M2	Workers' capital (DM'000 her head).
PIW2	Ratio: (profits paid to workers)/(wages and salaries).

Labour Force

SBYU	Ratio: skilled/unskilled workers.
APP	Ratio: apprentices/total manual employees.
CERT	Ratio: white collar workers with qualifications/total white collar workers.
HIED	Ratio: white collar workers with higher education/total white collar workers.
TREXP	Annual training expenditure per employee (DM'000).
WBYB	Ratio : white/blue-collar workers.
PCM9	Percentage male workers.
SAET	Percentage of employees with more than 10 years' service.
TMHNEM	Hours of work per manual worker.

Remuneration

MANW	Average manual wage (DM '000 per annum).
AVSAL	Average non-manual salary (DM '000 per annum).
AVIN	Average income of foremen, craftsmen and white-collar-workers.
EUE	Earnings of unskilled employees.
ETE	Earnings of skilled employees.

Control

CS4 Herfindahl index of organisational concentration:

$$CS4 = \sum_{i=1}^{n} S_i^2,$$ where S_i = proportion of employees at i'th hierarchical level.

I2 Ratio: performance related pay/wages and salaries.

Voice and Exit

PWU9	Percentage unionised in 1979.
PWU1	Percentage unionised in 1971.
WOCO	Works council dummy (1 if present)
ATS	Skilled labour turnover dummy (1 if 'high')
ATU	Unskilled " " " (1 if 'high')

Technology and Finance

JO, BA, FL	Production method dummies	JO: 1 if Job production used. BA: 1 if Batch production used. FL: 1 if Flow production used.
IT	'Intermediate' technology dummy (1 if used).	
KBYL	Capital/labour ratio (DM '000 per employee).	
GEAR	Gearing ratio (ratio of debt to total capital).	
INVEST	Ratio of investment to value added.	

Market and Industry

HERF	Herfindahl index of market concentration.
MSE	Percentage of sales exported.
PS5, PS10	Proportion of 1979 sales consisting of products developed within the last 5 and ten years, respectively.
ID1, ID2, ID3	Industry intercepts for sub-sectors of the metal-working industries.

Location

UBYR	Dummy: 1 = urban, 0 = rural.
YEAR	Year founded.

Size

NET	Total employment.

Productivity

VBYL	Value added per employee.
VBYK	Value added per unit capital.

6. PARTICIPATION AND PRODUCTIVITY

6.1 Introduction

In the preceding chapter we saw signs of a weak productivity advantage in participatory firms, and evidence of differences in technology and factor inputs - especially with respect to human capital enhancement - between participatory and traditional firms consistent with the theory of chapter 2. To round off the present analysis, we investigate the productivity-participation relationship further in this chapter, taking the technological and factor-input differences into account. In previous empirical studies going beyond the comparison of sub-sample means and simple regression, it has become standard methodology to estimate 'augmented' production functions of the general form:

$$\underset{\sim}{Y} = \underset{\sim}{X}\,\underset{\sim}{\beta} + \underset{\sim}{Z}\,\underset{\sim}{\alpha} + \underset{\sim}{W}\,\underset{\sim}{\delta} + \underset{\sim}{u}$$

where $\underset{\sim}{Y}$ = output vector,

$\underset{\sim}{X}$ = factor-input matrix,

$\underset{\sim}{Z}$ = matrix of augmenting variables,

$\underset{\sim}{W}$ = matrix of interaction terms.

$\underset{\sim}{X}\,\underset{\sim}{\beta}$ is typically specified as Cobb-Douglas, CES or translog and $\underset{\sim}{Z}\underset{\sim}{\alpha}$ includes measures of the degree of participation and other firm-specific and contextual variables. $\underset{\sim}{W}$ captures interactions between the augmenting variables and factor inputs, and is thus important for picking up embodied productivity effects. When $\underset{\sim}{Z}$ and $\underset{\sim}{W}$ are omitted the models reduce to the orthodox (unaugmented) production-function specifications.

Such analyses encounter formidable problems of specification and estimation, not wholly overcome in previous work. Thus, for example, whereas it is well-known that the production function is merely a technical constraint, embedded in a simultaneous equations model, the majority of early studies presented OLS estimates of single-equation models (e.g. Backus and Jones 1977; Jones 1982; Cable and FitzRoy, 1980). Subsequently, some simultaneous results have been presented from models in which productivity, participation in control and/or profit-sharing and financial participation are treated as endogenous variables (Cable and FitzRoy, 1983; Defourney, Estrin and Jones, 1985; FitzRoy and Kraft, 1985), thus allowing potential 'feedbacks' from performance to participation. As we will argue below, however, the concern out of which these specifications grew may have been misplaced, insofar as the equation systems addressed may plausibly be considered recursive, rather than strictly simultaneous. Moreover, like their OLS predecessors, these models also neglect the more fundamental identification problem encountered in production function estimation, namely that "actual observed data are the results of economic decisions in which the production function is but one constraint ... The available data correspond to reduced form observations and raise familiar identification problems, for the production function is embedded in a simultaneous equation model and cannot be identified if, for example, the marginal productivity conditions are not distinguishable from it" (Wallis, 1979, p.39). So far as this author is aware, only one previous study in the participation/self-management area has explicitly tackled this problem; in their comparative analysis of Israeli 'Koor' firms and unionised capitalist firms, Ben-Ner and Estrin (1985) report iterative 3SLS estimates of a three equation system (production function, wage

equation and labour-demand equation). For reasons given below we do not follow this route in the present analysis, but report OLS and TSLS estimates of augmented production functions from the VW data set, in the latter case assuming, like Ben-Ner and Estrin, that capital is predetermined, but using additional instruments (including earnings) for the endogenous labour-input variables.

Secondly, while several of the forementioned studies use pooled cross-section, time-series, or 'cohort' data, none has directly addressed the estimation problems to which this kind of data gives rise, in particular the characteristic forms of autocorrelation and heteroskedasticity which may be present. Complete resolution of these problems in the present analysis is unfortunately precluded by data limitations since there are only two cross-sections with a maximum of 61 observations appearing in each. In particular, with up to 45 other parameter estimates called for by the theoretical specification, we are unable to utilise the full dummy variable model of individual effects, or fully implement the time-wise autocorrelated, cross-sectionally heteroskedastic model (TACH) described, for example, in Kmenta (1971, pp508-517). However this matters less in the first stage of our analysis, where we are primarily concerned with model selection using F-tests and their asymptotic equivalents; the significance levels of individual coefficients which are likely to have been distorted by autocorrelation and heteroskedasticity are of secondary importance. In later stages of the analysis where individual coefficients become central, we employ the first (autoregressive) stage of the Kmenta model (in effect, a Cochrane-Orcutt two-step transformation adapted to the pooled data

case, with Prais-Winsten modification to retain first period observations), in conjunction with robust, heteroskedasticity-consistent standard errors (White, 1980). We also exploit an advantage of pooled data in first difference models, where firm-specific characteristics which do not change from cross-section to cross-section drop out. (In practice, this covers all those variables identified in the previous chapter as 'survey' rather than 'annual' variables, together with all other non-included firm-specific constants.) So far as is possible these adjustments are carried out for both OLS and IV estimates, and in models allowing for parameter variation between participatory and traditional firms in the sample. No single model satisfactorily combines all the desired estimation properties. Some, however, come close to achieving this. Even where this is not the case, it is possible, by taking together the results of the various partial solutions to the total set of problems in hand, to form a view as to their robustness to the various potential biases and distortions that may be at work.

The results of the present analysis provide an alternative to those obtained by FitzRoy and Kraft (1985), based on a very similar sample to that of this study, and utilising the same VW database. Drawing heavily on previous work by Cable and FitzRoy (1983), FitzRoy and Kraft estimate a three-equation model with production, participation-in-control and profit-sharing as the endogenous variables. They report positive productivity impacts of profit-sharing, workers' ownership of capital, and participation-in-control, together with a strongly significant causal feedback from productivity to profit-sharing, and a possible, less

significant feedback to participation-in-control. These results must, however, be discounted.[1/] Amongst other things, Fitzroy and Kraft ignore the previously discussed simultaneity problem concerning factor inputs, especially labour, and their results depend on the use of an arbitrarily-weighted index of participation-in-control which, as we saw in chapter 3 above, is statistically invalid. In common with other previous studies, FitzRoy and Kraft's analysis makes no attempt to address the estimation problems peculiar to pooled data, and is devoid of any theoretical framework or justification for the specification of the equations in their model. In consequence of the latter omission, the inclusion or exclusion of variables in particular equations is ad hoc, and the true identification properties of the model remain obscure. More generally, FitzRoy and Kraft fail to take account of the essential interdependence between the firm's choice of work organisation - in particular, whether this is of a participatory nature or not - and its technological and factor-input choices. The importance of this has already been seen in our theoretical analysis of chapter 2 and the empirical results of chapter 5, and will be further confirmed in the estimates reported below. Before presenting these estimates and the methods by which they were obtained, we consider the broad causal framework within which the relationship to be estimated (i.e. the augmented production function) is embedded.

6.2 A Sequential Model of Work Organisation and Productivity

As was emphasised in chapter 2, the outcome of the strategic game between employers and workers, in terms of which we model the choice of work organisation and firm performance, is not independent

of the environment in which the firm operates. On the contrary, the firm's political, historical and socio-economic context affects both the bargaining strength of the players and their expectations about the probability of given outcomes : the possibility of achieving outright unilateral control, or the inevitability of surplus-eroding conflict. Also, the social, legal and economic environment delimits the range of tactical options which are available in pursuit of broad strategic options - what is legally and socially acceptable behaviour, what is technically feasible within a given state of technological understanding and educational attainment, what is tax-efficient in a given fiscal system, and so on.

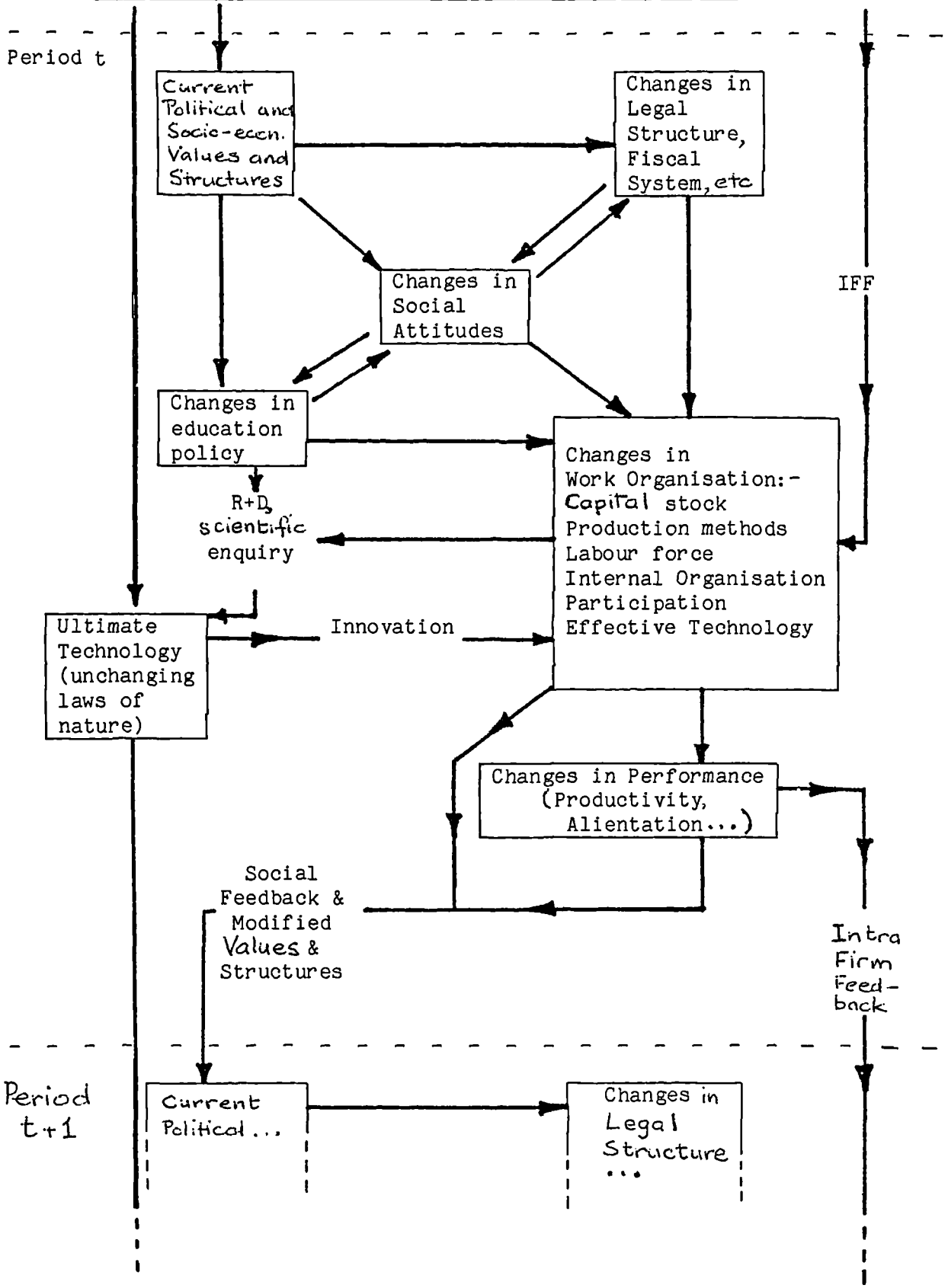
These broad influences on the firm's structure and performance are, of course, not fixed for all time. Rather they respond to events and experience, both in general ways and, more particularly from the point of view of our present interest, to the way firms at large choose to organise themselves, and to how well they perform as a consequence of those choices. The feedbacks in question operate at two levels - societal and intra-firm. At the societal level, external to the individual firm, experience of participatory and traditional production is absorbed into the political, social and economic consciousness of society via such mechanisms as media reporting, personal contact and academic research. Within the firm, recent past successes or problems evoke adaptive responses; organisational structures and operating procedures adjust via a process of organisational learning.[2/] But feedbacks of this kind involve learning and medium and long-term structural change rather than only short-term behavioural adjustment, and therefore cannot take place instantaneously, or even within short-term periods of, say, up

to a year. Thus we have, not a truly simultaneous system, but more a sequential process in which the firm's external environment and its internal structure, behaviour and performance are interacting and evolving continuously - or more plausibly intermittently, insofar as some adaptations, including the choice of participatory or traditional regime, may take place in discrete steps in response to traumatic past events or evidence of failure.[3/]

Figure 6.1 sketches a simplified, schematic representation of the process in which, we are arguing, the work-organisation choice and firm performance are determined. (The principal simplification is that, in order to highlight the work-organisation and performance aspects, other feedbacks, such as those occuring via direct social learning within legal, social and educational circles, etc. are suppressed.) In each relevant period in the life of an economic community, feedback from the past and experience with existing values and structures creates pressure for change in areas relevant to work-organisation and performance, including legal and fiscal systems, social attitudes and education policy, and so forth.[4/] Thus from time to time changes come about in the range of available labour contracts (slavery, indenture, dismissal without compensation); in conditions of trading under alternative legal forms of business organisation (limited-liability, joint-stock companies, cooperatives, partnership, etc.); in labour law (rights to organise, picket and strike, and sometimes to information and 'voice' (co-determination)); in the differential tax treatment of e.g. corporate and personal income, small vs larger firms, or profit-linked as opposed to other forms of pay.[5/] Historically-induced changes also occur in relevant social attitudes, e.g. towards deference, authority, hierarchy,

Figure 6.1

A Sequential Model of Participation and Productivity



individual rights, and collective vs individual goals, modifying aspirations inter alia about the appropriate role of employees in the work process, and the economic and social potential of employee-involvement. Still further changes occur in and via the educational system, both affecting and affected by the relative emphasis placed on individualism vs collectivism, on providing the manpower skills existing industry 'needs' vs creating social demands for greater job enrichment, and so forth. These various changes interact in complex ways, may be reinforced or moderated in the process, and subsequently impinge on the organisation of work, modifying the opportunities and shifting the balance of costs and benefits under alternative modes of operation. Also impinging on work organisation, as we have seen, is the intra-firm feedback: the firm's direct experience from its own individual past. A final determinant of work-organisation which must be mentioned is that of innovation: technological progress resulting from R+D and scientific enquiry prompted and guided both by general educational developments and by business objectives.

Economic performance, encompassing both material output (productivity) and its by-product, alienation (but not innovation which is seen as the means to higher performance rather than an end in itself) is then the outcome of the choice of work organisation (which, as we saw in chapter 2, is determined jointly with the choice of effective technology and of factor requirements) and the behavioural response this elicits from all those associated with the firm's production activities. At the end of the period, realised performance then forms part of the social and intra-firm feedthrough to the next period.

This, then, is the broad causal structure within which the participation-productivity relationship to be estimated may be seen as embedded. Note that because of adjustment lags there is no simultaneous (i.e. within-period) feedback from productivity to participation; current participation depends only on past performance, not its current level. Thus we may reasonably regard the system as recursive, and obtain consistent estimates of the performance equation without treating participation as endogenous. There is, however, a caveat. A further condition which must be met in recursive systems is that each equation's error term is independent of all the other error terms in all time periods. As Stewart and Wallis (1981, p.266) point out, this seemingly innocuous condition may not be met since 'an error term represents (amongst other things) the influence of omitted variables and it seems likely that some of these may be common to a number of equations in a model'. Whether this condition is met in the present case is hard to say since, in the absence of firmer theoretical guidelines, we are unable to specify and estimate the participation equation fully, and hence speculate on likely common omissions. In any event, recentstudies which treat participation and current performance as endogenous have misspecified the lag structure. Estimation of an appropriate participation equation would in any case be impossible from the available data.[6/] When we consider the nature of the determinants of participation in the light of figure 6.1, it is clear that these are primarily long term influences which we would not expect to observe in cross-sections of data for a particular country taken over a period of three years. For example in the VW data there will be no inter-firm variation in legal and fiscal conditions, social attitudes and education policy, etc., or at most only minor, regional differences. Thus if we wish to understand the determinants of

participation, we must turn either to very long time series for a given country - an essentially historical approach - or to international cross-section analysis across countries generating variation in the relevant political and socio-economic contextual variables.

On the other hand, we may reasonably expect to observe the participation-productivity or 'performance' equation in the data, provided sufficient variation in participation is generated according to the game structure of chapter 2; provided, that is, that there is

sufficient individual variation amongst firms and their circumstances such that not all make the same choice. In view of the results already presented in the preceding chapter for high and low participation subsamples of firms, this condition appears to be met. As we have seen, no simultaneity problem arises with respect to participation if the system is recursive. A problem may arise, however, if profit-sharing is among the augmenting variables in the production function. If profit-sharing is measured as the amount currently paid in the form of profit-linked pay, then a within-period feedback from current productivity will likely be present; given the existence of a specific profit-sharing formula, profit-linked pay is obviously a function of current profitability which, in turn, depends on current productivity. No problem arises, however, if profit sharing is entered dichotomously, as the existence of a scheme; in this case we may reasonably treat the profit-sharing variable, like participation, as predetermined, since within-period adjustment involving the adoption of profit-sharing is unlikely to have been observed, and whether or not the existence of profit-sharing is due to past performance will not affect the estimates. Arguably the dichotomous profit-sharing variable is theoretically the more appropriate; a performance incentive from financial participation is more likely to register as a shift effect as between firms which have it and those which do not, rather than as a continuous relationship among firms with limited variation in the degree of profit-sharing, and a concentration of zero values. In any event, we experiment with both types of measure in the analysis reported below, in recognition of both simultaneity and specification of variables problems.

6.3 Marginal Productivity Conditions, Factor Returns and Factor Demands

While the simultaneity problems addressed in recent participation studies may, on the foregoing arguments, be discounted, there remains the classic simultaneity problem encountered in production function estimation concerning marginal productivity conditions, factor returns and factor demands which, ironically, all but one study (Ben-Ner and Estrin, 1985) have ignored. In the worst case, under conditions of perfect competition where all firms face the same prices, and with inputs which are continuously variable and continuously substitutable in production at all times, no estimates will be possible at all. Thus as Wallis (1979, pp.50-51) shows, writing the three-equation system for a Cobb-Douglas production function

$$V_i = AK_i^{\alpha} L_i^{\beta} e^{u_i}$$

and its associated marginal productivity conditions for labour (L) and capital (K) with endogenous variables on the left-hand side, the right-hand sides of the three equations contain only constants and random disturbances.7/ Hence the production function is indistinguishable from an arbitrary linear combination of the three equations, and the scatter of firms observed will be randomly distributed around the same point on the relevant isoquant.

In practice things may not be this bad. Following Griliches and Ringstad (1971) and Feldstein (1967), and congruently with the

sequential model outlined in section 6.2, we may assume both that prices do vary between firms (e.g. due to differences in local labour market conditions and to differential access to capital markets), and that not all inputs are continuously substitutable at all times. Thus, capital at least (plus, we will subsequently argue, the firm's technology, internal organisation and workforce composition) is predetermined according to the firm's planned output for a given period and incompletely flexible within that period. Random output shocks in product markets then generate output fluctuations which leave capital unaffected but induce associated changes in (at least) labour input. Further interfirm variation (in capital as well as labour inputs) occurs if, due to differences in expectations of future factor-price ratios in formulating their plans, some firms' K/L choices appear as 'mistakes' in retrospect. Now estimation is possible, and the marginal productivity condition for capital does not come into play. But assuming profit maximisation, the output disturbances will be transmitted to the labour market, so that there is at least one other equation in the system, the marginal productivity condition for labour:

$$L = \beta(\frac{p}{w})\ Ve^{v}.$$

Faced with this difficulty, one available option is to continue to follow Griliches and Ringstad, living with the bias expected from single equation estimation methods, and subsequently asking "whether our more interesting results could be explained purely by such 'biases'" (op cit, p.14). In Section 6.6 below we do report OLS estimates in this spirit. However, since fairly reliable data for

total wages and economic salaries at firm level is available, we also present instrumental variable (2SLS) estimates, using average earnings (wages and salaries per employee) as an additional instrument for the endogenous, aggregated labour-input variable.8/ This is an incomplete solution, however, for at least three reasons. First, since good product-price data is not available, we are constrained to use absolute rather than relative earnings. Secondly, for reasons advanced by Feldstein (1967) and also as an index of capacity utilisation (Marris, 1964), we include hours as well as men in the production function, but then have only one price (the wage rate) for both inputs. Thirdly, our observed average earnings variable may not be strictly exogenous if it includes elements of implicit intra-firm surplus or rent-sharing (in terms of Aoki (1980) and chapter 2, the firm-specific supplements w' and s', in addition to market-alternative wages and salaries, w and s). Nevertheless, the IV estimates do in practice seem to lead to sensible adjustments to the OLS estimates in at least some models, as we shall see.

Moreover, a superior solution is not easy to find, since other standard remedies are either not available or are unattractive in the context of the present study. Thus, estimation of marginal products from factor shares (Klein, 1953) is not possible (a) because we do not have complete and reliable earnings figures for different types of labour (which we know from the preceding chapter to vary in relative quantities as between participatory and non-participatory firms) and (b) if the previous assumption of factor-price variation across firms in the sample is correct.9/ Similarly, reduced form estimation by means of cost functions (Nerlove, 1963) is inapplicable in the absence of the necessary special conditions, in Nerlove's case

satisfied by the electricity industry.[10/] Finally, the three equation model used by Ben-Ner and Estrin (1985) is too unwieldy in the present case. Ben-Ner and Estrin use iterative 3SLS to estimate a wage equation:

$$w = \bar{w} + (\eta' + \Delta_1 F) \frac{pY - rK}{L} + u_1,$$

and a labour-demand equation:

$$p \cdot \frac{\partial Y}{\partial L} = w - (\Omega' + \Delta_2 F) \frac{pY - rK}{L} + u_2,$$

subject to the production function:

$$Y = A^F f(L, K),$$

where F is a dichotomous variable taking unit value for a 'participatory' (Koor) firm and $\bar{w}$ is the (variously specified) market-alternative wage. (Here, too, capital input K is treated as predetermined.) Even in the absence of qualitative data on capital and labour force characteristics, etc., to which Ben-Ner and Estrin do not have access, the system raises substantial estimation problems, which inclusion of the wide array of firm-specific variables of interest in the present study would likely compound. Moreover, as an estimating framework for the present study this approach would offer compelling attractions only if it were possible to develop separate wage and labour-demand equations for different types of labour input. However this is precluded by the previously mentioned absence of an

appropriate wage vector for all different kinds of labour input (male vs female, skilled vs unskilled, white vs blue collar, etc.).

6.4 Production Function Specifications

The overall aim is to test for the existence and nature of a participation effect on productivity. Further, in the light of the theoretical framework set out in chapter 2, we are especially interested in whether such an effect, if it exists, occurs via a shift within a given technology (e.g. due to greater intensity of application or 'effort' of given factor inputs) or works via production input choices (and hence is associated with qualitative input differences). In conducting the empirical experiments, we have to recognise that this second type of effect could exist independently of participation, especially if our theoretical hypothesis is false.

Throughout the analysis we assume Cobb-Douglas production technology. As is well known, the C-D function is more restrictive than other functional forms in common use (such as CES and transcendental logarithmic), being an homothetic function with constant output elasticities α, β for each input (in a simple, two input model), homogeneity of degree $v = \alpha + \beta$, and constant (unit) elasticity of substitution $\sigma = d \log (K/L)/d \log (\partial Q/\partial L) = 1$. However, although for example the proponents of the very much less restrictive translog function, using US annual time series data, find that the restrictions imposed by more specific functional forms including C-D are false (Christensen, Jorgensen and Lau, 1971), C-D restrictions are in practice often not rejected in empirical work (e.g. Corbo and Meller, 1979 [11]). Moreover the relative advantage of

the CES function must be qualified by the fact that various estimation procedures of the non-linear function, and of its linear approximation due to Kmenta (1967), tend to provide reliable estimators of each parameter except the parameter σ (Thursby, 1980) which, as Thursby remarks, is "particularly disappointing since the CES is desirable primarily as a means of estimating a nonunitary elasticity of substitution". Finally, neither CES nor translog lend themselves as readily to augmentation as does the simpler C-D function. Translog, in particular, calls for the inclusion of all squares and cross products of the (logarithms of) all right hand side variables, and thus becomes prone to multicollinearity and problems of interpretation when the number of arguments rises beyond two or three; this of course would be a major problem in the present analysis, where richness of data in this dimension leads to large models.[12/] In short whilst it is true that, by confining the analysis to C-D, we will be unable to demonstrate robustness with respect to alternative feasible specifications, this seems a reasonable price to pay for a large gain in tractability in both modelling and estimation.

With qualitative dimensions of the inputs and other augmenting variables to be entered at a later stage, we begin with a familiar two input, stochastic model

$$V_i = A\, K_i^{\alpha}\, L_i^{\beta}\, e^{u_i}$$

where K is a measure of total capital stock, L is total employment and, following standard practice, $\exp(u)$ is a log-normally

distributed random variable taking values above and below one, representing the technical or productive efficiency of the firm (Wallis, 1979, pp.50-57). Adding a vector of control variables $\underset{\sim}{Z}$ which are unrelated to the issue of participation, as listed in table 6.1, under the assumption that these exert Hicks-neutral shift effects, we arrive at the first and most restrictive of a set of models to be estimated, in which it is assumed that there is no participation effect, and qualitative input dimensions etc. do not matter:

$$V_i = A_o K_i^{\alpha} L_i^{\beta} \exp \left(\sum_{j=1}^{J} \gamma_j Z_{ji} + u_{1i} \right). \qquad (6.1)$$

Now allowing for a simple Hicks-neutral shift effect due to participation, we have

$$V_i = A_o K_i^{\alpha} L_i^{\beta} \exp \left(\lambda P_i + \sum_{j=1}^{J} \gamma_j Z_{ji} + u_{2i} \right). \qquad (6.2)$$

where P denotes participation. In principle P may be either a binary or some continuous participation index. In practice we will work with a simple binary distinction between high and low participation firms, as in the previous chapter (i.e. the variable GS4D), preliminary experiments with dummy structures based on the full five-point Guttman scales having proved unpromising.[13/] Next we can relax the Hicks-neutrality assumption, allowing relative output

elasticities to vary according to participation:

$$V_i = A_o K_i^{(\alpha+\delta P)} L_i^{(\beta+\eta P)} \exp(\lambda P_i + \sum_{j=1}^{J} \gamma_j Z_{ji} + u_{3i}). \qquad (6.3)$$

If, on the other hand, there is no participation effect, but input qualities, internal organisation and so forth do matter, we may write

$$V_i = A_o K_i^{\alpha} L_i^{\beta} \exp(\sum_{j=1}^{J} \gamma_j Z_{ji} + \sum_{h=1}^{H} \phi_h Q_{hi} + u_{4i}) \qquad (6.4)$$

where $\underset{\sim}{Q}$ is a vector of qualitative and organisational variables (table 6.1). Combining neutral and non-neutral participation (P) effects with 'quality' (Q) effects captured in (4), we obtain, respectively,

$$V_i = A_o K_i^{\alpha} L_i^{\beta} \exp(\lambda P_i + \sum_{j=1}^{J} \gamma_j Z_{ji} + \sum_{h=1}^{H} \phi_h Q_{hi} + u_{5i}) \qquad (6.5)$$

and

$$V_i = A_o K_i^{(\alpha+\delta P)} L_i^{(\beta+\eta P)} \exp(\lambda P_i + \sum_{j=1}^{J} \gamma_j Z_{ji} + \sum_{h=1}^{H} \phi_h Q_{hi} + u_{6i}) \qquad (6.6)$$

However, equations 6.5 and 6.6 impose the same Q-effect coefficients for both participatory and non-participatory firms. Equation 6.7, our least restricted model, relaxes this restriction by the addition of a

further vector of slope dummies:

$$V_i = A_o K_i^{(\alpha+\delta P)} L_i^{(\beta+\eta P)} \exp(\lambda P_i + \sum_{j=1}^{J} \gamma_j Z_{ji} + \sum_{h=1}^{H} \phi_h Q_{hi} + \sum_{h=1}^{H} \mu_h P_i . Q_{hi} + u_{7i}) \qquad (6.7)$$

Finally, we also test the hypothesis that participation affects production, not directly, but via qualitative input choices only:

$$V_i = A_o K_i^{\alpha} L_i^{\beta} \exp(\sum_{j=1}^{J} \gamma_j Z_{ji} + \sum_{h=1}^{H} \phi_h Q_{hi} + \sum_{h=1}^{H} \mu_h P_i . Q_{hi} + u_{9i}) \qquad (6.9)$$

Equations 6.1, 6.7 and 6.9 form a structure of nested hypotheses with non-unique paths, which can be set out schematically as in figure 6.2. Model selection can then be carried out within this framework, using F and LR tests according to estimation method. As can be seen, we can test independently for the existence of a P-effect under various Q-effect assumptions (e.g. 6.9 vs 6.7, 6.4 vs 6.5, 6.1 vs 6.2, etc.) and vice versa (e.g. 6.3 vs 6.6 and 6.7, 6.2 vs 6.5, 6.1 vs 6.4 and 6.9, etc.), as well as for various joint effects (e.g. 6.9 vs 6.7, 6.6 vs 6.7). For consistency with an overall significance level of 5% for the overall test (6.1 v 6.7), and treating all models symmetrically, significance levels for intermediate stage tests are given by the relation

$$(1 - \varepsilon)^n = 0.95,$$

where ε is the intermediate stage significance level, and n is the number of models in the relevant path from equation 6.1 to equation 6.7 (Mizon, 1976).

While 6.7 is a crucial and relatively satisfactory equation for hypothesis testing within the framework sketched in figure 6.2, it is a potentially poor method of isolating and obtaining reliable estimates of the effects of individual right hand side variables. The vectors $\underset{\sim}{Z}$ and $\underset{\sim}{Q}$ contain 4 and 18 variables respectively. With a constant, two factor inputs and participation, equation 6.7 therefore calls for a total of 46 parameter estimates, of which 20 are interaction terms. Inevitably the results will be prone to multicollinearity, and perhaps incapable of interpretation.

Two lines of approach may however be pursued to circumvent this difficulty. First, given that 6.7 includes intercept and slope dummies for nearly all explanatory variables, it is but a short step to introduce four further interaction terms for the remaining variables (i.e. the elements of $\underset{\sim}{Z}$), and reduce the multicollinearity problems by proceeding to separate regressions for subsamples of high and low participation firms, as designated in the previous chapter by the P-dummy (GS4D). This amounts to estimating equation 6.4 (that is equation 6.7 with all participation and interaction terms deleted) separately across all $i = 1, 2, \ldots s$ participatory firms and the remaining, non-participatory subset containing all $i = s + 1, s + 2, \ldots t$ firms. We refer to these equations as 6.8(a) and 6.8(b) respectively. Each subsample equation now requires only 25 parameter estimates but, more importantly,

Figure 6.2

Estimating Framework : Model Selection

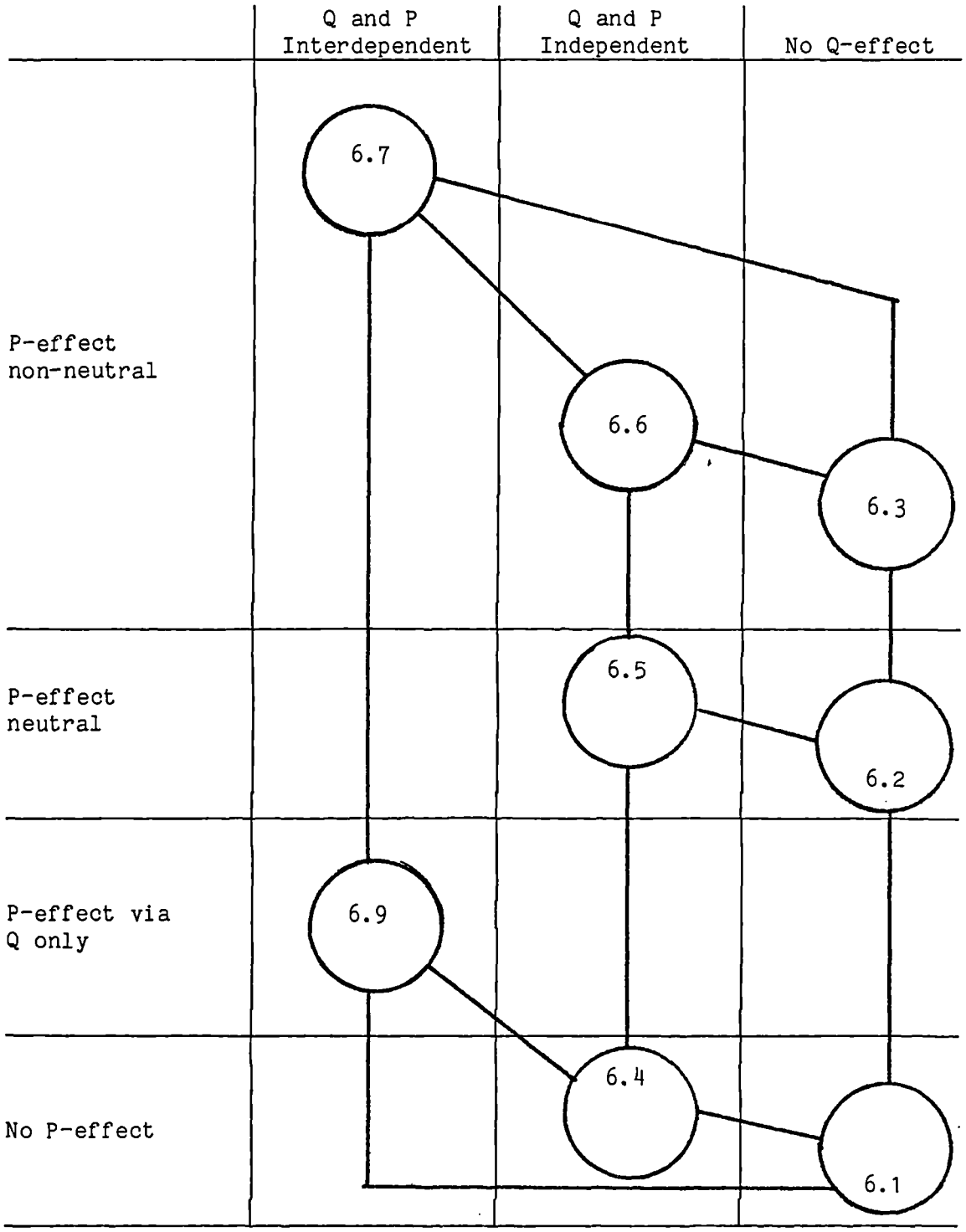


Table 6.1

$$\underset{\sim}{Z} = \begin{bmatrix} \text{Time} \\ \text{ID2} \\ \text{ID3} \\ \text{HERF} \end{bmatrix}$$

$$\underset{\sim}{Q} = \begin{bmatrix} \text{SBYU} \\ \text{WBYB} \\ \text{APP} \\ \text{CERT} \\ \text{HIED} \\ \text{TREXP} \\ \text{SAET} \\ \text{PCM9} \\ \text{PIW2} \\ \text{I2} \\ \text{M2} \\ \text{CSTOP} \\ \text{CS4} \\ \text{JO} \\ \text{BA} \\ \text{FL} \\ \text{IT} \\ \text{TMHNEM} \end{bmatrix}$$

excludes all of the potential multicollinearity-inducing cross-product regressors. Against this, there are of course fewer observations in the subsamples than the overall sample, and satisfactory results are by no means guaranteed.[14/]

Secondly, we may exploit an advantage of pooled data in which some variables do not change over time: in the present case, the 'survey' variables identified in the previous chapter. These variables then drop out if we take first differences. Starting from equation 6.7 we are then left with just seven right-hand-side variables in the subsample regressions, and these plus five slope dummies that remain in the corresponding equation for the full sample (table 6.6). Superficially these equations resemble those used by Cable and FitzRoy (1980), but the crucial difference is that the variables are now in differences not levels, and the fixed firm-specific characteristics which were not controlled for by Cable and FitzRoy, have been allowed for. Of course, on this approach we do not obtain estimates of the individual effects concerned.[15/] However, we do thereby obtain a model which is potentially the most capable of revealing differences in output elasticities between participatory and non-participatory firms. Moreover, profit sharing is among the variables which remain which, as we have seen, is of particular interest in the light both of our underlying theory and of current policy debate.

6.5 Estimation from Pooled Data

Before proceeding to the empirical results, it remains to consider the particular problems of estimation which arise when pooled

data is used. The general model in this case can be written as

$$y_{it} = \beta_{1it} + \sum_{k=2}^{K} \beta_{kit} x_{kit} + e_{it}$$

where $i = 1, 2, \ldots N$ denotes a cross-sectional unit (e.g. a sampled firm or individual) and $t = 1, 2, \ldots T$ denotes a time period (e.g. a yearly cross-section). In the VW database a maximum of 61 firms appear with complete data for 1977 and 1979[16/]; thus in the present case we have $N = 61$ and $T = 2$. In the general model all coefficients vary over time and individuals, and are mainly assumed random. Usually, however, more restrictive assumptions are made, and Judge, Griffiths, Hill and Lee (1980) identify four other cases: all coefficients constant; constant slope coefficients with the intercept varying over individuals; constant slope coefficients with the intercept varying over individuals and time; and all coefficients varying over individuals. In all but the first (constant coefficients) case, Judge et al continue, the variable coefficients may be assumed to be either random (leading to error components models and the Swamy random coefficient model) or fixed (leading to dummy variable models). For the present analysis we work mainly with two models; the all coefficients constant model, and a variant on the dummy variable model.

Under the all coefficients constant assumption we have

$$y_{it} = \beta_1 + \sum_{k=2}^{K} \beta_k x_{kit} + e_{it},$$

with the disturbance term capturing differences over both time and individuals. Since there is both cross-sectional and time-wise variation, it is necessary to allow for both heteroscedasticity and autocorrelation. Thus we arrive at the time-wise autoregressive cross-sectionally heteroscedastic model (TACH) in which $\beta_{kit} = \beta_k$ for all k and the e_{it} are heteroscedastic and autocorrelated. That is, the variance of the disturbance can be different for different individuals, $E(e_{it}^2) = \sigma_i^2$; there is cross-sectional independence, $E(e_{ij}e_{jt}) = 0$, for all $i \neq j$; but, initially at least, the disturbance vector for a given individual follows a first-order autoregressive process.[17/]

The TACH model can readily be estimated on certain standard regression packages such as SHAZAM,[18/] which implements the procedure set out by Kmenta (1971, pp508-517). Difficulties and limitations are encountered in the present application, however, primarily because we have only two cross-sections. Thus, the estimation procedure can be envisaged as requiring two transformations of the data. First, a Cochrane-Orcutt two-step transformation is carried out to clean for autocorrelation, using

$$\hat{\rho}_i = \frac{\Sigma e_{it} e_{i,t-1}}{\Sigma e_{i,t-1}^2} \quad (t = 2, 3, \ldots T)$$

where the (unbiased and consistent) e_{it} are obtained from prior OLS estimates using all $N \times T$ observations. But with $T = 2$ we have only one 'observation' for each $\hat{\rho}_i$, the ρ vector will be unstable, and it is more desirable to impose $\rho_i = \rho_j = \rho$ for all $i, j = 1, 2,$

...N, using

$$\hat{\rho} = \frac{\Sigma_i \Sigma_t e_{it} e_{i,t-1}}{\Sigma_i \Sigma_t e^2_{i,t-1}} .$$

Moreover in the $T = 2$ case it is clearly essential to retrieve the initial observations when estimating the transformed equations, by means of the Prais-Winsten modification. With these adjustments, however, the once-transformed equation may be estimated by OLS.

The second transformation, to correct for heteroscedasticity, may be accomplished by dividing both sides of the previous transformed equation by

$$S_{ui} = \sqrt{\frac{1}{T-K} \sum_{t=1}^{t} \hat{u}^{*2}_{it}}$$

where the $\hat{u}^*_{it}$ are the (asymptotically nonautoregressive) residuals from the transformed equation, and S^2_{ui} are the estimated variances of the u_{it} (i.e. the σ^2_{ui}).[13/] However with $T = 2$ we encounter a degree of freedom problem since $T < K$ and, strictly, the second transformation cannot be carried. In these circumstances SHAZAM offers an asymptotically equivalent (DN) option using $1/T$ in place of $1/(T-K)$. As an alternative in the present analysis, the first, ρ-transformation only was carried out using SHAZAM, and the transformed equation was then estimated by TSP to obtain robust, heteroscedasticity-consistent standard errors (White, 1980). It

should be pointed out, however, that this expedient is not entirely satisfactory because, whereas heteroscedasticity is usually assumed to arise from individual effects, in the present case the individual cross-section units appear more than once in the pooled data set.

The alternative, dummy-variable model assumes constant slope coefficients and intercepts that vary over individuals, i.e.

$$y_{it} = \bar{\beta}_1 + \mu_i + \sum_{k=2}^{K} \beta_k x_{kit} + e_{it}$$

where μ_i (assumed fixed) is the difference between the mean intercept ($\bar{\beta}_1$) and the intercept for the i'th cross-sectional unit. Again, however, there are difficulties when T is small. In the present case, with $N = 61$, $T = 2$ and, as we have seen in the previous section, k between 6 and 45, there are insufficient degrees of freedom for reliable estimates to be obtained; in the worst case we would be attempting to estimate 106 parameters with only 122 observations. We can, however, turn to the 'within estimator' (using variation of the variables within each group or cross-section unit so that individual effects drop out). Where $T = 2$ this involves first differences, and so brings us back to the final model considered in the previous section, the advantages and limitations of which were discussed there.

6.6 Empirical Results

Three principal experiments were carried out in the

empirical analysis. First, model selection was carried out within the framework outlined in figure 6.2, to test for the existence of an overall participation effect in production and for its general nature. Secondly, attempts were made to isolate parameter estimates of more detailed, individual impacts separate regressions for high and low participation firms Thirdly, first difference models were used as an alternative method of getting at these individual impacts.

Model Selection

The model structure outlined in figure 6.2 was estimated by both OLS and 2SLS using all 122 pooled observations. The autocorrelation and heteroscedasticity affecting estimation with pooled data is not a problem in the present context, where the statistical significance of individual parameters is not under examination. OLS estimation has the advantage that small-sample F-tests may be used in hypothesis testing, but the disadvantage that the estimates remain subject to potential simultaneity bias. The 2SLS estimates will hopefully mitigate this problem and yield consistent estimates, but hypothesis testing in 2SLS is complicated by unknown distributions, and at best may be interpreted only asymptotically. Thus neither estimation method yields ideal results, and this must be borne in mind when interpreting them.

Table 6.2 sets out F-values for the relevant hypothesis-tests indicated by figure 6.2 based on the OLS estimates. At the five percent confidence level any departure from the most general model 6.7 is rejected. Model 6.3 is also rejected at the higher, Mizon significance level (approximately 1%), as is model 6.9

Table 6.2

F-tests, equations 6.1-6.7 and 6.9, (OLS estimates)(i)
(d.f. in parentheses)

Restricted Equation	Unrestricted Equation						
	6.9	6.7	6.6	6.5	6.4	6.3	6.2
6.9		3.42** (3,76)					
6.7							
6.6		2.04** (18,76)					
6.5		2.13** (20,76)	2.39 (2,94)				
6.4	1.66 (18,79)	2.03** (21,76)		0.24 (1,96)			
6.3		2.30*** (36,76)	2.14** (18,94)				
6.2				1.93** (18,96)		0.85 (2,112)	
6.1	1.93*** (36,79)	2.20*** (39,76)			1.96** (18,97)		0.43 (1,114)

Note (i) **, ***, denote significance at 5% and 1% respectively. Mizon significance levels for equivalence with an overall test at 5% are, respectively:

1.70% with 3 models;
1.27% with 4 models; and
1.02% with 5 models.

when considered in the sequence 6.7 - 6.9 - 6.1, the relevant significance level in this case being approximately 2.5%.[20/] Elsewhere, however, the results display what may initially appear as a contradiction. Thus, on the one hand, it is possible to proceed from model 6.7 all the way to the most restricted equation 6.1 without encountering statistically unacceptable restrictions when these are tested at the relevant significance level at each step; actually, there are four feasible routes, three via model 6.6 and different paths thereafter, and one via models 6.9 and 6.4. Yet, on the other hand, model 6.1 is emphatically rejected in the overarching, direct test against 6.7, not only at the required 5% level, but also at 1%. In reality there is no contradiction, however, since the overall test is of the joint hypothesis that all restrictions hold simultaneously, whereas the step-by-step tests relate to various subsets of restrictions only; the situation here is merely an extension of the familiar discrepancies which can arise as between t-tests on individual parameter restrictions, and F-tests on sets of such restrictions.

Nevertheless, we are left with an interpretation problem in that, while 6.1 is unambiguously rejected, it is not clear where the effective restriction occurs and, in particular, whether it lies in the importance of input-quality effects or in participation. Taking the 1% level rejections of 6.3 and 6.9 into account, it would be hazardous to conclude that quality effects can be omitted (even though 6.3, 6.2 and 6.1 can be reached via 6.6), or that, if there is a participation effect, this operates solely via such quality effects. (Incidentally, we may note in passing that all models suppressing quality effects are rejected at the 5% level, i.e. 6.3 v 6.7 and 6.6;

6.2 vs 6.5; and 6.1 vs 6.4.) But this still leaves unanswered the central question in the present analysis; whether there is a participation impact and, if so, whether it operates interdependently with qualitative input choices.

In tests based on 2SLS estimation, however, there is no such uncertainty. In this case LR tests reject 6.3, 6.6 and 6.9 against 6.7 not only at 5% but also at 1% (table 6.3). Alternatively, the remaining ambiguity in the OLS estimates can be removed by reformulating the hypothesis slightly. Thus if we simply regard 6.7 as the maintained hypothesis and follow conventional practice testing various restricted models at the 5% level then, as we have seen, no departure from 6.7 to equations 6.3, 6.6 or 6.9 is admissable under OLS estimates also. On balance, therefore, we accept 6.7 as the appropriate model.

Though based on less than perfect empirical estimates, the foregoing analysis suggests, at the very least, a balance of probabilities in favour of the proposition that participation affects the production process interdependently with the qualitative choice of factor inputs, and this is an important result. Unfortunately however, direct estimation of equation 6.7 does not reveal the impact of particular qualitative aspects of the inputs and their individual interactions with participation. As expected with so many regressors and interaction terms, the results appear to be badly affected by multicollinearity; we tend to observe either unstable and non-significant coefficients or pairs of variables and their cross products with significant coefficients of comparable magnitude but opposite sign. To progress further we therefore turn to the separate

Table 6.3

LR-Tests, Equations 6.1-6.7 and 6.9, 2SLS Estimates(i)
(Number of Restrictions in Parentheses)

Restricted Equation	Unrestricted Equation						
	6.9	6.7	6.6	6.5	6.4	6.3	6.2
6.9		17.20*** (3)					
6.7							
6.6		48.92*** (18)					
6.5		55.11*** (20)	6.19** (2)				
6.4	39.46*** (18)	56.67*** (21)		1.55			
6.3		90.73*** (36)	41.81*** (18)				
6.2				38.02*** (18)		2.40 (2)	
6.1	76.73*** (35)	93.94*** (36)			37.27*** (18)		0.81 (1)

Note (i) **, ***, denotes significance at 5% and 1% respectively.

subsample regressions (6.8 (a) and (b)) and the first difference models described in section 6.4.

Subsample Regressions: High and Low Participation Firms

Equations 6.8A and 6.8B were estimated (for high and low participation subsamples respectively) by OLS, RHOTRAN and 2SLS, with heteroskedasticity-consistent (robust) standard errors, and using the continuous PIW2 variable and the dummy variables PSA and PSB as alternative profit sharing variables. The results are reported in full in appendix tables A.6.1, A.6.2 and A.6.3. In interpreting them, and where they differ, more weight should be given to the autocorrelation-adjusted RHOTRAN estimates and unbiased 2SLS estimates; the OLS results are for comparison only. In all cases it should be recalled that, though the estimates and variances are unaffected, 'true' degrees of freedom are less than is apparently the case for those (survey) variables which do not change between time periods; critical t values and significance levels of the relevant coefficients should therefore be notionally adjusted.[21/] In general, multicollinearity problems appear to be less severe than was the case with equation 6.7; a fair number of variables now attract significant coefficients of plausible magnitude. However, as we shall see, coefficients and significance levels in some cases remain sensitive to very small changes in specification - in particular the use of alternative indices of profitsharing - indicating that a non-trivial multicollinearity problem most likely remains. Thus, for various reasons, interpretation of the results should proceed with more than the usual caution. Subject to this caveat, the main features of the results are as follows.

Inspection of tables A.6.1 and A.6.3 reveals a number of striking differences in the results for the two subsamples. Chow and LR tests, based on the OLS and 2SLS estimates respectively, confirm the existence of significant parameter differences as between high and low participation firms overall. The relevant test statistics are $F = 1.84 > F^{.05}_{25,72} = 1.67$, and $LR = 54.73 > \chi^{2.05}_{25} = 37.7$, respectively.[22] Amongst other things, this confirms the choice of equation 6.7 in the preceding model selection exercise in that, amongst the models considered, only equation 6.7 allows for parameter variation according to participation.

Direct productivity differences between the two subsamples, if present, will appear in the intercept term C and the factor input variables, primarily LCFW and LNET but also TMHNEM. Table 6.4 extracts the relevant results, for all three estimation methods, and from equations with profit sharing entered variously as P1W2, PSA and PSB. At face value, these results suggest a disembodied relative efficiency gain in low-participation firms (reflected in the large, highly significant intercept terms not present in the high participation subsample), but a much higher capital productivity in high participation firms (reflected both in the estimated output elasticities of capital and, arguably, the man-hours variable (TMHNEM), bearing in mind that the latter should tend to pick up <u>scale</u> rather than marginal productivity effects, in which capital productivity would again register). These results are on the whole robust with respect to variations in estimation method and specification though there is some instability of the capital elasticity coefficients in the high subsample (within extreme values of 0.25 and 0.49) and the tiny and sometimes negative, non-significant

Table 6.4

Subsample regressions : factor input coefficients

	PW12		PSA		PSB	
	HIGH	LOW	HIGH	LOW	HIGH	LOW
OLS						
C	0.6433	2.5138**	0.5963	1.8961**	0.3316	2.4764**
	(1.16)	(3.49)	(1.01)	(3.28)	(0.55)	(4.26)
LCFW	0.2450**	0.0291	0.3448**	0.3831**	0.3017**	0.0822
	(3.22)	(0.17)	(4.11)	(2.21)	(3.56)	(0.60)
LNET	0.8066**	0.7777**	0.5900**	0.3635*	0.7094**	0.6713**
	(7.22)	(4.11)	(4.77)	(1.95)	(6.52)	(4.21)
TMHNEM	0.0005**	-0.0002	0.0006**	0.0004*	0.0006**	0.0003
	(4.16)	(1.09)	(4.50)	(1.88)	(4.53)	(1.49)
RHOTRAN						
C	0.6974	2.5976**	0.7026	2.9562**	0.7226	2.6559**
	(1.16)	(3.74)	(1.16)	(5.19)	(1.14)	(3.94)
LCFW	0.2658**	0.0428	0.2686**	0.0807	0.2820**	0.0512
	(2.95)	(0.26)	(2.92)	(0.58)	(2.83)	(0.32)
LNET	0.7844**	0.7600**	0.7814**	0.7075**	0.7676**	0.7488**
	(6.29)	(4.22)	(6.18)	(4.58)	(5.70)	(4.30)
TMHNEM	0.0005**	0.0003	0.0005**	0.0004	0.0005**	0.0003
	(3.71)	(1.18)	(3.66)	(1.59)	(3.45)	(1.25)
2SLS						
C	0.1751	2.5108**	0.1343	2.0279**	0.2233	2.5665**
	(0.24)	(3.51)	(0.23)	(3.48)	(0.35)	(4.37)
LCFW	0.4080*	-0.0545	0.4918**	0.2816	0.3396*	-0.0089
	(1.99)	(-0.30)	(3.47)	(1.55)	(1.96)	(-0.06)
LNET	0.5516*	0.8805**	0.3530	0.4867**	0.6504**	0.7940**
	(1.69)	(4.41)	(1.52)	(2.43)	(2.44)	(4.65)
TMHNEM	0.0007*	0.003	0.0007**	0.0004*	0.0006**	0.0003
	(3.67)	(1.11)	(4.53)	(1.90)	(3.40)	(1.53)

values reported for the smaller low subgroup might indicate that the coefficients here are simply not well determined. Labour productivity, on the other hand, is marginally higher in high participation firms according to the OLS and RHOTRAN estimates (by some 10.2% on average over the six coefficient values), but substantially lower (on average by some 39.0%) according to the 2SLS estimates, which should presumably be given more weight in interpretation in view of the expected simultaneity bias, affecting the labour intput variable in particular, in single equation models. Again, however the coefficient values are sensitive to specification of the profit sharing variable, and to that extent suspect. Taking the results as a whole, it would be reasonable to conclude that there are strong suggestions of the better utilisation of capital in participatory firms, of a kind which the higher average quality of the labour force in such firms, as noted in the previous chapter, might lead us to expect. However labour productivity may well be lower than in low participation firms, in which there also appears to be some kind of disembodied positive productivity shift. Overall, the mixed nature of the results is consistent with the absence of any clearcut difference in average productivity levels, as reported in the previous chapter.

Turning to the effects of financial participation, we observe no significant influence of workers capital (M2) in either subsample. However profit-sharing appears to exert a significance impact on productivity in participatory firms, and this result is robust over both estimation methods and profit-sharing measures (table 6.5). Taken in isolation, this result appears consistent with a priori arguments and some previous empirical evidence suggesting maximum firm-performance benefits when participation in control and

financial participation are combined (e.g. Cable and FitzRoy, 1980). But this interpretation is less compelling in the light of (a) the evidence from the previous chapter indicating that participation and profit-sharing are to a considerable degree separate phenomena, and (b) the fact that table 6.5 also provides some evidence, albeit weaker and of a non-robust kind, of significant profit-sharing effects on productivity in low participation firms. In order to account for all the evidence, we might conclude that, as is not unlikely, profit-sharing can in fact have differing incentive effects in different contexts. On the present evidence, it exerts a stronger productivity impact where it is used in conjunction with participatory decision-making, but is capable also of inducing productivity gains when used as a group incentive in non-participatory settings.

Elsewhere in the results (tables A.6.1, A.6.2 and A.6.3) we observe some evidence of a significant training effect (TREXP) in participatory firms, but virtually none elsewhere. This is consistent with theoretical expectations. Interestingly, there is also a robustly significant negative relationship between productivity and the proportion of apprentices in the labour force (APP) in high-participation firms, contrasting with positive but non-significant coefficients in the low participation subsample. If this reflects the fact that in the human capital oriented, participatory firms apprentices spend more time in genuine training activities, which consume current productive inputs, and less time contributing to current production than do their counterparts in non-participatory firms, then this too is consistent with expectations.

Table 6.5

Subsample Regressions: Profitsharing Coefficients

	HIGH	LOW	HIGH	LOW	HIGH	LOW
OLS						
PIW2	1.0300**	-0.3614				
	(6.47)	(-0.12)				
PSA			0.3434**	0.3745**		
			(3.43)	(2.96)		
PSB					0.3293**	0.1663*
					(2.83)	(1.70)
RHOTRAN						
PIW2	1.0050**	0.4477				
	(5.81)	(0.15)				
PSA			1.0020**	3.3332		
			(5.72)	(1.24)		
PSB					0.9882**	0.9867
					(5.35)	(0.34)
2SLS						
PIW2	0.8370**	-1.2273				
	(3.02)	(-0.40)				
PSA			0.3848**	0.3313**		
			(3.53)	(2.68)		
PSB					0.3195**	0.1277
					(2.46)	(1.43)

In the case of some labour force characteristics variables, signs do vary between subsamples in a consistent manner, but the results are mostly non-significant; thus in the case of skill and white collar ratios (SBYU, WBYB) and the proportion of workers with educational certificates (CERT) there are no sigificant coefficients at all, while the occasional significant coefficients for the male/female ratio (PCM9) and length of service (SAET) variables may be little more than quirks. However the proportion of workers with higher education (HIED) consistently attracts significant negative coefficients in low participation firms, and this is a puzzling result. (By contrast signs are consistently positive in participatory firms, though in one case only marginally significant at 10%. This is a more comprehensible outcome.) Given the importance of labour force 'quality' effects as a whole, as established in the preceding section, we clearly cannot simply interpret the absence of significant coefficients for most individual labour force quality dimensions as conclusive evidence to the contrary; especially in view of the pattern of mean differences between subsamples reported in the previous chapter, there may well be a collinearity problem, and our data may be too weak to permit individual quality effects to be isolated.

A similar problem may also be affecting the results for various control and technology variables, where a similar mixture of non-significant, quirky and puzzling outcomes appears. Thus job production (JO) and incentive pay (I2) coefficients are consistently non-significant; owner-control (CSTOP) occasionally registers a significant (positive) relationship with productivity but only in participatory firms; intermediate technology (IT) is significantly negative in low participation firms in both OLS and 2SLS estimates

when PSA is included, but only in OLS when PSB is present. Among the remaining variables, organisational concentration (CS4) and batch and flow production (BA, FL) provide the major puzzles. Thus it is counter-intuitive that productivity should increase with the size of control span in low participation firms, as is implied by the significant positive CS4 coefficients, since CS4 is an inverse measure of the degree of hierarchical control. Furthermore, it is by no means clear why batch production should show up as more productive among low participation firms and, though much less robustly, flow production should show up as more productive in the high participation subsample.

In the case of the remaining variables - TIME, ID2, ID3 and HERF - which are elements of the participation-unrelated augmenting vector $\underset{\sim}{Z}$, we observe no significant time effect (in part no doubt because value series have been converted to constant prices), and only the faintest suggestion of important industry intercepts (in OLS and 2SLS estimates when PSB is included). However, the consistently significant and positive HERF coefficients suggest rather strong evidence of value added enhancement due to market power among participatory firms, which is not present in the low participation subsample.

First Difference Models

As we saw in section 6.4, the principal attraction of first difference models is that, by eliminating the numerous individual (i.e. firm-specific) effects captured explicitly in previous specifications, we obtain a more sparse model. However the model is still potentially capable of revealing differences in output

elasticities between participatory and non-participatory firms, and thus their labour and capital productivity. Moreover it is in principle less prone to multicollinearity. Among the drawbacks of this approach, the number of observations is of course reduced to 36 and 25 for the high and low participation subsamples respectively, and to 61 for the full sample. In addition we are confined to the use of PIW2 as our profit sharing variable since the alternative PSA and PSB dummies are amongst the variables to drop out upon differencing.

In the event, first difference models add little to previous results. Despite the reduction in the number of regressors, the first difference equivalent of equation 6.7 apparently remains dogged by multicollinearity when estimated by OLS and 2SLS for the full sample; explanatory power is acceptable, but only one coefficient is significant and several attract wholly implausible values (table 6.6). Moreover in subsample regressions, statistically acceptable results are obtained for the high participation group only, and the OLS low participation equation is not significant overall. Thus meaningful comparisons between the two subsamples are precluded. In the high participation subsample we do see further evidence of high capital productivity, while the 2SLS estimates also suggest higher labour productivity in low participation firms.[23/] But in both cases the coefficients are implausibly large and, given their general shortcomings, these results can at best be considered not at variance with those of the foregoing models, rather than a reliable confirmation of them. Had it not been for the general unsatisfactoriness of the equations concerned, the apparently significant <u>negative</u> effect of profit sharing in low participation firms would have been a provocative result.

Table 6.6

First difference models : full sample

	OLS		2SLS	
	Coefficient	Robust t	Coefficient	Robust t
Constant	0.0123	0.23	0.0082	0.15
ΔLCFW	-0.1549	-0.23	-0.6570	-0.76
ΔLNET	0.3882	0.71	1.5362	1.61
ΔTMHNEM	0.0003	2.26**	0.0002	1.76*
ΔPIW2	-1.8191	-1.01	-1.2872	-0.82
ΔI2	-1.3071	-0.40	0.1435	0.04
ΔM2	-1.1334	-1.18	-1.4319	-1.54
Δ(GS4D.LCFW)	0.8377	1.20	1.3194	1.52
Δ(GS4D.LNET)	-0.0573	-0.09	-1.1837	-1.10
Δ(GS4D.PIW2)	2.2098	1.25	1.6899	1.05
Δ(GS4D.I2)	2.9851	0.88	1.5870	0.38
Δ(GS4D.M2)	1.1633	1.21	1.4639	1.58
R^2	0.514329			
$\bar{R}^2$	0.405300			
F	4.71738***			
RSS	5.08217			
d.f.	49			

Table 6.7

First difference models : subsample regressions

	HIGH (n = 36)		LOW (n = 25)	
	Coefficient	Robust t	Coefficient	Robust t
(a) OLS				
Constant	-0.0862**	-2.28	0.2231**	2.09
ΔLCFW	0.6912***	3.90	-0.4770	-0.79
ΔLNET	0.4921	1.22	0.3419	0.56
ΔTMHNEM	0.0003*	1.90	0.0000	0.31
ΔPIW2	0.6745	0.94	-4.6884**	-2.24
ΔI2	1.0925	0.83	2.4645	0.64
ΔM2	0.0215	1.23	0.2776	0.38
R^2	0.725999		0.271901	
$\bar{R}^2$	0.669309		0.0292017	
F	12.8065***		1.12	
RSS	1.84409		2.29630	
d.f.	29		18	
(b) 2SLS				
Constant	-0.0968**	-2.48	0.2192**	2.02
ΔLCFW	0.6107**	3.09	-0.7106	-1.06
ΔLNET	0.7736	1.58	0.9101*	1.97
ΔTMHNEM	0.0003*	1.78	-0.0000	-0.09
ΔPIW2	0.6988	1.04	-4.4978**	-2.37
ΔI2	0.8132	0.60	3.2884	0.76
ΔM2	0.0225	1.27	0.1427	0.19

6.7 Conclusions

The participation-productivity relationship can be seen as part of a recursive system in which the choice of work organisation and the structure and performance of firms are determined. From this perspective, the concern in some recent studies to correct for simultaneity bias arising from feedbacks from current productivity-performance to participation seems misplaced. However, attempts to quantify the participation-productivity relationship by estimating augmented production functions still encounter well-known simultaneity problems arising from marginal productivity conditions, amongst other difficulties. In the present analysis, the use of pooled time-series, cross-section data introduces further complications. Empirical results from suitably constructed models confirm that participation affects the firm's production process interdependently with its qualitative input and technological choices, but do not indicate any unambiguous productivity gains or losses as between high and low participation firms. This is consistent with the evidence from subsample means and discriminant analysis presented in the previous chapter. Multicollinearity problems vitiate precise estimates of the productivity impacts of individual firm and labour force characteristics, though there is some evidence of positive human capital effects in high-participation firms. Profit sharing, likewise, shows stronger signs of productivity-enhancement in a participatory context than elsewhere.

FOOTNOTES : Chapter 6

1/ For a sharp exchange of views on the FitzRoy and Kraft results, see Cable (1986) and FitzRoy and Kraft (1986).

2/ Sequential behaviour of this kind, particularly that involving organisational learning, is an essential feature of the behavioural theory of the firm, developed by Simon (1955) and Cyert and March (1963).

3/ Again, the behavioural concept of 'problematic' search and choice may be involved, action occurring not continuously, but only after some exogenous evidence of failure to meet previous targets has been registered. Leibenstein's (1966) concept of 'inert areas' is essentially similar, indicator variables needing to cross some critical threshold level before eliciting a response. Chandler's (1962) historical analysis of the adoption of corporate divisionalisation as a response to internal problems accumulated in firms having pursued strategies of vigorous diversification, provides a good illustration.

4/ Outstanding examples of political and economic events inducing cooperative work-organisation may be seen in the cases of Mondragon (Oakeshott, 1978), the cooperative movement under the short-lived Allende government (Espinosa and Zimbalist, 1978), and post-colonial Zimbabwe.

5/ As, for example, in the UK government proposals under discussion at the time of writing and set out in Cmnd 9835, (HMSO).

6/ In their participation equation, FitzRoy and Kraft include contemporaneous values of a wide range of firm structural, factor input, and environmental variables.

7/ In logarithms of the variables, we have

$$\begin{aligned} \log V_i - \alpha \log K_i - \beta \log L_i &= \log A + u_{1i}, \\ \log V_i - \log K_i &= \log (r/p) - \log \alpha + u_{2i}, \\ \log V_i - \log L_i &= \log (w/p) - \log \beta + u_{3i}, \end{aligned}$$

and the non-subscripted price variables r (capital), w (labour) and p (product) are constant across firms under the assumptions of competition.

8/ As is explained in the following section, aggregate labour (total employment) is the basic labour input variable in our analysis. Wallis points out that aggregating over types of factor input is valid 'provided that the marginal rate of substitution between any two kinds of one factor is independent of any variety of the other factor', and aggregate variables 'can be treated as if they were actual individual inputs provided that they are linear homogenous functions of the different varieties' (1979, op cit, p.38). Wallis continues by observing that researchers more often heriocally assume these necessary conditions than they introduce categories of K and L into the production function. While in the present study we do not go so far as to enter quantities of different labour input separately, we do explicitly introduce variables capturing 'quality' dimensions of the workforce and its composition.

9/ Estimation from factor shares also requires an asumption of constant returns.

10/ Namely, demand-determined output and price regulation (so that total revenue is predetermined), in addition to (short-run) factor prices which are given to a particular firm, but not identical across the whole industry.

11/ Corbo and Meller find C-D restrictions not rejected in 39 out of 44 Chilean industries.

12/ Translog also tends to fail in other complex estimating frameworks. See e.g. Ben-Ner and Estrin (1985).

13/ The more complex dummy structures would also exacerbate multicollinearity problems in later models featuring slope as well as shift dummies.

14/ Degrees of freedom per parameter are 2.65 in the overall, pooled sample, compared with 2.88 and 2.00 in the high and low participation subsamples respectively.

15/ For a method of retrieving these unobservable effects see Hausman and Taylor (1981).

16/ After minor interpolations to remove occasional gaps in the data.

17/ Modifications to allow for higher order autocorrelation are in principle available, but would not be relevant in the present case with T = 2.

18/ See K.J. White (1980).

19/ The procedure described is a less burdensome computational alternative to a full derivation of the Aitken GLS estimator. See Kmenta, 1971, p.511.

20/ The critical F value in this case is 3.30.

21/ Strictly, the correction is called for only in the case of variables which have in fact varied between periods but been observed only once. With 25 parameters and 72, 50 observations in the high and low subsamples respectively, apparent degrees of freedom are 47 and 25. After full adjustment, these would fall to 22 for the high participation group, implying critical t values of 2.09 and 1.73 rather than 2.01 and 1.67, at the 10 and 5 percent levels respectively. However the low participation estimates would become wholly suspect, since 'true' d.f. are now zero,

22/ The LR statistic in this context was calculated as

$$LR = n \ln \left(\frac{RSS_{6.4}}{RSS_{6.8A} + RSS_{6.8B}} \right)$$

where the subscripts refer to equation numbers in the text.

23/ Interpretation of the constant term in an efficiency sense is not appropriate in these models, where the intercept appears on account of the TIME variable included in the original equation.

Table A.6.1

OLS Estimates, 8A and 8B (Robust t values in parentheses)

	PIW2				PSA				PSB			
	HIGH		LOW		HIGH		LOW		HIGH		LOW	
	Coeff	Robust t	Coeff	Robust t	Coeff	Robust t	Coeff	Robust t	Coeff	Robust t	Coeff	Robust t
C	0.6433	1.16	2.5138	3.49***	0.5963	1.01	1.8961	3.28**	0.3316	0.55	2.4764	4.26**
LCFW	0.2450	3.22**	0.0291	0.17	0.3448	4.11**	0.3831	2.21**	0.3017	3.56**	0.0822	0.60
LNET	0.8066	7.22**	0.7777	4.11***	0.5900	4.77**	0.3635	1.95*	0.7094	6.52**	0.6713	4.21**
TIME	0.0617	0.96	-0.0600	-0.64	0.0336	0.49	-0.0052	-0.07	0.0495	0.73	-0.0322	-0.42
ID2	0.3447	1.38	0.0331	0.16	0.2432	0.92	-0.0405	-0.20	0.3475	1.31	-0.0316	-0.16
ID3	0.4466	1.57	-0.0613	-0.26	0.4689	1.56	-0.2371	-1.12	0.6105	1.97*	-0.1498	-0.64
HFUN	1.5935	3.18**	0.6810	1.30	2.1396	3.92**	0.3497	1.45	1.8279	3.44**	0.5449	1.89*
SBYU	0.0050	0.14	-0.0454	-0.41	-0.0035	-0.10	-0.1357	-1.25	0.0162	0.47	-0.1010	-0.94
WBYB	0.2050	0.55	-0.1863	-0.22	-0.3420	-1.00	-0.1032	-0.15	-0.8636	-0.23	-0.4273	-0.60
APP	-1.5415	-2.98***	0.6276	0.36	-1.8910	-3.58**	1.9050	1.17	-2.0087	-3.67**	1.3124	0.81
CERT	0.1130	0.70	0.0394	0.06	0.0178	0.10	-0.2046	-0.75	0.1837	1.08	-0.1352	-0.50
HIED	0.5113	1.16	-2.0197	-3.74***	0.7152	1.32	-1.9813	-3.84**	0.3740	0.74	-2.1220	-3.96**
TREXP	0.1341	1.63	0.2273	1.24	0.1870	2.22**	0.2215	1.36	0.1785	2.11**	0.2554	1.66
SAET	0.0006	0.22	-0.0044	-0.49	0.0012	0.46	-0.0030	-0.48	-0.0003	-0.13	-0.0030	-0.50
PCMG	0.0010	0.47	-0.0049	1.16	-0.0000	-0.01	0.0022	0.89	0.0013	0.70	0.0053	1.74*
TMHNEM	0.0005	4.16**	-0.0002	1.09	0.0006	4.50**	0.0004	1.88*	0.0006	4.53**	0.0003	1.49
PIW2/PSA/PSB	1.0300	6.47**	-0.3614	-0.12	0.3434	3.43**	0.3745	2.96**	0.3293	2.83**	0.1663	1.70*
I2	0.2936	0.89	0.1055	0.19	0.1710	0.49	0.3786	0.81	0.3057	0.93	0.1668	0.34
M2	0.0163	0.32	-0.0119	-0.19	-0.0415	-0.77	0.0039	0.10	-0.0471	-0.92	0.0153	0.24
CSTOP	0.1590	1.56	0.0624	0.44	0.2062	1.91*	0.0745	0.99	0.1429	1.31	0.0283	0.25
CS4	-0.0144	-0.02	2.2760	2.92**	0.6077	1.04	1.5979	2.42**	0.3274	0.57	2.4147	3.75**
JO	0.1644	1.73*	0.1936	0.96	0.0498	0.50	0.2094	1.42	0.0543	0.57	0.2343	1.23
BA	-0.2246	-1.48	0.5479	3.21***	-0.2300	-1.30	0.6359	4.67**	-0.1238	-0.75	0.6705	4.46**
FL	0.4273	1.96*	0.1082	0.54	0.3957	1.67*	0.0165	0.17	0.4709	1.94*	0.1324	1.01
IT	-0.0595	-0.24	-0.6160	-1.53	-0.1110	-0.3938	-0.7779	-2.77**	-0.1865	-0.69	-0.7218	-1.85*
RSS	5.12528		2.95568		5.63089		2.43629		5.7173		2.87614	
$\bar{R}^2$	.9615		0.9510		.957691		.959627		.957083		.952337	
F	74.8611		40.6415		49.53		49.53		66.9737		41.7942	

Table A.6.2

RHOTRAN estimates, 8A and 8B (Robust t values in parentheses)

	PIW2				PSA				PSB			
	HIGH		LOW		HIGH		LOW		HIGH		LOW	
	Coeff	t	Coeff	t	Coeff	t	Coeff	t	Coeff	t	Coeff	t
TCON	0.6974	1.16	2.5976	3.74**	0.7026	1.16	2.9562	5.19**	0.7226	1.14	2.6559	3.94**
TLCFN	0.2658	2.95**	0.0428	0.26	0.2686	2.92**	0.0807	0.58	0.2820	2.83**	0.0512	0.32
TLNET	0.7844	6.29**	0.7600	4.22**	0.7814	6.18**	0.7075	4.58**	0.7676	5.70**	0.7488	4.30**
TTIME	0.0656	1.15	-0.0450	-0.47	0.0660	1.17	0.0216	0.20	0.0681	1.27	-0.0345	-0.35
TID2	0.3293	1.29	0.0392	0.20	0.3270	1.28	0.0614	0.35	0.3159	1.22	0.0431	0.27
TID3	0.4176	1.45	-0.0524	-0.22	0.4137	1.43	-0.0094	-0.04	0.3951	1.35	-0.0461	-0.20
THFUN	1.5743	2.84**	0.5751	1.11	1.5717	2.80**	0.1671	0.34	1.5585	2.65**	0.5032	0.98
TSBYU	0.0067	0.17	-0.0530	-0.49	0.0069	0.18	-0.0721	-0.70	0.0081	0.20	-0.0577	-0.54
TWBYB	0.1772	0.48	-0.3334	-0.43	0.1737	0.47	-0.9336	-1.40	0.1571	0.42	-0.4346	-0.58
TAPP	-1.4808	-2.90**	0.8381	0.51	-1.4727	-2.88**	1.4340	1.04	-1.4331	-2.79**	0.9692	0.62
TCERT	0.0870	0.51	-0.1298	-0.21	0.0842	0.49	-0.8260	-1.48	0.0720	0.40	-0.2463	-0.41
THIED	0.4342	0.97	-2.0525	-3.82**	0.4248	0.95	-2.1899	-4.11**	0.3811	0.83	-2.0751	-3.87**
TTREXP	0.1279	1.30	0.2138	1.23	0.1271	1.27	0.1767	1.18	0.1232	1.15	0.2056	1.22
TSAET	0.0002	0.07	-0.0062	-0.72	0.0002	0.05	-0.0143	-1.93*	-0.0001	-0.03	-0.0075	-0.89
TPCMG	0.0011	0.45	0.0058	1.39	0.0011	0.45	0.0099	2.45**	0.0011	0.44	0.0064	1.55
TTMHNEM	0.0005	3.71**	0.0003	1.18	0.0005	3.66**	0.0004	1.59	0.0005	3.45**	0.0003	1.25
TPINS	1.0050	5.81**	0.4477	0.15	-	-	-	-	-	-	-	-
TPSA	-	-	-	-	1.002	5.72**	3.3332	1.24	-	-	-	-
TPSB	-	-	-	-	-	-	-	-	0.9882	5.35**	0.9867	0.34
TI2	0.2539	0.76	0.1494	0.27	0.2499	0.74	0.3362	0.70	0.2338	0.69	0.1799	0.34
TM2	0.0210	0.45	-0.0138	-0.21	0.0215	0.46	-0.0183	-0.25	0.0232	0.54	-0.0150	-0.22
TCSTOP	0.1577	1.53	0.0460	0.34	0.1577	1.52	-0.0021	-0.02	0.1579	1.49	0.0357	0.27
TCS4	-0.0270	-0.04	2.2049	2.95**	-0.0283	-0.04	1.9654	3.08**	-0.0340	-0.05	2.1593	2.98**
TJO	0.1553	1.63	0.2004	1.01	0.1542	1.61	0.2126	1.12	0.1489	1.53	0.2042	1.04
TBA	-0.2267	-1.37	0.5967	3.79**	-0.2273	-1.36	0.7934	5.30**	-0.2312	-1.31	0.6302	4.17**
TFL	0.3904	1.73*	0.1515	0.81	0.3856	1.71*	0.3204	2.08**	0.3633	1.57	0.1783	1.01
TIT	-0.0241	-0.09	-0.5884	-1.49	-0.1984	-0.07	-0.4968	-1.32	-0.0007	-0.00	-0.5709	-1.46
RSS	4.91247		2.92189		4.88528		2.63779		4.75735		2.89078	
$\bar{R}^2$	.963806		.959420		.964736		.989866		.969045		0.966467	
F	79.7779		49.2710		200.421		200.421		93.6120		59.8427	

Table A.6.3

2SlS Estimates, 8A and 8B

	PIW2				PSA				PSB			
	HIGH		LOW		HIGH		LOW		HIGH		LOW	
	Coeff	Robust t	Coeff	Robust t	Coeff	Robust t	Coeff	Robust t	Coeff	Robust t	Coeff	Robust t
C	0.1751	0.24	2.5108	3.51**	0.1343	0.23	2.0279	3.48**	0.2233	0.35	2.5665	4.37**
LCFW	0.4080	1.99*	-0.0545	-0.30	0.4918	3.47**	0.2816	1.55	0.3396	1.96*	-0.0089	-0.06
LNET	0.5516	1.69*	0.8805	4.41**	0.3530	1.52	0.4867	2.43**	0.6504	2.44**	0.7940	4.65**
TIME	0.0641	0.95	-0.0692	-0.72	0.0340	0.48	-0.0109	-0.15	0.0506	0.74	-0.0376	-0.48
ID2	0.2158	0.71	0.0222	0.11	0.1011	0.32	-0.0389	-0.20	0.3148	0.96	-0.0254	-0.13
ID3	0.4083	1.34	-0.0830	-0.34	0.3680	1.08	-0.2379	-1.14	0.5922	1.75**	-0.1567	-0.67
HFUN	2.0901	2.56**	0.8058	1.52	2.6819	3.21**	0.4013	1.57	1.9452	2.40**	0.5905	1.98**
SBYU	0.0109	0.28	-0.0046	-0.04	-0.0030	-0.08	-1.1083	-0.91	0.0171	0.48	-0.0559	-0.51
WBYB	-0.0658	-0.12	0.0066	0.01	-0.5911	-1.28	-0.0410	-0.63	-0.1411	-0.27	-0.2814	0.40
APP	-2.0257	-2.61**	0.1962	0.11	-2.22102	-3.57**	1.6491	1.01	-2.1053	-3.02**	1.0217	0.62
CERT	0.1330	0.83	0.2026	0.31	0.0123	0.07	-0.1629	-0.60	0.1859	1.11	-0.0819	-0.31
HIED	0.7789	1.69**	-2.0793	-3.91**	0.9604	1.62	-2.0364	-4.01**	0.4430	0.81	-2.1643	-4.10**
TREXP	0.1701	1.72*	0.2560	1.45	0.2253	2.39**	0.2380	1.52	0.1860	2.03**	0.2692	1.80*
SAET	0.0019	0.62	-0.0037	-0.42	0.0033	0.97	-0.0039	-0.62	0.0001	0.03	-0.0043	-0.69
PCMG	-0.0011	-0.31	0.0047	1.14	-0.0017	-0.63	0.0030	1.22	0.0008	0.27	0.0058	1.86*
TMHNEM	0.0007	3.67**	0.0003	1.11	0.0017	4.53**	0.0004	1.90*	0.0066	3.40**	0.0003	1.53
PIW2/PSA/PSB	0.8370	3.02**	-1.2273	-0.40	0.3848	3.53**	0.3313	2.68**	0.3195	2.46**	0.1277	1.43
I2	0.6387	1.20	-0.0077	-0.01	0.5976	1.16	0.2772	0.59	0.3980	0.76	0.0625	0.13
M2	0.0018	0.03	-0.0083	-0.13	-0.0629	-1.10	0.0014	0.03	-0.0489	-0.96	0.0080	0.12
CSTOP	0.2639	1.71*	0.0856	0.58	0.3015	2.27**	0.0739	0.96	0.1690	1.10	0.0365	0.31
CS4	0.6463	0.59	2.3491	3.01**	1.1891	1.48	1.6538	2.56**	0.4754	0.54	2.3504	3.69**
JO	0.0998	0.82	0.1679	0.81	0.0239	0.25	0.1907	1.24	0.0442	0.41	0.2032	1.01
BA	-0.2953	-1.61	0.5035	2.94**	-0.3258	-1.62	0.6231	4.60**	-0.1461	-0.80	0.6399	4.47**
FL	0.4324	1.91*	0.0920	0.46	0.3325	1.29	0.0492	0.52	0.4672	1.91*	0.1570	1.19
IT	-0.3207	-0.77	-0.6029	-1.47	-0.3078	-0.85	-0.7110	-2.41**	-0.2447	-0.62	-0.6329	-1.59
RSS	5.56593		2.97101		6.04644		2.45458					

7. CONCLUSIONS

7.1 Summary of Principal Results

The numerous participatory experiments that are taking place in Western economies offer rich research opportunities to economists and other social scientists. At the same time they challenge existing assumptions on the nature of the firm and the organisation of work. Previous empirical studies have been hampered by the absence of an adequately developed theoretical base and by measurement problems. With rare exceptions, they have also suffered problems of access to the right kind of data; of necessity, this must be raised from primary sources - a costly and time-consuming process. The present analysis benefits from the use of an existing, primary database for West Germany. Though limited in terms of the number of firms surveyed and, in particular, of years for which data is available, this contains both qualitative and quantitative data on an unusually wide area relevant to the participation-performance relationship. En route to presenting new empirical results, the analysis offers developments on both theoretical and measurement fronts.

Much existing thinking on employee participation can usefully be organised and considered in a simple game-theoretic framework. The two sides of industry are seen as having alternative strategic options, either to seek unilateral control over the enterprise or to cooperate over maximising joint welfare. Looking at the problem in this way leads to at least two new theoretical insights. Firstly, it can now be seen that the hypothesized participation-firm performance relationship might operate either as a means of achieving

'efficient bargains' within a given technology, (so maximising benefits to each side given the value of payoffs to the other), or as a precondition for the use of alternative, human-capital intensive technologies (which would otherwise be precluded by considerations of maintaining employers' control). Secondly, an a priori case can be developed for the existence of a prisoners' dilemma in the choice of work organisation, in which individually rational behaviour leads to a low performance, conflictual outcome that is Pareto inferior to the joint welfare maximising, participatory alternative. The significance of this result, if empirically substantiated, would be that, without direct policy intervention, participatory production would not necessarily become the norm, even if potential mutual gains to both workers and employers were ubiquitous.

On the measurement front, tests of the assumptions implicit in previously used indices of participation revealed unacceptable restrictions. Previously published results which depend on the use of such indices are therefore questionable, and should be reworked to demonstrate that the relationships 'found' have not been inadvertently imposed by researchers. Guttman scales of participation, however, were found to be statistically acceptable when tested on both the principal, West German data-set used in this study, and a second, comparable data-set for the UK. As well as providing an alternative way forward in the measurement of participation, the Guttman scale tests simultaneously provide support for an existing hypothesis that participation tends to follow a natural pattern of development, beginning in areas of decision-making close to workers' knowledge and

experience, and gradually spreading decision-making areas that are more remote in this respect.

Comparisons of participatory and profit-sharing subsamples of firms in the West German database revealed striking dissimilarities in their structural and performance characteristics. Relative to their respective peer groups, participatory firms showed distinct signs of the use of more human-capital intensive technologies, whereas profit-sharing firms exhibited some tendency towards the reverse. Mean differences in capital and labour productivity were positive in the case of participatory firms and of mixed sign in profit-sharing firms, though none of the differences were statistically significant. In general, the coincidence of participation and profit-sharing was not strong; on the West German evidence the two can and do exist independently.

Estimated production functions confirm the existence of a link between participation, the quality of the labour force, and the nature of production technology, but again provide no evidence of unambiguous productivity gains. Somewhat against the general run of other evidence in this study (in particular the evidence indicating a general non-coincidence of participation and profit-sharing in the sample) there is, however, some indication of a stronger profit-sharing effect in participatory firms than elsewhere, suggesting a degree of complementarity which many would expect. What we could be seeing here is that profit-sharing may be undertaken for different reasons, and perhaps operated in different ways, as between participatory and non-participatory firms - with different effects so far as productivity is concerned.

7.2 Policy Implications

The fact that, in common with most other studies, the present analysis has found no evidence of a significant productivity loss due to participation, provides further counter evidence to the claim put by skeptics that, however desirable on other grounds, employee-participation is not consistent with efficient production in the narrow, productivity sense. This is an important result for practitioners and public policy makers, which should not be overlooked simply because the existence of significant productivity gains cannot always be shown. For if there is no evidence that participatory production entails a serious resource cost, this implies that fears over the erosion of managerial prerogatives may have been exaggerated, and participatory production remains a viable economic option.

On the other hand, if the static productivity effects are indeed neutral, as this study suggests, one possible ground for policy intervention is certainly removed, and the focus of policy discussion shifts elsewhere - to other 'performance' dimensions such as technical progressiveness, flexibility, potential to survive economdic fluctuations, worker alienation, the quality of working life (for management as well as operatives), and so forth. In terms of the theoretical framework set out in chapter 2, the payoff structure does not, on the present evidence, conform to a prisoners' dilemma pattern in static productivity terms alone; but as was emphasized in that chapter, from a welfare perspective the game must ultimately be considered in utility terms, rather than purely in productivity terms. In practice, one must recognise that without striking evidence of

productivity gains, policy measures to promote participation are less likely to be forthcoming, even if other good grounds for them are found. To hard-nosed politicians and businessmen, especially in economies which are in recession, the prospect of concrete productivity advances is always likely to carry more weight than is the promise of more hypothetical, less quantifiable improvements in dynamic performance and welfare at the workplace.

Where policy measures to encourage participation are contemplated, the evidence from this study in support of the Espinosa-Zimbalist hypothesis on how participation develops - its evolution from areas close to workers' direct knowledge and experience - contains a direct implication for the form such measures should take. Specifically, it indicates that encouragement of 'bottom up' development, for example via tax incentives for shopfloor participation schemes, may be more likely to succeed than 'top down' policies, such as a formal requirement for worker-directors; whereas the former works with a natural development, the latter attempts to short-circuit the process. To this extent, the evidence supports the argument for encouraging voluntary developments rather than legal initiatives as put, for example, by the British Government in its reaction to recent moves on the Vredeling proposals in the EEC.[1/] On the other hand, it is important not to overlook the indirect role which, it has been found, legal developments can play in shaping public attitudes towards participation and towards expectations as to its effects (IDE, 1981), and this introduces an ambiguity. Presumably, some combination of measures is required for maximum effectiveness, though the nature of the ideal combination and its timing is in the present state of knowledge not clear.

With respect to the more recent public policy debate in the UK on profit-related pay (HMSO, 1986), the evidence from chapter 5 of this study, that participation and profit sharing can and to a large extent do exist independently of each other, has a direct bearing. In the view of a leading proponent (Weitzman, 1983, 1984, 1986) profit-sharing has favourable macroeconomic effects via increased employment - a proposition not tested in the present analysis - but these will obtain only if workers do not have influence in decision making, especially over manning levels (primarily because increased employment reduces individual profit shares, ceteris paribus). If so, the fact that profit-sharing apparently can exist unaccompanied by participation indicates that its desirable employment effects may be securable. On the other hand, the admittedly tentative evidence from chapter 6 that profit-sharing induced productivity enhancement (due to workers' greater motivation and sense of identity) is more likely in a participatory context could mean, if Weitzman is correct, that this more widely expected kind of benefit cannot simultaneously be achieved: the choice may be between profit- sharing alone with increased employment, and profit-sharing- cum-participation with improved productivity, but without Weitzman-type employment effects.

7.3 Further Research

The analysis carried out in the present study can usefully be replicated for other samples, in particular samples drawn from the relevant industries in other countries, thereby facilitating international comparisons and revealing the effects of participation under differing social, historical and legal environments. Two such further studies are in fact under way at the time of writing, in the

UK and Italy, and external funding is being sought for a third study in Australia/New Zealand.[2/] While each investigation stands as an independent enquiry in its own right, taken together they will provide an unusually strong basis for internationally comparative work.

With greater resources and manpower than were available for the present work, the scope of the analysis can be extended in a number of ways. Firstly, the empirical analysis of chapter 6 can straight-forwardly and usefully be extended to include parallel tests of the productivity effects of profit-sharing, simply by substituting the profit-sharing variable (PSA) for the participation variable (GS4D), and vice versa. Secondly, in the light of both the results of the present study, and of current policy debates, there is a clear need to cover other aspects of enterprise performance, in particular the uptake of new technology and product innovation, the level and stability (or otherwise) of employment, and job satisfaction (as an indicator of the quality of working life).

There is thus considerable scope for further cross-sectional and time-series analysis, to estimate general relationships and tendencies across samples as large as can be constructed with the available resources. With these as a backdrop, there is then, as always, scope for complementary case-study analysis of issues too elusive for purely statistically methods of investigation, for example the nature of profit-sharing under participatory and non participatory regimes, and the interaction betwen formal developments at national and international level, and informal developments at firm level.

FOOTNOTES

1/ See DOE/DTI (1983).

2/ The Italian study is being carried out by an international research team under the aegis of Professor Mario Nuti at the European University Institute, Florence. The Australian proposal is being pursued by Professor Richard Blandy of the National Institute for Labour Studies, Flinders University, Southern Australia.

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