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Industrial Policy for the Medium to Long-term

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Abstract

This report reviews the market failure and systems failure rationales for industrial policy and assesses the evidence on part experience of industrial policy in the UK. In the light of this, it reviews options for reshaping the design and delivery of industrial policy towards UK manufacturing. These options are intended to encourage a medium- to long-term perspective across government departments and to integrate science, innovation and industrial policy.

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Foresight, Government Office for Science

Contents

1. Introduction

This paper is concerned with industrial policy. It is not concerned with an assessment of current policy. It seeks instead to set out the key principles which should guide policy development for the medium to long term. We set out the different ways in which industrial policy may be defined and the case for governments adopting an industrial policy. We emphasise the policy challenges which arise in a world of rapidly developing and potentially transformative new technologies and innovation opportunities. We advocate an approach which adopts a holistic systems perspective. This approach encompasses policies addressing both market and wider system failures and spans the domains of science policy, technology policy and innovation policy as integral to a modern industrial policy.

The proposed approach emphasises both sector and technology specific policy domains. It emphasises the particular challenges which arise in designing and implementing policy in the specific context of the UK economic system with its particular institutional architecture governing product, labour and in particular capital markets.

2. What is Industrial Policy?

There currently exists a wide variety of definitions of industrial policy. In their review of industrial policy in Europe, Foreman-Peck and Federico (1999) adopt a very broad perspective. They define industrial policy as "every form of state intervention that affects industry as a distinct part of the economy" (Foreman-Peck and Federico, 1999, p3). A more focused approach, but still broad in its implications, emphasises the structural aspects of industrial policy and the relationship between it and the strategic objectives of national governments. Industrial policy is thus a set of "structural policies designed to strengthen the efficiency, scale and international competitiveness of domestic industrial sectors, typically contains an element of national champions, of self-reliance in bringing about growth and development' (Soete, 2007, p273). Similarly, Chang (1994) identifies industrial policy as being "aimed at particular industries (and firms as their components) to achieve the outcomes that are perceived by the state to be efficient for the economy as a whole" (Chang, 1994, p66).

A helpful and broad recent definition is the following:

> "*Industrial policy is any type of intervention or government policy that attempts to improve the business environment or to alter the structure of economic activity towards sectors, technologies or tasks that are expected to offer better prospects for economic growth or societal welfare than would occur in the absence of any such intervention ...*"
>
> (Warwick, 2013, pp. 16-17).

Within industrial policy it has been conventional to distinguish between 'horizontal' and 'selective' industrial policies. The latter are aimed specifically at improving the performance of particular industries or firms while the former are designed to benefit the economy more generally. However, the distinction is not always clear-cut. For example, since sectors differ in their research intensity or their reliance on transport infrastructure, 'horizontal' policies to encourage R&D or to improve the road network will help some more than others. All definitions of industrial policy have at their core a concern with economic growth, and especially productivity growth. Productivity performance is also central to 'national competitiveness' which might be understood in terms of achieving economic growth and successful participation in international trade. Since manufacturing is more internationally tradable and has achieved higher rates of productivity growth than services, industrial policy has often focused on support for this sector. The increased vertical spread of business models that bundle for example manufacturing activities and service provision means that this focus will need to broaden in the years ahead to vertically related value chains.

Long-run productivity performance depends upon decisions to invest, innovate, and adopt new technology, which in a market economy will be sensitive to incentive structures. This means that a wide range of government actions which comprise 'industrial policy' can potentially have an impact on productivity growth. It also means

that science, innovation and technology policy should be seen as closely related to or an integral part of industrial policy. In the context of designing a medium to long term industrial policy for manufacturing it is important to emphasise the way in which technical change and innovation are integrated into policy development. Policy must be sufficiently reflexive to respond to unexpected or rapid changes in technical and scientific advance affecting the location, structure, scale and nature of the manufacturing sector and its links with the wider economy.

3. What is the rationale for Industrial policy?

The classic justification for industrial policy in mainstream economics is that it remedies market failures, for example, by providing public goods, solving coordination problems, or subsidizing activities with positive externalities. For example, there is good reason to believe that the social rate of return considerably exceeds the private rate of return to R&D and leaving it to the market will mean too little R&D. It is quite straightforward to see how arguments of this kind might, in principle, be used in favour of 'horizontal' industrial policies.

The case for selective industrial policies has always been more controversial. However, the modern mainstream economics literature highlights three arguments in their favour, namely: infant-industry related capital market failures, agglomeration externalities, and rent-switching under imperfect competition. At the same time, a number of pitfalls in the use of such policies have been noted in this literature.

The 'infant-industry' case is for temporary protection of industries which are not currently internationally competitive but will be when productivity has improved through increasing returns and, in particular, learning by doing. The case for intervention really depends on the capital market's inability to finance these activities even though they will become privately profitable, perhaps because the learning effects accrue to the industry as a whole rather than being firm-specific. A key issue is whether the government can credibly commit to the policy intervention being temporary.

The advent of the new economic geography has increased awareness of the potential importance of agglomeration benefits which accrue when economic activity is characterized by external economies of scale. As city size increases, productivity gains can be realized through knowledge spillovers, better availability of intermediate inputs and the advantages of a thicker labour pool. Policy interventions may then be justified on the grounds of spatial externalities[1]. In cases where size matters, there may be gains from policy interventions that facilitate the expansion of an agglomeration or, indeed, the establishment of a successful cluster which obtains first-mover advantages.

The rent-switching argument came to prominence through the work of Brander and Spencer (1985). The argument here is that in cases of strategic rivalry in international trade, the state can influence entry and exit decisions by offering subsidies that result in higher market share for its firm at the expense of a foreign rival and redistribute super-normal profits accordingly. Because government values objectives other than private profits it may be able credibly to commit to finance entry where capital markets cannot. Whether such interventions will succeed may be hard to predict, and where their size and/or timing turn out to be inappropriate they may be

[1] These are now recognized as examples of the 'wider economic benefits' which can accrue from transport projects, see Department for Transport (2006).

expensive failures. However, Airbus appears to have been a successful example of a rent-switching industrial policy; Neven and Seabright (1995) estimated that Airbus was likely to produce an acceptable rate of return for Europe over fifty years while at the same time reducing Boeing's profits significantly and slightly cutting world-wide aircraft prices. That said, Airbus would not be easy to repeat – and was possibly illegal under WTO rules.

An example of an attempt to summarise the wide range of policy instruments based on these and related arguments is shown in Exhibit 1.

Exhibit 1. Examples of Industrial Policy Instruments

	Horizontal	***Selective***
Product Market	Competition Policy	National Champions
	Indirect Tax	Nationalization/Privatization
	Product Market Regulation	State Aids
	Exchange Rate Policy	Trade Policy
		Public Procurement
Labour & Skills	Education Policies	Targeted Skills Policy
	Training Subsidies	Apprenticeship Policies
	Wage Subsidies	
	Labour Market Regulation	
	Employment Taxes	
Capital Market	Corporate Tax Policy	State Investment Bank
	Financial Market Regulation	Strategic Investment Fund
		Emergency Loans
Land	Land-Use Planning Rules	Place-based Clusters Policy
	Infrastructure Policy	Enterprise Zones
Technology	R & D Tax Credit	Public Procurement
	Science Budget	Patent Box
	IPR Regime	Selective Technology Funding

Exhibit 1 is wide-ranging and includes a number of instruments that relate to problems facing UK manufacturing. For example, concerns about the absorptive capacity of firms with regard to taking advantage of technological opportunities might be addressed by policies to improve R&D capabilities; technology funding might be focused on helping businesses through the ‘valley of death’; capital market policies might target the need for more ‘patient capital’; instruments under the land category would be relevant to facilitating agglomeration and co-location of activities and to the shortfall in transport infrastructure; skills policies relating to the quality of education

and the content of syllabi may need to be designed to address future labour force requirements in manufacturing and its value chains etc.

4. New Perspectives: Systems, Institutional Architecture and Varieties of Capitalism

Current thinking and policy possibilities go beyond traditional market-failure arguments to embrace notions of 'systems failure', especially with regard to innovation and technical change. A systems approach focuses on coordination problems in the context of promoting the development, awareness and exploitation of new technological opportunities. The old approach to selective industrial policy identified sectors or firms to support but this new approach is based on selecting new ideas as they emerge from the science base or working back from sectoral problem-solving and technical challenges to the science base. Whereas the old vocabulary was about 'picking winners', the new terminology is that of 'choosing races and placing bets' (Hughes, 2012).

There are certain core elements of a systems approach, typically three are identified (Edquist, 2005). The first consists of the agents operating within the particular system domain (e.g. country, region, or sector). This includes not only private sector consumers and businesses, but also the public sector in its various manifestations and the third (or charitable) not-for-profit sector. Private sector firms in the system identify commercially attractive opportunities and devise business models to exploit them. In doing this they must invest human and financial capital and a wide range of intangible assets including R&D, design and ICT. A firm's investment in R&D both generates new knowledge and increases capacity to absorb ideas from external sources (Cohen and Levinthal, 1990). The second element is usually defined as "institutions" which are not to be understood as organisations or entities, but rather as the norms of conduct or rules of the game, including contractual legal and regulatory systems within which agents operate. The third element is usually defined in terms of the connections between agents. This will include, but is not restricted to, market connections. System connections include a wide variety of non-market relationships including collaborative and formal and informal interpersonal and inter-organisational networking connections. There may be significant variations across sectors, regions, technological trajectories and national systems in the strength, nature and variety of connections and their interplay with institutional differences (Lundvall, 2007).

The institutions and connections may be thought of as defining the "institutional architecture" within which the agents operate. This institutional architecture may then be used to characterise differences between national systems, their patterns of co-ordination and the way they impinge on the ability of private sector firms to identify and exploit business opportunities. This architecture will affect both the nature of systems failures and the feasibility and effectiveness of "traditional" policy measures applied in different systems (Dodgson et al, 2011; Edquist, 2005; Lundvall, 2007, Nelson, 1993). This is related to the concept of "varieties of capitalism" which has been used to suggest that the nature of investment will differ significantly between countries (Hall and Soskice, 2001) (see Exhibits 2-4). In relation to investment generally, and R&D in particular, it has been argued that the UK variety of liberal market capitalism inhibits long-term investment compared with more coordinated

varieties exemplified by Germany and Japan (Dore, 2000). Impatient capital markets driven by an over-concern with short-term movements in stock market prices, the threat of takeover, and arms-length relationships between the providers and users of finance, serves to promote short-termism in investment decisions (Haldane and Davies, 2011; Kay, 2012; Hughes, 2013). System architecture may also alter the nature of innovation by inhibiting incremental innovation. Impatient capital markets may be complementary to labour markets focused on hire and fire relationships which inhibit more stable labour contracts that foster investment in firm specific training and skills (Exhibit 2).

Exhibit 2 Varieties of Capitalism

The highly influential 'varieties of capitalism' approach to the analysis of economic policy and performance was originally developed by Peter Hall and David Soskice (2001). The core of the approach is based on a comparison between 2 ideal types, the co-ordinated market economy (CME) and the liberal market economy (LME), which comprise different environments in which firms operate. In the real world, the purest cases of the CME and the LME are Germany and the United States, respectively. Each of these economies can be thought of as having a different set of complementary institutions and, as a corollary of this, different comparative advantages in production, trade, human capital formation, and innovation.

The relevant aspects of these ideal types with regard to firms concern corporate governance, education and training, interactions with other firms, and industrial relations. Exhibit 3 illustrates the institutional complementarities that Hall and Soskice (2001) highlight as key characteristics of, respectively, the German CME and the American LME. As these diagrams suggest, the idea is that the value of one institution is enhanced by the presence of the others.

It should also be noted that the policies appropriate to each type of economy differ; for example, well-designed competition policy is a much more important attribute for the LME. A further dimension not shown here but emphasized by Cusack et al. (2010) is that CMEs (LMEs)] are found in countries whose elections are based on proportional representation (majoritarian system). Given the interlocking nature of these institutional configurations it might be that they tend to be persistent such that countries do not readily switch from LME to CME or vice versa.

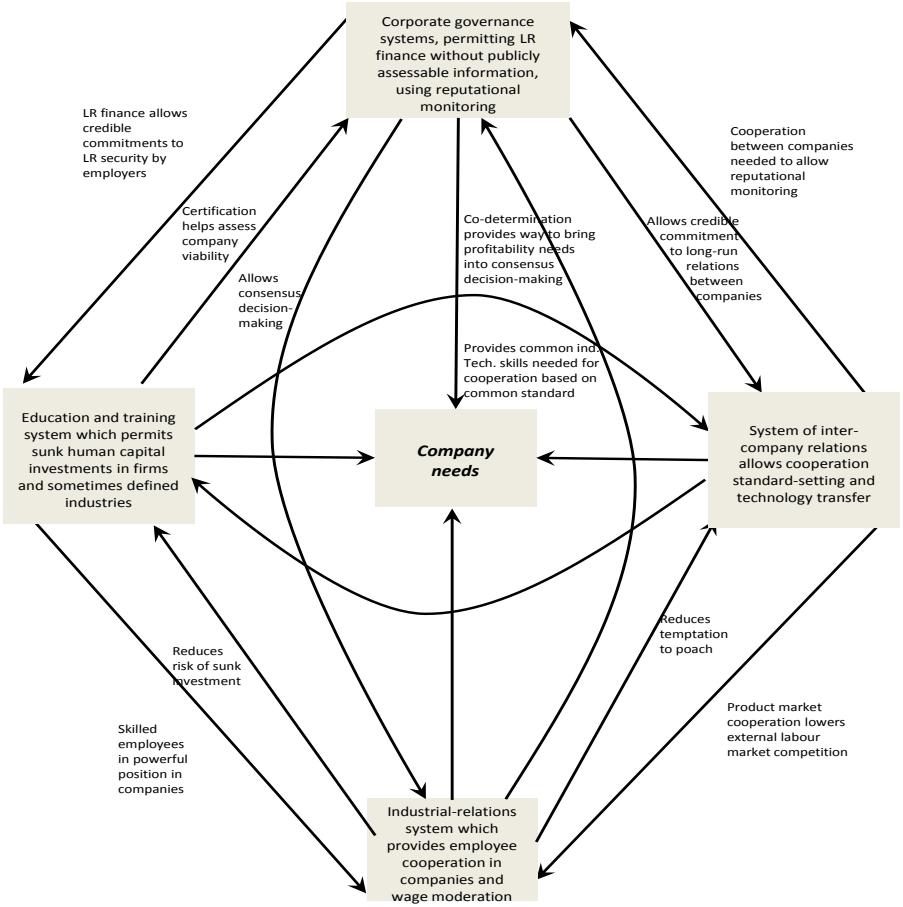
Hall and Soskice (2001) argued that CMEs would be relatively strong at 'incremental innovation' marked by continuous, small-scale improvements to existing product lines and production processes while LMEs would be more successful at 'radical innovation' which entails substantial shifts in product lines, the development of new goods or major changes to the production process. In terms of international trade, LMEs would have revealed comparative advantage in high-tech sectors based on tertiary human capital and CMEs would specialize in sophisticated engineering products requiring the deployment of long-term patient capital and a highly-skilled cooperative labour force.

A further major implication of varieties of capitalism is that CMEs with proportional representation and centralized wage bargaining will sustain relatively large shares of the workforce and superior international competitiveness (lower relative unit labour costs) in exportable manufacturing i.e. will be less exposed to de-industrialization of employment (Iversen and Soskice, 2010). The argument is that institutional arrangements in these economies will deliver high levels of training combined with wage restraint.

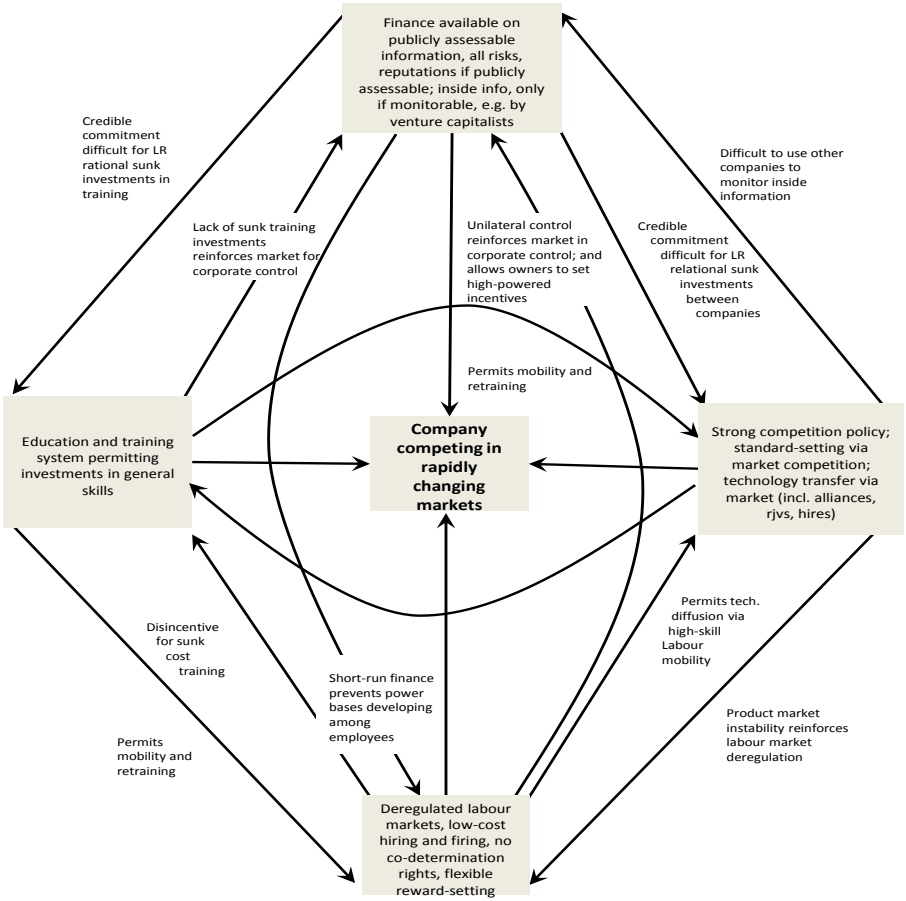
Subsequent empirical work has tried both to test how far economies correspond to these ideal types and whether these predictions about comparative advantages are confirmed by the evidence. This is clearly work in progress but some empirical support has been found. Schneider and Paunescu (2012) find that there are several intermediate varieties of capitalism, but that there are some 'pure' CMEs and LMEs. These have institutional configurations that are perfect mirror images of each other. The LME is characterized by lower employment protection, shorter average employment tenure, lower collective bargaining coverage, less occupational training and more university training, more cross-border mergers and acquisitions and strategic alliances, and greater stock market capitalization than the CME. They also find that countries can and do move between varieties (Exhibit 4). However, the UK as an LME and Germany as a CME match these profiles in a stable way.

Exhibit 3 Coordinated and Liberal Market Economies: Complementarities across sub-systems in Germany and the USA

Complementarities across subsystems in the German coordinated market economy



Complementarities across subsystems in the American liberal market economy



Note: LR = Long Run, rjvs = relationship-based joint ventures

Exhibit 4 Varieties of Capitalism, 1990-2005

Cluster	1990	1999	2005
State-dominated economies	TURKEY	TURKEY	PORTUGAL
	ITALY	PORTUGAL	GREECE
	SPAIN	GREECE	TURKEY
	Belgium	SPAIN	
	GREECE		
Coordinated Market Economies	**Austria**	**Austria**	**Austria**
	Germany	Czech Republic	**Belgium**
	Denmark	**Italy**	**Germany**
	Finland	FRANCE	FRANCE
	Sweden	**Germany**	
	FRANCE	**Belgium**	
	Netherlands		
Hybrid economies	**Norway**	South Korea	Poland
	Japan	Poland	ITALY
		Hungary	**Norway**
		Norway	Czech Republic
		Japan	Hungary
			South Korea
			Japan
Liberal Market-like economies	*Australia*	**Denmark**	Spain
	New Zealand	**Sweden**	**Finland**
	Rep. of Ireland		**Netherlands**
	Switzerland		**Sweden**
			Australia
			Rep. of Ireland
			New Zealand
Liberal Market Economies	*Canada*	**Switzerland**	**Switzerland**
	USA	**Finland**	**Denmark**
	UK	*Rep. of Ireland*	*UK*
		New Zealand	*Canada*
		Canada	*USA*
		Australia	
		Netherlands	
		UK	
		USA	

Notes: **Bold:** economies discussed as CMEs by Hall and Soskice;
Italics: economies discussed as LMEs by Hall and Soskice
CAPITALISED: economies discussed as Mediterranean by Hall and Soskice
Source: Derived from Schneider and Paunescu (2012) Table 1, p.10.

4.1 Varieties of Capitalism: Radical vs. Incremental innovation: An unhelpful distinction?

In the wider innovation literature radical innovations are most often defined in terms of fundamental shifts in the relationship of performance to price in the development of new industries, products or processes, and/or the pervasiveness of their effects across sectors. They are also linked to fundamental organisational changes *within* firms as well as between them. Radical innovations are, however, also frequently associated with subsequent long processes of incremental innovation within the firms and sectors where they occur. This makes simple binary classifications of sectors questionable (Fagerberg, 2005; Verspagen, 2005; Powell and Grodal, 2005; Sorescu et al., 2003; McDermott and O'Connor, 2002).

Salter and Alexy (2013) provide a useful overview of this area. They point out that where attempts have been made to measure the frequency of radical innovations, it appears that they may take decades to develop and are extremely infrequent, maybe occurring once in every three decades (Anderson and Tushman, 1990; Tushman and Anderson, 1986; McDermott and O'Connor, 2002). The implication is that in the average industry firms may operate and workers may work their entire lives without ever experiencing a radical innovation. Moreover, it appears that such innovations are best thought of as not specific to certain sectors and therefore not easily revealed in patterns of relative comparative advantage across sectors. Instead they are pervasive across many sectors i.e. they are what are known as general purpose technologies (Helpman, 1998).

It also appears to be the case that appropriating the value from radical innovations when they do occur depends critically upon the ability to implement and develop competitive strategies around substantial investment in incremental innovation. This has led to the emergence of a substantial literature on sectoral systems of innovation. This eschews simple twofold binary distinctions between sectors and their innovation systems. Instead it favours a more granular approach emphasising inter alia the interplay between technological opportunity and appropriability conditions (i.e. how value is captured by businesses). It also emphasises the way in which the nature of a sectoral system and the types of innovation it embodies can vary over time (Malerba, 2004 and 2005). Competition and competitive advantage shifts from 'radical' product innovation to 'incremental' product and process competition over a sector life cycle (Utterback, 1994). This has more to do with the maturity of a sector than its 'high-tech' status. It is also apparent that innovation in general is increasingly influenced by the pursuit of open collaborative and networked models. Rather than emphasising a contrast between liberal markets and coordinated markets this suggests a cross national move towards more inter-firm collaboration arguments (Chesborough, 2003 and 2006). When more direct measures of innovation outputs rather than indirect measure such as patents are used, it appears that company level variables dominate, with few signs of country effects (see, for example, Tellis et al., 2009). Moreover as Aoki (2010) argues it appears increasingly that similar business 'architectures' are emerging in the world's leading businesses which are global in character rather than defined by national boundaries. He provides an overview of relevant changes in Japan.[2] Finally, other organisational and networked based approaches have argued that the tight interconnections in coordinated economies such as Japan and Korea have been central in the past to their ability to

[2] See also Streeck (2009) and Carlin (2009) more generally.

outperform US firms in radical innovation rather than inhibit them (Aoki, 1988; Hager and Hollingsworth, 2000, Nonakka and Konno, 1998). Furthermore, an examination of detailed sector patterns of, for example, patenting (as we have shown above) reveal that even taking these patent proxies at face value, CME economies in many cases demonstrate comparative advantages in radical as opposed to incremental innovation (see, for example, the detailed discussion in Akkermans et al., 2009).

There is also abundant evidence to suggest that sectors which are classified as low-tech are also characterised by innovations of a transformative or radical kind (see, for example, the discussion in Von Tunzelmann and Acha, 2005). A particularly striking example here is the role of information technology in transforming business models and productivity in the United States in particular, as well as in other economies.

4.2 Varieties of Capitalism and Industrial Policy

A danger inherent in any analysis which characterises varieties of capitalism as consisting of a given set of structures observed at a point or period in time is that it can neglect the analysis of the way in which institutions evolve and change. As Hall and Gingerich (2009) point out, different varieties of capitalism can have embedded in them factors which will predispose systems to react to shocks in ways which are consistent with the established beliefs and practices of the firms and workers in those economies. Thus in response to an external shock a liberal market economy, it is hypothesised, will seek to pursue even more liberal market policies by more deregulation. On the other hand, in coordinated market economies the reverse is posited to be true. In thinking about the next 30 years, the question is whether liberal market economies such as the UK will be better served by more of the same or by an attempt to alter structural characteristics which inhibit the future development of the economy.

This is precisely the area in which the debate about industrial policy is now being conducted. It should lead to a fundamental re-examination of the way in which intermediate coordinating organisations can be created in LME varieties of capitalism. Current industrial policy debates emphasise the need to develop strategies around the allocation of resources to strategic sectors. Insofar as those sectors and technologies involve the accretion and consolidation of wide ranges of knowledge and expertise then the development of institutions (e.g. catapult centres (TSB, 2011) which have the potential to assist in these connections, become a central part of industrial policy.

The great interest in such intermediate institutions in the UK (and the USA) at present indicates the extent to which this message is being absorbed into industrial policy debates. Economies characterised as liberal market economies and coordinated market economies each contain within them sectors which are characterised as experiencing both radical and incremental innovation. This means that a view will need to be taken on a much more granular basis of the particular factors likely to inhibit or encourage innovation in each sector. Basing policy on an aggregated view of how the economy looks on average, or on its inherited structure from the past is not helpful.

5. Market Failures and System Failures

The mainstream market failure arguments we have set out earlier provide important rationales for public sector intervention, but rarely provide sufficient guidance for the degree of intervention in particular instances or different systems; nor do they address the many other potential institutional and connection failures which may arise when a systems based approach is adopted.[3] System failures can arise from various sources. Transition and lock-in problems, for example, arise from inertia due to substantial sunk investment by private and public sectors in existing or dominant technologies. These are linked to transition failures in moving to new technological structures which pose major problems of investment and business reorganisation (e.g. in the switch to low carbon vehicles (HMG, 2008; King, 2008). Then there are institutional system failures arising from a lack of congruence between formal and informal rules and incentives affecting different parts of the organisation of the system. A particularly prominent case is the alleged difference in norms and incentives between academic scientists and the private sector in conducting research. Here it is argued that the former emphasise open publication and disclosure, whilst the private sector, in its pursuit of research connected to private exploitation, is committed to secrecy and patent protection. This has engendered a major debate in the UK over the extent to which the allocation of public funds should be directed according to the motivations and the incentives of the former as compared to the latter, the nature of UK university-industry links, and the design of intermediary organisations on the boundaries of universities and industry (Royal Society, 2011; Hughes, 2012; Hauser, 2010; Mina et al., 2009; Deiaco et al., 2012; Hughes and Kitson, 2012).

One of the most important implications arising from the development of more systemic views has been the emphasis placed upon the development of demand side as well as supply side policies in addressing lock in and transition problems and uncertainties. This is based around the potential role of the public sector as a procurer of R&D. More specifically, it emphasises the role of public procurement in influencing the scale, direction and form of the provision of the goods and services it purchases (Edquist et al., 2000; OECD, 2010a; Connell and Probert, 2010). Public procurement is then seen as a potentially important innovation policy device for reducing uncertainty in areas where lead user activities are important. Public procurement can also be seen as complementary to supply side measures linked to standard market failure arguments which, through taxation and subsidy, influence the relative prices at which businesses conduct their innovation related activities (OECD, 2010b).

[3] See, for example, Metcalfe (2005), Dodgson et al., (2011), BIS (2011) and for a comparison of systems and market failures, Chaminade and Edquist (2010).

6. Innovation Systems, Institutional Architecture and Diffusion

An important aspect of productivity growth is the effective assimilation of new technology across the system. This highlights the importance of industrial policies in terms of their impact on the speed of diffusion of innovations. As is widely recognized, policy can impact on lags in diffusion through provision of information and the improvement of market and non-market connections between firms and other agents. This includes information which as a public good may be subject to market failure. Beyond this, however, it is important also to think about the determinants of technology diffusion in terms of absorptive capacity of firms and the profitability of adoption, as is proposed by probit models (Geroski, 2000), both of which may be influenced by industrial policy.

Absorptive capacity entails the ability to search for, evaluate, assimilate, and exploit knowledge. This is underpinned by education and skills but also by investments in intangible capital including crucially R&D (Griffith et al., 2004) but also economic competences including training, flexibility in use of business models, effective cooperation with research organizations, and organizational capabilities etc (Harris and Moffat, 2013). This offers a wide range of possibilities for both horizontal and selective industrial policy potentially to make a difference by focusing on increasing firms' absorptive capacity. More generally, the adoption of a new technology depends on the net present value of investment. This can also be affected by the business environment, for example how costly and time-consuming it is to invest in a start-up firm, environmental regulations, tax rules etc.

Diffusion of new technologies may also be inhibited where system lock-ins occur due to the strength of major sunk investments supporting existing technologies e.g. electric v petrol driven automobiles. Here sector based selective industrial policies may include the use of demonstrator or pilot plants and public procurement.

Some of these points can be illustrated by a notable recent success for the UK, namely, the relatively rapid diffusion of ICT which illustrates the value of the probit model of diffusion as well as the importance of horizontal industrial policy. The contribution of investment in ICT to growth of labour productivity over 1995-2005 was about twice as large in the United States and the UK compared with France or Germany (Timmer et al., 2010). ICT diffusion has been influenced by the absorptive capacity of firms, in particular investments in intangibles such as organizational capital and the quality of the labour force, but also by the profitability of investment in ICT capital which has a bigger productivity payoff if it is accompanied by organizational change in working practices and is therefore encouraged by low adjustment costs. Neither high employment protection nor product market regulation that inhibits the entry of new firms is conducive to a strong contribution of ICT to economic growth. The diffusion of ICT in the UK has been promoted by the relatively light-regulation environment and by the expansion of higher education (Conway, 2007). However, it is also important to recognize that management practices matter as well and in the case of IT appear to be a crucial part of absorptive capacity (Hughes and Scott Morton, 2006). In the UK context, Bloom et al. (2012) show that American-owned multinationals have used IT more effectively than either domestic firms or other multinationals. On a European-wide basis, these authors

find that this same pattern emerges and that the key advantage of the American multinationals lies in people-management practices.

7. Innovation Systems, Institutional Architecture and the UK variety of Capitalism

The UK share of capital investment in output has been low relative to competitor economies for many decades and continues to be so, both for the whole economy and for manufacturing. The growth rate of the fixed capital stock was negative for the period 2000-07. The growth of capital per worker in manufacturing has been about the average of competitor countries. Investment since the financial crisis has been particularly poor both absolutely and in comparison with competitor countries. Business investment remains around 20% below where it would have been had it continued to grow at its pre-2008 average rate and projections for investment growth in the next four years are around 6%, little more than half that forecast by the Office for Budget Responsibility in late 2012.

7.1 Investment in R&D

As with overall investment the UK has occupied a relatively weak and worsening position in terms of the overall R&D effort. This is a characteristic of manufacturing R&D spend as well as of the overall business R&D spend. The UK's R&D effort, especially in the manufacturing sector, is hugely reliant on overseas funding and also is carried out disproportionately by the subsidiaries of overseas organisations located in the UK. The vast bulk of R&D is carried out by a relatively small number of large firms and compared to other countries is relatively concentrated in high technology sectors (Hughes, 2013; Driffield, 2013).

7.2 Finance and Short-termism

There is substantial qualitative and quantitative evidence of short termist influences on investment decision taking in the UK (Hughes, 2013). These influences have increased over time. Survey based approaches show evidence of significant proportions of managers holding perceptions of short-term pressures especially in capital intensive sectors with long gestation periods. Econometric estimates for samples of non-financial companies in the period 1980-88 suggested that cash flows accruing six months in the future are underestimated by 5% relative to non-myopic discounting. Cash flows which do not accrue for five years are underestimated by almost 40%. The latest estimates for a large combined sample of US and UK firms covering the last 20 years suggest that short-termist influences have increased in importance since the 1980s (Haldane and Davies, 2011).

The UK variety of capitalism is heavily reliant on the use of internal cash flows to fund investment. Equity markets have not played a substantial role in funding new investment. Instead they have served as a vehicle for high levels of mergers and acquisitions and intense short term performance monitoring and corporate governance (Hughes, 2013). As a result cash flow is, for example, positively related to investment in R&D intensive firms in the UK (Bond et al., 2003). Shareholder value-enhancing corporate governance characteristics in the UK have had a negative impact on the

propensity to invest in long-term R&D projects. They have enhanced the responsiveness of corporate strategy to short-term expectation of financial markets with detrimental effects on long-term R&D investments. This is not the case in Germany which has a bank based financial system engendering long term relationship which is conducive to investment to R&D intensive businesses. British firms that do engage in R&D are a self-selected group, with significantly better cash flow and where financing constraints tend to be less binding (Bond et al., 2003).

International comparative studies show that stronger shareholder protection is associated with larger stock market capitalisation, but also with lower innovative activity (Honoré et al., 2011). These results imply a weaker performance for the UK driven by its financial system. International comparisons also show that widely held businesses tend to have higher R&D activity than family controlled businesses. This effect is however much weaker in the UK than in other European countries. This may reflect the absence of large block shareholders in the UK to act as a buffer against short-term performance pressures in its more dispersed market based governance systems (Munari et al., 2010).

Knowledge intensive SMEs in technology intensive industries continue to be constrained by a lack of early stage finance in the UK .The UK has the largest venture capital market outside the USA in absolute terms. It invests relatively little in early stage investments, and is sensitive to stock market volatility (Hughes, 2013). It is also the most international venture capital market with a relatively low weight of investment in the home country. Whereas around 60% of funds in the UK have some investment outside the UK, only one third of German funds invest outside that country (Mayer et al., 2005).

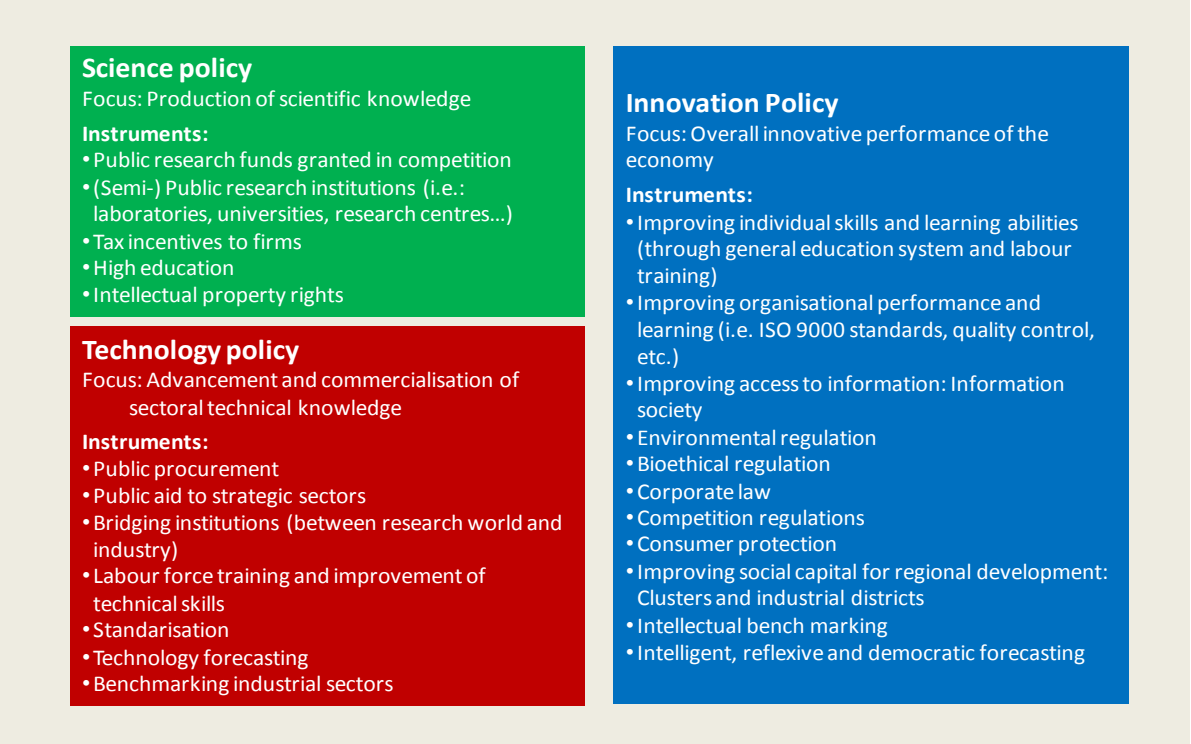
7.3 Systems thinking, Industrial Policy and the future for the UK variety of Capitalism

In thinking about the next 30 years, the question is whether a “liberal market economy” such as the UK will be better served by more of the same or by an attempt to alter structural characteristics, which inhibit the future development of the economy. This is precisely the area in which the debate about industrial policy is now being conducted. It should lead to a fundamental re-examination of the way in which intermediate coordinating organisations can themselves be created in economies, such as the UK, which lack them. It should also lead to a continued emphasis on the role of public procurement of R&D as an essential way of supporting early stage growth in knowledge intensive manufacturing SMEs. Whilst systems thinking is now used extensively to analyse innovation policy, it is not reflected explicitly in the current policy debate over the empirical or conceptual basis for industrial policy, although there has been some attempt to develop industrial policy thinking in the light of innovation studies (e.g. Bianchi and Labory, 2006).

8. Science Policy, Technology Policy, Innovation Policy and Industrial Policy

There have been a number of attempts to distinguish between science policy, technology policy and innovation policy. It is useful to discuss this before turning to their link with industrial policy.

Exhibit 5 **A Typology of Policy Domains**



Source: Lundvall and Borrás (2005)

Exhibit 5 shows a useful recent typology. The focus of science policy is on the production of scientific knowledge. The instruments associated with it are focused on the role of public research funding, tax incentives to firms, higher education and the role of intellectual property rights in relation to accessing the public knowledge base. Technology policy is seen as more concerned in advancing towards the commercialisation stage and in their classification is linked to sectoral bases for technical knowledge. In this domain public procurement, strategic action in relation to selective sectors, the development of bridging institutions, technology forecasting, benchmarking and standardisation all play an important role. Innovation policy is then seen as moving to more overall performance aspects and is linked to a set of "institutional architecture" arrangements operating at that level. These cover a wide range of skill and organisational based activities, information flows and regulation in relation to a wide range of environmental corporate and competition policy areas as well as consumer protection. This aggregation here is not at the level of sectors, but may include the development of geographically focused policy instruments.

In their analysis of the basis for policy in the science, technology and innovation policy domains Lundvall and Borrás draw the familiar distinction from a systems perspective between a neo-classical economic approach which focuses on market failures and a systems based approach. In the latter a critical step is made by recognising that pure arm's length and anonymous relationships between producers and users is logically incompatible with what they regard as the 'real' world of markets. In that world markets are organised and "constitute frameworks for interactive learning between users and producers" (Lundvall and Borrás, 2005, p613). They point out that there is a strong overlap between the instruments of intervention, in particular as the analysis moves from technology policy towards innovation policy.

In moving on to industrial policy, work based on sectoral and technological systems is central.

9. Sectoral Systems

In a study of six sectoral systems of innovation (SSI), Malerba (2004) concludes that "the principle role of the policy maker is to facilitate the self-organisation of the SSIs within the relative policy domain. An important consequence of this is that the policy-making process is itself the reflection of bounded rationality and learning in the presence of high heterogeneity in technical change and the innovation process. The sectoral system approach is an alternative to the concept of the optimising policy-maker, which characterises the market failure approach to innovation policy …" (Malerba, 2004, pp500-501).

An important insight of the sectoral systems approach is that innovation systems operate at multiple levels and within and across national economies and technologies. Each sectoral system therefore forms an intersection of different networks generating particular kinds of knowledge. The policy-maker therefore is faced not with the problem of analysing market failures *per se*, but system failures in terms of the interrelationship between the various sources of knowledge and the actors involved in the sectoral system. Thus "sectoral analyses should focus on the systemic features of innovation in relation to knowledge and boundaries, the heterogeneity of actors and networks, institutions, and transformation through co-evolutionary processes. As a consequence, the understanding of these dimensions becomes a prerequisite for any policy addressed to a specific sector." (Malerba, 2004, pp501-502).

Adopting this approach emphasises the need to see any policy towards the sectoral system of innovation linked to the broad range of other policy domains in which government may attempt to operate, including science policy, industrial policy and competition policy. The policy-maker needs to take into account the geographical boundaries which may differ across sectoral systems of local, national and international actors and institutions. This implies a granular approach to the formation of sector policies of which innovation policy *per se* is only one component.

Malerba (2004) concludes that "in general, if governments should intervene, they should do so at an early stage in the development of new sub-systems and new SSIs. Such intervention at an early stage may have a tremendous impact." Finally, Malerba (2004) notes, that the costs of creating the knowledge base for understanding the emergence and development of sectoral systems of innovation are substantial and frequently cross the standard industrial classifications which define sectors in most sets of national and industrial accounts.

10. Technological Systems

A technological system may be defined as “a network or networks of agents interacting in a specific technology area under a particular institutional infrastructure to generate, diffuse and utilise technology. Technological systems are defined in terms of knowledge or competence flows rather than flows of ordinary goods and services. They consist of dynamic knowledge and competence networks.” (Carlsson and Jacobsson, 1997, p.268). Whilst recognising that technological systems may be international in character, they argue that they are likely to have very strong national, regional or local dimensions. Technological systems failures may arise from lock-in problems as firms, institutions and networks become tied into old technologies. Similarly, the accumulated absorptive capacity of firms may limit or shape their research processes to focus on relatively localised knowledge and related sectors. A central policy issue is to what extent innovation should be concerned with improving the efficiency of existing systems as opposed to building new systems. In the first case policies are essentially concerned with creating bridging institutions and other activities to strengthen an existing system with an emphasis on enhanced diffusion of best practice. In the second case the object of the policy would be the development of processes to create diversity and, as Carlsson and Jacobsson put it, “to build options in the sense of stimulating and protecting technological and institutional diversity and by enhancing industry’s awareness of new technology”. (Carlsson and Jacobsson, 1997, p.270).

In relation to networks as part of the technological system, important government policy functions may be related to matching firms within a technological system that have currently good contact or linking separated actors, such as universities and researchers. Finally, the behaviour of different “agents” and institutional architectures (educational organisations, and in particular universities, as well as the role and nature of the financial system) may also play a critical role.

The evolution of systems may span several decades. From a policy point of view the question of the stage of development of the technological system is critically important in relation to the extent and nature of policy interventions. As with SSI, policy may be most effective in the early stages of the evolution of the technological system. Diversity should be the prime policy objective. A fundamental role for the policy-maker is then identified as being to raise awareness of new technological opportunities. This imposes a major knowledge gathering and opportunity identification role for policy-makers to either coordinate or fulfil. Secondly, for awareness to lead to action requires a combination of lead customers and financing, and access to these may vary across national boundaries. There is an important role for the university sector in identifying new technologies and spinning off firms exploiting that technology.

In each of these domains industrial policy may have an important role to play. This may be as a direct lead procurer through advanced purchase itself and/or through the shaping of policies to encourage knowledge exchange between the university and industrial sectors. Finally, interventions to promote new directions in technology systems are unlikely to be marginal. They are likely to require substantive investments and policy will require a strong element of anticipating change. This requires a system for the early identification of potential new directions and potential systems failings in their development.

11. The Design of System-based Industrial Policy

The sectoral systems and technological systems approaches reveal the importance of policy *design* as much as policy instruments *per se.* The bureaucratic and informational constraints on the exercise of industrial policy should not be taken as given. Three key elements to the design of industrial policy may be identified (Rodrik, 2006).

The first of these is "embeddedness" (Rodrik, 2006). Industrial policy development needs to be embedded in private sector networks and hence be able to draw upon and connect with and between information sources in that sector. This is a characterisation of policy which stands in sharp contrast to the mainstream top down economics model in which the government as a 'principal' designs a rule to provide incentives to the private sector as 'agents'. The agents are then expected to respond and act in a socially desirable manner (typically in the resolution of "market failures"). This approach takes the information asymmetry and lack of connections as given. Autonomous bureaucrats incentivise agents to respond to the "altered" market signals. This model is counterproductive in the context of industrial policy (Rodrik, 2006). In practice, "the government has only a vague idea at the outset about whether a set of activities is deserving of support or not, what instruments to use, and what kind of private sector behaviour to condition these instruments on. The information that needs to flow from the private sector to the government in order to make the appropriate decisions on these are multidimensional and cannot be communicated transparently through firms' actions alone. A thicker bandwidth is needed." (Rodrik, 2006, p.26).

This approach occupies the ground between the view of the autonomous industrial policy-maker of the neo-classical economic approach and the private capture, and suborning, of industrial policy makers by private enterprise emphasised in the "political economy" critique of coordinated selective planning approaches to industrial policy. It entails "strategic collaboration and coordination between the private sector and the government" (Rodrik, 2006, p.2). This needs to be designed to uncover significant bottlenecks and constraints, the design of effective interactions as well as of evaluations. It also critically involves learning from mistakes as the policy evolves. A wide range of institutional developments may serve this purpose from informal and formal development forums through to advisory councils and intermediating Research and Technology Organisations. From this perspective industrial policy is a process of learning and discovery. This approach is entirely consistent with the emphasis on policy learning in the innovation systems literature.

The second feature of institutional design is the necessity of combining sticks with carrots so that there are not only incentives, but also disincentives based on the weeding out of investments that fail or activities that become "honourable dead-ends" (Rodrik, 2006). The designation of industrial policy as a process of discovery means that policy makers and the political system must accept a failure rate consistent with the underlying riskiness of the activity being supported. These carrots and sticks need to be combined with full public accountability for the sums dispersed and the performance of the investment or activity supported under the industrial policy.

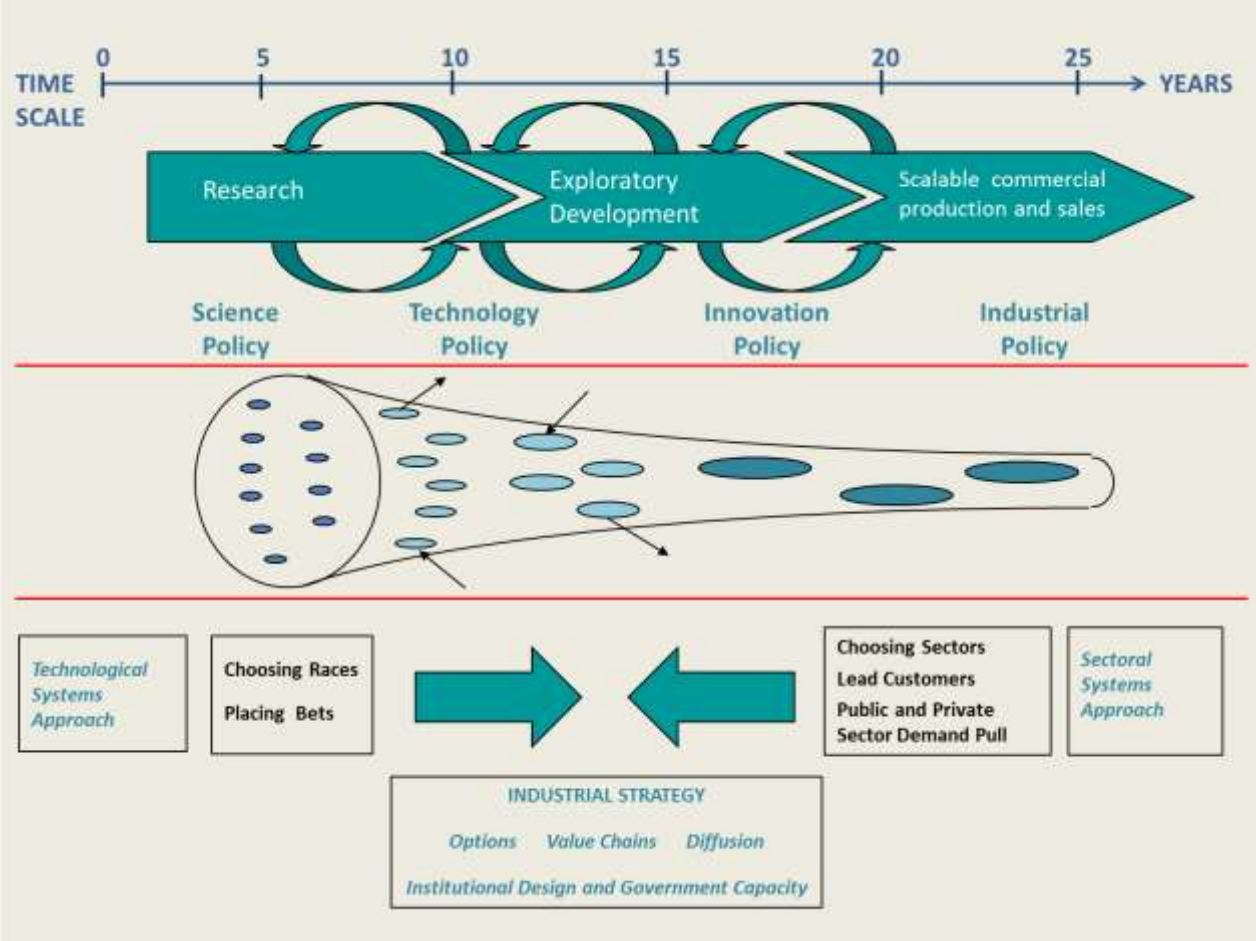
The sectoral and technological systems approaches both emphasise the potential role of industrial policy support at the earlier stages of systems formation. The impact of learning and of increased knowledge sharing and coordination at this stage is also emphasised. These relationships and their implications may also be important at the more mature phase of a sector's development in the phase of changing underlying demand or competence or resource based constraints. Moreover, once new specialisations are developed there may remain obstacles to sufficient subsequent investment in resources to develop them.

If a particular economy is not able to attract sufficiently skilled and capable resources, either in terms of financial or human capital, then industrial policy may need to be concerned with the design of ways to promote the role of users to pull through and stimulate innovation in emerging upstream developments (Arora and Gambardella, 2006). This point is intimately related to the role that industrial policy may play in stimulating multiple partners to take part in development processes, arising from early stage technological breakthroughs, as technologies emerge into potential commercialisable opportunities. It is important to note in this connection that the absence of venture capital funding in early stage developments may place an even greater emphasis on the role of early stage lead users and in particular the role of the public sector as a lead user procurement mechanism (Connell and Probert, 2010).

12. From Science Policy through to Industrial Policy

In the light of the foregoing discussion about the implications of developing a selective industrial policy and the need for careful policy design, an attempt is made in Exhibit 6 to encompass the key elements in policy design. Exhibit 6 takes the view that the term "industrial policy" is best conceived in a granular context, in relation to the specific technology or sector which is being considered for government support.

Exhibit 6 **From Science Policy to Industrial Policy**



The top bar in the diagram represents a flow of ideas from the public and private sector research base towards commercialisation. The direction of flow implies linearity, but there are multiple non-linear feedback loops in the process. This is captured by the loops in the top bar. The length of time this process may take is captured by the indicative timescale across the top of the diagram. It is important to note that the time scales over which the process operates may vary significantly from sector to sector and technology to technology. The conventional breakdown of policy into science policy, technology policy, and innovation policy is shown beneath the development arrow bar. Industrial

policy (and in particular selective industrial policy as conventionally defined) is shown as primarily focussing on policy support for the sectors in which the new products and processes are commercial developed and implemented.

In the middle of the diagram is a funnel which represents the process in which emerging ideas from the science base are gradually narrowed down as they proceed towards commercialisation in a particular sector or sectors. This funnel is shown as an "open" innovation funnel (Chesborough, 2003, 2006) with inward and outward flows of ideas and resources in the development process. The potential for unexpected development and spin-off opportunities is represented by the arrows emerging from the funnel whilst inputs and complementary investments from potential adopters or users of the technology are represented by inward arrows. The openness of the innovation process itself may of course vary from sector to sector and in the different stages along the overall innovation process.

The iterative evolutionary process from research to economic effects and the open innovation funnel will typically involve multiple investments beyond the original public and private sector research investments. The transition from early stage activities funded by the public sector to final commercialisation will, in particular require private sector investments which are usually many multiples of the original science base investment.

The bottom third of the diagram represents a schematic overview of a systems approach to policy. It shows on the right hand side of the diagram a sectoral systems approach looking backwards to technologies from sectors. This shows, as important pull factors, lead customers in both the public and private sectors. The technological systems approach is represented on the left side of the diagram. It represents the selection of technologies to support on the pathway to development and innovation in existing or new sectors. This selective approach is identified as choosing races and placing bets rather than picking winners.

The implications for policy are shown under the heading of industrial strategy which is shown as an integrative policy process spanning the sectoral and technological systems approaches Understanding value chains is shown as central to this policy process. It informs the choice of both technology races to enter and sectors to support. This requires a granular approach to policy rooted in the specifics of particular technologies and the way value is created and captured[4].

The technology support process is also to be understood as one in which the support provided is to be seen as an option to invest more, or to withdraw. At each stage of the process of development policy support should therefore be designed so far as possible to allow an options approach. Advances through the path to commercialisation leads to the discovery of new technical and commercial knowledge and this must be used to revise planned support. In this way initial investments have the opportunity to be topped up or modified as developments show potential promise whilst "honourable dead-ends" may cease to receive support for further stages of development[5].

[4] See for example CST (2007)

[5] On discovery driven planning in uncertain projects see McGrath and MacMillan (2009) and for real options and related stage gate models of assessing progress in uncertain projects see Cooper (2008),

The final key policy element shown in the diagram is diffusion. Policy design should encourage the entry of potential users along the development path and also the diffusion of innovations across firms in the sectors where implementation occurs[6]

[6] For an analysis of a number of intermediate technology organisations which represent variations across countries in policy design incorporating the elements of Exhibit 6 to different degrees see Mina et al. (2009).

13. Industrial Policy in the UK

13.1 Learning from the Past

Although there are many examples of successful industrial policies in developed economies (Chang et al, 2013) 'Industrial Policy' has long had a bad press in the UK. There is a good reason for this, namely, the policy failures of the 1960s and, especially, the 1970s. It is salutary to remember this episode since it would be very unfortunate to repeat these mistakes. Although the widely recognized failures of that period relate to selective policies, there were also serious flaws in the design of horizontal policies.

Selective industrial policy in the 1970s focused on support for firms and industries including through subsidies and nationalization and was a mixture of 'defensive' and 'strategic', although skewed to the former. Although 'picking winners' may have been the aspiration, "it was losers like Rolls Royce, British Leyland and Alfred Herbert who picked Ministers" (Morris and Stout, 1985, p. 873). There was a very clear tendency for subsidies to be skewed towards relatively few industries, notably aircraft, shipbuilding and, latterly, motor vehicles (Wren, 1996a). The high expenditure on shipbuilding is striking since this was clearly an industry in which the UK no longer had a comparative advantage in the face of Asian competition. More generally, there was quite a strong bias towards shoring up ailing industries which is well reflected in the portfolio of holdings of the National Enterprise Board (Wren, 1996b), in the pattern of tariff protection across sectors (Greenaway and Milner, 1994), and also in nationalized industries where the prevalence of very poor rates of return reflected a lack of political will to eliminate productive inefficiency (Vickers and Yarrow, 1988).

Policies to subsidize British high-technology industries with a view to increasing world market share in sectors where supernormal profits might be obtained were notably unsuccessful in this period in a number of cases including civil aircraft (which by 1974 had cost £1.5 billion at 1974 prices for a return of £0.14 billion (Gardner, 1976)), computers (Hendry, 1989) and nuclear power (Cowan, 1990). A combination of subsidies to American producers linked to defence spending and the relatively small size of the British market undermined these attempts at rent-switching. Contrary to popular perception, however, there actually were some successes, notably in pharmaceuticals and aerospace.

In pharmaceuticals one major impact of government may have been through the drug-purchasing policies of the NHS. The Pharmaceutical Price Regulation Scheme (PPRS) has shaped the incentives facing pharmaceutical companies. This provided a distinctive form of rate of return regulation which could be manipulated by the Department of Health to encourage R&D in the UK (Thomas, 1994). Even so, a more important aspect of government support may well have been through the science base and, in particular, the existence of elite research universities with world-class departments together with public funding for research through the Medical Research Council.

In aerospace Rolls-Royce was nationalized in 1971 and successfully privatized in 1987. This saved a company that had made a disastrous error in signing a fixed price contract to supply the RB-211 engine to Lockheed, a decision which bankrupted it when development and production costs rose far above initial estimates. Eventually, the sale

of Rolls-Royce realized £1.36bn for the government compared with net subsidies of £0.83bn over the previous 20 years and Rolls-Royce went on to become the highly-profitable, second largest producer of civil-aircraft engines in the world (Lazonick and Prencipe, 2005).

Several failures in horizontal industrial policies in the 1960s and 1970s also deserve a mention. First, investment subsidies, which amounted to about 10% of fixed investment at their peak in 1978, represented very poor value for money. The econometric evidence is that they had little effect on the volume of investment over the long run (Sumner, 1999) with the implication that there was a massive deadweight cost. Second, the UK spent heavily on R&D; at 2.3 per cent of GDP in 1964 this was second only to the United States and a high fraction was government financed. Unfortunately, this seems to have been badly directed and to have had little impact on productivity performance. Ergas (1987) summed up British policy as much too concerned with trying to produce radical innovations and too little aimed at effective technology transfer. Third, the persistence of protectionism and the weakness of competition policy undermined productivity performance by underwriting managerial failure and dysfunctional industrial relations (Crafts, 2012). Finally, the tax system was characterized by very high marginal direct tax rates such that Tanzi (1969) described it as the least conducive to growth of any of the countries in his study.

After the election of the Thatcher government in 1979, the stance of supply side policy changed markedly. Selective industrial policies were phased out, horizontal policies were downsized and narrowed in scope with the ending of most investment and employment subsidies, while competition in product markets was strengthened considerably, initially through reducing trade barriers and deregulation rather than by strengthening anti-trust policy. Privatization, reform of industrial relations, and restructuring taxation were the new priorities. By 1987/8 grant-equivalent expenditure on industrial subsidies which had peaked at £8.9bn (1980 prices) in 1970/1 had fallen to £0.4bn (Wren, 1996a).

Selective industrial policy fell out of favour partly because the 1970s experience led to disillusionment and partly because international treaties and, in particular, EU rules on state aids constrained policy. Department for Trade and Industry expenditure on industrial policy measures was £421.4 million in 1997/8 (prior to devolution) of which £121.9m was on science and technology schemes, £171.3m for support for small firms, and £128.2m on regional policy, almost all of which went on Regional Selective Assistance (Wren, 2001). Whereas in 1981/6 state aids were 3.8 per cent of manufacturing GDP by 1994/6 this had fallen to 0.9 per cent.

The changes that Labour made after its landslide victory in 1997 were to strengthen some aspects of horizontal industrial policies with a new emphasis on R&D, investing in public capital, strengthening competition policy, and a long term strategic commitment to public education and science base expenditure. Only in 2009, in the throes of the financial crisis, was there an announcement of rebalancing of industrial policy towards a somewhat more selective approach with *New Industry, New Jobs* (BERR, 2009). Nevertheless virtually all (91%) of state aid to industry in 2006 was for horizontal rather than selective policies (Buigues and Sekkat, 2011).

The most obvious improvement in horizontal policies from the 1970s was to increase competition across much of the economy through the abandonment of protectionism,

entry into the Single Market, deregulation and, ultimately, a strengthening of competition policy through new legislation in 1998 and 2002. These changes had positive effects on productivity performance (Criscuolo et al., 2004; Griffith, 2001; Proudman and Redding, 1998). The 1980s and 1990s also saw major changes in industrial relations prompted by high unemployment and trade-union legislation but pushed forward by stronger competition which promoted changes in working practices (Machin and Wadhwani, 1989; Gregg et al., 1993).

In other important respects, horizontal policies were less satisfactory and reflect regulatory failure government failure or, at least, political constraints. Four areas where this has been apparent are energy and water regulation, transport infrastructure, land-use planning, and the structure of taxation. The privatisation of the water and energy sectors and the subsequent regulatory frameworks put in place led to chronic under-investment in R&D weakened innovation and in the case of energy reduced the UK's technological and commercial capacity in nuclear generation (Cave 2009 CST 2005, CST 2009a). More generally from a growth perspective, the UK has been investing too little in infrastructure (CST 2009b). To maintain the level of public capital to GDP at a growth-maximizing level, investment of about 2.7 per cent of GDP would be needed (Kamps, 2005) but the average since 1997 has only been about half of this while the major investment in road building justified by the Eddington Report (2006) has not been made. The LSE Growth Commission (2013) has argued that failures in the institutional architecture need urgently to be addressed to deal with this issue. Land-use planning regulation creates massive allocative inefficiency and reduces labour productivity both by making land unduly expensive and by restricting city size which means that agglomeration economies are foregone and spatial adjustment is impeded – successful British cities are too small (Leunig and Overman, 2008). One of the implications is an implicit regulatory tax rate of around 300 per cent which makes office space in cities like Leeds and Manchester much more expensive than even New York and San Francisco (Cheshire and Hilber, 2008). The Mirrlees Review made a powerful case for tax reforms which it claimed would have significant positive effects on the level of GDP and its growth rate. The key it argued is to reduce personal and, especially, corporate income tax paid for by raising consumption and property taxes. The proposals made include implementing a land-value tax, ending exemptions from VAT, and making a normal rate of return non-taxable (Mirrlees et al., 2011).

The overall trajectory of UK industrial policy since the 1970s is perhaps best described as seeking to improve the workings of a liberal market economy (LME). In particular, the emphasis on strengthening competition and industrial relations reform has worked in this direction. The contrast with the earlier (failed) experiments of the 1960s and 1970s that sought to introduce a version of 'corporatism' into the UK economy is quite striking.

The liberal market competition-focussed policy from the 1980s onwards was accompanied by persistently higher levels of unemployment compared to earlier decades. This led to major public sector policy expenditures to promote small and medium sized enterprises as the key ingredient in the recipe for job creation and increased attention to innovation as a source of productivity growth.

13.2 From Industrial Policy to Enterprise and Innovation Policy

Enterprise policy is designed to promote the small and medium sized enterprise (SME) sector (defined as those businesses employing less than 250 people). The promotion of enterprise was initially linked to the belief that SMEs were to be the primary generators of employment and jobs. Later initiatives focused in addition on the promotion of technology intensive SMEs and spin offs to promote commercialization from the science base as part of a more general shift of emphasis to innovation policy.

The shift in policy emphasis towards the promotion of innovation has frequently involved both direct grants and elements of selectivity based on sectors or technologies.

A range of systems-inspired innovation-related policies were reinforced or introduced from the 1990's onwards as a result of a series of innovation policy reviews (DTI, 1998; DTI, 2003a; DIUS, 2008; BIS, 2011). These systems policies focused on networked and collaborative connections both between businesses and between businesses and the science base. These were often linked to specific technological systems, e.g. biotechnology or nanotechnology. System connections within specific geographical localities were also emphasised in the identification and promotion of innovation clusters (DTI, 2003b). In relation to innovation inputs R&D tax credits were introduced in 2000 for small firms and extended to larger firms in 2002.

The review of innovation policy in 2003 (DTI, 2003a) led to a rationalization of innovation policy support. Its delivery was transferred to a non-departmental executive agency, the Technology Strategy Board (TSB). The central policy 'products' under its domain included the Collaborative Grant for R&D (linking large and small firms and the science base), Knowledge Transfer Partnerships (linking SMEs and Higher Education Institutions (HEIs) through co-funded postgraduate placements), and Knowledge Transfer Networks (linking businesses in a sector)[7]. TSB programmes and initiatives have frequently selected sectoral or technological approaches.

At the same time here were also major changes in funding the science base. In 2001 the Higher Education Innovation Fund (HEIF) was introduced. This was intended as an extra "Third-Stream" of support for English HEIs. It was to sit alongside the Dual Support streams of Research Councils and Higher Education Funding Councils to promote business-industry links. In 2004, following the Lambert Review of Business-University Collaboration (HM Treasury, 2003), the Science and Innovation Investment framework 2004-2014 was launched. It included a long term commitment to increase public sector R&D faster than the rate of GDP growth. Assuming this was matched by the private sector this was designed to raise the overall UK R&D to GDP ratio from 1.9% in 2004 to

[7] Another long running innovation policy scheme the Small Firms Merit Award for Technology (SMART) offering grants for early stage technology projects was in 2004 relabelled the Grant for R&D and devolved to the Regional Development Agencies. It also began with the targeting of specific technologies on sectors. Following the subsequent demise of the RDAs it was re-labelled SMART and re-launched under the auspices of TSB in 2011. In 2012 the TSB was also given responsibility for the launch and management of the "Catapult" intermediate technology organizations linking businesses and HEIs in selected technology and sectoral domains.

2.5% by 2014. It was accompanied by a range of measures designed to upgrade the HEI capital stock and to place HEI research funding on a full economic cost basis.

The most recent developments in policy (BIS, 2011) have been associated with the recognition of the importance of establishing a richer set of institutional interconnections between universities and the business community and the development of sectoral and technological strategies. This has included the development of a set of "Catapult" centres focused around a selected set of themes and technologies. This followed a review of practices in other countries and under the auspices of the Technology Strategy Board has led to the creation of seven catapult centres once again selectively focused on a range of sectoral or technological domains (Hauser, 2010; TSB, 2011). Finally the use in the United States of the public procurement of R&D from SMEs through the Small Business Innovation Research (SBIR) Programme has been imitated in the UK.

Policy towards start-ups and SMEs included experimentation with a wide range of measures designed to meet capital market failures in the provision of risk capital and loan finance for SMEs as well labour market failures in the provision of SME training. The idea that SMEs are generally finance constrained because of capital market failures is wide spread. As a result most countries including the UK have a variety of loan guarantee and other support schemes to ameliorate capital market finance failures. It is clear that in periods of financial crises, such as in 1991 and 2008, smaller businesses report difficulties in obtaining access to finance or, in periods of high interest rates, complain about the price of such finance. Outside of these periods, however, the evidence suggests that UK SMEs in general obtains nearly all the finance they seek and that this comes primarily from banks. A particular difficulty in estimating financial constraints in times of financial instability and recession is that it is difficult to distinguish a lack of borrowing because the lenders are unwilling to lend or because the borrowers have lost the appetite to borrow in difficult financial circumstances (Armstrong et al., 2013; Cosh et al., 2010). Evidence of financial constraints for particular groups of SMEs, such as those involved in the relatively risky knowledge intensive or R&D intensive businesses, is more persuasive and has led to the introduction of a variety of innovation and R&D related policies. These include support for firms such as direct grant support and tax credits for R&D, alongside support for investors such tax breaks on capital gains and for investments in early stage and technology intensive businesses. Pressure for yet more support persists (Breedon, 2012; House of Commons Science and Technology Committee 2013a, 2013b; Small Business Task Force, 2013).

The burgeoning of small business support across multiple departments and policy measures from the 1980s onwards meant that by 2003-4 it was estimated that the sector was receiving nearly £8bn in support (roughly £220 per person of working age in the UK) (Hughes, 2010). This support included £3.6bn of foregone revenue through tax breaks (reduced corporation tax rates, VAT small traders exemption, SME R&D tax credit Enterprise Investment Scheme Venture Capital Trusts). It also included £1.7bn of training and skills subsidy. A relatively small amount (£425 million) was associated with the then DTI innovation policy support which included the TSB policy weapons discussed above (PACEC, 2006). The retreat from industrial policy has thus been associated with a massive commitment of resources to support 'enterprise

13.3 Learning from Enterprise and Innovation Policy

It is difficult to measure the extent to which manufacturing as a whole has benefitted from the horizontal and selective support activity for enterprise and innovation. Nor is it easy to assess the overall effects on the SMEs sector as a whole of the overall degree of subsidy. However the R&D intensity of manufacturing compared to the other sectors; the emphasis on commercializing engineering and physical sciences, and identification of certain manufacturing and "high-tech" sectors in SMART and TSB activity has meant that the sector has probably been a disproportionate recipient of innovation policy support.

In relation to SME support policy generally, Hughes (2010) compares size sector and age matched samples of SMEs in 1991, 1997 and 2004 and concludes that there was little change in the proportions exporting, innovating or training over the period. Rates of collaboration with HEIs were however higher in 2004 than earlier years. Outside of periods of macro-financial crisis there was no sign of market failures in access to finance. SMEs typically obtained the funding they sought (see also Cosh et al., 2007). There have been numerous evaluations of schemes to underwrite loan guarantees and to support venture capital. A useful recent review of these schemes (Ramlogan and Rigby, 2012) concludes that, in the case of the UK, schemes such as the loan guarantee scheme show positive effects, but that schemes supporting venture capital have a much weaker track record.

There are severe problems in evaluating the impact of innovation policies. First, the outcomes may take many years to appear. Second, the outcomes are typically heavily skewed with about 10% of the "treated" firms accounting for 70-80% of all the gains from a scheme, and third, there are problems of good firms being selected into the scheme which would have done well anyway compared to control group firms who weren't "treated" (see e.g. Hughes and Martin 2012).

A number of evaluations of the innovation policy schemes discussed above have nevertheless been made using methods which attempt to address these issues. Compared to the analyses of selective and other horizontal policies, the outcomes are more favourable and suggest a positive impact for policy intervention.

An econometric analysis of the impact of the SMART scheme on Total Factor Productivity yielded no significant effects (Harris and Robinson 2004) but a series of other evaluations combining case studies with econometrics and exploring skewness found a range of positive effects. These were concentrated in a small proportion of firms taking part in the schemes. These included positive impacts on sales, employment, access to other resources and ability to meet the firms' technical innovative and business objectives (PACEC 2001, 2011).

The Knowledge Transfer Partnership Scheme has supported over 5,000 partnerships. Around 60% of firms reported that their technical objectives were met and around 40% that their commercial objectives were met. In the period 2001-2 and 2007-8 between 5550 and 6010 net additional jobs were created generating around £1.7billion gross value added (of which the 25% most successful businesses accounted for 70%). This represented additional gross value added of between £4.70 and £5.20 per £1 government support (Segal Quince Wicksteed, 2002; Regeneris Consulting, 2010).

The Collaborative Grant for R&D has been estimated to have generated substantial behavioural additionality in terms of business and HEI processes for managing collaboration relationships and innovation. In addition since 2004, it was estimated to generate 13,350 net additional jobs and £2.9 billion additional gross value added. For each £1 of grant there was £6.71 of additional gross value added (PACEC, 2011).

The HEIF funding stream led to the injection of £592 million extra funding into the university sector between 2001 and 2007. This was estimated to have yielded between £2.9billion and £4.2 billion gross additional knowledge exchange income which universities attracted from business and other external user sources (PACEC/CBR, 2009).

In relation to the overall policy spend on direct and indirect (tax based) innovation and SMEs, Foreman-Peck (2013) shows that in the period 2002-4 SMEs which received innovation policy support (either directly through e.g. SMART or indirectly through R&D tax credits) were more likely to innovate than other businesses. Innovating businesses also grew faster than other businesses. His estimates suggest that SME innovation support policy cost £320 million p.a. in 2002-4 and yielded a return of £1,180 million p.a. in 2002 prices. He notes that the cost of R&D tax credit support was significantly higher than the other direct innovation support and that the R&D tax credit has a much smaller take up. As a result he concludes that 'much of the return to innovation could apparently be earned without the expensive tax credit' (Foreman-Peck, 2013, p68). In addition, a recent qualitative study HMRC (2010) focusing on business decision-making processes in relation to R&D tax credits and grants concluded that the R&D tax credits were almost always described by firms in the sample as a "bonus". They had little if any effect on decisions to conduct individual pieces of R&D work. On the other hand, grants, such as SMART, appeared to be crucial to start-up companies in particular and in the early stages of the life of research-based SMEs. The application process for a grant induced indirect benefits in terms of the discipline involved in putting together the proposal. The grants also exerted a leveraging effect on other funding by providing "kudos" for the company. It also had positive effects on staff recruitment and retention. This suggests that tax credits are a relatively inefficient way to supporting SME innovation activity.

14. Industrial policy, the Challenge of Globalization and the 'Second Unbundling'

Globalization entails reductions in trade costs and increased international mobility of capital. A major implication is that the relative attractiveness of locations that business chooses for different stages of production in the value chain including manufacturing may change over time. Indeed, a notable feature of the past quarter century has been the rapid expansion of 'vertically-specialized' trade where value added to the final product sold to the consumer has been built-up in a series of different locations perhaps in several countries (Yi, 2003). Linked to this has been the so-called '2nd Unbundling' in which technological change, especially in terms of ICT, has made it possible to disperse production stages that previously had to be performed in close proximity (Baldwin, 2006).

These developments have implications that change the optimal composition of industrial policies compared with the less globalized world in the earlier technological era of the 1970s (Baldwin and Evenett, 2012). First, with regard to selective industrial policies, it may be necessary to re-think the notion of giving support to particular manufacturing sectors and think instead in terms of interventions targeted at stages of production in a value chain. Second, the increased mobility of some factors of production means that it may be important not only to consider externalities but how far these will be internalized to the UK. This means that compared with earlier times, the weight of subsidy should tilt towards 'high-spillover, low-mobility' factors – for example, horizontal policies should emphasize human capital rather than transferable technology. Third, corporate taxation has to be designed for a world in which there is greater tax competition which typically implies lower marginal rates than in a closed-economy setting.

Perhaps most important of all is to recognize the value of increasing the 'stickiness' of economic activity by making alternative locations less good substitutes. This results from advantages that cannot easily be replicated elsewhere. In particular, this suggests that policies to nurture successful agglomerations deserve a high priority. It may be appropriate for the British government to follow the lead of the Dutch (CPB, 2010) and consider what a successful portfolio of British cities would look like in future and how this can be underpinned. This calls for an approach different from that of traditional industrial policy with its emphasis on subsidies to physical investment or promoting particular manufacturing industries. Instead, it will be important to develop well-designed transport infrastructure and land-use planning policies. Unfortunately, these are areas in which British policies leave a lot to be desired.

Increased international mobility of capital also entails 'tax competition'. As corporate tax rates are lowered in other countries, a policy response may be required from the UK in order to maintain its attractiveness for FDI. The prediction of simplistic models of tax competition is that there will be a 'race to the bottom' and corporate tax rates will tend to zero (Razin and Sadka, 1991). This has not happened because, in practice, capital is only imperfectly mobile even in the manufacturing sector and its choice of location is influenced by other factors besides taxation. Small countries, for example, Ireland and Luxembourg, find it attractive to cut tax rates because their domestic capital stock is

relatively small because the increase in the tax base compensates for the lower tax rate. For larger countries such as Germany and the UK, this is not the case, while political constraints and considerations of fairness mean that, in any case, for these countries, cuts in corporate taxes will be relatively limited (Plumper et al., 2009). This implies that if policymakers are concerned to combat tax competition they will need to focus on instruments that aim to improve human capital, the regulatory environment and infrastructure.

15. Institutional Architecture and the Future of Industrial Policy

We are proposing a different system based approach to medium to long-term industrial policy to that on which past UK policy has been based. There are nevertheless important lessons to be learned from past UK experience. These relate in particular to the ability of governments to design and deliver policy. This is a question of government failure. A systems approach might address these issues in four ways. First, there is a need for policy to be designed in an embedded way which eschews top down design and implementation. Second, in the face of uncertainty and the need for reflexive policy learning, an options approach would be essential. Third, there would be a requirement to build policy design and information processing capacity. Finally it would embody the creation and design of policy intermediaries to enhance the connectedness of the system and improve its institutional architecture.

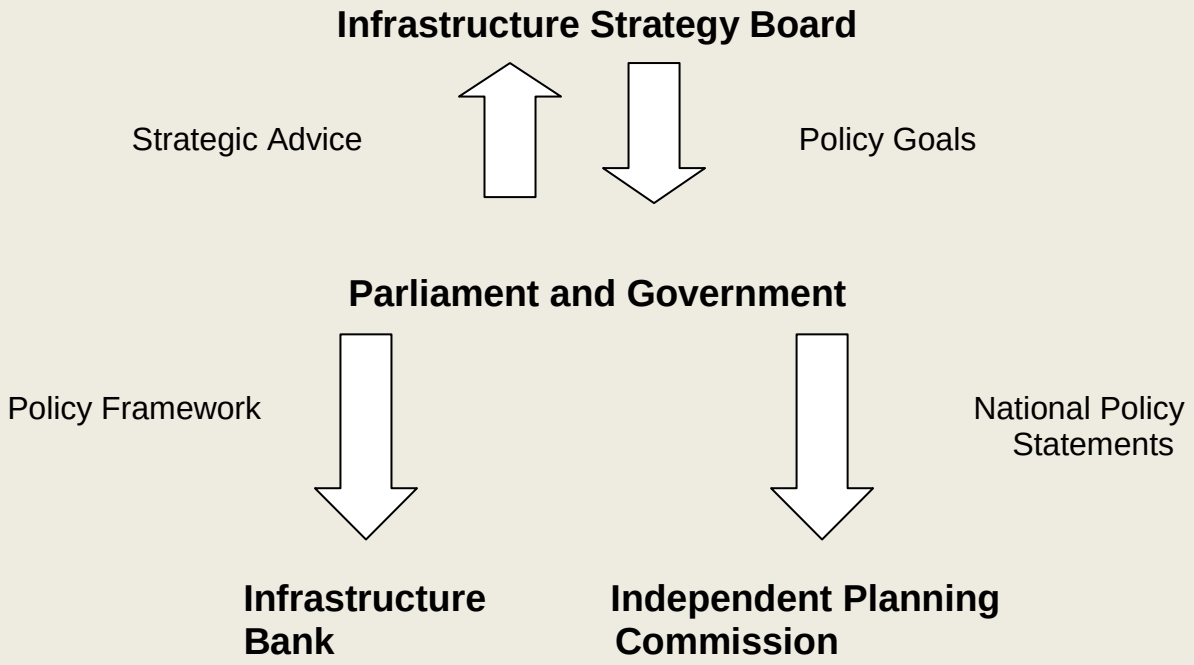
We have discussed each of these in earlier sections. Here we address a final and central problem relating to the provision of an institutional architecture that will ensure longer term stability in policy design and implementation. Exhibit 7 summarises a recent proposal to address this problem in relation to UK infrastructure while Exhibit 8 provides examples of relevant institutions from the UK, Australia and the USA.

Exhibit 7 The Institutional Architecture for Investment in Infrastructure

The need to improve infrastructure provision in the UK is urgent – as it has been for many years. This is a clear example of government failure which is costly to UK manufacturing. Among the obvious problems are:

- Difficulty in basing decisions on unbiased appraisals as opposed to lobbying
- The appeal of 'grand projects' to vote-seeking politicians
- Vulnerability to policy instability
- The chronic NIMBYism created by the planning system and incentives to local politicians to oppose projects that have high value for the nation

These systemic weaknesses have led the LSE Growth Commission (2013) to propose a new institutional architecture to govern infrastructure strategy, delivery and finance. This is described in the diagram below.



The ***Infrastructure Strategy Board (ISB)*** has the key function of providing independent expert advice. It would gather evidence, consult with the public and provide analysis of costs and benefits of policy options and provide regular reports on infrastructure needs and long-term priorities and challenges. Its mandate would be laid down by statute and it would be accountable to parliament. It would be governed by an independent management board.

The ***Independent Planning Commission*** would be charged with delivering on the ISB's strategic priorities and would not require ministerial approval for projects. It is designed to give predictability and effectiveness to investment.

The ***Infrastructure Bank*** is to facilitate the provision of stable, long-term, predictable and mostly private-sector finance for infrastructure to reduce policy risk and to structure finance in ways that share risk efficiently.

The overall design is intended to facilitate long-term planning and reduce policy instability. It allows the government to choose its priorities and decide on strategy but it would ensure that political decisions are taken in the right place and represent credible commitments for investors.

For further details see:
www.lse.ac.uk/researchAndexpertise/units/growthCommission/documents/pdf/SecretariatPapers/Binfrastructure.pdf

Exhibit 8 Examples of Oversight and Strategic Policy Institutions

The Office for Budget Responsibility (OBR)

The OBR is an independent fiscal watchdog that became a statutory body in April 2011 as a result of the *Budget Responsibility and National Audit Act.*

The OBR examines and reports on the sustainability of the public finances. It was set up with the strict instruction to provide only positive commentary, not normative commentary, on government policies. The Act gives the OBR right of access to Government information it may require for the performance of its duty, in addition to access to relevant officials and others.

A Memorandum of Understanding (MOU) was created between the OBR and those government departments with which it interacts most, namely the HM Treasury, HM Revenue and Customs and the Department for Work and Pensions. This is not a legally binding agreement but provides details of the working relationship between these four institutions. The OBR has an annual budget of £1.775m, a dedicated staff of 18 civil servants and three committee members (Chote, 2013).

Advanced Manufacturing National Programme Office (AMNPO), United States

Hosted by the National Institute of Standards and Technology (NIST), AMNPO is staffed by representatives from federal agencies with manufacturing-related missions as well as fellows from manufacturing businesses and universities.

Recommended by the Advanced Manufacturing Partnership Steering Committee and endorsed by the President's Council of Advisers on Science and Technology (Advanced Manufacturing Partnership Steering Committee, 2012), AMNPO is charged with implementing a whole of government advanced manufacturing initiative to facilitate collaboration across federal agencies; and convening and enabling private-public partnerships focused on manufacturing innovation and engaging U.S. universities.

By coordinating resources and programmes, AMNPO will enhance technology transfer and help businesses overcome technical obstacles to scaling up production of new technologies.

The Australian Productivity Commission

The Productivity Commission, created in 1998, is the Australian Government's independent research and advisory body on a range of economic, social and environmental issues affecting the welfare of Australians.

It is an advisory body and does not administer government programs or exercise executive power. Its contribution hinges on the value of the independent advice and information it provides.

Its operating principles include Independence (The Commission operates under the powers of its own legislation, with its own budgetary allocation and permanent staff, and reports formally through the Treasurer to the Australian Parliament); transparency: and taking a community-wide perspective (Australian Productivity Commission, 2013).

In the light of these examples the establishment of an Office for Manufacturing for the UK may be one way of encouraging stability industrial policy design and implementation.

16. The Office for Manufacturing (OfM)

Future industrial policy will play a key role in how the government seeks to capture future value from the manufacturing sector. This would be best achieved by a holistic systems perspective, addressing both market and systems failures and spanning the domains of economic, science, technology and innovation policy. To implement this approach, it is critical that the Government has, in the future, an institutional architecture with the capacity to deliver industrial policy in the medium to long-term.

One way to do this could be to introduce an 'Office for Manufacturing' with challenge, coordination, and evaluation functions for future industrial policy in order to ensure future policies work effectively to strengthen industry and rebalance the economy.

The remit of the OfM would be:

- To scrutinise industrial policy and support its coordination: The OfM will facilitate coordination across departments for existing and proposed industrial policies, and will work with other departments to seek out beneficial opportunities for coordinated action.
- To evaluate the impact of industrial policy: This would include ongoing analysis of data and policy outcomes, to support the development and implementation of future policies.
- To provide an audit function by producing an annual report on manufacturing in the UK. This would include analysis of manufacturing data using current Standard Industrial Classification and wider metrics including manufacturing services as advocated earlier. The report would be produced against the long term science and innovation investment framework.
- To support long-term progress being made against the challenges for Government set out in the Foresight, Future of Manufacturing report: Work to be refreshed every five years.

Given the cross governmental role of the OfM, it would be most appropriate for it to report to the Chancellor or a Cabinet Office Minister, potentially the Minister for the Cabinet Office or the Minister for Government Policy. To support its cross-Government role, it would be appropriate for the small team of staff to be drawn from across Government, with oversight provided by a handful of independent Commissioners.

It is likely that an Act of Parliament would be needed to establish the OfM, which was the case when the OBR was established. This included the following:

> *"Right of access (at any reasonable time) to all Government information which it may reasonably require for the performance of its duty….Entitled to require from any person holding or accountable for any government information any assistance or explanation which the Office reasonably thinks necessary for that purpose".*

A Memorandum of Understanding (MOU) would need to be in place between those departments which the OfM interacts most frequently.

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