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Abstract

Over the period since 1970, Britain has improved its relative productivity performance, but there remains a significant gap in market sector productivity between Britain and both Continental Europe and the United States. Much of the gap between Britain and Continental Europe is due to lower levels of capital intensity and skill. However, even taking these into account, there remains a significant gap between Britain and the United States. This reflects not just a weakness in high tech areas but an inability to absorb best-practice techniques and methods in wide swathes of the market sector. Part of this is due to a weakness in technological innovation despite a high quality science base. This includes comparatively low and falling levels of R&D and patenting as well as a distinct lag in the diffusion of innovations relative to other countries.

JEL Classification: D24, O31

Key Words: Innovation, technology, productivity growth.

1. INTRODUCTION

In the 1970s, Britain was widely known as the “sick man of Europe”. Why? During the European Golden Age, which stretched from the post World War II recovery to the first oil shock in 1973, Britain had been overtaken by the major countries of Continental Europe in terms of GDP per capita despite having been far ahead in 1950. Furthermore both unemployment and inflation had been rising steadily since the mid-1960s. Then, on top of this, the first oil shock itself was a disaster. By the end of 1974, unemployment was rising rapidly, inflation was heading towards 25 percent and the stock market had fallen in real terms to its level in 1920.

Performance continued to be relatively weak until the early to mid-1980s since when there has been some catch up with Continental Europe in terms of GDP per capita, unemployment has fallen substantially and inflation has stabilised at a relatively low level. Nevertheless, even today there is a significant productivity gap, with business sector productivity (output per hour worked) probably around 20 percent below that in France and Germany, and 30 percent below the United States.

So where does technological innovation fit into this story? Technological innovation across the world is one of the driving forces behind productivity advance. However, it is hard to argue that technological innovation, or the lack of it, in Britain is an important factor in explaining the vicissitudes of the last fifty years. The unemployment/inflation story has only the most tenuous connection with technological advance. Even the large fluctuations in productivity and GDP per capita relative to other countries have less to do with technological innovation, per se, and more to do with the extent to which UK companies utilise best practice methods. These are, of course, intimately related to technology but the fundamental problem is more organisational than technological.[1] And the basic questions concern the incentives to utilise best practice methods and the barriers against doing so. These are, of course, big issues[2] which we only discuss tangentially in what follows. Here, we shall focus on the role of technological innovation although this will, inevitably, lead us to touch on how innovations are used.

The remainder of the paper is set out as follows. In Section 2, we provide a

[1] The matched plant studies carried out in the 1980s and 1990s by the National Institute of Social and Economic Research bring this home vividly (see Steedman and Wagner, 1987, for example).

[2] McKinsey (1998) presents a comprehensive analysis of these questions.

picture of the economic performance of the UK over the past three decades, the main focus being on productivity. This is followed in Section 3 by a detailed review of technological innovation in the UK over the same period. The overall picture reveals that after a long period of falling behind, UK productivity performance over the last twenty years has been relatively good with some degree of catch-up on the major competitor countries. However there remains a productivity gap. With regard to technological innovation, the UK performance in basic science has been good but the innovation performance in the market sector is weak.

In the light of these overarching facts, in Section 4 we discuss various aspects of the environment in which UK companies operate in order to shed some light on their productivity and innovation performance. Then, in the concluding section, we set out our understanding of what has been happening with regard to technological innovation in Britain. Our basic story is one of a weakness in the UK in the commercial application of technological innovations despite the high quality science base. Major reasons for this are poor educational standards outside the top third of the ability range, lack of (and low valuation of) general management skills and low levels of product market competition in many sectors. Attempts are now being made to address these problems but there is some way to go.

2. THE ECONOMIC PERFORMANCE OF THE UK (1970-2000)

As we have already noted, the dramatic fluctuations in unemployment and inflation in Britain since 1970 have only the most tenuous relationship to technology, so after a very brief overview of the main macroeconomic indicators, we focus on GDP per capita and productivity.

2.1. Basic Macroeconomic Indicators

Since the 1960s, the UK economy has been on a bit of a roller-coaster ride. In Figures 2.1, 2.2 and 2.3 we report on unemployment, inflation and GDP growth. During the 1960s unemployment and inflation were low and GDP growth was high. Indeed GDP probably grew by more in the 1960s than in any other decade in UK history. However, by the end of the 1960s unemployment and inflation were both starting to rise and by the early 1970s they had both reached their highest level since 1950. After the first oil shock GDP growth fell and inflation and unemployment rose to new heights. After Mrs Thatcher came to power in

1979, macroeconomic policy was significantly tightened and with the onset of the second oil shock, the UK had its worst recession since the 1930s. A slow recovery followed but, assisted by macro policy relaxation in the latter half of the 1980s, a big drop in commodity prices and financial deregulation, this turned into a dramatic boom. This was immediately followed by an equally dramatic slump as monetary policy was tightened in response to rising inflation.. However since the exit from the European Exchange Rate mechanism in 1992, monetary policy has been placed on a sound footing (based on inflation targeting) and this has assisted in creating a stable and rather benign state of affairs which has lasted until the present day. However, it is clear that the period from 1970 to 1995 was one of great volatility relative to previous decades.

2.2. GDP per Capita, Productivity and Labour Input

In the mid-19th century, Britain was the richest country in the world. In Table 2.1 we present a brief summary of what has happened since. As a consequence of their superior growth rates, first the US and then Germany had overtaken the UK by 1914. However two world wars and the economic upheavals of the Inter-War years changed things somewhat, so that by 1950, both France and Germany[3] were over 30 percent below the UK in terms of GDP per capita and the US was nearly 70 percent above (see Table 2.2)[4]. Then, during the European Golden Age (1950-73), the forces of convergence assisted by the Common Market (1959) enabled Continental Europe to grow at an unprecedented rate, so that by 1973 France and Germany had overtaken Britain which, in its turn, had caught up slightly with the US. Until the early 1980s, the UK fell further behind its European competitors but since then it has been catching up so that by 1996 GDP per capita in the UK is fairly close to that of its European partners while still being well behind the US. Finally, it is worth noting that there is no sign of any dramatic improvements in growth rates in the late 1990s outside the United States.

[3] In the post-War period, Germany refers to West Germany.

[4] Note both France and (West) Germany has recovered from the Second World War by 1951 in the sense that GDP per capita was by then higher than in any pre-War year (see Crafts and Toniolo, 1996, Table 1.2).

Table 2.1
Rates of Growth of GDP per Capita (% pa)

	1860-1914	1920-39	1951-73	1974-95	1995-99
UK	1.04	1.56	2.24	1.87	2.03
France	0.96	0.78	4.92	1.63	1.93
Germany	1.47	2.91	5.11	2.01	1.89
US	1.70	0.86	1.54	1.72	2.74

Source: Crafts and Toniolo (1996), Table 1.10; Eurostat and OECD Economic Outlook.

Table 2.2
GDP per Capita (UK=100)

	1950	1973	1996
UK	100	100	100
France	69.7	110.2	105
Germany	63.3	104.7	113
US	167.4	151.6	137

Source: Bean and Crafts (1996), Table 6.2; O'Mahony (1999) Table 1.1.

In order to understand more clearly what has been happening in the Post-War period, it is important to divide GDP per capita into GDP per hour worked (productivity) and hours worked per capita (labour input). The reason for doing so is that there have been dramatic changes in labour input in some countries since 1973, which are shown in Table 2.3. The key feature is that while in 1973,

Table 2.3
Employment/Population Ratio (Age 15-64)

	1973	1979	1983	1990	1996	1999
UK	71.4	70.8	64.3	72.4	69.8	71.7
France	65.9	64.4	60.8	59.9	59.2	59.8
Germany	68.7	66.2	62.2	64.1	64.5	64.9
US	65.1	68.0	66.3	72.2	72.9	73.9
Japan	70.8	70.3	71.1	72.6	74.1	72.9
	Annual Hours Worked Per Worker					
UK	1929	1821	1719	1773	1732	1720
France	1904	1813	1711	1668	1644	1604
Germany	1868	1764	1733	1611	1668	1556
US	1924	1905	1882	1943	1951	1976
Japan	2201	2126	2095	2031	1955	1842

Source: OECD Employment Outlook (various issues).

the labour input (hours × employment/population) was of the same order of magnitude in all the countries except Japan, since that time it has fallen by over 20 percent in France and Germany, by over 10 percent in the UK whereas it has risen by over 10 percent in the US. Bearing this in mind, we now look at productivity growth rates in the Post-War period in Table 2.4. Here we see that after 1973, growth rates in output per hour are considerably higher than those for GDP per capita for the European countries, reflecting the decline in labour input. Moving on to total factor productivity growth rates, the most noteworthy is the fact that in the UK there is hardly any decline after 1973, in contrast to all the other countries which exhibit dramatic falls. This reflects the fact that

Table 2.4
Productivity Growth Rates (% pa)

	Output per hour		Total factor productivity	
	1950-73	1973-96	1950-73	1973-96
UK	2.99	2.22	1.74	1.65
France	4.62	2.78	3.10	1.62
Germany	5.18	2.56	3.76	1.67
US	2.34	0.77	1.49	0.38
Japan	6.11	3.06	3.57	1.33

Source: O'Mahony (1999), Tables 1.2 and 1.5.

the decline in labour productivity after 1973 was much lower in the UK than elsewhere allied to the UK's generally lower investment rates (see Table 3.4 in the next section). The interesting question of why labour productivity growth in the UK was so much higher relative to the other countries after 1973 than it was before, despite the roller-coaster ride of the macro-economy, has been the subject of much research (see, for example, Layard and Nickell, 1989; Nickell *et al.*, 1992; Bean and Crafts, 1996). Key factors include the transformation of industrial relations, the dramatic decline of unions in the private sector and the increase in product competition market following extensive privatisation, and the introduction of the European Single Market.

The consequences of all these differences in growth rates lead to the picture in 1996 which is set out in Table 2.5. Once we control for the differences in labour input we see that the US, France and Germany are relatively close to each other but there remains a significant productivity gap between these countries and the UK. If we focus on the market sector, in which output measures are more reliable, there is a 30 percent labour productivity gap between the UK and Germany and the US (see row 4). These gaps are, however, different in nature. Once we control for capital intensity and labour quality (in row 7), the gap between the UK and Germany all but disappears. However, the gap between the UK and the US remains at 16 percent. It is possible to "explain" this gap by including the stock of R&D in this analysis, because the US has a substantially larger stock of R&D per unit of output than the UK (see Crafts and O'Mahony, 2000, Table 5). The remaining gap of 16 percent between the UK and the US would then simply be down to lower levels of "innovation". This is rather simplistic, however, since it sheds no real light on the underlying process. This is what McKinsey (1998) sets out to explain and concludes that the gap is fundamentally due to the low levels of competitive intensity in the UK, the high level of product market regulation

Table 2.5
Levels of Productivity, 1996

	UK	France	Germany	US	Japan
1. GDP per capita	100	105	113	137	113
2. GDP per person engaged	100	126	126	129	102
3. GDP per hour	100	132	129	121	90
4. Market output per hour	100	120	131	128	81
5. TFP (1995), whole economy	100	118	109	112	77
6. TFP (1995), market sector	100	108	115	119	76
7. TFP (1995), skills adjusted, market sector	100	n/a	104	116	n/a

Source: O'Mahony (1999), Tables 1.1, 1.4 and 1.5.

Table 2.6
Total Factor Productivity by Sector in the UK

	Levels of TFP in US relative to UK, 1995	TFP Growth (% pa) 1973-95
Agriculture	100	2.92
Mining	140	-2.15
Utilities	115	2.87
Manufacturing	142	1.85
Chemicals	112	2.10
Metals	129	2.02
Engineering	166	2.02
Textiles etc.	132	1.29
Food etc.	166	0.18
Other	99	1.89
Construction	84	2.15
Transport/Communication	111	3.06
Distributive trade	135	0.43
Financial services	122	0.98
Personal services	135	1.21
Non-market services	-	0.17
Total	112	1.65

Source: O'Mahony (1999), Tables 2.9, 2.13.

and the lack of exposure to best practice. Looking at it from the viewpoint of technological innovation, the problem in the UK is the lack of effective use of technology in major sectors of the economy.

2.3. Productivity Growth in Different Sectors

The trends outlined in section 2.2 can be broken down by sector. Table 2.6 shows that the productivity gap relative to the US is not fundamentally driven by any particular sectors. Compared to the US, the UK's position is generally unfavourable. An exception is in agriculture were TFP was much higher in Britain than in France, Germany or Japan. UK TFP is also relatively strong in the utilities and construction compared to the other EU countries.

Britain's performance in manufacturing is generally worse than her relative position in the total market economy. However, even in the service sectors the UK does not enjoy a TFP advantage. Britain's TFP gap in financial services is large relative to Germany (41%), and her gap is large in personal services relative to the US (35%). Looking over time, Britain's relative decline in market services compared to Germany owes much to the decline in her relatively favourable position in services. Relative to the US, the productivity gap was closed proportionately less in services than in manufacturing.[5]

High Tech Sectors

In policy debates there is often a focus on 'strategic high tech' sectors. The OECD statistics classify these as the following: aircraft (ISIC 3845), office and computing (ISIC 3825), drugs and medicines (3522), radio, TV & communication equipment (3832).[6] Across the OECD these industries are characterised by having relatively high shares of skilled workers, high levels of productivity and high shares of trade. They have also had much higher than average growth rates of skilled workers, productivity and trade. Although the manufacturing sector as a whole has declined, high tech sectors enjoy an increasingly large share of this sector at the expense of low tech industries.

It is important to bear in mind that these sectors are small relative to the economy as a whole. For example, even within manufacturing the high tech sectors (including electricity machinery and instruments) employed only 20% of UK workers in 1994 relative to 16% in 1970 (OECD, 1996). About a fifth of manufacturing workers were also employed in these high tech sectors in the rest of the G5.

Looking at TFP growth by broad sector, manufacturing actually had slower growth over 1973-95 than the utilities (electricity, gas and water), transport and agriculture, forestry and fishing. Within manufacturing, however, it is the case that the relatively high tech chemical sector has enjoyed faster TFP growth than the relatively low tech textiles and food sectors.

[5] Although the caveats regarding measurement problems in the service sectors should be born in mind.

[6] For example, OECD (1999) Annex 1. The classification is based on R&D performed and R&D 'acquired' from other industries. Medium-high tech includes instruments, vehicles, electrical machinery, chemicals, other transport and non-electrical machinery.

2.4. Summary

UK labour productivity is lower than the US, France and Germany. Most of the productivity gap with France and Germany can be accounted for by different factor usage. Relative to Germany, for example, the UK invests less in physical and human capital. Even accounting for this, there remains a substantial TFP gap with the USA of the order of 16%. The UK made some improvement in closing this gap, especially in the 1980s. For this reason, the OECD wide post-1973 TFP slowdown appeared much less severe in the UK than in other countries. This improvement, however, was not primarily driven by better performance in the more technologically advanced parts of the economy. We now turn explicitly to UK innovation performance.

3. TECHNOLOGICAL INNOVATION IN THE UK (1970-2000)

As we have seen, the relative productivity performance of the UK has improved over the last two decades particularly given factor inputs. Over this period, TFP growth has been among the highest in the G7. In this section, we focus on the record of technological innovation in the UK over the same period. We start with the performance of the science base and then work outwards.

3.1. The Output of the Science Base

The UK has a relatively strong position on indicators of the science base. With only 1% of the world's population the UK produces 8% of the world's scientific research papers (Table 3.1). The share of citations stands at 9%. This is ahead of all other EU countries and Japan. Other indicators of elite science are also strong. For example, in winning science prizes in excess of $200,000 the UK is second only to the US and well ahead of third placed Germany.[7]

These figures need to be interpreted with care, however, as they may partially reflect the fact that English is the dominant language of science. It is no surprise that the US is ahead of the UK in these measures of the scientific base, but rather more surprising that Canada (although not Australia) has a higher share than the UK of scientific papers and citations.

[7] An often heard boast is that there are more scientific Nobel prizewinners in Trinity College, Cambridge than in France.

Not only is the UK strong in elite science it also produces a high proportion of graduates in science and engineering. In 1995 the flow of these graduates as a proportion of total employment was higher than any other G7 country (see OECD, 1999, Table 2.6.1). This is important in terms of stimulating technology transfer. A large proportion of these graduates, however, end up working outside the scientific sector, for example in finance or consultancy.

3.2. General Innovative Performance

3.2.1. R&D

Looking at the OECD as a whole, gross expenditure on R&D (GERD) as a proportion of GDP rose substantially in the 1970s and 1980s, but stabilised or fell in the 1990s (see Table 3.2). Much of the 1990s fall was due to government cutbacks in R&D especially in countries where there was a high military spend on R&D as a result of end of the Cold War. There has also been a general move away from direct government subsidies to R&D (and a increase in fiscal subsidies such as tax credits).[8]

Table 3.1
Indices of Papers and Citations per head (1981-94)(UK=100)

	Papers	Citations
UK	100	100
France	70	58
Germany	64	53
US	96	114
Japan	45	32

Source: UK Office of Science and Technology.

The UK stands out as having the lowest general R&D and business R&D (BERD) intensity of the G5 countries. It is also one of the very few countries to have cut its R&D expenditure as a proportion of GDP since the early 1980s. Furthermore, even if we focus on business performed R&D, stripping out R&D

[8] See Bloom *et al.* (2001). The USA, Canada, Australia and Spain have relatively generous tax breaks for R&D compared to the UK and Germany. Britain introduced an R&D tax credit for small firms in April 2000.

performed in government labs, universities and elsewhere in the public sector, Britain stands out as one of the only countries where business enterprise R&D fell in the 1980s.

The falling relative R&D intensity in the UK since 1981 is not really explained by change in the industry mix (such as the relatively fast rise of the low R&D

Table 3.2
Gross Domestic Expenditure on R&D (GERD) as Percentage of GDP

	1981	1985	1990	1995	1997
UK	2.4	2.2	2.2	2.0	1.9
France	2.0	2.3	2.4	2.3	2.2
Germany	2.4	2.7	2.8	2.3	2.3
US	2.4	2.9	2.8	2.6	2.7
Japan	2.1	2.6	2.9	2.8	2.9
OECD	2.0	2.3	2.4	2.2	2.2

Source: OECD (1999), Table 3.1.1.

Table 3.3
R&D Expenditure and Funding

	UK	France	Germany	US
1981				
GERD as a percentage of GDP	2.4	2.0	2.4	2.4
BERD as a percentage of GDP	1.5	1.1	1.7	1.7
Percentage of BERD financed by industry[a]	70.0	75.4	83.1	68.4
Percentage of BERD financed by government	30.0	24.6	16.9	31.6
Industry-financed BERD as a percentage of GDP	1.1	0.8	1.4	1.2
1996				
GERD as a percentage of GDP	1.9	2.3	2.3	2.6
BERD as a percentage of GDP	1.3	1.4	1.5	1.9
Percentage of BERD financed by industry[a]	90.5	87.3[b]	91.0	83.6
Percentage of BERD financed by government	9.5	12.7	9.0	16.4
Industry-financed BERD as a percentage of GDP	1.2	1.2	1.4	1.6

[a] Includes domestic and foreign industry, and also 'other' which is a very small category.
[b] Latest figures available for France is for 1995.
Notes: GERD - gross domestic expenditure on R&D, which covers all R&D carried out on national territory and therefore includes government intramural expenditure on R&D, expenditure by the higher education sector on R&D and BERD. BERD - business enterprise expenditure on R&D.
Source: Main Science and Technology Indicators, OECD, 1998.

service sectors in the UK). It is mainly a 'within industry' phenomenon (see Van Reenen, 1997)[9]. Interestingly, in the early 1970s, the UK general R&D intensity was second only to the US level amongst G7 countries, and even in 1981 the GERD/GDP ratio was 2.4%, similar to the US and Germany (see Table 3.2).

Part of the story is that the proportion of R&D performed by business but *funded* by government has fallen more dramatically in the UK than in other countries. The share of BERD funded by the UK government fell by from 30% to 10% between 1981 and 1996 (see Table 3.3). Industry funded BERD as a proportion of GDP has been broadly stable in the UK and in Germany and has risen in the

[9] A more recent decomposition analysis of business R&D intensity in manufacturing 1990-1997 (OECD, 1999, p.143) also reveals that the 0.6 percent fall in UK intensity was all within industry.

USA and France (and most other OECD countries). This is a result of explicit UK government policy to move away from funding 'near market' R&D.

Interestingly, of all the G7 countries only Canada has a higher proportion of its R&D performed by smaller companies (under 500). It appears to be the larger British firms who are failing to invest in R&D as much as other countries (see OECD, 1999, Table 5.4.1).

3.2.2. Investment in tangible capital

As we noted in Section 2, investment in tangible capital is low compared to other OECD countries (see Table 3.4 and Bond and Jenkinson, 1996). Disaggregating the types of investment is instructive. The UK invests about 8.3% of GDP in plant and equipment which is the OECD average. The poor position is mainly drive by very low investment in public infrastructure and in residential construction.

Table 3.4
Investment as a Percentage of GDP, 1960-95

	UK	France	Germany	US
Gross fixed capital formation	17.9	22.2	22.3	18.3
Gross fixed capital formation excluding residential construction	14.2	15.5	15.7	13.6
Gross fixed capital formation: machinery and equipment	8.3	8.8	8.7	7.5

Source: OECD Historical Statistics, 1960-95, 1997 edition.

On the other hand, the UK has successfully attracted the largest volume of foreign direct investment in the OECD. In 1997 inward investment was 2.8% of GDP compared to an EU average of 1.4% and OECD average of 1.1% (see OECD, 1999, Table 6.1.3). This internationalisation of investment is equally true of R&D - the UK had 15% of its R&D funded from abroad in 1997, which was the highest proportion in the OECD. Some of this position is simply due to financial flows - outward investment is also exceptionally high. Part of the FDI numbers, however, do reflect genuine new plant; but here the numbers are not so dramatic. The share of foreign affiliates[10] in manufacturing production, for example, is about equal to that in France (30.5% in UK, 25.8% in France) although higher than Germany (7.1%) or Italy (10.2%).

Overall investment in 'knowledge' (defined by OECD to be the sum of R&D, software and public spending on education) was 8.3% in 1995. The EU and OECD average were 7.9% (US spent 8.4%, Germany 8.1% and France 10.2%).

3.2.3. Patents

R&D is only a measure of the inputs to the science base. What about the outputs? The UK has a lower share of patents than other G5 countries (see OECD, 1999, Table 11.2.1). Furthermore, this share has declined over time (whether one uses US or EU patents) even if we exclude Japan which has had an enormous increase (see Table 3.5 for US patents). This is particularly disappointing given that the

[10] To be a foreign affiliate there has to be a greater than 50% holding in the establishment by a parent company.

UK's R&D spend is concentrated in pharmaceuticals which have a relatively high propensity to patent.

Table 3.5
US Patents Granted (1963-93)

	Percentage of Total (G7)			Percentage of Total (G7 excluding Japan)		
	1963-79	1985	1993	1963-79	1985	1993
UK	4.2	3.5	2.3	4.5	4.3	3.0
France	2.8	3.3	3.0	3.0	4.0	3.9
Germany	7.2	9.4	7.0	7.6	11.4	9.1
US	71.2	55.2	54.1	75.4	67.2	70.0
Japan	5.6	17.8	22.7	-		

Source: US Patent and Trademark Office, Patenting Trends in the United States, 1963-93.

3.2.4. Innovation

EU innovation surveys (CIS) give an alternative measure of innovative output. On this measure, UK manufacturing firms spent less of their turnover introducing new products and processes than those in France and Germany (Table 3.6). This appears mainly due to larger firms' lower spend. The position is reversed, however, in services.

The problem with the CIS is that the concept of innovation is somewhat vaguer than R&D where the OECD Frascati definition is more precise. Furthermore, whereas the response rates for the R&D surveys are close to 100% (they are confidential and compulsory in many countries) the CIS survey has a much lower response rate. In the UK response rates were about 43%.[11] Thus, one must be careful in drawing any strong conclusions from the innovation survey.

Table 3.6
Expenditure on Innovation as a Share of Sales, 1996

	Manufacturing	Services
UK	3.16	4.02
France	3.92	1.25
Germany	4.12	2.95

Source: OECD (1999), Table 5.5.1.

3.2.5. Diffusion

The main productivity benefits from innovation are only reaped as it becomes spread around the economy. Measuring the spread of a new technology is no easy task, however. Which technology do we choose to measure? Do we have internationally comparable data examining the same technology? Is this measured in a consistent way over time? Finally, the technological innovations may be less important than the organisational innovations that may accompany the new technology.[12]

- ICTs

Data sources are richest on ICTs (information and communication technologies). The UK seems to perform relatively well on these measures. Of the G7 countries the UK is second only to the US in ICT expenditure as a proportion of GDP in 1997 (according to Table 3.7). Secure web servers for e-commerce stood at 1.4 per 100,000 inhabitants in August 1998 which was higher than France, Germany and Italy, but below Canada and the USA. 18% of the UK population were regular internet users in 1998 compared to 37% in the US, 11% in Japan, 10% in Germany and 11% in France (OECD, 1999). The UK has some advantages in these areas because of a good IT infrastructure. Telecommunication prices are relatively low compared to other EU countries, thanks to tough competition.

[12] See Bresnahan *et al.*, 1998, for a study suggesting that the failure to introduce complementary organisational changes alongside computerisation harms productivity.

Table 3.7
ICT Expenditure as a Percentage of GDP, 1997

	IT hardware	IT services and software	Telecom	Total
UK	1.5	3.4	2.7	7.6
France	0.9	3.3	2.2	6.4
Germany	0.9	2.4	2.3	5.6
US	1.7	3.4	2.7	7.8
Japan	1.1	2.7	3.6	7.4
OECD	1.3	2.8	2.8	6.9

Source: OECD (1999), Table 2.3.1.

- Other indicators

Vickery and Northcott (1995) review a number of national surveys of the diffusion of advanced manufacturing technologies and microelectronics. The traditional S-shaped diffusion curve is observed. The UK does appear to be a laggard in the take up of these new technologies for both indicators (see Figures 3.1 and 3.2), although it eventually catches up. This would be consistent with the notion that poor workforce skills delay the introduction of new technologies.

The cross-national pattern in organisational innovations is less clear. According to Ruigrok *et al.* (1999) the picture mirrors that of technical diffusion. For example, 10.2% (17.9%) of all European firms sampled has introduced "extensive decentralisation of strategic decisions" in 1992 (1996). In the UK the figures stood at only 8% and 13.6%. The most comprehensive is probably the EU's 1996 EPOC survey covering 33,000 European establishments (OECD, 1999b). On a number of indicators the UK appears average or above average (teams-based work organisation, delayering of management, employee involvement).[13] Of course, it is controversial as to how innovative these organisational forms are, or how important they are in stimulating productivity growth.

[13] 33% of UK workplaces with at least 50 employees used team-based organisation compared to 30% in France, 28% in Italy and 20% in Germany. Denmark was the highest at 40%.

3.3. Innovation Performance by Industry

3.3.1. Science Base

As we can see in Table 3.8, the UK Science Base is particularly specialised in the medical-biological sector and is notably weak in chemistry, physics and engineering, exactly the opposite of Germany and Japan. In the US, the research effort is much more evenly spread with the notable exception of the weakness in chemistry.

Table 3.8
Specialization Profiles in Science, 1981-86
Based on Citations

	UK	France	Germany	US	Japan
Clinical Medicine	1.17	0.78	0.68	1.07	0.72
Bio-Medical	0.96	0.96	0.93	1.11	0.92
Biology	1.25	0.64	0.81	0.89	0.95
Chemistry	0.89	1.34	1.58	0.67	1.92
Physics	0.70	1.53	1.55	0.86	1.19
Earth and Space	0.93	0.87	0.71	1.19	0.33
Engineering/Technology	0.65	0.82	1.18	0.94	1.86
Mathematics	0.90	1.39	1.16	0.97	0.67

Source: CNR-ISRDS.

3.3.2. Industry Specifics

R&D intensity in manufacturing is lower than the G5 average in every industry except the chemicals, metal products and pharmaceuticals industry (see Figure 3.3). UK R&D is particularly low in the lowest tech industries (textiles, paper and wood products). The strength of pharmaceuticals is striking. About a quarter of all UK business R&D is located in this sector, and UK R&D intensity is well above average.

The UK has strongest biotech sector in Europe and is second only to the US in the OECD. There are more biotech firms in Britain than any other EU country. Despite the set-backs over the backlash against GM foods, the drugs related sector is forecast to have high worldwide growth. The strength of the sector rests in its close relation to the academic science base (clusters around universities such as Cambridge) and the presence of sophisticated capital markets in the UK. These may also have been factors behind the success of the pharmaceuticals industry. In fact, corporate venture capital from the companies in this sector is another advantage enjoyed by British biotech firms. The absence of a significant manufacturing component is probably an advantage given UK weakness in intermediate skills (see Section 4).

3.4. Some Notable UK Innovations

A picture seems to be emerging of a strong Science Base but weaknesses in translating scientific innovations into marketable and profitable products. This picture is worth illustrating with a few notable UK inventions.

The Computer. The 1500 valve, programmable Collosus computer was completed in 1943 in Bletchley Park in order to decode communications between Hitler and his generals encrypted using the Lorenz cipher. Built by Tommy Flowers based on a design of Max Newman and Alan Turing, it operated successfully until the end of the war after which it was destroyed, along with all the blueprints, on the orders of the UK government and those who worked on it were forbidden to talk about it!

The X-Ray Scanner. The most significant advance in radiology since the discovery of X-rays, it was invented by Geoffrey Houndsfield at EMI. Houndsfield won a Nobel prize but EMI lost so much money in disastrous attempts to manufacture and market the scanner that its medical electronics division ceased to exist.

The Structure of DNA. This discovery in 1953 by Crick and Watson at Cambridge laid the foundation of the bio-technology industry. Like penicillin, it was not patented.

Zantac. This anti-ulcer drug generated such gigantic profits that it turned Glaxo from a small player to the largest pharmaceutical company in the world (after the merger with Smithkline/Beecham). Zantac was not even the first in the field, which was Tagamet, but its world domination was essentially a marketing triumph.

The Proof of Fermat's Last Theorem. The most famous mathematical discovery of the latter part of the 20th century. Of no known commercial value.

3.5. Summary

Britain has a relatively strong academic science base. Inventiveness and the position of elite science continues to be impressive. The reasons for this are a complex mixture of culture, the fact that English is a global language and the ensemble of institutions around the universities.

Britain has been weak at translating this science base into innovation and industrial performance. Some high tech industries, such as pharmaceuticals, closely connected to the thriving bio-medical science base have also done well, but these are the exceptions to the rule. Business R&D and patenting are low (and falling) by international standards. Diffusion of innovations around the economy appears to lag behind other countries, although this may be less true of the current wave of ICTs than in the past.

There remains, however, an apparent contradiction. As we have seen, since the early 1970s, Britain's innovation performance in terms of R&D and patents has weakened relative to that of its main competitors. And yet, TFP growth has risen relative to these same competitors over the same period. So what is the explanation. Basically, we would argue that the good performance of TFP reflects catch-up, the process being driven by the factors discussed in Section 2.2. Nevertheless, there remains a TFP gap (see Tables 2.5, 2.6) and the fundamental reasons underlying this have already been discussed at the end of Section 2.2. But one of the more immediate factors relates to the picture of technological innovation which we have drawn, namely strong basic science but weak commercial follow-up. This reflects a weakness in the ability of the commercial sector to absorb basic innovations, with this weakness being directly related to low levels of R&D. For it is known that R&D investments help firms absorb innovations (see Griffith *et al.*, 1999, for strong evidence) including the output of basic science. To pursue this, and related issues, further, we turn next to the overall environment within which UK firms operate.

4. THE ENVIRONMENT IN WHICH FIRMS OPERATE

As we have seen, the level of technological innovation in UK companies is comparatively low and this is one of the factors behind the TFP gap between the UK and its main competitors. In order to see why this is so, we look at a number of features of the environment within which UK firms operate. So, in turn, we consider the capital market, the labour market, education, macroeconomic policy, industry structure, property rights, openness to trade and government policies more generally.

4.1. The Capital Market

Overall, these are deep and liquid being very well integrated into global markets with London being one of the top three financial centres in the world. Two particular aspects of the capital market are particularly important for innovation, namely equity markets and the venture capital sector. We look at these in turn.

4.1.1. The equity market

This is again very liquid and is dominated by institutional investors. It is driven by shareholder value and it is structured so that mergers and acquisitions are relatively easy to undertake. So there is a very active market for corporate control with "deal-making" being one of the main activities of corporate chief executives. To provide a picture of this, we present a analysis of public takeovers in Table 4.1 which reveals that the proportion of hostile takeovers in the UK is massively higher than elsewhere. What are the consequences of this? First, there is a direct consequence. Managers have a very strong incentive to avoid a hostile takeover because, in 90 percent of cases, the top management of the target company is replaced within two years (Franks and Mayer, 1992). What, then, do managers do when under threat of takeover. Basically they institute changes to improve total factor productivity and they reduce investment expenditure, particularly if the threat is hostile (see Nuttall, 1998 and Bond *et al.*, 1998). This latter result might, at first sight, be interpreted as supporting a short-termist view of takeovers. However, when combined with the result on TFP, it might equally support a disciplinary view of takeovers where the hostile threat reduces managerialist overinvestment.

Table 4.1
Number of Public Takeovers (1990-94)

	Non-Hostile	Hostile	Total	Percent Hostile
UK	285	68	353	18
France	492	4	496	1
Germany	51	2	53	4
US	831	27	858	3

Source: AMDATA; McKinsey Analysis in CBI (1996), Exhibit 23.

Despite this argument, there is no question that many commentators in Britain think that pressure from the equity market induces managers to behave in a short-termist fashion and that this explains the weakness of the R&D performance of UK firms. Thus in 1986, Nigel Lawson, UK Chancellor of the Exchequer, remarked "The big institutional investors nowadays increasingly react to short-term pressure on investment performance ... they are unwilling to countenance long-term investment or sufficient expenditure on R&D." However, hard evidence in favour of this view is in short supply. R&D or capital expenditure announcements tend to raise stock prices (see, for example, McConnell and Muscarella, 1985) and the apparently decisive econometric results in Miles (1993) are undermined by his less than convincing modelling of the risk premium. What about measures of the cost of capital? Major international studies of the cost of capital include McCauley and Zimmer (1989) and Coopers and Lybrand (1993) and some results are reported in Table 4.2. Taking the numbers at face value certainly indicates that the cost of capital in the UK tends to be on the high side for fixed capital compared to other European countries. This is partly a result of the high weight of equity relative to debt in UK investment funding. Table 4.2 also has some information on R&D user costs. Again, the UK is on the high side (although not out of line from France or Germany) because until recently there were no major tax breaks for R&D. It is noticeable that since 1979 there has been a general trend towards a more generous treatment of R&D that was not matched in the UK until the introduction of the R&D tax credit for small firms in 2000 and its proposed extension to laregr firms.

Table 4.2
After Tax Cost of Capital (%)

	McCauley and Zimmer Plant/machinery (20yr life)	Coopers and Lybrand All investment	Bloom et al (2001) tax component of the user cost of R&D	
	1988	1991	1997	1979
UK	9.2	19.9	38.2	38.0
Germany	7.0	17.5	38.5	39.1
US	11.2	15.1	30.3	38.0
Japan	7.2	14.7	36.6	36.6
France			38.2	38.5
Canada			21.9	23.8
Australia			33.3	38.0
Spain			22.2	38.2

Source: Coopers and Lybrand (1993), McCauley and Zimmer (1989), Table 2.Bloom et al (2001) Table A2

A final piece of evidence concerning the supply of capital to UK firms is the fact that the sensitivity of firm-level investment to cash flow is stronger in the UK than in Continental European countries (e.g. Bond *et al.*, 1997; Bond, Harhoff and Van Reenen, 1999). This fact could be interpreted as evidence of more severe financial constraints in Britain than elsewhere. There are alternative explanations, however. For example, current cash flow may be simply a proxy for better future demand opportunities and the greater sensitivity of UK firms an indication of their flexibility rather than their inability to finance projects.

Overall, UK managers are under considerable pressure from the stockmarket and they do appear to face somewhat higher levels of the cost of capital than their foreign counterparts. However, there is no strong evidence that this is a significant factor in explaining low levels of R&D expenditure.

4.1.2. Venture capital

The UK has a strong venture capital sector, the largest in the EU. However, very little UK venture capital goes into early-stage companies (17 percent as opposed to nearly 30 percent in Germany and the US). Survey evidence shows that 20 percent of UK companies reported delay, cancellation or prevention of innovation projects. Of these, sources and cost of finance was an important factor in around half the cases (around twice the EU average). High tech businesses were more likely to encounter financial constraints. So there is some evidence of a “finance gap” for new high tech projects, although this may currently seem hard to believe, in the light of the number of new dot.com companies which have been able to raise equity capital at minimal cost.

4.2. The Labour Market

4.2.1. General issues

The UK labour market is, and always has been, relatively lightly regulated. The major change since the 1970s has been the progressive disappearance of trade unions from the private sector, where union density is currently below 20 percent, having been above 50 percent in 1979. Furthermore, trade unions are now generally cooperative with regard to innovation whereas in the 1970s they were frequently hostile. Indeed, overall, trade unions are far less adversarial than they were in the 1970s as evidenced by a dramatic decline in industrial disputes. The reasons underlying this include anti-union legislation in the 1980s, increased product market competition and changes in industrial structure. Since the early 1980s, there is no reason to believe that the labour market has been an important factor in explaining the poor innovation performance of the UK market sector.

4.2.2. The managerial labour market

The key feature of the labour market for the brightest and the best in the UK was dramatically expressed by Sir John Harvey-Jones, former chairman of ICI (at that time the largest manufacturing company in Britain) on a BBC Radio 4 programme on the City (Jan. 5, 1995), “When I was chairman of ICI all the advisers that we used, advisers mark you, were all paid more than I was, be they the auditors, be they the merchant banks, be they the City solicitors. Now I ask you, in realistic national terms, who is likely to have the biggest impact on the fate of the bloody country?” (Reported in Owen, 1999, chapter 9).

Thus the starting salary (growth rate over first 5 years) for 1995 UK graduates was 23K (5.5) in merchant banking, 20K (7.0) in IT consulting, 17.5K (8.2) in accountancy and 14.5K (2.0) in blue-chip engineering.[14] One of the consequences of this structure is that UK management is not, on average, up to the quality of that of its main competitors. Thus, for example, in a comparison of domestically owned UK plants with US owned UK plants in comparable sectors, the US owned plants have a 32 percent value-added advantage. Of this 32 percent, 18 percent is down to extra capital and higher quality labour and the remaining 14 percent is down to better management (see study by National Institute of Social and Economic Research, June 1998). The managers in US plants are more likely to have been trained in a "best-practice" environment.

4.3. Education

The UK education system works very well for the top 30 percent of the ability range and this is reflected in the performance of the Science Base. However, it is weak in both the mid-range of abilities and at the bottom end. Considering the latter first, the International Adult Literacy Survey (1994-5) shows that 23 percent of the UK labour force is at the lowest level in quantitative literacy (e.g. unable to check their change in a shop) compared with 21 percent in the US and 7 percent in Germany. In the mid-range, relative to both Germany and the US, there is a distinct weakness in post-16 education in Britain for those who are not going on to degree level (see Steedman, 1999).

The upshot of this implies that science, engineering and quantitative disciplines produce high qualified manpower at a rate comparable to other OECD countries. There are, however, distinct shortages at the technician and craft level. Furthermore, because of the structure of demand, the long-term prospects of those highly qualified in science and engineering are far better in finance and consultancy than in industry. Thus, for example, in a survey of 1980 UK graduates, by 1987 those who worked in science and engineering tended to be rather badly paid whereas those with science and engineering degrees were, on average, rather well paid. The difference was due to those scientists and engineers who migrated to the financial sector.

4.4. Industry Structure

Concerning the basic industrial structure, a key feature is the very rapid decline of the proportion of employment in industry and the equally rapid rise in services

[14] IDS Management Pay Review: Pay and Progression for Graduates 1995/96.

since 1973. As we can see in Table 4.3, this change has been far quicker than elsewhere. More specific and perhaps relevant features of the UK product market environment are the following. First, Britain has had a relatively weak competition policy over the post-war period. This has allowed low levels of competition to exist in many sectors, a situation exacerbated by a desire to create national champions. Second, privatisation and the consequent regulatory framework introduced in the 1980s has led to some increase in competitive intensity.

Table 4.3
Per Cent of Total Employment

	Industry		Services	
	1973	1994	1973	1994
UK	43	26	55	72
France	40	27	49	68
Germany	47	38	45	59
US	33	24	63	73
OECD	37	28	52	64

Source: OECD Employment Outlook, 1996, Table D. (The missing sector is Agriculture.)

Third, the fact, as we have seen, that one of the main methods by which firms grow is via mergers and acquisitions[15] imposes substantial real resource costs as well as weakening competition in many cases. Overall, the low level of product market competition in the UK has probably been detrimental to TFP growth and, more specifically, to innovation (see Geroski, 1990 and Nickell, 1996).

4.5. Openness

The UK has a low level of trade barriers although its membership of the EU means that it suffers from EU-wide trade barriers which have adversely affected both UK agriculture and the automobile sector by reducing competitive pressures. It is worth noting that recent research indicates an important relationship between trade openness and the rate of cross-country sectoral productivity convergence. Furthermore, R&D intensity and human capital also speed up convergence by raising the rate at which imported technology is absorbed (see Proudman and Redding, 1998, and Griffith *et al.*, 1999).

[15] Amazingly enough, UK companies spent more on foreign mergers and acquisitions than US companies in 1998 (around $128 billion as opposed to $123 billion) (see OECD, 1999, Table 8.2). Of course, the quantity of foreign assets available to US companies is much less than that available to UK companies. Indeed more US assets were purchased by non-US companies than were purchased in the remainder of the G7.

4.6. Macroeconomic Policy

From the first oil shock in 1974 until Britain's ejection from the European Monetary System in 1992, it is safe to say that macroeconomic policy in Britain was not a great stabilising force.[16] Over this period, British firms faced more volatility than at any time since the 1930s. However, since 1992, with the onset of inflation targeting, the economy has been increasingly stable. However, whether this has impacted on productivity performance, which improved strongly in relative terms in the early 1980s, is a moot point.

4.7. Government Policies

Some recent policy changes and non-changes are relevant to some of the above. In summary we have

a) A strong current emphasis on basic education in order to improve literacy and numeracy. Intermediate vocational education remains weak although reforms are promised.

b) A new Competition Act came into force on the 1st March, 1998 and this promises to be much tougher on anti-competitive practices than has been the case hitherto. This should help to raise levels of competition in the UK.

c) The regulatory regimes in the utilities, telecom/IT and the financial sector are generally well thought out and tend to be focused on encouraging competition. However, there have been some notable exceptions such as the recent problems with British Telecom in unbundling the local loop.

d) Labour market regulations currently strike a reasonable balance between employer and employee although the act of complying with some of the increasingly complex rules (e.g. the EU working time directive) imposes substantial real resource costs per employee particularly on small firms.

[16] This is not a particular criticism of British policy-makers. The same situation applied in most countries, in part because of the size of the shocks and in part because of the lack of experience in dealing with large supply shocks. Here, Britain was notably badly placed because in 1973 it had been persuaded, by Milton Friedman, among others, that the best way to deal with shocks was to index wages. While this is fine for nominal demand shocks, for large imported commodity price shocks it is, of course, disastrous because to return to equilibrium, the real consumption wage must fall.

e) Planning and building regulations are overbearing and tend to be insensitive to economic costs and benefits.

f) Broadly the policy has generally been opposed to wide-ranging tax breaks in favour of innovation although an R&D tax break has, in fact, just been introduced for small firms (April 2000). Indeed current policy is moving towards special help for SMEs, the rationale being that they face financial constraints particularly in the high tech sector. However, there is a danger here of ineffectual tinkering with complicated measures which cost little, and probably have correspondingly small effects

4.8. Two Examples

To illustrate the implications of some of these features of the environment in which UK firms operate, we present two mini-industry studies. The first deals with the highly successful UK pharmaceutical sector (Box 1), the second looks at the distinctly less successful UK automobile industry (Box 2).

Box 1

The UK Pharmaceutical Industry

The pharmaceutical industry is a UK success story. Despite having only 3% of the world's market, almost 10% of world R&D in this sector is located in the UK. The R&D to value added ratio (in 1997) was higher in the UK than any other G7 country. In 1998 22% of all UK business R&D was performed by the drugs industry, a higher share than any of the other 14 major OECD countries. Not only is the level of R&D high, so is its productivity. For example, the ratio of first patent filings of new molecular entities (NMEs) to R&D is higher in the UK than any other major OECD country. The industry has been dominated by three players: Glaxo-Wellcome, Smithkline-Beecham and Astra-Zeneca. A remarkable number of the world's best selling drugs have come from British laboratories: Tenormin (ICI), Tagamet (Smithkline), Zantac (Glaxo), Zoviraz (Wellcome) and most recently Viagra (Pfizer's R&D lab in Sandwich, Kent).

What are the reasons for success in this field, but not in other science based sectors such as computers and semi-conductors? There are basically four factors to consider: regulation, foreign investment, the academic base and an "absence of negatives". Historically, many writers have pointed to the UK's regulatory system as an enabling factor. There are two aspects to this - price and quality regulation. The PPRS (Pharmaceutical Price Regulation Scheme)[17] allows firms to launch at prices of their own choosing subject to a rate of return cap (with generous allowances for R&D spend). The advantages of the PPRS have been in its stability - its precursor was introduced in 1957 - and its voluntary nature.

The UK drug licensing authority was one of the first (1967) requiring drugs to pass an efficacy test as well as a safety test. Regulatory approval is faster than most other European countries. This combination of fast access to market for highly effective drugs and a reasonable rate of return meant UK companies focused their efforts on developing world-class drugs (Thomas (1994)). The systems in France, Italy and Japan rewarded firms who develop "me too" drugs sold on the local market and penalise more innovative firms with low reimbursement prices and unstable regulation. It is noticeable that countries that have more flexible price controls and tougher quality regulation (USA, UK, Switzerland and Germany) also tend to also have a stronger pharmaceutical industry.[18]

[17] See Bloom and Van Reenen (1998) for a more extended discussion.

[18] Of course the causality may be reversed. Lobbying by strong indigenous drugs companies could result in more favourable regulations.

A second argument (Owen, 1999) stresses the importance of foreign direct investment (mainly by US and Swiss firms) in the 1940s and 1950s. This exposed British companies to competition from innovative world leaders.[19] By contrast many other industries were protected in the 1950s and 1960s by high tariffs or procurement policies. The National Health Service (founded in 1948) provided stable and high demand, support for clinical trials and unlike many European systems did not discriminate between national and international suppliers. Fortunately, there was no attempt to create "national champions" in pharmaceuticals.

All these arguments may explain *historically* why the British industry has grown strong, but inertia apart, they can no longer be the main reason why the industry continues to be an important R&D base. There are no strong reasons why drug discovery, clinical trials or even manufacturing (within the EU) need to be located in markets where regulation is better or the market is larger.

A more compelling explanation of why Britain remains a popular location for R&D is the strong tradition of bio-medical research (see Table 3.8). Scientific labour is less mobile than capital, so the proximity to research centres enables companies to capture both skilled labour and new ideas. This is particularly important for world class scientists, but also for the steady flow of pharmacology graduates. The strong academic science base would also explain why foreign firms locate their R&D labs in the UK.

The UK also has more biotechnology firms than any other EU country. This industry is reliant on a strong academic science base in bio-medicine - for example, the cluster around Cambridge. The presence of sophisticated capital markets and corporate venturing by the larger pharmaceutical firms are also factors in success.

Finally, the industry has been largely free of the negatives affecting other British industries. The manufacturing aspect is minor compared to the R&D and marketing aspects. Thus the UK's traditional weakness in manufacturing due to poor intermediate skills, labour relations troubles and delayed entry into the EU[20] were relatively unimportant.

[19] This was hardly welcomed by the locals. The CEO of Glaxo, Sir Harry Jephcott, concluded a 1957 study with the grim warning "having regard to the weight of certain US companies in men and money it is only a matter of time before the British firms were swamped out of existence ..." (Owen, p.371).

[20] The European market is far more fragmented in pharmaceuticals due to different national regulations.

Box 2: The UK Automobile Industry

A brief post-war history. In the 1950s, the UK car industry was booming. Output rose from 523 thousand units in 1950 to 1353 thousand units in 1960 and had risen to close on 2 million by the mid 1960s (Owen, 1999, Chapter 9). This level was maintained until the early 1970s, then halved over the next decade. From the mid 1980s there has been a significant recovery.

In the 1950s, the UK industry was dominated by three domestically owned companies, BMC, Rootes and Standard, and two American owned companies, Ford and Vauxhall (GM). By the end of the 1960s, there was one domestically owned company, British Leyland (BL), the "national champion". At the present time (2000), the national champion (Rover) has all but disappeared but three Japanese manufacturers (Nissan, Honda, Toyota) are major players, and Ford and Vauxhall remain strong. So we have a post-war history of two phases, a significant decline from the 1960s to the 1980s followed by a strong recovery.

Why the decline?

i) Britain's failure to join the European Common Market in 1958. So from 1958 to 1972, when Britain joined, the UK car industry faced substantial barriers to trade in what was then the fastest growing and most competitive mass car market in the world.

ii) The creation and subsequent mismanagement of British Leyland. More or less all the non-foreign owned UK car firms were merged in 1968, essentially because the then Labour government believed that the way to strengthen British industry was to create "national champions". This turned out to be a disaster, reducing domestic competition while creating a disparate and ramshackle entity which was, apparently, impossible to manage.

iii) Finally, the whole of the UK car industry, foreign and domestically owned, was beset by very poor labour relations.

The upshot of these factors was that by 1980, the UK car industry produced less than one third of the cars produced in either France or Germany. The engineering skills were there and brilliant cars like the Mini, the Land-Rover and the Jaguar E-type were designed, produced and sold in large numbers. But the techniques, management skills and effort required to compete successfully in the high volume sector of the market were missing, partly because of the absence of strong enough incentives. So, given this dire situation, why did things get better?

Why the recovery? By the late 1970s, it had become clear to car makers around the world that the Japanese had invented a system for designing and making cars which was vastly more effective than any used elsewhere. When Bill Hayden, head of manufacturing in Ford of Europe, went to Japan in 1978, he remarked subsequently that he could not believe the magnitude of the productivity gap (Owen, 1999, Ch.9, p.246). The methods used by the Japanese manufacturers became widely known within a short space of time and every car manufacturer in the world now uses them in some degree.

As a consequence, the British car industry benefited greatly from the fact that Nissan, Toyota and Honda all built car plants in Britain in the 1980s. This Japanese invasion had a substantial positive impact both on the other foreign owned car producers and on the supplying industries. For example, in 1992 the average rejection rate of parts from Nissan's UK supplier base was 1,180 per million. By 1995 it was down to 190 per million (see McKinsey, 1998). The introduction of efficient new plants in the UK and the consequent spill-over effects has meant that car production is now getting close to its 1960s peak.

Yet the impact of the new Japanese car plants (which produce around one quarter of UK cars) should not be overstated. On average, these Japanese transplants in the UK remain around twice as productive as the remaining plants. So why do the latter not simply adopt global (Japanese) best practice methods? It is not because of any lack of high-tech automotive engineering skills in the UK. For example, nearly all Formula 1 racing cars are made in Britain and most racing teams are based there. In fact, the basic problem is that the non-Japanese plants do not have a big enough incentive to undertake what is a complex and time consuming activity (switching to best practice). Voluntary trade restrictions limit Japanese manufacturers' share of UK (and other big European) export markets. These restrictions encourage Japanese manufacturers to maintain their prices in line with domestic producers rather than using their productivity advantage to cut prices and increase market share. This has obviously weakened the competitive pressure on non-Japanese domestic producers, resulting in persistently low productivity, with the high price umbrella enabling the relatively unproductive plants to continue operating as they are. This situation contrasts with that in the US, where domestic car manufacturers have been subject to unrestrained Japanese competition and have, as a consequence, improved their productivity performance by substantially more than their UK counterparts.

The overall picture. The UK car industry presents a typical example of some widespread problems in the UK economy. The fact that Britain dominates the world in the construction of specialised racing cars shows its excellence at high-tech automotive engineering. But this excellence does not translate into the ability to use best practice in mass vehicle manufacture even when examples of such best practice are just around the corner. One of the reasons is that for a substantial part of the post war period, the UK car industry has not been subject to the full blast of international competition - in the 1960s because Britain was outside the European Common Market, in the 1980s and 1990s because of Japanese quotas. Furthermore, domestic competition was deliberately emasculated by the misguided desire to create a national chamption. This lack of competition severely restricted the incentives for the domestic companies to go through the difficult process of adopting best practice techniques.

5. THE FINAL PICTURE

Over the period from 1970, Britain has improved its relative productivity performance, but there remains a significant market sector productivity gap between Britain and both Continental Europe and the United States. Much of the gap between Britain and Continental Europe is down to lower levels of capital intensity and skill. However, between Britain and the US, there remains a significant gap even if these are taken into account. These gaps cover all sectors and reflect not just a weakness in high tech areas but an inability to absorb best-practice technology and methods into wide swathes of the market sector. Underlying causes here include low levels of product market competition, high levels of product market regulation and general lack of exposure to best-practice methods and technology.

Part of this story is a weakness in technological innovation despite a high quality science base. This includes comparatively low and falling levels of R&D and patenting as well as a distinct lag in the diffusion of innovations. Specific factors underlying this weakness in the commercial application of technology innovations include the following.

(i) There is some evidence that financing constraints are important despite a thriving venture capital sector. Many also consider short-termism to be a significant factor but there is little hard evidence to support this commonly held view.

(ii) While the education system is excellent for those at the upper end of the ability range, the structure in place for post-school vocational education is weak and this leads to a noticeable shortfall in technician skills which holds back the absorption of innovations.

(iii) General management skills are not as highly valued as skills in finance, accounting and consultancy in the UK labour market, so the brightest graduates (science or arts) tend to go into the latter areas. Furthermore, because a large proportion of UK companies are not operating at the frontier of best-practice, the majority of managers learn the job in a non-best-practice environment. This, of itself, inhibits the generation and absorption of innovations.

(iv) Until the early 1980s, the rising power of trade unions and their adversarial nature sometimes militated against innovation. This problem no longer applies.

(v) Underlying the above has been an overall weakness in competitive intensity in the UK economy in many sectors. This weakness is gradually being eroded with deregulation in various product markets, privatisation and strengthened legislation against anti-competitive practices. In some sectors, however, there is a good way to go.

(vi) Finally, in recent years, the macroeconomy has been far more stable than of late and the structure of both monetary and fiscal policy is geared to maintaining this stability. This should help the overall investment climate for firms.

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Figure 2.1
UK Unemployment (%)

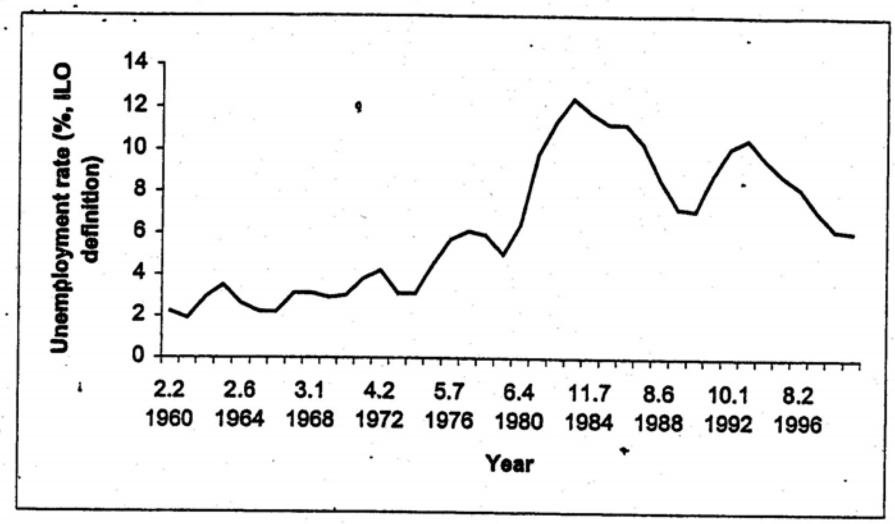


Figure 5.1:

Figure 2.2
Inflation (GDP deflator) (% pa)

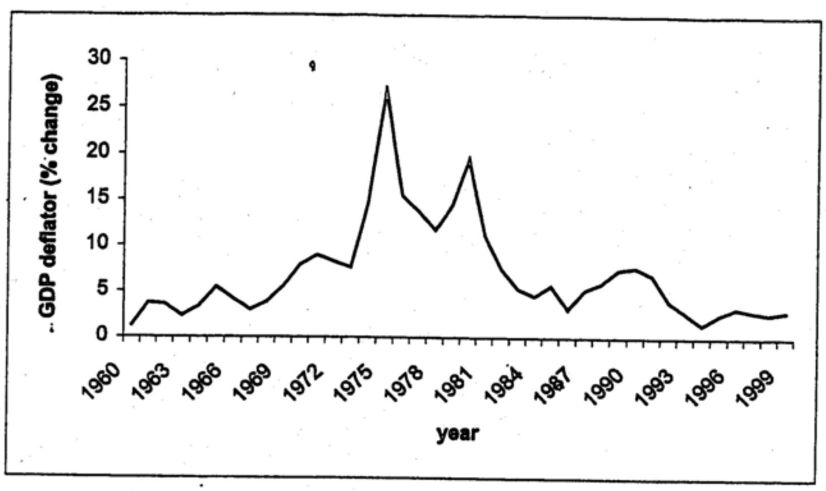


Figure 5.2:

Figure 2.3
GDP Growth (% pa)

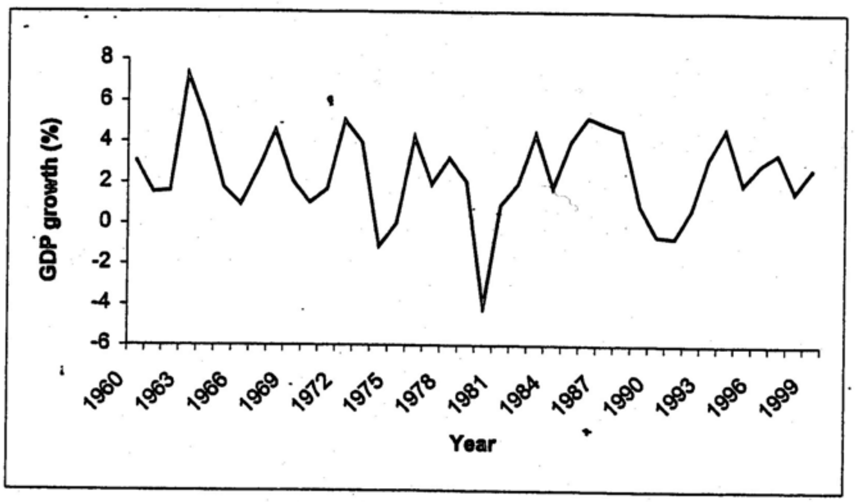
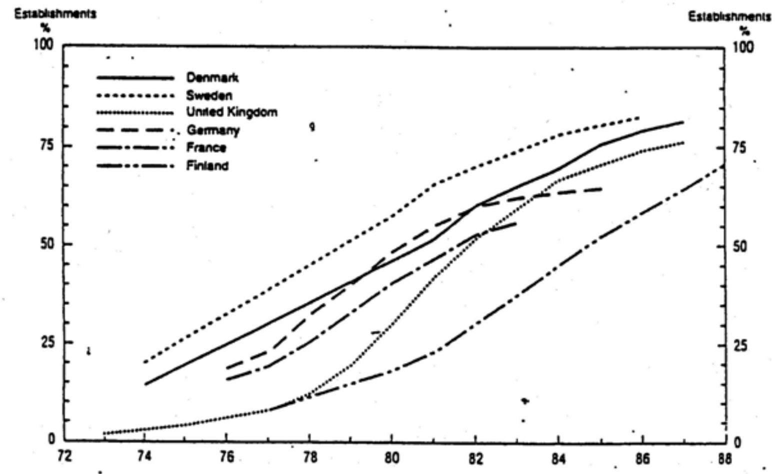


Figure 5.3:

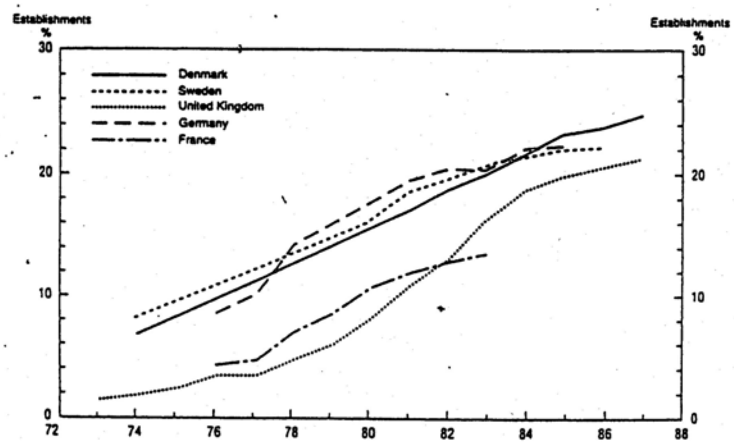
Figure 3.1
Introduction of advanced manufacturing technology



Source: Vickery and Northcott (1995) p.259

Figure 5.4:

Figure 3.2
Introduction of microelectronics in products



Source: Vickery and Northcott (1995) p 259

Figure 5.5:

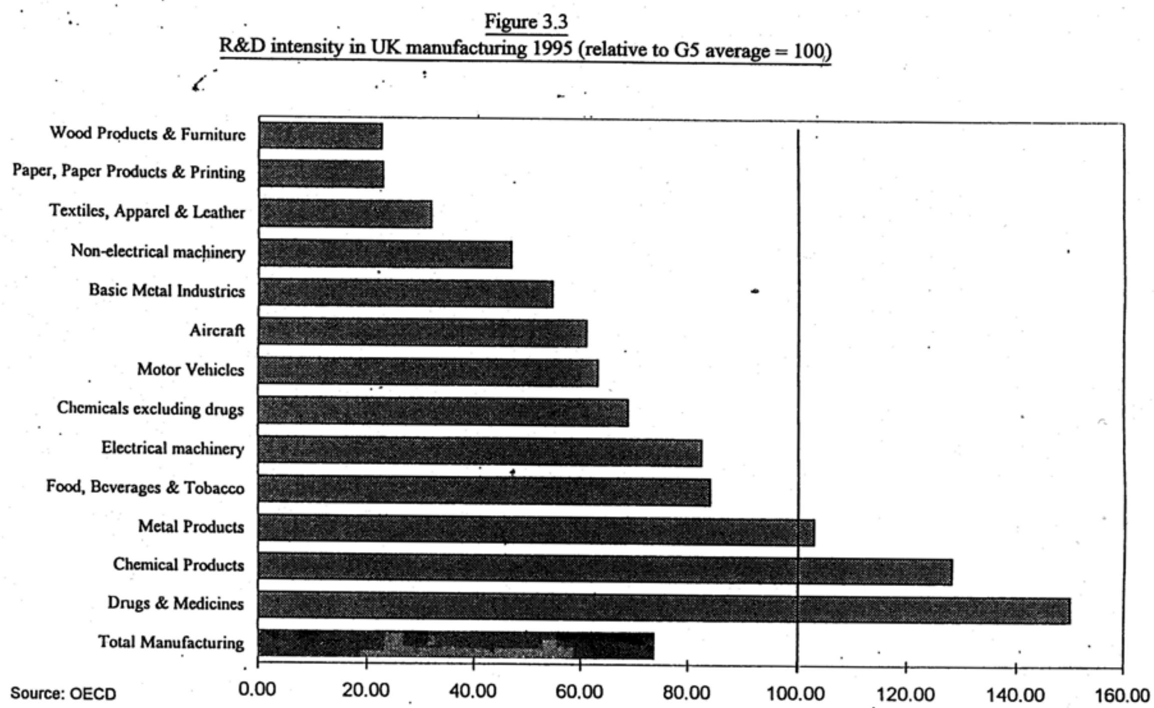


Figure 3.3
R&D intensity in UK manufacturing 1995 (relative to G5 average = 100)
Wood Products & Furniture
Paper, Paper Products & Printing
Textiles, Apparel & Leather
Non-electrical machinery
Basic Metal Industries
Aircraft
Motor Vehicles
Chemicals excluding drugs
Electrical machinery
Food, Beverages & Tobacco
Metal Products
Chemical Products
Drugs & Medicines
Total Manufacturing
Source: OECD
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00

Figure 5.6: