

SCIENCE BASE - SERVICES LINKS

Background Paper

1. Against the following backdrop, the Council for Science and Technology is intending to undertake a study, aimed at gaining a clearer picture of how firms in a suitable sample of sectors, outside the traditional manufacturing categories, are using the science base to create value and growth. The scope and focus of this study will be defined through a first, preparatory stage of work that is due to be completed by the end of November 2001.
2. There has been rapid growth in R&D in the services sectors in recent decades. With the exception of Japan and Germany, the services share of total Business Expenditure on R&D (BERD) since 1980 has risen sharply in most OECD countries from some 5% to some 15% on average. In the UK and the US, the share presently stands at around 20%, compared with Germany and Japan (some 4%), France (11%) and Australia, Denmark, Norway and Canada (around 30%).¹
3. More generally, the importance of the services sectors to the UK's economy, international trade, innovation, R&D, and productivity and employment is shown by the attached statistical annex.
4. Current models of innovation and the processes through which businesses exploit science and technology, generated by research in the science and engineering base, are largely derived from manufacturing industry, as are existing statistical sources.
5. However, a body of research and other studies into *service innovation* is developing, as the service innovation continues to grow in importance and significance from the viewpoints of both companies and policy makers. In summary, this evidential base indicates that:
 - Innovation in all sectors now increasingly requires the combination of many different kinds of knowledge and, in particular, knowledge of market opportunities.
 - A growing amount of the knowledge required for effective innovation originates outside of the firm and must be transferred into it. Not only do firms need to have arrangements for access this external knowledge, they also need to have developed an appropriate level of absorptive capacity.
 - The other key business requirements for effective innovation are:

¹ OECD Main S&T Indicators, 1999-1 database

- awareness of innovation opportunities;
 - access to the resources needed to cover all the dimensions of the innovation programme;
 - appropriate incentives to reward innovation;
 - and sufficient capabilities to successfully manage the process.
- Only rarely do S&T weaknesses themselves cause of business innovation failures.
- Knowledge intensive business services (KIBS) are playing an increasingly influential role, focussing on emerging technological and market opportunities, and proving the main nodes within increasingly diffused and volatile innovation networks and relationships.
- Service activity is increasingly a strong locus and driver of technological and manufacturing innovation. The traditional model of (mostly) manufacturing-centred firms generating new technology and innovations largely through their internal efforts, and feeding these through more technologically passive service firms to final consumers is fast becoming outmoded.
- Services are playing a more powerful role in shaping and being shaped by the fine structure of potential consumer demand. This is radically changing the links between final demand and innovation. Manufacturing firms are increasingly looking to sell selling services to their customers, with manufactured products as just part of the total customer service package.
- An increasing proportion of innovation is achieved by means of *several* firms (or other institutions) contributing various technical, marketing or production resources, and co-ordinating the deployment of those resources in "distributed innovation process". All stages and sub processes of the innovation process is now less likely to be conceived and implemented within one distinct enterprise, and instead is likely to be 'spread" across several enterprises or other institutions.
- This is because firms are responding to such factors as:
 - the tendency for any given product or service to require a wider and wider range of contributing technologies, thus making it more and more difficult for firms to be technologically self-sufficient;
 - the increasing proportion of innovative products and services which are themselves *systems*, thus tending to promote the use of consortia of firms to generate the sub-components of the systems; and
 - the increasing benefits which can be gained by combining quite diverse technologies. The very diversity of these technologies makes it unlikely that individual firms will have skills ion both fields.

- Central to these changes and the related distributed innovation processes is the emergence of new modes of co-ordinating firms, ones that have quite distinct 'functions' in the economic system. These are chiefly powerful service firms, which are active in networks that 'reach back' down the supply chain.
- The relationships amongst firms which are mainly concerned with delivering services to consumers; firms which produce intermediate products in supply chains; and firms which produce specialist knowledge and expertise to enable supply chains to be co-ordinated are the other key actors involved.
- Large R&D intensive companies (and other firms following their lead) are shifting the balance of their R&D portfolios further towards the medium and short-term activity in order to speed up innovation processes and aggressively exploit the currently available prolific technology platforms in IT, new materials, and biotechnology. They are rapidly globalising their basic, underpinning research activity for future business renewal purposes.

*CST Secretariat
July 2001*

ANNEX A: KEY FEATURES OF THE SERVICES SECTORS

I. OUTPUT.

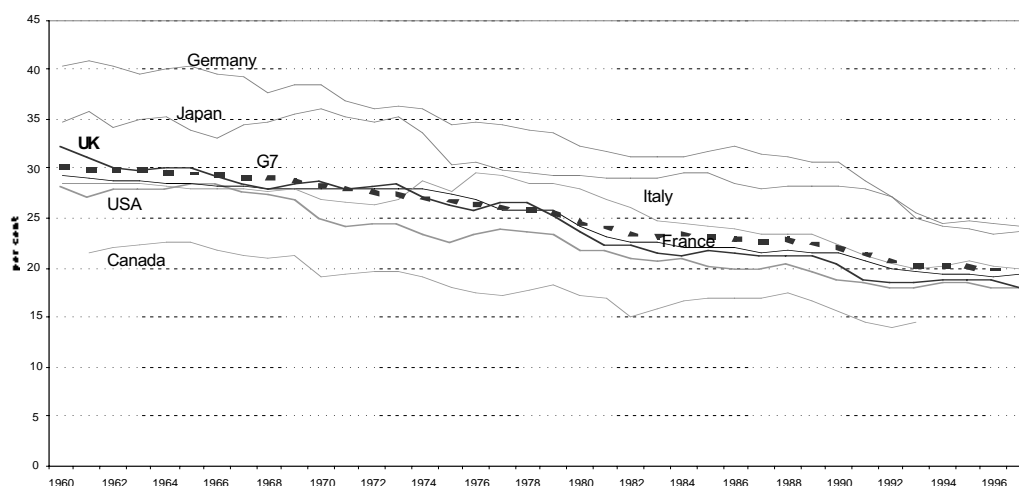
- Since 1985, the share of the services sector has increased from 55% to 70 per cent of GDP. The most rapid increase has been in financial and other business services (now larger than the manufacturing sector), and in education, health and community services

Chart 1 – Composition of UK economy output (gross value added by industry)
(in per cent)

	1985	1999
A/B. Agriculture, hunting, forestry and fishing	1.8	1.2
C. Mining and Quarrying	7.2	2.3
D. Manufacturing	23.5	18.8
E. Electricity, Gas, Water	2.5	2.2
Total Production (C+D+E)	33.2	23.3
F. Construction	5.7	5.2
G Wholesale and retail trade	10.2	11.7
H. Hotels and restaurants	2.3	3.1
I. Transport & storage	4.8	5.6
I. Communication	2.6	3.1
J. Financial intermediation	5.8	5.7
K. Renting and business activities	13.3	22.4
L. Public Administration and defence	7.1	5.1
M. Education,	3.9	5.3
N. Health & social work	4.8	6.5
O/P/Q Other social and personal services	3.6	5.2
Total Services (G-Q)	54.75	70.2

- Manufacturing's share of GDP has been declining for decades. in the UK and other developed economies

Chart 2 – Manufacturing Output as a share GDP in G7 from 1960-1996



- Within UK manufacturing sector, there has been some variation in the composition of output, but the changes have not been dramatic, at least since the major recession of 1980-81.

Chart 3 - Contributions of sectors to UK Manufacturing Output
(percent of the total added value of manufacturing)

Rising	1985	1999
Pulp, paper & publishing	10.2	12.2
Other manufacture	2.6	4.0
Rubber & plastic products	3.8	5.0
Transport equipment	9.7	11.3
Electrical & optical equipment	12.8	13.4
Chemicals and man-made fibres	10.3	10.5
Falling		
Wood & wood products	1.5	1.2
Non-metallic mineral products	3.5	3.4
Basic metals & fabricated products	12.0	9.9
Coke, petroleum & nuclear fuel	2.6	1.5
Food, drink & tobacco	14.0	13.6
Textiles, Leather and products of these materials	7.0	4.8
Machinery & equipment	9.6	8.8

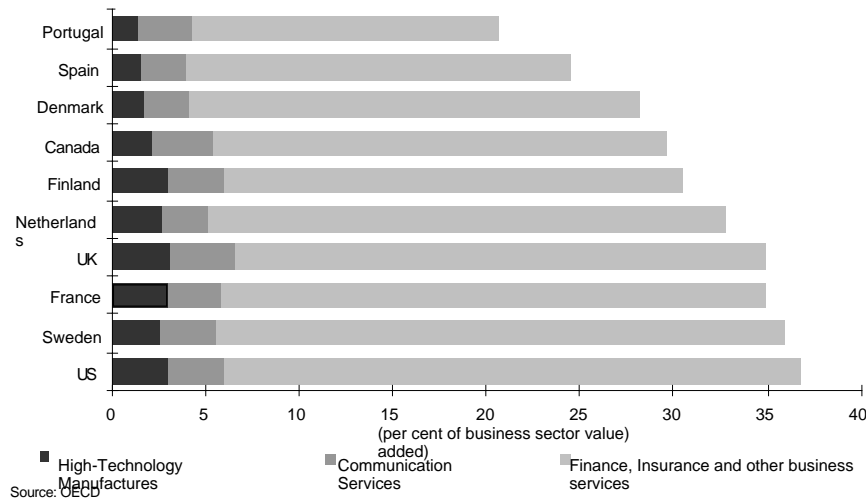
II. KNOWLEDGE BASED OR INTENSIVE SECTORS

- Changes in the UK economy are being driven principally by globalisation, changing attitudes and tastes, increasing levels of disposable income, and new technology.
- These changes are particularly pronounced in the traditional heavy industry sectors in which companies make "commodity items" and compete primarily on price and their ability to harness inputs of capital, labour and natural resources efficiently.
- They are driving a shift to higher value added activities involving the creation of more advanced, complex technology based products, processes and services.
- The UK is specialising in knowledge-based services and, to a lesser extent, high-tech manufacturing, as defined by the OECD².

² The OECD defines "knowledge based" industries as knowledge based services (telecommunications, computer and information services, finance, insurance, royalties and other business services) and high tech manufacturing (aerospace, computers and office equipment, radio, TV and communications equipment pharmaceuticals). The problem with such broad brush groupings is that they inevitably include some activities and firms that would in general not be described as knowledge based, while ignoring the importance of knowledge for performance across all other sectors. Nevertheless, looking at trade balances in these sectors can help identify broad trends in the UK's trade performance.

- The UK appears to have a comparative advantage in these knowledge based industries, and particularly knowledge based services.

Chart 4 - Comparative contributions to added value by Knowledge based Services



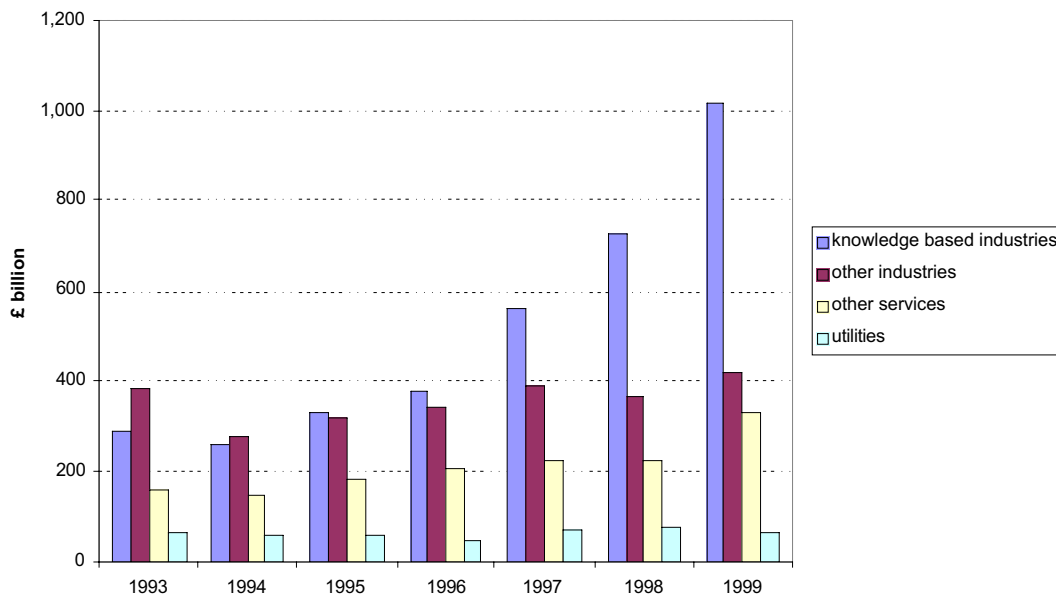
- In 1996, UK knowledge based industry was responsible for 35% of business sector value added. The rate of growth of knowledge based industry is higher than that for the business sector as a whole.
- New entrants to the FTSE 100 have been dominated by high-tech industries and knowledge-based services, replacing firms in basic industries.

Chart 5 – FTSE 100 Entrants and Exitors

	1984	2000	Exits	Entrants
Resources	6	6	2	2
Basic industries	17	3	14	1
General industries	7	3	4	1
Cyclical consumer goods	2	1	1	0
Non-cyclical consumer goods	18	11	10	4
Cyclical services	19	26	8	16
Non-cyclical services	7	12	1	8
Utilities	1	7	1	7
Financials	23	22	7	10
Information technology	0	9	0	9
	100	100	48	58
			+ 10 M&A	
Of which:				
Knowledge based services	24	47	7	32
High technology industries	9	10	3	5

- The market valuation of UK publicly listed, knowledge intensive industries and services was lower than the rest of the manufacturing sector in 1993 but higher by 1999 when they had a market value larger than that of all other firms (manufacturing, services and utilities) put together. The knowledge intensive services companies accounted for approximately 70 per cent of the total.

Chart 6 – Market Value of UK public listed companies



III. INTERNATIONAL TRADE IN GOODS AND SERVICES

- In cash terms, the value of UK exports of services and goods (excluding oil and erratics) increased by 80% between 1990 and 1999, by 70% for goods and by 108% for services.
- Over the same period, the share of services increased from 26% to 30% of the total. The main areas of growth were in the following sub-sectors of
 - Insurance (497%)
 - Computer and information (311%), from a small base
 - Other business (169%)
 - Royalties and licence fees (155%)
 - Communications (132%)
 - Financial (97%)
 - Travel (65%)
 - Transportation (52%)

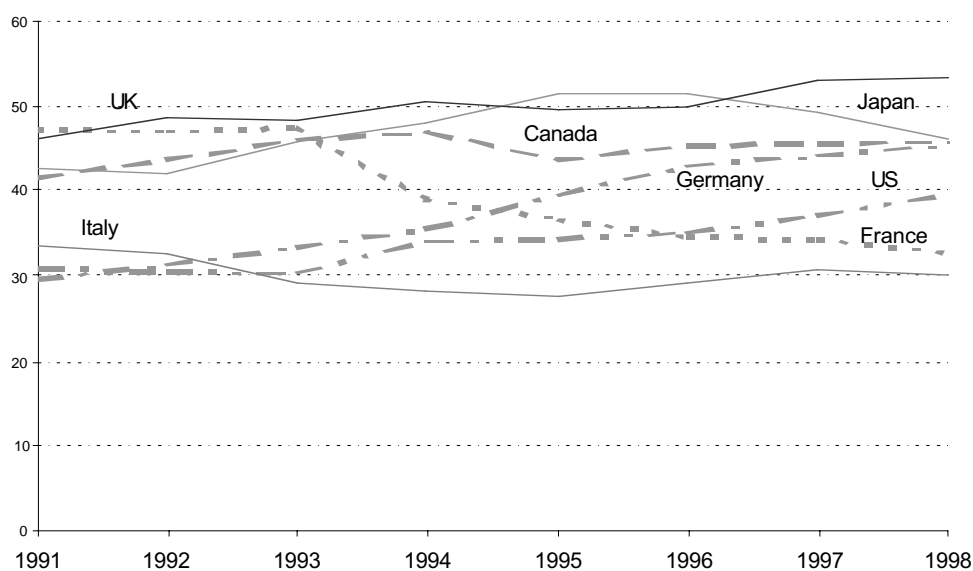
Chart 6 - UK Exports in Goods (excluding oil and erratics) and Services

£million in cash terms

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
GOODS	87072	89002	93931	105889	118558	136598	147308	150492	148114	147680
SERVICES:										
Transportation	7595	7207	7895	8770	9492	10200	10820	11179	11582	11583
Travel	8659	8330	8841	10509	10882	12990	13770	13805	14302	14293
Communications	-	1004	895	1070	1036	1009	1099	1147	1277	1484
Construction	-	-	-	-	-	-	173	288	298	267
Insurance	688	1278	1374	1895	2125	2935	2064	3213	3229	4111
Financial	-	3040	3711	3979	4310	4483	4951	5288	5438	5995
Computer and information	-	-	469	563	770	795	1090	1257	1585	1928
Royalties and licence fees	1709	1887	2388	2854	3200	3581	3887	4148	4199	4387
Other business	-	6339	7870	8413	9699	10571	13112	14303	18493	17083
Personal, cultural and recreational	-	-	-	-	-	-	734	820	900	782
Government	1461	1535	1474	1541	1305	1423	1180	1137	1090	1117
Total Services	31158	31426	35428	40039	43507	48587	52900	57543	61382	64825

- The UK is specialising in knowledge based services but less so in high and medium tech industries where its trade profile is similar to other G7 countries,

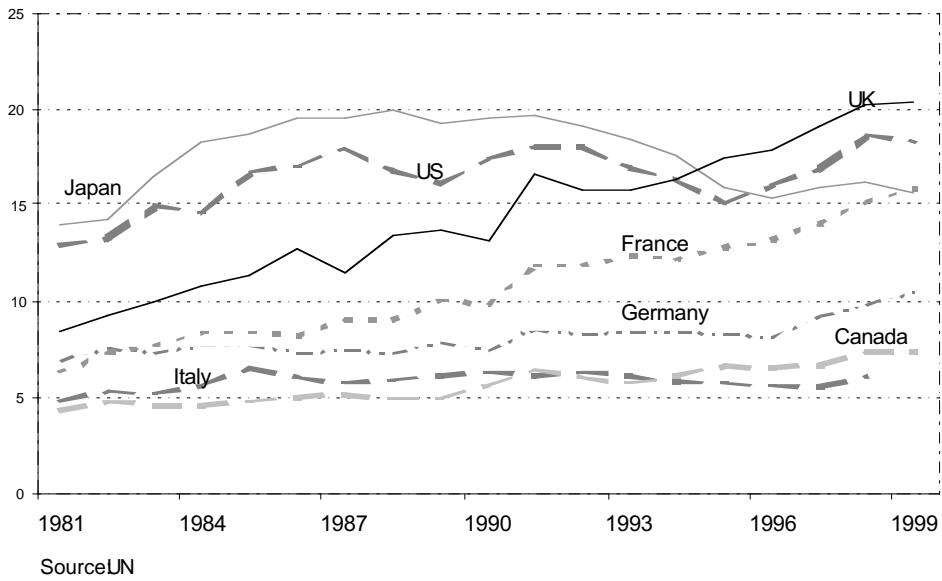
Chart 7 - UK exports of knowledge based services³
(G7 comparison, 1991-1998 Per cent of total services export)



Source: IMF

³ Using IMF data for categories of communications; insurance; financial; computer and information; other business; royalties and licence fees.

Chart 8 - UK exports in medium and high technology goods⁴

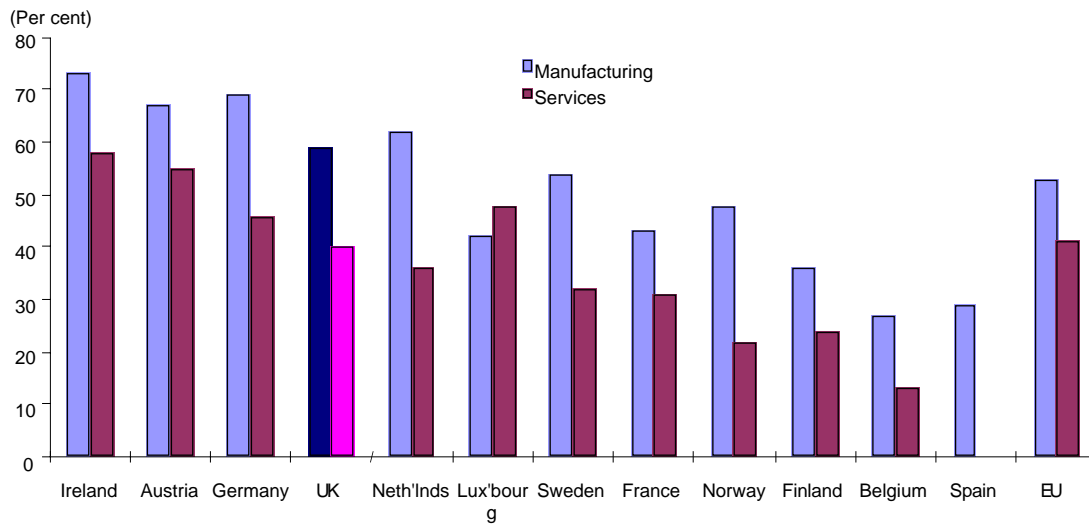


(G7 comparison, 1991-1998 Per cent of total services export)

IV. INNOVATION

- The proportion of firms in the UK services sectors which describe themselves as innovators is in line with the European average⁵.

Chart 9 - Proportion of firms that are innovators

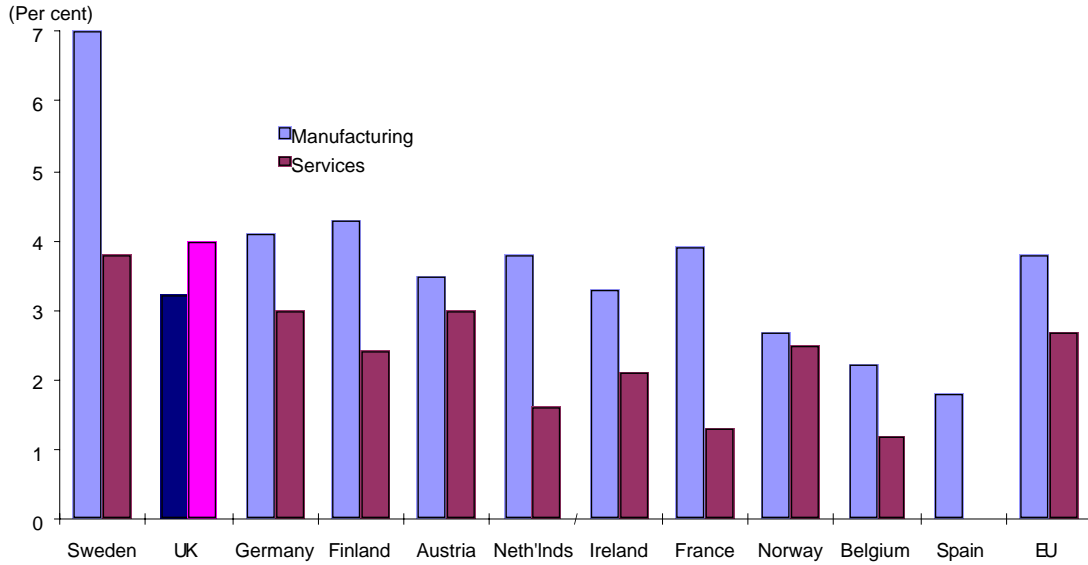


⁴ Includes pharmaceuticals: office machines and ADFP equipment; telecoms and sound recording apparatus and equipment; aircraft and associated equipment; spacecraft (inc satellites) and parts.

⁵ Data from Community Innovation Survey. Enterprises were asked whether products introduced between 1994 and 1996 were new, or improved, compared to those previously produced by the enterprise

- The UK services sector has the highest level of innovation expenditure in Europe. In contrast, although UK manufacturing does relatively well in the proportion of firms that innovate; its level of expenditure on new products or processes is relatively low.

Chart 10 - Business expenditure on innovation as a proportion of turnover in 1996.

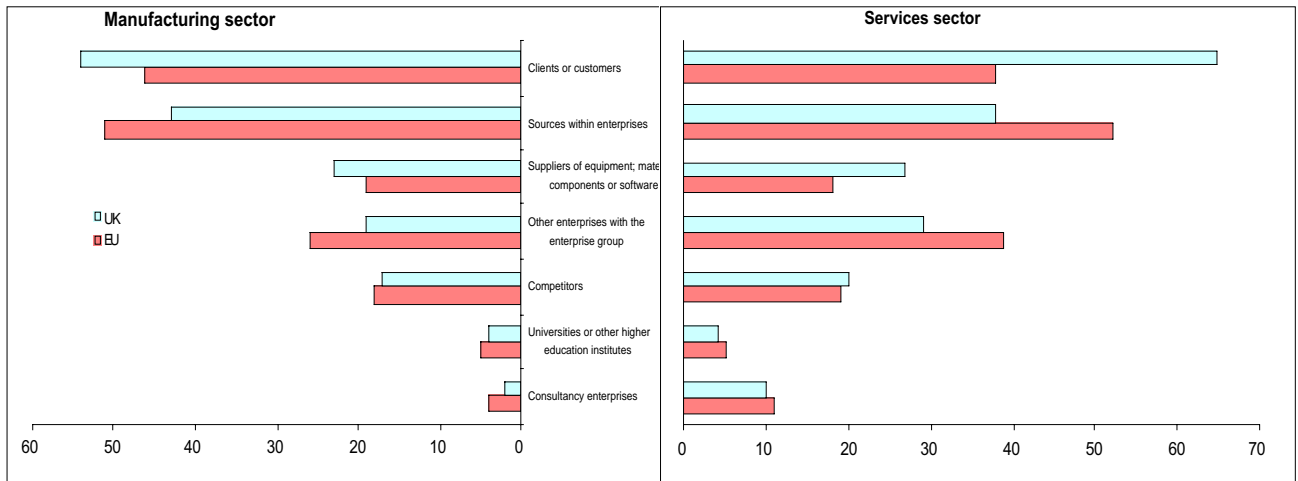


Source: Eurostat (1996 Community Innovation Survey)

- The importance of the Science Base as a source of information is rated similarly by innovative firms in the UK's manufacturing and service sectors.

Chart 11 - Sources of information considered as very important for innovation

(UK and EU average, 1996, per cent)



Source: Eurostat (1996 Community Innovation Survey)

V. EXPENDITURE BY UK BUSINESS ON INTRAMURAL RESEARCH AND DEVELOPMENT.

- In 1998, the services sector accounted for 23% of intramural business expenditure on R&D, the same as in 1990.
- Over this period, the services sectors in which R&D expenditure increased in real terms were:
 - Transport & Storage (122%), from a small base;
 - Construction (62%), from a small base
 - Wholesale and Retail (37%) from a small base;
 - Computer and related services (23%);
 - Agriculture, hunting, forestry and fishing (18%);
 - R&D services 10%
 - Post and Telecommunications (2.2%)

Chart 12 - UK Business expenditure on intramural R&D in UK

€million in cash terms:

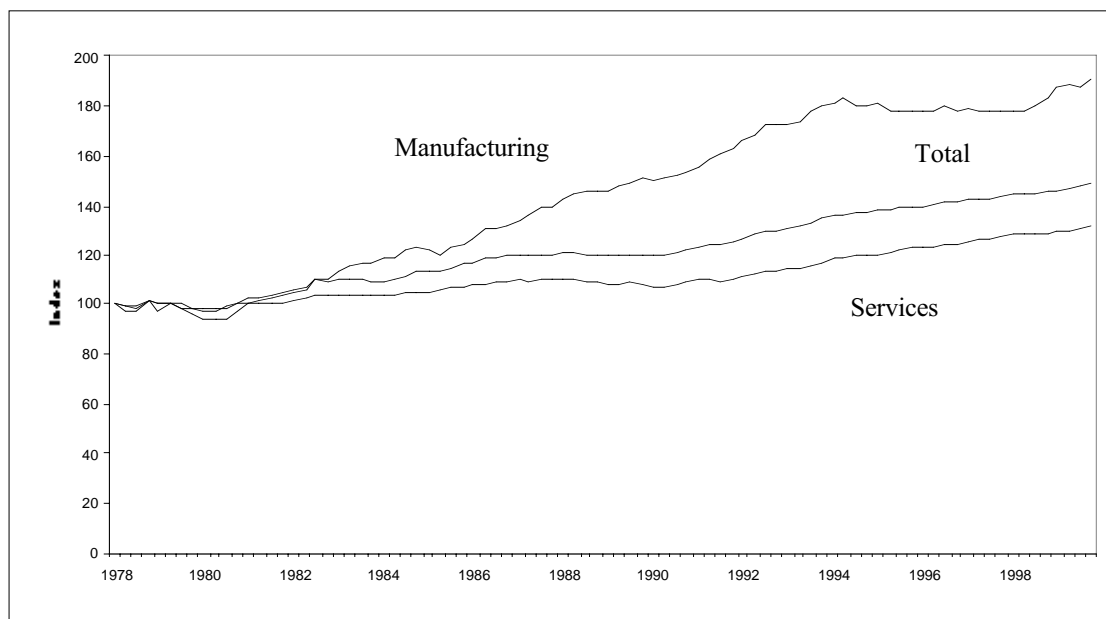
	1990	1991	1992	1993	1994	1995	1996	1997	1998
SERVICES:									
<i>Agriculture, hunting, forestry, fishing</i>	67	76	80	89	80	-	76	84	102
<i>Extractive industries</i>	115	129	126	62	66	65	64	44	41
<i>Refined petroleum products, coke oven products, processing of nuclear fuel</i>	373	369	386	370	354	377	364	349	362
<i>Electricity, Gas, Water supply</i>	188	192	187	214	177	168	148	130	140
<i>Construction</i>	19	19	15	11	11	8	8	38	39
<i>Wholesale & Retail trade</i>	4	4	4	5	6	8	4	5	8
<i>Transport and Storage</i>	7	8	10	13	8	15	8	12	21
<i>Post and Telecommunications</i>	341	317	386	389	408	414	455	496	449
<i>Miscellaneous business activities; Technical Testing and analysis</i>	144	146	156	195	181	-	141	142	157
<i>Computer and related activities</i>	435	494	555	635	744	675	749	680	688
<i>Research and Development Services</i>	244	244	261	329	311	247	369	313	346
<i>Public Administration.</i>	19	19	18	16	10	14	10	6	8
Total Services in cash terms	1956	2017	2184	2328	2356	2337	2396	2297	2359
Total Services in real terms (base year 1998)	2519	2446	2564	2662	2656	2561	2543	2372	2359
MANUFACTURING:									
<i>Chemicals</i>	722	707	720	721	689	701	627	680	688
<i>Pharmaceuticals</i>	1206	1198	1446	1679	1820	1813	1852	2151	2238
<i>Mechanical Engineering</i>	532	538	580	665	761	683	668	709	730
<i>Electrical Machinery</i>	1566	1329	1258	1386	1218	1245	1313	1181	1320
<i>Transport Equipment</i>	620	638	670	717	710	833	977	966	983
<i>Aerospace</i>	984	1005	898	782	860	886	812	893	1039
<i>Other manufacturing</i>	732	702	733	791	790	755	787	779	874
Total Manufacturing in cash terms	6362	6118	6305	6741	6848	6917	7035	7360	7872
Total Manufacturing in real terms (base year 1998)	8194	7420	7402	7709	7721	7580	7469	7600	7872
Total R&D in cash terms	8318	8135	8489	9069	9204	9254	9431	9657	10231

- The share of UK R&D accounted for by foreign affiliates is one of the highest in the OECD area. Between 1985 and 1996 the share more than doubled, partly reflecting take-overs of R&D establishments by foreign firms.

VI. PRODUCTIVITY

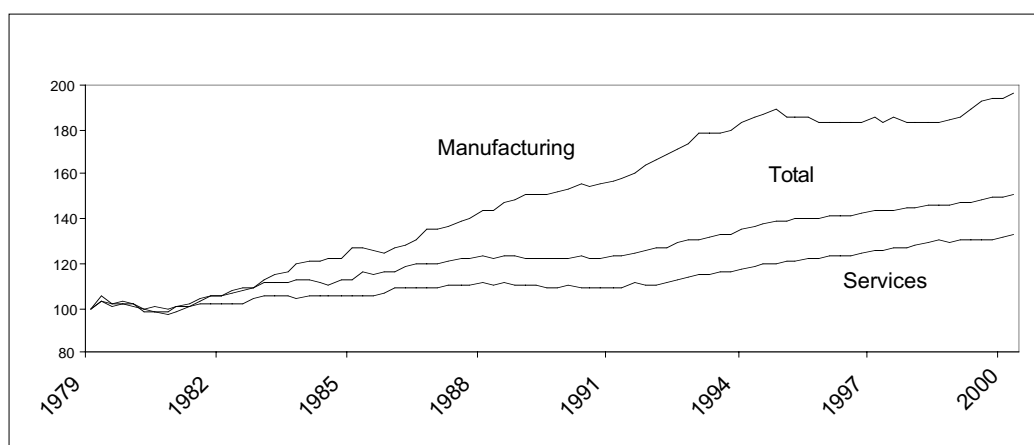
- Estimates by NIESR suggest that outside the oil and manufacturing sectors, productivity growth rates were virtually identical in the first and second half of the 1990s. However, within this total, there was a sharp increase in productivity growth in business services and a decrease in other sectors. Productivity in manufacturing industry had been virtually flat until about 18 months ago.

Chart 13 - Changes in UK Productivity as measured by output per worker



- *Despite relatively high levels of business investment, the capital labour ratio has been growing only slowly, by 0.4 per cent a year between 1995-99, compared with an average of 3 per cent from 1973-95.*

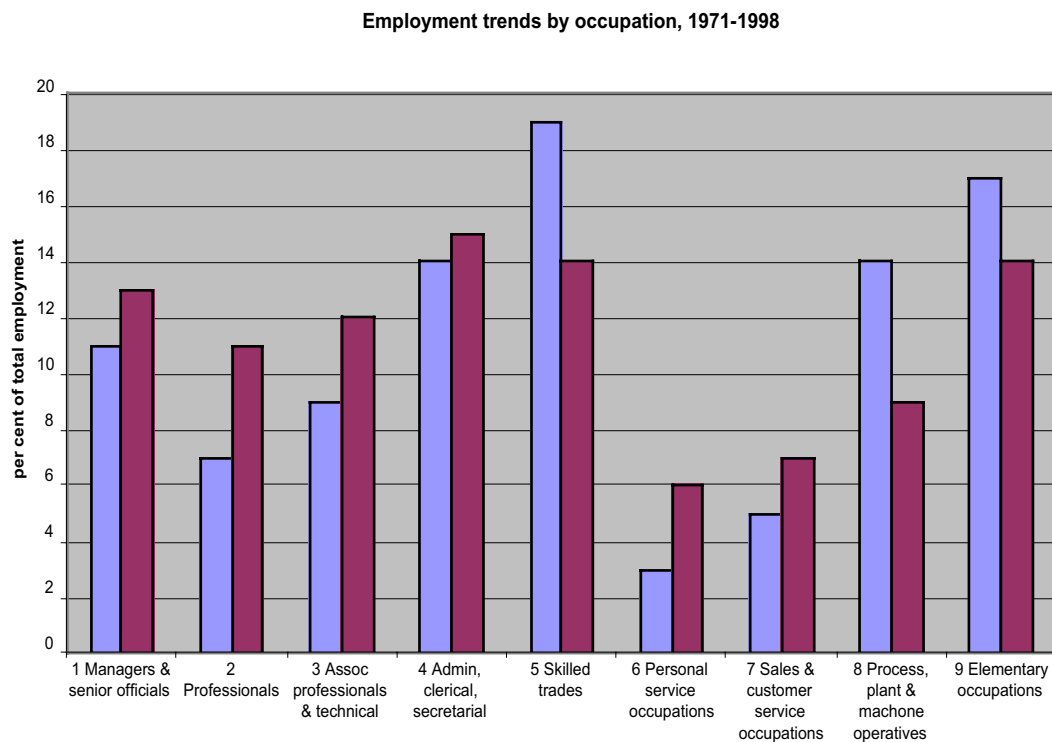
Chart 14 - Changes in GDP per worker
(1973=100)



VII. LABOUR MARKET

- There has been an increase in the proportion of jobs in the managerial and professional categories 1 to 3 and a reduction in the proportion of jobs in the manual categories.
- There has also been a shift in the occupational pattern within industries.
- For example, there has been an increase in the proportion of technical and professional personnel in manufacturing, in spite of the increased tendency towards outsourcing in manufacturing.

Chart 15 - Employment Trends by Occupation
(percent of total population)



- These trends are partly due to changes in the industrial composition of the economy.
- Service-sector employment has expanded at the expense of manufacturing employment.
- But they are also the result of a shift in the occupational pattern within industries.

Chart 16 - Employee Jobs in the United Kingdom 1985 to 2000
(percent of total for all sectors)

	June 1985	June 1991	June 00
A/B. Agriculture, hunting, forestry and fishing	1.6	1.4	1.4
C. Mining and Quarrying	1.3	0.7	0.3
D. Manufacturing	23.1	19.1	16.3
E. Electricity, Gas, Water	1.2	1.0	0.6
Total Production (C+D+E)	25.6	20.8	17.1
F. Construction	5.3	5.1	4.9
G Wholesale and retail trade	15.6	16.1	16.9
H. Hotels and restaurants	4.7	5.3	5.8
I. Transport & ,storage	4.1	4.1	4.0
I. Communication	2.1	2.0	2.1
J. Financial intermediation	3.9	4.5	4.1
K. Renting and business activities	9.3	11.3	14.5
L. Public Administration and defence	6.7	6.4	6.0
M. Education,	7.5	8.2	8.0
N. Health & social work	9.2	10.4	10.4
O/P/Q Other social and personal services	4.3	4.3	4.8
Total Services (G-Q)	67.5	72.8	76.6
Total all sectors %	100.0	100.0	100.0
Total number manufacturing (D)	5037063	4341983	3958426
Total number services (G-Q)	14732925	16524701	18597101
Total number of employees	21836678	22701652	24291328

- There have been changes in skill needs within occupational groups. The Skills Survey⁶ shows evidence of increased relative demand for certain types of skill, in particular cognitive and interpersonal skills.

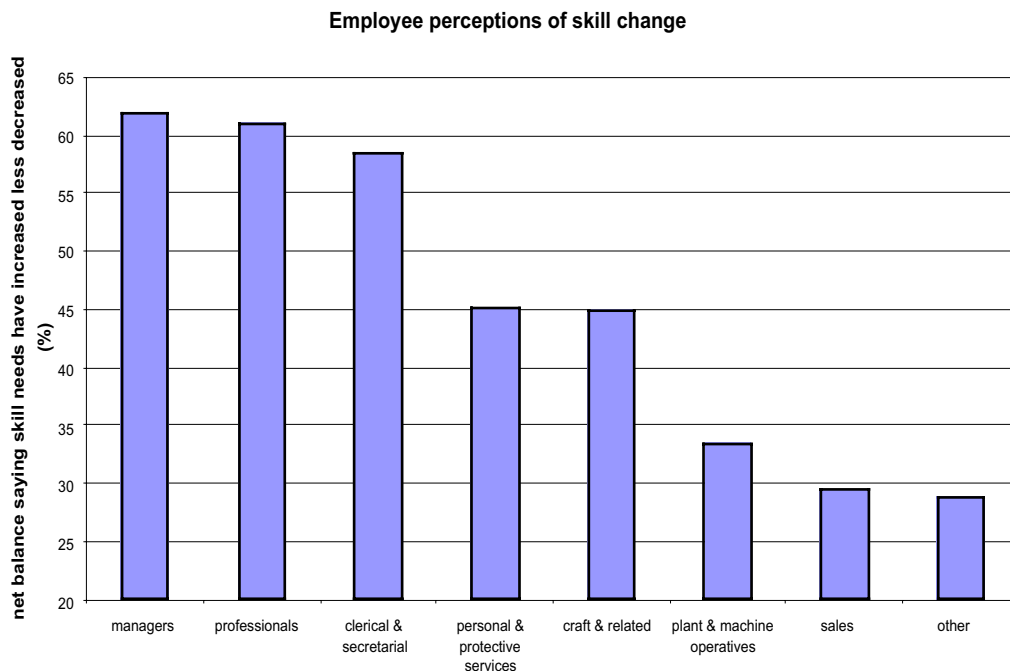
Chart 17 - Changes in work skills in Britain 1992-1997

Skill Type	Net Balance
Thinking of solutions to problems or faults	14.2
Analysing complex problems in depth	20.7
Persuading or influencing others	14.6
Counselling, advising or caring for customers	22.3
Working with a team of people	17.1
Physical stamina	-10.8
Skill or accuracy using hands	-5.9
Using a computer or other type of computerised equipment	31.6
Level of computer usage	23.1

⁶ Green et al

- The introduction of new technologies has also led to an increased demand for IT skills within the workplace.
- According to Skills 99, a report to the DTI, the proportion of workers using IT in their job has grown from around 25 per cent in 1999 to over 60 per cent by 1999.
- The Skills Survey reported that 42 per cent of respondents had increased their use of a computer, PC or other type of computerised equipment in the five years to 1997. This rises to 48 per cent for the proportion of managers reporting that their use of computers had increased over the past five years.
- The rising skill needs of employers, particularly in the IT sector, and the general strength of the labour market, lies behind increasing reports of skill shortages in the UK.

Chart 18 - Employee Perceptions of skill change⁷



- Despite the differences between occupational groups, the growth in the importance of generic skills in all groups is as a key trend.
- According to the Felstead study, all the generic skills, including IT skills were more evenly spread across the population in 1997 than they were 5 years previously. These include communication and problem-solving skills, and the ability to organise oneself and others within a team.

*CST Secretariat
OST
July 2001*

⁷ Felstead et al (2000)

