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Recent micro-economic trends in the manufacturing sector

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Recent micro-economic trends in the manufacturing sector

By

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Contents

Executive summary

Manufacturing occupies a unique position in the British economy. Despite only providing around 10% of UK output and employment, it produces over 50% of UK exports (ONS, 2012b, ONS 2013b). Manufacturing also accounts for over 50% of private sector R&D in the UK so is an important engine of technological progress. Moreover, input-output tables show that the manufacturing sector is an important source of demand for other sectors of the economy, particularly the service sector. However, despite its continued importance, the share of output, real gross value added (GVA), employment and investment attributable to manufacturing has declined faster over the last forty years in the UK than in most other developed countries. The purpose of this review article is to provide more detailed information on this process and to offer some speculation on future trends in manufacturing.

Section 2 looks at trends in real gross output, GVA, employment, capital and R&D in manufacturing between 1973 and 2009. Output in manufacturing was at a similar level in 2009 compared to 1973 (without the decline in output since 2007, it would have been around 11% higher) but GVA fell by almost 30% in 1973-2009, indicating that the use of intermediate inputs increased substantially. Over the same period, employment fell by 61% while the capital stock declined by 17% which implies that labour and total factor productivity (TFP) in manufacturing increased substantially. The substitution of labour for capital is likely to be explained at least in part by the relatively faster rate of increase of the price of labour compared to capital.

Aggregate R&D expenditure in manufacturing increased by almost 10% between 1997 and 2008 due to a large increase in expenditure on R&D performed externally to the firm. By far the largest source of funding for R&D was ‘own funds’ although the contributions from central government (usually over 10% of funding), private industry (usually around 5% of total funding) and other foreign funding excluding the EU (over 15% of funding in all years) have also been significant. The EU provides a very small proportion of R&D funding.

Section 3 provides disaggregated analysis on trends *within* manufacturing. Employment in all sectors has fallen dramatically between 1973 and 2009, having decreased by 58%, 64%, 65% and 55% in low-tech, medium high-tech, medium low-tech and high-tech manufacturing respectively. In terms of output, both high-tech and medium high-tech manufacturing increased their output (by 23% and 21% respectively) while medium low-tech and low-tech manufacturing experienced falls in output (of 20% and 12% respectively). There is therefore some evidence that manufacturing has become more specialised in more high-tech sectors where the UK is likely to have a comparative advantage. Unsurprisingly, high-tech and medium high-tech manufacturing spent the largest amounts on R&D while medium low-tech and low-tech manufacturing spent very little on R&D.

Output in foreign-owned manufacturing was almost as high in 2009 as in UK-owned manufacturing, having been almost six times smaller in 1973. This shows that the UK was seen as an attractive place for foreign investment over the period. In 1973-2009, US-owned plants managed to increase their gross output by 58% but a far higher rate of growth was achieved by EU-owned plants which began the period with gross output of only £8 billion (2000 prices) but finished it with gross output of

£79 billion. This signals the importance of investment within the common market. The value of gross output produced by South East Asia owned plants has also increased dramatically in 1973-2009. However, in 2008, UK-owned plants spent around 50% more than foreign-owned plants on R&D which suggests that foreign-owned firms tend to do much of their R&D at home rather than in the UK. In relation to sources of funding for R&D, throughout 1997-2008, UK-owned plants used foreign sources to fund their R&D to a far greater extent than foreign-owned plants used UK sources to fund their R&D.

In relation to the location of manufacturing, in 1973, manufacturing output and employment was concentrated in the central belt of Scotland, Tyneside, a belt covering Cheshire, Greater Manchester and Yorkshire, South Wales, Wiltshire and London. Overall, there was a relatively clear urban-rural divide with urban areas (and their immediate hinterlands) generally being more heavily dependent upon manufacturing. By 2009, the amount of manufacturing in and around London had fallen significantly. This was part of a broader trend which has obscured the urban-rural divide that was evident in 1973. Between 1997 and 2008, large amounts of manufacturing R&D were performed in Tyneside, the belt encompassing Cheshire, Lancashire and Yorkshire, and the central belt of Scotland. On the other hand, R&D expenditure is high in the area to the north and west of London which are not areas in which there was much manufacturing output or employment.

The fourth section presents results from a decomposition of GB TFP growth between 1997 and 2008. The decomposition shows whether and by how much groups of plants (defined by sector and ownership) have contributed to productivity growth and the channels through which this contribution was made. Manufacturing contributed just under 14% of total TFP growth of 1.6% per annum. Given that in 1997, manufacturing accounted for some 21% of total gross output, manufacturing made a smaller contribution to aggregate productivity growth than would be expected given its share of output.

The UK-owned sector was primarily responsible for the poor performance of manufacturing as a whole. Despite producing a third as much output as UK-owned manufacturing, the foreign-owned sector contributed more to TFP growth in manufacturing. Across sectors, high-tech plants had higher rates of productivity growth than low-tech sectors which will be part of the explanation for the higher rates of growth of output in these sectors. Sectors that experienced above average TFP growth did so mainly because of the opening of more productive plants although these sectors also benefited from more productive existing plants increasing their share of output. For low-tech manufacturing, the negative contribution to TFP growth was primarily due to the closure of relatively high productivity plants.

The fifth section provides indicative evidence on the degree and nature of fragmentation in UK manufacturing. The term fragmentation can be used to describe different activities. Outsourcing or vertical disintegration occurs when intermediate inputs that were previously produced within the firm are bought from outside. This therefore implies that firms are specialising in core activities and buying inputs from outside rather than producing these themselves. Geographic fragmentation or offshoring occurs when the production process is spread over a wider geographical area.

In 1973-2009, multi-plant and multi-industry firms in manufacturing experienced a much larger fall in employment than single--plant and single--industry firms respectively. There have also been large increases in purchases of intermediate inputs in both single- and multi-plant firms. These trends are suggestive of an increase in fragmentation. However, to gain a proper understanding of these trends requires an understanding of the relationship between manufacturing and other sectors. For firms with plants in both manufacturing and non-manufacturing, the proportion of employment accounted for by non-manufacturing plants increased which suggests that manufacturing became increasingly integrated into services between 1997 and 2009. Furthermore, there was a large increase in purchases of services by manufacturing plants in 1973-2009 which has occurred, to some extent, at the expense of the purchases of materials and fuel. This shows that not only were manufacturing plants becoming more integrated into the service sector, they were also buying more inputs from the service sector.

In section 6, some speculation on future trends in UK manufacturing is provided. The increasing usage of intermediate inputs which occurred during the 1980s and 1990s was arrested during the 2000s and is unlikely to be resumed. This is because one would expect the UK to specialise in products which involve the services of skilled labour and technologically advanced machinery rather than the assembly of intermediate inputs. Recent trends in the costs of labour and capital suggest that firms are likely to continue to substitute labour for capital in the immediate future.

In terms of the composition of manufacturing, it is likely that the foreign-owned sector will soon account for a larger share of output, GVA and employment than the UK-owned sector. If the trends observed between 1973 and 2009 continue, this will happen around 2020 for gross output and 2015 for employment. The implications for the UK of continuing contraction in UK-owned manufacturing are that a smaller proportion of the profits from manufacturing will remain in the UK. On the other hand, the efficiency of manufacturing may be boosted by this process, both due to the reallocation of market shares towards more productive foreign-owned plants and through spillovers. It is therefore difficult to say, a priori, whether the higher levels of foreign-ownership will be beneficial to the UK economy.

It is also to be expected that UK manufacturing will continue to shift away from low-tech activities and into high-tech activities. This reflects where the UK's comparative advantage as a human capital abundant country lies. However, recent trends suggest that this specialisation in high-tech industries will be a slower process than the move towards foreign-ownership. This move towards more advanced manufacturing is a more obviously beneficial process than the shift towards foreign-ownership as high-tech manufacturing has higher levels of productivity and is therefore likely to pay higher wages and offer higher returns to investors. However, this move towards high-tech manufacturing is unlikely to create many jobs as high-tech manufacturing is much less labour intensive than low-tech manufacturing.

Finally, given the high costs of labour and property in the south east, it is likely to remain relatively free of manufacturing in the immediate future.

1. Introduction

Manufacturing occupies a unique position in the British economy. Despite only providing around 10% of UK output and employment, it produces over 50% of UK exports (ONS, 2012b, ONS, 2013b) and therefore makes a major contribution to the balance of payments. Manufacturing also accounts for over 50% of private sector R&D in the UK so is an important engine of technological progress. Moreover, input-output tables (see, e.g. ONS, 2006, pp. 394-5) show that the manufacturing sector is an important source of demand for other sectors of the economy, particularly the service sector. However, despite its continued importance, the share of output, gross value added (GVA), employment and investment attributable to manufacturing has declined faster over the last forty years in the UK than in most other developed countries. The purpose of this review article is to provide more detailed information on this process and to offer some speculation on future trends in manufacturing.

The next section will look at trends in real gross output, real GVA, employment, capital and R&D in manufacturing between 1973 and 2009. Output in manufacturing was at a similar level in 2009 compared to 1973 but GVA fell by almost 30% in 1973-2009, indicating that the use of intermediate inputs increased substantially. Over the same period, employment fell by 61% while the capital stock declined by 17%. This substitution of labour for capital is likely to be explained at least in part by the relatively faster rate of increase of the price of labour compared to capital. Aggregate R&D expenditure increased by almost 10% between 1997 and 2008 due to a large increase in expenditure on R&D performed externally to the firm.

The third section provides disaggregated analysis on trends *within* manufacturing. There is some evidence that manufacturing has become more specialised in more high-tech sectors where the UK is likely to have a comparative advantage. The share of manufacturing owned by foreigners, particularly those from the EU and South East Asia, has increased substantially to the extent that foreign-owned plants now account for almost 50% of output and employment. In relation to the location of manufacturing, there is less manufacturing located in the south-east of England than there was during the 1970s. There has also been a shift from urban to rural areas.

The fourth section presents results from a decomposition of productivity growth in GB between 1997 and 2008. This decomposition shows that productivity growth in manufacturing was less than in services and that, consequently, manufacturing made a smaller contribution to aggregate productivity growth than would be expected given its share of output. Within manufacturing, foreign-owned plants made a larger contribution to productivity growth than domestically-owned plants, despite accounting for around a quarter of manufacturing output in 1997. Across sectors, high-tech sectors had higher rates of productivity growth than low-tech sectors which will be part of the explanation for the higher rates of growth of output and GVA in these sectors.

The fifth section provides evidence on fragmentation. Substantial declines in the size of multi-plant and multi-industry firms within manufacturing and increases in purchases of intermediate inputs appear to have been the consequence of manufacturing become more dependent on the service sector for inputs rather than greater fragmentation within manufacturing. Finally, some speculation on future trends in UK manufacturing will be provided.

2. Overall trends in UK manufacturing

This section will provide descriptive statistics on gross output, GVA, employment, capital and R&D in UK manufacturing. Comparison will be made with other sectors in the UK and with manufacturing sectors in other countries.

The main data source for this section is the Annual Respondents' Database (ARD). It is collected by the Official for National Statistics (ONS) each year as part of the Annual Business Inquiry (ABI), designed to obtain statistics for calculating the national income accounts. It contains plant and firm-level codes which allow plants and firms to be tracked throughout 1973-2009 (assuming that they did not close during this period) and for analysis of changes in ownership to be undertaken. Because of the availability of industry codes, foreign ownership codes and postcodes, the ARD allows analysis of trends in industry performance, in the performance of foreign-ownership groups and in the performance of different geographical areas. Because the ARD is a stratified sample of the population with larger plants having a higher probability of being included in the survey, it is necessary to weight the data so that calculated statistics are representative of the population of plants rather than just those sampled in the ABI. This has been done in such a way that the totals match the published ONS aggregate figures for gross output, GVA and employment. Further details on the ARD are provided in Appendix A.

Throughout this report, when using the ARD, manufacturing is defined as comprising those plants with 3-digit 1980 standard industrial classification codes (SIC) between and including 210 and 495. 3-digit SIC 1980 codes are reproduced in Table A.1 in Appendix B.

Data from the EU KLEMS dataset will be used to allow comparison with other sectors and other countries. The EU KLEMS dataset contains information at the industry level on outputs and factor inputs and has been used extensively in productivity analyses (see Timmer et al., 2007, for further details on EU KLEMS). The use of EU KLEMS is necessary because, in addition to allowing cross-country comparisons, it facilitates cross-sector comparisons within the UK since 1970 which are only possible using the ARD since 1997 when the ARD first collected information on services.

Data on R&D is taken from the annually released Business Enterprise Research and Development (BERD) Database and from four waves of the UK Community Innovation survey (CIS) covering innovative activities in 2002-2004, 2004-2006, 2006-2008 and 2008-2010. The data on R&D from CIS is likely to be more representative of the population because although both BERD and CIS use the Frascati definition of R&D[1], the BERD dataset surveys firms that consistently perform R&D while the CIS survey is a stratified sample of the population of plants. However, the disadvantage of CIS is that it is a far smaller sample, is not available on a yearly basis and does not provide figures on R&D expenditure.

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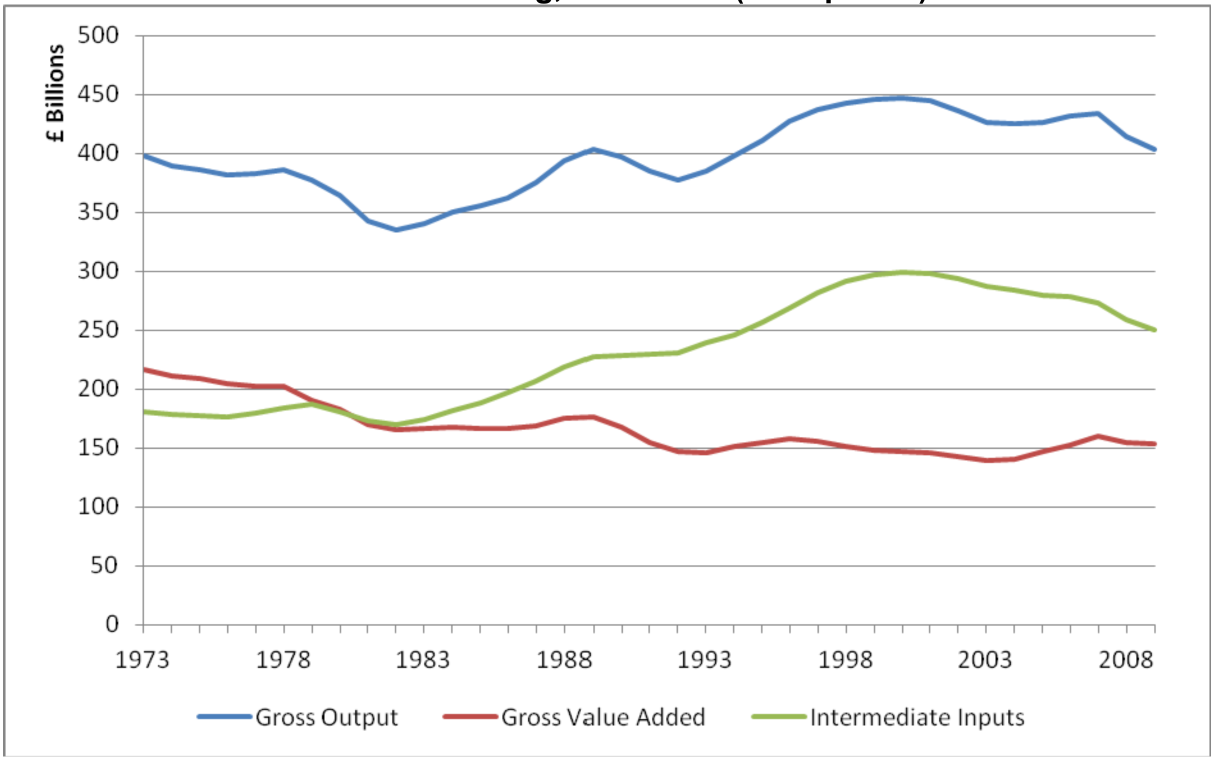
[1] The Frascati manual is available here:
http://unstats.un.org/unsd/EconStatKB/KnowledgebaseArticle10268.aspx

2.1 Output, GVA, Employment, Capital and R&D

Figure 2.1: Real Gross Output, Gross Value Added and Intermediate Inputs in UK Manufacturing, 1973-2009 (2000 prices)

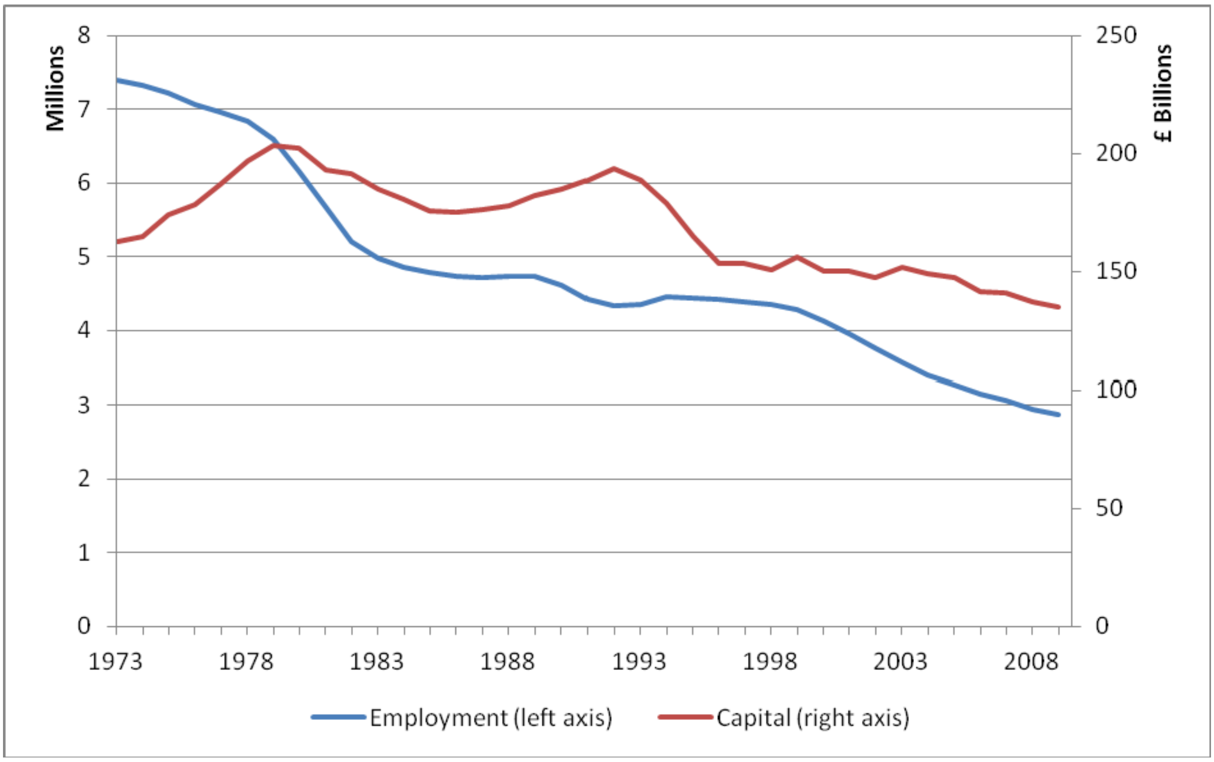


Source: ARD

Figure 2.1 shows aggregate real gross output, aggregate GVA and intermediate inputs in UK manufacturing in 1973-2009. Intermediate inputs are the difference between gross output and GVA and consist of purchases of materials and fuel, and purchases of services. The level of real gross output in manufacturing in 2009 was very similar to what it was in 1973 but, without the decline in output since 2007, would have been around £35 billion greater. By contrast, GVA fell by over £50 billion between 1973 and 2009, with most of the decline occurring prior to 1992. Focusing on the three recessions witnessed during the period, in the recession of 1978-1982, manufacturing output fell by over 13% which compares with a fall in GVA of 16%. Firms therefore became more dependent on the use of intermediate inputs during this period. The same happened to a far greater extent during the recession of 1989-1992 when there were falls in gross output of 6% and falls in GVA of 17%. The most recent recession is therefore unique in that gross output fell by a larger percentage than GVA (7% versus 5%) which shows that manufacturing firms became less dependent on intermediate inputs between 2007 and 2009.

The increase in the use of intermediate inputs may indicate that UK manufacturing has become more fragmented between 1973 and 2009. However, it is also possible that the increase in intermediate inputs is the result of greater dependence on the service sector. This question will be explored in detail in section 5.

Figure 2.2: Employment and Capital Stock (1995 prices) in UK Manufacturing, 1973-2009



Source: ARD

Having considered manufacturing output, Figure 2.2 shows the evolution of the two main inputs into the production process, employment and capital, between 1973 and 2009. The capital stock consists of purchases and hires of plant and machinery.[2] Between 1973 and 2009, employment in manufacturing fell by over 61% while the capital stock fell by 17%. These figures compare to an increase in gross output of 3% and a decrease in GVA of 29% and therefore show that labour and total factor productivity in manufacturing increased substantially between 1973 and 2009. While this is encouraging in terms of competitiveness, the fact that employment tends to have fallen during periods in which output has remained constant suggests that employment in manufacturing is likely to continue falling in the future. The two periods in which the series have diverged most starkly is 1973-1979 and 1989-1994. In the former, the capital stock grew by over 25% and employment fell by over 10%. In the latter, the capital stock continued to increase until 1992 but then declined by almost £50 billion. By contrast, employment reached its lowest point in 1992 but then began to recover. The relatively slow response of investment could be explained by the irreversibility of capital investment which makes firms more cautious both when investing and scrapping capital than when hiring and firing workers (Bloom, et al. 2007). Since 1996, both series have declined but employment has fallen at a greater pace.

To understand these trends, it is helpful to consider trends in the cost of labour and capital. However, it is acknowledged that changes in the capital to labour ratio are determined by a number of other factors including the extent to which technological progress is labour or capital augmenting, returns to scale and the elasticity of

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[2] Details on the construction of the measure of the capital stock are given in Harris and Drinkwater (2000).

substitution between labour and capital. Factor demand equations are provided in Harris (1985).

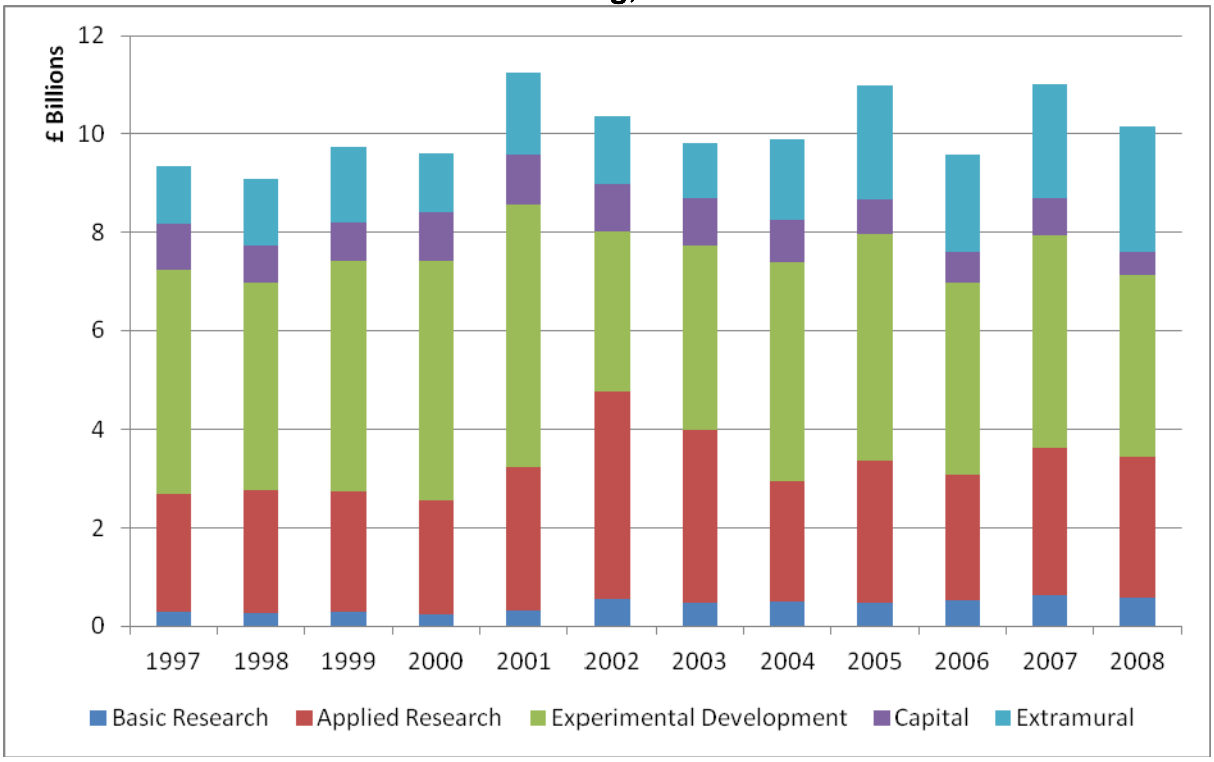
Figure 2.3: Labour and Capital Costs, 1980-2009 (1980=100)

Source: EU KLEMS

Figure 2.3 shows data on labour and capital costs from the EU KLEMS dataset from 1980 to 2009, unfortunately, data is not available for the period prior to 1980 when the capital to labour ratio changed most dramatically. At the start of the 1990s, capital costs did fall relative to the cost of labour which may partly explain why a substitution of capital for labour took place. Similarly, the steady increase in the capital to labour ratio witnessed since 1996 is likely to have been caused by the large relative increase in the price of labour. Indeed, given the dramatic nature of the divergence in the trends for labour and capital costs, it is somewhat surprising that the divergence in the two series witnessed in Figure 2.2 has not been greater although, as discussed above, a number of other factors are important in determining the capital to labour ratio.

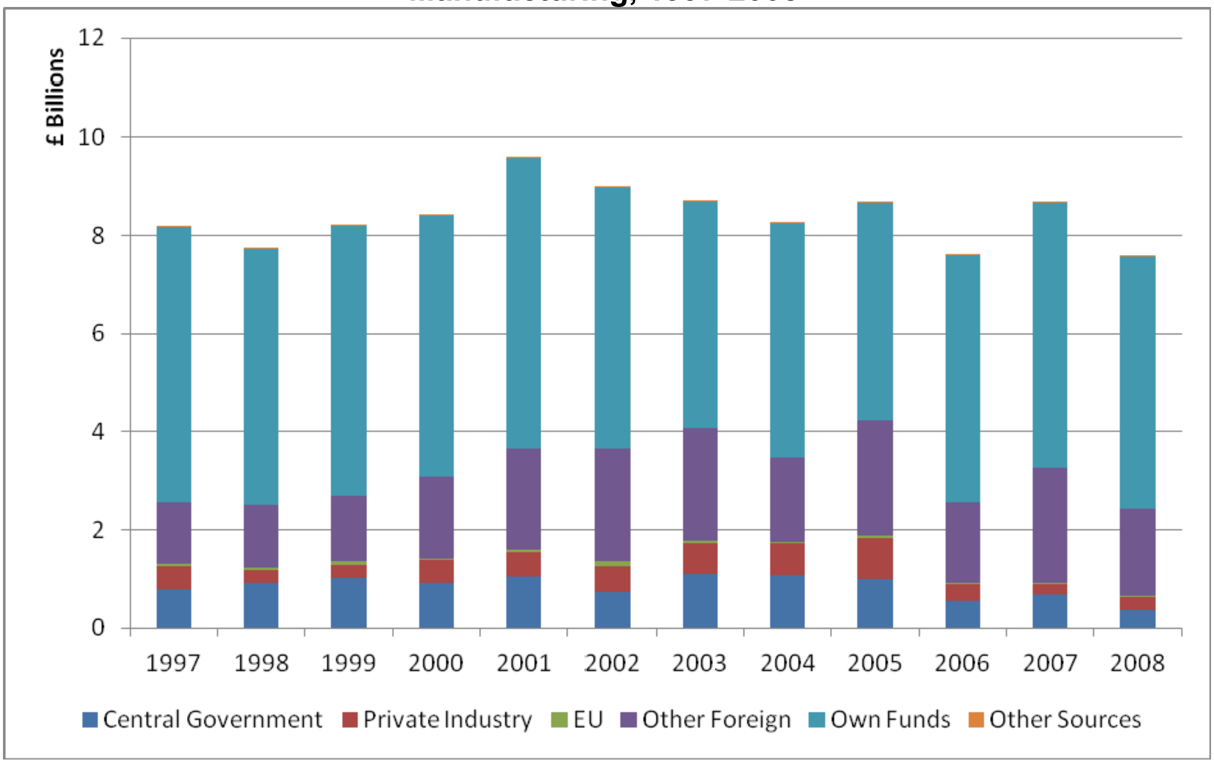
Turning to R&D, the existence of an R&D sector (SIC73), classified as part of the service sector, which is likely to do at least some of its R&D on behalf of manufacturing means that it is difficult to calculate precisely how much R&D expenditure is done for the benefit of manufacturing. The following figures are therefore calculated by allocating R&D expenditure in SIC73, where possible, to the sector which it benefits (details on how this is accomplished are given in Appendix B).

Figure 2.4: Intramural and Extramural R&D Expenditure (2005 prices) in UK Manufacturing, 1997-2008



Source: ARD/BERD

Figure 2.5: Sources of Funding for R&D Expenditure (2005 prices) in UK Manufacturing, 1997-2008



Source: ARD/BERD

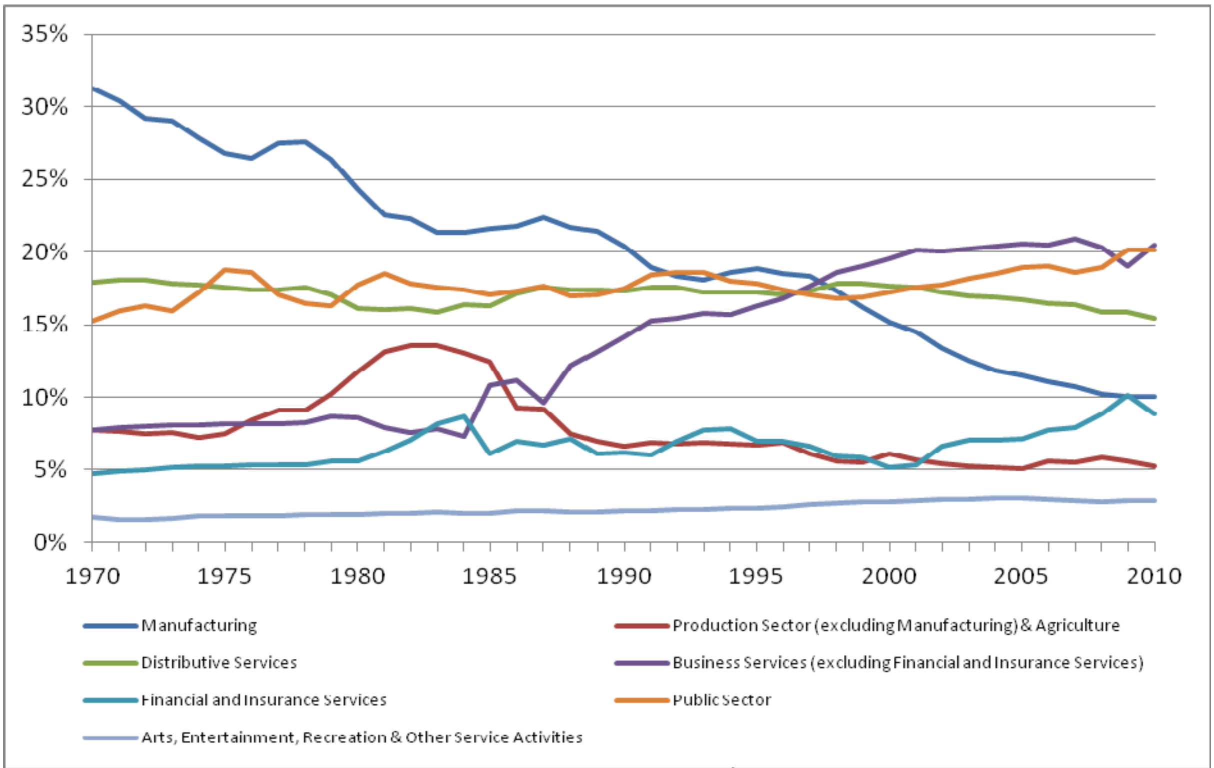
Figure 2.4 shows trends in aggregate expenditure on R&D in UK manufacturing and on its constituent parts. The first four components of R&D comprise intramural R&D which refers to expenditure on R&D that is done within the firm while extramural R&D refers to expenditure on R&D that is done outside the firm. R&D is crucial in determining future trends in productivity (see, e.g. Crepon et al., 1998). Total spending on R&D in manufacturing was almost £1 billion higher in 2008 than it was in 1997. This is entirely due to increases in expenditure on extramural R&D as intramural R&D fell slightly over the period. This decline is the result of the fall in expenditure on experimental development since 2005.

The difference between the aggregate figures presented in Figure 2.4 and Figure 2.5 is expenditure on extramural R&D. By far the largest source of funding has been ‘own funds’ although the contributions from central government (usually over 10% of funding), private industry (usually around 5% of total funding) and other foreign funding excluding the EU (over £1 billion in all years) have also been significant. The EU provides a very small proportion of R&D funding.

The extent to which R&D is funded from abroad will be further explored in Figure 3.11. The figures upon which all these R&D graphs are based are produced for the entire economy, manufacturing, the foreign-owned sector and foreign-owned manufacturing in tables A.2-A.5 in Appendix B.

2.2 Comparisons with other sectors

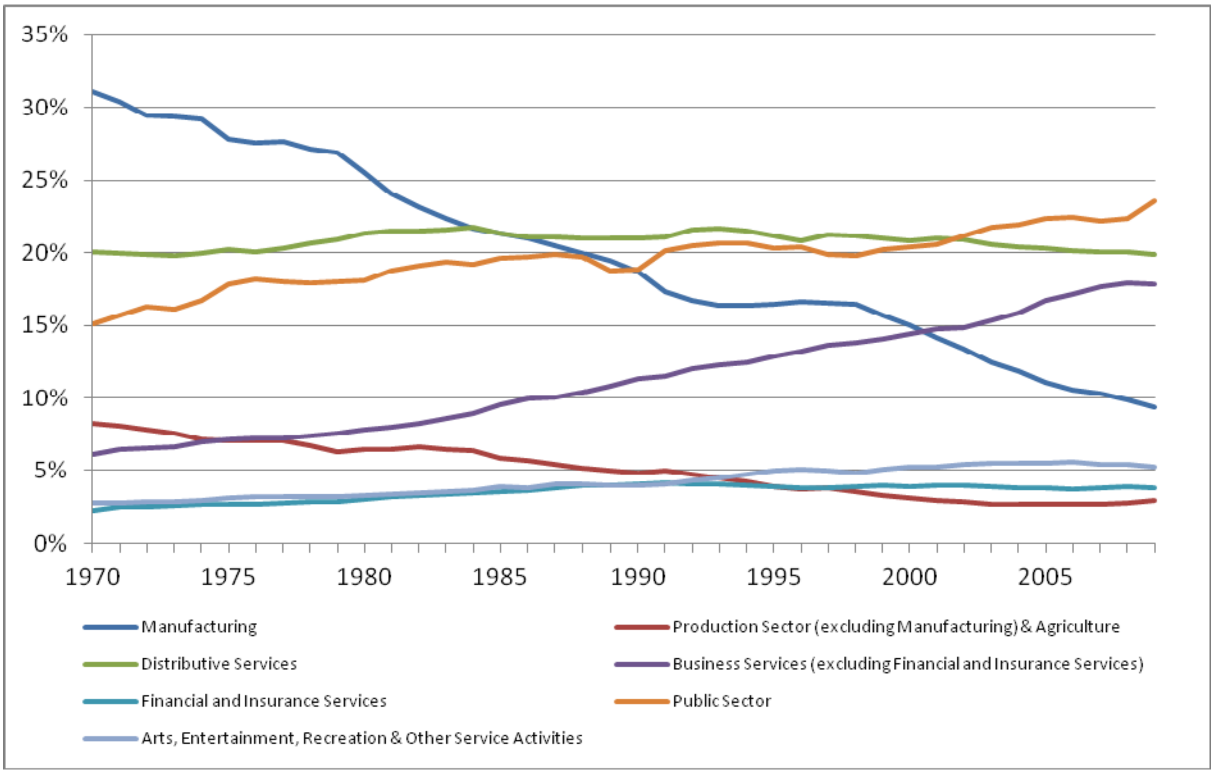
Figure 2.6: Percentage of UK GVA accounted for by selected sectors, 1970-2009



Source: EU KLEMS[3]

[3] This data is taken from the EU KLEMS dataset because the ARD only covered manufacturing prior to 1997.

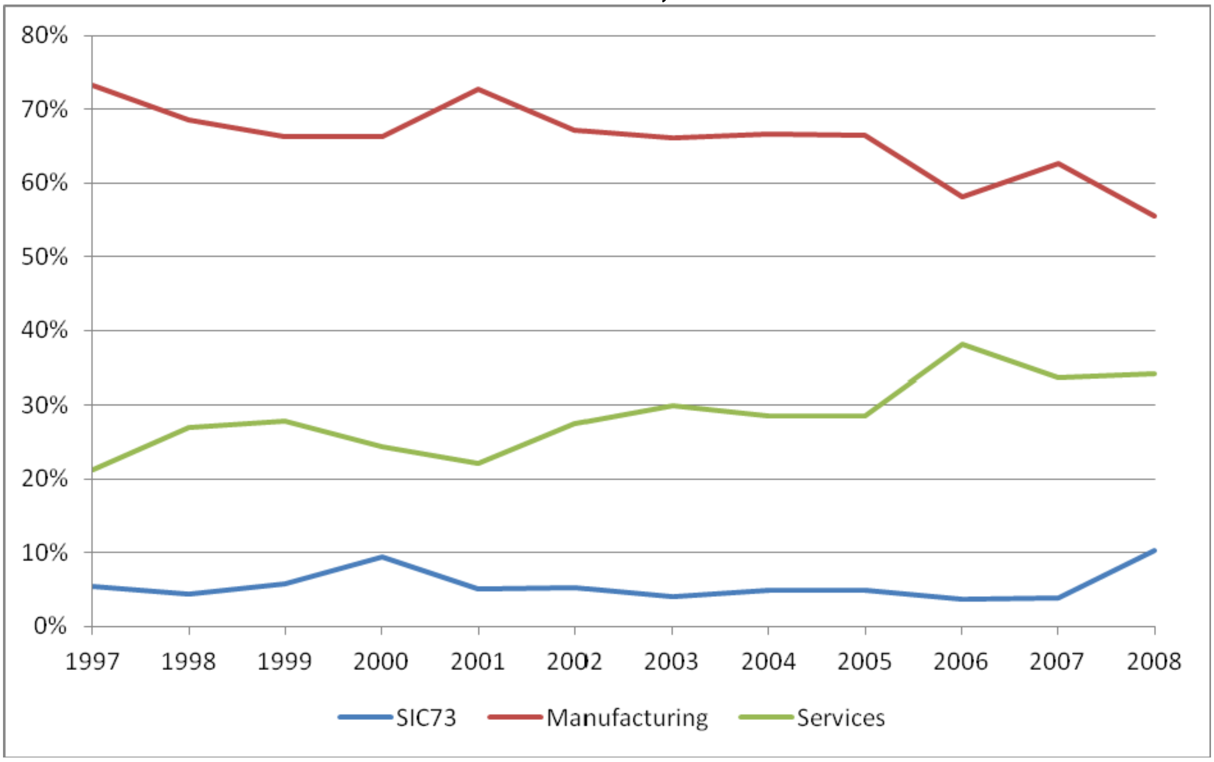
Figure 2.7: Percentage of UK Employment accounted for by selected sectors, 1970-2009



Source: EU KLEMS

Because manufacturing output stagnated over the last forty years (see Figure 2.1) while other sectors have grown, manufacturing has experienced the most dramatic falls in GVA of all the sectors considered (Figure 2.6). By contrast, business services has roughly tripled its share of GVA. Figure 2.7 provides the equivalent information for employment. The decline in manufacturing's share of employment has been even greater than the decline in its share of GVA. These figures show that labour productivity increases in manufacturing were greater than those experienced by most other sectors of the economy.

Figure 2.8: Percentage of UK R&D accounted for by Manufacturing, Services and the R&D sector, 1997-2008[4]



Source: ARD/BERD

The proportion of R&D accounted for by manufacturing, despite falling over recent years (Figure 2.8), remains remarkably high when account is taken of the fact that manufacturing only provides around 10% of GVA and employment in the UK.

[4] Details on how this was done are provided in Appendix B.

Table 2.1: Percentage of establishments in Manufacturing and Services that perform R&D related activities between 2002-2004 and 2008-2010

	Manufacturing	Services
	% establishments that do R&D	
2002-2004	46.00	26.70
2004-2006	43.32	26.16
2006-2008	46.23	28.39
2008-2010	41.66	23.48
	% establishments that process innovate	
2002-2004	23.65	14.08
2004-2006	21.08	9.19
2006-2008	18.09	11.40
2008-2010	23.32	13.40
	% establishments that product innovate	
2002-2004	35.65	22.24
2004-2006	33.26	19.64
2006-2008	34.24	21.67
2008-2010	36.92	24.55

Source: CIS

Turning to some of the determinants of productivity, Table 2.1 shows that in all periods, manufacturing establishments are over 65% more likely to do R&D and over 50% more likely to process and product innovate.

The information in Table 2.2 shows the importance of exporting to the manufacturing sector with, on average over the four year period, over half of manufacturing establishments exporting. The corresponding figure for services is less than a quarter. As a result, the performance of manufacturing is more dependent upon economic conditions in other countries than services.

Table 2.2: Percentage of establishments in Manufacturing and Services that export between 2002-2004 and 2008-2010

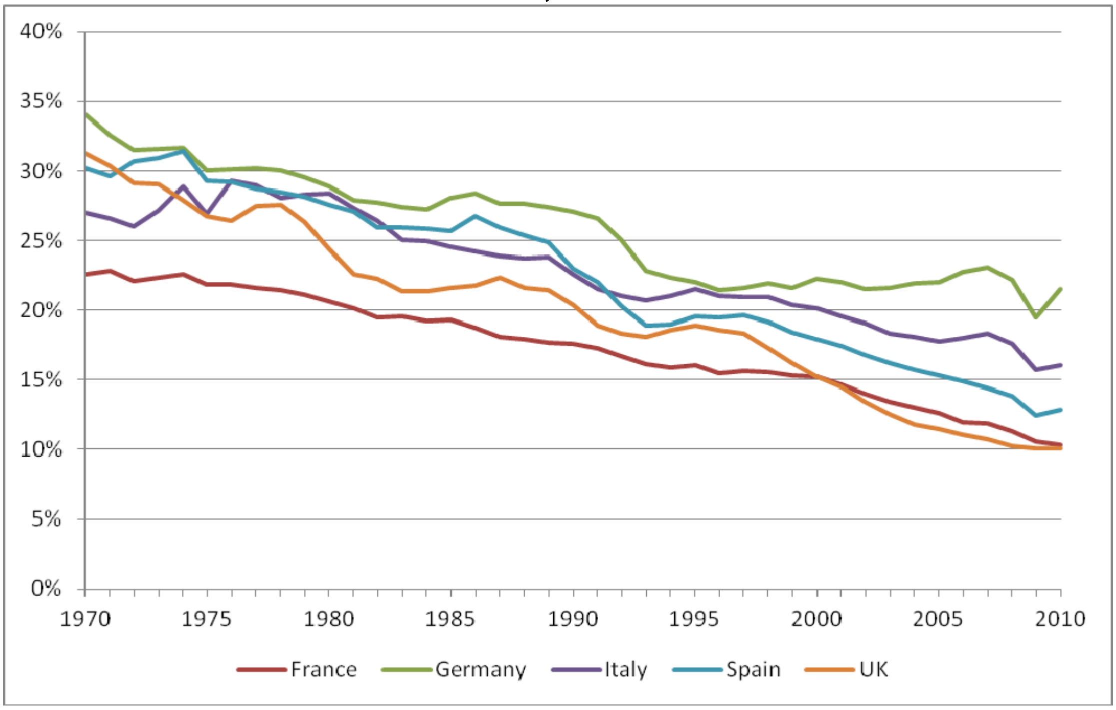
	Manufacturing	Services
	% establishments that export	
2002-2004	48.93	20.81
2004-2006	55.47	24.70
2006-2008	45.45	19.12
2008-2010	60.74	27.11

Source: CIS

Together, these figures on R&D, innovation and exporting show the unique position of manufacturing in the UK economy.

2.3 Comparisons with other countries

Figure 2.9: Percentage of GVA accounted for by manufacturing across countries, 1970-2009

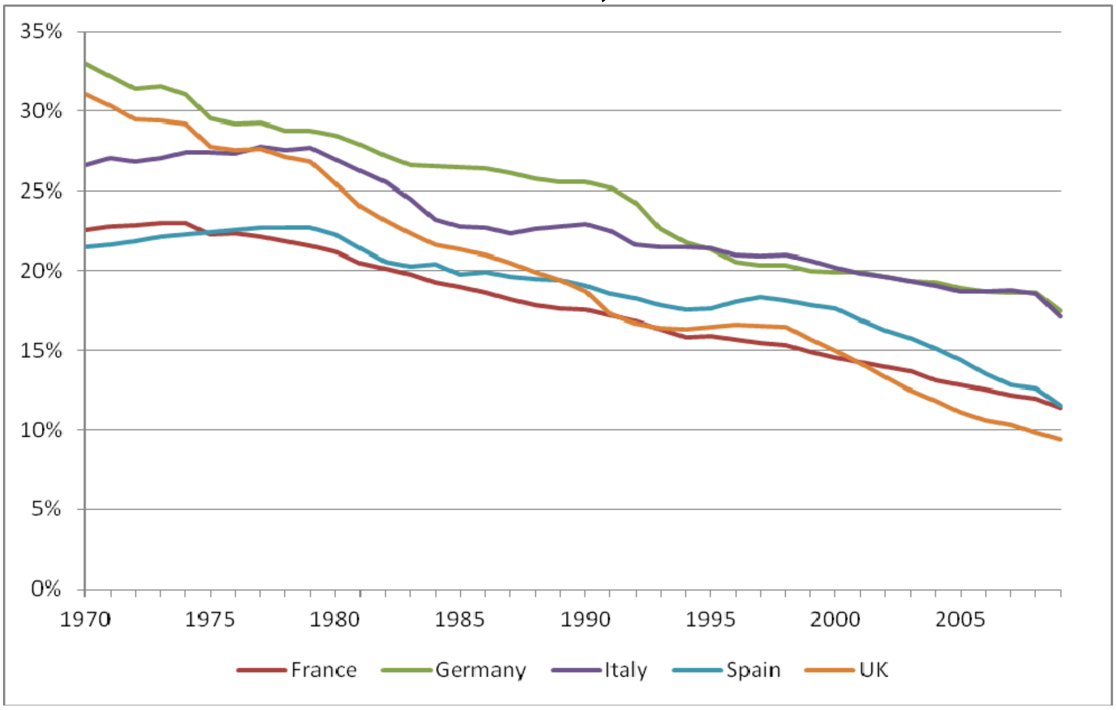


Source: EU KLEMS

Figures 2.9 and 2.10 show that all the countries considered have experienced falls in the proportion of GVA and employment accounted for by manufacturing. However, it is the UK that has experienced the largest fall with manufacturing accounting for around 10% of GVA and employment in 2010, down from over 30% for both variables in 1970.

A similar proportion of GVA is attributable to manufacturing in France but the fall between 1970 and 2010 has been far smaller because manufacturing only provided 23% of French GVA in 1970. Furthermore, French manufacturing employs a larger proportion of the workforce. Unsurprisingly, the only major European economy where manufacturing still provides over 20% of GVA is Germany although it has also witnessed large falls in this measure over the last 40 years. The fall in the share of German employment accounted for by manufacturing has been even greater which indicates that, like British manufacturing, its manufacturing has become more productive relative to other industries.

Figure 2.10: Percentage of Employment accounted for by manufacturing across countries, 1970-2009



Source: EU KLEMS

In relation to R&D, the CIS survey is conducted on an EU-wide basis which allows the innovation of member states to be compared. Abramovsky et al. (2005) show that 34% of establishments in the UK manufacturing sector produced innovations between 2002 and 2004. This was less than Germany (60%), France (41%) and Spain (35%). More recent data taken from the CIS shows that throughout the EU27 in 2006-2008, the average proportion of turnover attributable to products new to the enterprise and market was 13.3%. The corresponding figure for the UK was only 7.3%. These figures indicate that, despite the strong R&D and innovation performance of manufacturing relative to other UK sectors, the performance was relatively weak compared to manufacturing in other countries.

2.4 Summary

This section has looked at trends in real gross output, real GVA, employment, capital and R&D in manufacturing between 1973 and 2009. The main results are that output in manufacturing was at a similar level in 2009 compared to 1973 but GVA fell by almost 30% in 1973-2009, indicating that the use of intermediate inputs increased substantially. Over the same period, employment fell by 61% while the capital stock declined by 17%. This substitution of labour for capital is likely to be explained at least in part by the relatively faster rate of increase of the price of labour compared to capital. Aggregate R&D expenditure increased by over £1 billion (2005 prices) between 1997 and 2008 due to a large increase in expenditure on R&D performed externally to the firm.

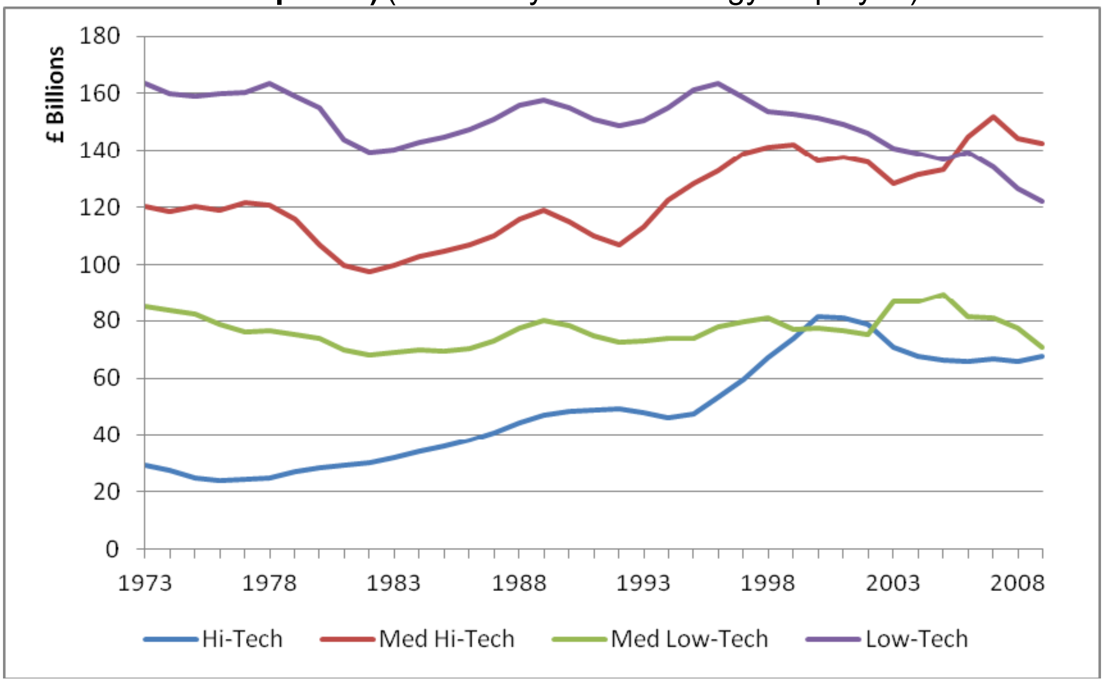
3. Disaggregated trends within UK manufacturing

This section will provide information on the evolution of gross output, GVA, employment, capital and R&D disaggregated by sector, foreign-ownership and location.

3.1 Differences across sectors

The Heckscher-Ohlin model of international trade suggests that countries have a comparative advantage and therefore ought to specialise in those industries which use their abundant factor of production intensively (Ohlin, 1933). As a country which is relatively abundant in skilled labour, the UK should therefore be specialising in more high-tech manufacturing which uses skilled labour more intensively. Because productivity is higher in high-tech than low-tech manufacturing (see, e.g. Harris and Moffat, 2011), such a specialisation will be beneficial for the UK as it has the potential to provide higher wages to workers and higher profits to and owners of capital and land respectively.

Figure 3.1: Real Gross Output by Sector in UK Manufacturing, 1973-2009 (2000 prices) (defined by the technology employed)[5]



Source: ARD

In 1973, low-tech manufacturing accounted for 35%, medium high-tech for 29%, medium low-tech for 22% and high-tech for 14% of aggregate gross output (see Figure 3.1). Until the mid-1990s, the four sectors broadly followed similar trends. However, from 1992, medium high-tech manufacturing grew faster than the other sectors. From 1995 to 2000, high-tech manufacturing grew quickly but output in this

[5] The sectoral breakdown is given in Table 3.1 below.

sector has since fallen from its 2000 peak. Over the whole period, both high-tech and medium high-tech manufacturing increased their output (by 23% and 21% respectively) while medium low-tech and low-tech manufacturing experienced falls in output (of 20% and 12% respectively), which suggests that UK manufacturing is specialising more in higher-tech activities (where it may be expected to have a comparative advantage – BIS, 2010). It also suggests that there is likely to have been an upskilling in the labour force in UK manufacturing between 1973 and 2009.

Table 3.1: Sectoral Breakdown (1980 Standard Industrial Classification)

High-tech manufacturing	Pharmaceutical products (SIC257) Office machinery & computers (SIC33) Telecommunication equipment, electrical measuring equipment, electronic capital goods & passive electronic components (SIC344) Other electronic equipment (SIC345) Aerospace equipment manufacturing & repair (SIC364) Instrument engineering (SIC37)
Medium high-tech manufacturing	Chemicals (SIC25 exc. SIC257) Production of man-made fibres (SIC26) Mechanical engineering (SIC32 exc. SIC320) Electrical & electronic engineering (SIC34 excluding SIC344 & SIC345) Motor vehicles & parts thereof (SIC35) Other transport equipment (SIC36 exc. SIC361 and SIC364)
Medium low-tech manufacturing	Metal manufacturing (SIC22) Extraction of minerals (SIC23) Non-metallic mineral products (SIC24) Metal goods n.e.s. (SIC31) Industrial plant & steelwork (SIC320) Shipbuilding & repairing (SIC361) Processing of rubber & plastics (SIC48)
Low-tech manufacturing	Food, drink & tobacco manufacturing (SIC41 & SIC42) Textiles (SIC43) Leather & leather goods (SIC44) Footwear & clothing (SIC45) Timber & wooden furniture (SIC46) Paper, printing & publishing (SIC47) Other manufacturing (SIC49)

Source: Adapted from Eurostat definitions

Table 3.2 shows which industries are responsible for the changes in output observed in Figure 3.1. The increase in the size of high-tech manufacturing is mainly due to increases in output in instrument engineering and office machinery and computers. The motor vehicle industry has been the largest contributor to the growth of output in medium high-tech manufacturing. The main cause of the decline in the share of manufacturing output attributable to medium low-tech and low-tech manufacturing has been metal manufacturing and food, drink and tobacco respectively. Food, drink and tobacco produced almost one quarter of UK manufacturing output in 1973 but produced less than one-sixth in 2009. It has therefore suffered the largest output fall of all the industries considered here.

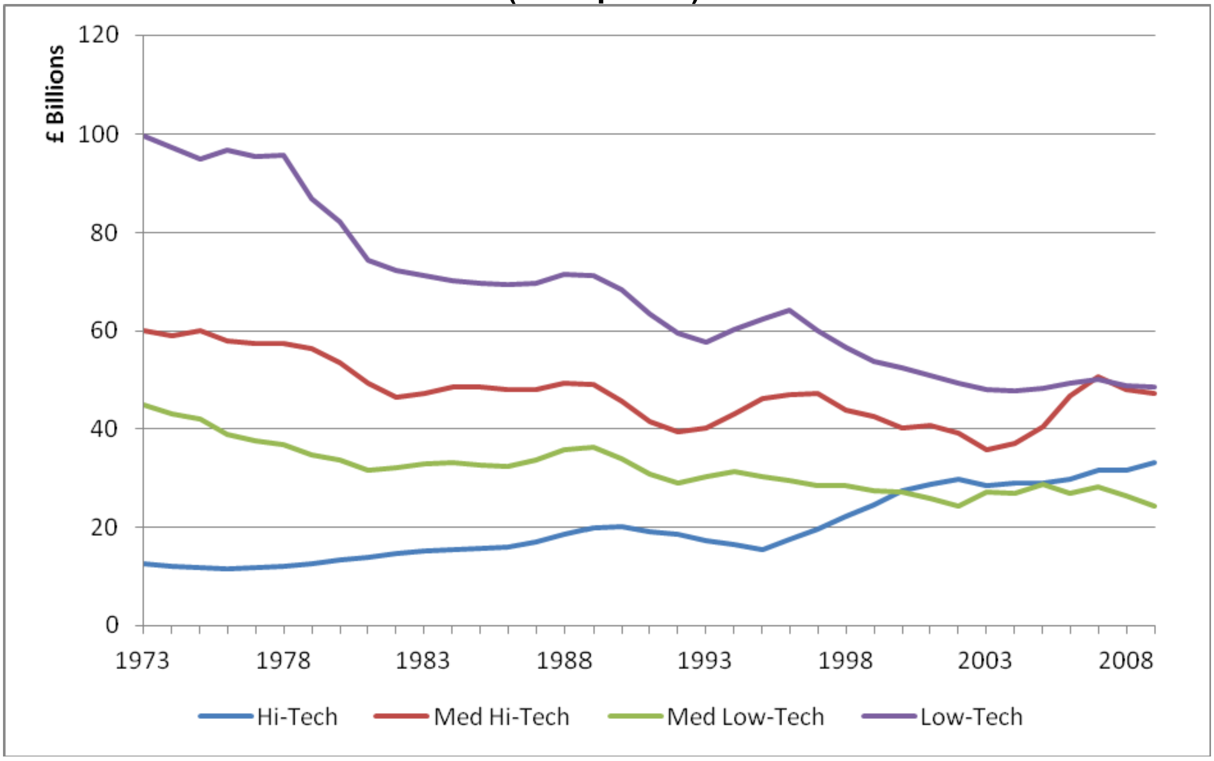
Table 3.2: Percentage of Total Manufacturing Real Gross Output in 1973 and 2009 by Industry

Sector	Industry	1973	2009	Difference
High-Tech	Aerospace equipment manufacturing & repair	4.51%	5.48%	0.97%
	Instrument engineering	0.81%	3.93%	3.12%
	Office machinery & computers	0.18%	2.54%	2.37%
	Other electronic equipment	0.58%	1.80%	1.22%
	Pharmaceutical products	1.00%	2.07%	1.07%
	Telecommunication equipment, electrical measuring equipment, electronic capital goods & passive electronic components	1.28%	1.70%	0.42%
	Total	8.35%	17.53%	9.18%
Medium High-Tech	Chemicals	6.43%	7.66%	1.24%
	Electrical & electronic engineering	3.66%	3.19%	-0.47%
	Mechanical engineering	10.30%	10.08%	-0.22%
	Motor vehicles & parts thereof	7.65%	9.72%	2.07%
	Other transport equipment	*	*	*
	Production of man-made fibres	*	*	*
	Total	29.26%	31.68%	2.42%
Medium Low-Tech	Extraction of minerals	0.07%	0.06%	-0.01%
	Industrial plant & steelwork	1.22%	3.85%	2.63%
	Metal goods n.e.s.	5.09%	4.13%	-0.95%
	Metal manufacturing	6.34%	2.28%	-4.06%
	Non-metallic mineral products	4.17%	3.23%	-0.94%
	Processing of rubber & plastics	2.71%	4.53%	1.82%
	Shipbuilding & repairing	1.32%	0.87%	-0.46%
	Total	20.93%	18.96%	-1.97%
Low-Tech	Food, drink & tobacco manufacturing	23.33%	15.78%	-7.55%
	Footwear & clothing	2.31%	1.14%	-1.18%
	Leather & leather goods	0.52%	0.11%	-0.41%
	Other manufacturing	1.22%	0.78%	-0.44%
	Paper, printing & publishing	7.11%	9.01%	1.90%
	Textiles	3.66%	1.11%	-2.54%
	Timber & wooden furniture	3.30%	3.90%	0.60%
	Total	41.46%	31.84%	-9.62%

* Suppressed to avoid disclosure

Source: ARD

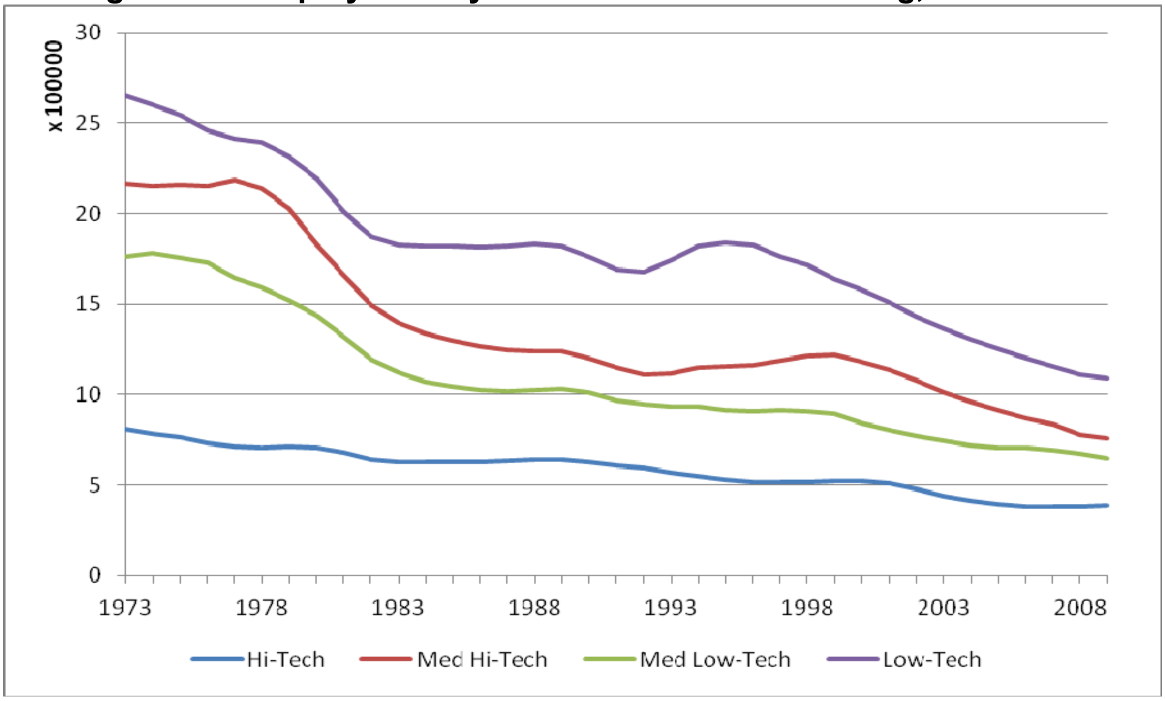
Figure 3.2: Real Gross Value Added by Sector in UK Manufacturing, 1973-2009 (2000 prices)



Source: ARD

With the exception of high-tech manufacturing, all sectors experienced falls in GVA (see Figure 3.2) but high-tech and medium high-tech manufacturing, reflecting what was seen in Figure 3.1, experienced smaller falls. One interesting difference between gross output and GVA is the trend for high-tech manufacturing after 1995. Gross output in high-tech grew by almost 50% between 1995 and 2000 but then fell by almost 20% between 2000 and 2009. By contrast, GVA increased by 25% in 1995-2000 and 19% in 2000-2009. This indicates that the initial period of output increases was associated with a proportionally large increase in the use of intermediate inputs but that the later period of falling output was associated with proportionally large decreases in intermediate inputs.

Figure 3.3: Employment by Sector in UK Manufacturing, 1973-2009



Source: ARD

Employment in all sectors has fallen dramatically between 1973 and 2009 (see Figure 3.3), having decreased by 58%, 64%, 65% and 55% in low-tech, medium high-tech, medium low-tech and high-tech manufacturing respectively. Over the same period, medium low-tech and low-tech manufacturing experienced falls in gross output of over 20% and 12% respectively while medium high-tech and high-tech manufacturing increased their output by over a fifth. The fact that employment falls were similar for all sectors despite these large differences in output growth rates indicates that labour productivity increases were particularly large in high-tech and medium high-tech sectors. As these manufacturing sectors are those in which the UK may be thought to have a comparative advantage, it is concerning that they have not increased their employment, even during periods in which output has been rising rapidly.

The four sectors in Figure 3.3 are disaggregated in Table 3.3 which shows the share of total manufacturing employment in the industries which comprise each of the sectors. The fact that both high-tech and medium high-tech manufacturing increased their employment by a far smaller percentage than they increased their share of output casts doubt on whether this type of manufacturing can generate large increases in employment in the future. The increase in the share of employment in high-tech manufacturing was largely attributable to instrument engineering (but not office machinery and computers). Most of the decline in the share of employment in medium high-tech manufacturing was due to employment falls in motor vehicles. This is despite the large increase in the share of output accounted for by motor vehicles.

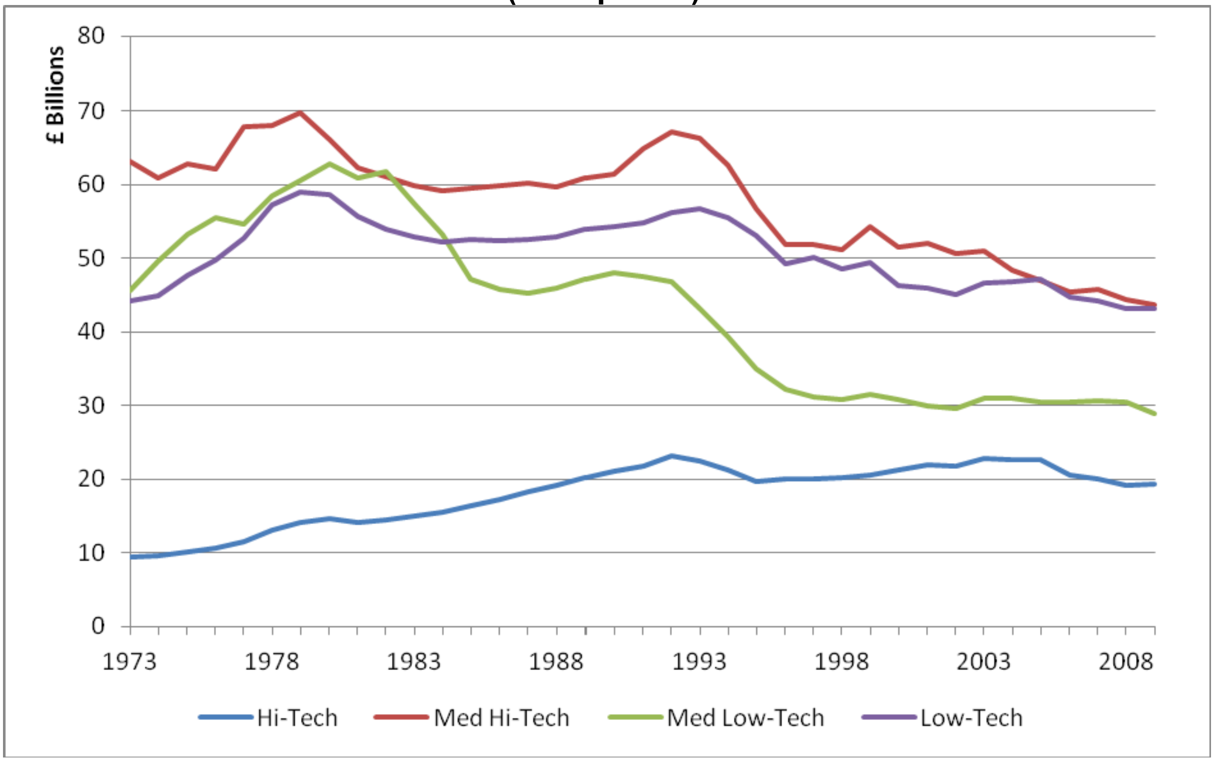
Medium low-tech and low-tech manufacturing both experienced higher rates of growth (or lower rates of negative growth) in employment that in output. As with output, almost all of the decrease in employment share in the latter is due to footwear and clothing and textiles.

Table 3.3: Percentage of Total Manufacturing Employment in 1973 and 2009 by Industry

Sector	Industry	1973	2009	Difference
High-Tech	Aerospace equipment manufacturing & repair	3.15%	4.26%	1.11%
	Instrument engineering	1.56%	4.17%	2.61%
	Office machinery & data processing equipment	0.91%	0.96%	0.04%
	Other electronic equipment	1.46%	1.44%	-0.02%
	Pharmaceutical products	0.91%	1.43%	0.52%
	Telecommunication equipment, electrical measuring equipment, electronic capital goods & passive electronic components	3.13%	1.19%	-1.94%
	Total	11.11%	13.45%	2.34%
Medium High-Tech	Chemicals	4.19%	4.19%	0.00%
	Electrical & electronic engineering	4.60%	3.57%	-1.02%
	Mechanical engineering	11.47%	12.16%	0.70%
	Motor vehicles & parts thereof	6.86%	5.08%	-1.78%
	Other transport equipment	1.17%	0.78%	-0.38%
	Production of man-made fibres	0.67%	0.09%	-0.58%
	Total	28.96%	25.88%	-3.07%
Medium Low-Tech	Extraction of minerals	0.36%	0.08%	-0.28%
	Industrial plant & steelwork	1.27%	2.65%	1.39%
	Metal goods n.e.s.	6.99%	6.22%	-0.78%
	Metal manufacturing	5.40%	2.22%	-3.18%
	Non-metallic mineral products	4.30%	4.09%	-0.21%
	Processing of rubber & plastics	3.59%	5.72%	2.13%
	Shipbuilding & repairing	1.92%	1.47%	-0.45%
	Total	23.83%	22.45%	-1.38%
Low-Tech	Food, drink & tobacco manufacturing	10.31%	14.35%	4.04%
	Footwear & clothing	6.07%	1.79%	-4.28%
	Leather & leather goods	0.51%	0.16%	-0.36%
	Other manufacturing	1.33%	1.24%	-0.09%
	Paper, printing & publishing	7.58%	12.57%	5.00%
	Textiles	6.56%	1.92%	-4.64%
	Timber & wooden furniture	3.74%	6.18%	2.44%
	Total	36.10%	38.21%	2.11%

Source: ARD

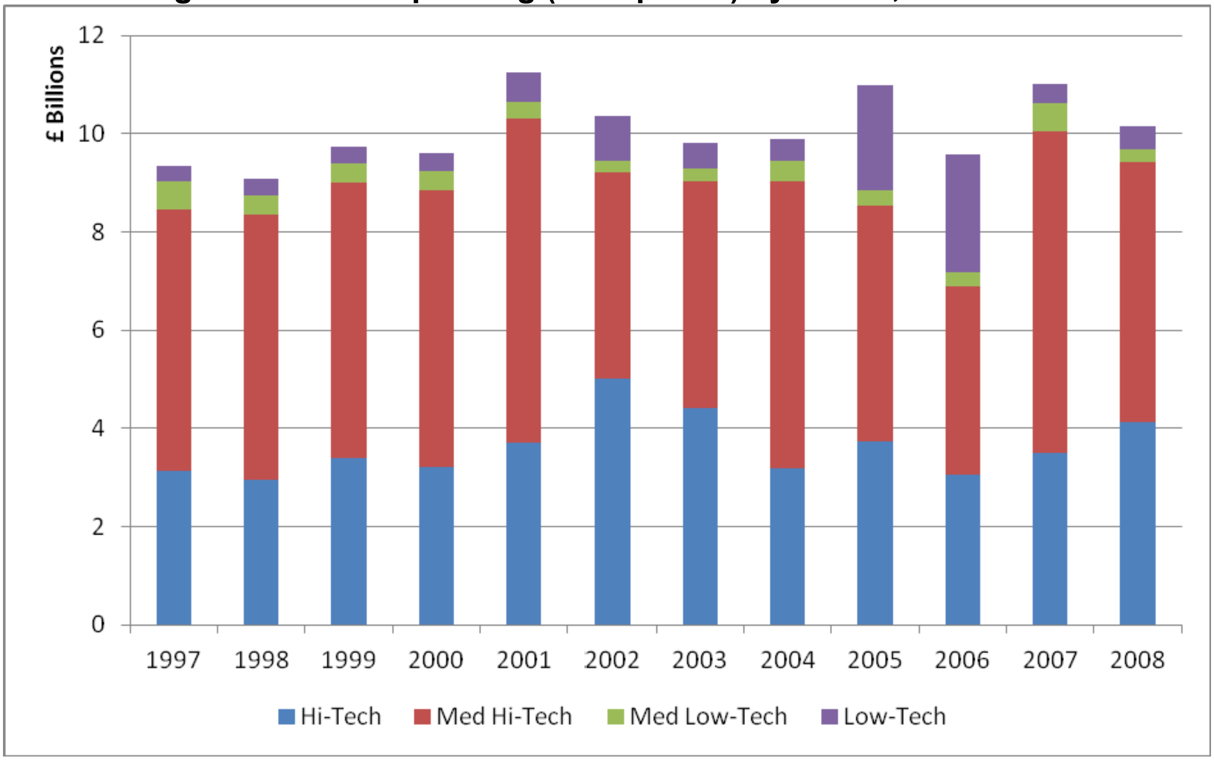
Figure 3.4: Capital Stock by Sector in UK Manufacturing, 1973-2009 (1995 prices)



Source: ARD

All sectors shared in the increase in the capital stock during the 1970s seen in Figure 2.2. However, the only sector that increased its capital stock over the full period was high-tech manufacturing which almost doubled its capital stock (Figure 3.4), although from a low base. This compares with a fall in employment of 58% and shows that this sector has become far more capital intensive. Between 1973 and 2009, medium low-tech manufacturing experienced the largest fall (of 40%) of all the sectors in its capital stock although this is still smaller than its fall in employment of 64%. Given that output increased by over a fifth in this sector, this implies particularly large gains in TFP. With the exception of a larger fall in the capital stock for medium high-tech manufacturing between 1992 and 1996 (also evident although to a less extent in employment), the capital stock of medium high-tech and low-tech manufacturing have followed similar trends. Overall, the capital stock of the former in 2009 is 30% lower than its level in 1973 while the capital stock of low-tech manufacturing is roughly the same. These sectors also experienced large falls in employment (of 65% and 55% respectively).

Figure 3.5: R&D spending (2005 prices) by sector, 1997-2008



Source: ARD/BERD

Unsurprisingly, high-tech and medium high-tech manufacturing spent the largest amounts on R&D while medium low-tech and low-tech manufacturing spent very little on R&D (Figure 3.5). Comparison with figure 3.1 reveals that, on a per unit of output basis, high-tech manufacturing spent by far the largest amount on R&D while low-tech manufacturing spent the lowest amount.

3.2 Differences across foreign-ownership groups

The impact of foreign investment on host economies has received a lot of attention in the academic literature. If it is assumed that foreign-owned firms simply displace UK-owned firms, one obvious disadvantage of foreign investment is that it replaces companies which provide profits for UK residents with companies which provide profits to foreigners and therefore reduces gross national product (GNP) per capita. However, it is not necessarily the case that foreign-owned firms simply displace UK-owned firms. If foreign investment is additional (i.e. it does not displace domestic firms), it creates employment, increases exports (and therefore improving the balance of payments) and provides tax revenue. It can also have a number of other less obvious benefits.

Because it can be assumed that domestic firms have better knowledge of the domestic market than foreign-owned firms, the latter must have some characteristics which allow them to overcome this disadvantage and compete with domestic firms (Hymer, 1976). One such advantage may be access to superior technology which will contribute positively to average productivity levels in the UK economy.

However, there are a number of reasons why foreign-owned firms may not increase productivity levels in the UK. Firstly, cultural differences between the owners of the plant, particularly in the period after the setting up or acquisition of a new plant may act to lower productivity levels in foreign-owned plants. Secondly, foreign-owned plants may undertake foreign direct investment (FDI) to source technology from the host economy rather than to exploit superior technology from the home country (Fosfuri and Motta, 1999). Finally, foreign multinationals may choose to keep higher value added production at home and leave low productivity activities to foreign subsidiaries (Doms and Jensen. 1998). It is also possible that foreign-owned plants 'cherry-pick' UK-owned plants. If this were the case, it would suggest that foreign-owned plants are more productive because they buy productive UK-owned plants, rather than because being foreign-owned raises productivity levels.

The empirical evidence generally suggests that foreign-ownership does raise productivity levels in the UK (see, e.g. Harris and Robinson, 2003 and Criscuolo and Martin, 2009). FDI therefore has the potential to improve allocative efficiency as market share moves from low productivity existing firms to high productivity foreign entrants. Empirical evidence on this is provided by Harris and Moffat (2011) and in section 4.

Assuming that foreign owned plants do use superior technology, there is then the potential for knowledge spillovers from foreign to domestic firms. The extent to which knowledge will spill over from foreign to domestic firms is dependent on levels of absorptive capacity in domestic firms and the appropriability of the technological assets possessed by foreign firms. A large empirical literature has tested for the existence of spillovers from foreign to domestic firms (see, e.g. Blomstrom, 1986, Aitken and Harrison, 1999, Harris and Robinson, 2004). In their review of the literature Gorg and Greenaway (2004) conclude that 'although theory can identify a range of possible spillovers channels, robust empirical support for positive spillovers is at best mixed' (p. 171).

The most remarkable feature of Figure 3.6[6] is that output in foreign-owned manufacturing is almost as high as in UK-owned manufacturing, having been almost six times smaller in 1973. With the exception of the group consisting of Australia, Canada and South Africa (comprising the bulk of the Old Commonwealth countries), the amount of output produced by all the foreign ownership groups considered here increased steadily between 1973 and 2009. This contrasts with a fall in gross output produced by domestically owned firms of over a third. Under the assumption that the performance of the UK-owned sector was not influenced by that of the foreign-owned sector,[7] aggregate gross output in UK manufacturing would have been 31% lower than the actual level in 2009 without the increase in the output of the foreign-owned sector between 1973 and 2009. This is a stark illustration of the importance of inward investment to UK manufacturing and also an indicator of a loss of competitiveness in domestic manufacturing between 1973 and 2009 (despite the large productivity increases that have occurred over the period).

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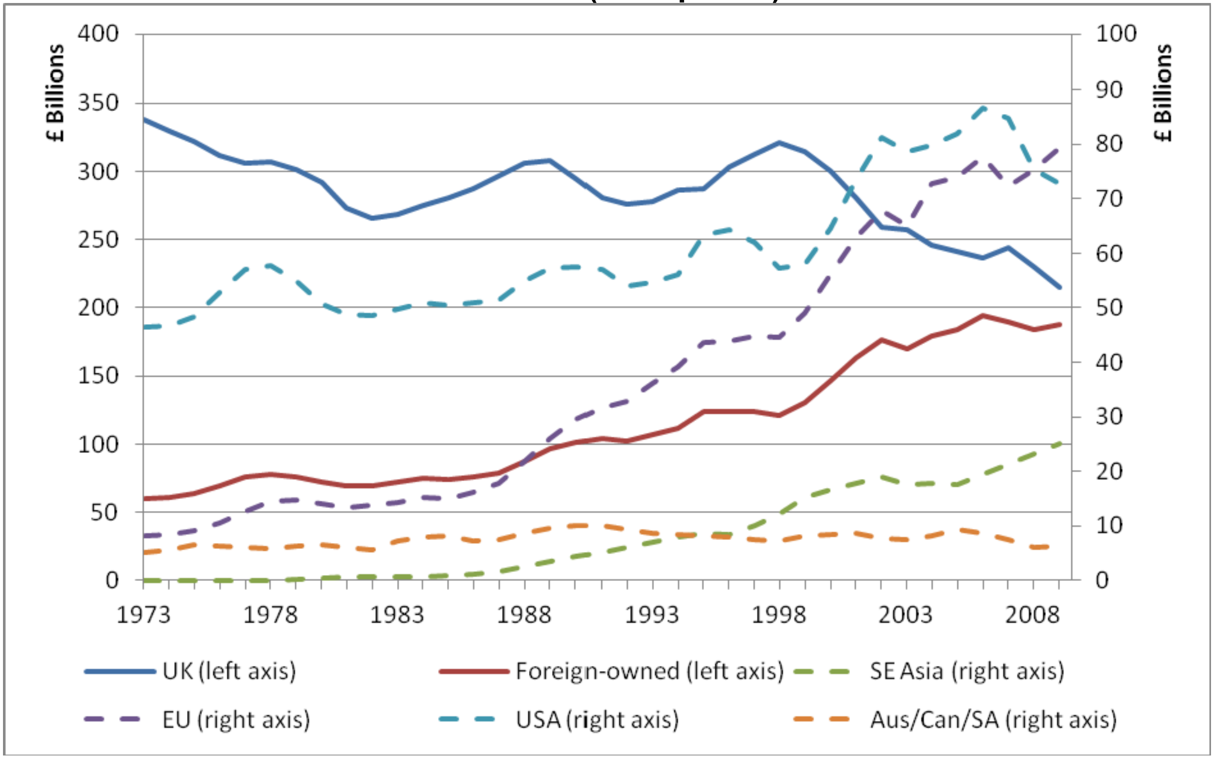
[6] Due to the large difference between the size of the UK and the full foreign-owned sector and the size of individual foreign-owned sectors, the UK-owned sector and aggregate foreign-owned sector is plotted against the left axis while individual foreign-owned sectors are plotted against the right axis.
[7] This is a very great assumption as some of the decline in the output of UK-owned plants will be the result of losing market share to foreign-owned plants.

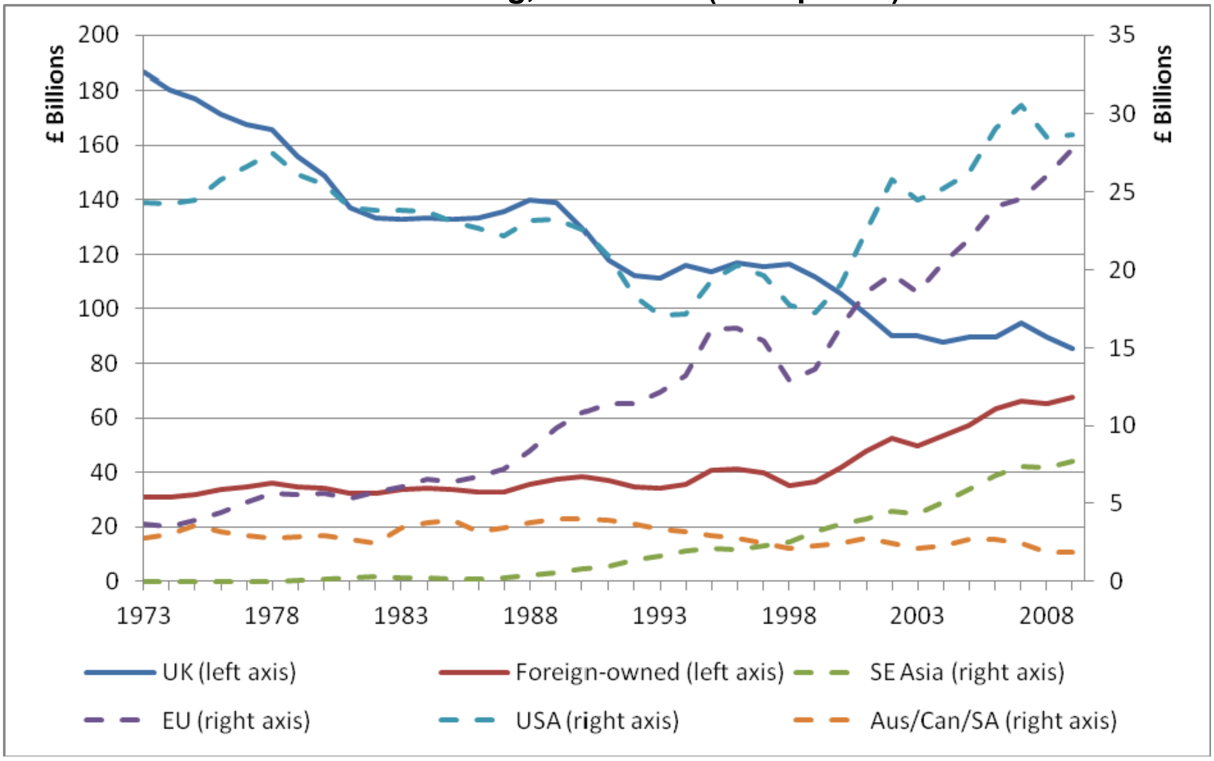
Figure 3.6: Real Gross Output by Country of Ownership in UK Manufacturing, 1973-2009 (2000 prices)



Source: ARD

Focusing on foreign-owned plants, between 1973 and 2009, US-owned plants managed to increase their gross output by 58%. A far greater rate of growth was achieved by EU-owned plants which began the period with gross output of only £8 billion but finished it with gross output of £79 billion. Given that the UK joined the EU in 1973, this signals the importance of investment within the common market. The value of gross output produced by South East Asia owned plants has also increased dramatically in 1973-2009. Overall, these figures show that the UK was seen as an attractive place for foreign investment.

Figure 3.7: Real Gross Value Added by Country of Ownership in UK Manufacturing, 1973-2009 (2000 prices)

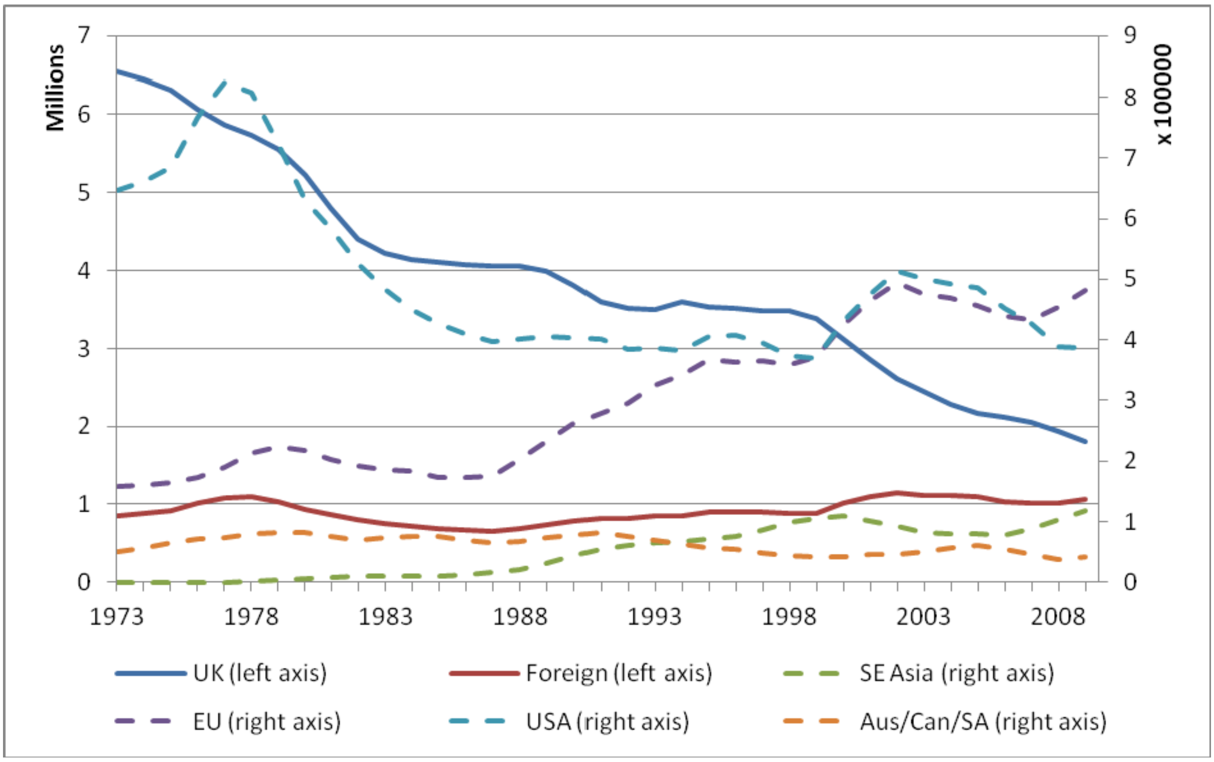


Source: ARD

The picture shown in Figure 3.7 is similar to that presented in the previous figure although, due to the increase in the use of intermediate inputs (see Figure 2.1), the downward trends for the output of domestically-owned plants are larger than the upward trend for foreign-owned plants (with the exception of the group of plants in the Aus/Can/SA sub-group). GVA from UK-owned plants is now less than half its level at the beginning of the period. There is a convergence in the GVA of EU-owned plants and US-owned plants but, unlike for gross output, US-owned plants produced greater GVA throughout the period, which indicates that EU-owned plants use more intermediate inputs.

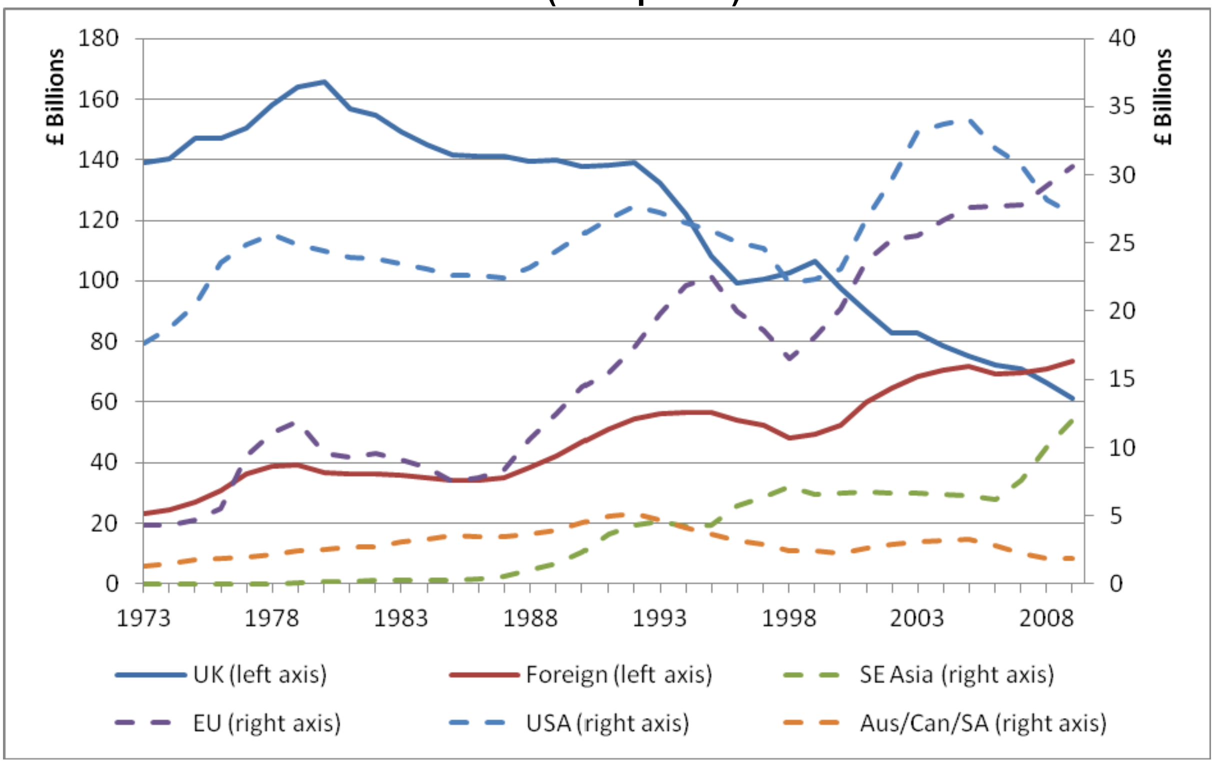
Over the period, employment in UK-owned plants has fallen by 72% (see Figure 3.8). Mirroring what was observed for output in Figure 3.6, the largest per annum falls came during the recession of the early 1980s but employment has also been falling rapidly since 2000. Employment in US-owned firms declined by 40% between 1973 and 2009, a time when gross output and GVA increased by 58% and 18% respectively in this sector. However, this fall has been offset by the large increase in employment of EU-owned plants which are now the largest foreign-owned grouping. South East Asian plants, which managed to increase their output dramatically between 1973 and 2009 still only provided employment of less than 120,000 in 2009. Unlike with gross output, foreign-owned plants contributed negatively to employment growth between 1973 and 2009 although, on a pro rata basis, their negative contribution was far smaller than that of UK-owned plants.

Figure 3.8: Employment by Country of Ownership in UK Manufacturing, 1973-2009



Source: ARD

Figure 3.9: Capital Stock by Country of Ownership in UK Manufacturing, 1973-2009 (1995 prices)

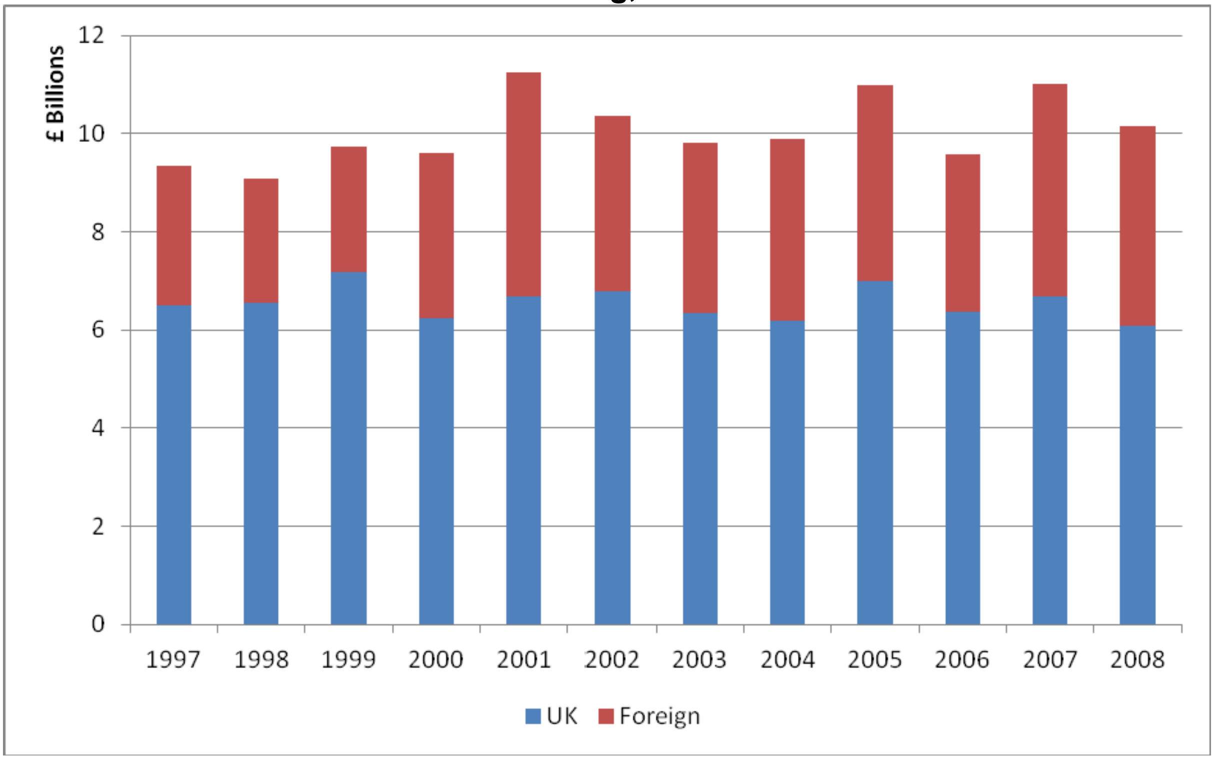


Source: ARD

Figure 3.9 shows in common with the series for employment, output and GVA (see Figures 3.6, 3.7 and 3.8 respectively), the UK-owned sector has experienced the largest decline (of over 55%). The result of this is that the capital stock of foreign-owned plants is now greater than that of UK-owned plants.

Mirroring the situation for employment, the largest increase, in absolute terms, came in EU-owned plants which increased their capital stock by £26 billion between 1973 and 2009. The largest increase in the capital stock, in percentage terms, is in South East Asian plants which increased their capital stock from zero in 1973 to £12 billion in 2009. US-owned plants showed an increase of roughly 50% and the plants owned by Australians, Canadians and South Africans by 13% over the same time frame. Once again assuming that the performance of the UK-owned sector was not influenced by that of the foreign-owned sector, the UK capital stock would have been 36% lower than it was in 2009 without the increase in the capital stock of foreign-owned plants. Again, this shows the importance of foreign direct investment in UK manufacturing.

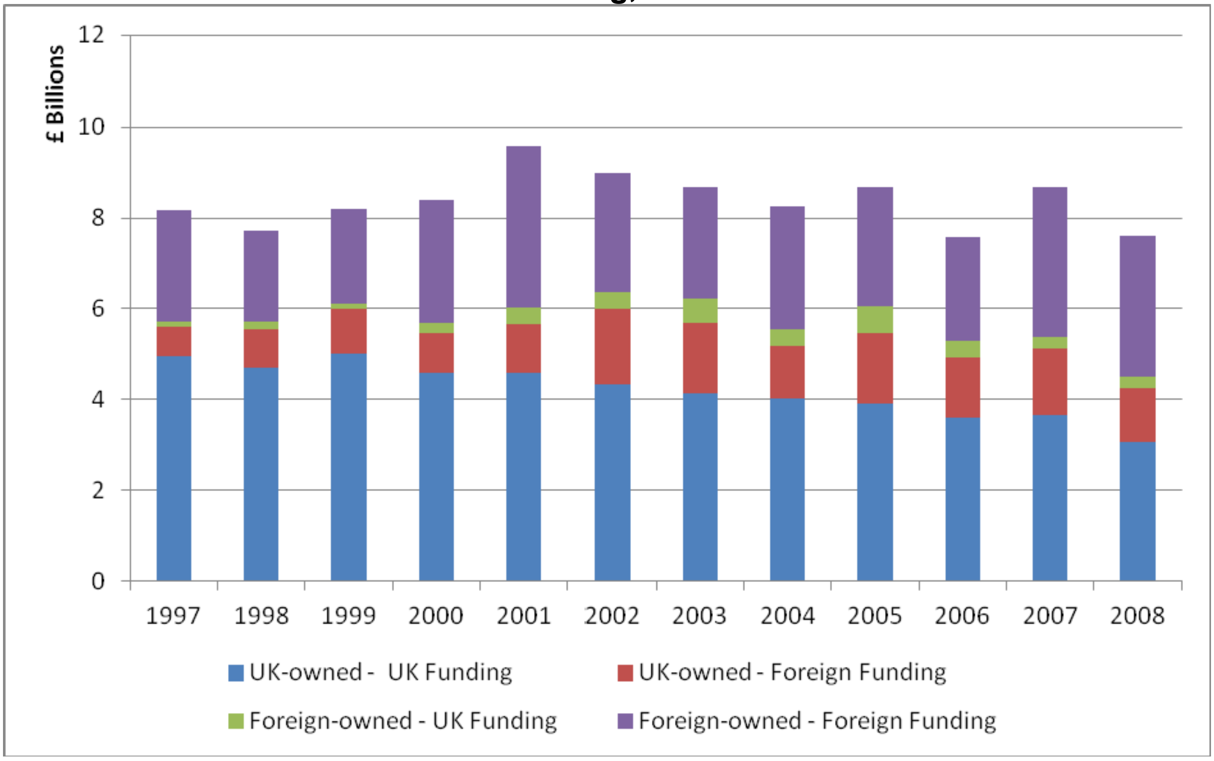
Figure 3.10: R&D expenditure (2005 prices) by ownership status in UK Manufacturing, 1997-2008



Source: ARD/BERD

Throughout the period, less has been spent on R&D by foreign-owned plants than UK-owned plants although the former have increased their share of R&D expenditure slightly. Still, in 2008, UK-owned plants spent around 50% more than foreign-owned plants (see Figure 3.10) which is far greater than the difference between UK-owned and foreign-owned employment and output. This may suggest that foreign-owned firms tend to do much of their R&D at home rather than in the UK.

Figure 3.11: Sources of Funding for R&D Expenditure (2005 prices) in UK Manufacturing, 1997-2008



Source: ARD/BERD

Figure 3.11 disaggregates the figures provided in Figure 2.5 in a different way to show whether UK and foreign-owned manufacturing plants obtain their funding for R&D from the UK or abroad. Throughout 1997-2008, UK-owned plants used foreign sources to fund their R&D to a far greater extent than foreign-owned plants used UK sources. The use which UK-owned plants have made of foreign sources of funding increased over the period so that in 2008 almost 30% of the intramural R&D performed by UK-owned plants was funded from foreign sources. By contrast, less than 10% of foreign-owned R&D was funded from UK sources in 2008.

Table 3.4: Percentage of establishments that are UK/foreign-owned that perform R&D related activities in UK Manufacturing between 2002-2004 and 2008-2010

	UK-owned	Foreign-owned
	% establishments that do R&D	
2002-2004	45.22	72.21
2004-2006	42.85	69.68
2006-2008	45.95	55.56
2008-2010	41.15	55.01
	% establishments that product innovate	
2002-2004	23.30	35.20
2004-2006	20.83	34.81
2006-2008	17.92	23.89
2008-2010	23.19	26.59
	% establishments that process innovate	
2002-2004	34.91	60.66
2004-2006	33.18	37.85
2006-2008	33.84	47.84
2008-2010	36.29	53.21

Source: CIS

All the activities detailed in Table 3.4 occurred more frequently in all periods in foreign-owned than in UK-owned manufacturing. Comparison of these results with those presented in Figure 3.10 implies that those UK-owned firms that do R&D tend to do it more intensively than foreign-owned firms but that a higher proportion of foreign-owned establishments do some R&D.

3.3 Differences across location

The choice of where to locate will be determined primarily by considerations of cost: firms will wish to locate to a place which minimises their costs of production and the costs of transporting their goods to consumers. The latter suggests that the size of the local market will be an important determinant of location choice, as firms will wish to locate plants near concentrations of potential consumers. This explains the so-called 'home market' effect (Krugman, 1980) which is a feature of New Economic Geography models.

A desire to minimise production costs implies that labour costs, which vary greatly throughout the UK (ONS, 2013a), will also be an important determinant of plant location.[8] Similarly, the cost of land, which also differs significantly throughout the UK, will have an important impact on the geographical distribution of manufacturing. Government policy in the form of investment incentives (which lower the cost of capital) such as Regional Selective Assistance (Hill and Munday, 1992, Taylor, 1983) and location controls (Twomey and Taylor, 1985) also have the

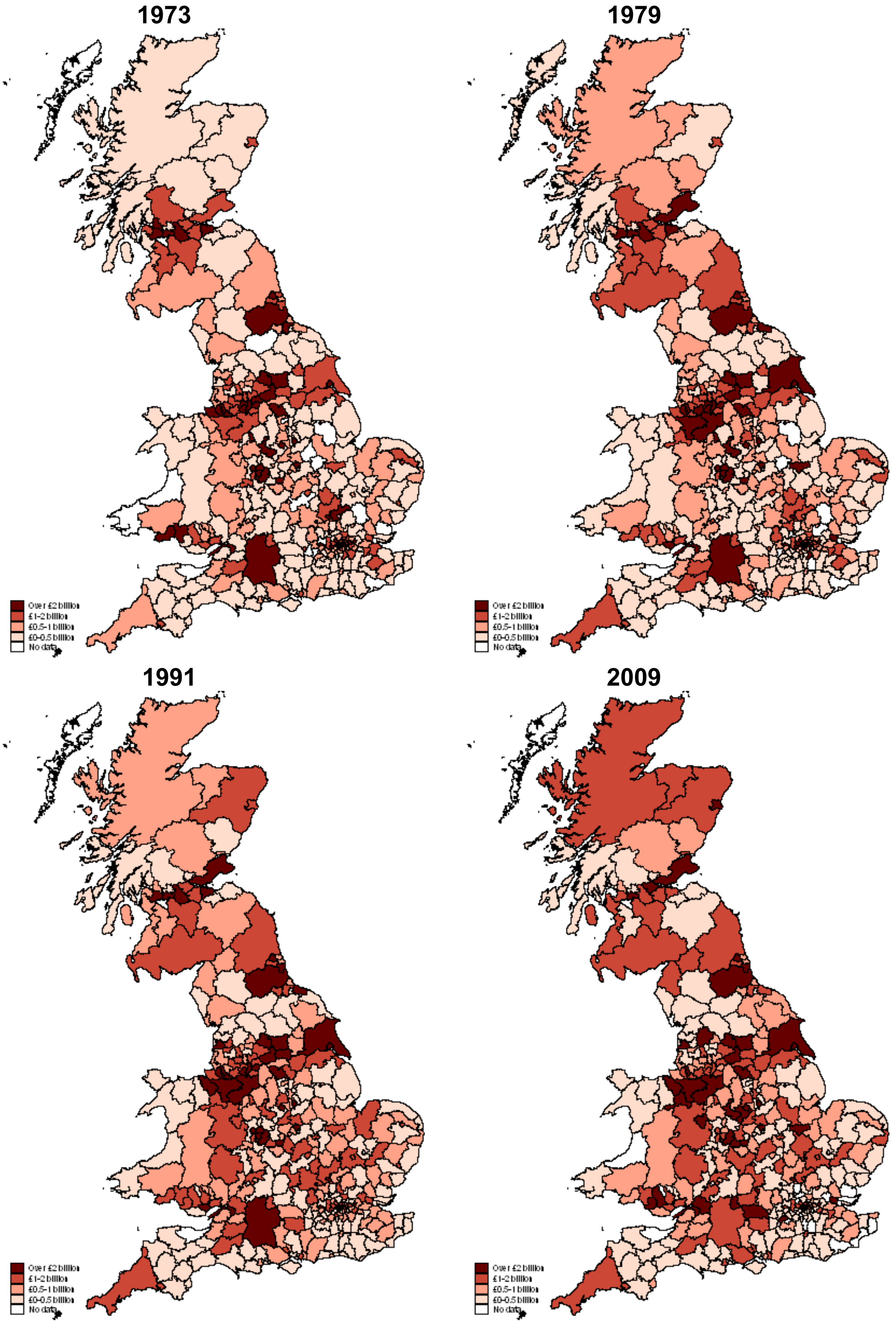
[8] A recognition of the importance of labour costs was the motivation for the Regional Employment Premium, which operated between 1967-73. This was a labour subsidy for manufacturing plants in assisted areas.

potential to influence location choice. However, the importance of government policy will have declined since the heyday of regional policy in the 1960s and 1970s (Wren, 2005).

The determinant that has received the most attention in the recent literature is spatial spillovers or agglomeration externalities. These are benefits that accrue to plants from being situated in the vicinity of other plants. Duranton and Puga (2004) describe the mechanisms which give rise to agglomeration externalities: as summarized by Overman et al. (2009), these are 'sharing', 'matching' and 'learning'. In addition to sharing facilities, such as ports and roads, plants can share the benefits of a wide variety of inputs suppliers and of a specialised labour force in areas of concentrated economy activity. In relation to matching, locations with large numbers of firms and workers make it easier for both to find productive matches, thereby reducing recruitment and training costs. Learning is also enhanced by the proximity of other firms because distance continues to act as a barrier to knowledge transmission, particular when knowledge is tacit in nature. By facilitating face-to-face contact, both between firms in the same industry and between customers and suppliers, concentrations of economic activity allow firms to benefit from knowledge spillovers. A rich empirical literature exists that tests for the existence of agglomeration externalities (see, e.g. Ciccone and Hall, 1996, Andersson and Loof, 2011, Rice et al., 2006). In his review of the literature, Puga (2010) refers to the study of Rosenthal and Strange (2004) which reports that doubling city size increases productivity by 3-8 per cent.

Agglomeration externalities are often distinguished in the literature according to whether they are an intra- or inter-industry phenomenon. The former type of externalities are termed MAR (Marshall, 1890; Arrow, 1962, Romer, 1986) or localisation externalities while inter-industry externalities are termed Jacobian (Jacobs, 1970, 1986) or urbanisation externalities. The mechanisms that give rise to agglomeration externalities (described above) can support both types of externality. For instance, firms may learn from other firms in the same industry and from firms in another industry. Empirical studies have managed to find evidence of both types of externality. For instance, Henderson (2003), Baldwin et al. (2010) and Martin (2010) find evidence in support of the existence of localisation externalities while the results of Graham (2009) and Overman et al. (2009) suggest that urbanisation externalities are more important.

Figure 3.12: Manufacturing Gross Output (2000 prices) across local authorities



Source: ARD

In 1973, manufacturing output was concentrated in the central belt of Scotland, Tyneside, a belt covering Cheshire, Greater Manchester and Yorkshire, South

Wales, Wiltshire and London (see Figure 3.12). By contrast, there was relatively little manufacturing output in the peripheral areas of Great Britain. With the exception of some parts of London, the South East of England along with most of the south coast also produced relatively little manufacturing output while, further north, Lincolnshire also had little manufacturing output. Overall, there was a relatively clear urban-rural divide with urban areas (and their immediate hinterlands) generally being more heavily dependent upon manufacturing.

By 2009, the amount of manufacturing output in and around London had fallen significantly. This is part of a broader trend which has obscured the urban-rural divide that was evident in 1973. Relatively large amounts of manufacturing output are still produced in the central belt of Scotland, Tyneside, Cheshire, Greater Manchester and Yorkshire, South Wales and Wiltshire. However, Shropshire and Herefordshire and many other parts of the West Midlands have increased the amount of manufacturing output produced. Thus, the urban-to-rural shift in manufacturing that was becoming apparent in the late 1970s and early 1980s (see Fothergill and Gudgin, 1982) appears to have continued.

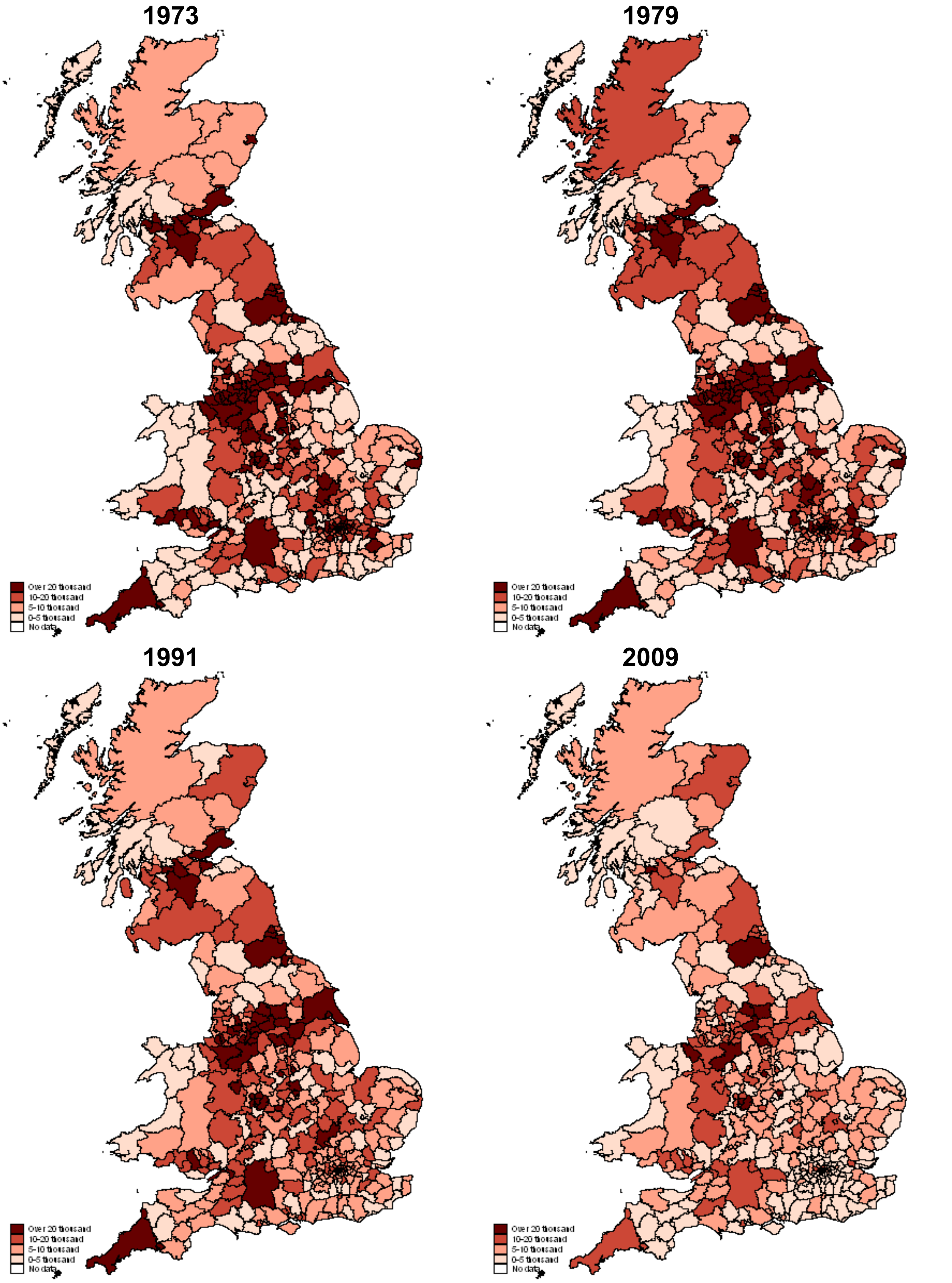
This is confirmed by Table 3.5 which classifies areas into four groups: large urban areas which had a population density of at least 10 per square kilometre and employment over 100,000 in 2005; small urban areas which had a population density of at least 10 per square kilometre and employment under 100,000 in 2005; large rural areas which had a population density of less than 10 per square kilometre and employment over 100,000 and small rural areas which had a population density of less than 10 per square kilometre and employment under 100,000. The data on employment and population is taken from ONS (2012a). The decrease in manufacturing in large urban area is mostly explained by the increase in manufacturing output attributable to small rural areas which increased their share of manufacturing output from a third to over a half.

Table 3.5: Percentage of UK Manufacturing Output by Area Type

	1973	1979	1991	2009
Large Urban Area	41.71%	36.64%	29.12%	25.57%
Small Urban Area	20.89%	21.57%	18.82%	17.47%
Large Rural Area	4.39%	5.74%	6.07%	6.70%
Small Rural Area	33.00%	36.04%	45.99%	50.26%

Source: ARD

Figure 3.13: Manufacturing Employment (2000 prices) across local authorities



Source: ARD

The general brightening of the maps shown in Figure 3.13 across time reflect the falls in aggregate employment in manufacturing between 1973 and 2009. Taking this into account, the picture shown by Figure 3.13 is broadly similar to that provided by Figure 3.12 which implies that the process of capital deepening witnessed in Figure 2.2 has occurred at a similar rate across local authorities. Table

3.6 provides the equivalent analysis to Table 3.5 for employment. This shows that urban to rural shift in manufacturing output also occurred in employment.

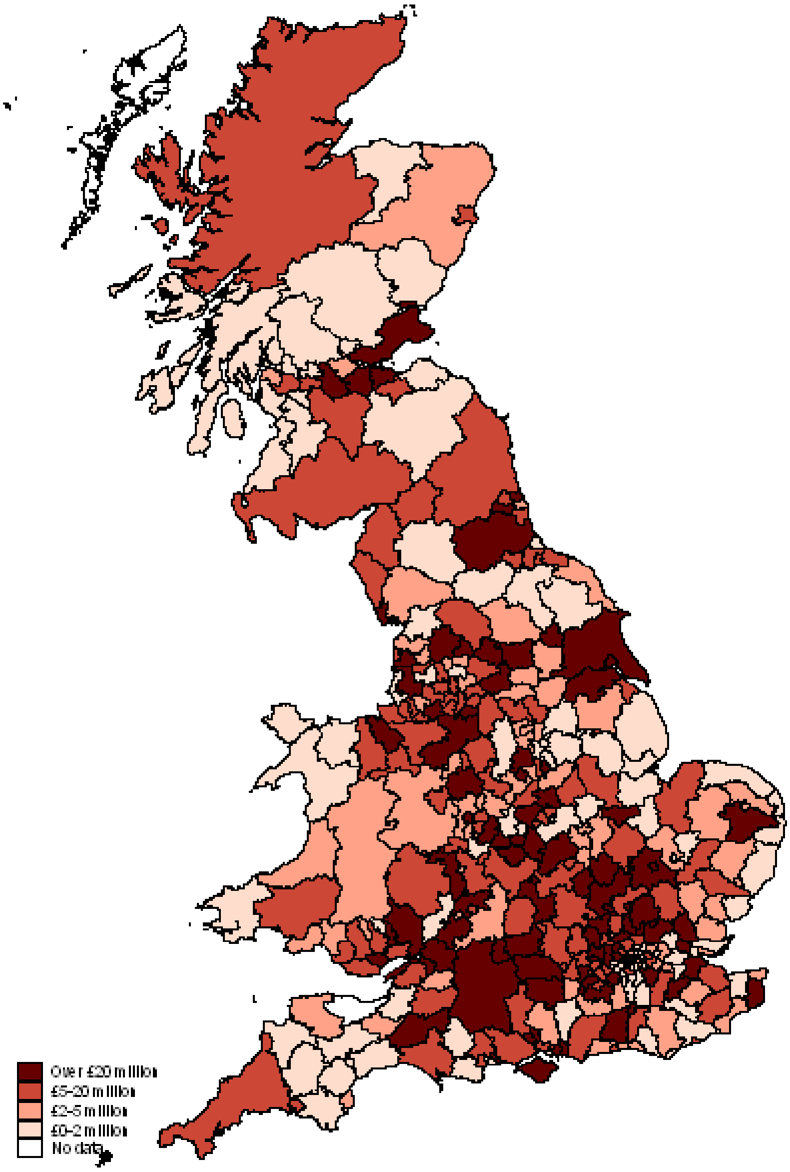
Table 3.6: Percentage of UK Manufacturing Employment by Area Type

	1973	1979	1991	2009
Large Urban Area	40.07%	37.73%	30.26%	25.91%
Small Urban Area	22.09%	21.14%	18.83%	17.00%
Large Rural Area	4.75%	6.13%	6.34%	6.56%
Small Rural Area	33.08%	35.00%	44.58%	50.53%

Source: ARD

Figure 3.14 shows average annual expenditure on manufacturing R&D between 1997 and 2008 across the local authorities of the UK. During this period, large amounts of R&D were performed in Tyneside, the belt encompassing Cheshire, Lancashire and Yorkshire, and the central belt of Scotland. These are also areas where relatively high amounts of manufacturing output were produced (see Figure 3.12). However, compared to output, R&D expenditure in South Wales was low. On the other hand, R&D expenditure is high in the area to the north and west of London which are areas where there was not much manufacturing output. This suggests that R&D expenditure may be more susceptible to spillovers and hence agglomeration than output, perhaps because of the greater importance of transports costs to the latter.

Figure 3.14: Average Manufacturing R&D (2005 prices), 1997-2008



Source: ARD/BERD

3.4 Summary

This section has provided disaggregated analysis on trends within manufacturing. There is some evidence that manufacturing has become more specialised in more high-tech sectors where the UK is likely to have a comparative advantage. The share of manufacturing owned by foreigners, particularly those from the EU and South East Asia, has increased substantially to the extent that foreign-owned plants now account for almost 50% of both output and employment. In relation to the location of manufacturing, there is far less manufacturing output and employment located in the south-east of England than during the 1970s. There has also been a shift of manufacturing from urban to rural areas.

4. Productivity

Observations can be made about changes in productivity from the figures presented above. For example, it is clear from Figures 2.1 and 2.2 that both labour and total factor productivity have increased dramatically between 1973 and 2009. This section takes a more rigorous approach by presenting results from a Haltiwanger (1997) decomposition of TFP growth. TFP is used as a measure of productivity rather than labour productivity because the former is only a function of efficiency and technology levels while the latter is determined by efficiency, technology and factor inputs. The decomposition shows whether and by how much groups of plants (defined by sector and ownership) have contributed to productivity growth and the channels through which this contribution was made.

Specifically, the decomposition splits productivity growth in different sub-groups into five different terms. The first term shows the contribution of productivity growth within plants that were open in both 1997 and 2008. The second term measures the impact of changing output shares across continuing plants. This term will be positive if plants with higher productivity in 1997 experienced increases in market shares. This term needs to be complemented with a third: the cross plant or covariance effect that shows the contribution from the coincidence of increases in productivity and increases in market shares. This term will be positive when increases in productivity are accompanied by increases in market share. Lastly, there are terms to show the contributions of entering and exiting plants, both measured with respect to the economy average in the base year. If entering plants are more productive than existing plants, they make a positive contribution to productivity growth and this term will therefore be positive. The exitors' term will be negative if exiting plants have lower productivity.[9] Thus the Haltiwanger (1997) decomposition disaggregates changes in TFP into those due to 'within plant' increases, 'between plant' increases[10] and entry and exit. It shows the relative contributions of TFP growth within continuing plants but also the contribution from reallocations of output shares across plants.

To help interpret the results, the figures are produced showing the contribution of different sub-groups to aggregate TFP growth obtained from the decomposition (i.e., column 1 in Table 4.1 below) but also these figures weighted to take account of the relative size of each sector (column 2 in Table 4.1). Similarly, the figures showing the contribution of each component are also weighted (columns 3-6).

A standard TFP index is also produced for each sub-group (which weights each plant by its share in total *sub-group* rather than *total* output) and from this a standard estimate of TFP growth (columns 9 – 11 in Table 4.1) is calculated, in order to show that this approach, which does not take account of reallocation of output across industry sub-groups, often gives very different results if inter-industry reallocation has been occurring. The more general Haltiwanger (1997) approach

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[9] A negative sign is imposed in the tables below to make it easier to interpret the results.

[10] The 'between plant' and cross plant/firm effects obtained from the Haltiwanger approach are combined into one 'between plant' effect. While the separate information is of some interest, the focus is mainly on whether there were changes in TFP within plants, between plant, or through entry and exit.

does allow for this, and is therefore a more informative measure of the contribution to aggregate productivity growth. That is, since plant entry and exit in markets inherently involve changes in market shares, and thus industrial restructuring, it is necessary to include and measure the impact of such ‘churning’, as well as the impact on TFP of any intra-industry reallocations of resources, when describing aggregate productivity growth.

Box 4.1 Productivity decomposition methodology

The first step is to obtain estimates of TFP for each plant. Further details on this stage are given in Harris and Moffat (2012). Here TFP is defined using a Cobb-Douglas log-linear production function approach (including fixed-effects, α_i):

$$y_{it} = \alpha_i + \alpha_E e_{it} + \alpha_M m_{it} + \alpha_K k_{it} + \alpha_X X_{it} + \alpha_T t + \varepsilon_{it} \quad (4.1)$$

where *y*, *e*, *m* and *k* refer to the logarithms of real gross output, employment, intermediate inputs and the capital stock in plant *i* in time *t* (*i* = 1,…, *N*; *t*=1,…*T*); and X_{it} is a vector of observed (proxy) variables determining TFP. In order to calculate TFP, equation (4.1) is estimated *directly* (e.g., Harris, et al. 2005) providing values of the elasticities of output with respect to inputs (α_E, α_M, and α_K). TFP could then be calculated as the level of logged output that is not attributable to factor inputs (employment, intermediate inputs and capital) – i.e., TFP is due to efficiency levels and technical progress. Thus, such a measure of TFP is equivalent to:

$$\ln T\hat{F}P_{it} \equiv y_{it} - \hat{\alpha}_E e_{it} - \hat{\alpha}_M m_{it} - \hat{\alpha}_K k_{it} = \hat{\alpha}_i + \hat{\alpha}_X X_{it} + \hat{\alpha}_T t + \hat{\varepsilon}_{it} \quad (4.2)$$

Equation (4.1) – in dynamic form with additional lagged values of output and factor inputs – was estimated using the system-GMM approach (Blundell and Bond, 1998). This is sufficiently flexible to allow for both endogenous regressors and a first-order autoregressive error term. Note, all data were also weighted to ensure that the samples are representative of the population of GB plants under consideration.

Having obtained estimates at the plant-level of TFP, the index of productivity in year *t* (and its growth between *t* and *t-k*) is a geometrically weighted average of individual plant-level productivity:

$$\ln T\hat{F}P_t = \sum_j \sum_i G_{ij} \times \theta_{ijt} \ln T\hat{F}P_{ijt}, \qquad \Delta \ln T\hat{F}P_t = \ln T\hat{F}P_t - \ln T\hat{F}P_{t-k}, \quad (4.3)$$

where θ_{ijt} is the share of gross output for plant *i* in period *t* and G_{ij} is a set of mutually exclusive dummy variables indicating whether a plant belongs to sub-group *j*.

The approach taken by Haltiwanger (1997), reviewed and contrasted with other decomposition methods in Foster, Haltiwanger and Krizan (2001), is used to decompose measures of productivity growth into various components that represented the impact of resource allocation across surviving plants as well the impact on productivity of the entry and exit of plants. Thus $\Delta \ln T\hat{F}P_t$ equals:

Continuers: Within plant	$\sum_j \sum_i G_{ij} \times \theta_{ijt-k} \Delta \ln T\hat{F}P_{ijt} +$	
Continuers: Between plant	$\sum_j \sum_i G_{ij} \times \Delta\theta_{ijt} \left(\ln T\hat{F}P_{ijt-k} - \ln T\hat{F}P_{t-k}\right) +$	
Continuers: Cross plant	$\sum_j \sum_i G_{ij} \times \Delta\theta_{ijt} \Delta \ln T\hat{F}P_{ijt} +$	(4.4)
Entering plants	$\sum_j \sum_i G_{ij} \times \theta_{ijt} \left(\ln T\hat{F}P_{ijt} - \ln T\hat{F}P_{t-k}\right) -$	
Exiting plants	$\sum_j \sum_i G_{ij} \times \theta_{ijt-k} \left(\ln T\hat{F}P_{ijt-k} - \ln T\hat{F}P_{t-k}\right)$	

4.1 Comparison with services

Table 4.1 gives the results of the productivity decomposition for manufacturing and services. Between 1997 and 2008, TFP increased in Great Britain by on average 1.6% p.a. (see column 1) to which manufacturing contributed just under 14%. Given that in 1997 (2008), manufacturing accounted for some 21% (19%) of total gross output (columns 7 and 8), it can be seen that manufacturing performed less well vis-à-vis services. The breakdown of the manufacturing results into survivors (columns 3 and 4) and net entrants (columns 5 and 6) provides the main reason for this under-performance; manufacturing plants with above average TFP were being closed.

Services contributed more to aggregate TFP growth, particularly because they account for some 80% of all gross output produced in the market sector covered here, but also because they experienced higher TFP growth on the basis of both approaches used here. There was little difference in terms of the column (2) – Haltiwanger – and column (11) – standard TFP – approaches because there was relatively little redistribution of output between them during 1997-2008.

For services, Table 4.1 shows that ‘churning’ dominates as the explanation of changes in TFP as both entrants and exitors contributed positively to growth. In contrast, changes in manufacturing TFP were dominated by between-plant effects (0.88% p.a.) indicating that on average plants with higher TFP were gaining market share. The net impact of ‘churning’ in manufacturing was much smaller, because while entrants had a large (positive) impact on TFP growth, plants that closed had a large (negative) impact.

Table 4.1: Plant-level TFP Growth (average per annum) in Manufacturing and Services, 1997-2008, Great Britain

	Haltiwanger approach[a]						Output share (%)		Standard approach[b]		
	TFP growth (% p.a.)		Decomposition of (weighted) TFP growth						TFP index[f]		TFP growth (% p.a.)
	Contribution	Weighted[d]	Within plant	Between plant[e]	Enterers	Exitors	1997	2008	1997	2008	within sub-group[g]
Sector[c]	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Manufacturing	0.22	1.03	-0.16	0.88	2.37	-2.06	21.40	19.47	1.18	1.22	1.03
Services	1.37	1.74	-0.22	0.60	1.01	0.35	78.60	80.53	0.95	1.04	1.84
All sectors	1.59	1.59	-0.20	0.66	1.30	-0.17	100.00	100.00	1.00	1.07	1.59

[a] Includes change in plant and market shares *across* sub-groups (i.e., θ_{it} in equation 4). See text for details. Source: ARD
[b] Only considers TFP (and its growth) for plants *within* each sub-group.
[c] Continuing plants that switched sub-groups between 1997-2008 are allocated by their 2008 status in columns (1) to (6); in the other columns they are assigned based on their sub-group status in each year.
[d] Column (1) divided by column (7) ÷ 100. Note, figures are based on underlying data (not rounded data presented here).
[e] Note, the second and third terms on the right-hand-side of the equal sign in equation (4.4) are combined.
[f] The actual TFP scores have been normalised on the 1997 'all sub-groups' value of 2.403
[g] 100 × 2.403 × [col. (10) – col. (9)] ÷ 11 to provide % p.a.

Table 4.2: Plant-level TFP Growth (average per annum) in UK-owned and Foreign-owned Manufacturing plants, 1997-2008, Great Britain

	Haltiwanger approach[a]						Output share (%)		Standard approach[b]		
	TFP growth (% p.a.)		Decomposition of (weighted) TFP growth						TFP index[f]		TFP growth (% p.a.)
	Contribution	Weighted[d]	Within plant	Between plant[e]	Enterers	Exitors	1997	2008	1997	2008	within sub-group[g]
Sub-group[c]	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
UK-owned	0.10	0.64	-0.19	0.74	2.59	-2.50	15.65	12.47	1.22	1.28	1.30
Foreign-owned	0.12	2.09	-0.09	1.27	1.77	-0.88	5.75	7.00	1.07	1.13	1.39
All Manufacturing	0.22	1.03	-0.16	0.88	2.37	-2.06	21.40	19.47	1.18	1.22	1.03

For notes to table see Table 4.1 Source: ARD

Table 4.3: Plant-level TFP Growth (average per annum) in Manufacturing sub-sectors, 1997-2008, Great Britain

	Haltiwanger approach[a]						Output share (%)		Standard approach[b]		
	TFP growth (% p.a.)		Decomposition of (weighted) TFP growth						TFP index[f]		TFP growth (% p.a.)
	Contribution	Weighted[d]	Within plant	Between plant[e]	Enterers	Exitors	1997	2008	1997	2008	within sub-group[g]
Sector[c]	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
High-Tech	0.13	5.23	-0.15	2.55	6.14	-3.31	2.48	2.75	1.40	1.55	3.28
Medium High-tech	0.14	2.04	0.04	0.85	1.43	-0.29	6.87	6.82	1.01	1.09	1.74
Medium Low-Tech	0.04	1.04	-0.38	0.68	0.78	-0.05	4.24	3.85	0.99	1.04	1.06
Low-Tech	-0.09	-1.22	-0.24	0.48	2.87	-4.32	7.80	6.05	1.35	1.34	-0.20
All Manufacturing	0.22	1.03	-0.16	0.88	2.37	-2.06	21.40	19.47	1.18	1.22	1.03

For notes to table see Table 4.1 Source: ARD

4.2 Comparisons within manufacturing

Table 4.2 disaggregates the results given in Table 4.1 to show the importance of UK-owned and foreign-owned plants to TFP growth within manufacturing. The UK-owned sector was primarily responsible for the poor performance of manufacturing as a whole. Despite producing a third as much output as UK-owned manufacturing, the foreign-owned sector contributed more to TFP growth in manufacturing. Based on the standard TFP calculations, column (11) shows foreign-owned plants experienced relatively higher TFP growth in the (1.4% p.a. versus 1.3% p.a.). However these figures ignore the large reallocation of output shares that occurred in favour of the foreign-owned sector.

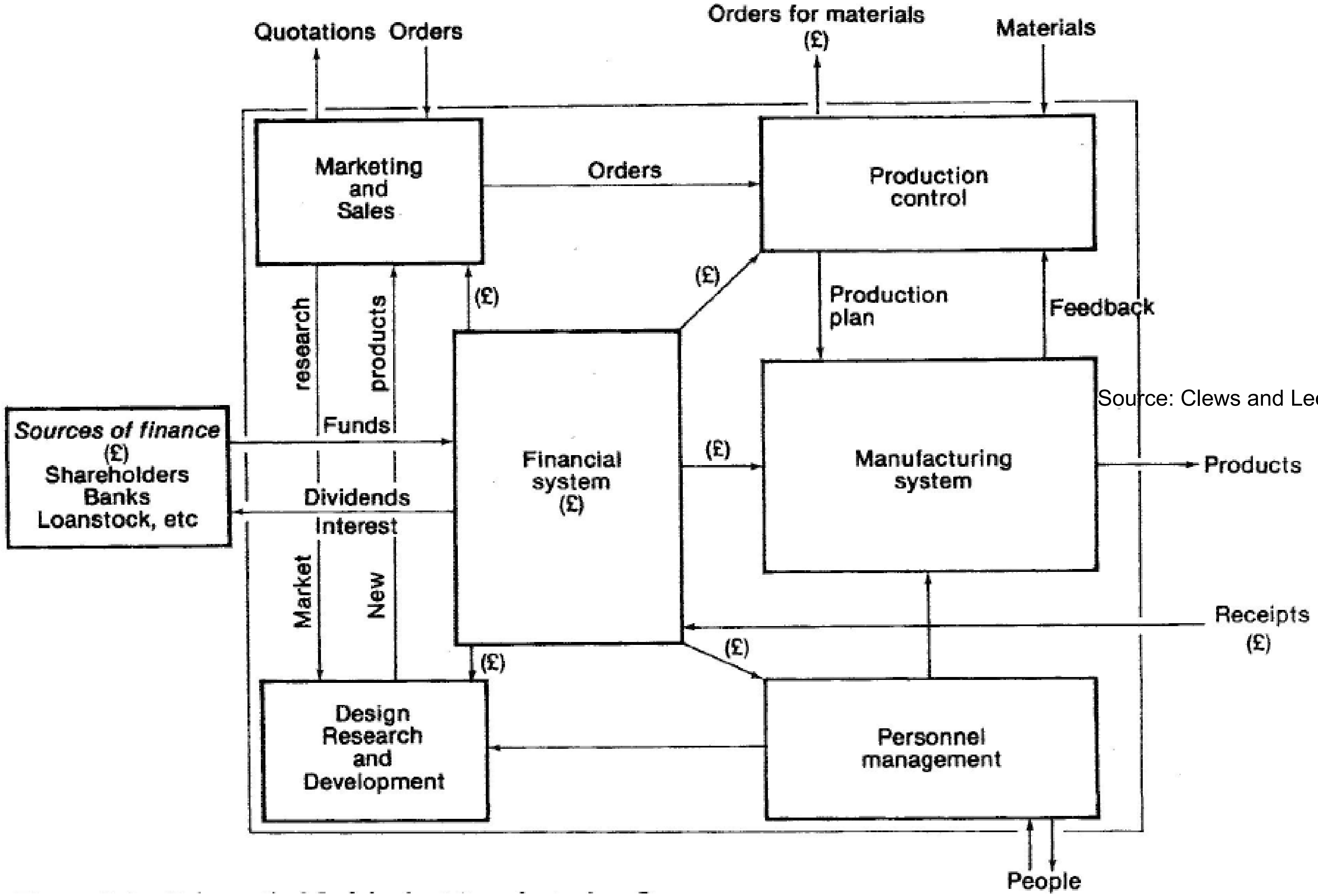
TFP growth in foreign-owned plants was dominated by both net entry (with higher productivity entrants having an important impact), and resource reallocations in favour of ‘continuing’ plants. However, the net entry effect was significantly truncated by the negative contribution of foreign-owned plants with relatively high productivity that closed. For UK-owned manufacturing plants, Table 4.2 shows that the ‘between plant’ effect dominates since the contribution of entrants (2.6% p.a.) is largely cancelled by the contribution of exiting plants (–2.5% p.a.). Table 4.3 expands the results in Figure 4.1 to cover the four industry sub-groups used in this article. In absolute terms, medium high-tech plants made the largest contribution to aggregate TFP growth but taking into account the relative size of each sector, high-tech manufacturing made the largest contribution to TFP growth in manufacturing. The largest decline in TFP in manufacturing was in low-tech manufacturing. The ordering of TFP gains and losses in columns (1) and (2) accord with prior expectations.

Sectors that experienced above average TFP growth did so mainly because of the opening of more productive plants although these sectors also benefited from more productive existing plants increasing their share of output. For low-tech manufacturing, the negative contribution to TFP growth was primarily due to the closure of relatively high productivity plants. Within-plant improvements in TFP over 1997-2008 were generally negative. Overall, the net impact on TFP growth of those plants remaining open throughout 1997-2008 was generally small in both absolute terms and relative to net ‘churning’. Using the standard approach to obtaining TFP indices, column (9) in Table 4.3 shows which industry sub-groups had on average the highest levels of TFP in the base year: high-tech manufacturing is ranked highest followed by low-tech manufacturing and other-low knowledge intensive services. Based on column (11), high-tech manufacturing experienced the highest growth in TFP (at some 3.3% p.a.) followed by medium high-tech manufacturing (1.7% p.a.).

4.3 Summary

This section has provided the results from a decomposition of productivity growth between 1997 and 2008. The results show that TFP in manufacturing grew slower than in services and that manufacturing consequently made a relatively small contribution to aggregate TFP growth. Within manufacturing, foreign-owned plants contributed more to TFP growth than UK-owned plants, despite accounting for around a quarter of manufacturing output in 1997. Across sectors, high-tech sectors had higher rates of productivity growth than low-tech sectors which will be part of the explanation for the higher rates of growth of output and GVA in these sectors.

Figure 5.1: Schematic Model of a Manufacturing Company



Source: Clews and Leonard (1985, Figure 2.1)

5. Fragmentation in UK Manufacturing

This section will provide indicative evidence on the degree and nature of fragmentation in UK manufacturing over the period, 1973-2009. The term fragmentation can be used to describe different activities. Outsourcing or vertical disintegration occurs when intermediate inputs that were previously produced within the firm are bought from outside the firm. This therefore implies that firms are specialising in core activities and buying inputs from outside the firm rather than producing these inputs themselves. Geographic fragmentation or offshoring occurs when the production process is spread over a wider geographical area. Figure 5.1 above provides a visual representation of the functions performed by manufacturing, most of which were performed in-house during the 1970s, many of which could be (and eventually were) outsourced.

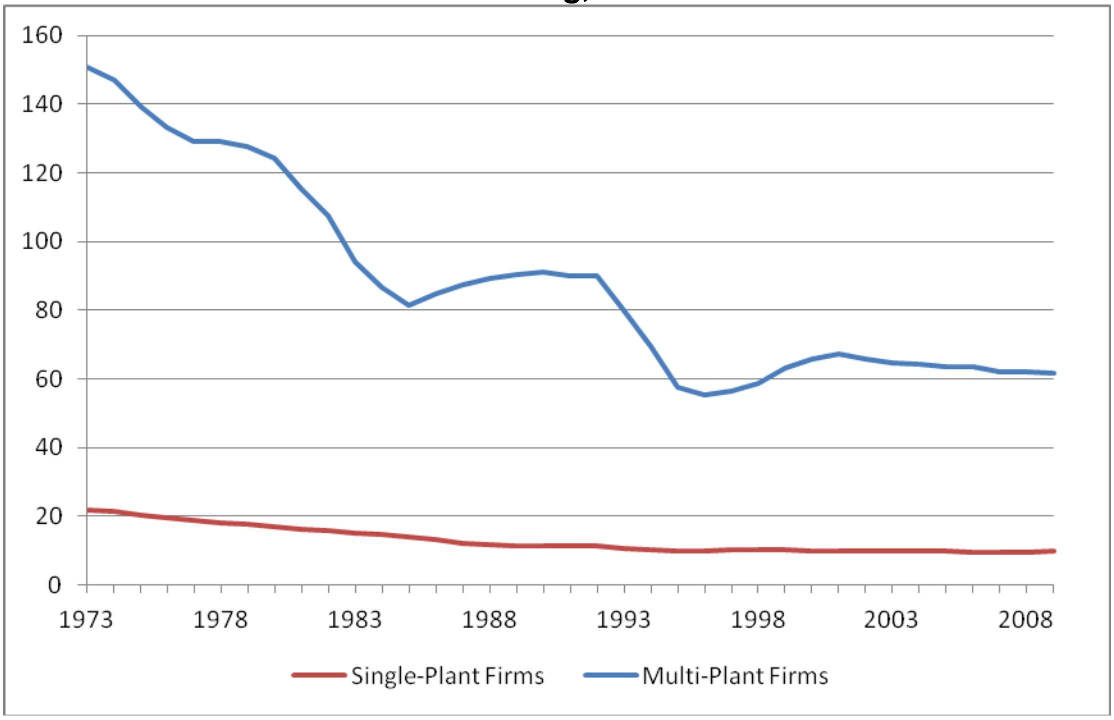
Abramovsky and Griffith (2007) examine the extent of fragmentation by combining information from input-output tables with the Business Structural Dataset (BSD). The former shows which industries are vertically linked, while the BSD allows the identification of firms in which there are establishments from supplier and purchaser industries (i.e. vertically linked industries). They assume that establishments source all of their inputs from a given industry from within the firm first (and only go outside the firm if internal production is not sufficient), if an establishment from the relevant industry exists within that firm. This approach is not taken here because of the strength of such an assumption (there is actually no information on within- and between-firm trading patterns for goods and services) and because its validity has been questioned by recent evidence from Atalay et al. (2012) who show, using US data, that within firms that could potentially be vertically integrated, roughly one half of upstream plants do not provide inputs to downstream plants. To explain this, they suggest that an important motivation for vertical integration is access to intangible rather than tangible inputs.

So instead, more general information is provided that gives more of an indication of what has been happening in relation to fragmentation over the period. Evidence has already been presented in Figure 2.1 which shows that the value of intermediate inputs has increased by 38% between 1973 and 2009, a period when gross output rose only slightly. This may indicate that manufacturing has indeed become more fragmented as plants are buying in more inputs from other firms than previously. Further evidence can be provided by making use of the information on ownership available in the ARD. We therefore start by looking at average plant size for multi-plant and single--plant firms between 1973 and 2009. If multi-plant firms are growing relative to single--plant firms this would suggest that they are producing more inputs in-house. On the other hand, a faster relative growth rate of single--plant firms would suggest greater specialisation of production and greater fragmentation.

5.1 Firm ownership structure

As would be expected, multi-plant firms are always much larger than single--plant firms. However, the difference between the two series has fallen significantly over time (see Figure 5.2). In 1973, multi-plant firms had an average of 153 employees while single--plant firms had an average of 22 employees. Over the period, the average number of employees at single--plant firms fell steadily so that, in 2009, it was only 10. However, the fall in the average number of employees for multi-plant firms has been more dramatic and now stands at 62, only 41% of the value at the beginning of the period.

Figure 5.2: Average plant size for multi-plant and single-plant firms UK manufacturing, 1973-2009



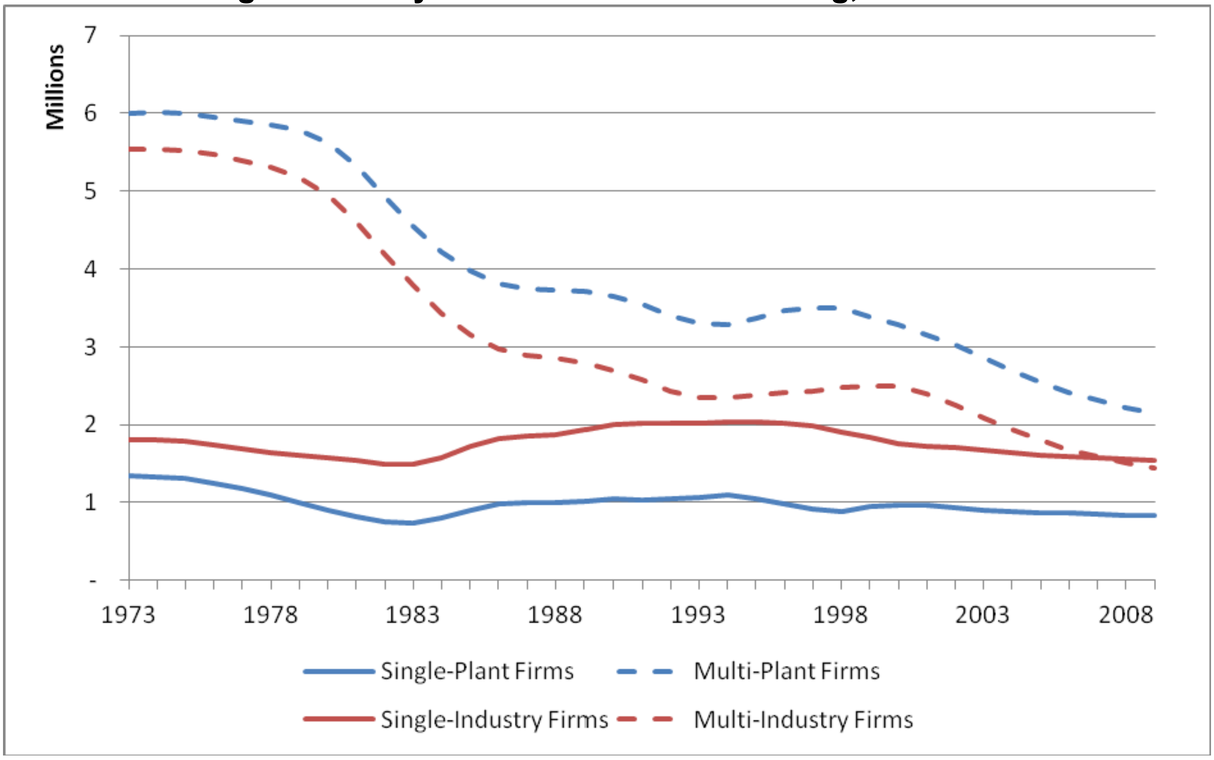
Source: Author's own calculations based on the ARD

The fact that employment in multi-plant manufacturing firms has fallen so much faster than employment in single--plant firms would suggest the fall in employment in multi-plant firms cannot be solely attributed to the substitution away from labour in the production process seen in Figure 2.2. Instead, if the fall in the average size of multi-plant firms indicates that manufacturing firms are now sourcing their intermediate inputs from outside the firm rather than producing such inputs themselves (i.e. are now less vertically integrated), it implies that the manufacturing sector has become more fragmented. Moreover, the *relative* increase in the size of single--plant firms would imply that that there is greater scope for specialised suppliers that provide inputs to and are supplied by other firms. However, given that the above provides information on manufacturing only, it is possible that manufacturing firms are obtaining services from other plants within the firm (outside of manufacturing) which were previously provided within plants designated as manufacturing plants. This would suggest that there is geographic fragmentation rather than outsourcing. single-single- Unsurprisingly, single--plant firms have always had the smallest share of overall employment of the four groups (see Figure 5.3[11]) and this has fallen, in 1973-2009, from 1.3 million in to 0.8 million employed.

[11] Note, only manufacturing is being considered here (data for services only begins in 1997), so if plants belong to a firm which also operate in services, this is not captured here. Note also, both sub-groups (single-- and multi-plant firms; and single-- and multi-industry firms) each cover the entire level of employment in manufacturing (i.e., the red lines and blue lines both sum to total manufacturing employment).

Multi-plant firms have experienced a much larger fall in employment from 5.5 million in 1973 to 1.4 million in 2009 with the fastest pace of decline seen during the 1980s. The fact that employment in multi-plant firms has fallen at a faster rate than average employment in multi-plant firms shows that 1973-2009 was also a period of net closure of multi-plant firms.

Figure 5.3: Employment in Multi-Plant and Single--Plant and Multi-Industry and Single--Industry Firms in UK manufacturing, 1973-2009



Source: Author's own calculations based on the ARD

In relation to fragmentation, as above, the proportionally larger fall in employment in multi-plant firms is suggestive of an increase in outsourcing if multi-plant firms in manufacturing are obtaining more intermediate inputs from outside the firm or an increase in geographic fragmentation if multi-plant firms have moved functions to other plants in the firm that operate in the service sector.

The other two series show the equivalent figures for single--industry and multi-industry firms. This is a better indicator of fragmentation as multi-plant firms may have many plants in the same industry producing the same output which are not vertically integrated. However, the picture is very similar which suggests that the story which can be told for single- and multi-plant firms can also be told for single- and multi-industry firms. Employment in single--industry firms was 1.8 million in 1973[12] (suggesting that 0.5 million worked in multi-plant firms in a single- industry) while employment in multi-industry firms was 5.5 million. By 2009, employment in single--industry firms had fallen slightly to 1.5 million but employment in multi-industry firms had declined far more dramatically to 1.4 million, meaning that more people were employed in single--industry firms than multi-industry firms despite employment in the latter being three times as large in 1973. As above, this provides

[12] This suggests that 0.5 million (1.8 million in single--industry firms minus 1.3 million in single- plant firms) worked in multi-plant firms in a single- industry

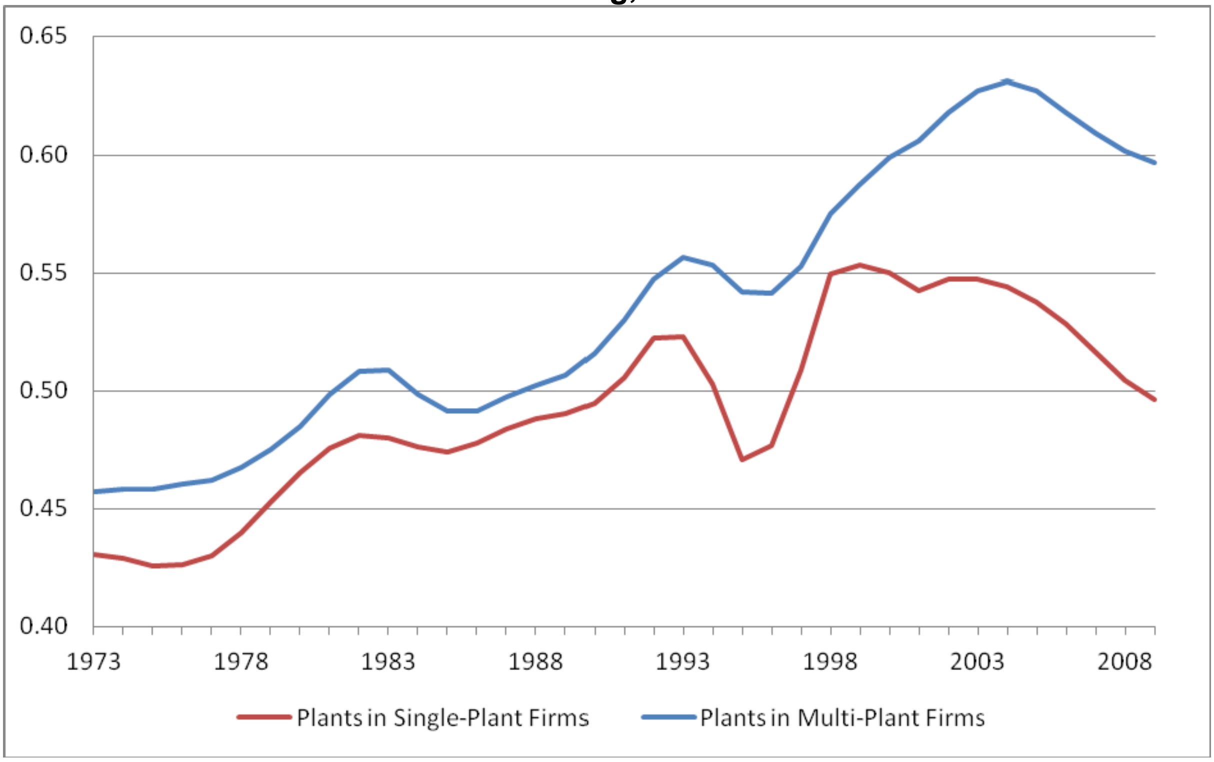
support for the conclusion that either manufacturing firms have been outsourcing to other manufacturing firms over the period or have been receiving services from specialised service sector plants within the firm that were previously provided within manufacturing plants.

Figures A.3-A.6 in Appendix B disaggregates the figures in Figure 5.3 by sector and by foreign-ownership. In relation to the sectoral disaggregation, Figure A.3 and A.4 show that all sectors experienced a larger decline in employment in multi-plant and multi-industry firms than in single--plant and single--industry firms, respectively. Indeed, with the exception of low-tech manufacturing, employment in single--plant and single--industry firms did not change much between 1973 and 2009. The greatest disparity in the rate of decline in single- versus multi-plant firms and single- versus multi-industry firms occurred in low-tech manufacturing, followed by medium high-tech manufacturing, medium low-tech manufacturing and high-tech manufacturing.

Turning to the foreign-ownership disaggregation presented in Figures A.5-A.6, the UK-owned sector experienced a far greater rate of decline in employment in multi-plant and multi-industry firms than in single--plant and single--industry firms, respectively. Employment in foreign-owned single--plant and single--industry firms increased slightly between 1973 and 2009 but this was offset in the case of single--industry firms by a fall in employment in multi-industry firms but reinforced in the case of single--plant firms by employment increases in multi-plant firms.

5.2 Intermediate inputs usage

Figure 5.4: Median Ratio of Intermediate Inputs to Real Gross Output in UK Manufacturing, 1973-2009



Source: Author's own calculations based on the ARD

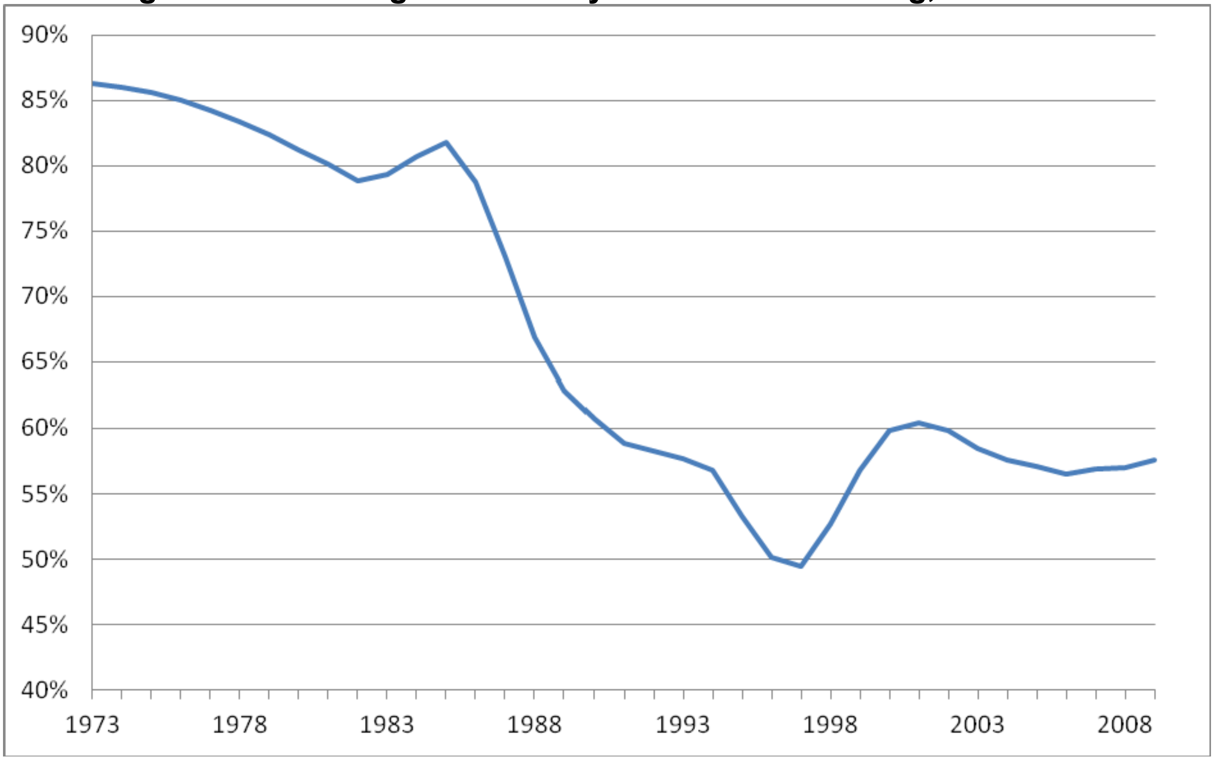
Evidence on fragmentation can also be provided by looking at the use of intermediate inputs (Figure 5.4). That the series for plants in multi-plant firms is always higher than the series for plants in single--plant firms is contrary to expectations if multi-plant firms are able to buy more of their intermediate inputs from within the firm than single--plant firms due to them being vertically integrated. On the other hand, multi-plant firms may be operating in industries which have more complicated production processes than single--plant firms which gives them greater need of and scope for vertical integration.

Both series have trended upwards over the full period, which is indicative of greater fragmentation as both multi-plant and single--plant are buying in more inputs from other firms. However, there is a larger gap in 2009 than in 1973, which suggests that this process has been particularly strong for single--plant firms.

Figure 5.5 shows how the percentage has fallen dramatically from 86% to 57% although this fall has occurred at very different rates.[13]

[13] The rebound in the series after 1985 is likely to be, at least partly, an anomaly caused by the ONS (and its predecessor the CSO) moving in 1984 to a new register of plants/firms which included information from VAT registrations; plants and firms were 'discovered' that were not captured before VAT records were used.

Figure 5.5: Percentage of Multi-Plant Firms that operated in more than one 4-digit manufacturing SIC industry in UK Manufacturing, 1973-2009

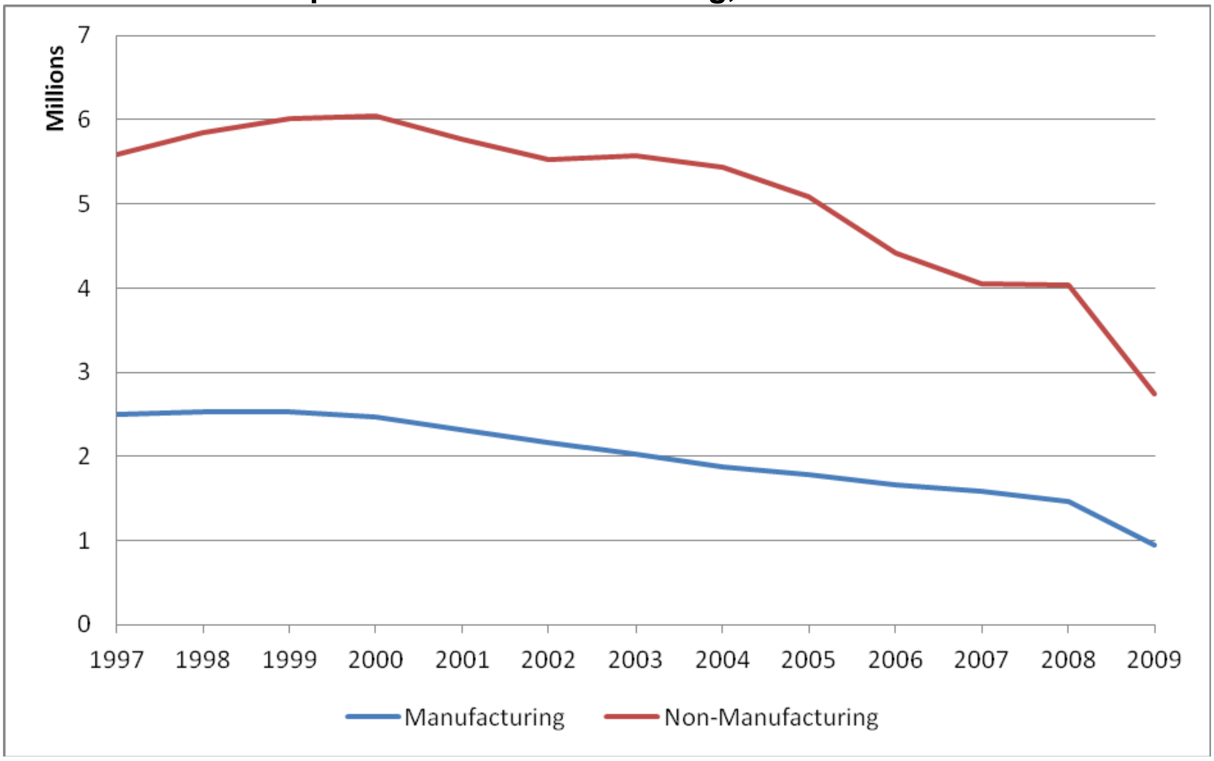


Source: Author's own calculations based on the ARD

Overall, the series is indicative of an increase in fragmentation as it suggests that either, firms were specialising in core activities and preferred to purchase inputs which would have been produced in-house previously; alternatively, these manufacturing firms may have been diversifying into services (they now operate in industries where specialist services are provided). This is a problem with the data considered previously as it does not take account of firms which operate plants in manufacturing and plants outside of manufacturing. The following figure shows that this is an important omission.

5.3 Relationship between manufacturing and services

Figure 5.6: Employment in Manufacturing and Non-Manufacturing of firms with plants in UK manufacturing, 1997-2009



Source: Author's own calculations based on the ARD

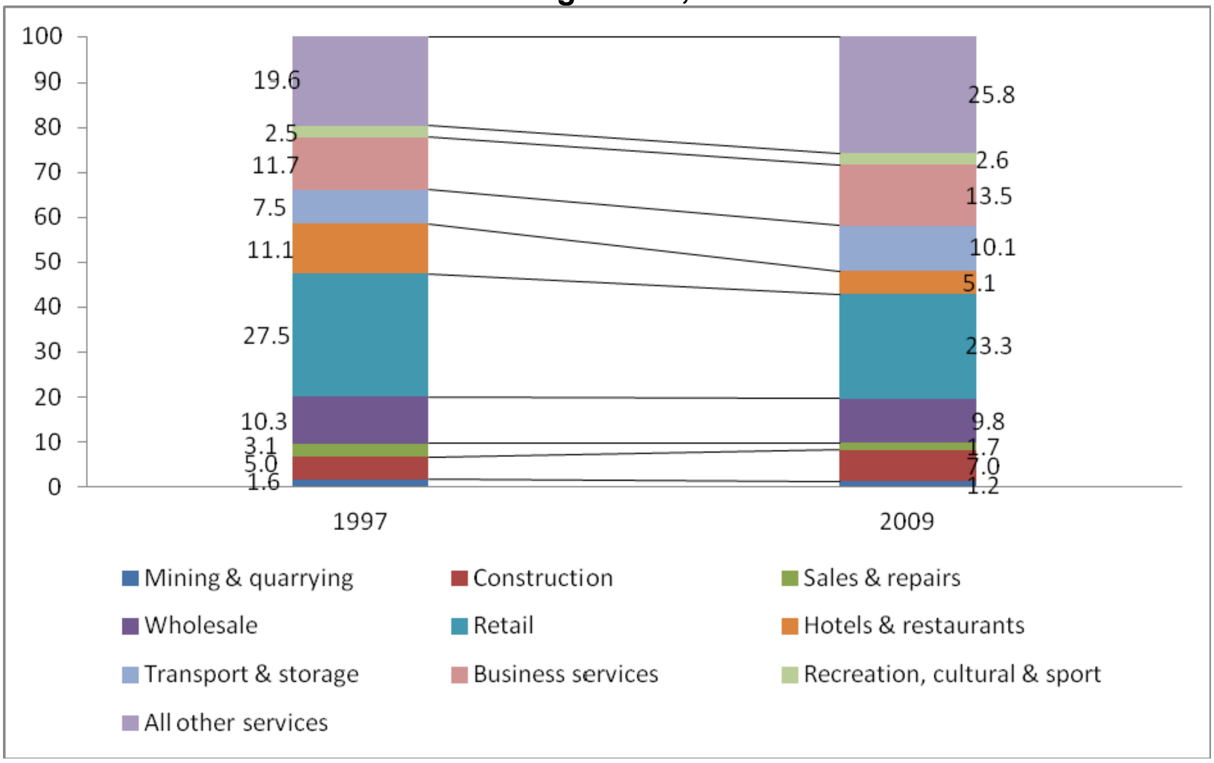
Figure 5.6 shows employment in the manufacturing and non-manufacturing sector for firms that operate plants in both sectors between 1997 and 2009. The latter consists of all sectors covered by the ARD and therefore excludes financial services. It is not possible to provide information for before 1997 because service sector plants were not included in the ARD prior to this year.

Total employment is always greater in the non-manufacturing than in the manufacturing sector, which suggests that, in employment terms, manufacturing is not the primary activity of many firms which have plants in the manufacturing sector. However, given that manufacturing is less labour intensive than other activities, manufacturing may still dominate firm output. Nevertheless, it is clear that, when trying to explain trends in fragmentation, ignoring the service sector, as was done in the earlier figures, is problematic as manufacturing firms are also heavily involved in services.

Both series have fallen over time (Figure 5.6). Employment in the manufacturing sector has declined at a relatively constant rate and was over one million lower in 2009 than in 1997 (a fall of 44%). Employment in the non-manufacturing sector is around 1.4 million lower in 2009 than in 1997 (a fall of 25%). Given that the percentage employment fall in manufacturing is greater than that of non-manufacturing, this shows that manufacturing has become less important in employment terms in firms with plants in manufacturing and other non-manufacturing sectors. This suggests that there is scope for the decrease in employment in multi-plant firms and the increase in the use of intermediate inputs that occurred within manufacturing (see earlier figures) to have been the consequence of manufacturing firms performing more functions within plants outside of manufacturing rather than buying more inputs from outside the firm.

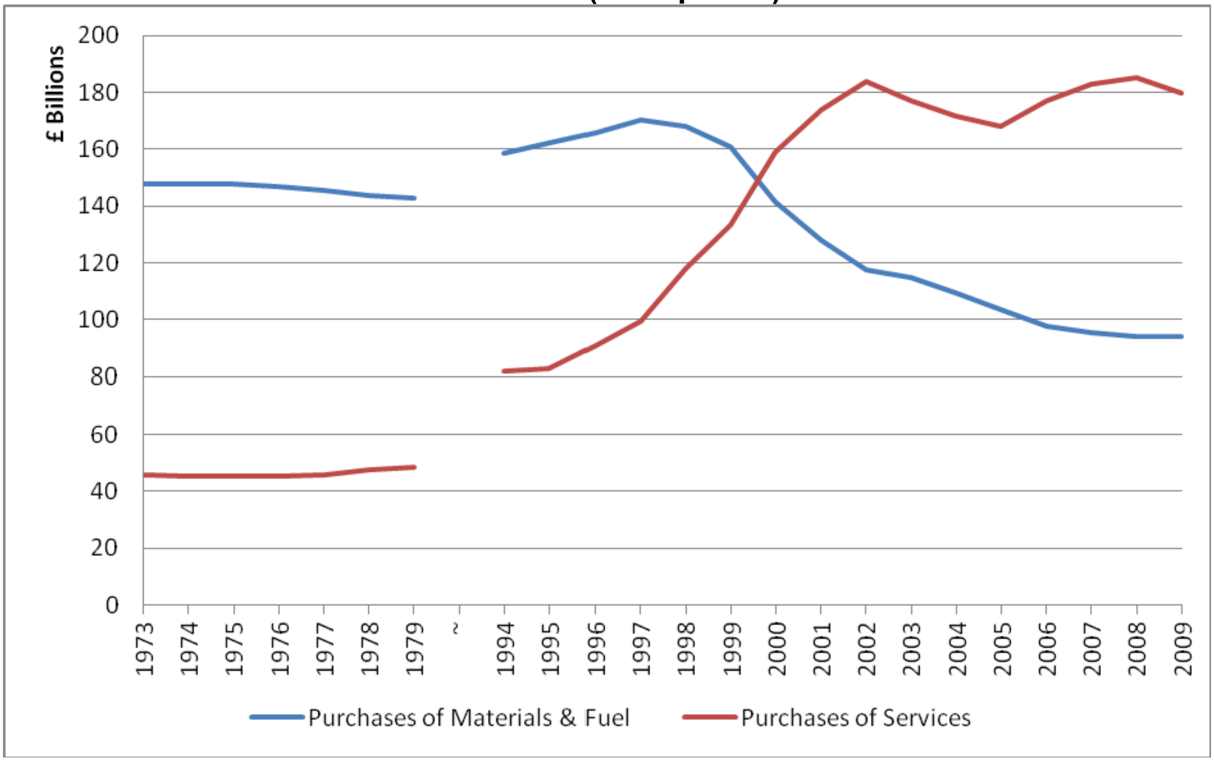
Having shown that multi-plant firms with manufacturing plants were heavily involved in other non-manufacturing activities, it is interesting to see in which non-manufacturing industries this employment is located. Figure 5.7 shows the distribution of employment in non-manufacturing industries for multi-plant firms that own plants across manufacturing and non-manufacturing. Excluding the all other services sector (which comprises a large number of individually small sub-groups), the largest sector in 2009 was retail which had 23.3% of non-manufacturing employment in firms that own plants in manufacturing and other sectors. Other large sectors were business services, transport and storage, wholesale and construction of the total employment in non-manufacturing in firms which owned plants in both manufacturing and non-manufacturing.

Figure 5.7: Distribution of Employment across other sectors for Firms with Manufacturing Plants, 1997-2009



Source: Author's own calculations based on the ARD

Figure 5.8: Purchase of intermediate inputs in UK manufacturing, 1973-79, 1994-2009 (2000 prices)



Source: Author's own calculations based on the ARD

Figure 5.8 shows the total value of purchases of materials and fuel and purchases of services in UK manufacturing for 1973-1979 and 1994-2009. Data on these variables were not available in the ARD for the intervening period. The big change was the large increase in purchases of services which has occurred, to some extent, at the expense of the purchases of materials and fuel, which have dropped significantly since the end of the 1990s. This shows that manufacturing has become more dependent on the purchase of intermediate inputs from services.[14] This is despite the increase in the proportion of employment accounted for by the service sector within firms operating in both manufacturing and non-manufacturing (see Figure 5.6) which could have suggested that manufacturing firms would not need to purchase so many services from outside the firm. In other words, not only were manufacturing plants becoming more integrated into the service sector, they were also buying more inputs from the service sector. The reduction in the value of purchases of materials and fuel suggests that the increase in the mean ratio of intermediate inputs (see Figure 5.5) was not the result of an increase in fragmentation within manufacturing.

[14] This statement would not necessarily be accurate if the price of services had grown at a faster rate than that of materials and fuels between 1973 and 2009 because the series in Figure 5.8 are deflated by an aggregate purchaser's price index (PPI) rather than separate PPIs for materials and fuels and services. Because such indices are not available for 1973-2009, it is not possible to examine this issue for the full period but Figure A.2 the Appendix B shows that, since 1996, the producer price index for materials and fuels has increased at a faster rate than that of corporate services (this does not cover all services but is the best index available for this purpose). This implies that the quantity of services purchased since 1996 may have grown at a faster rate, relative to materials and fuels, than that suggested by Figure 5.8 and therefore that the use of nominal rather than real values does not undermine the central conclusion that manufacturing plants have become more dependent on services rather than materials and fuels since 1973.

Figure A.7 in Appendix B disaggregates the figures provided in Figure 5.8 to show differences in these series across sectors. With the exception of high-tech manufacturing, all sectors have reduced their purchases of materials and fuel and increased their purchases of services in 1973-2009. This trend is most pronounced in low-tech manufacturing. High-tech manufacturing actually increased their purchases of materials and fuel between 1973 and 2009 but not to the same extent as it increased purchases of services.

Rather than disaggregating by sector, Figure A.8 disaggregates by foreign-ownership status. Foreign-owned plants increased their purchases of both types of intermediate input between 1973 and 2009 which implies that UK-owned plants were responsible for the fall in the purchase of materials and fuel seen in Figure 5.8. However, foreign-owned plants increased their purchases of services at a far greater rate than their purchases of materials and fuel and were therefore, like UK-owned plants, more dependent on services than materials and fuels in 2009 than in 1973.

5.4 Summary

This section has provided indicative evidence on whether UK manufacturing has become more fragmented over recent years. Since 1973, employment in multi-plant and multi-industry firms within manufacturing has fallen and the use of intermediate inputs in the production process has increased. However, the latter is explained by a substantial increase in the purchase of services rather than materials and fuels and there has also been an increase in the proportion of employment accounted for by service sector plants within firms that own both manufacturing and service sector plants. This suggests that manufacturing has become increasingly integrated into the service sector rather than becoming more internally fragmented.

6. Future trends in manufacturing

This section will provide some speculation on future trends in UK manufacturing. Given the importance of exports to UK manufacturing, as shown in Table 2.3, it is necessary to consider the UK in its international context. There has recently been some speculation on the impact on UK manufacturing of rising labour costs and currency appreciation in China (e.g., Hurley, 2012). While this may be of some benefit to low-tech UK manufacturing, it is unlikely to have a significant impact overall because UK comparative advantage will not lie in the production of the type of product in which China will lose competitiveness. However, the large fall in the UK's real effective exchange rate (REER)[15] that occurred between 2007 and 2009, and which has only been partially reversed since (see IMF, 2012), indicates that external conditions are currently very favourable for UK manufacturing and that there is therefore scope for growth in exports.

The increasing usage of intermediate inputs which occurred during the 1980s and 1990s was arrested during the 2000s and is unlikely to be resumed. This is because one would expect the UK to specialise in products which involve the services of skilled labour and technologically advanced machinery rather than the assembly of intermediate inputs. Recent trends in the costs of labour and capital suggest that firms are likely to continue to substitute labour for capital in the immediate future. The fact that this process has not been occurring at a faster rate in recent years may be explained by the cautionary effects on investment of the financial crisis.

In terms of the composition of manufacturing, it is likely that the foreign-owned sector will soon account for a larger share of output, GVA and employment than the UK-owned sector. If the trends observed between 1973 and 2009 continue, this will happen around 2020 for gross output, 2016 for GVA and 2015 for employment.[16] Indeed, if these trends continue, there will be no employment in UK manufacturing by 2025. While this is a highly unrealistic scenario, it does demonstrate the extent to which UK manufacturing has declined since 1973. The implications for the UK of continuing contraction in UK-owned manufacturing are that a smaller proportion of the profits from manufacturing will remain in the UK. On the other hand, the efficiency of manufacturing may be boosted by this process, both due to the reallocation of market shares towards more productive foreign-owned plants and through spillovers. It is therefore difficult to say, *a priori*, whether the higher levels of foreign-ownership will be beneficial to the UK economy.

It is also to be expected that UK manufacturing will continue to shift away from low-tech activities and into high-tech activities. This reflects where the UK's comparative advantage as a human capital abundant country lies. However, recent trends suggest that this specialisation in high-tech industries will be a slower process than the move towards foreign-ownership. If the trends witnessed between 1973 and 2009 are extrapolated forward, high-tech manufacturing will overtake low-

[15] The real effective exchange rate is calculated by measuring the value of a currency against a weighted average of foreign-currencies.

[16] These figures are calculated by extrapolating the trends witnessed between 1973 and 2009 in Figures 3.6, 3.7 and 3.8 and are not intended as serious forecasts of what will happen in the future.

tech manufacturing in both output and employment around 2038. This move towards more advanced manufacturing is a more obviously beneficial process as high-tech manufacturing has higher levels of productivity and is therefore likely to pay higher wages and offer higher returns to investors. However, this move towards high-tech manufacturing is unlikely to create many jobs as high-tech manufacturing is much less labour intensive than low-tech manufacturing.

Finally, given the high costs of labour and property in the south-east, it is likely to remain relatively free of manufacturing in the immediate future. Government initiatives, such as Enterprise Zones and the Regional Growth Fund will tend to enforce this trend.

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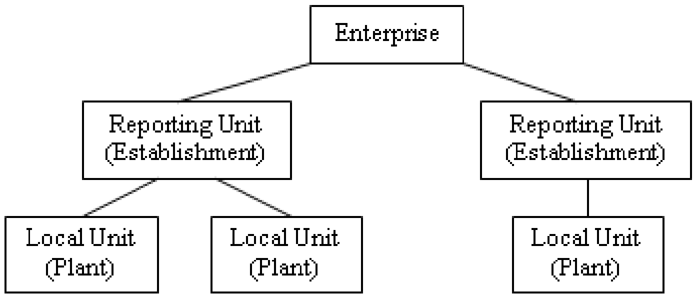
Appendix A: The Annual Respondents' Database

The ARD is a longitudinal dataset dating from 1970 (see Griffith, 1999 for more information on the ARD).[17] In the ARD, plants are organised into local units, reporting units and enterprise groups. Local units are plants or offices at a single-geographical location. A reporting unit, or establishment, is the smallest unit which can provide the full range of data required for the Annual Business Inquiry (ABI), which is discussed below. When a local unit can provide the full range of information necessary for the ABI, it will report to the ABI. When it reports on behalf of itself only, it is a 'single-' as the reporting unit consists of only one local unit. However, not all local units are able to provide the required information for the ABI and, for these plants, another local unit will report on their behalf. In this case, the local unit that reports is a 'parent' while those local units on whose behalf it reports are its 'children'. The reporting unit then consists of both the parent and children local units. Enterprises consist of reporting units that share a common owner. A hypothetical enterprise consisting of two reporting units, one of which is a parent with one child while the other is a single-, is shown below.

Structure of Hypothetical Enterprise



Local units, reporting units and enterprises are all identified by unique reference numbers in the IDBR which allow them to be tracked through time.

The ARD is created by combining information from the IDBR, termed 'indicative data', with more detailed information collected at the reporting unit level by the ABI, referred to as 'returned data'. The IDBR provides the name, address, ownership structure, industrial classification and employment level of all plants in the UK while the ABI provides more detailed financial information on investment, intermediate inputs and gross output. In each year there is a 'selected' and a 'non-selected' file. The 'selected' file contains a combination of indicative and returned data on reporting units – the level at which the ABI is collected - which were selected for surveying in the ABI. The 'non-selected' file contains indicative data from the IDBR and covers establishments that were not selected for sampling in the ABI, the local associated with such reporting units and the local units associated with reporting units selected for inclusion in the ABI.

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[17] However, the data from 1970 to 1972 is incomplete.

Reporting units are selected for surveying in the ABI based on employment data contained in the IDBR with the sampling frame skewed towards larger reporting units. At present, 25% of reporting units with fewer than 10 employees are surveyed in the ABI; 50% of reporting units with between 10 and 99 employees are surveyed; the proportion surveyed of reporting units with between 100 and 249 employees varies by industry from 100% to less than 50% while 100% of reporting units with 250 or more employees are surveyed (Robjohns, 2006). As most of the information provided above requires the financial data from the ABI (the notable exception is the employment series), it is necessary to weight the data. This is done in such a way that the statistics presented above match ONS aggregate statistics.

A further difficulty arises because it is necessary to use data at the local unit rather than the reporting unit. This is particularly important when calculating spatial statistics because reporting units may consist of local units in different areas and it is therefore incorrect to attribute the full value of a particularly variable to the area in which the reporting unit is located. A more general problem with using data at the reporting unit level results because the reporting unit is an accounting rather than an economic unit. As such, the number of plants covered by a reporting unit may change as enterprises open and close plants, buy and sell plants or simply because of changes in the way that an enterprise chooses to report to the ABI (Harris, 2005b). The consequences of using the reporting unit rather than the local unit to calculate measures of the capital stock are investigated by Harris (2005a). To permit econometric analysis at the more appropriate local unit level, it is therefore necessary to 'spread back' to the local unit those variables that are only collected in the ABI at the reporting unit. These include important variables such as gross output, intermediate inputs and investment. This is done using the plant level employment data collected in the IDBR using the assumption of constant labour-investment ratios and labour productivity levels within reporting units.

The foreign ownership codes available in the ARD are not consistent over time. Specifically, the foreign-ownership codes changed between 1999 and 2000, 2002 and 2003 and 2008 and 2009. It has therefore been necessary to create a new foreign-ownership code to create the series which show the changes in the amount of different variables attributable to foreign-ownership sub-groups over time. Similarly, a new local authority code variable had to be created because no local authority code was provided for 1998 and 2001 and because the local authority code used in earlier years was phased out and replaced by another local authority code between 1997 and 2000.

Appendix B: Supplementary figures and tables

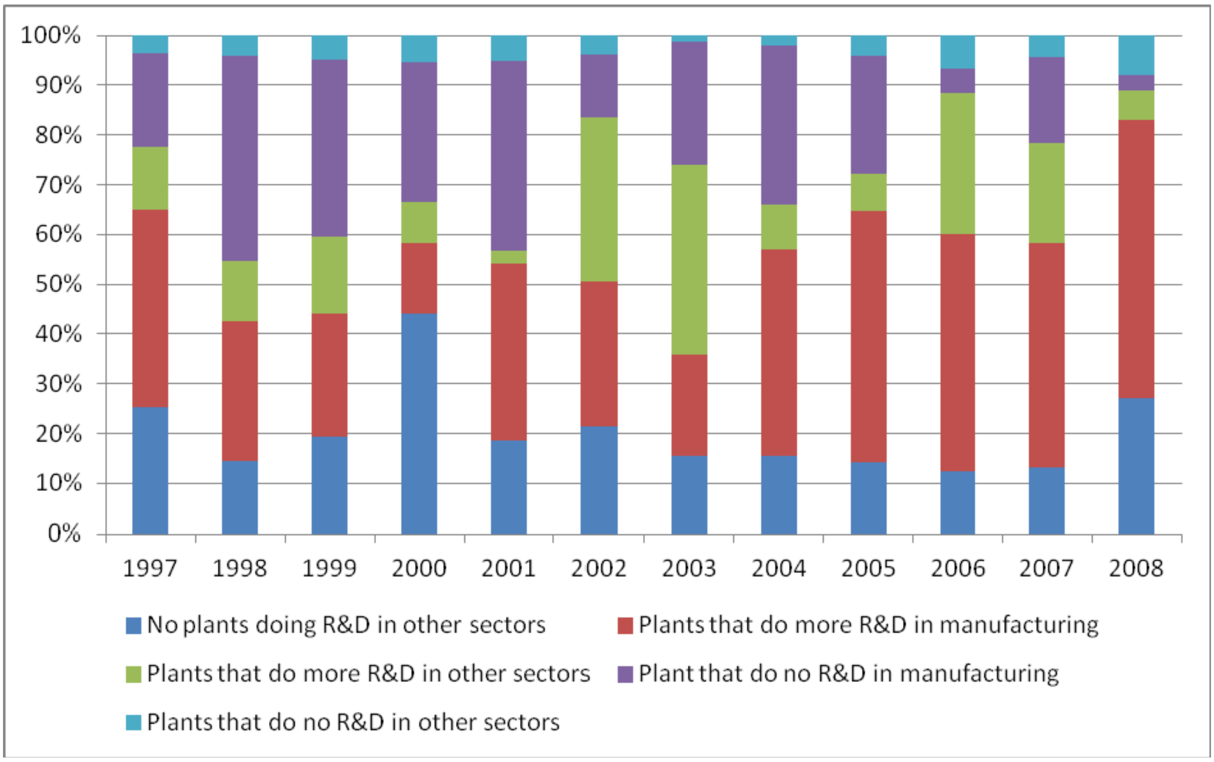
Table A.1: SIC Codes

SIC	Industry
210	Extraction & preparation of metalliferous ores
221	Iron & steel industry
222	Steel tubes
223	Drawing, cold rolling & cold forming of steel
224	Non-ferrous metals industry
231	Extraction of stone, clay, sand & gravel
233	Salt extraction & refining
239	Extraction of other minerals not elsewhere specified
241	Structural clay products
242	Cement, lime & plaster
243	Building products of concrete, cement or plaster
244	Asbestos goods
245	Working of stone & other non-metallic minerals not elsewhere specified
246	Abrasive products
247	Glass & glassware
248	Refractory & ceramic goods
251	Basic industrial chemicals
255	Paints, varnishes & printing ink
256	Specialised chemical products mainly for industrial & agricultural purposes
257	Pharmaceutical products
258	Soap & toilet preparations
259	Specialised chemical products mainly for household & office use
260	Production of man-made fibres
311	Foundries
312	Forging, pressing & stamping
313	Bolts, nuts etc; springs; non precision chains; metals treatment
314	Metal doors, windows etc
316	Hand tools & finished metal goods
320	Industrial plant & steelwork
321	Agricultural machinery & tractors
322	Metal-working machine tools & engineer's tools
323	Textile machinery
324	Machinery for the food, chemical & related industries; process engineering contractors
325	Mining machinery, construction & mechanical handling equipment
326	Mechanical power transmission equipment
327	Machinery for printing, paper, wood, leather, rubber, glass & related industries; laundry & dry cleaning equipment
328	Other machinery & mechanical equipment

329	Ordnance, small arms & ammunition
330	Manufacture of office machinery & data processing equipment
341	Insulated wires & cables
342	Basic electrical equipment
343	Electrical equipment for industrial use & batteries & accumulators
344	Telecommunication equipment, electrical measuring equipment, electronic capital goods & passive electronic components
345	Other electronic equipment
346	Domestic-type electric appliances
347	Electric lamps & other electric lighting equipment
348	Electrical equipment installation
351	Motor vehicles & their engines
352	Motor vehicle bodies, trailers & caravans
353	Motor vehicle parts
361	Shipbuilding & repairing
362	Railway & tramway vehicles
363	Cycles & motor cycles
364	Aerospace equipment manufacturing & repairing
365	Other vehicles
371	Measuring, checking & precision instruments & apparatus
372	Medical & surgical equipment & orthopaedic appliances
373	Optical precision instruments & photographic equipment
374	Clocks, watches & other timing devices
411	Organic oils & fats (other than crude animal fats)
412	Slaughtering of animals & production of meat & by-products
413	Preparation of milk & milk products
414	Processing of fruit & vegetables
415	Fish processing
416	Grain milling
418	Starch
419	Bread, biscuits & flour confectionery
420	Sugar & sugar by-products
421	Ice cream, cocoa, chocolate & sugar confectionery
422	Animal feeding stuffs
423	Miscellaneous foods
424	Spirit distilling & compounding
426	Wines, cider & perry
427	Brewing & malting
428	Soft drinks
429	Tobacco industry
431	Woollen & worsted industry
432	Cotton & silk industries
433	Throwing, texturing, etc of continuous filament yarn
434	Spinning & weaving of flax, hemp & ramie
435	Jute & polypropylene yarns & fabrics
436	Hosiery & other knitted goods

437	Textile finishing
438	Carpets & other textile floor coverings
439	Miscellaneous textiles
441	Leather (tanning & dressing) & fellmongery
442	Leather goods
451	Footwear
453	Clothing, hats & gloves
455	Household textiles & other made-up textiles
456	Fur goods
461	Sawmilling, planing, etc of wood
462	Manufacture of semi-finished wood products & further processing & treatment of wood
463	Builders' carpentry & joinery
464	Wooden containers
465	Other wooden articles (except furniture)
466	Articles of cork & plaiting materials, brushes & brooms
467	Wooden & upholstered furniture and shop & office fittings
471	Pulp, paper & board
472	Conversion of paper & board
475	Printing & publishing
481	Rubber products
482	Retreading & specialist repairing of rubber tyres
483	Processing of plastics
491	Jewellery & coins
492	Musical instruments
493	Photographic & cinematographic processing laboratories
494	Toys & sports goods
495	Miscellaneous manufacturing industries

Figure A.1: R&D activities of plants belonging to firms which owned plants in SIC73, 1997-2008



Source: ARD/BERD

Figure A.1 divides R&D expenditure in the R&D sector according to the activities of plants outside of the R&D sector belonging to firms with plants in the R&D sector. This information is then used to allocate R&D performed in the R&D sector to either manufacturing or services in Figure 2.8.

The dark blue portion of the columns shows the percentage of R&D undertaken by firms in the R&D sector which have no plants in other sectors. Presumably, this R&D is done for other sectors but, unfortunately, the dataset does not contain information which can be used to allocate this R&D to the sector for which it is done. The red section of the columns shows the percentage of R&D done in SIC73 by firms which have plants in the R&D sector as well as plants in other sectors and which undertake the majority of their non-R&D sector R&D in manufacturing. The green section of the column is the equivalent of the red for firms for which the majority of non-R&D sector R&D is done in sectors outside of manufacturing. The red and green sections are then allocated to the manufacturing sector. The purple section of the columns shows the percentage of R&D undertaken by firms in SIC73 which have employment in other sectors, most of which is in manufacturing plants, but do no R&D outside of SIC73. The light blue section shows the equivalent information for firms which have the majority of their non-R&D sector employment outside of manufacturing. The purple and light blue sections are therefore allocated to the services sector.

Table A.2: Spending on and Sources of funding for R&D, 1997-2008 (£ millions, 2005 prices)

	Intramural Spending																	Extramural spending				Total
	Current						Capital			Total	Sources of Funding											
	Salaries	Other	Basic Research	Applied Research	Experimental Development	Total	Land & Buildings	Plant & Machinery	Total		Central Government	Private Industry	EU	Other Foreign	Own Funds	Other Sources	Total	UK	Central Government Funds	Other Sources outside UK	Total	
	(1)	(2)	(3)	(4)	(5)	(6)[a]	(7)	(8)	(9)[b]	(10)[c]	(11)	(12)	(13)	(13)	(14)	(15)	(16)[d]	(17)	(18)	(19)	(20)	(21)[e]
1997	4356	5603	507	3624	5828	9959	354	871	1225	11184	995	772	133	2093	7189	1	11184	969	33	591	1594	12778
1998	4578	5739	525	4205	5587	10317	404	834	1238	11555	1135	741	116	2357	7205	0	11555	1032	33	628	1693	13248
1999	5016	6258	557	4394	6323	11274	422	957	1378	12652	1298	835	152	2743	7623	1	12652	1278	47	724	2050	14703
2000	5077	6282	547	3865	6946	11358	446	861	1307	12666	1107	859	106	2610	7981	3	12666	1060	33	753	1846	14511
2001	5523	6489	466	4249	7298	12012	476	852	1328	13340	1227	879	127	3234	7870	3	13340	1171	39	918	2128	15469
2002	5909	5943	864	5748	5238	11851	277	1038	1315	13166	843	949	189	3678	7503	3	13166	1174	12	1077	2263	15429
2003	5797	5816	757	5018	5838	11613	272	958	1230	12843	1283	1034	90	3521	6912	2	12843	985	5	1013	2003	14846
2004	5994	5603	720	4229	6648	11597	198	880	1078	12675	1379	1129	55	2884	7225	4	12675	1046	59	1079	2184	14859
2005	6443	6070	702	4691	7120	12513	202	796	998	13511	1152	1316	102	3577	7361	3	13511	1231	163	1614	3009	16519
2006	6246	6411	769	4881	7007	12657	142	747	889	13546	983	1088	48	3028	8396	1	13546	1256	33	1643	2932	16478
2007	7158	6399	908	4942	7707	13557	181	818	999	14556	975	904	24	3396	9244	14	14556	1241	7	1796	3043	17599
2008	6705	6926	942	5263	7426	13631	151	639	791	14422	754	833	30	3556	9224	24	14422	1561	21	2287	3869	18291

Notes: [a] (6)=(1)+(2)=(3)+(4)+(5)

Source: ARD/BERD

[b] (9)=(7)+(8)

[c] (10)=(6)+(9)

[d] (16)=(10)+(11)+(12)+(13)+(14)+(15)+(16)

[e] (22)=(10)+(21)

Table A.3: Spending on and Sources of funding for R&D in UK Manufacturing, 1997-2008 (£ millions, 2005 prices)

	Intramural Spending																	Extramural spending				Total
	Current						Capital			Total	Sources of Funding											
	Salaries	Other	Basic Research	Applied Research	Experimental Development	Total	Land & Buildings	Plant & Machinery	Total		Central Government	Private Industry	EU	Other Foreign	Own Funds	Other Sources	Total	UK	Central Government Funds	Other Sources outside UK	Total	
	(1)	(2)	(3)	(4)	(5)	(6)[a]	(7)	(8)	(9)[b]	(10)[c]	(11)	(12)	(13)	(14)	(15)	(16)	(17)[d]	(18)	(19)	(20)	(21)	(22)[e]
1997	3078	4153	294	2414	4524	7231	309	622	931	8162	801	463	58	1231	5608	0	8162	665	33	490	1188	9350
1998	3036	3942	273	2494	4211	6978	196	557	753	7732	912	276	38	1287	5218	0	7732	771	26	558	1355	9086
1999	3248	4162	303	2435	4672	7411	149	625	774	8185	1028	268	60	1350	5478	1	8185	922	46	592	1560	9745
2000	3266	4148	239	2335	4840	7414	361	627	988	8403	925	465	37	1649	5322	3	8403	742	32	431	1204	9607
2001	3873	4681	320	2931	5303	8554	357	664	1021	9575	1051	495	61	2051	5916	1	9575	844	30	793	1667	11242
2002	4089	3915	555	4230	3219	8004	135	846	982	8986	728	540	110	2283	5324	1	8986	766	2	621	1388	10374
2003	3883	3832	470	3519	3725	7714	195	774	969	8684	1115	610	53	2311	4593	1	8684	560	5	559	1124	9807
2004	3708	3692	500	2445	4455	7400	153	692	845	8245	1079	652	24	1720	4768	2	8245	700	57	898	1655	9900
2005	3996	3971	474	2891	4603	7967	116	590	706	8673	1010	836	47	2335	4444	2	8673	740	162	1415	2318	10991
2006	3472	3509	527	2557	3897	6981	88	516	604	7585	567	329	24	1641	5024	1	7585	708	18	1264	1990	9575
2007	4231	3698	624	3016	4289	7929	150	603	753	8682	696	204	15	2365	5390	12	8682	864	6	1465	2336	11017
2008	3406	3711	592	2862	3663	7117	98	384	482	7599	383	251	16	1777	5154	19	7599	767	19	1766	2552	10151

Notes: [a] (6)=(1)+(2)=(3)+(4)+(5)

Source: ARD/BERD

[b] (9)=(7)+(8)

[c] (10)=(6)+(9)

[d] (16)=(10)+(11)+(12)+(13)+(14)+(15)+(16)

[e] (22)=(10)+(21)

Table A.4: Spending on and Sources of funding for Foreign-owned R&D, 1997-2008 (£ millions, 2005 prices)

	Intramural Spending																	Extramural spending				Total
	Current						Capital			Total	Sources of Funding											
	Salaries	Other	Basic Research	Applied Research	Experimental Development	Total	Land & Buildings	Plant & Machinery	Total		Central Government	Private Industry	EU	Other Foreign	Own Funds	Other Sources	Total	UK	Central Government Funds	Other Sources outside UK	Total	
	(1)	(2)	(3)	(4)	(5)	(6)[a]	(7)	(8)	(9)[b]	(10)[c]	(11)	(12)	(13)	(14)	(15)	(16)	(17)[d]	(18)	(19)	(20)	(21)	(22)[e]
1997	1306	1702	103	1296	1608	3007	229	320	549	3557	73	130	40	1011	2303	0	3557	263	0	104	367	3924
1998	1372	1693	119	1244	1701	3064	204	306	510	3575	119	138	10	1104	2204	0	3575	310	8	110	428	4002
1999	1501	1837	141	1409	1788	3338	290	348	638	3977	94	188	15	1349	2331	0	3977	437	7	138	583	4559
2000	1521	1937	187	1195	2076	3457	243	264	507	3965	78	201	14	1293	2377	3	3965	372	0	196	568	4533
2001	2136	2509	246	1861	2538	4645	199	395	594	5239	133	333	41	1766	2965	1	5239	554	1	292	848	6087
2002	1926	2025	294	1727	1930	3951	93	282	376	4327	161	315	65	1356	2429	1	4327	460	2	350	813	5139
2003	2118	2242	213	1642	2506	4360	119	267	386	4746	422	350	37	1503	2433	1	4746	359	0	246	606	5352
2004	2534	2205	308	1941	2490	4739	125	333	457	5197	367	394	29	1491	2914	2	5197	387	2	480	868	6065
2005	2382	1930	255	1921	2136	4313	102	285	387	4700	295	447	45	1591	2320	1	4700	480	6	448	933	5633
2006	1991	1574	204	1429	1932	3565	66	354	421	3986	181	310	16	1012	2466	0	3986	412	16	401	830	4816
2007	2817	2076	299	2050	2544	4893	73	451	524	5417	182	346	9	1546	3327	7	5417	544	6	475	1025	6442
2008	2965	2618	413	2248	2922	5583	57	370	427	6010	121	504	12	1773	3599	1	6010	632	5	715	1352	7361

Notes: [a] (6)=(1)+(2)=(3)+(4)+(5)

Source: ARD/BERD

[b] (9)=(7)+(8)

[c] (10)=(6)+(9)

[d] (16)=(10)+(11)+(12)+(13)+(14)+(15)+(16)

[e] (22)=(10)+(21)

Table A.5: Spending on and Sources of funding for Foreign-owned Manufacturing R&D, 1997-2008 (£ millions, 2005 prices)

	Intramural Spending																	Extramural spending				Total
	Current						Capital			Total	Sources of Funding											
	Salaries	Other	Basic Research	Applied Research	Experimental Development	Total	Land & Buildings	Plant & Machinery	Total		Central Government	Private Industry	EU	Other Foreign	Own Funds	Other Sources	Total	UK	Central Government Funds	Other Sources outside UK	Total	
	(1)	(2)	(3)	(4)	(5)	(6)[a]	(7)	(8)	(9)[b]	(10)[c]	(11)	(12)	(13)	(14)	(15)	(16)	(17)[d]	(18)	(19)	(20)	(21)	(22)[e]
1997	904	1222	55	887	1185	2126	216	215	431	2557	59	57	34	607	1800	0	2557	224	0	73	297	2854
1998	889	1059	53	657	1239	1949	68	161	230	2178	109	45	6	468	1550	0	2178	272	8	77	357	2535
1999	886	1045	73	699	1159	1931	88	163	251	2182	77	32	10	404	1659	0	2182	286	7	83	376	2558
2000	1135	1376	119	792	1599	2510	205	214	419	2930	69	148	10	785	1915	3	2930	315	0	124	439	3369
2001	1589	1840	174	1369	1887	3429	167	316	483	3912	95	277	35	1015	2490	1	3912	430	1	208	639	4551
2002	1345	1374	209	1143	1366	2719	55	226	280	2999	152	229	42	700	1877	0	2999	360	1	238	599	3598
2003	1298	1415	124	940	1649	2712	86	185	271	2983	363	171	20	772	1657	1	2983	270	0	199	470	3453
2004	1509	1233	190	1125	1427	2742	101	233	334	3076	183	189	12	582	2111	1	3076	249	0	379	628	3704
2005	1623	1336	177	1329	1454	2959	51	197	248	3208	278	322	34	798	1775	1	3208	369	6	400	775	3982
2006	1305	1027	165	810	1357	2332	51	285	336	2667	177	200	15	332	1943	0	2667	262	15	253	530	3198
2007	1719	1432	210	1269	1672	3151	56	359	415	3566	158	95	6	910	2390	7	3566	396	6	365	767	4333
2008	1473	1584	222	1047	1788	3057	34	252	287	3344	104	152	8	604	2477	0	3344	314	5	401	720	4064

Notes: [a] (6)=(1)+(2)=(3)+(4)+(5)

Source: ARD/BERD

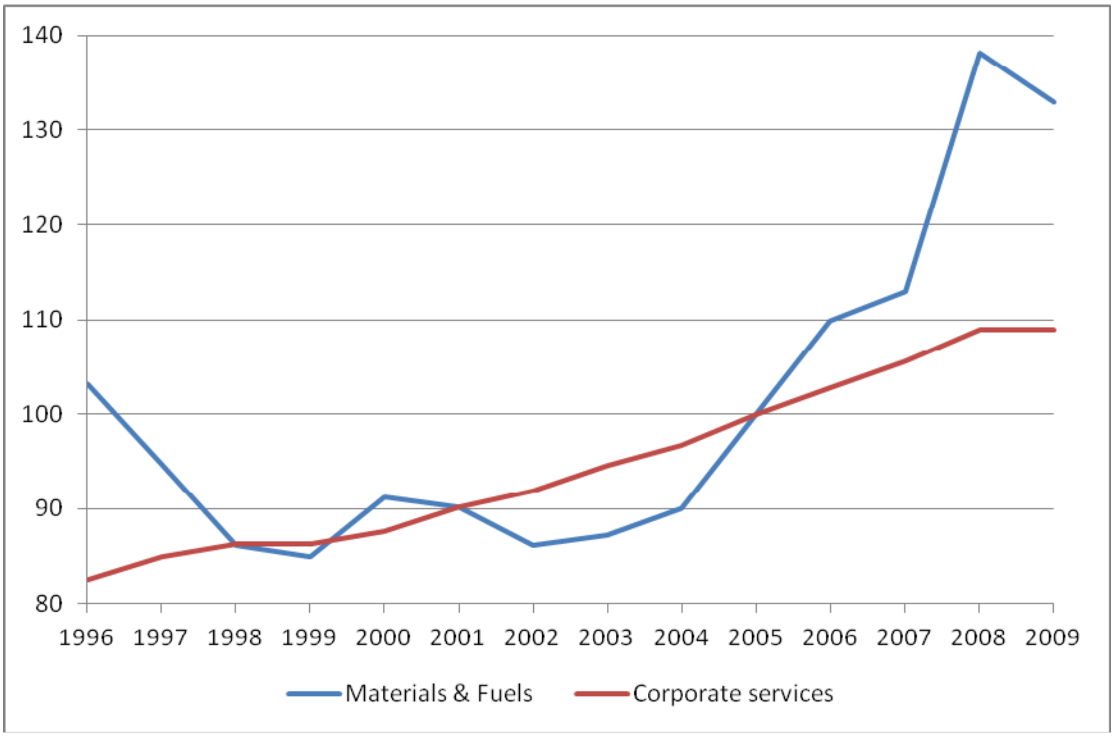
[b] (9)=(7)+(8)

[c] (10)=(6)+(9)

[d] (16)=(10)+(11)+(12)+(13)+(14)+(15)+(16)

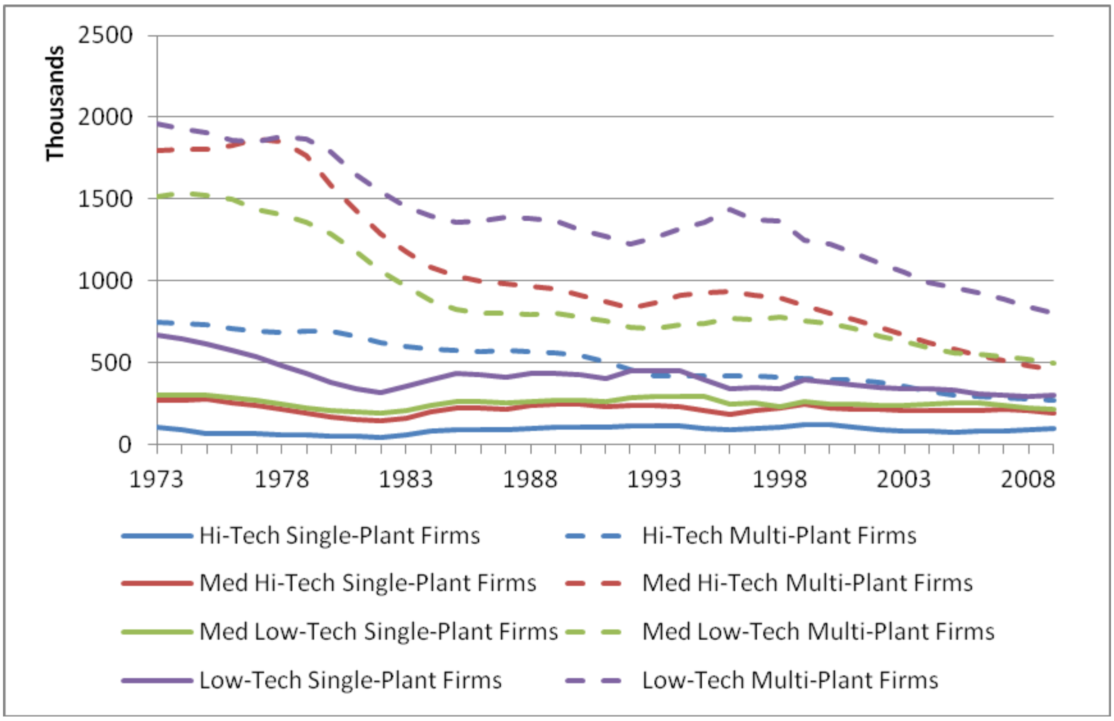
[e] (22)=(10)+(21)

Figure A.2: Purchaser's Price Index for Materials and Fuels and Corporate Services, 1996-2009 (2005 = 100)



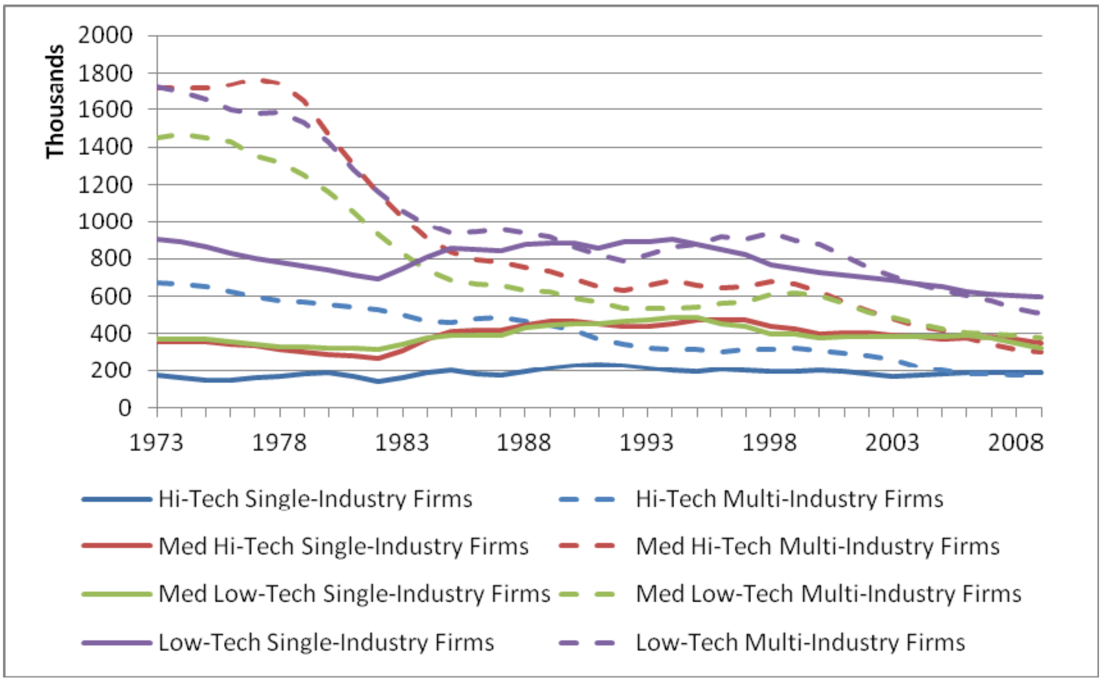
Source: ONS

Figure A.3: Employment by Sector in Single--Plant and Multi-Plant Firms in UK manufacturing, 1973-2009 (thousands)



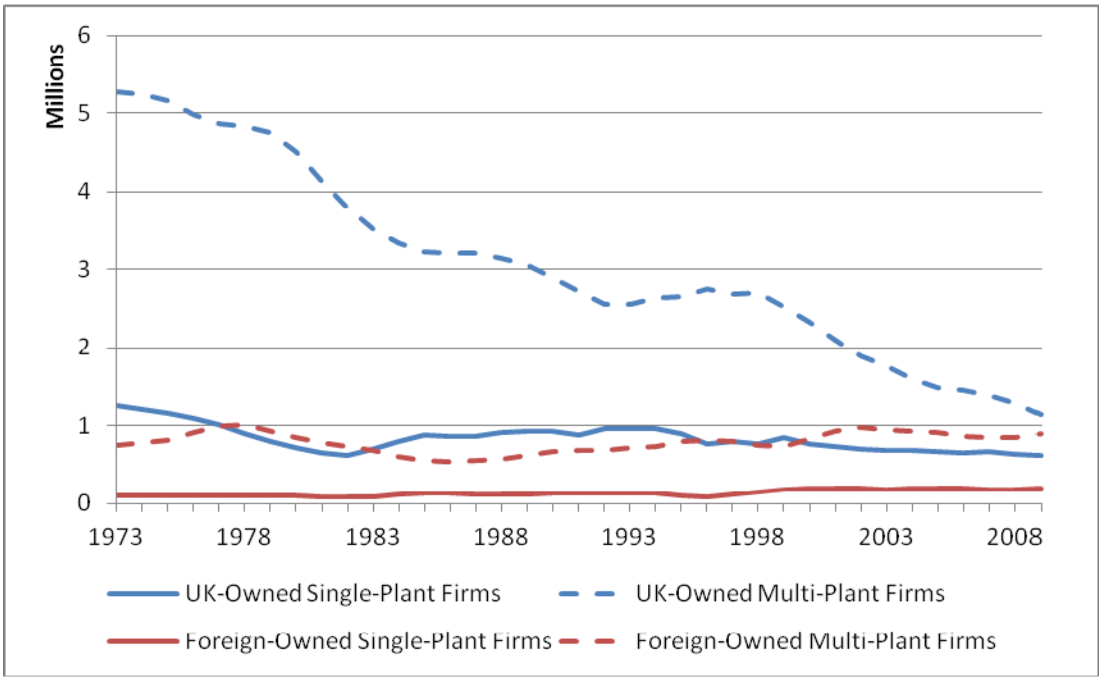
Source: Author’s own calculations based on the ARD

Figure A.4: Employment by Sector in Single--Industry and Multi-Industry Firms in UK manufacturing, 1973-2009 (thousands)



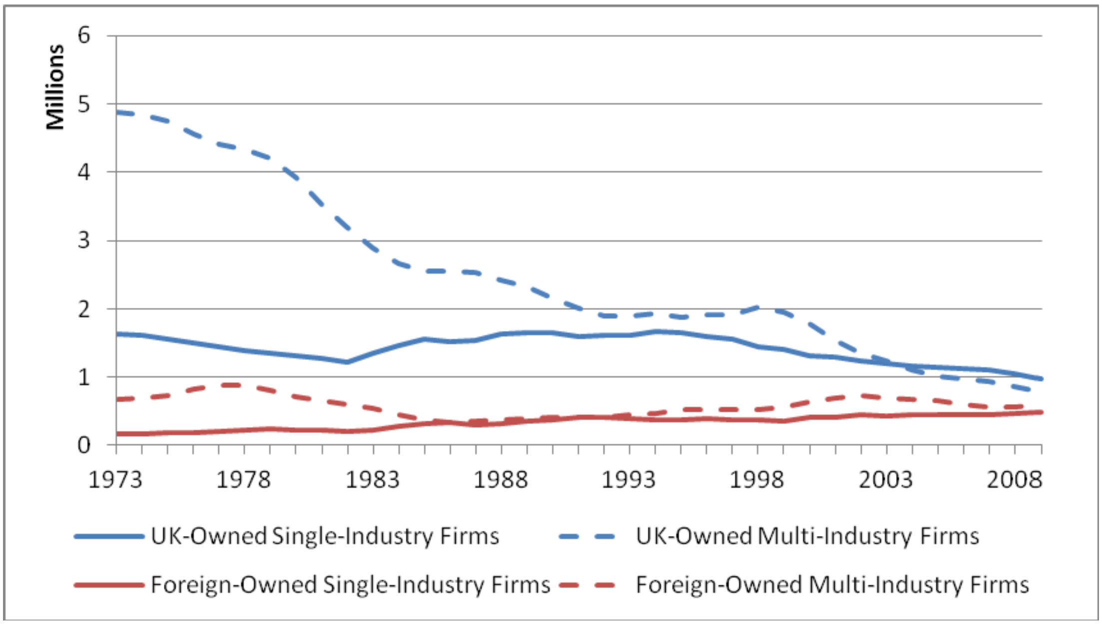
Source: Author's own calculations based on the ARD

Figure A.5: Employment in UK-Owned and Foreign-Owned Single--Plant and Multi-Plant Firms in UK manufacturing, 1973-2009 (thousands)



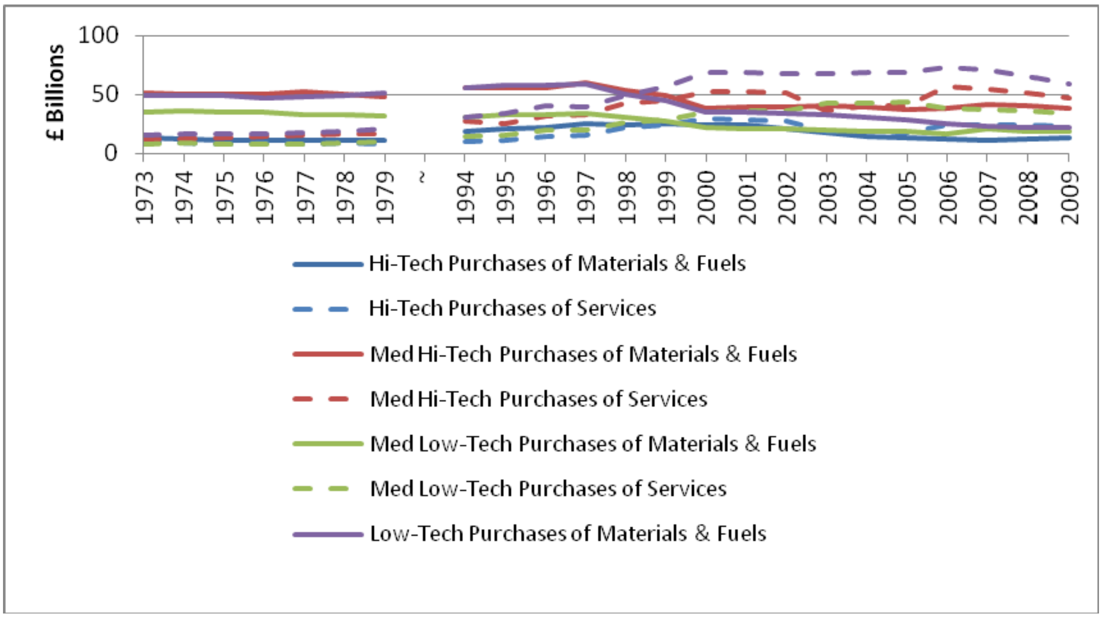
Source: Author's own calculations based on the ARD

Figure A.6: Employment in UK-Owned and Foreign-Owned Single--Industry and Multi-Industry Firms in UK manufacturing, 1973-2009 (thousands)



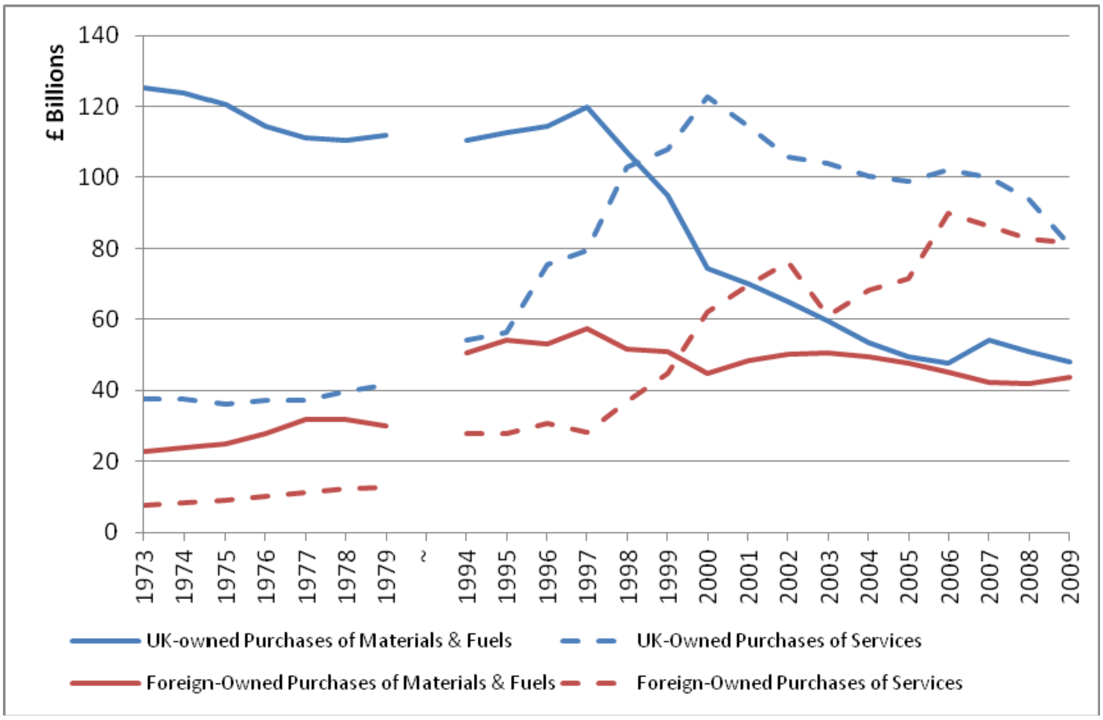
Source: Author's own calculations based on the ARD

Figure A.7: Purchase of intermediate inputs by sector in UK manufacturing, 1973-79, 1994-2009 (2000 prices)



Source: Author's own calculations based on the ARD

Figure A.8: Purchase of intermediate inputs in UK-Owned and Foreign-Owned in UK manufacturing, 1973-79, 1994-2009 (2000 prices)



Source: Author's own calculations based on the ARD

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