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CHARACTERISTICS OF FOREIGN-OWNED FIRMS IN BRITISH MANUFACTURING

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Abstract

This paper describes the characteristics of manufacturing establishments in Britain over the period 1980 to 1996. Particular attention is paid to differences between plants of different ownership nationality. The findings suggest that establishments that are always foreign-owned have significantly higher labour productivity than those that remain under domestic ownership. In addition, labour productivity improves faster over time and faster with age in foreign-owned establishments. The difference in labour productivity is matched by an equivalent difference in levels of investment per employee. Establishments that change ownership nationality do not seem to experience very large changes in labour productivity levels. The proportion of skilled workers in the workplace, and wages for both skilled and operative workers are higher in foreign-owned establishments than domestic-owned, in line with differences in labour productivity.

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Summary

This paper investigates the characteristics of manufacturing establishments in Britain over the period 1980 to 1996, differentiating between establishments owned by foreign multinationals and domestic (UK) owned establishments. Multinational firms may play a role in increasing productivity either due to a composition effect, if they are more productive, or by increasing competition, which in turn drives productivity improvements, or by facilitating technology transfer from more technologically advanced economies.

Over the 1980s labour productivity in British manufacturing increased rapidly compared with the previous decade, and saw continued but slower growth during the 1990s. But labour productivity in the UK manufacturing sector remains lower than in the US, France and Germany. This labour productivity pattern observed in international comparisons is mirrored to some extent when we look across different nationalities of establishments operating within Britain.

We consider establishments that do not change ownership nationality separately from those that change from foreign to domestic-ownership or vice versa, due to a takeover or merger. Those establishments that remain under foreign-ownership are found to have significantly higher labour productivity, measured by value-added per worker, than those that remain under domestic-ownership. Larger differences are found in investment per employee, suggesting that the labour productivity differences are largely attributable to differences in investment levels.

For this group, labour productivity is found to increase with establishment age. Labour productivity is found to improve faster with age for foreign-owned establishments, but much of this difference appears to be explained by differences in establishments' capital stocks. Establishments are found to have lower labour productivity in their year of exit. When we examine establishments that change ownership nationality labour productivity differences between foreign and domestic-owned establishments are smaller.

Foreign-owned establishments are found to use a higher proportion of skilled (administrative, technical or clerical) workers in their workforce than domestic-owned

establishments. Wages for both skilled workers and operatives are higher in foreign-owned establishments, in line with differences in labour productivity.

The results raise interesting questions about why foreign-owned establishments are investing more and using different skill mixes, and how foreign-owned establishments have affected the performance of their domestic-owned counterparts.

1 Introduction

The 1970s and 1980s saw an increase in the international openness of the British economy. By 1980 the British government had removed exchange controls and had joined the European Economic Community. By the late 1980s Britain was embarking on the EU Single Market Program which aimed to improve the international mobility of capital. This opening up of the UK economy was expected to bring increased growth through a number of routes. In this paper we focus on the impact of inward investment. From the early literature of Vernon (1966), Dunning (1977) and Caves (1974) it has been suggested that multinational firms are more productive, and are concentrated in knowledge-intensive industries. The endogenous growth[1] and new trade literatures[2] focus on the role multinational firms play in transferring technology from the frontier to economies that lag behind technologically. Empirical work, largely at the aggregate level, has identified correlations between the openness of an economy and growth in productivity or export performance.[3]

Value-added per worker in British manufacturing grew rapidly over the 1980s relative to the 1970s, with slower but continued growth during the 1990s (see Figure 1). But Britain remains at the bottom of the Premier League of countries. Figure 2 compares labour productivity in the manufacturing sector within each of these countries. It shows that, while the position of the UK relative to the US has improved somewhat, it still lags behind the US, and to a lesser extent behind France, Germany and Japan. The figure shows labour productivity of manufacturing activity undertaken within these countries, both by domestic and foreign-owned firms. Studies comparing total factor productivity

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[1] See, inter alia, Barro and Sala-i-Martin (1995), Aghion and Howitt (1998), Grossman and Helpman (1991).

[2] See, inter alia, Krugman (1991a,b, 1994), Venables (1994), Smith (1994) and Edwards (1998).

[3] These studies have generally used labour productivity, see, for example, Bernard and Jones (1996a,b), Barrell and Pain (1997); Cameron, Proudman and Redding (1998) look at TFP; studies using micro-data include Blomstrom and Persson (1983), Davies and Lyons (1991), Globerman (1979).

show a similar picture.[4] One interesting question is whether improvements in the UK's relative position have been driven by the presence of foreign-owned multinational firms in the UK.

In this paper we examine whether similar differences arise when we look across different nationalities of establishments operating within Britain. We examine differences in labour productivity and factor usage between foreign-owned and domestic-owned firms using plant level data. In doing so we control for industry, age, size, year of exit and plant specific unobservable characteristics. This will be informative in understanding whether it is physical location in Britain or British-ownership that underlies the observed international differences in labour productivity. If it is location in Britain that matters this may point to factors such as national competition policy, employment laws or the regulatory environment, for example planning regulations as highlighted in a recent report by McKinsey. However, if we find labour productivity differences between foreign and domestic-owned establishments both operating within Britain, this may indicate differences in the organisation of production and input usage, or that domestic-owned establishments differ from their foreign-owned counterparts technologically.

There are many studies of labour productivity using plant level data in the US and a growing number in the UK.[5] Two particular studies that are relevant for our purposes are Doms and Jensen (1998) and Howensteine and Zeile (1994). Using US data Doms and Jensen (1998) show that that there are substantial differences between domestic and foreign-owned establishments. They find that foreign-owned establishments have higher labour productivity than the average US-owned plant, but lower labour productivity than plants owned by US multinationals. This indicates that what may be important is ownership by a multinational rather than foreign ownership per se. They also find that foreign-owned plants are more capital intensive and pay higher wages

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[4] See, inter alia, O'Mahony (1999), Dougherty and Jorgenson (1997), Nickell et. al. (1992), Layard and Nickell (1989), Bean and Crafts (1995), Bean and Symons (1989), Oulton and O'Mahony (1994), Mayes (1996), Cameron, Proudman and Redding (1998), van Ark (1996), Lansbury (1995) and Oulton (1998).

[5] See Bartelsman and Doms (2000) for a review, also Caves, R. (1998).

than the average US owned plant. Howensteine and Zeile (1994) describe the characteristics of foreign-owned establishments in the US. They find that foreign-owned establishments are more capital intensive and larger. They have higher average wage rates but this is largely because they are in higher wage industries, not because they pay workers higher wages than other firms in the same industry.

Globerman, Ries and Vertinsky (1994) have shown, using Canadian plant-level data, that there are significant differences between domestic and foreign-owned plants. Foreign-owned plants are found to have higher labour productivity, but after controlling for size, capital intensity, share of non-production workers, and share of male workers these differences disappear.

Another motivation for this line of research is that plant level studies in both the UK and US have found that within industry variation in labour productivity is greater than between industry variance.[6] Understanding sources of within industry variation helps explain both the determinants of productivity differentials between plants, such as differences in capital intensity, and the determinants of industry level productivity growth, for example by the replacement of low productivity plants with high productivity entrants.

In this paper we look at differences in characteristics between foreign and domestic-owned establishments. We consider establishments that do not change ownership nationality separately from those that experience a change in ownership nationality, due to a take over or merger. The findings suggest that establishments that are always foreign-owned have significantly higher labour productivity than those that are always domestic-owned. In addition, labour productivity improves faster with age in foreign-owned establishments. This is matched by an equivalent difference in levels of investment per employee. Both the proportion of skilled workers employed in the workforce, and wages for both skilled and operative workers are higher in foreign-owned establishments than domestic-owned, in line with differences in labour productivity.

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[6] See, inter alia, Disney et al (2000) and Doms and Jensen (1998).

Domestic establishments that become foreign-owned do not have higher labour productivity, though their labour productivity improves faster after being taken over than that of establishments that go from being foreign to domestic-owned.

The remainder of this paper is structured as follows. The next section describes the data. Section 3 describes trends in foreign ownership. Section 4 describes differences between domestic and foreign-owned establishments. A final section summarises. An appendix gives a more detailed description of the data.

2 Data description

Our main data source is the Annual Census of Production (ACOP) Respondents Database (ARD). This is the plant level data that underlies the Annual Census of production in Britain.[7] The ARD contains basic information on the population of production plants in Britain, including the number of employees and the nationality of the ultimate owner. Detailed information on outputs and inputs is collected from all establishments with over 100 employees, and below that threshold a stratified sample is taken. We use a cleaned up sample of the establishment level data for our main analysis and gross up to the population. The Data Appendix provides details on how we construct our sample and our grossing up factors.

Detailed data on outputs and inputs is reported at the establishment level. An establishment can be a single plant or a group of plants. In 1980 there were around 29 thousand incorporated establishments in manufacturing with at least 20 employees included in the ARD.[8] By 1996 there were one thousand more, as shown in Table 1.[9], whereas total employment in British manufacturing fell during this period. Around 7% of these establishments were foreign-owned. These were on average bigger than

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[7] This is now called the Annual Business Inquiry (ABI). It is the UK equivalent of the US LRD.

[8] See Oulton (1997), Griffith (1999) and Perry (1995) for descriptions of the structure of the ARD.

[9] These numbers exclude establishments that were not incorporated and those that were not yet in production.

domestic-owned establishments. The average size of both domestic and foreign-owned establishments has fallen over time.

We do not observe capital stock in the ARD. We do observe the purchase and sales of investment goods and from this we construct a capital stock series using the perpetual inventory method (see Appendix for details).

Our sample contains around 12 thousand annual observations of establishments, which account for around 70% of employment in the population. It contains a higher proportion of foreign-owned establishments than the population, and the establishments are on average larger (due mainly to the ONS sampling procedure).

Table 1: Sample statistics

	1980	1996
Population		
Total employment (millions)	5.3	4.0
Number establishments	28,605	29,748
Percentage establishments foreign-owned	6.9%	7.3%
Average employment per domestic-owned establishment	167	114
Average employment per foreign-owned establishment	425	391
Sample		
Total employment (millions)	4.1	2.6
Number establishments	12,900	10,457
Percentage establishments foreign-owned	9.2%	12.4%
Average employment per domestic-owned establishment	295	205
Average employment per foreign-owned establishment	566	534

Notes: Plants or establishments with less than 20 employees are excluded from both the population and the sample. Only incorporated and in production plants and establishments are included (sole proprietorships, partnerships, government-owned and other legal structures are excluded as are plants that are not yet in production). See Data Appendix for details on construction of sample.

Figure 3 shows the distribution of the population of establishments by employment size band. Panels (a) and (b) show the distribution of foreign and domestic–owned establishments across size bands in the population for 1980 and 1996 respectively. The largest group of domestic establishments is in the 20-49 range, while foreign-owned establishments are fairly evenly distributed across size bands. There is a larger proportion in the smallest size band in 1996, due in part to efforts by the ONS to improve the register of companies. This may also reflect a trend towards downsizing and a growth in self-employment.

Panels (c) and (d) show the same distributions for our sample of establishments. In contrast to the population, domestic-owned are more evenly distributed and foreign-owned are concentrated in the larger size bands. We gross all results up to population levels using grossing-up factors at the industry-size-year level (see discussion in Appendix). Figure 4 shows aggregate value-added per worker calculated using our grossed up sample. This is similar to Figure 1 which was calculated using aggregate data from the OECD STAN dataset, and gives an indication that our grossed-up sample is representative of manufacturing as a whole.

We are interested in controlling for the age of an establishment, and looking at how labour productivity changes with age. We do not know the date that establishments were set up, but we can use information on the population of establishments back to 1973 to construct a truncated age variable. This gives us the length of time that a particular location has been used as a production facility, i.e. it is not linked to ownership but to the physical existence of the plant.

Table 2: Age distribution of establishments in 1996

Age	Domestic-owned	Foreign-owned
1-3	17.3	13.9
4-6	10.9	6.8
7-9	7.6	7.2
10-12	8.3	7.4
13-15	6.1	5.9
16-18	2.9	2.5
19-21	3.9	3.6
22+	42.9	52.6

See Notes: to Table 1.

Table 2 shows the age distribution of establishments in the sample in 1996 for domestic and foreign-owned establishments. The distributions are largely similar, although there are a larger proportion of young domestic establishments.[10]

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[10] Note that there are also some problems with the continuity of the establishment level identifier code that may affect the age calculation. In addition, age is calculated from 1973 so the largest proportion of establishments is always in the highest age category. See Appendix for details.

3 Trends in foreign ownership

This section describes the level of activity in foreign-owned establishments in British manufacturing over the period 1980 to 1996.[11] We document that the proportion of manufacturing employment in foreign-owned establishments has remained fairly stable over the period at around 15% to 20%. North American-owned firms represent by far the largest share, although there has been an increase in the presence of European Union and Japanese-owned firms. The dominant form of entry for foreign-owned firms was takeovers of domestic-owned establishments.

Table 3 shows how employment, value-added and investment are broken down between different nationalities of ownership in our sample. The grey shaded rows give the totals of value-added, employment and investment. Employment declined over this period while value-added and investment have increased. The proportion of employment by foreign-owned establishments has risen by around ten percentage points over this period, and the composition has changed. The proportion of employment in North American-owned establishments has fluctuated but increased over the whole period. There has been an increase in the proportion of employment in European and Japanese-owned establishments. Foreign-owned establishments account for a larger percentage of total value-added and investment than they do the number of establishments (from Table 1 we see that 12.4% of establishments in the sample were foreign-owned in 1996). The proportions of value-added and investment accounted for by each ownership nationality follow a broadly similar pattern to the employment shares, except for Japanese-owned establishments which consistently accounted for a larger share of investment than employment or value-added.

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[11] We analyse the real production activity of foreign-owned firms located in Britain. Much empirical research addressing the issues of how multinational investment affects the local economy has used data on the flows or stocks of foreign direct investment. However, foreign production (or even investment by foreign-owned firms) and foreign direct investment are not the same thing. The former is a measure of the amount of real activity that is undertaken by a firm that is resident in another country, while the latter is a measure of the flow of financial capital. They will differ to the extent that foreign-owned establishments finance expenditure from local capital markets and repatriate profits back to the parent country. This difference is pointed out by Auerbach and Hassett (1993). Grubert and Mutti (1991) show that the two series are unrelated using data on US firms investment in Canada.

Table 3: Percentage of sample by nationality of owner

	1980	1984	1988	1992	1996
Employment (millions)	4.1	3.6	5.0	3.0	2.6
British-owned	83.7	83.9	90.3	78.8	73.1
North American	12.1	11.2	6.2	10.6	13.3
European Union	2.5	2.4	1.7	5.6	7.7
Other European	1.3	1.8	1.2	2.7	3.2
Japanese	0.0	0.1	0.3	1.8	2.0
Other foreign	0.4	0.6	0.3	0.6	0.7
Value-added (1980 £m)	37,924	39,991	45,229	40,991	43,363
British-owned	80.5	79.1	79.8	73.5	65.6
North American	15.3	15.6	13.4	14.4	20.6
European Union	2.5	2.7	3.5	5.6	7.7
Other European	1.3	1.8	2.0	3.1	3.1
Japanese	0.0	0.1	0.5	2.3	1.9
Other foreign	0.4	0.7	0.9	1.0	1.0
Investment (1980 £m)	4,573	4,760	6,125	5,779	6,973
British-owned	79.1	79.4	77.9	68.0	60.7
North American	15.2	15.3	12.0	15.0	20.3
European Union	3.0	2.5	3.5	6.1	11.1
Other European	2.2	2.1	3.5	4.7	3.4
Japanese	0.1	0.3	2.5	5.2	3.2 [a]
Other foreign	0.3	0.3	0.6	1.0	1.3

Note: Percentages are calculated from a sample of the selected ARD data. European Union countries are Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.

[a] In the selected data Japanese investment accounts for over 4% of total investment in 1996, however some establishments are excluded from our sample because they have negative value-added, (see Data Appendix).

Source: Authors' calculations using ARD.

Table 4 shows how activity in foreign-owned establishments is divided across industries within the population. The first column gives the proportion of total manufacturing employment in foreign-owned establishments in each industry in 1980. Column 2 shows the same figure for 1996. In 1980 nearly 20% of all employment in foreign-owned firms was in the mechanical engineering industry (32). By 1996, the sector that accounted for the highest proportion of employment in foreign-owned firms was motor vehicles (35).

Foreign-owned establishments may enter the UK either by taking over an existing establishment, or by setting up a greenfield site. The final four columns show that the distributions of greenfield entrants and takeovers were broadly similar across industries

to the employment distribution across industries, with a few notable exceptions. Domestic entry via greenfield sites was low in chemicals (25). Foreign greenfield entry was high in the technologically more advanced industries - office machinery (33), electrical and electronic engineering (34) and instrument engineering (37) – and low in food, drink and tobacco (41/42). The motor vehicles industry accounted for a low proportion of total entry (35).

Table 5 shows the importance of foreign-owned establishments in each sector. This period saw an increase in the proportion of employment in each industry that was in foreign-owned establishments, notably office machinery (33), motor vehicles (35) and other transport (36). Only two industries experienced a decline in the proportion of employment in foreign-owned establishments – instrument engineering (37) and other manufacturing (49). Columns three to five show what proportion of greenfield entrant, exiting and incumbent establishments were foreign-owned for each industry. In almost all industries the proportion of greenfield entry is less than the proportion of incumbents, suggesting that the growth in the share of employment is due more to changes in employment patterns between surviving establishments, (e.g. employment growth in foreign-owned incumbents and decline in employment levels in domestic incumbents), than it is to greenfield entry. The final two columns show the proportion of foreign entrants within an industry that enter via greenfield versus takeover. Takeover is the dominant form of entry in all industries except office machinery (33) and instrument engineering (37), though in most cases it is not much higher than greenfield.

Table 4: Sectoral composition of employment in the population of foreign-owned plants by industry

2-digit industry (sic80)	% total manufacturing employment in foreign-owned plants		% of foreign greenfield	% of domestic greenfield	% of domestic to foreign takeovers	% of foreign to domestic takeovers
	1980	1996				
22 Metal Manufacturing	3.31	1.90	2.76	1.74	3.31	3.48
24 Non-metallic mineral products	1.97	2.20	2.70	3.70	4.48	4.12
25 Chemicals	12.47	11.77	9.61	3.03	8.86	8.69
31 Metal Goods n.e.s	3.89	3.91	6.19	9.21	7.10	6.50
32 Mechanical Engineering	19.69	12.32	17.45	14.85	15.57	18.39
33 Office machinery & data processing equipment	2.42	4.39	3.42	1.52	1.65	1.19
34 Electrical and Electronic Engineering	15.94	14.28	16.26	11.99	13.67	11.99
35 Motor Vehicles	10.47	16.21	3.55	2.40	4.28	4.39
36 Other Transport	0.64	4.11	2.50	2.06	2.29	1.46
37 Instrument Engineering	2.91	2.32	5.86	2.57	3.84	4.30
41/42 Food, Drink & Tobacco	9.02	9.46	4.61	8.21	6.42	6.59
43 Textiles	1.20	1.35	1.78	3.05	2.48	2.93
45 Clothing	1.52	0.97	0.92	7.75	1.61	1.56
47 Paper and Paper Products	6.85	7.09	10.99	10.07	12.51	12.81
48 Rubber and Plastics	5.44	5.56	5.40	5.74	8.03	6.86
49 Other manufacturing	1.12	0.80	3.09	3.68	1.41	1.37
Total %	100.00	100.00	100.00	100.00	100.00	100.00
Total number			1,519	28,547	2,055	1,093

Note: Columns 1 and 2 show the distribution of total manufacturing employment in foreign-owned establishments across industry. Columns 3-6 show how employment was distributed across industries by category, these are the average % 1980-1996. The omitted sectors (21, 23, 26, 44, 46) each account for less than 1% of employment in foreign-owned establishments.

Table 5: % of each type that were foreign establishments by industry, 1980-1996

2-digit industry (sic80)	% industry employment in foreign-owned plants		% industry greenfield	% industry exits that are foreign	% industry incumbents	% industry foreign entrants that are:		
	1980	1996				greenfield	takeover	
							D-F	F-F
22 Metal Manufacturing	16.2	15.74	7.81	9.37	11.48	36.84	59.65	[a]
24 Non-metallic mineral products	6.75	11.26	3.74	4.88	5.89	29.93	67.15	[a]
25 Chemicals	31.18	38.04	14.46	21.12	23.53	41.24	51.41	7.35
31 Metal Goods n.e.s	8.25	14.30	3.45	3.70	3.93	37.01	57.48	5.51
32 Mechanical Engineering	21.12	23.16	5.88	7.60	7.58	41.93	50.63	7.44
33 Office machinery and data processing equipment	48.27	67.40	10.68	13.36	17.87	58.43	38.20	[a]
34 Electrical and Electronic Engineering	20.75	26.97	6.73	11.41	11.06	44.03	50.09	5.88
35 Motor Vehicles	23.05	61.93	7.30	7.42	10.01	36.00	58.67	5.33
36 Other Transport	3.00	18.64	6.06	6.16	6.19	41.76	51.65	6.59
37 Instrument Engineering	28.04	22.59	10.80	14.71	11.19	51.15	45.40	3.45
41/42 Food, Drink & Tobacco	11.50	16.69	2.90	4.55	5.29	33.02	62.26	4.72
43 Textiles	3.32	7.46	3.01	2.90	2.57	32.14	60.71	7.14
45 Clothing	3.82	4.77	0.63	1.24	1.54	28.57	67.35	[a]
47 Paper and Paper Products	13.14	16.77	5.49	7.77	6.64	37.28	57.37	5.36
48 Rubber and Plastics	19.22	23.15	4.76	6.29	7.63	31.66	63.71	4.63
49 Other manufacturing	14.89	11.95	4.28	6.15	4.46	58.75	36.25	[a]
Mean	*18.72*	*24.69*	*7.80*	*9.39*	*7.88*	*41.33*	*51.31*	*7.36*

Note: Average percentage of establishments in each category from 1980-1996. Column 1 is the percentage of greenfield entrants that were foreign-owned. Column 2 is the percentage of exits that were foreign-owned. Column 3 is the percentage of incumbents that are foreign-owned in any year. Column 4 is the percentage of incumbents that change from domestic to foreign-ownership in a year, and column 5 is the percentage of incumbents that change from foreign to domestic-ownership in a year. The omitted sectors (21, 23, 26, 44, 46) each account for less than 1% of employment in foreign-owned establishments.

[a] Figures cannot be disclosed for data confidentiality reasons

In the next section where we compare the characteristics of domestic and foreign-owned establishments we divide our sample into two groups: (1) establishments that are either always domestic or always foreign-owned; (2) establishments that change nationality between foreign and domestic ownership (at any point between 1973 and 1996). Note that the first group also includes establishments that are taken over, e.g. those that go from domestic to domestic ownership or from foreign to foreign ownership. Table 6 shows that the establishments that remain under British ownership make up the largest proportion of establishments. The next largest category is those that are initially domestic and are taken over by a foreign-owned firm.

Table 6: Distribution of establishments by nationality

	Number establishments	Number observations
Always domestic	38,725	173,102
Always foreign	1,248	7,340
Domestic to foreign	2,342	21,028
Foreign to domestic	1,091	9,895

Note: calculated from sample of establishments 1980 to 1996.

4 Characteristics of establishments

This section compares the characteristics of foreign-owned manufacturing establishments that operate in Britain with British-owned establishments. Figure 5 shows real value-added per worker in French, German, Japanese and US-owned establishments relative to UK-owned establishments. These were calculated by aggregating up the ARD to the nationality-year level and constructing labour productivity measures in an analogous way to the aggregate macro measures shown in Figure 2. Value-added per worker in US-owned establishments has been increasing relative to British-owned. This is in contrast to Figure 2, where we saw that levels of labour productivity in manufacturing activity located in the US has become more similar to that located in the UK. This is interesting and suggests that one source of the convergence seen in Figure 2 may be US-owned establishments located in Britain.

In this section we examine the differences between domestic and foreign-owned establishments at the micro level. We first look at differences in labour productivity as measured by real value-added per worker. Value-added is reported in the ARD and we deflate it by a 4-digit output price deflator. Employment in the ARD is measured as the average number employed in an establishment during the year.

We also look at differences in the usage of intermediate inputs, investment and labour. Different usage of intermediates may reflect the fact that establishments are at different positions on the value-added chain, for example higher intermediate usage may indicate that the establishment is an assembly plant. Higher investment per worker will reflect more capital intensive production and newer capital stock. These differences may help explain differences in labour productivity. Higher usage of skilled workers may also explain labour productivity differences between establishments. We would expect labour productivity differences to be reflected in differences in wages. It may also be the case that the use of performance related pay or efficiency wages induce higher labour productivity.

We do not present estimates of total factor productivity. This is because of a number of concerns we have about the measurement of the capital stock and about the appropriate methodology for measuring TFP when product markets are not perfectly competitive.[12]

Comparison of firms that are always foreign

We first look at establishments that remain under either domestic or foreign-ownership, over the entire period 1973-1996. Foreign-owned establishments are much larger than British-owned, as shown in Table 7. They have higher output and value-added per employee, invest more per employee and use more intermediate inputs than British owned-establishments. They use a higher proportion of administrative, technical and clerical (ATC) workers (used as a measure of skilled workers) and pay both ATC and operatives higher wages.

Table 7: Descriptive statistics, constant nationality sample

	1980		1996	
	Foreign	Domestic	Foreign	Domestic
No. establishments	*446*	*10,798*	*500*	*8,756*
Gross output [a]	27,142	6,5002	58,539	8,752
Value added [a]	8,982	2,312	15,798	3,013
Investment [a]	1,222	260	2,792	442
Intermediate inputs [a]	16,109	3,667	44,200	5,742
Employment	763	264	597	197
Output/employee [b]	40,541	22,891	87,570	37,461
Value-added/employee [b]	13,326	8,071	25,869	13,028
Investment/employee [b]	1,948	808	3,528	1,709
Intermediate inputs/employee [b]	25,466	13,572	68,459	25,121
% employees ATC	41%	26%	42% [c]	33% [c]
Average wage ATC [b]	6,797	5,874	9,984 [c]	8,235 [c]
Average wage OPS [b]	5,301	4,466	7,089 [c]	5,414 [c]

[a] *In 1980 £,000.*

[b] *In 1980 £s.*

Price deflator for output and value-added are at 4-digit level, for investment a combination of 3-digit and aggregate. Wages are deflated by the RPI. ATC: administrative, technical and clerical, OPS: operatives.
[c] *data from 1995, variable not available in 1996.*

Source: Authors' calculations using the ARD data.

These characteristics are similar to the results seen in the US work where there were large unconditional differences. In that work it was found that it was important to compare to domestic multinationals with their foreign-owned counterparts. It is not possible for us to differentiate UK-owned multinationals in our data. Instead we condition on observable and unobservable characteristics.

We concentrate on the following explanatory variables:

- nationality of parent, $f(F_i)$;

- age of the establishment, and a separate age profile for foreign-owned in some specifications, $g(age_{it}, F_i)$;

- size of establishment (measured by employment and normalised on mean industry employment), $h(size_{it})$;

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[12] See Hall (1988), Nickell (1996) and Klette (1999).

- year of exit, $exit_{it}$;

- time effects, and a separate time effect interacted with foreign-owned in some specifications, $\delta(t_t, F_i)$.

We are concerned that there may be other unobservable differences in firms that may be correlated with age, size or probability of exit. We allow for this by including a time invariant firm-specific effect, η_i,

$$\ln(lp_{it}) = \beta f(F_i) + \gamma g(age_{it}, F_i) + \phi h(size_{it}) + \lambda exit_{it} + \delta t(t_t, F_i) + \eta_i + e_{it}.$$

We estimate this model in two steps (see Hsiao (1986)). First we estimate

$$\ln(lp_{it}) = \gamma g(age_{it}) + \phi h(size_{it}) + \lambda exit_{it} + \delta t(t_t) + \eta_i + e_{it} \qquad (1)$$

using the within groups estimator. Then we estimate the residual (including the fixed effect), take the time series mean, and estimate a regression of the form,

$$\overline{\hat{\eta}_i + \hat{e}_{it}} = \beta f(F_i) + u_i. \qquad (2)$$

We assume a quadratic form for g(.) and h(.) while f(.) is represented by a series of dummies for different nationalities and t(.) is a full set of time dummies (in some specifications interacted with ownership).

Table 8 compares differences in real value-added per worker in establishments that do not change nationality. The top half of the table shows the first step estimates, i.e. the coefficients from equation (1). The bottom half shows the second step estimates, i.e. the coefficients from equation (2).

In column (1) labour productivity is regressed on age, size, a dummy for the year of exit and a full set of time and industry dummies. In column (2) and subsequent columns the sample is restricted to only those establishments that we observe five or more times. Conditioning on this sample is necessary to enable us to use the within groups estimator. This does not changes the coefficient significantly. In column (3) individual establishment fixed effects are included. This changes the sign and significance of most variables.

Table 8: Differences in real value-added per worker, constant nationality sample

	(1)	(2)	(3)	(4)
Dependent variable: $\ln(lp_{it})$				
Obs	180,442	131,097	131,097	131,097
age	-0.005	-0.011	0.018	0.017
	0.003	*0.003*	*0.003*	*0.003*
age^2	-0.00001	0.0002	0.0003	0.0003
	0.0001	*0.0001*	*0.0001*	*0.0001*
foreign*age	-	-	-	0.014
				0.013
foreign*age^2	-	-	-	0.0001
				0.0004
size	0.029	0.032	-0.034	-0.034
	0.002	*0.003*	*0.006*	*0.006*
size^2	-0.0007	-0.0009	0.001	0.0007
	0.0001	*0.0001*	*0.0002*	*0.0002*
Exit	-0.079	-0.099	-0.094	-0.093
	0.027	*0.028*	*0.022*	*0.022*
F-test, foreign-age interaction				21.45
(P-value)				(0.00)
Year	yes	yes	yes	yes[a]
Industry	yes	yes		
Within groups			yes	yes
Dependent variable: $\overline{\hat{\eta}_i + \hat{e}_{it}}$				
Obs			13,909	13,909
North American	-	-	0.517	0.311
			0.042	*0.044*
European Union	-	-	0.424	0.202
			0.086	*0.076*
Other European	-	-	0.351	0.168
			0.052	*0.053*
Japanese	-	-	0.496	0.376
			0.132	*0.132*
Other foreign	-	-	0.572	0.432
			0.146	*0.153*

Notes: numbers in italics are robust standard errors. All regressions are grossed up to population weights, and weighted by establishments employment. ln(lp): log of real output per worker. Number below F-test in ( ) are P-values. Year indicates full set of year dummies; Industry indicates full set of 4-digit industry dummies. Size is number of employees normalised on 4-digit industry-year average employment.

[a] *Includes interaction of year dummies with foreign-ownership dummy.*

In column (3) we see that labour productivity is increasing in age, and at an increasing rate and is decreasing in size, though at a decreasing rate. Establishments have lower labour productivity in their year of exit than in previous years. In column (4) we explore the idea that foreign-owned establishments may adapt to new technologies better than British-owned establishments. We do this by interacting a foreign-ownership dummy with the age terms. If foreign-owned establishments improve faster with age then this should be captured by this term. Although these interactions are not individually significant they are jointly significant (as indicated by the F-test). The domestic and foreign age effects are shown graphically by the solid lines in Figure 6 (the dashed lines are explained in the discussion after Table 9). After 24 years the contribution of the age effect is almost twice as large in foreign-owned establishments as in domestic-owned. We also tried interacting the year dummies with foreign-ownership. These were individually and jointly insignificant.

In the bottom half of the table we use the estimates from the top half to obtain estimates of the unexplained part of labour productivity, $\overline{\hat{\eta}_i + \hat{e}_{it}}$, and regress this on dummies for different nationalities of ownership, as described in equation (2). The results in column (3) suggest that North American-owned establishments have around 68% higher labour productivity than British-owned, EU-owned around 53% higher, other European-owned 42% higher, Japanese-owned around 64% and other foreign around 77% higher.[13] These are all significant and quite large differences. In column (4) we repeat this exercise. Conditioning on differences in the age profile explains some of the differences in labour productivity, but large and significant differences remain. North American-owned establishments have around 36% higher labour productivity than British-owned, EU-owned around 22% higher, other European-owned 18% higher, Japanese-owned around 46% and other foreign around 54% higher.

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[13] $\exp(\beta) - 1$ is approximately the proportional difference, where β is the coefficient on a dummy variable in a log linear regression.

The differences in inputs are investigated in Table 9. In the first column we see that investment per employee is increasing in age, at an increasing rate. The profile for foreign firms is different, while the coefficients on the interaction between the foreign dummy and age are individually insignificant they are jointly significant. Investment per worker for foreign-owned establishments is initially decreasing then increasing.

Establishments invest less per employee in the year before they exit. In the bottom half of the table the unexplained part of investment per employee is regressed against the nationality of ownership dummies, the same procedure as used above and described by equation (2). These are all positive and significant. Their magnitude is larger than those for labour productivity. North American-owned establishments invest twice as much per worker as British-owned, EU-owned around twice as much, other European-owned two and half times as much, Japanese-owned around eight times as much and other foreign around twice as much. This suggests that differences in value-added per worker seen in Table 8 are largely attributable to differences in investment levels.

In Figure 6 we investigate the extent to which the higher age profile for labour productivity in foreign-owned establishments is explained by differences in their capital stocks. We run a regression of capital stock per employee similar to that shown in column (1). We take the coefficients on the age and foreign-age profiles and subtract them, multiplied by the average share of capital in value-added, from the age profiles for labour productivity from column (4) in Table 8.[14] These capital adjusted age profiles for labour productivity are shown by the dashed lines in Figure 6. We see that the age profiles are now very close for the first ten years. This is because foreign-owned firms have both higher labour productivity and a correspondingly higher capital stock. After 22 years the adjusted profiles diverge by around 20 percentage points.

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[14] The coefficients are age (0.015), age^2 (0.00035), age*foreign (0.0657), age^2 *foreign (0.0015). The average share of capital in value-added is 0.26.

Table 9: Differences in inputs, constant nationality sample

Dependent variable	(1) ln(investment per employee)$_{it}$	(2) ln(proportion skilled workers)$_{it}$	(3) ln(average skilled wage)$_{it}$	(4) ln(average operative wage)$_{it}$
obs	122,398	125,917	125,910	124,525
age	0.010	0.003	0.024	0.012
	0.005	*0.002*	*0.001*	*0.001*
age^2	0.0007	0.00014	-0.00014	0.00004
	0.0002	*0.00007*	*0.00005*	*0.00004*
foreign*age	-0.010	-0.0001	-0.002	0.005
	0.018	*0.0055*	*0.004*	*0.005*
foreign*age^2	0.0009	-0.0001	0.0003	-0.0001
	0.0006	*0.0002*	*0.0001*	*0.0002*
size	-0.031	-0.004	-0.007	-0.010
	0.009	*0.003*	*0.002*	*0.003*
size^2	0.0008	0.00003	0.0002	0.0002
	0.0003	*0.00013*	*0.0001*	*0.0001*
exit	-0.106	-0.013	-0.009	-0.012
	0.042	*0.013*	*0.010*	*0.009*
F-test, foreign-age interaction	8.08 (0.00)	3.25 (0.04)	31.29 (0.00)	4.03 (0.02)
Year	yes	yes	yes	yes
Within groups	yes	yes	yes	yes

dependent variable: $\overline{\hat{\eta}_i + \hat{e}_{it}}$

Obs	13,898	13,908	13,908	13,832
North American	0.817	0.386	0.183	0.179
	0.095	*0.055*	*0.022*	*0.021*
European Union	0.713	0.418	0.197	0.108
	0.097	*0.074*	*0.024*	*0.027*
Other European	0.934	0.166	0.157	0.136
	0.137	*0.088*	*0.026*	*0.038*
Japanese	2.25	0.012	0.271	0.166
	0.39	*0.066*	*0.075*	*0.109*
Other foreign	1.09	0.448	0.133	0.185
	0.31	*0.131*	*0.092*	*0.096*

Notes: numbers in italics are robust standard errors. All regressions are grossed up to population weights and weighted by establishments employment. Year indicates full set of year dummies. Size is number of employees normalised on 4-digit industry-year average employment.

Finally we investigate differences in the type of workers employed and their average wages. In column (2) we see that the proportion of skilled workers is increasing in age and in size and is lower in the year before exit. We also see that foreign-owned establishments employ more skilled (ATC) workers. This could also partly explain higher levels of labour productivity. In columns (3) and (4) we see that wages are increasing in age, decreasing in size and lower in the year before exit. We see that foreign-owned establishments pay higher wages to both skilled workers and operatives, which is consistent with higher levels of labour productivity.

Comparison of firms that change nationality

In this section we compare establishments that change nationality and look at how their characteristics compare before and after the ownership change. Table 10 describes establishments that change nationality (at some time between 1973 and 1996). It is important to note that we do not necessarily observe an establishment in the sample both before and after the change in ownership nationality.

The first two columns consider establishments that go from being British to foreign-owned and describe their characteristics before and after the takeover. The size of establishment does not change noticeably, apart from a fall in average employment. Labour productivity, investment per employee and wages all increase. The final two columns describe establishments that go from being foreign to British-owned. There are fewer of these. Labour productivity prior to takeover is higher than for the domestic to foreign takeovers. The size of establishment is on average less after the transition, while labour productivity remains fairly stable.

Table 10: Descriptive statistics, changing nationality sample

	Domestic to foreign takeover		Foreign to domestic takeover	
	Before (domestic)	After (foreign)	Before (foreign)	After (domestic)
No. observations	*8,846*	*11,117*	*4,598*	*4,828*
Gross output	19,927	18,330	17,089	13,075
Value added	7,104	6,014	5,541	4,439
Investment	1,019	945	692	647
Intermediate inputs	12,201	12,453	10,972	8,538
Employment	563	379	388	296
Output/employee	35,804	45,764	39,903	39,402
Value-added/employee	12,385	15,098	13,428	13,580
Investment/employee	1,633	2,101	1,587	1,769
Intermediate inputs/employee	22,848	31,181	25,327	25,993
% employees ATC	35%	38%	38%	36%
Average wage ATC	7,509	7,824	7,365	8,113
Average wage OPS	5,510	5,876	5,514	5,755

[a] In 1980 £,000.

[b] In 1980 £s.

Price deflator for output and value-added are at 4-digit level, for investment a combination of 3-digit and aggregate. Wages are deflated by the RPI.

Source: Authors' calculations using the ARD data.

For this group of establishments, those that change nationality, we consider the same variables as for the constant nationality group, and additionally consider the number of years since the establishment changed nationality, and whether the change was from domestic to foreign or the other way around. In this case we can estimate the equation directly because the foreign ownership dummies are now time varying,

$$\ln(lp_{it}) = \beta f(F_{it}) + \gamma g(age_{it}, t.o.) + \phi h(size_{it}) + \lambda exit_{it} + \delta t(t_t) + \eta_i + e_{it}. \qquad (3)$$

The coefficient on the foreign nationality dummies, β, now picks up the difference in the level of labour productivity between when the establishment was domestic-owned and when it was foreign-owned.

Column 1 of Table 11 shows estimates for the coefficients from this model including only nationality dummies and year effects, i.e. not controlling for unobservable firm-specific characteristics. This suggests that establishments have around 13% higher labour productivity when they are North American-owned, other European-owned

around 5% higher, and other foreign-owned around 30% higher than when they were British-owned.

Table 11: Differences in real value-added per worker, changing nationality sample

	(1) $\ln(lp_{it})$	(2) $\ln(lp_{it})$	(3) $\ln(lp_{it})$	(4) $\ln(lp_{it})$	(5) $\ln(lp_{it})$
Dependent variable					
Obs	26,651	24,070	24,070	24,070	24,070
North American	0.123	0.123	0.055	0.058	-0.018
	0.021	*0.021*	*0.023*	*0.021*	*0.030*
European Union	0.006	0.009	0.004	0.006	-0.041
	0.028	*0.029*	*0.031*	*0.029*	*0.039*
Other European	0.048	0.047	0.032	0.035	0.069
	0.027	*0.028*	*0.022*	*0.021*	*0.035*
Japanese	0.045	0.049	-0.113	-0.077	-0.205
	0.083	*0.084*	*0.060*	*0.061*	*0.089*
Other foreign	0.260	0.277	0.083	0.068	-0.012
	0.052	*0.054*	*0.041*	*0.040*	*0.040*
age				0.003	0.025
				0.007	*0.011*
age^2				0.00004	0.0002
				0.00026	*0.0003*
size				0.036	-0.035
				0.005	*0.010*
size^2				-0.0015	-0.00003
				0.0003	*0.00041*
year of exit				-0.157	-0.118
				0.049	*0.046*
Year	yes	yes	yes	yes	yes
Industry			yes	yes	
Within groups					yes

Notes: numbers in italics are robust standard errors. All regressions are grossed up to population weights and weighted by establishments employment. Year indicates full set of year dummies; Industry indicates full set of 4-digit industry dummies. Size is number of employees normalised on 4-digit industry-year average employment.

In column 2 we condition on establishments that we observe at least 5 times; this makes little difference to the coefficient estimates. In column 3 we add 4-digit industry dummies. This reduces the North American difference to around 6%. Japanese-owned establishments exhibit around 11% lower labour productivity, and other foreign-owned

have around 9% higher labour productivity. In column 4 we condition on age, size and year of exit. This drives the Japanese-owned dummy into insignificance. Labour productivity is increasing in size and is lower in the year before exit.

In column 5 we use a within groups estimator to condition on establishment-specific unobservables. This means that the nationality coefficients are capturing the difference in productivity that arises due to different ownership. This drives the coefficient on North American owned into insignificance. Establishments have around 7% higher labour productivity when they are owned by other European firms, compared to British-owned. Those that are owned by Japanese firms have around 23% lower labour productivity, compared to British-owned firms.

We also tried allowing separate profiles for the number of years since the nationality change and whether it was domestic to foreign or foreign to domestic. This was intended to capture learning effects. The coefficients were not significant. In all specifications establishments have lower labour productivity in the year before they exit.

In Table 12 we compare inputs in establishments that change nationality. In column (1a) we regress the log of investment per worker on nationality dummies, age, size, year of exit, year and industry dummies. In column (1b) we use a within groups estimator to control for unobservable differences in establishments. Establishments invest more per worker when North American, EU or Japanese-owned than when British-owned.

Are the differences in labour productivity reflected in the type of labour used or wages paid? We look at this question in the remaining columns. In column (2) we see that more skilled workers are employed when the establishment is North American-owned than when British-owned. In column (3) we see that skilled workers are paid more in Japanese-owned establishments, and in column (4) that operatives are paid more when establishments are EU or other European-owned.

Table 12: Differences in inputs, changing nationality sample

	(1)		(2)		(3)		(4)	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Dependent variable	ln(investment per employee)$_{it}$		ln(proportion skilled workers)$_{it}$		ln(average skilled wage)$_{it}$		ln(average operative wage)$_{it}$	
obs	22,717		23,011		23,009		22,680	
North American	0.118	0.067	0.076	0.048	0.062	0.011	0.046	0.007
	0.028	*0.041*	*0.010*	*0.013*	*0.006*	*0.009*	*0.007*	*0.008*
European Union	0.140	0.134	0.004	0.005	0.017	0.013	0.017	0.026
	0.034	*0.043*	*0.016*	*0.015*	*0.008*	*0.012*	*0.008*	*0.010*
Other European	0.051	0.069	-0.055	-0.037	0.030	0.015	0.031	0.033
	0.048	*0.062*	*0.020*	*0.022*	*0.011*	*0.016*	*0.009*	*0.010*
Japanese	0.481	0.461	-0.057	-0.028	0.009	0.105	-0.021	0.028
	0.092	*0.120*	*0.045*	*0.039*	*0.027*	*0.042*	*0.023*	*0.036*
Other foreign	-0.000	-0.146	-0.093	0.028	0.060	0.022	0.005	-0.018
	0.096	*0.105*	*0.040*	*0.021*	*0.019*	*0.018*	*0.017*	*0.015*
age	-0.046	-0.010	0.009	0.010	-0.010	0.021	-0.009	0.013
	0.012	*0.015*	*0.004*	*0.005*	*0.003*	*0.003*	*0.002*	*0.002*
age^2	0.0013	0.0018	-0.000	-0.0002	0.0002	0.0001	0.0002	0.0001
	0.0005	*0.0005*	*0.000*	*0.0002*	*0.0001*	*0.0001*	*0.0001*	*0.0001*
size	0.075	-0.034	-0.002	-0.014	0.022	-0.002	0.028	-0.006
	0.007	*0.016*	*0.003*	*0.005*	*0.002*	*0.003*	*0.002*	*0.003*
size^2	-0.0023	0.0007	0.0004	0.0009	-0.0009	-0.0001	-0.0089	0.0002
	0.0003	*0.0005*	*0.0002*	*0.0002*	*0.0002*	*0.0001*	*0.0001*	*0.0001*
year of exit	-0.165	-0.109	0.038	0.030	0.014	0.020	0.036	0.023
	0.104	*0.092*	*0.035*	*0.027*	*0.029*	*0.025*	*0.028*	*0.023*
Year	yes	Yes	yes	yes	yes	yes	yes	yes
Industry	yes		yes		yes		yes	
Within groups		Yes		yes		yes		yes

Notes: numbers in italics are robust standard errors. All regressions are grossed up to population weights and weighted by establishments employment. Year indicates full set of year dummies; Industry indicates full set of 4-digit industry dummies. Size is number of employees normalised on 4-digit industry-year average employment.

5 Summary and conclusions

This paper has investigated the differences in characteristics of manufacturing establishments in Britain over the period 1980 to 1996. Particular attention was paid to differences between plants of different nationality. At the aggregate level we see that value-added per worker has grown rapidly in the UK since the early 1980s. However, the UK still remains behind the other G5 countries in the league tables. We see a somewhat similar picture when we look within the UK. In aggregate British-owned firms have lower labour productivity than firms of other nationalities that are operating within Britain. There do seem to be some differences in the time trend of labour productivity levels, particularly with respect to North American firms. Comparing across countries, Britain is catching up with the US, but looking within Britain we see that North American-owned firms are widening the gap with British-owned firms.

When we look at the micro level we find that establishments that are always foreign-owned have significantly higher labour productivity than those that are always domestic-owned. In addition, labour productivity improves faster with age in foreign-owned establishments. However, this is matched by an almost equivalent increase in levels of investment per employee. Once we take this into account there is little difference between firms of different nationalities. When we look at establishments that change nationality, differences in labour productivity between foreign and domestic owned establishments are smaller.

These findings suggest that investment patterns, and usage of other inputs such as skilled workers, may go a long way towards explaining differences in value-added per worker between establishments. This raises the question of why foreign-owned establishments are investing more and using more skilled workers. Do British-owned establishments face some constraint, or is there some other explanation? We are addressing this and other interesting questions, such as how foreign-owned

establishments have affected the performance of their domestic-owned counterparts, in ongoing research.

Data Appendix

The data used in this paper comes from the Annual Census of Production (ACOP) or Annual Business Inquiry (ABI) Respondents Database (ARD). This data is collected annually by the Office of National Statistics (ONS).[15]

Two types of information are contained in the ARD. Information on employment and group structure is available for all local units involved in production. A local unit is the smallest entity reported in ARD, it is effectively a plant (a single address).[16] Three main identifier codes are given – at the plant, establishment and enterprise group level. These indicate which local units (and establishments) are linked through common ownership.

Detailed information on inputs and output are collected at the establishment level. An establishment can be a single local unit or a group of local units. The number of local units accounted for by each establishment varies, and is reported. All production establishments located in Britain with more than 100 employees are sampled every year. Below 100 employees a stratified sample is taken. Only production establishments are surveyed. There is no information on non-production activities or activities located in other countries. When collecting the data the ONS asks that all non-production activities undertaken within the production establishments be excluded. This detailed data is called the selected data (the basic data on local units that are not surveyed is called the non-selected data).

In this paper we use data on the population of manufacturing plants and a sample of manufacturing establishments (we do not look at non-manufacturing production activities). We use a grossed up sample of the selected data for our main analysis.

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[15] See Oulton (1997), Perry (1995) and Griffith (1999) for more details.

[16] There are a small number of cases where the local unit is reporting for several plants. Since 1993 the list of local units comes from the Interdepartmental Business Register.

Details on the construction of the population, the grossing up factors and the sample are given below.

The ARD categorises establishments into seven types: incorporated or company, sole proprietor, partnership, public corporation, central government body, local authority, and other (this includes non-profit making bodies and others). We use information on only those local units and establishments classified as incorporated or company (acp_stat=1). These represent 96% of local units on average over the period 1980-1996. We exclude establishments that are not yet in production (prd_stat $\neq$ 1). Establishments are (almost) always made up of local units within the same 4-digit industry (5-digit after 1992). In the selected data output, investment, employment and intermediate inputs are reported in nominal terms for each establishment.

The price deflators for output and intermediate inputs are at the 4-digit industry level and were obtained from the ONS directly. Price indices for investment in plant and machinery are at the 2/3-digit level from Price Index Numbers for Current Cost Accounting, various years. For investment in buildings and land an annual price index from Price Index Numbers for Current Cost Accounting, various years, is used. For vehicles an annual price index is obtained using prices series for road motor vehicles from three series from Price Index Numbers for Current Cost Accounting, various years. The first series ran from 1974-1983 (1980=100) and the second from 1984-1993 (1985=100) but there was no common year to convert it. The price index for private vehicles published in CSO Retail Prices 1914-1990, Tables 70 and 71 is used to merge the two series.). The third series runs 1994-1996 (1995=100). The retail price index (RPI) is available at the aggregate level (CSO, various years). Price deflator series for output and inputs are interpolated using the RPI up to 1996 where there is missing data.

The ARD gives the country of residence of the ultimate owner of the local unit. The domestic to foreign and foreign to domestic takeovers are identified using the nationality of ownership indicator (fo_code). There appear to be some miscodings in this variable. Where we observe fo_code changing for one year and then reverting to its

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previous value we assume that this is a miscoding. We discard establishments that appear to be taken over more than twice during the period.

The foreign ownership data in ARD is collected under a separate annual survey which is also used for the FDI statistics, thus the ownership data for FDI is exactly the same as for ARD. This data is augmented through with information from Dun and Bradstreet. The definition of foreign direct investment into Britain used for statistical purposes in collecting the FDI data is, *"investment that adds to, deducts from or acquires a lasting interest in an enterprise operating in an economy other than that of the investor, the investor's purpose being to have an effective voice in the management of the enterprise. For the purposes of the statistical inquiry, an effective voice is taken as equivalent to a holding of 20% or more in the foreign enterprise. Other investments in which the investor does not have an effective voice in the management of the enterprise are mainly portfolio investments …"*.[17]

Capital stock data is not available in the ARD and we construct this using the perpetual inventory method (PIM) at the establishment-level. In order to do this we need to approximate the first period capital stock. We do this by allocating each establishment with a portion of an estimated 3-digit industry-level capital stock. The industry level capital stocks are estimated using a 1979 value from a study by Oulton and O'Mahony (1990) and then using the PIM with 3-digit industry level investment calculated by aggregating the ARD and grossing it up. An initial capital stock for each establishment is then estimated by using that establishment's share of energy usage within its 3-digit industry in that year. Where the capital stock is negative we set the capital stock to zero.

The entry and exit year of an establishment is calculated by identifying the first and last years that the establishment is present in the population of incorporated establishments that are in production. We do this using data on the population back to 1973. If an establishment goes from being a public corporation to being incorporated this is counted

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[17] CSO (1996).

as an entrant. Similarly, establishments that go from being "not yet in production" to in production are counted as entrants.

We construct the population of local units (or establishments) by taking all local units (establishments) that are:

(i) in the selected data and are single local units (establishments) (these do not appear in the non-selected data),

(ii) in the non-selected data and not in the selected data (for these there will be one observation in the non-selected data that represents the aggregate of all others (i.e. the establishment), this should be denoted by struct=8 but seems to be coded incorrectly in many cases. We have identified the aggregate observation by using the selected employment (sel_emp) variable. We then remove it from the population of local units and retained it in the construction of the population of establishments.

(iii) in both selected and non-selected data we drop observations if sel_stat=7 or 8, these are ones marked deleted by ONS.

We create grossing up factors using employment in the population of establishments. Two populations are used for this purpose. The first contains all establishments that are either always under domestic or foreign-ownership, and the second contains establishments that change ownership nationality due to a takeover. Grossing up factors are calculated at the 4-digit sic80-size-year level. Grossing up factors are not calculated by ownership nationality, as there are too many empty cells, where no foreign-owned establishments in a particular industry and size category are observed in the selected data, but they are in the population.

We allocate establishments to their mode 4-digit SIC code (so it is time invariant for each establishment). From 1992 we map sic92 codes to sic80 codes. The mapping is constructed using data from 1992 and 1993 when both industry codes are reported in the ARD. For each sic92 we use the sic80 from which the largest number of local units

were recoded. We verify these mappings using *Indexes to the UK Standard Industrial Classification of Economic Activities 1992, ONS.*

The ONS has made changes to the establishment identifier codes several times. Where possible we map over this coding change using postcode and industry code.

Around 1% of observations in our sample have negative value-added (expenditure on intermediate goods is greater than the value of output). We drop these observations.

Around 20% of observations have a wage bill that is greater than value-added (that is variable costs are greater than the value of output). This occurs more often in recessions, but is spread fairly evenly over years, industries, ages of establishments, and foreign and domestic establishments. These observations have lower value-added per employee, lower investment and pay lower wages, a shown in Table 13.

Table 13: Characteristics of establishments with wage bill greater than value-added

Characteristic	Dummy = 1 if wage bill greater than value-added
Value-added per employee	-0.37
	0.01
Investment per employee	-0.23
	0.02
Wage ATC	-0.01
	0.01
Wage OPS	-0.02
	0.01

Coefficients are from a weighted regression of log characteristic on dummy for observations to be dropped from the sample, industry and time dummies

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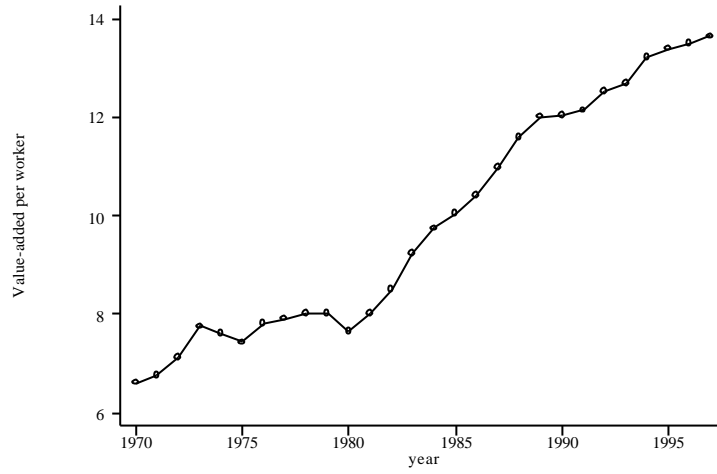
Figure 1: Value added per worker (in 1980 UK£,000) in manufacturing
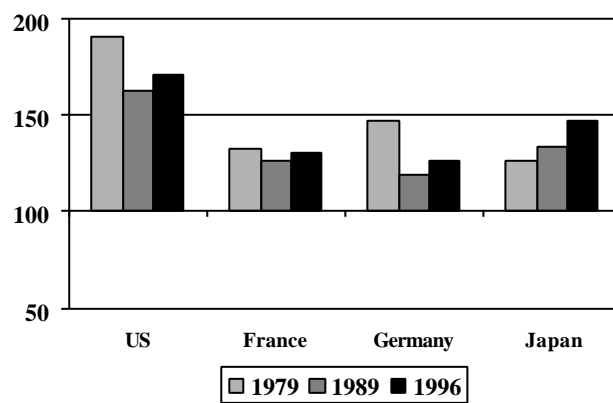Data from OECD STAN database.

Figure 2: Output per hour worked in manufacturing, UK=100
by Country of location
Source: O'Mahony (1999)

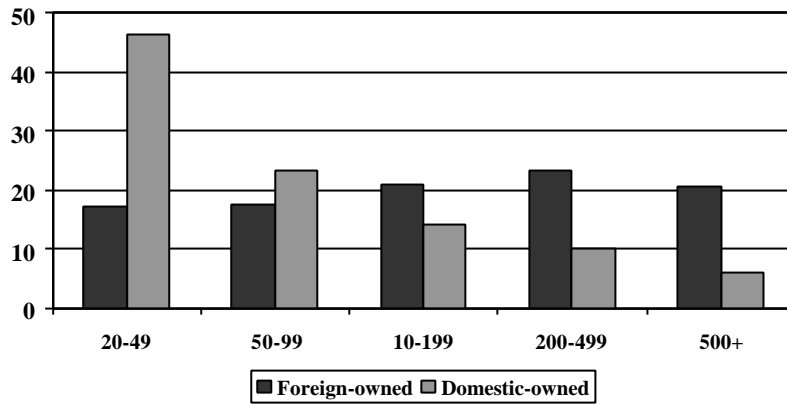Figure 3(a): Employment size distribution population of establishments 1980

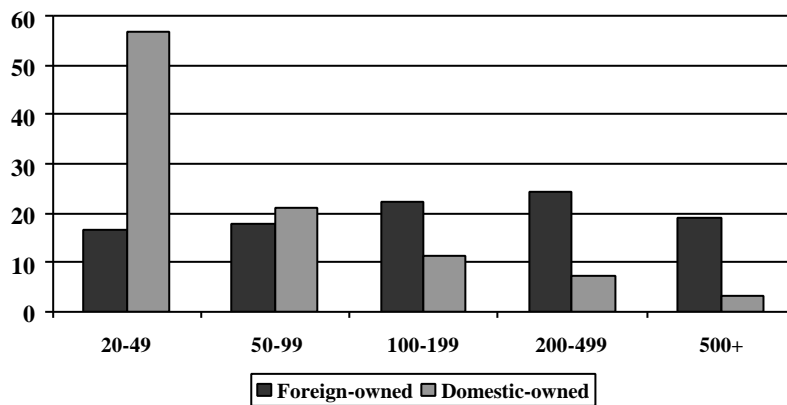Figure 3(b): Employment size distribution population of establishments 1996

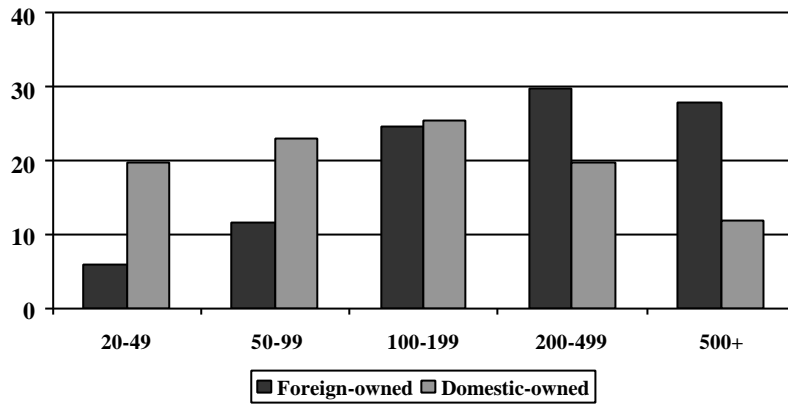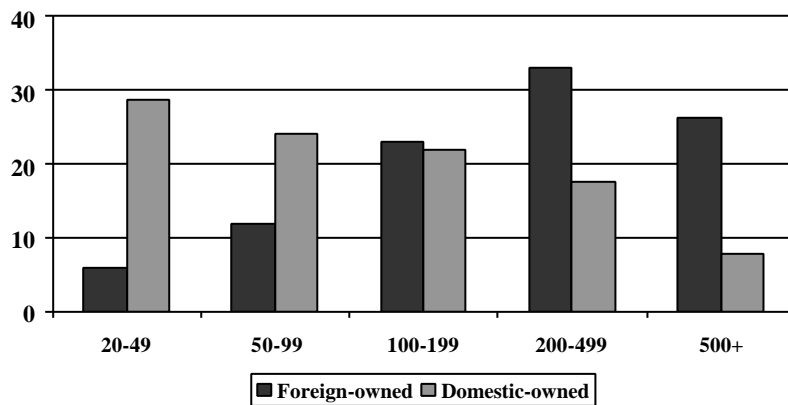Figure 3(c): Employment size distribution sample of establishments 1980

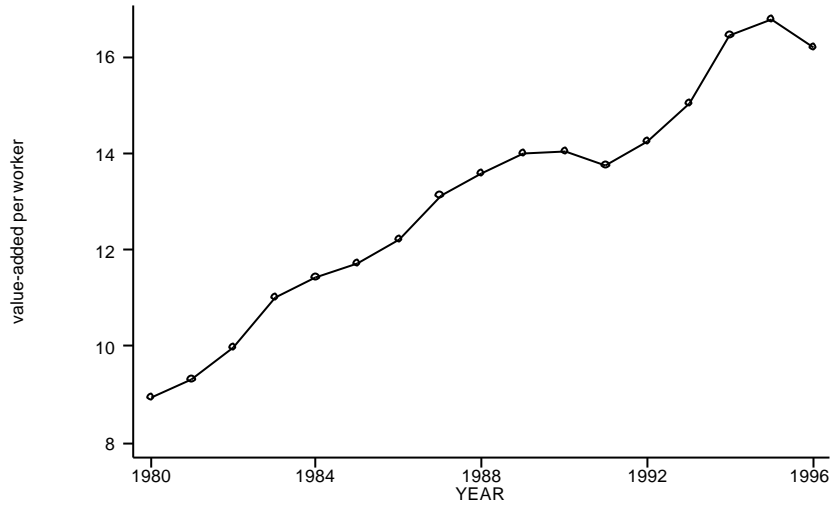Figure 3(d): Employment size distribution sample of establishments 1996

3

Figure 4: Value added per worker (in 1980 UK£,000) in manufacturing
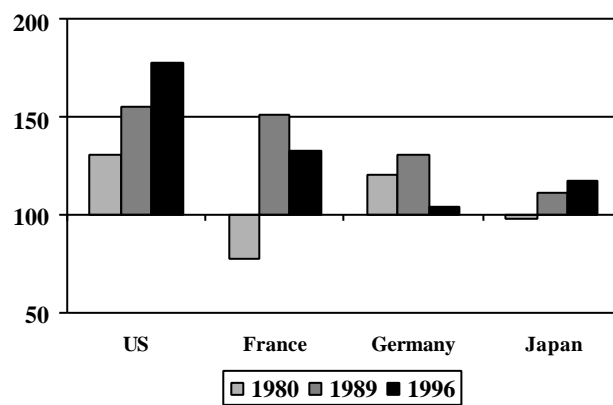Grossed up ARD sample

Figure 5: Output per worker in manufacturing, UK=100
Located in Britain, country of nationality

Figure 6: Age effect on real value-added per employee