Multinationals, foreign ownership and US productivity leadership: Evidence from the UK *

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Abstract

Several studies using firm level data find that foreign-owned firms are more productive than domestic ones. This could reflect a foreign advantage or an omitted variable bias: foreign firms are by definition multinational enterprises (MNEs), and MNEs are typically more productive than non-MNEs. This paper attempts to discriminate between these hypotheses. We are the first to study the productivity of foreign owned firms relative to UK firms separated into MNEs and

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non-MNEs. We obtain three main results. First, the foreign productivity advantage is mostly a multinational advantage: MNEs, foreign and UK, are more productive than non-MNEs. Second, US owned firms maintain a productivity advantage with respect to both UK and other foreign owned firms. Third, examining the longitudinal dimension of our data we find no evidence that higher MNE productivity is driven by sharing superior firm specific knowledge among affiliated plants. Thus, the MNE advantage must lie in an ability to takeover already productive plants or in setting up above average productivity plants on green field.
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1 Introduction

Several studies using firm level data find that foreign-owned firms are more productive than domestic ones. Using US data, Doms and Jensen [7] find that, controlling for capital, age, industry and region, productivity[1] in foreign owned plants is on average 11 to 13% higher than domestic plants. Griffith et al. using UK data [11] find an advantage of 9%.

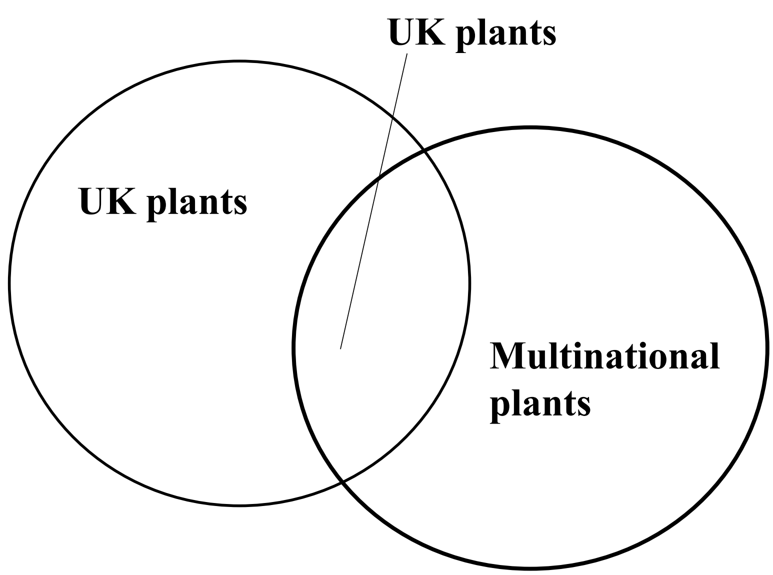
In the UK this result has been interpreted in the context of a poor aggregate performance relative to other advanced market economies. O'Mahony and de Boer [20] find that the US, French and German manufacturing as a whole have 55, 32 and 29% higher labor productivity than UK manufacturing. Commentators[2] have suggested that the aggregate productivity gap and the gap between foreign and domestic firms within the UK are driven by the same factors, namely bad management and inferior technology in UK owned firms. This differs from earlier explanations for the aggregate productivity gap such as low skill level of the labour force and poor institutions which would affect both domestic and foreign firms in a similar way.

[1] Measured as value added per employee

[2] see for example Dorgan et al. [8].

Does the gap between foreign and domestic firms necessarily lead to such a conclusion? Figure 1 shows a possible alternative explanation: the comparison of foreign owned plants with all domestic plants in a country is potentially affected by a selection problem. Foreign owned plants are, by definition, part of multinational firms (MNEs). However, only a small fraction of domestic plants are part of UK MNEs. If MNEs have an intrinsic productivity advantage, the superior performance of foreign firms might simply reflect a multinational advantage. A number of authors[3] have suggested that MNEs

Figure 1: The populations of firms in a country



[3]Hymer [16], Dunning [9], Markusen [17]

should have an advantage over firms which only operate in one country. The idea is that a foreign firm will always have higher costs in setting up in business compared to a domestic one. These additional costs might arise, for example, from barriers due to language, unawareness of local business networks, or from assigning workers abroad. If, nevertheless, a firm sets up abroad it must have some particular characteristic, such as a patent, a trademark or some firm-specific knowledge that allows it to achieve lower costs of production or higher prices than rival firms and thereby stay profitable despite higher set-up costs [4]. To establish if foreign owned firms have indeed a superior technology to domestic firms we should therefore provide a fair comparison and compare the performance of foreign owned firms relative to domestic MNEs.

The key innovation of the current paper is to do this for the UK. This was only possible after merging a recently available dataset, the Annual Inquiry into Foreign Direct Investment (AFDI), to the Annual Respondents Database (ARD), the UK's main dataset for productivity research at the microlevel. We find that MNEs, both UK and foreign owned, are more productive than non MNEs which suggests that the foreign effect is by large a multinational effect. Doms and Jensen are - to the best of our knowledge - the only ones who have done a similar investigation, but for the US. They find that US MNEs are more productive than foreign owned firms in the US. US non MNEs are less productive than both, foreign and US MNEs. To compare our results to Doms and Jensen we control separately for US ownership. This yields the same ranking: US owned multinationals are the most productive followed by other foreign and UK MNEs, with domestic non MNEs being the least productive. Our study therefore confirms but also qualifies Doms and Jensen's result, because it suggests that their finding of US leadership reflects a genuine advantage of US firms and not a home advantage[5]. In the second part of the paper we exploit the panel structure of our dataset to examine the

[4]In his OLI framework Dunning calls this ownership advantage

[5]i.e. MNEs might be more productive in their home country because they do not have the additional setup costs mentioned earlier

nature of the MNE advantage in more detail. We try to disentangle if firms are productive because they are multinational - we call this Generic MNE effect - or because the most productive firms and plants become multinational, by either investing abroad themselves or by having a higher probability of being taken over by a multinational firm. We find a small but significant Generic MNE Effect of about two percent. We then estimate a double fixed effects model to examine if it is mainly firm or plant specific effects which drive the multinational effect. We find a large significant positive difference between plants effects for plants that are part of MNEs and no significant difference between MNE and non MNE firm effects.

The rest of the paper is organised as follows: in sections 2 and 3 we describe our dataset. Section 4 shows that the foreign ownership effect is rather a multinational effect. In section 5 we examine the existence of a *Generic MNE Effect* and calculate firm and plant specific effects. We discuss in depth the double fixed effects technique used for this purpose. The section also features an illustrative model. Section 6 concludes. The Appendix A contains more detailed descriptions of the variables in our dataset, Appendix B details of the Model introduced in Section 5 and Appendix C robustness checks for the results presented in Section 4.

2 Data Sources

Our dataset contains information from two sources: the Annual Respondents Database (ARD) and the Annual Survey into Foreign Direct Investment (AFDI). We describe each in turn[6].

[6] More details on the ARD data can be found in Griffith[13], Oulton[21], Disney et al.[5], and Barnes and Martin[19]

2.1 The Annual Respondents Database (ARD)

The ARD is a dataset made available by the Office for National Statistics (ONS) based on information drawn from the Annual Business Inquiry (ABI)[7], the annual survey of UK businesses. Until 1997 the ARD only included the production sector. Since 1998 it covers the whole economy. In our study we use the production sector data only. Response to the ABI is mandatory under the 1947 Statistics of Trade Act. The ABI requires extensive operational information on inputs and outputs, which we use to estimate productivity. The most disaggregated unit on the ARD is a production facility at a single mailing address referred to as local unit. The ONS keeps a register that keeps track of all local units in the country, which also captures if a local unit is part of a larger firm or group of firms. This register is drawn from a variety of sources including historical records, tax returns and other surveys. However, for at least two reasons the ARD is not actually a census of all local units. First, businesses are required to report about their activities at the "enterprise level". For the ONS an enterprises are relatively autonomous business units which are not necessarily different units in a legal sense. Consequently an enterprise does not necessarily correspond to a firm. Larger firms might consist of several enterprises. Nor does an enterprise necessarily correspond to a single plant. As a consequence the observations in our dataset correspond to local units either if a firm consists of a single plant or if any of the business units of a larger firm consists of one plant only. 80 percent of the local units in the manufacturing part of the ARD register report at the local unit level which makes our dataset by large a plant level dataset. Therefore, to simplify discussion in what follows we will refer to this level as the plant level and to the observational units as plants in what follows.

The second reason for the ARD not being a census is that smaller reporting units - or plants as we call them now - do not have to complete the survey

[7]Before 1998 it was called Annual Census of Production and included the production sector only

every year. Plants with employment below a certain threshold[8] are sampled on a random basis. The sampled plants altogether are referred to as the "selected sample", while all non-sampled plants constitute the "non-selected sample". Each year the selected sample accounts for around 90% of total U.K. manufacturing employment (Oulton, [21]).

The country of ownership of a foreign owned firm operating in the UK - and thus the ability to identify foreign MNE plants in the UK - is an information which is already part of the ARD register[9]. Whilst this identifies foreign-owned plants, until now it has not been possible to identify UK MNEs. To do this we use the Annual Inquiry into Foreign Direct Investment (AFDI) described in the next section.

2.2 The Annual Inquiry into Foreign Direct Investment(AFDI)

The AFDI is an annual survey to businesses which requests a detailed breakdown of the financial flows between UK firms and their overseas parents or subsidiaries. The AFDI is thus a survey run at the firm and not at the plant level as the ARD. The inquiry has an "outward" part that measures foreign direct investment (FDI) by UK firms abroad and an 'inward' part that measures FDI in the UK by foreign corporations.

To conduct the AFDI, the ONS maintains a register which holds information on the country of ownership of each firm and on which UK firms have foreign subsidiaries or branches [10]. This register is designed to capture the

[8]The threshold was 100 employees in most years but increased to 250 in later years

[9]The ARD data is supplemented here with information from Dun&Bradstreet global "Who own's Whom" database.

[10]In the following we refer to subsidiaries and branches jointly as affiliates. The ONS distinguishes between subsidiaries and branches as follows: a 'subsidiary' is mainly a company where the parent company holds more than 50% of the equity share capital; a 'branch' is a permanent plant as defined for UK corporation tax and double taxation relief purposes; companies where the investing company holds between 10% and 50% of the equity share capital, i.e. does not have a controlling interest but participates in the

universe of firms that are involved in foreign direct investment abroad and in the UK[11]. It is drawn from (and continuously updated) using a variety of sources including administrative records, (from HM Customs and Excise and from Inland Revenue), Dun and Bradstreet's 'Worldbase' system and ONS inquiries on acquisitions and mergers involving UK companies.

2.3 Merging the ARD with the AFDI

The main innovation of this paper is to be able to identify UK MNEs by merging the AFDI to the ARD.

We merge the two datasets at the firm level, so that all plants in merged firms are marked as MNEs. We, therefore, classify an ARD plant as being part of a UK MNE if it is owned by a firm which appears in the AFDI and is not foreign owned. The merging procedure is subject to two measurement error problems. First, although, the ONS register tries to include all firms engaged in FDI, in practice, the register population has varied with the ONS' success and effort in identifying such firms [12]. Second, to combine the information in both datasets we have to rely on the ARD's firm identifier. This variable has been subject to a major coding change in 1998, which is only incompletely documented and there appear to be minor inconsistencies and errors also in other years. In the appendix we document in greater detail our efforts to clean this variable.

As a consequence of these problems, a number of plants is likely to be recorded as domestic despite being multinational. Also there may be plants whose status changes from domestic to multinational although they have always been multinational. For more details on the AFDI and the merging of

management, are defined 'associates'. ONS [10] p.120.

[11]The annual inquiry regards direct investment as an investment made abroad in order to have an effective voice in the management of a foreign firm. For practical purposes this is defined, since 1997, as holding a share of at least 10% (20% before 1997) in the foreign company, whereas holdings below this threshold are considered portfolio investment.

[12]Particularly after 1997 the AFDI population has increased dramatically after the ONS started to include information from the Dun&Bradstreet database

the two datasets refer to Criscuolo and Martin [4]

3 Descriptive Statistics

Table 1 shows the number of multinational plants that we can identify in our sample over time. The top panel shows the total number and relative

Table 1: Number of multinationals over time

			1996	1997	1998	1999	2000
All	absolute numbers	UK non MNE	162937	166312	165175	164090	161234
		foreign	2883	2920	2539	3523	3499
		UK MNE	2743	2624	3255	3257	2919
	shares	UK non MNE	0.967	0.968	0.966	0.960	0.962
		foreign	0.017	0.017	0.015	0.021	0.021
		UK MNE	0.016	0.015	0.019	0.019	0.017
Selected	absolute numbers	UK non MNE	9793	9527	9805	9596	9257
		foreign	1636	1521	1490	1686	1685
		UK MNE	1507	1332	1527	1529	1343
	shares	UK non MNE	0.757	0.770	0.765	0.749	0.754
		foreign	0.126	0.123	0.116	0.132	0.137
		UK MNE	0.116	0.108	0.119	0.119	0.109

Source: Authors calculations based on ARD and AFDI

Notes: "Selected" refers to those establishment in the ARD population that received and returned a survey form in a given year

shares of domestic, foreign and UK multinational plants in the complete ARD population. Row 2 shows a jump of about 25 percent of UK MNEs from 1997 to 1998. Rather than actual changes in ownership status this most likely reflects the measurement error problems described earlier. The bottom panel shows the same numbers for the selected plants; i.e. the plants surveyed in a given year. Note that the jump in the number of UK MNEs is not as dramatic for this subsample. This reflects the fact that the ONS is more likely to overlook smaller firms, when building the AFDI register, which also have a lower probability to be in the ARD selected sample. Consequently the sample we use for our regression analysis is affected to a lesser extent by the measurement error problems described in the last section. Also, since MNEs are on average larger, the relative share of MNEs in the selected sample is much higher. Whereas in the total population UK and foreign MNEs combined take a share of a about 4 percent, in the selected sample this same figure rises to almost 30 percent . The share of UK MNEs remains fairly constant over time and the share of foreign owned firms has very slightly increased.

Table 2 shows the shares that the various ownership types represent in terms of aggregate value added and employment. The top panel shows employment shares for the whole population based on a combination of the employment variable kept in the plant register - which is available for the whole population - and the employment variable obtained from the returned surveys. The second panel (rows 3 to 6) shows employment shares for the selected sample only. The remaining 2 panels report value added shares, first for the selected sample, unweighted, and then weighted to provide an estimate for the value added shares of the whole population. Here, as in the remainder of the paper, the weights are calculated on 4-digit industry, 11 region and employment band cells.

Consider first panel one. In terms of employment the importance of MNEs is much larger than when considering the numbers of plants. In column 6 we observe that all MNEs account on average for more than 40 percent of total employment. The reason for this is the larger size of MNE plants.

Looking at the last panel, we see that with more than 50 percent the MNEs are even more significant in terms of value added. These two pieces of evidence hint at a superior productivity of MNEs. The time series of the shares of both employment and value added show a slight decrease in the importance of domestic firms. However, changes are not very dramatic.

Table 2: Value added and employment share over time

			(1)	(2)	(3)	(4)	(5)	(6)	(7)
			1996	**1997**	**1998**	**1999**	**2000**	**Average**	**Diff.: 2000-1996**
un-weighted	**value added**	**UK nonMNE**	0.37	0.39	0.37	0.34	0.35	0.37	-0.019
		foreign	0.37	0.35	0.33	0.35	0.37	0.35	0.000
		UK MNE	0.26	0.26	0.29	0.31	0.28	0.28	0.019
	employ-ment	**UK nonMNE**	0.47	0.48	0.48	0.44	0.43	0.46	-0.039
		foreign	0.28	0.27	0.27	0.28	0.31	0.28	0.025
		UK MNE	0.25	0.26	0.25	0.28	0.26	0.26	0.014
weighted	**value added**	**UK nonMNE**	0.50	0.52	0.50	0.47	0.47	0.49	-0.029
		foreign	0.29	0.27	0.27	0.28	0.30	0.28	0.004
		UK MNE	0.21	0.21	0.23	0.25	0.23	0.23	0.025
	employ-ment	**UK nonMNE**	0.61	0.62	0.62	0.59	0.57	0.60	-0.041
		foreign	0.20	0.19	0.20	0.20	0.23	0.20	0.022
		UK MNE	0.18	0.18	0.18	0.21	0.20	0.19	0.019

Source: Author’s calculations based on ARD and AFDI

Notes: Weights are calculated for employment (sel_emp), sector cells and regional cells. Value added is gross value added at factor costs

Table 3 distinguishes further the MNE group: it classifies foreign owned plants by the country or world region of ownership[13]. The table shows that among the foreign owned plants US MNEs are by far the largest group. Column 1 reports the number of plants in the whole population and column 2 the number of plants for each group in the sample of selected plants. Column 3 and 4 describe the distribution of plants, employment and value added shares. The table shows that 20 percent of all plants in the UK are US-owned, almost as much as all other foreign owned firms combined. Similar figures hold for the share in employment, 24%, and value added, 28%. These figures are consistent with the fact that the most productive companies should also have the highest market share[14].

Table 4 reports averages and standard deviations for various variables. Consider employment in row 1. Comparison of column 1 and 2 of panel 1 shows that foreign owned plants are much larger than all UK plants. When we distinguish all UK plants between non MNEs (column 3) and MNEs (column 4) we observe that UK MNE plants are on average almost as large as foreign owned plants and more than double the size of domestic non multinational plants. Row 2 reports labour productivity - measured as value added per employee - for the various plant groups. Column 1 and 2 report averages for all domestic and all foreign plants. Foreign owned plants have an advantage of more than 50 percent in respect to UK plants. If we distinguish between UK MNEs (column 4) and UK non MNEs (column 3) we find that UK MNEs are more similar to foreign owned plants than to UK non MNEs. However, foreign owned plants (column 2) still have an advantage of more than 20 percent over UK MNEs. In columns (5) and (6), we further distinguish foreign owned plants between US owned and non US owned foreign MNEs, and we observe that US owned plants are the most productive. When looking at gross output per employee (Panel 3) the foreign advantage becomes more dramatic: UK MNEs lag behind foreign MNEs by almost 45 percent. Also,

[13] A detailed description of the country groups that feature in the table can be found in the data appendix

[14] Note that it is also a feature of our model below

Table 3: Multinational types

MNE types	plants in popula tion	Selected	Shares in popula tion	Shares selected	employ-ment share, pop.	employ-ment share, selected	Value added share
UK MNEs	3062	1428	0.52	0.50	0.51	0.49	0.47
EUnorth[1]	405	192	0.07	0.07	0.05	0.05	0.04
EUsouth[2]	55	21	0.01	0.01	0.01	0.01	0.01
France	211	110	0.04	0.04	0.04	0.04	0.04
Germany	268	122	0.05	0.04	0.04	0.04	0.03
Japan	148	89	0.02	0.03	0.04	0.04	0.03
Netherlands	188	96	0.03	0.03	0.02	0.02	0.03
Tax[3]	64	22	0.01	0.01	0.00	0.00	0.00
USA	1172	615	0.20	0.21	0.24	0.24	0.28
other[4]	85	35	0.01	0.01	0.01	0.01	0.00
otherEurope[5]	157	79	0.03	0.03	0.03	0.02	0.03
otherOECD[6]	126	58	0.02	0.02	0.02	0.03	0.03

Notes: [1] Eunorth: Austria, Belgium, Denmark, Finland , Luxembourg, Sweden, Republic of Ireland

[2]Eusouth: Italy, Spain and Canary Islands, Portugal, Greece

[3]Tax: British Virgin Islands, Channel Islands, Isle of Man, Liechtenstein, Antigua and Barbuda, Cyprus, US Virgin Islands

[4]other: residual category

[5]otherEurope: Norway and Switzerland

the ranking has now changed: in terms of gross output per employee, foreign non-US owned plants are the most productive, as shown in columns (5) and (6). Do these gaps represent the "true" UK disadvantage? Panels 6 and 7 of table 4 suggest otherwise: foreign owned plants have much higher intermediates to labour and capital to labour ratios than UK MNEs, with non US foreign owned MNEs being the most capital intensive. At least part of the gap in productivity can therefore be explained by foreign owned plants being more capital intensive and employing more intermediates. Indeed, panel 6 reports the averages of the logarithm of TFP for UK and foreign owned plants. Foreign owned plants are still more productive but the difference is less pronounced. Columns 3 to 6 show that non US foreign MNEs have a slightly lower average TFP than domestic UK plants. Are these differences due to industry, location, size or age of the plants? Table 5[15] addresses this issue: it reports regression coefficients for UK MNE, US MNE and other foreign MNE dummies, which indicate the relative difference to UK domestic plants. Column 1 reports for each group values without any further controls which leads to the same qualitative result as table 4. Columns 2 report the coefficients from regressions that controls for size, age, location of the plant and industry. The table shows that for most variables the differences among UK non-MNEs and MNEs found in column 1 are still significant, although attenuated, and the ranking for the different MNE groups remains virtually unaffected when controlling for compositional differences. A notable exception is TFP, however: controlling for compositional differences other foreign plants turn out to be more productive than domestic non MNEs.

4 Foreign or Multinational Effect

Several studies[16] have examined equations of the following type:

$$y_{it} = \delta X_{it} + \beta FOR_{J(i;t)} + \varepsilon_{it} \tag{1}$$

[15]this table follows Doms and Jensen's table 7.4

[16]e.g. Griffith [13] and [12], Harris [14], Doms and Jensen[7]

Table 4: Averages for the pooled 1996-2000 sample

	(1)	(2)	(3)	(4)	(5)	(6)
	UK all	**Foreign**	**UK non MNE**	**UK MNE**	**US**	**Foreign other**
1 Employment	203.39	485.08	142.09	475.00	537.00	445.49
	(491.39)	(1254.59)	(264.44)	(954.58)	(1394.88)	(1134.66)
2 VA/Emp	29.64	44.61	27.98	36.98	46.57	43.12
	(166.61)	(65.78)	(183.42)	(40.22)	(80.79)	(51.44)
3 GO/Emp	81.82	151.98	76.52	105.30	146.23	156.36
	(196.45)	(262.62)	(207.86)	(132.20)	(232.02)	(283.70)
4 Mat/Emp	54.07	107.81	50.52	69.76	99.16	114.40
	(85.50)	(198.51)	(85.02)	(85.90)	(163.67)	(221.22)
5 K/Emp	43.24	98.82	38.23	65.41	85.54	108.95
	(90.07)	(288.24)	(92.75)	(73.06)	(125.61)	(366.32)
6 TFP	1.06	1.06	1.06	1.09	1.08	1.04
	(0.74)	(0.36)	(0.49)	(1.38)	(0.35)	(0.37)
7 Average wage	18.00	23.71	17.24	21.35	24.13	23.40
	(8.50)	(8.35)	(7.89)	(10.14)	(8.53)	(8.21)
8 ValueAdded/ Sales	0.47	0.35	0.43	0.64	0.38	0.33
	(7.81)	(0.16)	(0.19)	(18.19)	(0.15)	(0.16)

Notes: Standard Deviations in parenthesis. Figures in panels 2 to 5 and 7 are in thousands of £. Number of observations is 38,522 (38,510 for TFP).

Table 5: Conditional averages

		UK MNE		US		Foreign other	
		(1)	(2)	(1)	(2)	(1)	(2)
1	**Emp**	1.412 (0.047)	1.128 (0.040)	1.498 (0.036)	1.237 (0.030)	1.350 (0.032)	1.101 (0.030)
2	**VA/Emp**	0.306 (0.021)	0.149 (0.014)	0.486 (0.022)	0.279 (0.017)	0.412 (0.017)	0.196 (0.015)
3	**GO/Emp**	0.354 (0.027)	0.178 (0.016)	0.592 (0.034)	0.373 (0.022)	0.691 (0.020)	0.418 (0.014)
4	**Mat/Emp**	0.429 (0.032)	0.193 (0.021)	0.684 (0.041)	0.414 (0.028)	0.871 (0.023)	0.530 (0.017)
5	**K/Emp**	0.764 (0.036)	0.216 (0.022)	0.974 (0.035)	0.411 (0.023)	1.149 (0.028)	0.527 (0.020)
6	**TFP**	0.021 (0.006)	0.042 (0.005)	0.043 (0.006)	0.071 (0.006)	-0.000 (0.005)	0.027 (0.005)
7	**Average wage**	0.264 (0.014)	0.055 (0.010)	0.384 (0.014)	0.126 (0.011)	0.357 (0.009)	0.120 (0.008)

Note: The numbers are regression coefficients (robust standard errors in parenthes).
The number of observations is 38,522 (38,510 for TFP). The omitted group is UK Non MNE.

(1) No controls. (2) Control for 4-digit industry, age, region and plant size (excluding regression where dependent variable is log employment)

where y is a productivity measure, typically log gross output per worker, $\mathbf{x}_{it}$ is a vector of observed explanatory variables such as the log capital labor ratio and FOR_{it} is a dummy equal to one if a plant is foreign owned. These studies find large, positive and significant values for β. There are two explanations for this finding. First, there is a specific domestic productivity disadvantage: all UK plants are worse than foreign owned plants. Second, since foreign owned plants are part of a MNE, and MNEs are more productive than non-MNEs, positive and significant values for β are just reflecting a multinational advantage. To test between these two hypotheses, we note that the latter implies that plants belonging to domestic MNEs should have similar productivity advantages as foreign owned plants. Thus, a high value for β could be the result of an omitted variable bias. To examine this, we include in equation 1 a dummy for MNE:

$$y_{it} = \delta X_{it} + \beta_1 MNE_{J(i;t)} + \beta_2 FOR_{J(i;t)} + \varepsilon_{it} \tag{2}$$

where MNE takes value one if a plant is part of a MNE, be it domestic or foreign owned.

In the UK the advantage of foreign owned plants, found in previous studies, has often been interpreted as evidence of a UK productivity lag in the context of an aggregate productivity gap compared to other leading economies, in particular the US. The idea is that the same factors which make the US economy more productive are also responsible for higher productivity of US owned plants in the UK. To account for this and to be able to compare our results directly with the study by Doms and Jensen [7] our preferred specification of Equation 1 includes a separate identifier for US owned plants:

$$y_{it} = \delta X_{it} + \beta_1 MNE_{J(i;t)} + \beta_2 FOR_{J(i;t)} + \beta_3 USA_{J(i;t)} + \varepsilon_{it} \tag{3}$$

Table 6 reports results of estimation of equations 2 and 3 using the pooled sample for the years 1996 to 2000 and real gross output per employee as dependent variable. In column 1 we only include a foreign ownership dummy and find a result which other studies have found before: foreign plants enjoy a strong and significant labour productivity advantage of more than 56.5

Table 6: OLS regressions: dependent variable log gross real output

	0.4480	0.2241					
	(0.0144)***	(0.0199)***					
		0.2872	0.2872	0.0335	0.0378	0.0447	0.0452
		(0.0166)***	(0.0166)***	(0.0056)***	(0.0056)***	(0.0055)***	(0.0055)***
			0.2036	0.0463	0.0457	0.0463	0.0459
			(0.0269)***	(0.0079)***	(0.0079)***	(0.0079)***	(0.0079)***
			0.2398	0.0147	0.0135	0.0127	0.0122
			(0.0199)***	(0.0075)*	(0.0075)*	(0.0075)*	(0.0075)
				0.0581	0.0637	0.0658	0.0682
				(0.0030)***	(0.0032)***	(0.0034)***	(0.0035)***
				0.6181	0.6143	0.6157	0.6133
				(0.0049)***	(0.0050)***	(0.0049)***	(0.0050)***
						-0.0116	-0.0085
						(0.0017)***	(0.0018)***
					0.0016		0.0018
					(0.0012)		(0.0012)
!					-0.0002		-0.0002
					(0.0001)***		(0.0001)***
! "					0.0134		0.0129
					(0.0072)*		(0.0072)*
#$ %	38522	38522	38522	38522	38522	38522	38522
&' !	0.38	0.40	0.40	0.89	0.89	0.89	0.89

Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%
4-digit industry dummies and regional dummies included.

percent[17] with respect to the reference group of all UK plants. As discussed previously, the estimates in column 1 are likely to be affected by an omitted variable bias. Column 2 shows that once we include a separate dummy for being part of a MNE, foreign owned plants are 25 percent more productive than the reference group, which now includes only UK domestic plants that are not part of an MNE. Column 2 also shows that plants that are part of a multinational firm are 33.3 percent more productive than non MNE plants. This result shows that about half of the foreign advantage found in previous studies is actually a multinational effect. In column 3 we separate foreign owned MNEs into US owned MNEs and non US owned MNEs. This column shows that in addition to the 33 percent for being part of a MNE, plants that are US owned have a 22.2 percent and non US foreign owned plants a 27.1 percent additional productivity advantage with respect to UK plants that are not part of MNEs [18].

Column 4 shows estimates of a Cobb Douglas specification of equation 3, where we control for capital intensity and material usage. The productivity advantage of MNEs is still significant but lower at 3.5 percent. The US MNEs are now the productivity leaders, and significantly so, with an additional advantage of 4.7 percent. The coefficient on foreign non-US MNEs is now only 0.015 and is not significantly different from zero at the 5 percent level. Column 5 extends the results of the previous column: it accounts for age effect by including a quadratic term in age[19]. Column 6 controls for scale effects. Finally, column 7 shows that, controlling for both age and scale ef-

[17] The percentage differences are calculated from the coefficients of the dummy variables in Table 6 according to the formula diff $= e^{\beta} - 1$

[18] Table 13 in the appendix reports estimates of a specification with real gross value added as dependent variables. A comparison of column 3 of table 6 and Table 13 shows that US MNE appear to be the most productive establishments when log of real value added per employee is the dependent variable. This is can be expained by differences in the use of material inputs

[19] Since our age variable is left censored in 1980, we include an age censoring dummy. We have tried alternative specifications for the age effect, including age categories; the estimates do not change significantly from the ones obtained under the current specification.

fects MNEs are on average 4.6 percent more productive than UK non MNEs, US MNEs are the productivity leaders with an additional advantage of 4.7 percent, while the foreign non US advantage is a non significant 1 percent. The last four columns confirm that US MNEs are significantly more productive than all other groups of plants and that UK MNEs are as productive as non US foreign MNEs.

Our results so far suggest the following. First, the foreign labour productivity advantage estimated in previous studied appears to be by and large a MNE effect. Second, as shown in table 6, once we control for capital intensity, material usage, scale and age effects, US MNEs appear to be the productivity leaders, with UK and non-US foreign MNEs having a comparable productivity advantage with respect to UK plants that are not part of MNEs.

Several issues arise when estimating Equation 1. We address them in turn and report the results of our robustness checks in Appendix C. The first issue is whether our results are robust to the choice of the dependent variable: in Table 6 our dependent variable is log real gross output, deflated using 4-digit industry producer price indices. We address this issue replicating Table 6 using value added as dependent variable in Table 13 and in column 5 of Table 11 we use relative TFP as dependent variable.

The second set of problems with equation 1 is the adoption of a suitable specification for the production function. In the previous section, we have adopted a static Cobb-Douglas specification, but in the appendix we show that our results are robust to the adoption of a more flexible production function, such as the translog production function (column 4 of table 11), and a dynamic specification to capture adjustment lags in the output following changes in the factors of productions in column 6 of table 11.

A third issue arises from the sample used. One may want to extend the results obtained from this sample to the whole population. For this purpose we run weighted regressions, reported in column 3 of Table 11.

The fourth concern arises from the fact that in our preferred specification, we do not control for workforce skills. Thus, in column 2 of Table 11 we include the average wage as a proxy for the average skill level in the plant [20]. Fifthly, in column 7 of table 11 we report the results of a random effects estimation. Under the assumptions of the random effects model, this estimator is more efficient than OLS. Finally, the classification of the various MNEs groups may be debatable. Table 11 in the appendix shows the effect of variations in the definition of 'MNE'. In column (4) we consider UK MNEs only those that have FDI in manufacturing sectors. The rationale behind this more restrictive definition is to exclude those UK MNEs that only have export platforms or distributors abroad [21]. Also, in column 5 we differentiate the "other Foreign" group further into various country groups. The results shown in table 6 seem to be robust: US MNE are the most productive with UK MNEs and foreign Non US MNEs alternating each other in the second position. UK plants that are not part of a MNE are the least productive. Our results, thus, confirm that the foreign effect found in earlier studies is by and large a multinational effect. Therefore, rather than examining further why foreign owned firms are more productive we focus now on why MNEs are more productive. Ideally to answer this question, one would like to have more structural information, like R&D expenditure, skill mix, innovation activity or management techniques, which at present is not available in the dataset. It is part of our research agenda to construct datasets containing variables of this type. Currently we can get additional insight into the nature of the MNE advantage exploiting the longitudinal nature of our data. This will be the topic of the next section.

[20] Previous studies; e.g. Griffith et al [12] could further distinguish between average wage for operatives and average wage for administrative. We cannot make such a distinction since since 1996 this information is not reported in the ARD.

[21] The AFDI data contains information on the sector of activity of the UK MNE's branches or subsidiaries abroad at the three digit level. Thus, we distinguish among the following type of activity: manufacturing, wholesale, mining and quarrying and services.

5 Decomposing the MNE effect

Should we conclude from Section 4 that whenever a foreign firm takes over a domestic plant or a domestic firm starts to invest abroad its productivity will increase on average by 4.5%? Only if in estimating Equations 2 and 3 we have not ignored any unobserved heterogeneity among plants and firms. To understand in more detail which problems might have arisen let us consider the following version of Equation 2:

$$y_{it} = \mathbf{x}_{it}\delta + bMNE_{it} + \mu_{J(i;t)} + \alpha_i + \epsilon_{it} \tag{4}$$

where we decompose the error term ε_{it} into a firm effect $\mu_{J(i;t)}$, a plant effect α_i, both assumed non time-varying, and ϵ_{it} a statistical residual. $\mu_{J(i;t)}$ captures factors which affect every plant in a particular firm. These include scale effects and complementarities at the firm level or firm specific knowledge. α_i captures particular advantages of individual plants. This could include for example the geographical features of a plant location or certain work cultures and attitudes which occur at specific plants only.

Productivity advantages that arise from expanding a business internationally - captured by b in Equation 4 - we call *Generic MNE effect*. These could arise from factors such as scale effects or easier access to capital as well as complementarities of combining various national advantages. If multinational status is correlated with firm and plant effects, the OLS estimate of β in equation 2 is an upward biased estimate of b.

What could drive a correlation between firm, plant effects and MNE status? There are at least three factors. First, multinational firms could takeover the best plants and firms. We call this the *Cherry Picking effect*. Second, MNEs start up the best greenfield sites. Third, only the best firms become multinational, which we call the *Best firm effect*. This is essentially the idea of Dunning. MNEs are those firms which have an ownership advantage (high μ_J) which allows them to overcome the obstacles of setting up abroad and still be competitive [22].

We illustrate this idea with a simple model. Demand is derived from a love of variety utility function a la Dixit-Stiglitz [6] which gives each producer a certain market power for her products:

$$U = \left(\int_0^N q_i^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \tag{5}$$

where σ is the elasticity of substitution between differentiated goods and N the number of firms operating in the market. Maximizing (5) subject to a budget constraint leads to the following demand function for each producer:

$$q_i = \left(\frac{p_i}{P} \right)^{-3/4} \frac{R}{P} \tag{6}$$

where R is the total revenue of the industry and p_i the price of the variety produced by firm i. P is a composite price index [23]. Suppose there is only one input, for example labour. Each producer has a specific productivity μ_i and a fixed set up cost f_i. Given an economy wide wage w, μ_i translates into a marginal unit cost of $c_i = \frac{w}{1_i}$. Profit maximisation

$$\pi_i = \max_{p_i} \left[(p_i - c_i) q_i - f_i \right] \tag{8}$$

[22] Could there also be a *best plant effect*? To answer this question, let us illustrate two possible scenarios. In the first, a single plant (that is not part of any larger firm) with high α_i is more likely to start investing abroad. Its productivity would still be explained by a plant and a firm specific component. The firm specific component captures factors which are transferable to other plants at home or abroad, i.e. Dunning's ownership advantage. Thus, in this case, what looks like a best plant effect is a best firm effect. By contrast consider the following scenario: there are credit constraints so that only firms which have enough own resources will be able to invest abroad. Then MNEs will not necessarily be firms that can transfer some superior knowledge to some other location but rather firms owning plants that generated sufficient profit in the past; i.e. high α_i plants. In this case, there is a best plant effect.

[23]

$$P = \left(\int_0^N p_i^{1-\sigma} \right)^{\frac{1}{1-\sigma}} \tag{7}$$

leads producers to observe the markup pricing rule

$$p_i = \frac{c_i}{\rho} \tag{9}$$

where $\rho = \frac{¾-1}{¾}$

Using (6) and (8) the equation for profits of firm i can be written as:

$$\pi_i = \left(\frac{w}{\mu_i}\right)^{1-¾} \left(\frac{1-\rho}{\rho}\right) \rho^{¾} P^{¾-1} R - f_i \tag{10}$$

Assume now that there are 2 countries H and F and both with an equally sized continuum of entrepreneurs $[0, E]$. The productivity of these entrepreneurs is distributed on a support $\mu_i \in [0, \bar{\mu}]$[24] according to a distribution function $\Xi : [0, \bar{\mu}] \rightarrow [0, 1]$ which - for simplicity - is the same in both countries. Assume now that set-up costs are the same for all firms setting up in their home market $f_{H \rightarrow H} = f_{F \rightarrow F}$ but higher when setting up abroad: $f_{H \rightarrow H} < f_{F \rightarrow H}$ and $f_{F \rightarrow H} = f_{H \rightarrow F}$. Each producer has now to decide if her productivity μ_j makes it worthwhile to set up in her home market. If this is the case then she has to decide as well if her productivity is so high that even setting up abroad is profitable. The existence of an equilibrium in this economy is confirmed in the appendix. The equilibrium solution is characterised by two cut-off productivity levels $\underline{\mu}$ and $\underline{\mu}_M$. Producers with $\mu_i < \underline{\mu}$ will not produce at all, whereas producers with $\mu_i > \underline{\mu}_M$ will be multinationals that produce in both countries. From Equation 10 it follows immediately that $\underline{\mu}_M > \underline{\mu}$. As a consequence the average productivity of MNEs will always be larger than that of domestic firms:

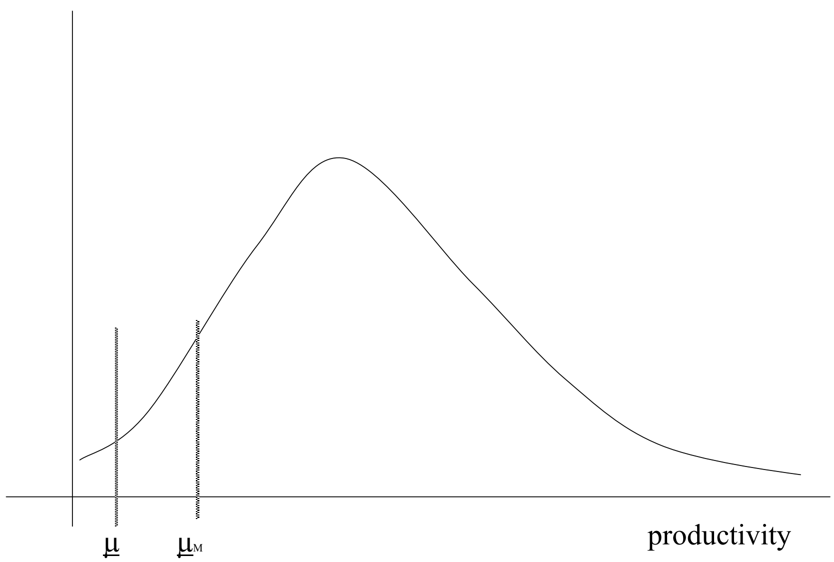
$$E\{\mu_i | MNE\} - E\{\mu_i | nonMNE\} \geq 0 \tag{11}$$

Figure 2 illustrates this idea graphically.

Is the distinction between *Best Firm*, *Picking* and *Generic MNE Effect* of any relevance? The British government has handed large subsidies to multinationals in the past, partly in the hope that more foreign direct investment

[24] $\bar{\mu}$ represents the first best technology

Figure 2: The productivity distribution



would help boost aggregate productivity. Thus far, our results show that attracting foreign capital is not the only solution to improve productivity; British policy-makers should switch their policy focus from nationality of ownership to multinationality of the firm. However, if the MNE is primarily a picking effect then policies would not lead to any welfare improvement. If the MNE effect is rather a Generic MNE or a Best Firm Effect, encouraging the activity of MNEs would certainly lead to a productivity increase. But also in this case, it is far from clear that subsidies to MNEs would bring welfare gains: for that to happen we must have some additional market failure, such as technology spillovers from MNEs to other firms, or credit constraints which prevent firms from investing abroad even when it would be profitable for them.

Distinction between the various effects is thus relevant in the current political debate. Is there any hope that our data allows such a distinction?

We address this issue in the next section. We proceed by treating Equation 4 as a double fixed effects model. Techniques to handle such models have been pioneered by Abowd et al. [2] in the context of employer-employee datasets. In our case the dimension of the employee is replaced by the plant and the dimension of the employee by the firm. Although in principle double fixed effects means algebraically simply to include a dummy variable for each firm and each plant, estimation and identification are far from trivial. In the next section we explain in detail how we address the problem.

5.1 How to implement double fixed effects

Various identification issues arise in the estimation of double fixed effects and of the parameter b. First, estimation of fixed effects is only possible for plants that are present in the selected sample at least twice. Second, separate identification of firm and plant effects is only possible to the extent that plants change owner, or, using the matched employer-employee jargon, that 'plants move between firms'. Third, to be able to identify b we need the presence in the sample of domestic firms that start investing abroad (i.e.

Table 7: MNE status and ownership changes

		Selected twice		
		UK non MNE	**UK MNE**	**Foreign**
Status changes	**UK non MNE**	11852	581	533
	UK MNE	257	3339	155
	Foreign	315	108	3506
Owner-ship changes	**UK non MNE**	1553	249	533
	UK MNE	167	47	155
	Foreign	315	108	415

Notes: Row 1 Column 2, for example reports that there are 590 transitions from UK non MNE to UK MNE in the sample of esatblishments that have been selected twice. Row 5 Column 2 reports that 258 of those involved a change in enterprise at the same time.

become an MNE) over the sample period. Table 7 reports the occurrence of all these changes in our dataset. The upper panel reports the number of status changes for each possible transition between UK non MNE, UK MNE and Foreign. For example the cell in row 1, column 2 reports that there are 581 transitions from UK non MNE to UK MNE in the sample of selected plants. The lower panel reports only the number of status changes that also involved an ownership change. Therefore, the cell in row 4 column 2 reports that 249 of the 581 UK plants that became multinational did so by means of an ownership change, and thus a "move to a new firm". This implies that 332 plants became part of a UK MNE because the firm they belonged to became itself an MNE. This is the variation we use to identify b. In total, the upper panel shows that we have 1686 changes between non MNE and MNE status[25]. The lower panel shows that 1264 of those involved a change in ownership. How many and which fixed effects can we identify from these changes? To answer this question, we follow Abowd et al. [2] and define sets of 'double fixed effect groups' (DFG). We define a DF group DFG_g as the set of all firms and plants which interact over the sample period. A firm and a plant interact simply if the plant is owned by the firm. Two plants interact if they are both owned by the same firm at some but not necessarily the same point in time. Two firms interact if they own the same plant at different points in time.

Abowd et al. [2] show that for each plant and each firm in a DFG one can identify a fixed effect which is informative about its productivity relative to the group average, where the group average includes the fixed effect of an omitted reference firm, μ_R, and an omitted reference plant α_r. Thus, any estimated fixed effect has to be interpreted as relative to the omitted plant and firm. Table 8 reports various statistics concerning these groups in our dataset. In total there are 7518 DF groups in our dataset. The columns of Table 8 report statistics on the number of observations, firms, plants and MNEs across these groups. For example from the third panel of column 1

[25] i.e. summing the off diagonal elements of row 1 and column 1 in the upper panel

Table 8: Descriptive statistics for DF groups

	(1)	(2)	(3)	(4)	(5)
Percentiles	**No of obs**	**Firms**	**Plants**	**MNE firms**	**MNE plants**
1%	2	1	1	0	0
5%	2	1	1	0	0
10%	2	1	1	0	0
25%	2	1	1	0	0
50%	3	1	1	0	0
75%	4	2	1	0	0
90%	5	2	2	1	1
95%	9	3	3	2	2
99%	31	4	10	3	8
Smallest values	2	1	1	0	0
	2	1	1	0	0
	2	1	1	0	0
	2	1	1	0	0
Largest values	150	19	42	7	40
	160	19	49	7	42
	283	32	83	14	80
	699	57	212	28	197
Mean	4.159	1.399	1.412	0.319	0.557
Std. Dev.	11.289	1.101	3.378	0.736	3.233
No of groups	7518				
No of firms	10517				
No of plants	10619				

Notes: Column 1 reports in the the first panel percentiles of the distribution of the number of observations per group; e.g. the group at the first percentile has two observations. The second panel reports the largest and smallest values; e.g. for the largest group we had 699 observations. The last panel contains mean and standard deviation of the number of observations accross groups.

Column 2 reports the same statistics for the number of firms in each group, column 2 for the number of plants and columns 4 and 5 report about the number of multinational firms and plants in each group, respectively.

we see that 699 is the largest number of observations in any single group.
In principle, one could estimate Equation 4 by least squares including a dummy for each group, firm and plant and dropping a reference firm and a reference plant per group. From the last three rows of Table 8 we see that this would lead to the inclusion of $10517 + 10616 - 7518 = 13618$ dummy variables. As well known from classical panel data applications, the inclusion of so many variables is computationally unfeasible. We therefore proceed with the following two-stage estimation procedure. In the first stage, we apply a special kind of within transformation on Equation 4. For example for y, we define:

$$\widetilde{y}_{it} = y_{it} - \frac{1}{\#\left[iJ(i,t)\right]} \sum_{¿ \text{ s.t.} J(i;¿)=J(i;t)} y_{i¿} \tag{12}$$

and for all other variables analogously, where $\#\left[iJ\right]$ is the number of years plant i is owned by firm J. Thus, we take deviations from within plant-firm cell means. This transformation allows us to estimate all time varying coefficients and - in particular b - consistently by applying least squares to the following equation:

$$\widetilde{y}_{it} = \widetilde{X}_{it}\delta + \widetilde{MNE}_{it}\beta + \widetilde{\varepsilon}_{it} \tag{13}$$

In the second stage we first estimate the sum of residual and fixed effects as:

$$\widehat{\eta_{it}} = y_{it} - X_{it}\widehat{\delta} - \widehat{\beta} MNE_{J(i;t)} \tag{14}$$

We then run, for each DF group g separately, a least squares regression of $\widehat{\eta_{it}}$ on a set of dummy variables for the firms and plants in the group and a constant

$$\widehat{\eta_{it}} = Z_{itg}\gamma \tag{15}$$

where Z_{itg} is a row vector with $1 + \mathcal{F}_g + \mathcal{D}_g$ elements, $\mathcal{F}_g$, the number of firms and $\mathcal{D}_g$ the number of plants in DF group g. This is only possible if the number of firms and plants in any given group is not too large. Table 8 confirms that the largest group contains 57 firms and 212 plants, a total of

269 which is still computationally feasible. The second stage nature of this regression implies a non standard covariance formula for the estimated fixed effects γ:

$$\begin{aligned}
\mathbf{\Sigma}_{\circ} &= \sigma^2_{"}(\mathbf{Z}_g'\mathbf{Z}_g)^{-1} \\
&+(\mathbf{Z}_g'\mathbf{Z}_g)^{-1}\mathbf{Z}_g'\mathbf{X}_g\mathbf{\Sigma}_{-;\pm}\mathbf{X}_g'\mathbf{Z}_g(\mathbf{Z}_g'\mathbf{Z}_g)^{-1} \\
&-\sigma^2_{"}(\mathbf{Z}_g'\mathbf{Z}_g)^{-1}\mathbf{Z}_g'(\mathbf{X}_g(\widetilde{\mathbf{X}}'\widetilde{\mathbf{X}})^{-1}\widetilde{\mathbf{X}}'\mathbf{Q}_g)\mathbf{Z}_g(\mathbf{Z}_g'\mathbf{Z}_g)^{-1} \\
&-\sigma^2_{"}(\mathbf{Z}_g'\mathbf{Z}_g)^{-1}\mathbf{Z}_g'(\mathbf{Q}_g'\widetilde{\mathbf{X}}(\widetilde{\mathbf{X}}'\widetilde{\mathbf{X}})^{-1}\mathbf{X}_g')\mathbf{Z}_g(\mathbf{Z}_g'\mathbf{Z}_g)^{-1}
\end{aligned} \tag{16}$$

where $\mathbf{Q}_g$ is a block diagonal matrix of dimension $N \times N_g$. The blocks consist of idempotent transformation matrices $\mathbf{Q}_{g;iJ}$[26] of dimension $\#iJ \times \#iJ$ for each combination of firm J and plant i in group g. N is the total number of observations in the dataset N_g the number of observations in group g. Further, let iJ_g the total number of firm-plant combinations in group g. Then

$$\mathbf{Q}_g = \begin{bmatrix} \mathbf{Q}_{g;1} & \mathbf{0} & \dots & \mathbf{0} \\ \mathbf{0} & \mathbf{Q}_{g;2} & \dots & \mathbf{0} \\ \vdots & \vdots & \vdots & \vdots \\ \mathbf{0} & \dots & \mathbf{0} & \mathbf{Q}_{g;iJ_g} \\ \mathbf{0} & \dots & \dots & \mathbf{0} \\ \vdots & \vdots & \vdots & \vdots \\ \mathbf{0} & \dots & \dots & \mathbf{0} \end{bmatrix} \tag{17}$$

and

$$\mathbf{Q}_{g;iJ} = \mathbf{I}_{\#iJ} - \frac{1}{\#iJ}\mathbf{e}_{\#iJ}\mathbf{e}'_{\#iJ} \tag{18}$$

5.2 Testing for various MNE effects

Testing for a Generic MNE Effect, $b > 0$, follows from the first stage regression (Equation 13). To test for the best firm effect we need an estimator of

[26] compare with Hsiao [15] p31

the statistic in Equation 11, the difference between a MNE and a non MNE firm effect:

$$\Delta_F = E\{\mu_i|MNE\} - E\{\mu_i|nonMNE\}$$

The obvious sample analog is the difference between estimated MNE and non MNE fixed effects:

$$\frac{1}{\#\mathbb{M}_F}\sum_{J\in\mathbb{M}_F}\widehat{\mu}_J - \frac{1}{\#\mathbb{D}_F}\sum_{J\in\mathbb{D}_F}\widehat{\mu}_J \tag{19}$$

where $\mathbb{M}_F$ is the set of all firms in our sample that are multinational at some point in the sample period and $\mathbb{D}_F$ its complement. The problem with this is that any fixed effect we can estimate will always be relative to its DF group's reference firm; i.e. we cannot estimate μ_J but only $\mu_J - \mu_{R_{g(J)}}$, where $\mu_{R_{g(J)}}$ denotes the fixed component of the reference group productivity. This leads to the following test statistic:

$$\begin{aligned}\widehat{\Delta}_F \;=\; & \tfrac{1}{\#\mathbb{M}_F}\textstyle\sum_{J\in\mathbb{M}_F}\widehat{\mu_J - \mu_{R_g}(J)} \\ & -\tfrac{1}{\#\mathbb{D}_F}\textstyle\sum_{J\in\mathbb{D}_F}\widehat{\mu_J - \mu_{R_g}(J)}\end{aligned} \tag{20}$$

Both, $\widehat{\Delta}_F$ will be an unbiased estimators of (20) if there is no systematic relationship between the reference group for a particular firm and its multinational status, which implies:

$$E\{\mu_{R_{g(J)}}|J\in\mathbb{M}_F\} = E\{\mu_{R_{g(J)}}|J\in\mathbb{D}_F\} \tag{21}$$

Since the choice of the firm and plant *within* each DF group that become the reference group is random, no correlation might be introduced in this way.
Yet, the groups differ considerably in size and in the presence of MNEs. Also it could be possible that multinational firms with higher productivity are more likely to exchange plants with other high productivity firms. As a consequence we expect that multinationals have a higher probability to be in groups with a high productivity reference firm so that:

$$E\{\mu_{R_{g(J)}}|J\in\mathbb{M}_F\} > E\{\mu_{R_{g(J)}}|J\in\mathbb{D}_F\} \tag{22}$$

This would bias $\widehat{\Delta}_F$ downward, which implies that if we were to reject the hypothesis that there is no multinational firm effect on the biased statistic, then we would also reject it for a non biased version. In other words: If we find any positive MNE firm effect in this way than we can be quite sure that it is really there.
We can compute a similar statistic for the plant level:

$$\widehat{\Delta}_P = \frac{1}{\#\mathbb{M}_P} \sum_{J \in \mathbb{M}_P} \alpha_i \widehat{- \alpha_{r_g(i)}} - \frac{1}{\#\mathbb{D}_F} \sum_{J \in \mathbb{D}_F} \alpha_i \widehat{- \alpha_{r_g(i)}} \tag{23}$$

Again it might be downward biased if multinationals tend to be in groups with above average plants. In the following section we describe the results of the double fixed effect estimation and these various statistics.

Table 9: Is there a Generic MNE Effect?

Dependant Variable	ln(go/emp)
ln(k/l)	0.234
	(0.006)***
ln(mat/l)	0.419
	(0.004)***
ln(MNE)	0.023
	(0.009)***
Number of firm plant combinations	14078
R-squared	0.49

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

5.3 Decomposition Results

Is there any evidence for a *Generic MNE Effect*? Table 9 reports regression results for Equation 13, the first stage of our Double Fixed Effects procedure described in Section 5.

We find a significant value of about 2 percent for the coefficient b on the multinational dummy. This finding suggests that there is a significant *Generic MNE Effect*; on average, becoming multinational boosts a firm's productivity by 2 percent. Table 10 reports average values for the firm and plant fixed effects along with the test statistics discussed in Section 5.1. Consider first the firm effects displayed in the upper panel. The point estimates reported in the second row suggest the following ranking: non US MNE come first followed by non MNEs and US MNEs are last. However, rows 2 and 3 reveal that any differences between the three groups are not significant. This means that we cannot find any evidence for best firms effects whatsoever.

Panel 2 shows the the results for plant effects. The ranking here is different.

Table 10: The evidence on Best Firm Effects and Plant Picking Effects

		US	otherMNE	nonMNE
firm level	nobs[a]	133	299	888
	mean	0.006	0.027	0.014
		(0.017)	(0.012)	(0.007)
	diff.[b]	-0.022		0.013
		(0.021)		(0.014)
plant level	nobs[a]	518	1552	1042
	mean	0.034	0.015	-0.006
		(0.007)	(0.004)	(0.005)
	diff.[b]	0.019		0.021
		(0.008)		(0.007)

Notes: Table reports average values of plant and firm fixed effects for various US, other MNE and non MNE firms.

(a) Reports the number of observations on which statistics are based.

(b) Reports difference between US and other MNEs and difference between other MNEs and non MNE plants

Standard errors in parenthesis

Plants owned by US MNEs turn out to be the most productive ones. They have a significant advantage of about two percent over other MNEs. Equally other MNEs are signficiant two percent more productive than non MNE plants.

Is the empirical evidence therefore suggesting that there is no Best firm effect and the multinational effect is essentially driven by cherry picking of the best plants? Maybe, but not necessarily. There are other explanations which equally fit the facts. First are the biases discussed in Section 5.1. If MNEs self select themselves into DF groups with other high productivity firms then we might not detect a multinational effect even though there is one. Secondly, we should remember on what the identification of the firm effects rests: our estimator allocates a high firm fixed effect μ_J to a firm J, if the productivity of plants that are taken over by J rises subsequent to the takeover. If the beneficial impact of a firm's intangible assets on the productivity of its plants[27] does not affect all plants in the same way then this could well lead to the results we get. A notable example of this latter case is that MNEs can only achieve high productivity in green field startups and not in existing plants they takeover.

Even if we take this last point into consideration our hold nevertheless a clear message for policy makers: There is no evidence that encouraging MNEs to takeover existing plants is a policy which will have dramatic direct effect on the UK's productivity performance. From our results we would expect a modest improvement of about two percent as a consequence of the *Generic MNE Effect* [28]

[27]i.e. Dunning's ownership advantage

[28]Note that the Generic MNE effect, the firm effect and plant effect need not add up to the overall level effect of about 4 percent found in Table 6, to the extent that μ_J and α_i are correlated. Also, if there is either a strong firm or plant effect then the MNE effect found in the pooled level regresssion is lower because high performance plants or firms that become multinational only at the end of the sample contribute to a higher average performance of the non MNE group earlier in the sample.

6 Conclusions

We started by conjecturing that what has been considered up to now a foreign effect is most likely a multinational effect. We find that this conjecture is true in general: the foreign effect is in fact a MNE productivity advantage; multinationals are more productive than domestic plants, whether foreign owned or not.

Our level regressions provide strong evidence of a US productivity advantage. US owned establishments are consistently more productive than other MNEs. Indeed the ranking of productivity advantage from our level regressions is exactly the same as the one found by Doms and Jensen: US MNEs are the most productive, followed by non US MNEs and establishments of domestic non-MNEs being the least productive.

When we analyse the nature of the MNE effect in more detail using the longitudinal dimension of our data we find a significant causal effect from multinationality on productivity of 2 percent. We cannot find that multinational firms have a positive impact on plants they take over beyond that which would indicate a *Best Firm Effect*. We find a large positive difference between fixed effects of MNE and non MNE plants which suggest that MNEs are very good at taking over the best firms or starting up the best plants on green field. For economic policy this implies that encouraging MNEs to takeover domesitc firms or domestic firms to become MNE would at best lead to direct productivity gains of 2 percent.

References

[1] J. M Abowd, Francis Kramarz, and David Margolis. High wage workers and high wage firms. *Econometrica*, pages pp.251–333, March 1999.

[2] Robert H. Creecy Abowd, John M. and Francis Kramarz. Computing person and firm effects using linked longitudinal employer-employee data. March 2002.

[3] Christensen L.R. Caves, D.W. and W.E. Diewert. Mulitlateral comparisons of output, input and productivity using superlative index numbers. *Economic Journal*, 92:73–86, March 1982.

[4] Chiara Criscuolo and Ralf Martin. Using the annual inquiry into foreign direct investment to create a multinational identifier in the ard. Ceriba data guide, 2003.

[5] Richard Disney, Jonathan E. Haskel, and Ylva Heden. Exit, entry and establishment survival in uk manufacturing. *Journal of Industrial Economics*. forthcoming.

[6] A. Dixit and J. Stiglitz. Monopolistic competition and optimum product diversity. *American Economic Review*, 67:297–308, June 1977.

[7] Mark E. Doms and J. Bradford Jensen. Comparing wages, skills and productivity between domestically and foreign-owned manufacturing establishments in the united states. In R.E. Lipsey R.E. Baldwin and J.D. Richardson, editors, *Geography and Ownership as bases for economic accounting*, pages 235–258. Universtiy of Chicago, 1998.

[8] John Dorgan, Stephen J.and Dowdy and Peter Whawell. Better uk productivity: An inside job. *The McKinsey Quarterly*, (4), 2001.

[9] J. H. Dunning. *International Production and the Multinational Enterprise*. George Allen and Unwin, 1981.

[10] Office for National Statistics. *Foreign Direct Investment 2000 - Business Monitor MA4*. HMSO, London, 2002.

[11] Rachel Griffith, Helen Simpson, and Frank Windmeijer. Understanding productivtiy differences between foreign and domestic firms. October 2001.

[12] Rachel Griffith and Helen Simpson. Characteristics of foreign owned firms in british manufacturing. *IFS Working Paper*, March 2001.

[13] Rachel. Griffith. Using the ard establishment level data to look at foreign ownership and productivity in the uk. *Economic Journal*, 109:F416–F442, June 1999.

[14] Richard Harris. Efficiency in uk manufacturing 1974-1994. mimeo, 12 1999.

[15] C. Hsiao. *Analysis of Panel Data*. Cambridge University Press, Cambridge, 1986.

[16] Stephen H. Hymer. The efficiency (contradictions) of multinational corporations. *The American Economic Review*, 60, Papers and Proceedings of the Eighty-second Annual Meeting of the American Economic Association(2):441–448, May 1970.

[17] James R. Markusen. The boundaries of multinational enterprise and the theory of international trade. *Journal of Economic Perspektives*, 9(2):169–186, Spring 1995.

[18] Ralf Martin. Building the capital stock. 2002.

[19] Barnes Matthew and Ralf Martin. Business data linking: An introduction. *Economic Trends*, (581), 2002.

[20] Mary O'Mahony and Willem de Boer. Britain's relative productivity performance: updates to 1999. Final report to dti/hm treasury/ons, NIESR, March 2002.

[21] Nicholas Oulton. The abi respondents database: A new resource for industrial economics research. *Economic Trends*, 528:46–57, November 1997.

A Variable Definitions

- Capital stock: capital stock was calculated using a perpetual inventory method (PIM). For a more detail description of the method adopted we refer to Martin [18]

- Deflators: to deflate output measures (gross output and value added) we use producer price indices at the 4-digit SIC92 industry level. To deflate intermediates, we use material price deflators at the 2-digit SIC92 industry level. The base year is 1995. Capital stock is deflated using investment deflators with base year 1995; for years pre-1995 these are implicitly derived from nominal and real sectoral ONS historical investment series. From 1995 on we use the publicly available MM17 series.

- Foreign plants are plants owned by foreign owned enterprise groups

- Foreign owned, Headquarters in the UK (Foreign Head-UK) are foreign owned enterprise groups that are undertaking foreign direct investment from the UK.

- we define MNEs with affiliates in the manufacturing sector (Manufacturing MNEs) those MNEs that have at least one affiliate in the manufacturing sector abroad.

- Country groups:

  EUnorth includes plants owned by Austria, Belgium, Denmark, Finalnd , Luxembourg, Sweden and Republic of Ireland.

  EUsouth includes plants owned by Italy, Spain and Canary Islands, Portugal, Greece.

  Tax includes plants owned by British Virgin Islands, Channel Islands, Isle of Man, Liechtenstein, Antigua and Barbuda, Cyprus, US Virgin Islands.

otherEurope includes plants owned by Norway and Switzerland.

otherOECD includes plants owned by Australia, Iceland, Poland, Mexico, Turkey, Czech Republic and South Korea.

other is a residual category that include plants owned by the rest of the world and plants which are foreign owned but whose nationality is unknown.

- We calculate TFP relative to the 4 digit industry median using the differential TFP formula of Caves et al. [3]; i.e. we calculate TFP as

$$\begin{aligned} lnTFP_{it} &= lnY_{it} - ln\bar{Y}_{It} \\ &\quad -\bar{\alpha}_K (lnK_{it} - ln\bar{K}_{It}) \\ &\quad -\bar{\alpha}_L (lnL_{it} - ln\bar{L}_{It}) \\ &\quad -\bar{\alpha}_M (lnM_{it} - ln\bar{M}_{It}) \end{aligned}$$

  where $ln\bar{Y}_{It}$ denotes the 4 digit industry median and the factor shares are the mean of the plant factor share and the median industry factor share $\bar{\alpha}_K = \frac{alpha_{Kit} + al\bar{p}ha_{KIt}}{2}$.

- Weights are calculated using the register employment information on the basis of 4 digit sector, region and employment cells. For each cell i the weight is caclulated as $\frac{\text{Number of plants in register in cell i}}{\text{Number of selected plants cell i}}$.

B Equilibrium in the MNE model

This section shows that an equilibrium exists in the Dixit-Stiglitz style economy described earlier. Recall how the equilibrium is determined in the standard Dixit-Stiglitz Model. There, unit (c)and fixed costs (f),and consequently prices (p) are the same across all firms. The total number of firms that an industry supports (N^*) is then found by the zero profit condition which reduces to

$$0 = N^{-1}\kappa - f \tag{24}$$

where $\kappa = c^{-1}(1-\rho)R$.
This condition is well defined only for $\sigma > 1$ because the first term on the right hand side will be positive and declining in N. In our case the problem is more complex because unit costs and fixed costs vary across entrepreneurs that are active. Matters can be solved in a very similar fashion however once we realize that - subject to the cost distribution $\frac{1}{2}\Lambda(\cdot)$ being invertible - we can write costs as a function of the number of active entrepreneurs. If we normalise the total mass of entrepreneurs in each country to 1 we can write the mass of active entrepreneurs as

$$F(\mu, \underline{\mu}_F) = \begin{cases} 2\left(1 - \Xi(c)\right) & \text{if } \mu \geq \underline{\mu}_F \\ \\ 2 - \Xi(\underline{\mu}_F - \Xi(\mu) & \text{otherwise} \end{cases} \tag{25}$$

If $\Xi(\cdot)$ is invertible we can invert $F(\cdot)$[29]. The result is:

$$\mu(N, \bar{N}_F) = \begin{cases} \Xi^{-1}\left(1 - \frac{1}{2}N\right) & \text{if } N \leq \bar{N}_F \\ \\ \Xi^{-1}\left(1 - N + \frac{1}{2}\bar{N}_F\right) & \text{otherwise} \end{cases} \tag{26}$$

where $\bar{N}_F$ is the mass of firms in the market beyond which foreign multinationals do not enter. $\mu(\cdot)$ is decreasing in N but non-decreasing in $\bar{N}_F$. For a given mass of firms, $\tilde{N} > \bar{N}_F$, increasing the mass of firms from abroad

[29] All that is required for that is a positive density of the productivity distribution

allows to fill up the mass with more higher productivity firms because we can draw from both the home and foreign pool of firms.

The market equilibrium can now be stated in terms of $\bar{N}_F$ and $\bar{N}$ - the total mass of active firms. It is characterized as a situation in which the least productive foreign firm and the least productive domestic firm make zero profits:

$$P(\bar{N}, \bar{N}_F)^{¾-1} \left(\frac{w}{\Xi^{-1}(1 - \bar{N}_F)} \right)^{1-¾} \tilde{\kappa} - f_F \quad = \quad 0 \qquad (27)$$

$$P(\bar{N}, \bar{N}_F)^{¾-1} \left(\frac{w}{\Xi^{-1}(1 + \frac{1}{2}\bar{N}_F - \bar{N})} \right)^{1-¾} \tilde{\kappa} - f_H \quad = \quad 0 \qquad (28)$$

where $\tilde{\kappa} = (1-\rho)\rho^{¾-1}R$ and

$$P(\bar{N}, \bar{N}_F) = \left(\int_0^N \left(\frac{w}{\rho\mu(n, \bar{N}_F)} \right)^{1-¾} dn \right)^{\frac{1}{1-\sigma}} \qquad (29)$$

Note that $P(\cdot)$ is decreasing in both, $\bar{N}$ and $\bar{N}_F$. The intuition for this is as follows: If $\bar{N}_F$ increases while $\bar{N}$ stays constant we have the same mass of firms in the market but because this mass is now selected for a larger interval from foreign as well there will be more higher productivity firms than before. Because the lower costs are partly passed through to consumers the overall price index declines. Increasing $\bar{N}$ on the other hand increases the total number of products produced and therefore competition among producers. Because consumers have now more products to substitute to they are forced to reduce prices.

To proceed divide the 2 conditions. This yields

$$\Xi^{-1}\left(1 - \bar{N}_F\right)\left(\frac{f_F}{f_H}\right)^{\left(\frac{1}{1-\sigma}\right)} = \Xi^{-1}\left(1 + \frac{1}{2}\bar{N}_F - \bar{N}\right) \qquad (30)$$

The equilibrium can now be characterized by 30 and 27. Equation (30) establishes $\bar{N}$ as an increasing function of $\bar{N}_F$:

$$\frac{d\bar{N}}{d\bar{N}_F} > 0 \qquad (31)$$

Because the left hand side of 27 is decreasing partially in $\bar{N}$ and $\bar{N}_F$ it is thus decreasing in $\bar{N}_F$ totally. Profits are therefore always lower than fixed costs and no production takes place or we can always find a mass $\bar{N}_F$ and in turn $\bar{N}$ such that profits of the least productive firms become zero.

C Robustness checks

Table 11: Robustness checks

	(1) Table 1 (7)	(2) Control for skills	(3) Weighted	(4) translog	(5) TFP	(6) Dynamic specification	(7) Random Effects
MNE	0.0452	0.0438	0.0780	0.0368	0.0271	0.0157	0.0243
	(0.0055)***	(0.0052)***	(0.0277)***	(0.0050)***	(0.0060)***	(0.0036)***	(0.0038)***
US MNE	0.0459	0.0406	0.1194	0.0192	0.0315	0.0157	0.0258
	(0.0079)***	(0.0073)***	(0.0397)***	(0.0066)***	(0.0085)***	(0.0055)***	(0.0057)***
Non US MNE	0.0122	0.0162	0.0880	-0.0209	-0.0128	-0.0061	0.0105
	(0.0075)	(0.0072)**	(0.0326)***	(0.0066)***	(0.0075)*	(0.0049)	(0.0058)*
ln(k/emp)	0.0682	0.0406	0.0646			0.0356	0.1025
	(0.0035)***	(0.0031)***	(0.0115)***			(0.0030)***	(0.0021)***
ln(mat/emp)	0.6133	0.5736	0.5563			0.3495	0.5480
	(0.0050)***	(0.0049)***	(0.0158)***			(0.0086)***	(0.0024)***
lnemp	-0.0085	-0.0263	-0.0220			-0.0037	-0.0151
	(0.0018)***	(0.0016)***	(0.0066)***			(0.0015)**	(0.0015)***
age	0.0018	0.0001	0.0281	0.0030	0.0041	-0.0021	0.0027
	(0.0012)	(0.0011)	(0.0067)***	(0.0011)***	(0.0014)***	(0.0013)	(0.0009)***
age squared	-0.0002	-0.0002	-0.0014	-0.0002	-0.0003	0.0000	-0.0003
	(0.0001)***	(0.0001)***	(0.0003)***	(0.0001)***	(0.0001)***	(0.0001)	(0.0000)***
age dummy	0.0129	0.0162	0.0590	0.0073	0.0142	0.0115	0.0077
	(0.0072)*	(0.0065)**	(0.0235)**	(0.0066)	(0.0077)*	(0.0065)*	(0.0089)
ln(average wage)		0.2743				0.4972	
		(0.0068)***				(0.0119)***	
lag(go/emp)						0.1060	
						(0.0235)***	
Observations	38522	38522	38522	38522	38970	16199	38522
R-squared	0.89	0.91	0.81	0.99	0.06	0.96	

Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

Year dummies, 4-digit Industry Dummies and Regional dummies included

Table 12: Further Robustness checks

	(1) Table 1 (7)	(2) Foreign Head-UK to UK MNE	(3) Foreign Head-UK dropped	(4) Manufacturing MNEs	(5) Countries
MNE	0.0452	0.0494	0.0461	0.0425	0.045
	(0.0055)***	(0.0051)***	(0.0056)***	(0.0059)***	(0.006)***
US MNE	0.0459	0.0421	0.0475	0.0477	0.046
	(0.0079)***	(0.0079)***	(0.0084)***	(0.0087)***	(0.008)***
Non US MNE	0.0122	0.0073	0.0134	0.0136	
	(0.0075)	(0.0074)	(0.0079)*	(0.0081)*	
South EU					0.008
					(0.027)
North EU					0.018
					(0.011)*
France					0.015
					(0.012)
Germany					-0.016
					(0.010)
Japan					-0.017
					(0.015)
Netherlands					0.027
					(0.016)
other European					0.061
					(0.028)**
other OECD					0.059
					(0.019)***
Tax					-0.102
					(0.026)***
Other					-0.027
					(0.025)
Observations	38522	38522	38522	38522	38522
R-squared	0.89	0.91	0.81	0.99	0.89

Robust standard errors in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%

Preferred specification: controls for capital and material intensity, size and age.
Year dummies, 4-digit Industry Dummies and Regional dummies included

Table 13: Dependent Variable: log real value added

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Foreign	0.2770	0.0846						
	(0.0123)***	(0.0169)***						
MNE		0.2469	0.2470	0.1015	0.1069	0.0997	0.1013	0.0914
		(0.0137)***	(0.0137)***	(0.0116)***	(0.0116)***	(0.0120)***	(0.0120)***	(0.0110)***
US MNE			0.1364	0.0868	0.0863	0.0869	0.0863	0.0636
			(0.0207)***	(0.0177)***	(0.0177)***	(0.0177)***	(0.0177)***	(0.0155)***
Non US MNE			0.0451	-0.0205	-0.0234	-0.0201	-0.0223	-0.0285
			(0.0192)**	(0.0169)	(0.0169)	(0.0169)	(0.0169)	(0.0159)*
ln(k/emp)				0.2220	0.2253	0.2210	0.2223	0.1085
				(0.0046)***	(0.0046)***	(0.0051)***	(0.0051)***	(0.0047)***
lnemp						0.0019	0.0065	-0.0312
						(0.0035)	(0.0037)*	(0.0033)***
age					0.0106		0.0104	0.0063
					(0.0025)***		(0.0025)***	(0.0023)***
age squared					-0.0006		-0.0006	-0.0005
					(0.0001)***		(0.0001)***	(0.0001)***
age dummy					0.0145		0.0149	0.0246
					(0.0159)		(0.0159)	(0.0137)*
ln(average wage)								0.6323
								(0.0130)***
Obs.	38522	38522	38522	38522	38522	38522	38522	38522
R-sq.	0.23	0.25	0.25	0.36	0.36	0.36	0.36	0.48

Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

4-digit industry dummies and regional dummies