Does global size matter for productivity of MNEs?

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Abstract
Previous research has shown that multinationals (MNEs) and in particular US-owned plants, are more productive than domestic ones. Existing evidence for the UK has shown that this US advantage is explained by US MNES picking the best plants to takeover and by US owned plants getting higher returns from ICT capital. One possible explanation for the MNE and US advantage is the existence of economies of scale and of scope. However, due to lack of necessary data, this hypothesis could not be tested. This study is the first to match to a cross-section of UK plant level data information on the global size of the plant's ultimate owner. The results show that global size is positively correlated with plant level productivity and explains part of the multinational advantage. This result is qualitatively robust to using alternative measure of productivity and of global size.

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1 Introduction

A number of studies have robustly established that multinational enterprises are more productive than other companies. There is still considerable debate over the reasons for this productivity advantage. Results from Criscuolo and Martin (2005) suggest that a large part of the advantage rests on cherry picking; i.e. MNEs have the capabilities and/or financial muscle to takeover the best non MNE establishments. Bloom et al. (2005) find evidence that MNEs – in particular US ones – derive advantage from higher returns to IT investments and suggest that this might be due to better management practices and organizational structures. This hypothesis is supported by evidence in Crespi et al. (2006) who find that US multinationals are more likely to implement organizational changes.

Information on the global size of MNEs could be of great relevance in making further progress in this area. The extent to which the productivity advantage of certain firms rests on mere scale economies rather than firm specific knowledge and practices has implications, both for understanding the facts and for the design of economic policies to improve efficiency or competition policy. Because there are potentially both, costs and benefits from being large, it is not even clear that the correlation between productivity and size is positive. While a larger size potentially offers economies of scale and scope, it might also lead to higher co-ordination costs. These costs might increase if a firm is operating across different countries. It is therefore possible that returns to size are smaller for multinationals that spread their size across countries. Besides, the incidence of these costs and benefits might differ according to the internal organisation of multinationals.

Despite the potential relevance of global size, studies of firm level productivity rarely take it into account. As so often in applied econometrics, this is due to lack of suitable data. Datasets used for business level productivity analysis are typically held and maintained by government statistical agencies allowing restricted access only on government premises to ensure confidentiality. Moreover they only hold data for establishments within their jurisdiction. To derive the global size of an MNE one would consequently have to pool these datasets from all relevant countries. However, this is not possible because of access restrictions. A number of commercial companies provide firm level data typically derived from balance sheet information: while these contain measures of global size such as global turnover or employment they are often ill suited to compute good measures of productivity such as value added per employee or total factor productivity (TFP). The main contribution of this study is therefore combining information from both sources for the UK in order to examine the impact of global size on business level productivity. The productivity data comes from the Annual Respondents Database (ARD) maintained by the UK Office of National Statistics (ONS); global size measures are derived from databases provided by Bureau van Dijk.

2 The data

2.1 The 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), the annual survey of UK businesses. Since 1997 the ARD covers the whole economy. 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 maintains 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" or "reporting unit" (RU) level. However, the ONS definition of RU does not necessarily correspond to a local unit, since the ONS defines a RU as an autonomous business unit (not necessarily a different legal unit), thus a reporting unit often comprises of several local units. Similarly, a RU does not necessarily correspond to a registered firm. Larger firms might consist of several RUs, which in turn might report on the activity of several plants. In practice most observations in the ARD correspond to smaller firms that consist of only one local unit. In those cases RU, local unit and registered firm refer to the same entity.

The second reason for the ARD not being a census is that smaller RUs are not surveyed every year. Plants with employment below a certain threshold are sampled on a random basis. The sample of surveyed plants is referred to as the ``selected sample'', while all non-sampled plants constitute the ``non-selected sample''.

The information on the country of ownership of a foreign owned firm operating in the UK comes from the Interdepartmental Business Register (IDBR) using as source mainly Dun & Bradstreet global "Who own's Whom" database. However, the IDBR and consequently the ARD does not identify UK firms that have subsidiaries abroad (UK MNEs). To do this we use the Annual Inquiry into Foreign Direct Investment (AFDI) described in the next section.

2.2 The 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 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. This register is designed to capture the universe of firms that are involved in FDI abroad and in the UK.[2] It is drawn from (and continuously updated)

[2] 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.

using a variety of sources including administrative records, (from HM Customs and Excise and from Inland Revenue), Dun and Bradstreet's Worldbase and ONS inquiries on acquisitions and mergers involving UK companies.
Matching the information from the AFDI register with the ARD, we can identify those ARD RUs which are part of a UK MNE as those that are owned by a firm which appears in the AFDI and is not foreign owned.

2.3 The Bureau van Dijk data (BvD)

2.3.1 Fame, Amadeus and Icarus

The main database used in this analysis is called FAME (Financial Analysis Made Easy). It is a database published by BvD that contains information for companies in the UK and Ireland. FAME contains information on 3.1 million companies, 1.9 million of which are in a detailed format. For the top 2.2 million companies the reports typically include: contact information, activity details, profit and loss account and balance sheet information, cash flow and ratios, credit score and rating, security and price information (listed companies only), names of bankers, auditors, previous auditors and advisors, details of holdings and subsidiaries (including foreign holdings and subsidiaries), names of current and previous directors with shareholder indicator, heads of department, shareholders, subsidiaries, and other information.
This study also uses two other datasets published by BvD, called Amadeus and Icarus. Amadeus is the sister dataset to Fame for Europe. It contains the same information as Fame does for the UK on approximately 8 million public and private companies in 38 European countries. It combines data from over 35 specialist regional information providers. Icarus is a database containing profiles of 1.4 million public and private US companies and 200,000 public and private Canadian companies. An Icarus report typically contains: contact information, details of sales and number of employees, activities (US SIC and NAICS), management and executives, the company's bank and accountant, shareholders, subsidiaries and news.

2.3.2 Construction of the global size dataset

For the purpose of this study, we rely on information on from the BvD ownership database to construct a measure of the global size of companies operating in Britain. For each company in FAME the BvD ownership database reports its ultimate owner (UO) along with basic characteristics of this owner. We use the consolidated size – in terms of revenue or employment - of this UO as our measure of global size. This raises a number of issues, which we discuss in turn.

2.3.2.1 The definition of ultimate ownership.

Appendix A discusses in more detail how BvD defines ultimate owners. Roughly, the UO is a single shareholder that owns at least 25 percent of a firm, directly or indirectly via other firms. The UO can be a private individual or another company. If there is no such shareholder a company can also be owned by itself. Note that a company that is an UO must by definition be owned by itself.

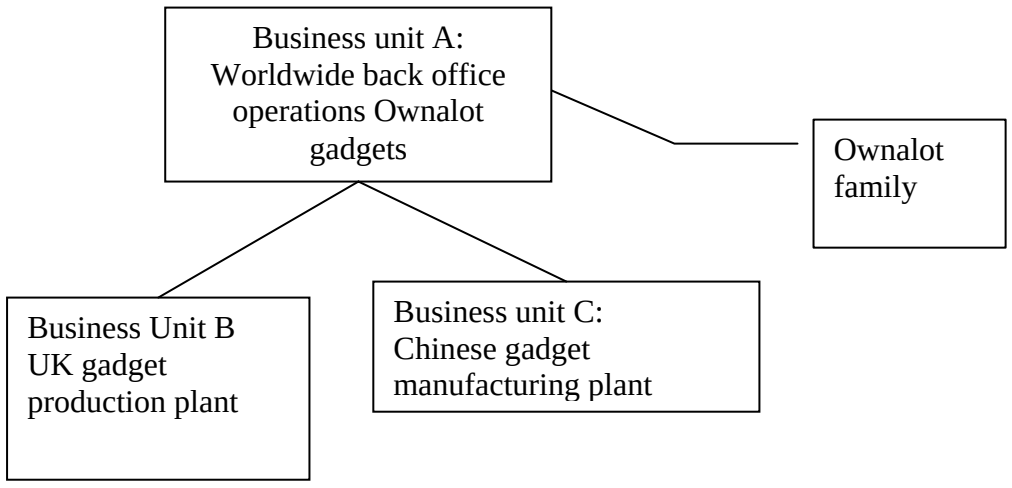
2.3.2.2 The economic meaning of ownership

Ownership of a company is driven by at least two very different objective:

1. Horizontal or vertical integration of different companies
2. Purely financial investments

Our focus here is on the first of these. Unfortunately, the BvD has no information, which would allow an easy distinction between these two types of ownership, but distinguishes between a slightly different set of ownership categories.
Table 1 gives an overview of the BvD ownership categories along with the numbers of firms that fall in each category. Firms can be owned by financial institutions, individuals, public entities, charities or other industrial companies.
The columns of Table 1 differentiate further by the nationality of the UO. Focus first on the last column reporting totals. The great majority of firms – roughly 80 % - are owned by individuals or families. An individual or family has by definition no meaningful global size in the current context. Because ownership might not be direct this does not mean that the global size of a company owned by a family corresponds to its own size. Figure 1
shows the problem. A UK company (Unit B) is ultimately owned by the Ownalot family via a global holding. The economically meaningful number we would require in this case is the consolidated size of the holding. However from the BvD database we can only infer the identity of the Ownalot family. Rather than only relying on the BvD ultimate owner information we could in principle examine structures such as the one in Figure 1
by tracing through all direct ownership links in the BvD databases or using data from other sources such as the Dun & Bradstreet Who-owns-whom database. However, for the purpose of this initial study we decided to drop these observations from the analysis all together. Dropping 80 % of the available data might seem like a drastic step. However, recall that our focus here is to examine how controlling for global size, as a proxy for company integration, affects our estimates of multinational effects.

Figure 1



Family ownership is concentrated among smaller purely domestic firms. To some extent we can infer that from table 1. For example, in column 1 we find that among

companies with foreign ultimate ownership less than 30 % fall in the in the individual and families category.[3]
Another problematic ownership category from the perspective of this study is that of financial institutions. Unless a bank owns another bank it is very likely that the ownership objective is not for the purpose of company integration, so we drop these cases from our analysis.

2.3.2.3 Which size measure?

The most easily available global size measure in the BvD data is the UO turnover, which is part of the FAME database. Below we also show initial results using consolidated UO employment. However to get this information we have to link the FAME UO information to the Amadeus and Icarus databases. This is problematic in a number of ways. Firstly, Amadeus and Icarus only cover European and North American firms. Thus we have no global size information for e.g. Asian firms. Secondly, in particular regarding the Icarus database the link is not perfect; i.e. a FAME record might inform us that a firm is ultimately US owned but the reference number which would allow us to link it to the Icarus database is missing. Thirdly, even if we manage to identify the correct firm in Icarus it might have missing employment information.

Table 1: Ultimate owners' types in FAME

Ultimate owner type	Foreign	UK Multinational	UK Domestic Ultimate Owner	UK undetermined	Unknown origin	Total
Bank	4,941	n.a.	n.a.	5,447	144	10,532
Financial	423	183	625	1,094	423	2,748
Insurance	1,669	n.a.	n.a.	2,163	22	3,854
Individual/families	34,544	n.a.	n.a.	1,020	1,414,828	1,450,392
Employees/Managers	15	n.a.	n.a.	n.a.	936	951
Foundation	1,125	15	566	183	470	2,359
Mutual & Pension fund	4,329	1,212	3,803	3,529	8,848	21,721
State, Public authority	732	n.a.	n.a.	235	105	1,072
Industrial	**76,272**	**34,360**	**64,593**	**22,933**	**22,573**	**220,731**
Total	124,050	35,770	69,587	36,604	1,448,349	1,714,360

Source: Fame

[3] Strictly speaking we cannot rule out that some of the large number of companies with unknown origin of their ultimate owner (column 5) in reality fall into the foreign category. However, this case is unlikely to be large.

3 Merging ARD and BvD data

In order to analyse how global size affects productivity we have to merge the BvD UO information with the ARD data. This raises a number of issues that we discuss in this section.

3.1 Issues with matching the datasets

The ARD and the BvD differ in both, the unit at which data is held and in the register and coding system used. The ARD works at the so-called ARD reporting unit (RU) level, which for most firms refers to the enterprise level. However, enterprises, in particular those that are part of larger groups, are often split into several ARD RUs.

The BvD data for the UK is, on the other hand, at the UK Company's House Company Register Number (CRN). Again for most enterprises, the enterprise level is equal to the CRN level. However, in particular larger enterprises might consist of several CRN units.

A second important difference between the ARD and the BvD data is the following. The ARD reporting unit data refers solely to the single reporting unit. The BvD data includes not only information on holding companies - reporting both non-consolidated and consolidated accounts referring jointly to all companies in the holding - but also information on lower level establishments, which only report from themselves. This difference is not really a major issue in our analysis as our goal is to control in the productivity regressions run at the RU level for the consolidated global size of the ultimate owner of the enterprise an ARD RU belongs to, and therefore we are only interested in the ARD data at the RU level and the consolidated information from the BvD data.

The matching procedure between ARD and BvD data consists of two steps:

1. We need a pointer from each ARD RU to the enterprise it belongs to. This information is already part of the ARD files.
2. We need a pointer from this enterprise to the CRN identifier for this same enterprise in the BvD data. To get this, we rely on a lookup table derived from the UK government Interdepartemental Business Register (IDBR). Figure 1 to 3 illustrates the issues that arise in the process.

In some cases, the match is straightforward. Figure **2** illustrates this case.

The ARD RUs are matched to their enterprise. The example in the figure considers RU 1 belonging to enterprise A. There is then a one-to-one match in the IDBR lookup, which gives us their Companies House number (CRN), so that enterprise A is actually the same entity as the one designed by CRN 21. Finally, in the Fame dataset, the firm identified by this CRN is present and has a well-defined Ultimate Owner (UO1), with information on his global size.

Figure 2: Combining ARD and BvD data – perfect match

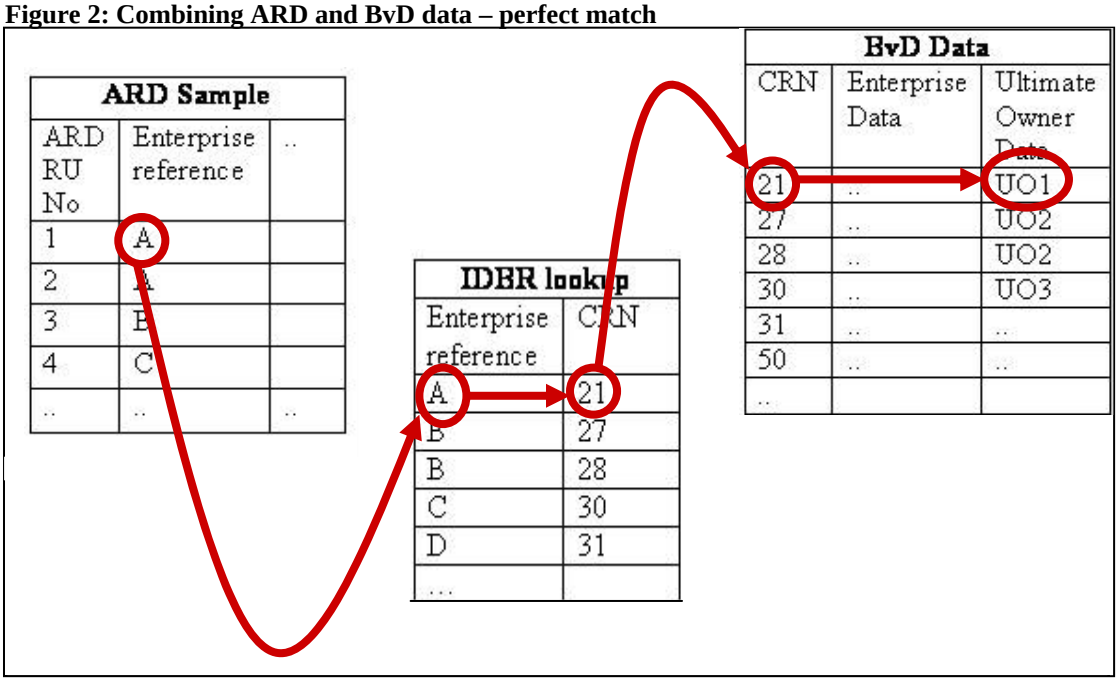
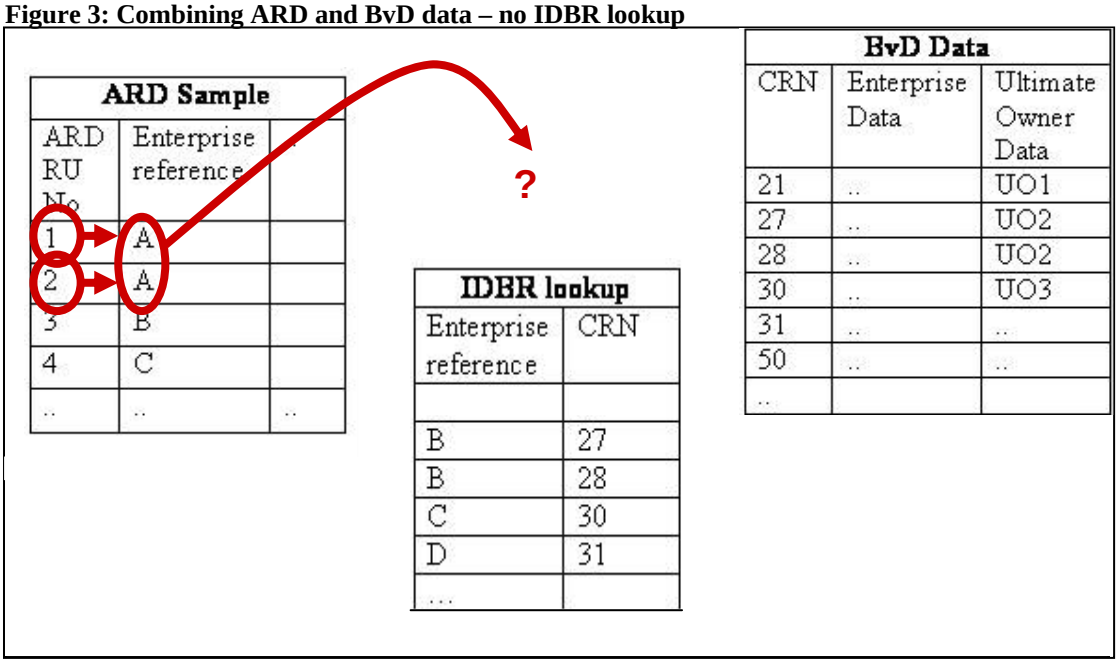


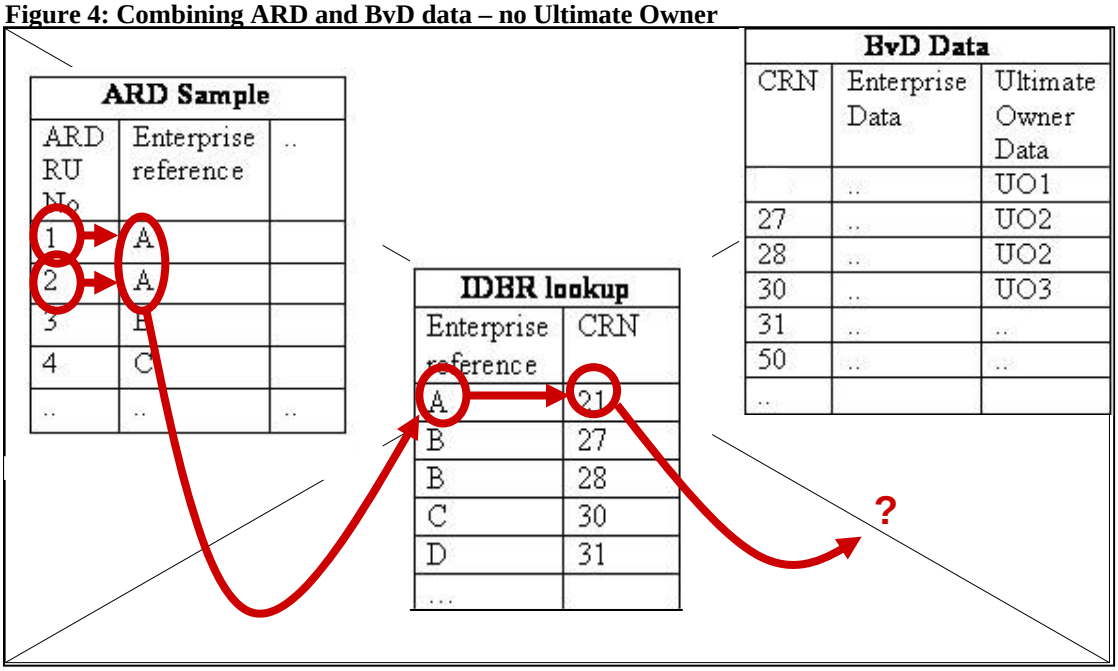
Figure 3: Combining ARD and BvD data – no IDBR lookup



In other cases, some ambiguities arise from the match. We illustrate three possible scenarios in figures 3, 4 and 5.

In the case illustrated in Figure 3, the ARD RU is matched to an enterprise, but there is no corresponding firm in the lookup table. In these cases we proceed as follows: if information from the ARD and the AFDI suggests that the firm is a domestic non MNE then we include them in the sample as domestic firms and their global size will be their own turnover if they are not part of a group; alternatively we use the consolidated turnover in the UK of the group they belong to, calculated from the information available in the ARD. However, if the ARD and AFDI information suggest that these firms are part of multinational corporations, either UK or foreign, we drop them from subsequent analysis, as we have no information on their global size.

Figure 4: Combining ARD and BvD data – no Ultimate Owner



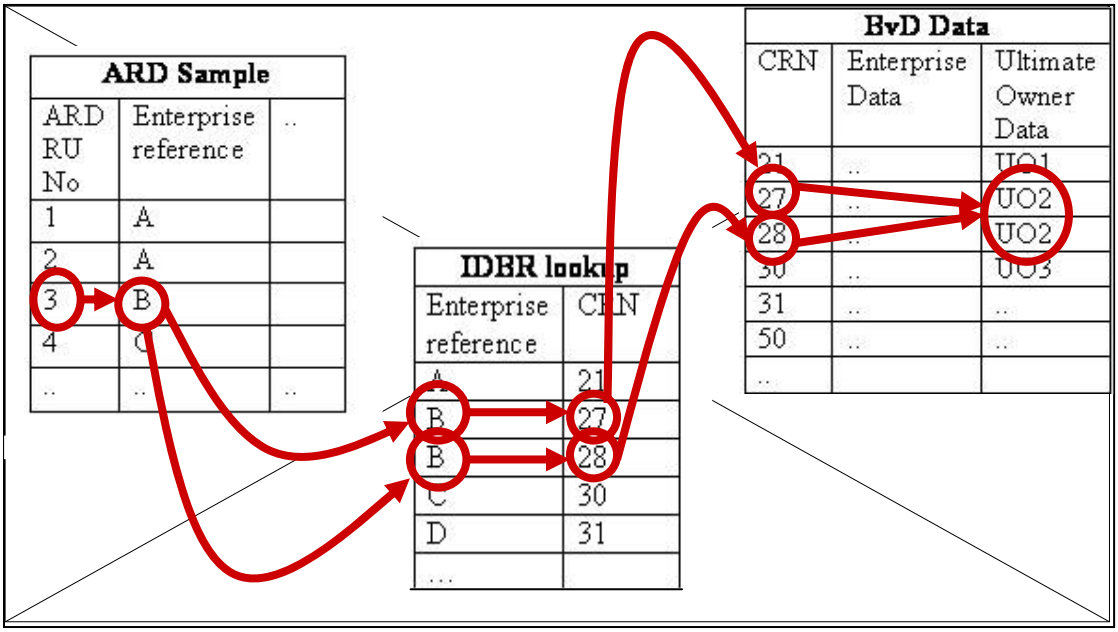
As shown in Figure 4, another possibility is that there is a CRN associated with the ARD enterprise, but this has no correspondence in our BvD dataset. This means that these reporting units do not have an Ultimate Owner, which is an industrial firm. As in the case described in Figure 3 if information from the ARD and the AFDI suggests that the firm is domestic then we include them in the sample as domestic firms and their global size will be their own turnover, if they are not part of a group; alternatively we use the consolidated turnover in the UK of the group they belong to, calculated from the information available in the ARD. However, if the ARD and AFDI information suggest that these firms are part of multinational corporations, either UK or foreign, we drop them from the analysis.

Finally, multiple matches can arise. In Figure 5, enterprise B matches simultaneously with two CRNs, CRN 27 and CRN 28.

This is only a problem for us if the two CRNs correspond to two different ultimate owners. For most cases, the two or more CRN identifiers correspond to a single ultimate owner, as in Figure 5. We consider, therefore this unique ultimate owner and its size in our analysis. If however several ultimate owners remain we take their average size.[4] Table 2 summarizes the occurrence of these different cases. The case of no match between Enterprise reference and CRN depicted in Figure 3 occurs in 14511 cases (row 1 column 1 of Table 2), 34% of all enterprises included in the ARD. The number is slightly higher when looking at RUs, given that some enterprises comprise several RUs. A further 21977 RUs (row 1 column 3 – column 2) are matched to a CRN but cannot be matched to a valid FAME observation with UO information.

Figure 5 : Combining ARD and BvD data – multiple matches

[4] We also experimented dropping these observations without really affecting the results.



As for multiple matches, this occurs frequently when using the IDBR lookup table. The largest multiple match is a special case where one enterprise has 2674 CRNs associated with it. However, once we only consider those CRNs that match into the BvD data, although the number of successful matches is reduced, so is the occurrence of multiple matches. As we are mainly interested in the size of the industrial UO of each RU, it is reassuring to observe that multiple matches only occur for 107 RUs once we consider the match between RU and UO. These will be excluded from our analysis.

Table 2: **Successful and multiple matches**

number of matches	enterprise to CRN	RU to CRN	RU to CRN with FAME match	RU to UO CRN with FAME match	RU to UO Industrial Company FAME match
0	14511	14556	36533	36533	36533
1	24858	25027	5101	5818	5246
2	1812	1922	747	787	97
3+	1351	1692	816	59	10
Largest multiple match	2674	2674	49	5	4
Total successful matches	28021	28641	6664	6664	5353

Source: ONS and FAME

3.2 The matched sample: Descriptive statistics

As shown in the first row of Table 3, of the 46,054 reporting units in the ARD in 2003 we can match about 4,598, less than 10%. This apparently worrying statistics improves when looking at the matching rate of MNEs. Looking at column 4 we see that the worst matching rate concerns the group of domestic non-MNE firms. However, for these firms, we can derive the global turnover figures directly from the ARD: the "global turnover of the ultimate owner" for these firms is the total turnover in the UK of the domestic group they belong to, which could also consists of a single UK enterprise. Note that the slightly higher matching rate for the US MNEs is probably due to a better coverage by the BvD of US firms in its Ownership database.

Table 3: ARD sample vs. Fame Matched Data - nationality

type	Total	matched	Proportion successfully matched %
overall	46,054	4,598	9.98%
domestic	42,414	2,743	6.47%
UK MNE	1,871	1,035	55.32%
US MNE	515	305	59.22%
Foreign non-US MNE	1,254	515	41.07%

Source: ONS and FAME

As described above, the pure matching of the ARD with the FAME database leads to the loss of quite a few observations. Furthermore, some ARD reporting units are further discarded from our analysis due to missing or inconsistent data. As reported in Table 4, out of 46,054 reporting units in the ARD, only 40,785 have non-missing data on the labour productivity measure, log value added over employment. Of the original ARD sample, Only 4,420 can be matched with a Fame UO and have a measure of their ultimate owner's global turnover. Productivity can be measured for all of these reporting units. But for 692 RUs, their turnover in the ARD is greater than their UO's global turnover reported by BvD. These inconsistent observations are discarded from our sample. Finally, 2108 reporting units in the ARD are on the basis of the AFDI regarded as multinationals, but we do not have global size information from Fame (case e). Those are dropped from the analysis.

Table 4: Observations with non missing values and consistent information across data sources

	number of observations
(a) non missing ln(GVA/L)	40,785
(b) non missing ln(ultimate owner turnover)	4,420
(c) (a) & (b)	4,420
(d) (c) & ARD turnover < BvD turnover	3,728
(e) MNE but BvD global turnover not available	2,108

Source: ONS and FAME

To test whether the group of multinational firms that we do not manage to match to FAME is random two characteristics of these firms are compared: size, measured as the number of employees, and labour productivity, defined as value added per employee. This allows us to measure any systematic differences between matched and unmatched firms. The results reported in Table 5 are mixed, but the regressions carried out below suggest that these differences do not drive our results.

Table 5: ARD sample vs. Fame Matched Data - comparison

	Labour Productivity (GVA/EMP)		Size (EMP)	
type	**non matched**	**matched**	**non matched**	**matched**
Overall	31	89	115	805
	(541)	*(850)*	*(1284)*	*(4650)*
Domestic	30	77	90	605
	(552)	*(586)*	*(1023)*	*(3012)*
UK MNE	54	77	717	1469
	(179)	*(359)*	*(2688)*	*(8387)*
US MNE	48	83	470	704
	(99)	*(220)*	*(1405)*	*(1376)*
Foreign non-US MNE	47	179	616	599
	(156)	*(2081)*	*(5085)*	*(1124)*

Notes: Standard errors in parenthesis.
Source: ONS and FAME

Table 6 describes the distribution of ultimate owner turnover - our main measure of global size - in the total FAME sample for domestic firms; UK MNEs and foreign companies, distinguishing between US owned and non-US owned foreign firms. The table shows the following. First, domestic firms are much smaller that MNE firms and this is the case along the whole distribution of global size: at the median domestic firms are almost 20 times smaller than MNEs. Secondly, when we look at the average global size of MNEs, we find that the average US MNE is larger than other foreign MNEs and twice as large as the average UK MNE. However, when we look at the distribution we find that it is only the top 5th percentile which drives the US global size advantage: at the bottom quartile and at the median US MNEs global size is less than both UK MNEs and other foreign, while at the 75th and 90th percentile they are larger than UK MNEs but smaller than other foreign companies. Finally, the table shows foreign non-US firms are always larger than UK MNEs, except at the bottom quartile.

Table 6: Ultimate owner turnover based on FAME sample

ultimate owner turnover							
		number	percentiles				
	Mean	of obs.	25	50	75	90	95
Domestic	2,838,574	59,042	9,000	53,008	619,000	4,880,000	13,266,000
UK MNE	4,247,237	32,657	189,000	931,000	3,006,000	8,891,000	18,303,000
foreignOther	7,220,294	7,040	99,709	960,815	7,313,072	23,504,000	34,766,972
ForeignUS	8,537,035	6,432	48,000	813,000	5,049,000	19,397,000	79,185,000

Source: Authors' calculations based on FAME
Notes: The MNE categories are based on FAME.

As discussed earlier, the "global employment" variable is not directly available in FAME and we recover it using the various Bureau van Dijk databases. As a consequence the number of observations drops. This is particularly severe where we have to rely on the Icarus database. We lose observations both because in many instances the identifiers that allow us the linking from FAME Icarus are missing and because the employment information within Icarus is not complete. As a consequence we cannot include the US firms in any meaningful comparisons when using the global employment variable.

Nevertheless, we checked whether the ranking found using global turnover held when using global employment as a measure of global size. Table 7 provides an answer to this question: for other MNEs we find the same pattern as for global turnover: UK MNEs are larger than domestic firms both at the mean and across percentiles. Equally, Foreign non US MNEs are larger than UK MNEs except at the bottom quartile.

Table 7: Descriptive statistics on ultimate owner employment using FAME only

	ultimate owner employees						
			Percentiles				
	Mean	number of obs.	25	50	75	90	95
Domestic	1196.275	14928	44	168	649	2244	6523
Ukmne	20785.28	10396	851	5967	22038	53483	70326
ForeignOther	51545.77	3983	428	9225	71654	162244	235521

Source: Authors' calculation using FAME, Icarus and Amadeus data.
Notes: MNE categories based on FAME

The interesting question is now to see whether these rankings hold in the matched ARD-FAME sample. If the rankings do hold, this would suggest that we are not selecting particularly small or large MNEs in any of the four groups considered.

Tables 8 and 9 look at global turnover across different types of MNE. First, note that the information to categorise firms into domestic, UK MNE and foreign owned can now come from either of two sources: from the AFDI, i.e. from the ONS, or from FAME. Tables 8 reports statistics based on the AFDI classification, whereas table 9 is based on the FAME classification. In both tables US MNEs do not appear to be the largest global firms both on average and at various points of the distribution. Secondly, the matched domestic firms are very large, especially in Table 8. This might be due to the fact that we cannot match many purely domestic firms in the ARD with FAME, as we described above. This is the reason why we decided to use both matched and unmatched observations for purely domestic firms and derive global size measures from the ARD. Also, the very large figure in Table 8 might be due to misclassification[5]: i.e. a firm classified as UK MNE in FAME is classified as domestic in the ARD. Finally, the foreign non US MNEs are now the largest group across the whole distribution.[6]

[5] Note that this is not necessarily an error in the data, rather this could arise because of discrepancies in the threshold to be classified as multinationals in the two data sources.
[6] At least until the 75th percentile. In a future version we will compute figures for more points in the distribution.

Table 8: Ultimate owner turnover in ARD sample with FAME match

	ultimate owner global turnover				
			Percentiles		
	mean	obs	25	50	75
Domestic	2,946,357	2298	17,989	82,844	853,000
UKMNE	1,836,061	502	61,030	244,064	1,224,950
foreignOther	9,059,694	343	386,000	1,751,000	8,878,460
ForeignUS	5,774,745	214	259,000	1,211,500	4,568,000

Source: Authors' calculations based on FAME and AFDI
Notes: The MNE categories are based on AFDI.

Table 9: Ultimate owner turnover in ARD sample by FAME MNE categories

	ultimate owner global turnover				
			Percentiles		
	mean	obs	25	50	75
Domestic	105,774	1,196	9,375	26,012	75,160
UKMNE	4,388,067	1,101	86,788	435,000	2,397,750
foreignOther	9,059,694	343	386,000	1,751,000	8,878,460
ForeignUS	5,395,597	667	100,000	745,000	3,285,000

Notes: ARD sample with ***FAME*** MNE categories

Table 10 reports the same statistics for the sample of FAME matched ARD businesses. When using global employment as a measure of global size: the matched domestic firms are smaller than MNEs, but still quite sizeable almost as much as UK MNEs and foreign non US MNEs are the biggest firms.

Table 10: Descriptive statistics on ultimate owner employment using matche ARD-FAME

	ulitmate owner employees				
			percentiles		
	mean	number of obs.	25	50	75
Domestic	9727	1707	116	353	1658
UKMNE	12016	453	489	1693	7839
ForeignOther	50382	183	2052	10686	70918

Source: Authors' calculation using FAME, Icarus and Amadeus and ARD data.
Notes: MNE categories based on AFDI

4 Regressions

In Criscuolo and Martin (2005) we found that both foreign- and UK MNEs-owned establishments have significantly higher productivity levels than domestic non-MNE establishments.

Table 11 reproduces the main regressions from Criscuolo and Martin for a cross-section of the ARD from 2003, which is the year for which – so far – we were able to construct global size measures. In our earlier paper we were working with data for the years 1996 to 2001 for manufacturing firms only. Although in 2003 we also have data on firms in the service sector, columns 1 and 2 start – for comparability – with regressions for manufacturing establishments only.

Column 1 regresses value added per employee on various MNE dummies. As in the earlier paper we find a strong and significant effect of around 30 percent for MNEs. In line with our previous results, we find that US owned establishments are about 14 percent more productive than our reference group of domestic non-MNEs. For other foreign firms in our earlier paper we found - in a similar specification - a significant 5 percent advantage. With our current sample we find that their productivity is not significantly different from UK MNEs.

In column 2 we report the same regression in terms of gross output over employment, the results again resembles closely those obtained in the previous paper with UK and non US foreign MNE having a TFP advantage of about 4%, and the US MNE having an additional TFP lead of about 4% relative to other MNEs, and thus an 8% TFP advantage relative to UK domestic firms.

Columns 3 and 4 repeat the exercise for the complete ARD sample available in 2003, covering the whole economy. Here, the picture for the value added regression in column 3 is very similar to column 1, but when looking at TFP the ranking changes slightly: the advantage of UK MNEs rises to 8.5%, US MNEs are now as productive as UK MNEs while other non US foreign firms have a significant additional TFP advantage of 5.6%.[7]

Columns 5 through 8 report on the same regressions as columns 1 through 4, except that now we restrict the sample to firms where we have a valid measure of global size; i.e. we exclude establishments owned by MNEs for which we could not find a valid match in the BvD databases.[8]

A comparison of the coefficient estimates of these last two panels with the first two panels of the table shows that the main difference across the two is a drop in the significance of the foreign coefficient in column 8 relative to column 4 and of the US coefficient in column 7 relative to column 3.

The main messages we can draw from this table is that, in our BvD-matched sample, MNEs have a clear advantage in terms of TFP, but we find no additional advantage from being foreign owned. The MNE productivity advantage doubles when we look at the whole economy rather than just at the manufacturing sector.

[7] Note that we have calculated the figures reported as (1+exp(coefficient))-1.

[8] Recall that for non MNE firms we can construct a global size measure by simply aggregating over all their UK operations using information from the ARD only.

Table 11**: Productivity Regressions for 2003**

	Complete ARD sample				Sample with valid global Turnover information			
	Manufacturing		Whole Economy		Manufacturing		Whole Economy	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
dep. Var.	**ln(VA/L)**	**ln(GO/L)**	**ln(VA/L)**	**ln(GO/L)**	**ln(VA/L)**	**ln(GO/L)**	**ln(VA/L)**	**ln(GO/L)**
MNE	0.288	0.041	0.416	0.0816	0.33	0.070	0.459	0.153
	(.023)***	(.013)***	(.023)***	(.017)***	(.031)***	(.018)***	(.030)***	(.023)***
other foreign	.0063	.014	.003	.055	.075	.024	.0697	.056
	(.0347)	(.018)	(.0351)	(.024)**	(.051)	(.028)	(.050)	(.037)
US	0.136	0.042	0.125	0.054	0.12	0.050	0.1	0.045
	(.044)***	(.023)*	(.048)***	(.033)	(.056)**	(.031)	(.060)*	(.044)
ln(K/L)		0.092		0.1		0.095		0.101
		(.006)***		(.004)***		(.007)***		(.004)***
ln(M/L)		0.596		0.551		0.582		0.545
		(.007)***		(.004)***		(.007)***		(.00497)***
ln(L)		0.016		-0.004		0.017		-0.004
		(.003)***		(.002)**		(.003)***		(.002)**
3 digit sector dummies	yes	yes	yes	yes	yes	Yes	yes	yes
obs	9720	6264	40785	35293	8615	5265	38380	33056
R2	0.118	0.825	0.172	0.738	0.112	0.814	0.182	0.734

Source: ONS and FAME

Notes: All regressions included 3 digit sectoral dummies

With the data on the global size of multinational groups we can now for the first time examine to what extent this finding is driven by differences in size between MNEs and other firms. This is the topic of Table 12. Columns 1 to 4 use all valid observations first for manufacturing (columns 1 and 2) and then for the whole economy (columns 3 and 4). While the point estimate of the coefficient on global turnover varies considerably it is clearly significant in all specifications. Further, while still significant in most specifications the MNE effect is now considerably lower.

One concern might be that this strong correlation is driven by observations from UK non MNE establishments where our dependent variable for many observations is directly constructed from what is at the same time our global size measure; i.e. the establishments turnover. To examine this, columns 5 to 8 repeat the exercise using only those firms for which we could derive the global size measure from the BvD databases. We still find a strong positive relationship between global size and productivity.

It is difficult to draw conclusions about causality on the basis of these results. The effects might go both ways; i.e. more productive firms might grow faster and larger and/or it might be easier for larger firms to achieve higher productivity in their subsidiaries. These results should therefore be understood rather as descriptive evidence.

A clear implication of these results however is that BvD data can be combined in a meaningful way with ARD data, which is a strong encouragement for researchers wanting to conduct further work involving information from both sources.

Table 12: Productivity regressions with a control for global Size

	Sample with valid global Turnover information				ARD sample with FAME match only			
	Manufacturing		Whole Economy		Manufacturing		Whole Economy	
dep. Var.	**ln(VA/L)**	**ln(GO/L)**	**ln(VA/L)**	**ln(GO/L)**	**ln(VA/L)**	**ln(GO/L)**	**ln(VA/L)**	**ln(GO/L)**
ln(Global Turn)	0.096	0.060	0.143	0.322	0.059	0.012	0.063	0.025
	(.002)***	(.003)***	(.001)***	(.002)***	(.007)***	(.003)***	(.005)***	(.003)***
MNE	-0.105	-0.060	-0.322	-0.581	0.119	0.035	0.106	0.035
	(.031)***	(.018)***	(.03)***	(.0201)***	(.0396)***	(.014)**	(.033)***	(.015)**
US	-0.094	-0.049	-0.163	-0.46	-0.026	-0.020	-0.069	-0.039
	(.0485)*	(.028)*	(.046)***	(.030)***	(.056)	(.020)	(.0469)	(.021)*
other foreign	0.014	0.005	-0.028	-0.227	0.053	0.001	0.024	-0.004
	(.053)	(.0303)	(.055)	(.0367)***	(.060)	(.022)	(.055)	(.025)
ln(K/L)		0.078		0.053		0.119		0.142
		(.0073)***		(.003)***		(.010)***		(.008)***
ln(M/L)		0.544		0.364		0.627		0.588
		(.007)***		(.004)***		(.0105)***		(.008)***
ln(L)		-0.053		-0.35		0.007		-0.038
		(.005)***		(.003)***		(.006)		(.004)***
obs	8615	5265	38380	33056	1717	1542	3728	3486
R2	0.219	0.826	0.297	0.822	0.198	0.894	0.258	0.895

Source: ONS and FAME

Notes: All regressions included 3 digit sectoral dummies

While all regressions in Table 12 reveal a robustly significant correlation between global size and site level productivity the scale effects are markedly smaller in the second set of regressions (columns 5 to 8) where we restrict ourselves to the group of businesses that have a match with FAME ultimate owner information. This suggests that the global size coefficient is potentially very different for different sub groups in our sample. Table 13 follows this up by interacting global turnover with our MNE categories. This leads to a number of relevant insights.

Firstly, looking at manufacturing for the whole ARD sample (column 1) we find that the overall MNE effect is significantly positive; while the interaction between MNE and global turnover on the other hand is significantly negative implying that non-MNEs have higher returns to size. This result might be explained in different ways. Fone possible explanation could be that there are a number of very large firms that are highly productive but not multinational and/or a number of fairly small MNEs that are equally highly productive. A more intuitive explanation is that returns to size level off with larger size. A firm can only expand to a limited size within its national boundaries. Further, growth is then only possible by going international. While still beneficial the marginal return to this growth is lower, possibly because of additional

co-ordination costs as discussed in the introduction. Going further through the table we find that foreign non-US firms do not seem to differ significantly from UK MNEs.

Table 13: Interacting size and MNE categories

dep. Variable	ln(go/emp)			
	ARD sample		ARD sample with FAME/Amadeus ultimate owner employment information	
	manufacturing	All	manufacturing	all
MNE	.356	1.98	.121	.11
	(.124)***	(.141)***	(.10)	(.105)
foreign other	-.218	-.457	-.18	-.382
	(.212)	(.226)**	(.154)	(.154)**
foreign US	-.559	-.654	-.419	-.346
	(.23)**	(.275)**	(.166)**	(.186)*
ln(UO turnover)	.064	.336	.0115	.023
	(.00332)***	(.00257)***	(.00394)***	(.00357)***
Ln(UO turnover)X MNE	-.0321	-.194	-.00637	-.00541
	(.00943)***	(.0105)***	(.00757)	(.00787)
ln(UO turnover)Xforeign Other	.0148	.0209	.0116	.0235
	(.0146)	(.0156)	(.0106)	(.0106)**
ln(UO turnover)Xforeign US	.0416	.0427	.0298	.0242
	(.0162)**	(.0193)**	(.0117)**	(.0131)*
ln(K/EMP)	.0784	.0511	.119	.142
	(.00732)***	(.00378)***	(.0101)***	(.00807)***
ln(M/EMP)	.543	.358	.627	.587
	(.00785)***	(.00427)***	(.0105)***	(.00814)***
ln(EMP)	-.0568	-.363	.00658	-.0381
	(.00514)***	(.00323)***	(.00629)	(.00492)***
3 digit sector dummies	Yes	Yes	Yes	yes
Obs	5265	33056	1542	3486
R2	.827	.825	.895	.896

US MNEs, however, have markedly different characteristics. The simple US MNE effect is strongly negative, leading to a net effect even below domestic firms (subtract the "foreign US" coefficient from the "MNE" coefficient) but the interaction between global size and US effect on the other hand is strongly positive, leading to a net effect even exceeding the size effect of purely domestic firms.[9]

What exactly explains these patterns is hard to determine without further analysis. One potential explanation could be the special relationship: because of the cultural similarities between Britain and the US the entry barrier for US MNEs in Britain is much lower than for firms from other countries. As a consequence the spectrum of US firms that operate in Britain would be much wider. Initial evidence consistent with this are the apparent wider spreads in size as found in tables 6 to 9. Another explanation could be centred on the idea that US firms are better managed and employ information technology in a more appropriate way, which allows them to size up firms in a more efficient way.

Column 2 of table 13 repeats the exercise for the whole economy. This leads to similar conclusions as column 1, but both the returns to global size and the MNE

[9] However, because US firms are on average much larger than domestic firms this does consequently not imply that domestic firms are on average more productive than US firms (see Table 8).

advantage are much larger than when we looked at the manufacturing sector alone. In columns 3 and 4 which restrict the sample to FAME matched observations: the MNE effects now become insignificant and the returns to global size are smaller than in the first two columns. This is not surprising because the reference group is now the sample of larger domestic firms. Still however, the result that US firms have higher returns to size remains.

5 Robustness checks

In this section we report some robustness checks.
Table 14 repeats regressions similar to tables 11 and 12 using a factor share method when estimating productivity. The factor share method we use is as follows:

$$TFP_{it} = go_{it} - \overline{s}_{Mit} m_{it} - \overline{s}_{Lit} l_{it} - \left(1 - \overline{s}_{Lit} - \overline{s}_{Mit}\right) k_{it}$$

where gross output and production factors enter as log deviations from the median plant in terms of gross output per employee. The factor shares are computed as

$$\overline{s}_{Xit} = \frac{s_{it} + s_{Mediant}}{2}$$

We first check the robustness of our results without controlling for global size: the MNE advantage is significant in both manufacturing and the whole economy samples and is robust to restricting the sample only to those firms for which we have global turnover information. Finally columns 5 to 8 contain regressions including ultimate owner turnover as a measure for size. Again we find significant positive returns to global size whether restricting to the sample of FAME matched observations or not.

Table 14**: Regressions of TFP on global size and MNE categories**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. Variable	TFP							
	ARD sample		ARD sample with UO turnover information		ARD sample		ARD sample with FAME UO turnover information	
	Manu.	all	Manu.	all	Manu.	all	Manu.	all
ln(UO turnover)					0.012	0.004	0.014	0.009
					(.001)***	(.001)***	(.002)***	(.0028)***
MNE	0.051	0.038	0.068	0.044	0.020	0.024	0.028	0.020
	(.010)***	(.012)***	(.014)***	(.017)**	(.015)	(.018)	(.013)**	(.015)
foreign other	-0.002	-0.009	0.005	0.000	-0.018	-0.007	-0.021	-0.034
	(.015)	(.018)	(.023)	(.028)	(.023)	(.028)	(.019)	(.021)
Foreign US	0.020	0.042	0.002	0.025	-0.010	0.022	-0.022	0.002
	(.019)	(.025)	(.026)	(.034)	(.026)	(.034)	(.020)	(.025)
3 digit sector dummies	Yes	Yes	yes	yes	Yes	yes	Yes	yes
obs	4312	24917	3610	23312	3610	23312	1116	2620
R2	0.976	0.948	0.976	0.946	.976	.946	.985	.978

The second robustness check concerns our measure of global size: up to now our preferred measure has been global turnover. Are the results robust to using worldwide employees as a measure of global size? Table 15 reports the results, which again suggest positive returns to global size, a positive productivity advantage for MNEs,

and no significant differences across multinationals of different countries. These results are, as those in the previous table, robust to using the restricted sample of successful FAME matches.

Table 15**: Productivity regressions with ultimate owner employment**

	ln(go/emp)			
	ARD sample		ARD sample with FAME/Amadeus ultimate owner employment information	
	manufacturing	all	manufacturing	all
ln(UO employment)	0.016	0.036	0.008	0.009
	(0.005)***	(0.005)***	(0.005)*	(0.004)**
MNE	0.040	0.079	0.034	0.044
	(0.022)*	(0.027)***	(0.017)**	(0.018)**
foreign other	-0.027	-0.040	-0.035	-0.023
	(0.038)	(0.048)	(0.027)	(0.027)
foreign US	-0.114	-0.160	-0.080	-0.131
	(0.202)	(0.229)	(0.137)	(0.128)
ln(K/EMP)	0.090	0.098	0.103	0.134
	(0.008)***	(0.005)***	(0.013)***	(0.010)***
ln(M/EMP)	0.575	0.541	0.641	0.592
	(0.009)***	(0.005)***	(0.014)***	(0.011)***
ln(EMP)	-0.001	-0.043	0.008	-0.027
	(0.006)	(0.006)***	(0.008)	(0.006)***
Obs	4666	31800	976	2317
R2	0.795	0.723	0.889	0.885

6 Conclusions

The aim of this analysis was twofold. First we wanted to investigate whether matching the ARD and Fame datasets was possible. Secondly, we wanted to examine whether having additional information on global size brought new insight on the multinational productivity advantage debate. The answer to both of these questions is yes.

The matching between Fame and the ARD, although, not straightforward, resulted in good matching rates, especially for the group of multinational firms.

Secondly, our research has shown that global size is an important variable to include when analyzing the productivity of multinational firms. We have derived results showing that it is significantly correlated with establishment level productivity. Although our data cannot say much concerning causality given its cross-sectional nature, it opens up new avenues for future research: Do more productive firms grow faster and larger or is it easier for larger firms to achieve higher productivity in their subsidiaries? To answer this question we intend to develop a dynamic panel of FAME and UO data.
Besides, we found that the multinational effect drops significantly when including global size measure. Finally, we show that returns to global size are smallest for non-US multinationals and largest for non-multinational firms.
At present, we do not have fully satisfactory explanations for these two results.

The answer to these questions together with the causality issue constitutes the topic of our next research.

7 References

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Crespi, G.; C. Criscuolo and Jonathan Haskel (2006), "Information Technology, Organistational Change and Productivity Growth: evidence from UK firms" Queen Mary, Department of Economics working paper 558, London.

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Appendix A. Details on BvD ownership information

BvD complements the financial accounts of each company with data from its Ownership database which reports owner and subsidiary links worldwide with over 8.6 million links providing information on 4.6 million companies.
Three concepts derived from this ownership information are used in the present analysis: direct vs. total ownership, independence, and ultimate ownership. Each of these is described in the following three points.

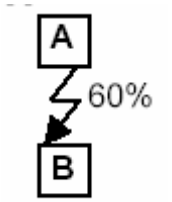
1. **Direct and Total Ownership**

- Direct ownership

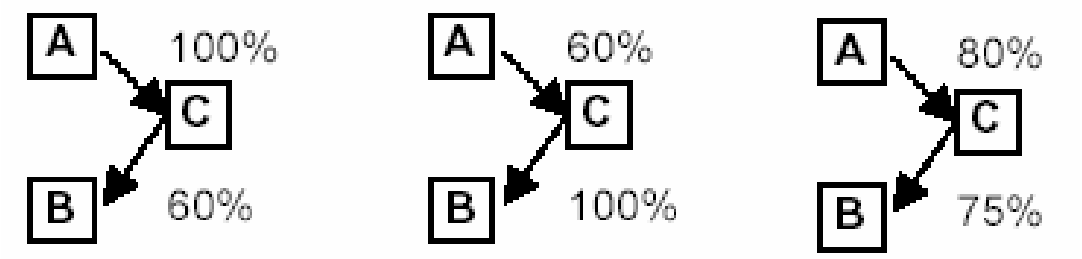
There exists a direct ownership link between two companies, when entity A owns a certain percentage of Company B, whether 100% (or "wholly owned (W.O.)"), less than 100%, or an unknown percentage (n.a.).
For example:

- Total ownership

The data might also indicate that entity A has a total stake in Company B without specifying the path through which the ownership is held. Total ownership links are represented with jagged lines:



Examples of a total ownership of 60% can be[10]:



A total link may appear in the database with or without a specific figure. It can also occur that no figure is mentioned, but rather an indication that B is "ultimately owned" by A (see below for a definition of this concept).

- Total and Direct Ownership

If a direct percentage co-exists with a total percentage, BvD makes the summation of the direct and indirect percentages and notes it as Total. This is why total ownership percentage might exceed 100%.

2. Independence Indicator

Based on the ownership data BvD creates an Independence Indicator reflecting the degree of independence of a company with regard to its shareholders.
The hypothesis is made that shareholders that are recorded as employees/directors/managers, individuals and families unnamed (or "private shareholders"), a bulk list of shareholders, or public cannot exert their voting power jointly. They are consequently excluded from the independence consideration. These are denoted as "type I" shareholders.
The BvD Independence Indicators are noted as A, B, C, and U, with possible further qualifications:

- Indicator A

Any company with no recorded shareholder (excluding type I) with an ownership over 24.99%, either direct or total.
BvD also gives an A notation to a company reported as being the ultimate owner of another company, even when they do not comply with the above criteria (i.e. when there is no explicit information about the shareholders of this company). In this analysis, any quoted company will also be regarded as independent.

- Indicator B

This is attached to any company with no recorded shareholder (excluding type I) with an ownership percentage (direct or total) over 49.99%, but having one or more shareholders with an ownership percentage over 24.99%.

[10] Even if these direct links between A and a third company C, and between C and B were known, BvD would not compute the weighted average of company A's stake in B to calculate the Total ownership figure. This is because BvD cannot assert for sure that other indirect links between A and B do not exist which would impact the calculation.

- Indicator C

Attached to any company with a recorded shareholder (excluding type I) with an ownership (direct or total) over 49.99%. The C indicator is also given to a company when a source indicates that the company has an Ultimate Owner.

- Indicator U

Attached to the companies not falling into the categories A, B or C, indicating an unknown degree of independence.

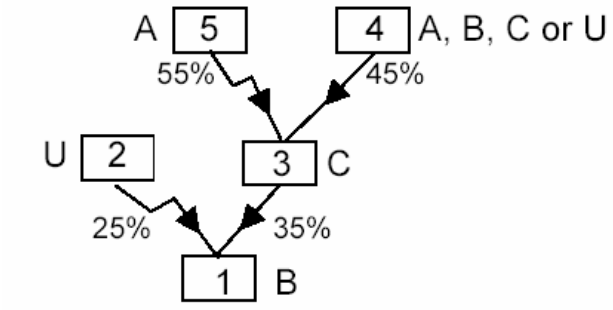
3. Ultimate Owner

A firm is considered having an ultimate owner if one shareholder is in possession of over 24.9% stock and no others hold that much.
The concept of Ultimate Owner is directly linked to the concept of the Independence Indicator. BvD proceeds in the following way to define ultimate ownership:

1. If company 1 has an independence indicator "A", by definition it has no UO.
2. If company 1 has an indicator "B" or "C", BvD follows the upward path through its shareholders until reaching
- a company with a "U", indicating company 1 has no known UO;
- a company with an "A", indicating that it is the UO of 1.

Only links with percentages over 24.99% are taken into consideration for inclusion in a path. When more than one link relates a company to upward shareholders, the link chosen to continue the path is the link with the highest Total or Direct percentage.
However, if a company is indicated by a source (Annual Report, Private Communication, and Information Provider) to be the UO of another company, this path takes priority over all other paths – even if the percentage of ownership is unknown.
The following examples illustrate a few possible patterns of ownership[11].

Example 1[12]:

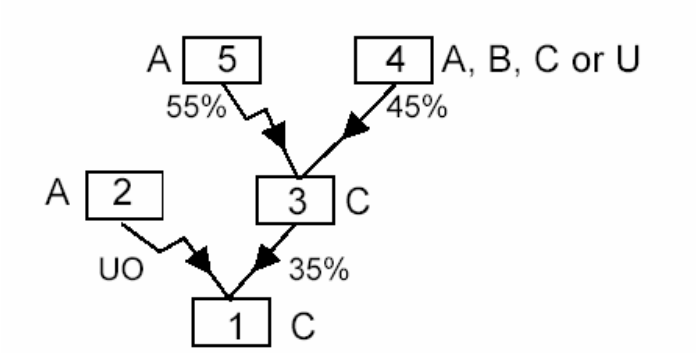


The ownership path is followed from company 1 to company 3 and from company 3 to company 5. Company 5, which has an indicator "A", is said to be the UO of company 1. Company 5 is also the UO of company 3.

[11] Total ownership links are pictured with jagged lines.

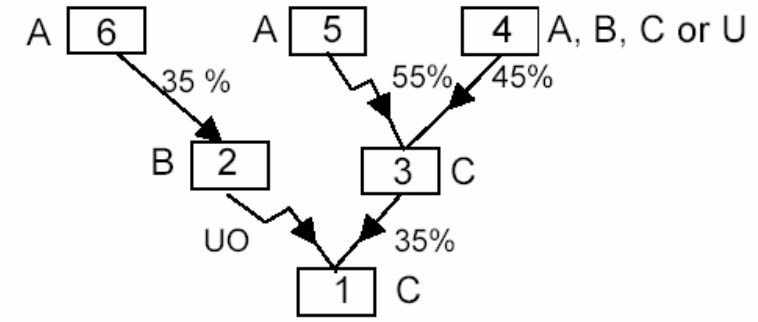
[12] The graphs in the following four examples are extracted from the document entitled “Ownership Database” from the Bureau Van Dijk.

Example 2:



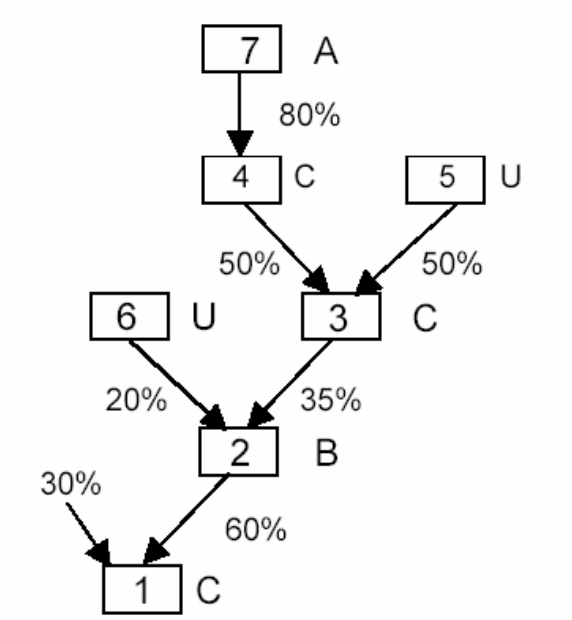
The link between company 1 and company 2, given directly by the information source of BvD, has the priority on the link between company 1 and company 3, even though its percentage is unknown. Therefore, company 2 is labelled the UO of Company 1.

Example 3:



As in example 2, a source indicates that company 2 is the UO of company 1. However, company 2 has a "B" as independence indicator since it has a shareholder owning more than 24.99% (whereas in example 2, the independence indicator was "A"). This means that BvD will look upwards for the most important shareholder in company 2. This company (company 6) will be qualified as the UO of company 1 in place of company 2.

Example 4: Jointly owned companies:



When a company (company 3 in the following scheme) is reported as jointly owned by two parents (company 4 and company 5), BvD notes 50% for the ownership percentage of company 4 and company 5 in company 3, and does not indicate the Ultimate Owner. Firm 1 does therefore not have an UO.

Example 5:
When a company Co.Y has a "U" Independence Indicator, the subsidiaries along the ownership link paths with over 24.99% are given the ownership status **CR** (indicating "Controlled by"). This is done to highlight the fact that we do not know whether Co.Y is independent, but if it where independent, it would indeed be the Ultimate Owner of the named subsidiaries.

It should also be noted that BvD never computes weighted averaged percentages of indirect ownership between a shareholder and a subsidiary. This is because all existing links might not be recorded in the database. Also, in certain cases of complex ownership structures, it could be misleading when trying to evaluate a controlling power.

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