The Impact of Exporting and Importing Goods and Services on Productivity in the UK

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Abstract

This paper investigates the impact of exporting and importing goods and services on productivity for UK plants using a combination of regression and propensity score matching. Unlike earlier papers, the data allows us to distinguish the effects of exporting and importing goods and services. In confirmation of the results from other countries, we find that plants in both manufacturing and non-manufacturing that both export and import have higher productivity than plants that only do one of these activities. In manufacturing, this is the case regardless of whether the trade is in goods or services (which suggests that servitisation of manufacturing is beneficial). The results are more mixed for services, and the benefits from involvement in international goods networks that are seen in manufacturing do not occur in services.

Keywords: Exports, Imports, Intermediate Inputs, Productivity

JEL codes: D24; F14; O14

1. Introduction

A large literature exists on the relationship between exporting and productivity. In addition to emphasising that firms need to be more productive prior to exporting in order to overcome the fixed costs of exporting (Melitz, 2003), this literature discusses the potential for a 'learning-by-exporting' effect which further enhances exporters' productivity. This arises because firms may benefit from knowledge flows from international consumers of their outputs and also because the more competitive nature of international markets may require exporters to improve their productivity. For the UK, the empirical evidence is mostly in favour of 'learning-by-exporting' effects although they are often found to be temporary (Greenaway and Kneller, 2008; Girma, Greenaway and Kneller, 2004; Greenaway and Kneller, 2004). However, in his survey of the evidence on the exporting-productivity relationship, Wagner (2007) concludes by saying that 'the big picture that emerges... is that exporters are more productive than non-exporters, and that the more productive firms self-select into export markets, while exporting does not necessarily improve productivity' (p. 67).

A smaller literature exists on the effect of importing intermediate inputs on productivity. A positive impact could arise due to the superior quality of foreign intermediate inputs. In addition, the import of intermediate inputs from foreign firms could open channels of communication with more technologically advanced firms through which knowledge may be diffused. The availability of varieties of inputs that are not available domestically may also improve the productivity of importing firms. A theoretical model capturing some of these ideas is provided by Halpern et al (2011). However, because of fixed costs involved in importing, it is likely that firms self-select into importing and this creates difficulties in identifying the causal effect of importing. Most empirical studies (Kasahara and Rodrigue, 2008; Augier et al. 2013; Lööf and Andersson, 2010) have found positive impacts of importing on productivity.

Other studies have looked at the effect of both importing and exporting on productivity. These studies are preferable to those which look at only one of importing or exporting because of the likely correlation between the two activities. Empirical evidence has been obtained for Chile (Kasahara and Lapham, 2013), Sweden (Andersson et al., 2008), Belgium (Muûls and Pisu, 2009), Italy (Castellani et al., 2010), Germany (Vogel and Wagner, 2010) and Ireland (Haller, 2010) showing that firms that both export and import (so-called 'two-way traders') have higher productivity than firms that are involved in just one of these activities. For the United Kingdom (UK), Breinlich and Criscuolo (2011) show that service-sector establishments that both export and import services have higher productivity but no attempt is made to identify a causal effect.[1] Furthermore, the data only provide information on trade in services so trade in goods is not covered.

This paper uses UK plant-level data to estimate the impact of exporting and importing goods and services on total factor productivity (TFP). In order to deal with the self-selection of plants into exporting and importing, the empirical model is estimated using a sample created by propensity score matching. There are two main innovations of this study. Firstly, as far as

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[1] Only year and industry dummies are included in their empirical model.

we are aware, this is the first study that has sought to estimate the effect of exporting and importing on productivity for both manufacturing and services[2] using UK data. The second innovation is the drawing of the distinction between trade in goods and services. The effect on productivity of trade in goods and services is likely to differ because of intrinsic differences in their nature since goods, unlike services, are storable, observable before purchase and are usually produced and consumed in different locations and also because barriers to trade in services are substantially higher within the EU (and presumably elsewhere) than barriers to trade in goods. This is primarily due to differences in regulatory regimes across countries (Ardy and El-Agraa, 2011; OECD, 2009).

The results indicate that plants that import and export tend to outperform plants that do only one of these activities. In manufacturing, this is the case regardless of whether the trade is in goods or services. In services, the results are more mixed and suggest that service sector firms which trade in goods do not experience the same productivity gains that manufacturing firms that trade in services do.

The next section discusses the dataset. The third section describes the methodology and the fourth section provides results. The final section concludes.

2. Data

The dataset consists of plant-level data for 2011 and 2012 obtained primarily from the UK's Annual Respondents Database (ARD). The ARD is collected annually by the UK's Office for National Statistics as part of the Annual Business Inquiry in order to facilitate the calculation of National Accounts statistics (further information on the ARD is given in Robjohns, 2006). It contains the financial variables necessary for the estimation of TFP such as investment, intermediate inputs, employment and gross output. Our choice of years is constrained by the fact that information on exporting and importing has only been collected since 2011.[3]

Table 1 around here

Information on intra- and extra-mural expenditure on R&D is taken from the Business Enterprise R&D (BERD) database on enterprises that undertake this activity each year.[4] These data have been merged into the ARD using the unique enterprise reference codes available in both the ARD and BERD, and where these were missing, information on industry SIC codes and geographic postcodes to match respondents in the two databases were used.

The Annual Inquiry into Direct Investment (AFDI) provides information on outward foreign direct investment (OFDI) and covers some 8,500-12,000 observations per year (although only

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[2] Note, Other Community, Social and Personal services are excluded (SIC90-93 under the 1992 Standard Industrial Classification). This is because this sub-group is only very peripherally involved in international trade, but is quite a large sub-set of the service sector sample of plants (we found their inclusion contaminated our findings, producing some very hard to explain outcomes – more information is available from the authors for those wanting the results for this sub-set of plants).

[3] The following industries are omitted because we have no data on capital stocks for them or they are only partially covered in the ARD: those areas of agriculture, fishing and forestry covered in the ARD; mining & quarrying; utilities; construction; and financial services.

[4] Note that the BERD data captures firms that 'regularly' undertake R&D, and this could potentially underestimate R&D in smaller firms and/or those in low-tech sectors.

about 980-2,500 firms, since many firms have multiple subsidiaries/branches in different countries); these were amalgamated into a single observation per firm per year and merged into the ARD using the inter-departmental business register (IDBR) code available in both datasets. A full list of variable descriptions is given in Table 1.

3. Methodology

The basic specification is the following augmented log-linear production function:

$$y_{it} = \beta_E e_{it} + \beta_M m_{it} + \beta_K k_{it} + \beta_x x_{it} + \beta_{EXP} EXP_{it} + \beta_{IMP} IMP_{it} + \beta_{EXP \times IMP} EXP \times IMP_{it} + \epsilon_{it} \qquad (1)$$

where y_{it} denotes the log of real gross output in plant i in time t;[5] e_{it} is the log of employment; m_{it} is the log of real intermediate inputs; k_{it} is the log of the capital stock; and x_{it} is a vector of control variables (those variables in Table 1 not mentioned above).[6] The key variables are EXP_{it} and IMP_{it}, which are dummy variables that equal 1 if plant i in time t exports or imports (goods or services), respectively, but does not do both activities, and $EXP\&IMP_{it}$ which takes the value of one if the plant both exports and imports. These three variables are therefore mutually exclusive.

The extended model takes advantage of the information in the dataset on whether plants are trading in goods or services. Table 2 shows the 16 categories into which plants may fall. Therefore, 15 dummy variables measuring whether plants are exporting or importing goods or services are included in place of EXP_{it}, IMP_{it} and $EXP\&IMP_{it}$ in equation (1). The excluded category in the extended model is plants that are not involved in exporting or importing goods or services (those in the column 1, row 1 of Table 2).

<div align="center">Table 2 around here</div>

Because plants that export and import are a self-selected group of the population of plants, they will tend to have different characteristics from plants that do not export or import. While the inclusion of the observed covariates in Equation (1) provides some control for differences in characteristics, the estimated 'treatment' effects will only be unbiased if the functional form (which is assumed to be linear) of equation (1) is correct. One means of reducing this sensitivity to functional form is to create a matched sample in which plants that export and plants that import are matched to plants that do neither of these activities on the basis of their observed characteristics using propensity score matching (Dehejia and Wahba, 2002). This involves the estimation of a probit model of 'treatment status' and the use of the estimated propensity scores to match each plant that either exported or imported to the plant with the most similar characteristics that did neither of these activities. If this approach successfully removes all differences between the 'treated' and 'untreated' groups (achieves a perfect 'balance' of the covariates), it will not be necessary to include any covariates in equation (1) beyond the exporting and importing variables. Whether this was achieved will be tested

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[5] As is standard in the literature, output is calculated from sales data using industry level price deflators (Van Beveren, 2012). Such deflators used will therefore not necessarily reflect the price of output for the plant and the estimated coefficients will measure the impact of the relevant variable on both physical and revenue productivity. This issue also arises for plants involved in producing outputs classified to more than one industry.
[6] A justification for the inclusion of these variables is provided in Harris and Moffat (2011).

below and, if differences in the distributions of the covariates across the 'treated' and 'untreated' groups remain in the matched sample, a combination of matching and multivariate regression will be used.[7] Because the number of plants that exported or imported was greater than the number of plants that did neither activity, the matching procedure involved the removal from the sample of 'treated' observations for which no similar plant in the 'untreated' group could be found.[8]

4. Results

The parameter estimates from the probit model used to generate propensity scores are given in Table A1. Table 3 shows the effectiveness of the matching procedure in reducing differences in the means of the covariates across the treated and untreated groups. This reveals that the matching procedure has gone some way towards improving the balance of the covariates across the treated and untreated groups but has not eliminated them. To take a representative example, the difference in the mean of logged employment between the treated and untreated groups in unmatched manufacturing sample is 1.041. In a t-test of equality of means, the null hypothesis is rejected at the 1% level. In the matched sample, the difference falls to 0.142 but the null of equality of means is still rejected at the 1% level. The failure of the matching procedure to eliminate differences across the treated and untreated groups provides further support for the strategy of combining matching and regression so that the latter can control for remaining differences in the distribution of covariates.

Table 3 around here

Table 4 presents results from estimation of both the basic and extended versions of equation (1). Full results are available in Table A2 in the appendix for the extended versions (which are the preferred set of estimates) using both the unmatched and matched samples.[9] The following discussion focuses on the unmatched results since these do not suffer from the reduced variation in the covariates that follows from using a matched sample. The coefficient estimates on the factor inputs (intermediate inputs, employment and capital) are broadly in line with those obtained using more sophisticated methods of estimating production functions (Del Gatto, 2011; Van Beveren, 2012). This is important as it provides confidence that the estimated coefficients on the exporting and importing variables are measuring effects on TFP. In terms of the other covariates, most of the coefficients have the expected sign. Foreign-ownership is found to have a positive effect on TFP, suggesting that being part of a multinational firm provides access to superior technologies. Being engaged in outward FDI is also associated with higher TFP, except in wholesale and retail. The coefficient on the age variable is generally negative and statistically significant which implies that older plants use less advanced technologies. Plants belonging to firms with plants in more than one region have higher TFP than plants belonging to firms operating in only one region in all sectors apart from wholesale and retail but single plant enterprises operating in one region are more

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[7] This approach is recommended by (Imbens and Wooldridge, 2009).
[8] The precise form of matching was one-to-one nearest-neighbour matching without replacement using a caliper of 0.001. The latter ensures that matched plants are not excessively dissimilar.
[9] As would be expected, there is little difference in the coefficient estimates for the control variables between the basic and extended versions.

productive than plants belonging to multi-plant enterprises operating in a single region. The effect of higher levels of concentration (which is assumed to be associated with less competition) is negative for manufacturing but positive for services. In terms of spatial externalities, higher levels of urbanisation have negative effects on TFP, suggesting the existence of congestion diseconomies, while higher levels of agglomeration have a positive effect, implying the existence of localisation externalities. The effect of R&D is positive and statistically significant in services. In manufacturing, plants with small R&D stocks (less than £10,000 in 2010 prices) have lower TFP while larger R&D stocks have no significant effect. The latter is surprising but may reflect the fact that resources devoted to R&D do not have a direct impact on output and will therefore, at least in the short-run, reduce observed TFP. As would be expected, being located in an assisted area is generally associated with lower productivity.

Focusing on the exporting and importing variables in Table 4, for manufacturing, engaging in exporting (without importing) and importing (without exporting) has no statistically significant impact on TFP (column 1). But exporting and importing has the overall effect of increasing TFP by 9.2%.[10] This result therefore confirms those of other studies that show that plants that both export and import have higher productivity than plants that do only one of these activities.

<center>Table 4 around here</center>

For services (excluding wholesale, retail and other community, social and personal service activities), the results in column (3) show the effect of exporting (without importing) and importing (without exporting) is to increase TFP by 5.1%. But plants that both export and import experience larger TFP gains (of 6.1%). A similar story applies to wholesale and retail. In this sector, the effect of exporting (without importing) and importing (without exporting) is to raise TFP by 5.4% and 3.9% respectively. Two-way traders have 6.3% higher TFP.

Columns (2) and (4) provide the results in which 15 mutually exclusive dummy variables (measuring which category in Table 2 a plant belonged to) are included in the model in place of the three dummy variables used in the basic model. These coefficient estimates are replicated in Table 5, along with the percentage of plants in each sub-group. The first set of observation counts is weighted to be representative of the population of plants and the second set shows the actual number of plants in the sample. For manufacturing, Table 5 confirms the results in column (1) of Table 4, that in general plants that export and import experienced significant productivity gains and that involvement in only one of these activities is not sufficient to boost TFP. Note however that the largest gains were obtained by manufacturing plants that export and import services. This group of plants, which account for 10.8% of manufacturing plants, are presumably heavily involved in 'manu-service' activities (see Neely, et al., 2011; Baines and Lightfoot, 2014).[11] However, it is possible that this result is

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[10] Because the dependent variable is logged, the coefficients presented in the table are transformed as follows: $exp(\beta) - 1$

[11] For example, plants belonging to firms that rent their products rather than sell them, and bundle other services with these goods, are likely to fall into this sub-group. A well-known example is Rolls-Royce aircraft engines

driven by higher prices in services rather than being a physical productivity effect (see footnote 6).[12] Plants that import both goods and services (without exporting) experienced a fall in TFP of 12.5% which suggests that using imported intermediate inputs to produce outputs that are sold only in the domestic market was a large productivity reducing activity.

Column (4) of Table 4 and the second panel of Table 5 provide the equivalent information for services. Focusing on plants that do not trade in goods (the top line of the second panel), plants that export (without importing) have 4.7% higher TFP and plants that import (without exporting) have 10.6% higher TFP than plants that are not involved in trade of any type. However, two-way traders benefit most since their TFP is 14.6% higher than plants not involved in trade. Since relatively few plants (27.9%) are involved in trade at all in services and only 9% export and/or import goods, these results are the most important and reliable of those obtained for this sector.

Among service sector plants that trade in goods, the picture is very mixed. Of the two largest groups, those that export and import goods but do not trade in services experience gains in TFP of 8.7% but those that export and import both goods and services have similar TFP levels to those that do not trade at all. Among small groups, large negative effects are seen for plants that export (without importing) goods and import (without exporting) services (-27%) and plants that import (without exporting) goods and plants that both export and import goods (-17.4%).[13] Overall, the results suggest that service sector plants do not benefit from involvement in international supply chains for goods to the same extent as manufacturing firms benefit from involvement in international supply chains in services.

Column (5) and the lower panel of Table 5 shows the coefficients on the 15 exporting and importing dummies for wholesale and retail. Almost all groups experienced increases in TFP as a result of their trading activities. The only exceptions are plants that do not trade in goods and export (without importing) services which have 2.9% lower TFP and those that import (without exporting) goods and export (without importing) services which have 3.5% lower TFP. However, both groups are very small, comprising less than 3% of plants in wholesale and retail.

Trade in goods is a popular activity within wholesale and retail with over 40% of plants involved in exporting and/or importing of goods. Most of these plants are two-way traders in goods and they experience productivity gains of between 4.8% and 12%, depending on whether they import and/or export services. Another relatively large group is plants that import (without exporting) but are not involved in trade in services. They receive a gain in TFP of 14%, relative to plants that do not trade at all which is smaller than the gain achieved by the group of plants that export (without importing) goods and do not trade in services (9.7%) and two-way traders in goods that are not involved in services trade (4.8%).

(although we cannot verify this using the ARD since our access to these data is predicated on complying with a strict confidentiality rule ensuring there is no disclosure of the identity of data providers').

[12] Unfortunately, we lack data on the services traded so are unable to check whether they have higher prices than the manufacturing goods which they produce.

[13] The relatively small numbers of plants involved in these activities needs to be noted, and further work is needed to confirm and then establish the underlying reasons for such 'mixed' results.

Table 5 around here

5. Conclusion

This paper has estimated the impact of exporting and importing on TFP in UK plants using a combination of regression and propensity score matching. In confirmation of the results from other countries, we find that plants in both manufacturing, services (excluding Retail, Wholesale and Other Community, Social and Personal Service Activities) and wholesale and retail that both export and import have higher productivity than plants that only do one of these activities. For manufacturing, this is true regardless of whether trade occurs in goods or services (which suggests that servitisation of manufacturing is beneficial). The results are more mixed for services, and the benefits from involvement in international goods networks that are seen in manufacturing do not occur in services. For wholesale and retail, trade in goods is both a very frequent activity and a productivity enhancing one.

Further research is necessary to gain a more complete understanding of the differences in the relationship between importing and exporting goods and services. For the UK, as more years of data become available in the ARD, it will be possible to use panel data estimators which control for time-invariant heterogeneity. Such research is important as the results obtained here have important implications for policy. In particular, they suggest that a blanket promotion of all types of exporting is not necessarily an optimal policy, since exporting does not always lead to productivity gains; in manufacturing, exporting without importing (of both goods and services) fails to produce positive TFP effects which implies that manufacturing firms should be encouraged to become more integrated in international trade networks rather than simply to export. By contrast, in services, exporting and importing goods fails to produce productivity gains while exporting services only improves productivity in some categories. This suggests that different policies are required for the manufacturing and service sectors.

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Appendix

Table A1 around here

Table A2 around here

Table 1: Variable Definitions

Variable	Definitions	Source
Real gross output	Plant level gross output data deflated by 2-digit ONS producer price (output) indices. Data are in £'000 (2000 prices)	ARD
Export	Dummy coded 1 if plant exports (but does not import)	ARD
Import	Dummy coded 1 if plant imports (but does not export)	ARD
Export & Import	Dummy coded 1 if plants exports and imports	ARD
Intermediate inputs	Plant level intermediate inputs (gross output minus GVA) deflated by 2-digit ONS producer price (input) indices (services only has a single PPI). Data are in £'000 (2000 prices)	ARD
Employment	Number of employees in plant.	ARD
Capital	Plant & machinery capital stock (£m 1995 prices) plus real value of plant and machinery hires (deflated by producer price index) in plant. Source: Harris and Drinkwater, 2000)	ARD
Foreign-Owned	Dummy coded 1 if plants is foreign-owned	ARD
Outward FDI	Dummy coded 1 if plant belongs to a UK firm involved in outward FDI	AFDI
Age	Number of years plant has been in operation based on year of entry	ARD
Single-Plant Firm	Dummy coded 1 when plant comprises a single-plant enterprise	ARD
Multi-Region Firm	Dummy coded 1 if plant belongs to multiplant enterprise operating in more than 1 UK region	ARD
Herfindahl Index	Herfindahl index of industry concentration (3-digit level)	ARD
Diversification	% of 5-digit industries (from over 650) located in travel-to-work area (TTWA) in which plant is located – Jacobian spillovers	ARD
Agglomeration	% of industry output (at 5-digit SIC level) located in TTWA in which plant is located – MAR-spillovers	ARD
Low R&D*	Dummy coded 1 if plant had a positive R&D stock based on undertaking intramural and/or extramural R&D valued at less than £10,000 (2011 prices)	BERD
R&D*	Dummy coded 1 if plant had a positive R&D stock based on undertaking intramural and/or extramural R&D valued at greater than £10,000 (2011 prices)	BERD
Assisted Area	Dummy coded 1 if plant is located in assisted area	ARD
2012 Dummy	Dummy coded 1 in year 2012	ARD
Region	Dummies coded 1 if plant is located in particular administrative region	ARD
City	Dummies coded 1 plant is located in major GB city (defined by NUTS3 code)	ARD
Industry	Dummies coded 1 depending on 1992 SIC of plant (used at 2-digit level)	ARD

* R&D stocks are computed using perpetual inventory method with 30% depreciation rate for the largest components of R&D spending (intra-mural current spending and extra-mural R&D). See HARRIS, LI AND TRAINOR (2009) for details of methods used.

Table 2: Combinations of Exporting and Importing Goods and Services

		Trade in services			
		(1)	(2)	(3)	(4)
Trade in goods	(1)	No exporting or importing	No trade in goods, export services	No trade in goods, import services	No trade in goods, export & import services
	(2)	Export goods, no trade in services	Export goods, export services	Export goods, import services	Export goods, export & import services
	(3)	Import goods, no trade in services	Import goods, export services	Import goods, import services	Import goods, export & import services
	(4)	Export & import goods, no trade in services	Import goods, export services	Export & import goods, import services	Export & import goods, export & import services

Table 3: Tests of Covariate Balance in Unmatched and Matched Sample, UK, 2011-12

	Unmatched			Matched			Unmatched			Matched		
	Treated	Untreated	Difference	Treated	Untreated	Difference	Treated	Untreated	Difference	Treated	Untreated	Difference
	Manufacturing						Services					
Foreign-Owned	0.379	0.145	0.235***	0.215	0.199	0.017**	0.246	0.186	0.060***	0.236	0.236	0.000
Outward FDI	0.251	0.086	0.166***	0.122	0.116	0.007	0.390	0.271	0.120***	0.285	0.278	0.007**
Ln Intermediate Inputs	7.298	5.197	2.101***	6.131	6.000	0.131***	5.851	4.252	1.599***	5.311	5.406	-0.096***
Ln Employment	3.287	2.246	1.041***	2.778	2.636	0.142***	2.599	2.056	0.543***	2.527	2.608	-0.081***
Ln Capital	-0.892	-2.429	1.537***	-1.709	-1.951	0.241***	-1.930	-3.763	1.834***	-2.737	-2.532	-0.206***
Ln Age	2.378	2.207	0.171***	2.289	2.251	0.038*	1.839	1.705	0.134***	1.816	1.866	-0.050***
Single	0.179	0.548	-0.369***	0.433	0.388	0.045***	0.053	0.169	-0.116***	0.078	0.089	-0.010***
Multi-Region Firm	0.701	0.327	0.374***	0.430	0.453	-0.022**	0.904	0.750	0.154***	0.864	0.850	0.014***
Ln Herfindahl Index	-2.323	-2.617	0.294***	-2.511	-2.482	-0.029*	-2.761	-3.010	0.249***	-3.037	-3.033	-0.004
Ln Diversification	-0.495	-0.497	0.003	-0.498	-0.497	-0.001	-0.439	-0.441	0.002*	-0.432	-0.434	0.002*
Ln Agglomeration	0.255	-0.312	0.567***	-0.011	-0.107	0.096**	-0.095	-0.204	0.109***	-0.041	-0.059	0.018
Low R&D	0.006	0.005	0.001	0.006	0.006	0.000	0.001	0.001	0.000	0.001	0.001	0.000
R&D	0.195	0.056	0.139***	0.098	0.078	0.020***	0.023	0.007	0.016***	0.013	0.012	0.001
Assisted Area	0.362	0.359	0.003	0.360	0.363	-0.003	0.261	0.267	-0.006***	0.259	0.259	0.001
2012 Dummy	0.446	0.480	-0.034***	0.483	0.468	0.014	0.501	0.514	-0.014***	0.511	0.509	0.002
	Wholesale and Retail						Other Community, Social and Personal Service Activities					
Foreign-Owned	0.284	0.220	0.064***	0.243	0.241	0.002	0.332	0.066	0.266***	0.180	0.157	0.023***
Outward FDI	0.391	0.265	0.126***	0.303	0.298	0.006*	0.348	0.429	-0.080***	0.339	0.240	0.098***
Ln Intermediate Inputs	6.336	6.057	0.279***	6.167	6.145	0.022**	5.962	5.946	0.016	5.785	5.440	0.344***
Ln Employment	2.415	2.111	0.304***	2.209	2.205	0.005	2.111	1.905	0.205***	2.154	2.177	-0.023
Ln Capital	2.512	-3.118	5.630***	2.777	-2.793	5.570	-1.533	-2.465	0.933***	-1.675	-1.760	0.085***
Ln Age	2.047	2.097	-0.051***	2.127	2.109	0.017***	2.013	2.163	-0.150***	2.066	2.053	0.013
Single	0.030	0.158	-0.128***	0.088	0.082	0.006***	0.041	0.148	-0.107***	0.078	0.086	-0.009**
Multi-Region Firm	0.947	0.773	0.175***	0.854	0.864	-0.010***	0.903	0.764	0.139***	0.833	0.802	0.031***
Ln Herfindahl Index	2.660	-2.612	5.272***	2.634	-2.597	5.231***	-2.006	-2.002	-0.005	-2.079	-2.122	0.043***
Ln Diversification	0.467	-0.485	0.953***	0.480	-0.481	0.961	-0.453	-0.452	0.000	-0.456	-0.462	0.006**
Ln Agglomeration	0.316	-0.494	0.809***	-0.448	-0.471	0.023**	-0.359	-0.316	-0.043*	-0.374	-0.467	0.093***
Low R&D	0.001	0.000	0.000**	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.001	0.000
R&D	0.006	0.003	0.003***	0.005	0.003	0.002***	0.007	0.003	0.005***	0.007	0.006	0.001
Assisted Area	0.323	0.330	-0.008***	0.330	0.332	-0.001	0.316	0.330	-0.013***	0.312	0.303	0.009
2012 Dummy	0.513	0.509	0.004	0.509	0.510	-0.001	0.509	0.514	-0.006	0.532	0.521	0.011

*/**/*** denotes rejection of the null in a *t*-test of equality of means at the at the 10%/5%/1% level respectively.　　　　　　Source: ARD/BERD

Observation counts are at the bottom of Table A2

Table 4: Estimates of Production Function (equation 1) using Matched Sample, UK, 2011-12[a]

	(1)	(2)	(3)	(4)	(5)	(6)
	Manufacturing		Services		Wholesale & Retail	
Export	-0.021		0.050***		0.053***	
	(0.022)		(0.006)		(0.006)	
Export Goods		-0.005		0.109***		0.093***
		(0.028)		(0.021)		(0.007)
Export Services		-0.059		0.046***		-0.029***
		(0.038)		(0.006)		(0.009)
Export Goods & Services		0.004		0.070*		0.098***
		(0.063)		(0.042)		(0.025)
Import	-0.036		0.050***		0.038***	
	(0.022)		(0.005)		(0.003)	
Import Goods		-0.023		-0.000		0.014***
		(0.025)		(0.007)		(0.003)
Import Services		0.027		0.101***		0.044***
		(0.070)		(0.009)		(0.008)
Import Goods & Services		-0.134**		0.083***		0.119***
		(0.052)		(0.009)		(0.006)
Export & Import	0.088***		0.059***		0.063***	
	(0.014)		(0.004)		(0.002)	
Export & Import Goods		0.072***		0.083***		0.047***
		(0.017)		(0.012)		(0.003)
Export & Import Services		0.190***		0.136***		0.050***
		(0.036)		(0.005)		(0.006)
Export & Import Goods & Services		0.125***		0.010		0.113***
		(0.028)		(0.009)		(0.005)
Export Goods & Import Services		0.043		-0.315***		0.140***
		(0.142)		(0.085)		(0.049)
Export Services & Import Goods		-0.049		-0.080***		-0.036***
		(0.106)		(0.021)		(0.007)
Export & Import Goods & Export Services		0.067		0.016		0.100***
		(0.047)		(0.010)		(0.006)
Export & Import Goods & Import Services		0.035		0.076***		0.066***
		(0.034)		(0.029)		(0.006)
Export & Import Services & Export Goods		-0.004		-0.129***		0.104**
		(0.104)		(0.027)		(0.043)
Export & Import Services & Import Goods		0.043		-0.315***		0.140***
		(0.142)		(0.085)		(0.049)
R²	0.928	0.929	0.926	0.927	0.959	0.960
No. 'Untreated'	4,433		45,992		47,985	
Observations	8,866		91,984		97,950	

*/**/*** denotes significance at the 10%/5%/1% respectively. Standard errors in parenthesis.

[a] This table reports the impact on output of the trade variables; Table A2 provides the results for all the other variables included in the extended version of Equation (1)

Source: ARD/AFDI/BERD

Table 5: Matrix of Exporting and Importing Effects, UK, 2011-12: expanded model

Manufacturing						
		Trade in Services			
		No Exporting, No Importing	Exporting, No Importing	No Exporting, Importing	Exporting, Importing
Trade in Goods	No Exporting, No Importing	0.000 (46.3) [23.1]	-0.059 (1.9) [2.5]	0.027 (0.8) [1.5]	0.190*** (2.8) [4.6]
	Exporting, No Importing	-0.009 (5.7) [5.2]	0.004 (1.1) [0.6]	0.043 (0.2) [0.2]	-0.004 (0.3) [0.3]
	No Exporting, Importing	-0.023 (6.6) [7.7]	-0.049 (0.3) [0.4]	-0.134** (1.2) [1.9]	0.228** (0.3) [0.5]
	Exporting, Importing	0.072*** (18.9) [25.1]	0.067 (2.2) [3.7]	0.035 (4.1) [8.4]	0.125*** (7.2) [14.2]

Services (excluding Retail, Wholesale and Other Community, Social and Personal Service Activities)						
		Trade in Services			
		No Exporting, No Importing	Exporting, No Importing	No Exporting, Importing	Exporting, Importing
Trade in Goods	No Exporting, No Importing	0.000 (78.1) [59.6]	0.046*** (5.0) [4.7]	0.101*** (1.5) [2.2]	0.136*** (6.4) [11.2]
	Exporting, No Importing	0.109*** (0.4) [0.4]	0.070* (0.2) [0.1]	-0.315*** (0.0) [0.0]	-0.129*** (0.2) [0.3]
	No Exporting, Importing	-0.000 (2.1) [4.7]	-0.080*** (0.4) [0.6]	0.083*** (0.9) [2.6]	-0.192*** (0.8) [2.4]
	Exporting, Importing	0.083*** (1.5) [3.4]	0.016 (0.7) [1.9]	0.076*** (0.2) [0.2]	0.010 (1.7) [5.8]

Retail & Wholesale						
		Trade in Services			
		No Exporting, No Importing	Exporting, No Importing	No Exporting, Importing	Exporting, Importing
Trade in Goods	No Exporting, No Importing	0.000 (54.2) [27.2]	-0.029*** (1.2) [1.9]	0.044*** (1.3) [2.0]	0.050*** (2.0) [4.9]
	Exporting, No Importing	0.093*** (2.6) [2.0]	0.098*** (0.3) [0.1]	0.140*** (0.1) [0.0]	0.104** (0.1) [0.1]
	No Exporting,	0.014*** (11.1)	-0.036*** (1.6)	0.119*** (2.4)	0.140*** (1.2)

	Importing	[15.3]	[3.8]	[5.0]	[2.7]
	Exporting, Importing	0.047*** (12.6) [18.2]	0.100*** (2.3) [5.0]	0.066*** (3.1) [5.4]	0.113*** (3.8) [7.3]

Figures in round and square brackets are weighted and unweighted percentages respectively of plants involved in the particular activity

Source: Table 4

Table A1: Estimates of Probit Model used to estimate propensity scores, UK[a], 2011-12

	Manufacturing	Services	Wholesale and Retail
ln Intermediate Inputs	0.203***	0.233***	-0.127***
	(0.009)	(0.003)	(0.004)
ln Employment	-0.122***	-0.196***	0.195***
	(0.012)	(0.004)	(0.006)
ln Capital	-0.016**	0.088***	0.077***
	(0.007)	(0.002)	(0.003)
Foreign-Owned	0.128***	-0.043***	0.107***
	(0.026)	(0.009)	(0.008)
Outward FDI	0.336***	0.018**	0.126***
	(0.030)	(0.008)	(0.007)
ln Age	0.023*	-0.085***	-0.128***
	(0.013)	(0.004)	(0.004)
Single-Plant Firm	-0.520***	-0.465***	-0.389***
	(0.032)	(0.018)	(0.019)
Multi-Region Firm	0.282***	0.391***	0.684***
	(0.032)	(0.014)	(0.016)
ln Herfindahl Index	0.054***	-0.104***	-0.154***
	(0.015)	(0.004)	(0.004)
ln Diversification	-0.091	-0.079***	-0.084***
	(0.056)	(0.028)	(0.027)
ln Agglomeration	0.033***	-0.005*	0.015***
	(0.006)	(0.003)	(0.003)
Low R&D	0.392***	0.003	0.692***
	(0.123)	(0.122)	(0.142)
R&D	0.527***	0.166***	0.460***
	(0.034)	(0.030)	(0.050)
Assisted Area	-0.076***	-0.049***	-0.036***
	(0.024)	(0.009)	(0.008)
2012 Dummy	-0.041**	-0.040***	-0.008
	(0.020)	(0.007)	(0.006)
Region Dummies	Yes	Yes	Yes
City Dummies	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes
Pseudo R^2	0.230	0.241	0.098
Observations	27,168	189,135	204,040

*/**/*** denotes significance at the 10%/5%/1% respectively. Standard errors in parenthesis.

Dependent variable takes the value of one if plant is engaged in either exporting or importing in and zero otherwise

Source: ARD/AFDI/BERD

Table A2: Estimates of Production Function (extended equation 1), UK, 2011-12

	Unmatched				Matched		
	Manufacturing	Services	Wholesale & Retail	SIC 90-93	Manufacturing	Services	Wholesale & Retail
ln Intermediate Inputs	0.614***	0.525***	0.764***	0.733***	0.559***	0.531***	0.765***
	(0.003)	(0.001)	(0.001)	(0.003)	(0.005)	(0.001)	(0.001)
ln Employment	0.333***	0.450***	0.221***	0.208***	0.395***	0.430***	0.232***
	(0.004)	(0.001)	(0.001)	(0.004)	(0.008)	(0.002)	(0.002)
ln Capital	0.044***	0.056***	0.018***	0.007***	0.049***	0.067***	0.015***
	(0.002)	(0.001)	(0.001)	(0.003)	(0.004)	(0.001)	(0.001)
Foreign-Owned	0.038***	0.046***	0.036***	0.255***	0.065***	0.030***	0.053***
	(0.008)	(0.003)	(0.002)	(0.012)	(0.018)	(0.004)	(0.003)
Outward FDI	0.053***	0.119***	-0.046***	0.310***	0.108***	0.143***	-0.027***
	(0.009)	(0.003)	(0.002)	(0.010)	(0.021)	(0.004)	(0.003)
ln Age	-0.052***	-0.048***	-0.031***	-0.001	-0.076***	-0.057***	-0.019***
	(0.004)	(0.002)	(0.001)	(0.005)	(0.008)	(0.002)	(0.002)
Single-Plant Firm	0.015	0.158***	0.033***	0.335***	-0.011	0.144***	0.063***
	(0.011)	(0.006)	(0.004)	(0.016)	(0.019)	(0.009)	(0.006)
Multi-Region Firm	0.058***	0.005	-0.022***	0.090***	0.082***	0.043***	-0.034***
	(0.010)	(0.005)	(0.004)	(0.013)	(0.020)	(0.007)	(0.005)
ln Herfindahl Index	-0.011**	0.007***	0.004***	0.032***	-0.045***	-0.002	-0.004***
	(0.005)	(0.002)	(0.001)	(0.005)	(0.010)	(0.002)	(0.001)
ln Diversification	-0.167***	-0.054***	-0.022***	-0.369***	-0.279***	-0.110***	-0.033***
	(0.017)	(0.010)	(0.005)	(0.024)	(0.035)	(0.014)	(0.009)
ln Agglomeration	0.067***	0.018***	0.009***	0.079***	0.084***	0.019***	0.009***
	(0.002)	(0.001)	(0.001)	(0.003)	(0.004)	(0.001)	(0.001)
Low R&D	-0.069*	0.011	0.114***	0.041	-0.175**	0.074	0.128***
	(0.038)	(0.042)	(0.026)	(0.145)	(0.076)	(0.062)	(0.048)
R&D	-0.014	0.085***	0.117***	0.449***	0.025	0.075***	0.087***
	(0.009)	(0.011)	(0.009)	(0.045)	(0.023)	(0.015)	(0.016)
Assisted Area	-0.015**	-0.015***	-0.005***	0.003	-0.011	-0.018***	-0.008***
	(0.007)	(0.003)	(0.002)	(0.008)	(0.015)	(0.005)	(0.003)
2012 Dummy	-0.006	0.042***	-0.012***	0.015**	-0.005	0.044***	-0.032***
	(0.006)	(0.002)	(0.001)	(0.006)	(0.013)	-0.057***	(0.002)
Export & Import Dummies[a]	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.955	0.933	0.969	0.899	0.929	0.927	0.960
Observations	27,618	189,135	204,040	44,480	8,866	91,984	95,970

*/**/*** denotes significance at the 10%/5%/1% respectively. Standard errors in parenthesis.

[a] Coefficient estimates and standard errors for export and import dummies are presented in Table 4.

Source: ARD/AFDI/BERD