Productivity and International Trade: Firm Level Evidence from a Small Open Economy

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Abstract: This paper presents a comprehensive description and analysis of the international trading activities of firms based on novel and detailed Swedish data. We provide robust evidence of selection operating from market to market which is consistent with that low productive firms are confined to markets with low productivity thresholds. We further show that selection also applies to the number of products traded. There is a substantial heterogeneity among exporters and importers in terms of the number of markets they trade with and in terms of the number of products they trade. Productivity premiums increase in the number of markets and the number of products traded, respectively. Firms that both export and import (i.e. two-way traders) are more productive than firms that only export or only import. This finding can be explained by that two-way traders are deeply engaged in the international division of labor and employ inputs based on frontier knowledge and technology in their production process, which increase their productivity and success on export markets. JEL no. F23, F14, D21, D24
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1 Introduction

Since the seminal work by Bernard and Jensen (1995) a series of papers on how different characteristics of individual firms affect their export activities have emerged (see Wagner (2007), Greenaway and Kneller (2007a), Tybout (2003) for surveys). Several studies from different countries show

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that exporters are larger, more productive and have higher skill and capital intensity.[1] In short, firms engaged in international trade show better performance than firms operating solely on domestic markets.

Although the literature is vast the current knowledge about the relationship between firms' participation in international markets and other firm characteristics is based on quite limited information. First, the bulk of papers on selection on export markets rely on export indicators in the form of exporter dummy variables or aggregate figures on total exports. The heterogeneity among exporters in terms of the geographical scope and number of products that firms trade is typically not analyzed.[2] Yet, Eaton et al. (2004) remark that such data are necessary to unravel the nature of entry costs and to what extent they differ among markets. Existing evidence is based on data from very few countries, notably the United States (Bernard et al. 2007) and France (Eaton et al. 2004). Second, the majority of studies are restricted to exports. Little is known about firms' import behavior though it constitutes a significant part of firms' trade. Imports are particularly interesting in view of the literature on international technology diffusion (Keller 2004; Acharya and Keller 2007). This literature advances imports of capital goods as a channel for knowledge and technology diffusion which boosts sector-wide productivity. Such findings imply that the productivity level in sectors is linked to the import behavior of firms in the sectors, warranting studies of firm characteristics and import behavior.

This paper contributes to the literature by presenting a comprehensive analysis of the international trading activities of Swedish firms. The data material used in the paper provides detailed information on the characteristics of each firm and how much each firm exports to and imports from each and every market. As a small open economy with a limited domestic market and adjacent countries (with similar language and culture) to which Swedish firms presumably face low entry costs (Andersson 2007; Johansson and Westin 1994), Sweden constitutes an interesting case. Our regression analyses are based on over 50,000 firm level observations over eight years (1997–2004). Controlling for an extensive set of firm attributes, we estimate productivity premiums using various indicators of firms' participation in

[1] These findings have inter alia inspired novel perspectives on the relationship between trade and aggregate productivity. Melitz (2003) introduces heterogeneous firms (marginal cost heterogeneity) in the general Dixit and Stiglitz (1977) framework and shows how exposure to trade leads to reallocations towards firms with high productivity.

[2] There are simply few data sets that provide the pertinent information.

international trade. Besides the usual controls, the data allow us to control for four different ownership structures: (i) non-affiliate (independent) firm, (ii) domestic corporation, (iii) domestic multinational and (iv) foreign multinational. We also extend the analysis and test for productivity differences between firms trading different number of products and trading with different number of markets.

The remainder of the paper is organized in the following fashion: Section 2 presents our theoretical framework. In Section 3 we present our data and provide a set of descriptive statistics which are compared with data from the United States and France. Section 4 describes and motivates the estimation methodologies and presents the results of the estimations. Summary and concluding remarks are presented in Section 5.

2 Productivity, Selection and International Trade

It is a stylized fact that exporting firms exhibit better performance than non-exporting ones. Two alternative but not mutually exclusive explanations for the observed differences between exporters and non-exporters have been advanced (Wagner 2007). The first is that the most productive firms self-select into foreign markets because they are in a better position to recover sunk costs associated with foreign sales. Such a self-selection hypothesis has been suggested by Clerides et al. (1998), Bernard and Jensen (1999) and Aw et al. (1998). The second is that firms active on international markets acquire knowledge and technology such that exporting activities have positive feedback effects on firms' knowledge and technology accumulation. Although there are studies pointing to 'learning-by-exporting'[3] the predominant finding in the literature is self-selection, i.e., ex ante productivity advantages (Bernard et al. 2007; Arnold and Hussinger 2005). Hence, within-industry variations in export participation across firms are explained by a combination of sunk costs of entry on international markets and heterogeneity in the underlying characteristics of firms (Greenaway and Kneller 2007a). Whilst the empirical literature accounts for several firm characteristics, the theoretical literature focuses exclusively on productivity. In view of the weak evidence for 'learning-by-exporting' virtually

[3] See, e.g., Castellani (2002), Castellani and Zanfei (2003), Criscuolo et al. (2004), Hansson and Lundin (2004), Greenaway and Kneller (2007b).

all theoretical models incorporate self-selection, such that exports require ex ante productivity advantages.[4]

Alongside new empirical evidence of heterogeneity among exporters in terms of the geographical scope of firms' exports, models of exports with asymmetric countries and asymmetric sunk costs of entry have been developed (see e.g. Chaney (2008) and Helpman et al. (2007)). In such models self-selection naturally occurs from market to market. Firms will enter all markets whose productivity threshold is lower than their own productivity level. Because of this, firms enter markets according to a hierarchy where firms with low productivity serve a limited number of markets of low order, i.e., low productivity thresholds, whereas firms with higher productivity can export to a larger number of markets.

There are several reasons why productivity thresholds vary across markets. Obvious rationales are cross-country variations in market size and variations in transport costs between country pairs.[5] Sunk costs of entry emanating from search processes for potential customers or suppliers, inspection of goods, negotiation and contract formulation, etc. are also likely to be market-specific and depend on the familiarity and affinity with the foreign market in question (Andersson 2007; Johansson and Westin 1994). If productivity thresholds among markets differ substantially and certain destinations are associated with low productivity thresholds, differences among firms which export to different destinations can potentially be much larger than overall differences between non-exporters and exporters. However, there is only limited evidence of productivity differences among firms exporting to different numbers of markets.

The existing literature on characteristics of individual firms and international trade is primarily concerned with exports. Imports are seldom analyzed and discussed. There are strong arguments in favor of a causality going from imports to productivity, implying that import activity can stimulate exports.[6] By importing an individual firm can exploit global spe-

[4] Bernard et al. (2003) present a model that builds on Eaton and Kortum (2002) with Ricardian differences in technological efficiency between firms. Melitz (2003) develops a dynamic monopolistic competition model with heterogeneous firms and sunk costs of exporting, and derives intra-industry reallocation effects of trade.

[5] Larger markets have lower productivity thresholds, because sales are larger in larger markets. All else equal, higher transport costs require higher productivity for sufficient volume of sales.

[6] Based standard transaction-costs theory it could also be argued that there are also sunk costs associated with imports. An importing firm has by definition established exchange agreements with foreign suppliers and transactions-cost theory suggest suggests that the

cialization and employ inputs from the forefront of knowledge and technology. The literature on international technology diffusion (surveyed in Keller (2004)) advances imports as an important vehicle for knowledge and technology transfers. The conceptual framework for this literature is derived from R&D-based models of growth and trade in which technology and knowledge is embodied in differentiated intermediate capital goods.[7] The empirical analyses in Keller (2002), Acharya and Keller (2007) and Lööf (2008) provide recent evidence that imports of intermediate capital goods from foreign countries are a source of domestic firms' productivity. In addition, an import strategy can also allow the firm to focus resources and specialize on activities where it has particular strengths.

In the subsequent section we present a comprehensive description of Swedish firms' participation in international trade. We estimate export and import productivity premiums using various indicators of firms' participation in international trade controlling for potential endogeneity between productivity and international trade activities. We also test for productivity differences between firms trading different number of products and trading with different number of markets and contrast the findings to models based on heterogeneous firms and asymmetric countries separated by asymmetric trade barriers.

3 Swedish Firms in International Trade

3.1 Data

The empirical analysis presented in this paper is based on data material which describes Swedish firms' export and import activities on a yearly basis between 1997 and 2007. Four sources of data have been matched based on a unique identification number of each firm. All data originate from the Swedish customs office and Statistics Sweden. In all data sources a firm is defined as a legal entity. The first set of data provides information on the

establishment of such agreements is associated with sunk costs (Williamson 1979). An exchange agreement is typically preceded by a search process for potential suppliers, inspection of goods, negotiation and contract formulation, etc. These activities are associated with costs that are irrevocably committed, i.e., sunk.

[7] See, e.g., Romer (1990), Grossman and Helpman (1991), Rivera-Batiz and Romer (1991), Kortum (1997), Eaton and Kortum (1999, 2002).

how much each firm is exporting and importing to and from each country by product per year. Products are distinguished from each other based on an 8-digit classification code according to the combined nomenclature (CN). Exports and imports by product, country and year are measured in value and volume (kilogram). The second set of data contains balance-sheet information for each and every firm and includes information on employment, value added, sales, gross investments, short- and long-run debts, etc. The third data source is the Swedish employment database (RAMS) which provides information on the education structure of each firm's employees. The fourth data source is a database of the ownership structure of firms. These data provide information on whether a firm is an independent firm or belongs to a domestic corporation, a domestic multinational or a foreign multinational.

In the subsequent presentations we provide data based on all firms with at least one employee as well as data covering only firms with at least 10 employees. The reason for this is twofold. First, most existing papers only have information on firms with at least 10 employees. Comparison with earlier studies is thus easier for the reader if we present separate figures. Second, the quality of the balance-sheet information is better for larger firms.

We limit the present study to only cover firms in the manufacturing sector (NACE 15–36). Including all firms with at least one employee we created an unbalanced panel of over 197,000 firm level observations from the time period 1997–2004. When we restrict our analysis to firms with at least 10 employees we get an unbalanced panel of over 56,000 firm level observations. The regression analysis presented in Section 5 is based on the latter panel, but results on the larger panel is available form the authors upon request.

3.2 Swedish Firm's Participation in International Trade

The Swedish economy is an interesting case. The domestic market is small and Sweden has several adjacent countries that share many characteristics with Sweden, and to which Swedish firms presumably face low entry costs. Theory suggests that the combination of scale economies in production, limited domestic market and proximity to countries for which sunk costs of entry are presumably low imply relatively high participation rates in international trade.

Table 1: *Share of Firms That Are and Are Not Engaged in International Trade in 2004 (percent)*

	Fraction of firms 2004	
	≥ 10	*≥ 1*
Non-trading firm	24	60
Exporter	71	36
Importer	60	27
Exporter and importer	55	22
Importer (no exports)	5	5
Exporter (no imports)	16	13
Trading firms (exporter, importer or both)	76	40

Note: ≥ 10 denotes firms with at least 10 employees and ≥ 1 firms with at least one employee, i.e., all firms in Sweden (excl. single-person firms). The first group comprises 6,829 firms and the second 24,368 in 2004. Only firms in the manufacturing sector (NACE 15–36).

Table 1 presents the fraction of Swedish firms with at least 1 and 10 employees, respectively, engaged in international trade.[8] Larger firms have higher participation rates (a typical finding in the literature). However, the ordering of the figures in the table remains whether we study all firms or restrict attention to firms with less than 10 employees. The overall participation rate, measured as the fraction of firms that export, import or are engaged in both, amounts to 76 percent among firms with at least 10 employees and 40 percent across all firms. Moreover, the fraction of firms that export is 71 and 36 percent, respectively. Exporting is a more frequent phenomenon than importing, though the majority of exporters also import (55 and 22 percent).

Compared to the stylized facts concerning the United States reported in Bernard et al. (2007), Swedish firms have higher participation rates. That data from Bernard et al. (2007) for 1997 show that 27 percent of US manufacturing firms are exporters whereas 14 percent are importers.[9]

[8] Note that our data only cover direct exports and imports. Small firms can indirectly export through their role as suppliers and subcontractors to large firms. Similarly, firms that do not import directly can use imports indirectly by buying from trading companies in Sweden. The figures presented in Table 1 can thus underestimate the degree of internationalization.

[9] These figures are based on firms that appear in two different sets of data (see Bernard et al. (2007) for details).

About 11 percent of the firms are concurrently involved in both export and import activities. Although absolute participation rates are lower in the United States, exporting is more common than importing, which in turn is more common than engaging in both exports and imports.

Export participation varies substantially across industries. Table 2 presents export participation and exports as a fraction of sales across Swedish

Table 2: *Export Participation and Exports As a Fraction of Sales across Swedish Manufacturing Industries in 2004 (percent)*

	Share of firms that export		Export as a fraction of sales[a]		Export as a fraction of sales[b]	
	≥ 10	≥ 1	≥ 10	≥ 1	≥ 10	≥ 1
Pulp and paper	93	75	33	22	61	60
Petroleum and chemical	93	67	40	23	62	62
Plastic and rubber	92	59	25	12	37	34
Non-metallic mineral	92	37	17	7	17	16
Textiles and apparel leather	90	47	30	10	55	47
Transportation	81	46	23	10	43	42
Furniture and related products	81	41	17	7	25	22
Computers and electronic	79	43	27	11	60	58
Machinery and equipment	78	46	29	13	43	42
Wood products	68	27	19	6	35	32
Fabricated metal products	62	27	11	4	26	22
Printing	61	25	3	1	3	3
Basic metal	59	61	37	21	63	62
Food and beverages	43	20	7	3	13	13
Aggregate manufacturing	71	36	19	7	43	41

[a] Averages across firms. — [b] Total industry exports divided by total industry sales.
Note: ≥ 10 denotes firms with at least 10 employees and ≥ 1 firms with at least one employee, i.e., all firms in Sweden (excl. single-person firms). The first group comprises 6,829 firms and the second 24,368 in 2004. Only firms in the manufacturing sector (NACE 15–36).

industries in 2004.[10] The third column reports the average share of export in sales across firms, i.e., an unweighted average, whereas the fourth column reports the same fraction based on industry totals. Export participation ranges from 75 percent in *Pulp and paper* to 20 percent in *Food and beverages* when all firms are considered. The corresponding figures for firms with at least 10 employees are 93 and 43 percent, respectively.

Firms typically export a small fraction of their sales. The average exports share in manufacturing is 7 percent across all firms and 19 percent across firms with at least 10 employees. Even in sectors with high participation rates, firms export a relatively small share of their total sales. For instance, in *Pulp and paper* where 75 percent of all firms export the average firm exports 20 percent of its sales. Interestingly these figures correspond to US data. Bernard et al. (2007) show that the average exports share of manufacturing firms in the US amounts to 14 percent. Despite a higher overall export participation rate by Swedish firms, the average share of exports in total sales is lower than in the United States when all firms are considered. This pattern is consistent with that Swedish manufactures face low sunk costs of entry to certain markets, such as other Scandinavian countries and the Baltic States. Low sunk costs of entry can be recouped with low export sales volumes.

Table 2 also illustrates that when exports shares are computed based on industry totals the picture changes. About 40 percent of total manufacturing sales are shipped to foreign markets. The discrepancy between the average based on industry totals and the average across firms illustrate strong within-industry heterogeneity across firms in terms of exports shares. Such heterogeneity can be explained by the presence of a small number of large multinationals with established trade networks to foreign markets.

Table 3 presents the ownership structure of Swedish firms in 2004. Looking first at the sample of all firms, the largest group is non-affiliate firms (69 percent) followed by domestic firms belonging to a group with only domestic affiliates, i.e., a domestic corporation (19 percent). 12 percent of all Swedish firms belong to a multinational. If the sample is restricted to firms with at least 10 employees, the categories "non-affiliated", "domestic corporation" and "multinational" have roughly the same number of firms.

Table 4 presents the distribution of exporting firms according to the number of export products and the number of export destinations.

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[10] It is evident in the table that exports as a fraction of total sales is about 40 percent. The ratio of exports to manufacturing value added is vastly higher.

Table 3: *Distribution of Firms across Ownership Structure in Sweden, 2004 (percent)*

	Fraction of firms by ownership structure 2004	
	≥ 10	*≥ 1*
Non-affiliate firm	33	69
Domestic corporation	33	19
Domestic multinational	19	7
Foreign multinational	15	5

Note: ≥ 10 denotes firms with at least 10 employees and ≥ 1 firms with at least one employee, i.e., all firms in Sweden (excl. single-person firms). The first group comprises 6,829 firms and the second 24,368 in 2004. Only firms in the manufacturing sector (NACE 15–36).

Table 4: *Distribution of Swedish Exporting Firms across Number of Products and Number of Destinations*

	Number of products		*Number of destinations*	
	≥ 10	*≥ 1*	*≥ 10*	*≥ 1*
1	13	24	23	37
2	11	15	10	13
3	9	11	6	7
4	7	7	5	5
5+	59	43	56	38

Note: Data are from 2004. ≥ 10 denotes firms with at least 10 employees and ≥ 1 firms with at least one employee, i.e., all firms in Sweden (excl. single-person firms). The first group comprises 6,829 firms and the second 24,368 in 2004. Only firms in the manufacturing sector (NACE 15–36).

Among firms with at least 10 employees in Sweden, 59 percent export at least five products and 56 percent export to at least five destination countries. This share is substantially higher then the shares reported by Bernard et al. (2007) for the United States where the shares are 26 and 14 percent respectively. The high shares for Sweden reflect its status as a small open economy which faces relatively low sunk costs of entry to a number of adjacent countries.

Figures 1a and 1b illustrate a substantial heterogeneity among exporting and importing firms in terms of the number of destination markets (countries) they trade with. The number of firms decline quite smoothly as

Figure 1a: *Distribution of Swedish Manufacturing Firms According to the Number of Export Destination Markets (each dot represents the number of firms that export to a given number of markets)*

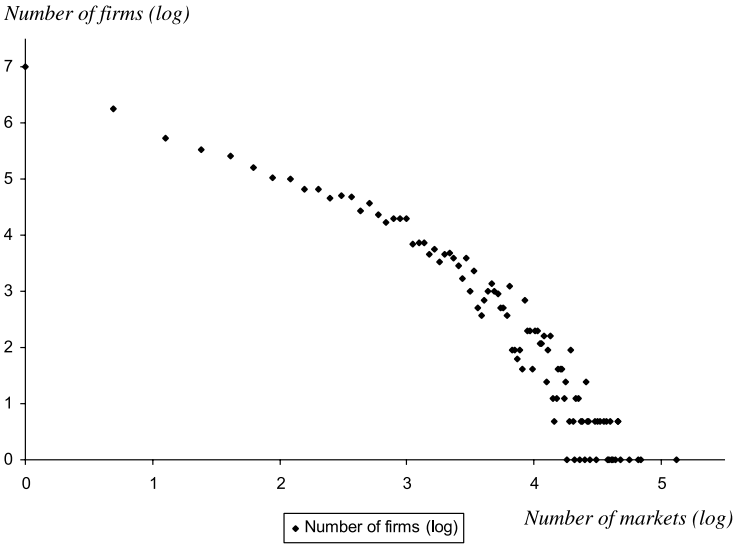
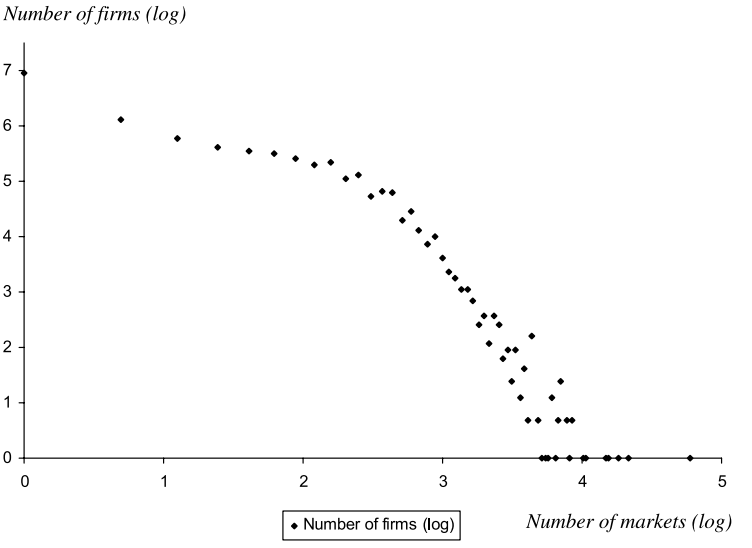


Figure 1b: *Distribution of Swedish Manufacturing Firms According to the Number of Import Origin Markets (each dot represents the number of firms that import from a given number of markets)*



the number markets increases. Similar results are reported by Eaton et al. (2004) on French data.

Export premia for Swedish firms are shown in Table 5. The first set of results (column (1)) reports the association between a dummy variable indicating whether or not a firm is exporting and 6 different dependent variables. The coefficients are from simple ordinary least squares (OLS) regressions without any other independent variables than the one noted in the relevant row. The second set of results (column (2)) includes industry dummies in the OLS regression, and the third set of results (column (3)) adds the log of firm size.

Table 5: *Exporter Premiums in Swedish Firms*

Dependent variable	(1)		(2)		(3)	
	≥ 10	≥ 1	≥ 10	≥ 1	≥ 10	≥ 1
Employment (log)	0.74	1.52	0.69	1.52	—	—
Sales (log)	1.15	2.03	1.08	2.21	0.33	0.42
Labor productivity (log)	0.16	0.31	0.14	0.30	0.10	0.14
Wage per worker (log)	0.08	0.39	0.06	0.39	0.03	0.04
Capital per worker (log)	0.36	1.15	0.39	1.20	0.23	0.33
Skill per worker (log)	0.05	1.83	0.04	1.79	0.02	0.77
Additional contros	None		Industry fixed effects		Industry fixed effects and employment (log)	

Note: Data are from 2004. ≥ 10 denotes firms with at least 10 employees and ≥ 1 firms with at least one employee, i.e., all firms in Sweden (excl. single-person firms). The first group comprises 6,829 firms and the second 24,368 in 2004. Only firms in the manufacturing sector (NACE 15–36). We have replicated the Bernard et al. (2007) estimation using Swedish data. All results are based on OLS regressions. Column (1) reports the association between a dummy variable indicating whether or not a firm is exporting and 6 different dependent variables. The results show that the exporter premium on manufacturing is 0.74 for the Swedish firms with at least 10 employees and 1.52 when all firms are included. The exporter premium is on sales is 1.15 and 2.03, respectively, and so on. Columns (2) and (3) include industry dummies plus control for (log) firm size. Skill is the fraction of workers with a university education in Sweden. Capital is gross investment per employee. All results are significant at the 1 percent level.

The first conclusion from the table is that in accordance with numerous previous studies, there are significant differences between exporters and non-exporters in Sweden that persist when controlling for industry fixed effects and size. This holds in the case of all firms as well as in that of firms with at least 10 employees. Exporters are larger in terms of both employment and sales, have higher labor productivity and wages, higher capital and skill intensity. The second conclusion is that differences between exporters and non-exporters are in general much larger when studying all firms compared to firms with at least 10 employees.

Since Swedish firms arguably face low sunk entry costs when selling to adjacent countries it can be expected that exporter premiums are relatively lower in Sweden than in the United States. However, a comparison with the results reported by Bernard et al. (2007) shows that the export premium on labor productivity is surprisingly similar in the United States and Sweden (around 0.10).

In the subsequent sections we estimate export premiums on the Swedish data using various indicators of firms' export participation, controlling for an extensive set of firm characteristics.

4 Productivity and International Trade

4.1 Empirical Model and Estimation Strategy

In the regression analysis we restrict attention to firms with at least 10 employees. This leaves us with 56,957 observations. We first conduct seven regressions where the sensitivity of labor productivity with respect to different trade variables is estimated by employing the random effects specification of the generalized least square (GLS) estimator. In these estimations firm characteristics, such as human and physical capital, corporate ownership structure and firm size are controlled for along with industry- and time-specific effects.

The general model can be written as:

$$y_{it} = \alpha_{it} + x'_{it}\beta_{it} + u_{it,} \qquad i =, ..., N, t = 1, ..., T, \tag{1}$$

where y_{it} is a scalar dependent variable, x_{it} is a $K \times 1$ vector of independent variables, u_{it} is a scalar disturbance term, i indexes firms in a cross section, and t indexes time. In order to estimate this general model, further restrictions needs to be placed on the extent to which α_{it} and β_{it} vary across

time and across firms. We therefore specify the individual-specific effects model, which allows each cross sectional unit to have a different intercept term:

$$y_{it} = \alpha_i + x'_{it}\beta + \varepsilon_{it}, \tag{2}$$

where y_{it} denotes log value added per employee, or labor productivity and ε_{it} is iid over firms and time. Motivated by the test statistics, we will first apply the variant of (2) that assumes that the unobservable individual effects α_i are random variables that are distributed independently of the independent variables.

In the regressions, we use the following trade variables:

- a dummy variable indicating whether or not the firm is an exporter and an importer, respectively
- log of trade (export or import) value per employee
- log of trade (export or import) volume per employee
- a set of dummy variables for the number of traded products according to four different classes
- a set of dummy variables for the number of countries with which the firm trade according to four classes.

In addition to observations of trading activities, we control for a large set of firm attributes that the theoretical and empirical literature suggests will influence labor productivity, i.e., human capital, physical capital, firm size and corporate ownership structure. Human capital is measured as the fraction of the workers with a university degree and the physical capital variables are measured as the log of gross investment per employee. The corporate ownership structure is defined according to the four different categories described in Table 3. In order to control for industry effects and time trend we include 14 industry indicators and 8 year dummies in the model. Descriptive statistics for the variables in (3) over the whole period (1997–2004) are presented in Table A1 and correlations between the variables are presented in Table A2 in the Appendix.

To deal with possible simultaneity we also apply the instrumental variable estimator. To derive consistent estimates of (3) in the presence of endogeneity we must find an instrumental variable that is uncorrelated with the disturbances and highly correlated with the endogenous regressor. We follow Baum (2006) and instrument the trade variables with lags and use robust regressions that allow the two-step generalized method of moments (GMM) estimator to compute efficient estimates. Test statistics

inform us that the second and third lag of the trade variable in general fulfills this requirement. In some case we have to extend the lag structure to the fourth lag. The drawback here is that the observations in our unbalanced panel are reduced to 26,640–19,542 observations depending on the lag structure.

4.2 Results

This section presents the estimated productivity premiums for firms engaged in international trade. Among the group of manufacturing firms in Sweden with 10 or more employees, Section 3 reported that 76 percent of the firms can be classified as trading firms. They are exporters, importers or both. The typical trading firm is an exporter and also an importer. Consequently, the Table A2 shows that imports and exports are highly correlated (the correlation coefficient is 0.5). The large degree of integration between both trade variables makes it challenging to estimate their individual effect on labor productivity.

One way to work around this type of simultaneity is to instrument imports with a variable that is correlated with trade and uncorrelated with the error term. However, such a variable is not easy to find. A less exhaustive method is simply to examine the difference in productivity between non-trading firms and only importers and only exporters, respectively. At least, this methodology will provide some indication whether there is both an export and import productivity premium. As discussed in Section 2 of the paper, there are arguments in favor of both methods.

Table 6 presents the results from the basic random effects model including dummy variables for different categories of trading firms with non-trading firms as a reference group. First column displays results for all manufacturing firms in Sweden with 10 or more employees. Second column shows the coefficient estimates for a subset with only small firms (10–25 employees). Controlling for human capital, physical capital, firm size, corporate ownership structure, industry classification and time trend, Row 2 suggests the presence of an export premium for firms that only export. The size of the estimate is about 0.04 and highly significant for both samples. Looking then at only-importers, Row 3 reports a similar result. In comparison to a non-trading firm, a typical firm that only imports has a trade productivity premium with an order of magnitude close to 0.04. The results for both samples also show that the productivity premium is largest for firms that both import and export.

Table 6: *The Relationship between Log Value Added per Employee and Different Trade Characteristics*[a]

	Firms with 10 employees or more (56,607 observations)	Firms with 10–25 employees (30,437 observations)
Trade dummies		
Non-trading firms	Reference	Reference
Only exports	0.042 (0.006)***	0.036 (0.006)***
Only imports	0.038 (0.007)***	0.037 (0.008)***
Exports and imports	0.080 (0.006)***	0.076 (0.007)***
Control variables		
Human capital[b]	0.121 (0.020)***	0.075 (0.025)***
Log physical capital	0.035 (0.001)***	0.030 (0.001)***
Log employment	−0.005 (0.003)	−0.094 (0.010)***
Non-affiliate firms	Reference	Reference
Domestic MNE	0.034 (0.007)***	0.019 (0.012)
Foreign MNE	0.048 (0.008)***	0.058 (0.015)***
Domestic uninational	0.013 (0.005)**	0.016 (0.007)**
Industry dummies	Included	Included
Year dummies	Included	Included

[a] Manufacturing firms in Sweden 1997–2004. GLS Random effects model. — [b] Employees with a university education as a fraction of total employment.
Note: The table displays the elasticity of log value added per employee (labor productivity) with respect to (1) international trade (dummy variables) and covariates. *** and ** denote significance at the level of 1 and 5 percent, respectively. Standard errors in parentheses.

The estimates in Table 6 thus show that there is both a separate export and import productivity premium, and that firms that both export and import (i.e., two-way traders) have significantly higher productivity than all other firm types. How can this pattern be explained? The export productivity premium can be explained by the literature emphasizing self-selection on export markets, which states that causality goes from productivity to exports. Regarding the import productivity premium, there are arguments in the literature that the causality goes in the opposite way.[11] Imports can be described as inputs in a firm's production process. By importing an individual firm can exploit global specialization and employ inputs from the forefront of knowledge and technology. In addition, an import strategy can allow the firm to focus resources and specialize on activities where it

[11] The design of the empirical analysis here does not allow us to discriminate between alternative directions of causality.

has particular strengths. Both effects are likely to raise a firm's productivity. This pattern can also explain the significantly higher productivity of firms that both export and import. These firms are likely to be highly globalized firms that are part of international value chains and are deeply engaged in the international division of labor. This allows for efficiency gains that increase their productivity.

We will now turn to estimating productivity differences between firms that export to different number of markets and export different number of products, respectively. Table 7 presents the regression estimates from the GLS estimator and the two-step GMM procedure for models where (log) labor productivity is regressed on different indicators of firms' engagement

Table 7: *The Relationship between Log Value Added per Employee and Exports*

	GLS, RE[a]	GMM[b]
	56,607 obs.	26,640–19,542 obs.
1. Export dummy	0.049 (0.005)***	0.051 (0.008)*** L.3
2. Log export value per employee	0.022 (0.000)***	0.021 (0.001)*** L.3
3. Log export volume per employee	0.011 (0.000)***	0.011 (0.001)*** L.3
4. Number of export products		
0	Reference	—
1–3	0.040 (0.005)***	—
4–8	0.066 (0.006)***	—
9 or more	0.102 (0.007)***	—
0–7	—	Reference
8 or more	—	0.073 (0.012) *** L.4
5. Number of export destination		
0	Reference	—
1–4	0.041 (0.005)***	—
5–13	0.082 (0.007)***	—
13 or more	0.153 (0.008)***	—
0–7	—	Reference
8 or more	—	0.098 (0.008)***
Covariates	Included	Included

[a] GLS random effects model. — [b] Two-step GMM model.
Note: L.3 instrumented by 2–3 lags and using 26,640 observations, L.4 instrumented by the 2–4 lags and using 19,542 observations. Tables A3 and A4 present the complete results for the regression results summarized in Table 6. *** denote significance at the level of 1 percent.

in export activity. The two-step GMM estimator is applied in order to correct for potential endogeneity between exports and productivity. Estimated parameters for control variables as well as test statistics are reported in Table A3 and A4. In column (1) of Table 7 the GLS estimates are presented whereas column (2) shows the GMM-estimates. As a robustness check, Table 8 presents estimates for the same model but conducts separate estimations for firms that only export and firms that both export and import (i.e., two-way traders).

The results reported in Table 7 confirm the finding in Table 6 and several previous analyses: exporters are more productive. This holds irrespective of export indicator and model specification. All estimates are significant and both models (GLS and GMM) produce more or less identical results.

Row 1 in Table 7 reports the elasticity of labor productivity with respect to the dummy variable indicating whether or not the firm is engaged in export activities. On average, exporters have 5 percent higher labor productivity than non-exporters, which is consistent with a vast body of previous empirical findings based on firm level data. The results in Rows 2 and 3 indicate that the productivity premium of exporters is lower when the export-related explanatory variables are defined in terms of export intensity. A 1 percent increase in export value per employee predicts a productivity premium of 2 percent whereas a 1 percent increase in export quantity per employee suggests a modest productivity premium of 1 percent.

The coefficient estimates reported in Row 4 and down show that the export premium is increasing in the number of products that firms are exporting. A firm that exports 1–3 products has on average 4 percent higher labor productivity than a non-exporting firm whereas the typical firm that sells 4–8 products on foreign markets has a productivity that is 6.6 percent higher than the average firm that only operates on the domestic market. A firm whose foreign sales contain 9 or more products has a productivity premium over non-exporters of 10.2 percent. The GMM estimator (column (3)) gives similar results; firms that export 8 products or more have 7.3 percent higher labor productivity than firms exporting between 0 and 7 products.[12] This result is consistent with that the production of different products is associated with different levels of fixed costs and profitability for firms, such that low productive firms produce only few products associated with low levels of fixed costs.

[12] In order to specify the GMM estimation in an appropriate way the reference groups are not identical to those in the GLS estimation.

The estimated parameters associated with the export dummy variables for different destination countries show that the export premium for labor productivity is increasing in the number of countries which firms export to. According to the GLS estimates, productivity is 4 percent larger for firms that export to 1–4 countries compared to non-exporters. The same figure for firms exporting to 4–8 countries is 7 percent, whereas it is 15 percent for firms exporting to at least 13 countries. With GMM estimation we find that the average firm that trades with 8 or more countries has 10 percent higher labor productivity than a reference group consisting of firms with 0–7 export products. These results provide strong support for models of exports with asymmetric countries and asymmetric sunk costs of entry (as in e.g. Chaney (2008) and Helpman et al. (2007)).

Tables A3 and A4 show that the estimated parameters associated with the control variables are in line with expectations. Not surprisingly, human capital and physical capital are significantly correlated with labor productivity. Foreign-owned multinational enterprises (MNEs) have on average a higher productivity than domestic MNEs. MNEs have on average higher productivity than firms belonging to a domestic corporation and non-affiliated firms.

Are the results reported in Table 7 affected by distinguishing between firms that only export and firms that both export and import? As stated previously, the latter category of firms is more internationalized than the former and exploits global specialization by importing inputs that are used in their production process. Through efficiency gains they are likely to overcome the productivity thresholds associated with various export markets and export products. In view of this it is interesting to investigate whether we find a similar hierarchy in terms of productivity premiums for number of destinations and number of products between the two categories of firms. We therefore estimate the model in Table 7 separately for two categories of exporters: (i) firms that only export and (ii) firms that both export and import (i.e., two-way traders). Table 8 reports the results.

The results in Table 8 show that among firms that only export, those that export with higher intensity, measured as export value or volume per employee, have higher productivity. For two-way traders we find similar results but the magnitude of the estimated coefficients is significantly higher. It is also evident that firms that export a larger set of products and export to a larger set of destination markets have higher productivity. This holds for both types of firms. Among firms that only export, however, we do not find a significant parameter estimate for those firms exporting to 13 or

Table 8: *The Relationship between Log Value Added per Employee and Export for Two Different Categories of Exporters*[a]

	Only exporters	Importers and exporters
	7,643 observations	32,649 observations
1. Log export value per employee	0.007 (0.001)***	0.026 (0.001)***
2. Log export volume per employee	0.007 (0.001)***	0.021 (0.001)***
3. Number of export products		
1–3	Reference	Reference
4–8	0.019 (0.008)**	0.014 (0.006)**
9 or more	0.060 (0.019)***	0.046 (0.007)***
4. Number of export destinations		
1–4	Reference	Reference
5–12	0.046 (0.012)***	0.038 (0.007)***
13 or more	0.030 (0.025)	0.112 (0.009)***
Covariates	Included	Included

[a] Manufacturing firms in Sweden 1997–2004. GLS Random effects model.
Note: The table displays the elasticity of log value added per employee (labor productivity) with respect to log export per employee and covariates (equation 1), log export volume per employee (equation 2), number of export products (equation 3) and number of export destinations (equation 4) for only exporters and firms that are both exporters and importers. *** and ** denote significance at the level of 1 and 5 percent, respectively. Standard errors in parentheses.

more destinations. Inspection of the data reveals, however, that the firms in this category typically export few products to a limited set of markets. The number of observations for the dummy 13 or more destinations is too limited to make any strong inference of this result.

5 Summary and Conclusions

There is a growing preference in the study of international trade of shifting the attention from the aggregate and industry level to the firm and product level. This paper contributes to the existing firm level literature in two distinct respects. First, it adds to the still rare descriptive statistics on the heterogeneity among trading firms by contrasting new firm level data from Sweden—a small open economy—against data for the United States and France. Second, it conducts a rigorous analysis of a panel over eight years comprising over 56,000 firm level observations with extensive firm

characteristics, such as human capital, physical capital, corporate ownership structure, number of products each firm trades and the number of countries each firm trades with. It estimates export and import premiums, controlling for possible simultaneity between trade and productivity.

The analysis for Swedish firms has yielded a number of key results on firms' participation in international trade. While the fraction of firms engaged in international trade in Sweden is larger than in the United States, the export premium with respect to labor productivity and wages in the United States and Sweden is almost identical. The average share of exports in total sales across firms in the manufacturing sector is also roughly similar. Moreover, the Swedish and the US data show a similar heterogeneity among firms in terms of the number of markets they trade with and the number of products they trade.

By separating between firms that only export, only import and firms that both export and import (i.e., two-way traders), we find that export and import productivity premiums are significant and of similar magnitudes. There is a productivity premium for firms that only import, which is of similar magnitude as for firms that only export. The export productivity premium can be explained by the literature emphasizing self-selection on export markets, which states that causality goes from productivity to export. For the import productivity premium, there are arguments in the literature suggesting the causality goes in the opposite way. Imports can be described as inputs in a firm's production process. By importing an individual firm can exploit global specialization and employ inputs from the forefront of knowledge and technology. In addition, it can be argued that an import strategy allows the firm to focus resources and specialize on activities where it has particular strengths. Both effects can account for our findings. We also find that the trade premium is highest for firms that both export and import. We interpret this in the way that those firms are deeply engaged in the international division of labor and employ inputs based on frontier knowledge and technology in their production process, which increase their productivity and success on export markets.

Another finding is that productivity premiums increase in both number of markets and number of products traded. The export productivity of firms that export at least 9 products is more than double that of firms exporting 1–4 products. Similarly, the export productivity premium for firms exporting to at least 13 destinations is more than three times as large as that of firms exporting to 1–4 destinations. We find similar results among firms that only export and two-way traders.

Differences in productivity between firms that trade with different number of markets and different numbers of products are at least as large as those between trading and non-trading firms. Selection operates across markets and across products. Furthermore, there are marked differences in productivity between firms that are deeply engaged in the international division of labor and both export and import, and firms that only export or import, respectively.

Appendix

Table A1: *Summary Statistics: Swedish Manufacturing Firms with 10 or More Employees (1997–2004)*

	Mean	Std. Dev.	Min.	Max.
Nace code			15,111	36,630
Exporters as a fraction of firms	71	45	0	100
– Only exporter as a fraction of firms	13	34	0	100
– Exporters and importers as a fraction of firms	58	49	0	100
Importers as a fraction of firms	64	48	0	100
– Only importers as a fraction of firms	7	25	0	100
Export as a fraction of sales (average across firms)	18	26	0	100
Import as a fraction of sales (average across firms)	8	14	0	100
Number of export products among exporters	14	30	1	162
Number of export countries among exporters	12	16	1	168
Number of import products among importers	20	37	1	593
Number of import countries among importers	7	7	1	118
Employment, firms participating in international trade	109	497	10	23,321
Employment, firms not participating in intern. trade	22	57	10	3,824
Log labor productivity, 10,000 Euro, intern. trade	3.84	0.46	−5.19	8.19
Log labor productivity, 10,000 Euro, non-intern. trade	3.66	0.44	−4.19	7.51
Log gross investment/emp, 10,000 Euro, intern. trade	0.96	1.32	−7.02	8.86
Log gross investment/emp, non-intern. trade.	0.54	1.37	−5.02	5.74
University educated/employment, intern. trade	15	15	0	100
University educated/employment, non-intern. trade	10	14	0	100
Domestic non-affiliated firm	38			
Domestic multinational	19			
Foreign multinational	12			
Domestic uninational	31			

Table A1: *Continued*

	Mean	Std. Dev.	Min.	Max.
Firm size 10–25 employees	54			
Firm size 26–50	20			
Firm size 51–100	12			
Firm size 101–250	8			
Firm size 251 and more	6			

Note: Number of observation 56,957. Foreign MNE is a firm in Sweden which is owned by a foreign company by more than 50 percent.

Table A2: *Correlation Matrix (1997–2004)*

Log lab. prod.	1.00										
Exp. dummy	0.08	1.00									
Imp. dummy	0.08	0.47	1.00								
Log exp. val/emp.	0.21	0.32	0.30	1.00							
Log imp. val/emp.	0.18	0.31	0.24	0.50	1.00						
Log exp. vol/emp.	0.19	0.60	0.36	0.81	0.44	1.00					
Log imp. vol/emp.	0.17	0.39	0.55	0.50	0. 81	0.63	1.00				
No. of exp. prod.	0.13	0.17	0.15	0.30	0.29	0.19	0.19	1.00			
No. of imp. prod.	0.17	0.19	0.21	0.30	0.40	0.20	0.29	0.82	1.00		
No. of exp. countr.	0.24	0.29	0.26	0.56	0.37	0.42	0.32	0.61	0.57	1.00	
No. of imp. countr.	0.19	0.30	0.34	0.45	0.55	0.30	0.41	0.66	0.74	0.77	1.00

Note: Number of observations 56,607. All correlations are significant at the 1 percent level.

Table A3: *The Elasticity of Log Value Added per Employee with Respect to Export, 1997–2007 (generalized least square, random effects)*[a]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Export premia	0.049 (0.005)***	—	—	—	—	—	—
2. Log export value/emp.	—	0.022 (0.000)***	—	—	—	—	—
3. Log export volume/emp.	—	—	0.011 (0.000)***	—	—	—	—
4. Number of export products							
– 0 product	—	—	—	Reference	—	—	—
– 1–3 products	—	—	—	0.040 (0.005)***	—	—	—

Table A3: *Continued*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
– 4–8 products	—	—	—	0.066 (0.006)***	—	—	—
– 9 or more products	—	—	—	0.102 (0.007)***	—	—	—
5. Number of export dest.							
– 0 dest.	—	—	—	—	Reference	—	—
- 1–5 dest.	—	—	—	—	0.041 (0.005)***	—	—
- 5–13 dest.	—	—	—	—	0.082 (0.007)***	—	—
- 14 or more dest.	—	—	—	—	0.153 (0.008)***	—	—
6. Log (exp. value/product)/emp.	—	—	—	—	—	0.017 (0.000)***	—
7. Log (exp. value/dest.)/emp.	—	—	—	—	—	—	0.015 (0.000)***
Human capital [b]	0.127 (0.020)***	0.108 (0.020)***	0.127 (0.020)***	0.119 (0.020)***	0.094 (0.020)***	0.118 (0.020)***	0.121 (0.020)***
Log physical capital per emp.	0.036 (0.001)***	0.035 (0.001)***	0.036 (0.001)***	0.036 (0.001)***	0.036 (0.001)***	0.035 (0.001)***	0.035 (0.001)***
Non-affiliate firms	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Domestic MNE	0.034 (0.007)***	0.022 (0.007)***	0.025 (0.007)***	0.028 (0.007)***	0.023 (0.007)***	0.025 (0.007)***	0.026 (0.007)***
Foreign MNE	0.046 (0.008)***	0.031 (0.008)***	0.034 (0.008)***	0.040 (0.008)***	0.031 (0.008)***	0.035 (0.008)***	0.036 (0.008)***
Domestic uninational	0.013 (0.005)**	0.011 (0.005)**	0.011 (0.005)*	0.013 (0.005)**	0.012 (0.005)**	0.011 (0.005)**	0.011 (0.005)**
10–25 emp.	Reference	Reference	Reference	Reference	Reference	Reference	Reference
26–50 emp.	0.001 (0.005)	−0.004 (0.005)	−0.006 (0.005)	−0.003 (0.005)	−0.006 (0.005)	−0.009 (0.005)*	−0.0079 (0.005)
51–100 emp.	−0.008 (0.008)	−0.002 (0.008)	−0.025 (0.008)***	−0.021 (0.008)**	−0.037 (0.008)***	−0.033 (0.008)***	−0.033 (0.008)***
101–250 emp.	0.002 (0.010)	−0.002 (0.010)	−0.020 (0.010)**	−0.017 (0.011)	−0.056 (0.011)***	−0.034 (0.011)***	−0.030 (0.011)***
251 or more emp.	0.061 (0.014)***	0.032 (0.014)**	0.031 (0.014)**	0.034 (0.015)**	0.024 (0.015)**	0.009 (0.015)	0.013 (0.015)
Industry dummies	Included	Included	Included	Included	Included	Included	Included
Year dummies	Included	Included	Included	Included	Included	Included	Included

[a] Number of observations 56,607. — [b] Employees with a university education as a fraction of total employment.
Note: The table displays the elasticity of log value added per employee (labor productivity) with respect to (1) export (dummy variable), (2) log export value per employee, (3) log export volume per employee, (4) number of export product, (5) number of export destinations, (6) log export value per exported product and (7) log export value per export destination. *** and ** denote significance at the level of 1 and 5 percent, respectively.

Table A4: *The Elasticity of Log Value Added per Employee with Respect to Export, 1997–2007 (two-step GMM estimation)*[a]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Export premia	0.051 (0.008)***	—	—	—	—	—	—
2. Log export value/emp.	—	0.021 (0.001)***	—	—	—	—	—
3. Log export volume/emp.	—	—	0.011 (0.000)***	—	—	—	—
4. Number of export products							
– less than 8 products	—	—	—	Reference	—	—	—
– 8 or more products	—	—	—	0.080 (0.010)***	—	—	—
5. Number of export dest.							
– less than 8 dest.	—	—	—	—	Reference	—	—
– 8 or more dest.	—	—	—	—	0.073 (0.008)***	—	—
6. Log (exp. value/product)/emp.	—	—	—	—	—	0.015 (0.001)	—
7. Log (exp. countr./product)/emp.	—	—	—	—	—	—	0.014 (0.001)***
Human capital	0.469 (0.020)***	0.428 (0.028)***	0.470 (0.028)***	0.450 (0.029)***	0.459 (0.033)***	0.458 (0.0233)***	0.464 (0.033)***
Log physical capital/emp.	0.085 (0.002)***	0.081 (0.002)***	0.081 (0.002)***	0.085 (0.002)***	0.083 (0.002)	0.079 (0.002)***	0.080 (0.002)***
Non-affiliate firms	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Domestic MNE	0.082 (0.008)***	0.057 (0.008)***	0.063 (0.008)***	0.073 (0.008)***	0.073 (0.008)***	0.065 (0.008)***	0.067 (0.010)***
Foreign MNE	0.099 (0.009)***	0.070 (0.009)***	0.070 (0.009)***	0.089 (0.009)***	0.089 (0.009)***	0.079 (0.011)***	0.081 (0.011)***
Domestic uninational	0.028 (0.005)***	0.024 (0.005)***	0.023 (0.005)***	0.029 (0.005)***	0.034 (0.005)***	0.031 (0.005)***	0.031 (0.005)***
10–25 emp.	Reference	Reference	Reference	Reference	Reference	Reference	Reference
26–50 emp.	−0.024 (0.006)***	−0.034 (0.006)***	−0.035 (0.006)***	−0.027 (0.006)***	−0.025 (0.006)***	−0.037 (0.007)***	−0.035 (0.007)***
51–100 emp.	−0.016 (0.007)**	−0.035 (0.007)***	−0.035 (0.007)***	−0.027 (0.008)***	−0.027 (0.009)***	−0.042 (0.009)***	−0.038 (0.009)***
101–250 emp.	−0.010 (0.010)	−0.033 (0.010)***	−0.031 (0.010)***	−0.031 (0.011)***	−0.038 (0.013)***	−0.053 (0.012)***	−0.049 (0.012)***
251 or more emp.	0.075 (0.014)***	0.046 (0.014)***	0.053 (0.014)***	0.047 (0.014)***	0.056 (0.016)***	0.036 (0.016)**	0.039 (0.016)**
Industry dummies	Included	Included	Included	Included	Included	Included	Included
Year dummies	Included	Included	Included	Included	Included	Included	Included
Lag structure	L3	L3	L3	L.4	L4	L3	L4
Underidentification test	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Overidentification test	0.124	0.148	0.115	0.408	0.234	0.461	0.163

[a] Number of observations 19,542–26,640 depending on the lag structure of the instruments.

Note: The table displays the elasticity of log value added per employee (labor productivity) with respect to (1) export (dummy variable), (2) log export value per employee, (3) log export volume per employee, (4) number of export product, (5) number of export destinations, (6) log export value per exported product and (7) log export value

Table A4: *Continued*

per export destination. The underidentification test is Anderson canon corr. The null hypothesis is underidentification and a Chi-square P-value = 0.000 rejects the null hypothesis. L.3 instrumented by 2–3 lags and using 26,640 observations, L.4 instrumented by the 2–4 lags and using 19,542 observations. The overidentification test of the instruments is Hansen J Statistics. A Chi-square P-value above 0.10 rejects the hypothesis on overidentification. Thus, if the underidentification test is 0 or close to zero and the overidentification test is above 0.10 the test statistics is satisfactory. *** and ** denote significance at the level of 1 and 5 percent, respectively.

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