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Valerie Smeets and Frederic Warzynski

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Department of Economics and Business

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# Estimating productivity with multi-product firms, pricing heterogeneity and the role of international trade*

Valerie Smeets
Aarhus University †

Frederic Warzynski
Aarhus University‡

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**Abstract**

In this paper, we analyze the relationship between exports, imports and firm productivity. We use a rich product-firm-level dataset providing both revenue and quantities of all products for a large panel of Danish manufacturing firms over the period 1998-2008 and link it to firms' international trade transactions by product. We use our detailed product level information to compute a firm level deflator and avoid the criticism of biased estimates due to the use of industry level deflator. We find that both importing and exporting behaviours are strongly associated with productivity, but firms involved in both importing and exporting are the most productive. We also find evidence of a self-selection into importing and exporting but no learning effect. Finally, we try to distinguish between cost effect and product quality effect by analyzing the importance of the origin of imports and the destination of exports. We find that both imports from countries with abundant and cheap labor like China and from countries with similar level of development matter, although the mechanism through

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†email: vas@asb.dk

‡email: fwa@asb.dk

which productivity is affected is likely to be different. In addition, exporting to more distant OECD economies is more strongly associated to productivity than exporting to neighboring or other EU countries, especially when controlling for the price specific effect.

# 1 Introduction

A large literature has been devoted to explaining the productivity difference between firms involved in international trade and those only selling on the domestic market. Both import and export decisions have been shown to be associated with higher productivity. However, studies to date have largely ignored pricing heterogeneity in their analysis. Various papers have documented the bias arising from deflating sales with an industry level price index and suggested indirect methods to correct this problem (e.g. Klette and Griliches, 1996; Levinsohn and Melitz, 2001; De Loecker, 2007b). An alternative and more direct approach chosen recently by several authors has been to use price and quantity information at the product level (e.g. Foster, Haltiwanger and Syverson, 2008) or compute a firm specific index (Eslava et al., 2004). On the other hand, another line of research has investigated markup differences between exporters and non exporters (De Loecker and Warzynski, 2010) and strategic price setting behavior on different export markets (see e.g. Manova and Zhang, 2010; Simonovska, 2010). In this paper, we combine these two different approaches within the standard framework of productivity estimation.

We use a detailed sample of Danish manufacturing firms providing both values and quantities of domestic and international trade transactions to study the link between international trade and productivity. We exploit the

richness of this dataset to define a firm-specific price index and discuss the importance of pricing heterogeneity in our estimation. We then modify the standard Olley and Pakes (1996) and Ackerberg, Caves and Frazier (2007) methodologies to explicitly take into account the fact that firms' input choices is potentially affected by their international trade status (see the discussion in De Loecker, 2007; Ackerberg et al. 2007; and De Loecker and Warzynski, 2011).

We find that importing and exporting behaviours are strongly associated with higher productivity, but the effect of importing is larger in most industries. Firms involved in both importing and exporting are the most productive. We then investigate the mechanisms behind this effect and try to divide the import effect between access to cheaper intermediate goods, access to offshoring (imports of final goods) and access to high quality intermediates. Our findings suggest that all three are positively related to productivity, although through different channels. Our analysis also suggests that part of the international trade premium comes from different pricing strategy.

So far, only a few studies have jointly considered export and import behaviors and how the size of the premium depends on the origin or the destination. These factors are likely to be important in countries that offshore part of their production process to countries where labor is cheap and then re-import it, and possibly re-export it. It is also important when access to better intermediate inputs facilitates product upgrading and creates new export possibilities. Bas (2010) specifically looks at the relationship between import access and export behavior and finds that firms in industries with lower tariffs are more likely to become exporter and have an higher produc-

tivity premium, suggesting that access to foreign inputs facilitates export and productivity improvements. She does not distinguish between different channels in her empirical analysis. Recent papers (e.g. Muuls and Pisu, 2009; Castellani et al., 2009; Altomonte and Békés, 2009; McCann, 2009) also found that two-way traders were on average more productive than firms only importing or exporting; a few other papers have addressed the destination/origin specific effect of export/import behavior (e.g. Serti and Tomasi, 2010). But all these papers have largely ignored the pricing heterogeneity issue. Bas and Strauss-Kahn (2011) consider import prices as an explanation for the productivity premium to distinguish between a price effect and access to more variety or better quality. They find a limited effect of import price but a stronger effect of using more variety. However, they do not use domestic or export prices in their analysis, which is the key focus of this paper.

The structure of the paper is the following. We first discuss our methodology in section 2. We then describe our data in section 3. Section 4 shows our preliminary results, while we discuss potential extensions in section 5.

# 2 Methodology

We start by discussing how we compute our firm level price index using our detailed firm-product level price data. We then describe the production function estimation.

## 2.1 Computing the firm level deflator

To deal with pricing heterogeneity and multi-product firms, we follow Eslava et al. (2004) and construct a firm-level price index using detailed information about the price of each product on each market where it is sold.[1] We use a single value for each product, which is the average price weighted by the relative value of each market. We then use a Tornqvist index, i.e. a weighted average of the growth in prices for all the individual products $h$ of firm $i$ in time $t$:

$$\Delta P_{it} = \sum_{h} \overline{s}_{hit} \Delta ln(P_{hit})$$

where

$$\Delta ln(P_{hit}) = ln(P_{hit}) - ln(P_{hi(t-1)})$$

and

$$\overline{s}_{hit} = (s_{hit} + s_{hi(t-1)})/2$$

We take 1998 as the base year ($P_{i,1998}$=1) and add the computed firm level price change to the index:

$$P_{it} = P_{i(t-1)} + \Delta(P_{it})$$

For firms entering after 1998, we use the industry average by sector for the entry year and then follow a similar procedure.

[1] An alternative would be to use product quantities at the level of the firm to estimate a production function for multiproduct firms. See Petrin and Warzynski (2011) and Dhyne, Petrin and Warzynski (2011).

## 2.2 Dealing with input endogeneity

A well known problem when estimating production functions comes from the endogeneity of inputs. Starting from a production function:

$$Q_{it} = \Theta_{it} f(L_{it}, M_{it}, K_{it})$$

where output Q of firm i in time t (sales deflated by our firm specific price index) is a function of labor (L), materials (M), capital (K) and an index of technical progress ($\Theta$).

Assuming a Cobb-Douglas function and taking logs:

$$q_{it} = \alpha_{Lit}\ l_{it} + \alpha_{Mit}\ m_{it} + \alpha_{Kit}\ k_{it} + \vartheta_{it}$$

where

$$\vartheta_{it} = \omega_{it} + \epsilon_{it}$$

and where $\omega$ is a measure of log TFP and $\epsilon$ is a true noise.

We use a modified version of the widely used Olley and Pakes (1996) methodology following De Loecker (2007)[2]. Their model delivers an investment policy function that depends on productivity and capital:

$$i_t = i_t(k_t, \omega_t)$$

so that we can invert it to write productivity as a function of investment and capital:

$$\omega_{it} = h_t(i_{it}, k_{it})$$

[2]See also Amiti and Konings (2007), Kasahara and Rodrigue (2008) and Rizov and Walsh (2009).

In addition, we take into account the fact that exporting firms are facing different market structures and factor prices when they make their decisions about exit and investment. In other words:

$$i_t = i_{e,t}(k_t, \omega_{it})$$

and therefore

$$\omega_{it} = h_{e,t}(i_{it}, k_{it})$$

We can follow a similar logic for importing firms:

$$i_t = i_{imp,t}(k_t, \omega_{it})$$

and

$$\omega_{it} = h_{imp,t}(i_{it}, k_{it})$$

The first stage of the estimation algorithm consists in estimating the coefficient of the variable outputs, labor and material, semi-parametrically using a polynomial in k and i and allowing the coefficients to be different for importing and exporting firms, as explained above.

$$q_{it} = \alpha_{Lit}\ l_{it} + \alpha_{Mit}\ m_{it} + \phi_{exp,imp,both,t}(i_{it}, k_{it}) + \epsilon_{it}$$

where

$$\phi_{exp,imp,both,t}(i_{it}, k_{it}) = \alpha_{Kit}\ k_{it} + h_{exp,imp,both,t}(i_{it}, k_{it})$$

The second stage estimates the survival decision where the coefficients also depend on international trade status.

$$Pr(\chi_{i(t+1)} = 1\,|I_t) = p_{exp,imp,both,t}(i_{it}, k_{it})$$

The last stage involves the non-linear least square estimation of the coefficient of capital:

$$q_{it} - \hat{\alpha}_{Lit}\ l_{it} - \hat{\alpha}_{Mit}\ m_{it} = \alpha_{Kit}\ k_{it} + g(\hat{\phi} - \alpha_{Kit}\ k_{it}, \hat{p}_{i,t+1})$$

We also test the robustness of our findings using alternative estimations algorithm following the criticism of Levinsohn and Petrin (2003), Ackerberg, Caves and Frazier (2007) and Wooldridge (2009).

In every specification, we compare our results when we use as dependent variable revenue deflated by a standard producer price index and revenue deflated by our firm-level price index.

## 2.3 The ACF algorithm

Following ACF, assume that the log of value added is given by $y_{it} = \ln VA_{it} + \epsilon_{it}$, where $\epsilon_{it}$ are unanticipated shocks to production and $i.i.d.$ shocks including measurement error. Firms do not observe $\epsilon_{it}$ when making optimal input decisions. We estimate the following production function for each industry separately:

$$y_{it} = f(x_{it}, k_{it}; \beta) + \omega_{it} + \epsilon_{it} \tag{1}$$

where $x_{it}$ contains all variable inputs and $\beta$ is the vector of coefficients to be estimated. We use a standard Cobb Douglas (CD) production function.

As in LP, we use materials to proxy for productivity:

$$m_{it} = m_t(k_{it}, \omega_{it}, \mathbf{z}_{it}) \tag{2}$$

where $\mathbf{z}_{it}$ is a vector containing other variables potentially affecting optimal

input demand choice, such as importing and exporting.[3]

In a first stage, we run

$$y_{it} = \phi_t(l_{it}, k_{it}, m_{it}, \mathbf{z}_{it}) + \epsilon_{it} \tag{3}$$

This gives us estimates of expected output ($\widehat{\phi}_{it}$) and $\epsilon_{it}$. Define productivity as $\omega_{it}(\beta) = \widehat{\phi}_{it} - \beta_l l_{it} - \beta_k k_{it}$.

Assume the following law of motion for productivity:

$$\omega_{it} = g_t(\omega_{it-1}) + z_{it} + \xi_{it} \tag{4}$$

Finally, by non parametrically regressing $\omega_{it}(\beta)$ on its lag, import and export behavior, we can recover the innovation to productivity $\xi_{it}(\beta)$.

As suggested by ACF, we use the following moments to obtain our estimates of the production function

$$E\left(\xi_{it}(\beta)\begin{pmatrix} l_{it-1} \\ k_{it} \end{pmatrix}\right) = 0 \tag{5}$$

# 3 Data

For our analysis, we combine various datasets provided by Statistics Denmark. We start with a transaction level dataset providing values and quantities of all domestic transactions aggregated by product code (8-digit CN) for all manufacturing firms with at least 10 employees over the period 1998-2003[4]. Table 1 provides a description of our sample. As we can see, around 80% of our sample is composed of multi-product firms.

[3]See De Loecker (2011) and De Loecker and Warzynski (2011) for a more complete discussion of the algorithm.

[4]See Smeets and Warzynski (2010) for a more detailed description.

We then merge this information with a dataset containing similar information, but regarding import and export transactions for the period 1993-2003. This dataset covers the entire economy. For each transaction, we know the identification number of the firm buying or selling, the 8-digit CN product code, the value, the quantity, and the destination or origin. Table 2 shows the number of firms in the manufacturing industry with more than 10 employees by trade status once we merge the data with our domestic transactions dataset (for the period 1998-2003). We can see that the percentage of firms involved in both importing and exporting is increasing over time, while the percentage of firms doing none or only exporting is decreasing. The proportion of firms only importing is also increasing.

We then matched firms with the accounting statistics dataset (Regnskab) that contains information on the population of firms for the period 1994-2003. The variables included are turnover, value added, capital, investment, employment and material costs.

# 4 Results

## 4.1 Exporter, importer and two-way trader premium

We estimate our production function using a) output deflated with a standard PPI; b) output deflated with our firm-level deflator. We also use both the OP and ACF algorithm, as discussed in section 2. Table 3 shows the results pooling our productivity estimates for a subset of industries (i.e. all sectors where we had at least 1,000 observations in all specifications; see Appendix A for the results by industry). We find that our estimated coefficients vary quite a lot depending on the type of deflator used, especially

the coefficients related to firms only importing or exporting. Estimates are going up when we use the firm-level deflator, suggesting that the use of a common deflator leads to over-deflating output for firms involved in international trade. We also notice some differences between the two methodologies, although the relative ranking between the different types of firms does not change.

## 4.2 Selection into exporting/importing and learning

We then follow Bernard and Jensen (1999) to try to detect some evidence of learning by exporting and also importing, i.e. try to distinguish the learning from the selection issue. We find strong evidence of selection into exporting and/or importing: among those firms previously non exporting/importing, the more productive ones will enter into exporting/importing. Firms exporting and importing are also more likely to survive in t+1. However, we were not able to detect any evidence of learning by exporting and/or importing. Firms that start exporting and/or importing do not become more productive in t+1, t+2 or t+3.

## 4.3 Price effect or quality effect?

The next step of the analysis is to try to distinguish between a price advantage of importers or an access to higher quality inputs or capital. We use the origin of imports as a way to proxy product quality, inferring that products coming from similar developed regions (like old EU member states or other OECD members) are probably of higher quality than goods coming from China, South East Asia or new members of the EU. Table 4 shows the results (Table A2 shows the results sector by sector where we also distinguish

imports by type of good[5] and by region of origin). We can see that imports of products from OECD countries are almost always positively related to productivity. These are likely to be high quality inputs or machinery improving efficiency. On the other hand, the coefficient of imports from low-wage countries like China or South East Asia is also positive, suggesting that access to cheaper inputs diminishes costs. Once we use the firm level deflator in our analysis, the size and significance of our results of some of our results are affected, suggesting that firms also adapt their prices and product mix once having access to foreign inputs. Once again, we observe that the coefficients are larger with the firm level deflator, suggesting that we might "over-deflate" sales for some firms involved in international trade when using a sector-specific deflator.

# 5 Conclusion

In this paper, we looked at the relationship between productivity and firms' international trade decisions controlling for pricing heterogeneity. We found that firms both importing and exporting were on average more productive than firms only involved in one of these activities. We also found that controlling for firm specific prices was affecting the magnitude of these effects. This suggests that future studies should seriously consider the relationship between domestic, import and export prices to understand better the causes of firms' trading activities and their consequences on productivity and product quality.

[5]We distinguish between intermediate goods used as inputs and final goods. We identify the 2-digit industry associated to the good and then match it to the 2-digit industry of the firm importing the good. If both industries are the same, we call them final goods; otherwise, we call them intermediate products.

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**TABLE I - Summary Statistics for Domestic Transactions**

| Year | # Firms | # Transactions | # Transactions with Price Information | Average # Transactions by Firm | # Single Product Firms |
|---|---|---|---|---|---|
| 1998 | 4,852 | 20,103 | 9,446 | 4.14 | 936 |
| 1999 | 4,694 | 19,160 | 9,391 | 4.08 | 999 |
| 2000 | 4,762 | 19,694 | 10,274 | 4.14 | 997 |
| 2001 | 4,666 | 19,380 | 10,531 | 4.15 | 978 |
| 2002 | 4,607 | 19,573 | 10,763 | 4.25 | 967 |
| 2003 | 4,535 | 19,114 | 10,277 | 4.21 | 945 |
| 2004 | 4,345 | 18,541 | 10,908 | 4.27 | 900 |
| 2005 | 4,172 | 18,082 | 10,746 | 4.33 | 827 |

TABLE II - Summary Statistics - Manufacturing Only

| **# Firms** | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|
| Not Importing nor Exporting | 1,261 | 1,193 | 1,226 | 1,149 | 1,007 | 948 |
| Importing Only | 288 | 305 | 299 | 279 | 290 | 323 |
| Exporting Only | 591 | 560 | 537 | 493 | 412 | 424 |
| Importing and Exporting | 2,414 | 2,401 | 2,483 | 2,543 | 2,706 | 2,631 |
| N | 4,554 | 4,459 | 4,545 | 4,464 | 4,415 | 4,326 |
| **% Firms** | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
| Not Importing nor Exporting | 27.69% | 26.75% | 26.97% | 25.74% | 22.81% | 21.91% |
| Importing Only | 6.32% | 6.84% | 6.58% | 6.25% | 6.57% | 7.47% |
| Exporting Only | 12.98% | 12.56% | 11.82% | 11.04% | 9.33% | 9.80% |
| Importing and Exporting | 53.01% | 53.85% | 54.63% | 56.97% | 61.29% | 60.82% |

TABLE III - Import, Export and Two-way Trading: PPI vs. Firm Deflator

| Dep. Variable: TFP | OP | | ACF | |
|---|---|---|---|---|
| | PPI | Firm | PPI | Firm |
| Export | -0.005 | 0.040*** | 0.002 | 0.097*** |
| | (0.004) | (0.004) | (0.006) | (0.010) |
| Import | 0.028*** | 0.062*** | 0.026*** | 0.142*** |
| | (0.006) | (0.006) | (0.008) | (0.013) |
| Import and Export | 0.047*** | 0.093*** | 0.065*** | 0.202*** |
| | (0.003) | (0.003) | (0.005) | (0.008) |
| Year dummies | | | YES | |
| Indutry dumiies | | | YES | |
| N | 15,559 | 12,922 | 14,706 | 12,150 |

TABLE IV - Import and Exports by Type of Good and Region of Origin/Destination: PPI vs. Firm Deflator

| Dep. Variable: TFP | | OP | | ACF | |
|---|---|---|---|---|---|
| | | PPI | Firm | PPI | Firm |
| Importing from | Neighbor country | 0.012*** | 0.013** | 0.041*** | 0.067*** |
| | | (0.004) | (0.006) | (0.059) | (0.011) |
| | Rest of EU | 0.025*** | 0.027*** | 0.025*** | 0.061*** |
| | | (0.004) | (0.006) | (0.006) | (0.011) |
| | OECD | 0.029*** | 0.028*** | 0.001 | -0.002 |
| | | (0.003) | (0.005) | (0.004) | (0.009) |
| | China | 0.025*** | 0.044*** | 0.014** | 0.038*** |
| | | (0.005) | (0.008) | (0.007) | (0.014) |
| | Other Asian Countries | 0.031*** | 0.035*** | 0.021*** | 0.059*** |
| | | (0.005) | (0.006) | (0.006) | (0.011) |
| | New EU Member | -0.010*** | 0.0003 | 0.036*** | 0.080*** |
| | | (0.004) | (0.005) | (0.004) | (0.009) |
| Export to Neighbor | | -0.0003 | 0.006 | 0.017*** | 0.057*** |
| | | (0.004) | (0.005) | (0.005) | (0.010) |
| Export to the Rest of EU | | -0.006 | -0.005 | -0.000 | -0.004 |
| | | (0.004) | (0.006) | (0.005) | (0.011) |
| Export to OECD | | 0.010** | 0.017*** | 0.002 | -0.004 |
| | | (0.004) | (0.005) | (0.005) | (0.010) |
| Year dummies | | YES | | | |
| Indutry dumiies | | YES | | | |
| N | | 15,559 | 12,922 | 14,706 | 12,150 |

**TABLE A1 - Import, Export and Two-way Trading: PPI vs. Firm Deflator**

| Dep. Variable: OP Productivity | Food and Beverages | | Publishing and Printing | | Rubber and Plastic | |
|---|---|---|---|---|---|---|
| | PPI | Firm | PPI | Firm | PPI | Firm |
| Import | 0.031 | 0.008 | 0.072*** | 0.089** | -0.005 | -0.061 |
| | (0.023) | (0.036) | (0.020) | (0.037) | (0.023) | (0.057) |
| Export | 0.010 | 0.021 | -0.005 | 0.078*** | -0.029 | -0.016 |
| | (0.021) | (0.032) | (0.015) | (0.029) | (0.020) | (0.049) |
| Import and Export | 0.089*** | 0.012*** | 0.058*** | 0.180*** | 0.008 | 0.023 |
| | (0.013) | (0.021) | (0.015) | (0.028) | (0.015) | (0.039) |
| N | 1,655 | 1,620 | 2,224 | 2,103 | 1,303 | 1220 |
| Dep. Variable: OP Productivity | Fabricated Metals | | Machinery | | Furniture, N.E.C. | |
| | PPI | Firm | PPI | Firm | PPI | Firm |
| Import | 0.003 | 0.003 | -0.003 | -0.022 | -0.024 | 0.005 |
| | (0.013) | (0.024) | (0.018) | (0.052) | (0.019) | (0.036) |
| Export | -0.033*** | -0.027 | -0.041*** | -0.085** | -0.026* | -0.039 |
| | (0.009) | (0.017) | (0.011) | (0.034) | (0.014) | (0.026) |
| Import and Export | 0.036*** | 0.065*** | 0.008 | -0.004 | 0.021* | 0.010 |
| | (0.007) | (0.013) | (0.008) | (0.023) | (0.011) | (0.021) |
| N | 4,288 | 3,885 | 4,018 | 3,859 | 2,071 | 2,019 |

## TABLE A1 - Import, Export and Two-way Trading: PPI vs. Firm Deflator

| Dep. Variable: ACF Productivity | Food and Beverages | | Publishing and Printing | | Rubber and Plastic | |
|---|---|---|---|---|---|---|
| | PPI | Firm | PPI | Firm | PPI | Firm |
| Import | -0.054* | -0.042 | 0.125*** | 0.191*** | 0.100*** | 0.076** |
| | (0.031) | (0.037) | (0.015) | (0.018) | (0.018) | (0.035) |
| Export | -0.004 | -0.019 | 0.079*** | 0.086*** | 0.007 | 0.030 |
| | (0.029) | (0.035) | (0.013) | (0.015) | (0.015) | (0.029) |
| Import and Export | 0.025 | 0.030 | 0.118*** | 0.139*** | 0.058*** | 0.043* |
| | (0.019) | (0.022) | (0.012) | (0.014) | (0.012) | (0.023) |
| N | 1,366 | 1,342 | 1,861 | 1,742 | 1,135 | 1052 |
| Dep. Variable: ACF Productivity | Fabricated Metals | | Machinery | | Furniture, N.E.C. | |
| | PPI | Firm | PPI | Firm | PPI | Firm |
| Import | 0.058*** | 0.061*** | 0.058*** | 0.050** | 0.066*** | 0.077*** |
| | (0.010) | (0.011) | (0.013) | (0.024) | (0.018) | (0.024) |
| Export | 0.024*** | 0.027*** | 0.048*** | 0.067*** | 0.036*** | 0.009 |
| | (0.007) | (0.008) | (0.008) | (0.016) | (0.014) | (0.019) |
| Import and Export | 0.069*** | 0.076*** | 0.092*** | 0.104*** | 0.083*** | 0.091*** |
| | (0.005) | (0.006) | (0.006) | (0.011) | (0.011) | (0.013) |
| N | 3,432 | 3,063 | 3,349 | 3,214 | 1,779 | 1,732 |

**TABLE A2 - Import and Exports by Type of Good and Region of Origin/Destination: PPI vs. Firm Deflator**

| Dep. Variable: OP Productivity | | Food and Beverages | | Publishing and Printing | | Rubber and Plastics | |
|---|---|---|---|---|---|---|---|
| | | PPI | Firm | PPI | Firm | PPI | Firm |
| Import of Intermediate Products from | Neighbor country | 0.048*** | 0.067** | 0.010 | 0.008 | -0.015 | -0.018 |
| | | (0.016) | (0.026) | (0.023) | (0.044) | (0.014) | (0.037) |
| | Rest of EU | -0.002 | 0.011 | -0.023 | -0.004 | 0.010 | -0.010 |
| | | (0.016) | (0.025) | (0.028) | (0.054) | (0.014) | (0.036) |
| | OECD | 0.070*** | 0.077*** | 0.002 | -0.011 | 0.021* | 0.008 |
| | | (0.013) | (0.021) | (0.018) | (0.034) | (0.011) | (0.029) |
| | China | 0.126*** | 0.153*** | 0.083** | 0.207*** | -0.030 | -0.170*** |
| | | (0.024) | (0.039) | (0.039) | (0.076) | (0.019) | (0.049) |
| | South East Asia | 0.109*** | 0.102*** | -0.069 | -0.166 | 0.003 | 0.247*** |
| | | (0.022) | (0.036) | (0.052) | (0.101) | (0.022) | (0.057) |
| | Other Asian Countries | 0.080*** | 0.040 | -0.042 | -0.120 | 0.044** | 0.053 |
| | | (0.023) | (0.037) | (0.045) | (0.086) | (0.017) | (0.044) |
| | New EU Member | 0.010 | 0.016 | 0.071** | 0.039 | -0.005 | -0.020 |
| | | (0.014) | (0.023) | (0.032) | (0.061) | (0.012) | (0.031) |
| Import of Final Products from | Neighbor country | -0.023 | -0.028 | 0.045* | 0.102** | -0.027** | -0.045 |
| | | (0.016) | (0.025) | (0.024) | (0.046) | (0.014) | (0.035) |
| | Rest of EU | 0.009 | -0.011 | 0.010 | -0.065 | 0.025* | 0.029 |
| | | (0.016) | (0.026) | (0.030) | (0.058) | (0.014) | (0.035) |
| | OECD | 0.011 | -0.025 | 0.078*** | 0.114*** | 0.015 | 0.017 |
| | | (0.014) | (0.022) | (0.025) | (0.048) | (0.011) | (0.030) |
| | China | -0.022 | -0.017 | -0.032 | -0.028 | -0.026 | 0.038 |
| | | (0.022) | (0.036 | (0.062) | (0.118) | (0.024) | (0.062) |
| | South East Asia | 0.027 | 0.086** | -0.012 | 0.157 | -0.003 | 0.013 |
| | | (0.021) | (0.035) | (0.061) | (0.108) | (0.032) | (0.080) |
| | Other Asian Countries | -0.067*** | -0.073* | 0.231*** | 0.180 | 0.012 | 0.015 |
| | | (0.026) | (0.041) | (0.056) | (0.119) | (0.022) | (0.056) |
| | New EU Member | -0.019 | -0.022 | -0.086* | -0.063 | -0.015 | -0.048 |
| | | (0.016) | (0.026) | (0.047) | (0.090) | (0.014) | (0.038) |
| Export to Neighbor | | 0.044*** | 0.044 | -0.019 | 0.037 | -0.023* | -0.054 |
| | | (0.017) | (0.027) | (0.014) | (0.027) | (0.013) | (0.034) |
| Export to the Rest of EU | | -0.040** | -0.019 | 0.012 | 0.011 | 0.030** | 0.081** |
| | | (0.016) | (0.026) | (0.025) | (0.050) | (0.014) | (0.036) |
| Export to OECD | | 0.004 | 0.018 | -0.001 | 0.065* | 0.027** | 0.054* |
| | | (0.013) | (0.021) | (0.019) | (0.036) | (0.011) | (0.030) |
| Adjusted R2 | | 0.15 | 0.08 | 0.03 | 0.03 | 0.03 | 0.03 |

**TABLE A2 (Continued)**

| Dep. Variable: OP Productivity | | Fabricated Metals | | Machinery | | Furniture, N.E.C. | |
|---|---|---|---|---|---|---|---|
| | | PPI | Firm | PPI | Firm | PPI | Firm |
| Import of Intermediate Products from | Neighbor country | 0.023** | 0.042** | -0.014 | -0.017 | -0.004 | 0.008 |
| | | (0.010) | (0.019) | (0.009) | (0.026) | (0.012) | (0.023) |
| | Rest of EU | 0.043*** | 0.060** | 0.011 | 0.076*** | -0.002 | -0.035 |
| | | (0.012) | (0.024) | (0.009) | (0.026) | (0.012) | (0.024) |
| | OECD | 0.031*** | 0.069*** | 0.019** | -0.019 | 0.047*** | 0.008 |
| | | (0.009) | (0.018) | (0.008) | (0.024) | (0.010) | (0.020) |
| | China | -0.009 | 0.037 | -0.001 | 0.091** | 0.044** | 0.033 |
| | | (0.021) | (0.040) | (0.013) | (0.040) | (0.019) | (0.037) |
| | South East Asia | 0.045** | -0.008 | 0.045*** | -0.026 | 0.025 | 0.062* |
| | | (0.021) | (0.039) | (0.012) | (0.036) | (0.017) | (0.032) |
| | Other Asian Countries | -0.033* | -0.166*** | 0.031*** | 0.023 | -0.012 | 0.013 |
| | | (0.018) | (0.035) | (0.012) | (0.035) | (0.016) | (0.031) |
| | New EU Member | -0.013 | -0.000 | 0.006 | 0.026 | -0.016 | -0.010 |
| | | (0.012) | (0.022) | (0.008) | (0.026) | (0.010) | (0.020) |
| Import of Final Products from | Neighbor country | 0.025** | -0.012 | 0.006 | -0.021 | 0.014 | 0.020 |
| | | (0.011) | (0.021) | (0.010) | (0.030) | (0.012) | (0.023) |
| | Rest of EU | -0.023* | 0.019 | 0.023** | 0.033 | 0.034** | 0.035 |
| | | (0.013) | (0.026) | (0.011) | (0.032) | (0.012) | (0.025) |
| | OECD | 0.018 | -0.014 | 0.000 | -0.027 | 0.002 | 0.010 |
| | | (0.012) | (0.023) | (0.008) | (0.023) | (0.013) | (0.026) |
| | China | 0.048** | 0.014 | -0.012 | 0.019 | 0.038* | 0.076** |
| | | (0.023) | (0.047) | (0.014) | (0.042) | (0.020) | (0.038) |
| | South East Asia | -0.004 | 0.088 | 0.010 | 0.101*** | 0.020 | -0.048 |
| | | (0.032) | (0.059) | (0.016) | (0.039) | (0.018) | (0.035) |
| | Other Asian Countries | -0.006 | 0.132*** | -0.012 | -0.054 | 0.021 | -0.019 |
| | | (0.023) | (0.046) | (0.013) | (0.049) | (0.019) | (0.036) |
| | New EU Member | -0.016 | -0.026 | -0.029*** | -0.036 | -0.027** | -0.011 |
| | | (0.013) | (0.025) | (0.008) | (0.026) | (0.011) | (0.021) |
| Export to Neighbor | | -0.022** | 0.008 | -0.014 | 0.010 | 0.019 | 0.003 |
| | | (0.008) | (0.016) | (0.009) | (0.029) | (0.011) | (0.021) |
| Export to the Rest of EU | | 0.004 | -0.033 | 0.017* | 0.021 | -0.026** | 0.003 |
| | | (0.011) | (0.027) | (0.009) | (0.028) | (0.011) | (0.021) |
| Export to OECD | | -0.007 | -0.008 | -0.008 | -0.011 | -0.008 | -0.010 |
| | | (0.009) | (0.017) | (0.009) | (0.026) | (0.010) | (0.019) |
| Adjusted R2 | | 0.03 | 0.02 | 0.02 | 0.006 | 0.05 | 0.004 |

**TABLE A2 - Import and Exports by Type of Good and Region of Origin/Destination: PPI vs. Firm Deflator**

| Dep. Variable: ACF Productivity | | Food and Beverages | | Publishing and Printing | | Rubber and Plastics | |
|---|---|---|---|---|---|---|---|
| | | PPI | Firm | PPI | Firm | PPI | Firm |
| Import of Intermediate Products from | Neighbor country | -0.049** | -0.036 | 0.041** | 0.012 | -0.005 | -0.039** |
| | | (0.022) | (0.027) | (0.019) | (0.021) | (0.011) | (0.020) |
| | Rest of EU | 0.001 | 0.002 | 0.013 | 0.064** | 0.030*** | 0.051*** |
| | | (0.021) | (0.025) | (0.023) | (0.027) | (0.010) | (0.019) |
| | OECD | 0.032* | 0.036* | -0.003 | 0.013 | -0.002 | -0.021 |
| | | (0.018) | (0.021) | (0.014) | (0.016) | (0.008) | (0.016) |
| | China | 0.084*** | 0.084** | 0.019 | -0.012 | -0.029** | -0.053** |
| | | (0.032) | (0.039) | (0.031) | (0.035) | (0.014) | (0.026) |
| | South East Asia | 0.066** | 0.060 | -0.025 | 0.040 | -0.001 | -0.025 |
| | | (0.031) | (0.037) | (0.041) | (0.047) | (0.016) | (0.030) |
| | Other Asian Countries | -0.023 | -0.043 | -0.009 | -0.009 | 0.019 | 0.049** |
| | | (0.031) | (0.037) | (0.036) | (0.036) | (0.013) | (0.025) |
| | New EU Member | 0.063*** | 0.035 | 0.021 | 0.021 | 0.032*** | 0.027 |
| | | (0.019) | (0.023) | (0.026) | (0.026) | (0.009) | (0.016) |
| Import of Final Products from | Neighbor country | 0.020 | 0.015 | -0.004 | 0.065*** | 0.012 | -0.010 |
| | | (0.021) | (0.025) | (0.019) | (0.021) | (0.010) | (0.019) |
| | Rest of EU | -0.028 | -0.040 | 0.020 | 0.012 | 0.027*** | 0.021 |
| | | (0.021) | (0.025) | (0.025) | (0.029) | (0.010) | (0.019) |
| | OECD | -0.000 | -0.010 | -0.007 | -0.036 | -0.011 | -0.033** |
| | | (0.019) | (0.022) | (0.020) | (0.022) | (0.009) | (0.016) |
| | China | -0.031 | -0.048 | 0.147*** | 0.148*** | -0.029* | -0.051 |
| | | (0.031) | (0.036) | (0.047) | (0.054) | (0.017) | (0.032) |
| | South East Asia | 0.092*** | 0.086** | 0.082* | 0.104* | -0.020 | 0.038 |
| | | (0.029) | (0.035) | (0.047) | (0.054) | (0.022) | (0.040) |
| | Other Asian Countries | -0.052 | -0.044 | 0.067 | 0.039 | -0.005 | -0.009 |
| | | (0.034) | (0.040) | (0.044) | (0.050) | (0.017) | (0.030) |
| | New EU Member | -0.039* | -0.0085 | -0.039 | -0.036 | 0.032*** | 0.020 |
| | | (0.021) | (0.025) | (0.035) | (0.041) | (0.010) | (0.020) |
| Export to Neighbor | | -0.008 | -0.008 | 0.029*** | 0.033** | -0.002 | 0.007 |
| | | (0.023) | (0.028) | (0.011) | (0.013) | (0.010) | (0.018) |
| Export to the Rest of EU | | 0.054** | 0.053** | -0.022 | -0.073*** | -0.014 | -0.013 |
| | | (0.022) | (0.026) | (0.021) | (0.024) | (0.010) | (0.019) |
| Export to OECD | | 0.022 | 0.037* | 0.047*** | 0.056*** | -0.009 | 0.0003 |
| | | (0.018) | (0.021) | (0.015) | (0.017) | (0.009) | (0.016) |
| N | | 1,366 | 1,342 | 1,861 | 1,742 | 1,135 | 1,052 |

**TABLE A2 (Continued)**

| Dep. Variable: ACF Productivity | | Fabricated | Metals | Machinery | | Furniture, | N.E.C. |
|---|---|---|---|---|---|---|---|
| | | PPI | Firm | PPI | Firm | PPI | Firm |
| Import of Intermediate Products from | Neighbor country | 0.030*** | 0.046*** | -0.008 | -0.016 | 0.024** | 0.028* |
| | | -0.007 | -0.009 | (0.006) | (0.011) | (0.011) | (0.015) |
| | Rest of EU | 0.026*** | 0.035*** | -0.005 | -0.014 | -0.015 | -0.017 |
| | | -0.008 | -0.011 | (0.006) | (0.011) | (0.011) | (0.015) |
| | OECD | 0.002 | 0.011 | -0.001 | 0.0004 | -0.026*** | -0.029*** |
| | | -0.006 | -0.008 | (0.006) | (0.010) | (0.010) | (0.013) |
| | China | 0.028** | 0.031* | 0.006 | 0.035** | -0.008 | 0.050** |
| | | -0.014 | -0.018 | (0.009) | (0.016) | (0.017) | (0.023) |
| | South East Asia | -0.014 | -0.036** | -0.019** | 0.024* | 0.035** | 0.053** |
| | | (0.014) | (0.017) | (0.008) | (0.014) | (0.015) | (0.020) |
| | Other Asian Countries | -0.004 | -0.050*** | -0.005 | 0.017 | 0.001 | -0.035* |
| | | (0.012) | (0.016) | (0.008) | (0.014) | (0.015) | (0.020) |
| | New EU Member | 0.014* | 0.013 | -0.002 | 0.020* | 0.035*** | 0.039*** |
| | | (0.008) | (0.010) | (0.006) | (0.010) | (0.010) | (0.013) |
| Import of Final Products from | Neighbor country | 0.000 | 0.008 | 0.025*** | 0.016 | 0.007 | 0.013 |
| | | (0.008) | (0.010) | (0.007) | (0.012) | (0.011) | (0.015) |
| | Rest of EU | 0.003 | -0.010 | 0.027*** | 0.032** | 0.040*** | 0.042*** |
| | | (0.009) | (0.012) | (0.007) | (0.013) | (0.012) | (0.016) |
| | OECD | -0.007 | -0.008 | 0.015*** | -0.005 | -0.034*** | -0.042** |
| | | (0.008) | (0.010) | (0.005) | (0.010) | (0.012) | (0.016) |
| | China | -0.000 | 0.020 | -0.039*** | -0.017 | 0.039** | 0.044* |
| | | (0.015) | (0.020) | (0.009) | (0.017) | (0.017) | (0.023) |
| | South East Asia | -0.039* | -0.073*** | -0.004 | 0.026 | -0.009 | 0.004 |
| | | (0.022) | (0.026) | (0.011) | (0.019) | (0.016) | (0.021) |
| | Other Asian Countries | 0.008 | 0.037* | 0.021** | 0.012 | -0.015 | -0.007 |
| | | (0.015) | (0.020) | (0.009) | (0.016) | (0.017) | (0.023) |
| | New EU Member | -0.012 | -0.027** | 0.003 | 0.011 | 0.060*** | 0.056*** |
| | | (0.008) | (0.011) | (0.006) | (0.011) | (0.010) | (0.013) |
| Export to Neighbor | | 0.016*** | 0.026*** | 0.041*** | 0.050*** | 0.036*** | 0.017 |
| | | (0.006) | (0.007) | (0.007) | (0.012) | (0.011) | (0.014) |
| Export to the Rest of EU | | -0.012 | -0.025** | 0.021*** | 0.011 | -0.021** | -0.007 |
| | | (0.007) | (0.009) | (0.007) | (0.012) | (0.010) | (0.013) |
| Export to OECD | | 0.010 | 0.002 | -0.014** | -0.019* | -0.002 | -0.005 |
| | | (0.006) | (0.008) | (0.006) | (0.011) | (0.009) | (0.012) |
| N | | 3,432 | 3,063 | 3,346 | 3,214 | 1,779 | 1,732 |

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