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Evidence for West and East German Plants, 2004**

Joachim Wagner

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**Joachim Wagner**

*University of Lueneburg,  
Max Planck Institute of Economics, Jena  
and IZA*

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IZA

P.O. Box 7240  
53072 Bonn  
Germany

Phone: +49-228-3894-0

Fax: +49-228-3894-180

E-mail: [iza@iza.org](mailto:iza@iza.org)

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## ABSTRACT

### **Productivity and Size of the Export Market: Evidence for West and East German Plants, 2004<sup>\*</sup>**

Using unique recently released nationally representative high-quality data at the plant level, this paper presents the first comprehensive evidence on the relationship between productivity and size of the export market for Germany, a leading actor on the world market for manufactured goods. It documents that firms that export to countries inside the euro-zone are more productive than firms that sell their products in Germany only, but less productive than firms that export to countries outside the euro-zone, too. This is in line with the hypothesis that export markets outside the euro-zone have higher entry costs that can only be paid by more productive firms.

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Corresponding author:

Joachim Wagner  
University of Lueneburg  
Institute of Economics  
PO Box 2440  
D-21314 Lueneburg  
Germany  
E-mail: [wagner@uni-lueneburg.de](mailto:wagner@uni-lueneburg.de)

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<sup>\*</sup> All computations for this study were done inside the Research Data Centre of the Statistical Office of Berlin. Many thanks to Anja Münch and Ramona Pohl for running my Stata do-files, and for carefully checking the log-files for violations of privacy.

## 1. Motivation

A recent survey of 54 micro-econometric studies with data for firms from 34 countries that were published between 1995 and 2006 shows that exporters are more productive than non-exporters (see Wagner 2007a). Germany is a case in point; productivity differentials in favour of exporting firms compared to firms that sell their products on the national market only are found to be statistically significant and economically important even when observed and unobserved firm characteristics are controlled for.<sup>1</sup>

According to findings from this literature, this productivity differential tends to be due to self-selection of more productive plants on export markets, and to a market driven selection process in which exporters that have low productivity fail as a successful exporter, while only those that are more productive continue to export. The reason for this is that there exist additional costs of selling goods in foreign countries. The range of extra costs include transportation costs, distribution or marketing costs, personnel with skill to manage foreign networks, or production costs in modifying current domestic products for foreign consumption. These costs provide an entry barrier that less productive firms cannot overcome.

This implies that plants that export to a larger number of foreign markets have to be more productive than plants that serve a smaller number of foreign markets only because at least some of the extra costs mentioned recur for each market (e.g., preparing a user's manual in another language, or checking the relevant national

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<sup>1</sup> Empirical evidence for Germany based on census data for plants from the federal state Lower Saxony is reported in Bernard and Wagner (1997, 2001) and Wagner (2002, 2006a, 2006b), while Arnold and Hussinger (2005a, 2005b) used enterprise data from the Mannheim Innovation Panel, a sample that covers Germany as a whole. Results from these earlier studies are summarized in tabular form in Wagner (2007a). Wagner (2007b) is comprehensive study using panel data for manufacturing plants from the official census for the years 1995 to 2004 that cover Germany as a whole.

laws). Furthermore, it seems plausible to assume that the larger the number of markets the higher will be (at least, on average) the distance related costs of exporting an exporter has to bear.

A case in point that can be expected to be relevant for German firms is the distinction between exporting inside the euro-zone only and exporting to countries that do not belong to the euro-zone, too. A plant that exports to, say, the US has to deal with all extra costs due to changes in the exchange rate between the euro and the dollar, while an exporter that serves markets where the euro is the local currency does not need to take care of this. Furthermore, transportation costs and other export related costs can be expected to be higher on average for serving markets outside the euro-zone.

This implication has not been tested empirically before. A reason for this gap in the literature is that the data from official statistics in Germany that were used in the past to investigate the relation between exporting and productivity did not contain any information about the countries the plants exported to. Beginning with the year 2003, plants have to report not only the value of total exports, but the value of exports to countries outside the euro-zone separately, too. This paper contributes to the literature by using this newly available information and unique recently released nationally representative high-quality data at the plant level to document the relationship between productivity and size of the export market for Germany, a leading actor on the world market for manufactured goods.

The rest of the paper is organised as follows: Section 2 introduces the newly available data set and discusses measurement issues. Section 3 presents descriptive evidence and results from statistical tests for the existence of productivity differentials between non-exporters and exporters by size of the export markets. Section 4 concludes.

## 2. Data and Measurement Issues

The empirical investigation uses data from an unbalanced panel of establishments (local production units, plants)<sup>2</sup> built from cross section data collected in regular surveys by the Statistical Offices of the German federal states. The surveys cover all establishments from mining<sup>3</sup> and manufacturing industries that employ at least twenty persons in the local production unit or in the company that owns the unit. Participation of firms in the survey is mandated in official statistics law, and the firms have to report the true figures. Only recently data from these surveys at the state level were matched over all federal states to form a data set that covers Germany as a whole. In this paper annual data for 2004, the most recent year for which information is available, are used. Note that the micro level data are strictly confidential and for use inside the Statistical Office only, but not exclusive. Further information on the content of the data set and how to access it is given in Wagner (2000) and in Zühlke et al. (2004).

It should be noted that in this data set *export* refers to the amount of sales to a customer in a foreign country plus sales to a German export trading company; indirect exports (for example, tires produced in a plant in Germany that are delivered to a German manufacturer of cars who exports some of his products) are not covered by this definition. Furthermore, note that single or multiple establishment enterprises with less than 20 employees in total do not report to the survey.

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<sup>2</sup> In this paper we will use the terms *firm*, *establishment*, and *plant* interchangeably to describe the (local production) unit of analysis.

<sup>3</sup> Given that there are only a few establishments from mining industries we will use the term manufacturing industries to describe our sample in this paper.

The plants are divided into three groups: Non-exporting plants, plants with exports to the euro-zone only, and plants that export to the euro-zone and to countries outside the euro-zone.<sup>4</sup>

*Productivity* is measured as total sales (in constant prices) per employee, i.e. labour productivity.<sup>5</sup> More appropriate measures of productivity like value added per employee (or per hour worked), or total factor productivity, cannot be computed because of a lack of information on hours worked, value added, and the capital stock<sup>6</sup> in the surveys. Controlling for the industry affiliation by using an index computed as labour productivity of the plant divided by the average labour productivity of all plants in the industry at the detailed 4-digit-level (and multiplied by 100), however, can be expected to absorb much of these differences in the degree of vertical integration and capital intensity.<sup>7</sup> Some establishments reported either tiny or

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<sup>4</sup> According to the questionnaire used in the survey for 2004 the euro-zone is defined to cover (besides Germany) Austria, Belgium, Finland, France, Greece, Ireland, Italy, Luxemburg, the Netherlands, Portugal, and Spain; neither Andorra and Monaco, nor San Marino and the Vatican (which have a currency union with the euro-countries France and Italy, respectively, and therefore should be regarded as members of the euro-zone, too) are included here. Note that a fourth group of plants – those that export to countries outside the euro-zone only – is omitted. The number of plants in this group is very small (only 1.2 percent of all plants from West Germany and 2.5 percent from East Germany), and the average labour productivity in these plants does not differ significantly from the average labour productivity in plants that export to the euro-zone only.

<sup>5</sup> Note that the number of employees is computed as the average value reported in the monthly surveys; establishments with less than twelve reports in a year were excluded from all computations because they were not active during the whole year, and are therefore not comparable to the rest of the establishments. Furthermore, note that the number of employees includes the owners of the firm if they worked in the firm.

<sup>6</sup> The survey has information about investment that might be used to approximate the capital stock. A close inspection of the investment data, however, reveals that many establishments report no or only a very small amount of investment in many years, while others report huge values in one year. Any attempt to compute a capital stock measure based on these data would result in a proxy that seems to be useless.

<sup>7</sup> Note that Bartelsman and Doms (2000, p. 575) point to the fact that heterogeneity in labor productivity has been found to be accompanied by similar heterogeneity in total factor productivity in

very huge amounts of turnover in some years, leading to tiny or very huge values of labour productivity. Due to data protection rules it is impossible to investigate the reasons for these implausible figures, and to discriminate between reporting errors, idiosyncratic events, or other causes. Given that outliers of this kind might influence findings from empirical investigations, as a sensitivity analysis establishments from the bottom and top one percent of the labour productivity distribution were excluded from all computations, and results for the reduced sample are reported, too.

Given that the East German economy still differs in many respects from the West German economy, all computations were done for both parts of Germany separately.<sup>8</sup>

### **3. Productivity and Size of Export Market**

Table 1 and table 2 report the results of the empirical investigation for West German and East German plants. The big picture is in accordance with the priors stated in the introduction to this paper: On average, firms that export to countries inside the euro-zone are more productive than firms that sell their products in Germany only, but less productive than firms that export to countries outside the euro-zone, too. These results hold for both parts of Germany, and when firms from the top and the bottom one percent of the productivity distribution are excluded from the calculations, too. T-tests show that all these differences are statistically significant at an error level that is smaller than 0.1 percent.

[Table 1 and table 2 near here]

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the reviewed research where both concepts are measured. Furthermore, Foster, Haltiwanger and Syverson (2005) show that productivity measures that use sales (i.e. quantities multiplied by prices) and measures that use quantities only are highly positively correlated.

<sup>8</sup> Note that the federal state of Berlin is included in East Germany here.



If one looks at differences in the mean value for two groups only, one focuses on just one moment of the productivity distribution. A stricter test that considers all moments is a test for stochastic dominance of the productivity distribution for one group over the productivity distribution for another group. More formally, let  $F$  and  $G$  denote the cumulative distribution functions of productivity for exporters to the euro-zone only and for non-exporters. Then first order stochastic dominance of  $F$  relative to  $G$  means that  $F(z) - G(z)$  must be less or equal zero for all values of  $z$ , with strict inequality for some  $z$ . Whether this holds or not is tested non-parametrically by adopting the Kolmogorov-Smirnov test. This method has been used to discuss the issue of exports and productivity for the first time by Delgado, Farinas and Ruano (2002); applications for German data are Arnold and Hussinger (2005b) and Wagner (2006a).

Here three Kolmogorov-Smirnov-tests were performed, comparing the productivity distributions of either non-exporting plants and plants with exports to the euro-zone only, or of non-exporting plants and plants with exports to both the euro-zone and the non-euro-zone, or of plants with exports to the euro-zone only and plants with exports to both the euro-zone and the non-euro-zone. For both West Germany and East Germany, and for samples including and excluding extreme values of productivity, the prob-value for the Kolmogorov-Smirnov test of the null-hypothesis that the distribution of labor productivity for the two groups of firms considered are identical against the alternative hypothesis that the distribution for the second group first-order stochastically dominates the distribution for the first group is 0.000 in all cases, indicating that the null-hypothesis can be rejected in favour of the alternative hypothesis at any usual error level.

#### 4. Discussion

Using unique recently released nationally representative high-quality data at the plant level, this paper documents that German firms that export to countries inside the euro-zone are more productive than firms that sell their products in Germany only, but less productive than firms that export to countries outside the euro-zone, too. This is in line with the hypothesis that export markets outside the euro-zone have higher entry costs that can only be paid by more productive firms.

An open question, however, is the direction of causality between exporting and productivity inside and outside the euro-zone. Are firms that export beyond the euro-zone more productive than firms that export inside the euro-zone only *before* they start to sell their products in these markets, or does selling on non-euro-zone markets increase productivity (more than selling inside this zone) due to learning effects and more intense competition that leads to higher improvements in productivity via more innovation? An empirical investigation of these questions can only be performed when longitudinal data over a period of at least seven years allow a comparison of plants over time before and after starting to export beyond the euro-zone. Suitable data are available for the years starting 2003; therefore, this has to be a topic for future research.

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Table 1: Productivity in non-exporting plants, and in exporting plants by export markets, West Germany, 2004

	Non-exporting plants	Plants with exports to euro-zone only	Plants with exports to euro- and non-euro zone
Average labour productivity (index)	88.07 <i>84.71</i>	99.37 <i>94.27</i>	108.68 <i>103.05</i>
Number of plants	12,849 <i>12,492</i>	5,241 <i>5,145</i>	18,206 <i>17,941</i>
Percentage share of all plants	34.98 <i>34.70</i>	14.27 <i>14.29</i>	49.57 <i>49.83</i>
	Test for difference in labour productivity between groups of plants		
	t-test (prob-value)	Kolmogorov-Smirnov-test (prob-value)	
Non-exporting plants vs. plants with exports to euro-zone only	0.000 <i>0.000</i>	0.000 <i>0.000</i>	
Non-exporting plants vs. plants with exports to euro-zone and non-euro zone	0.000 <i>0.000</i>	0.000 <i>0.000</i>	
Plants with exports to euro-zone only vs. plants with exports to euro-zone and non-euro-zone	0.000 <i>0.000</i>	0.000 <i>0.000</i>	

Note: The index of labour productivity is computed as the percentage difference of the labour productivity in a plant compared to the average labour productivity in all plants from the same 4-digit industry. The percentage shares of all plants for the three groups of plants do not sum to 100 percent because the few plants that export to the non-euro-zone only are omitted here. Figures *in italics* refer to a sample where the top and bottom one percent of firms from the distribution of labour productivity are dropped from all computation. The t-test does not assume identical variances for both groups. A p-value of 0.05 or less indicates that the difference between the two groups is statistically significant at an error level of 5 percent or less. The Kolmogorov-Smirnow -test tests the null-hypothesis that the distribution of labour productivity for the two groups of plants mentioned are identical against the alternative hypothesis that the distribution for plants from the second group first-order stochastically dominates the distribution for the first group. A p-value of 0.05 or smaller indicates that the null-hypothesis can be rejected in favour of the alternative hypothesis at an error level of 5 percent or better.

Table 2: Productivity in non-exporting plants, and in exporting plants by export markets, East Germany, 2004

	Non-exporting plants	Plants with exports to euro-zone only	Plants with exports to euro- and non-euro zone
Average labour productivity (index)	89.15 <i>87.95</i>	101.79 <i>97.34</i>	117.33 <i>109.96</i>
Number of plants	4,585 <i>4,509</i>	882 <i>860</i>	2,837 <i>2,773</i>
Percentage share of all plants	53.80 <i>53.97</i>	10.35 <i>10.29</i>	33.29 <i>33.19</i>
	Test for difference in labour productivity between groups of plants		
	t-test (prob-value)	Kolmogorov-Smirnov-test (prob-value)	
Non-exporting plants vs. plants with exports to euro-zone only	0.000 <i>0.000</i>	0.000 <i>0.000</i>	
Non-exporting plants vs. plants with exports to euro-zone and non-euro zone	0.000 <i>0.000</i>	0.000 <i>0.000</i>	
Plants with exports to euro-zone only vs. plants with exports to euro-zone and non-euro-zone	0.000 <i>0.000</i>	0.000 <i>0.000</i>	

Note: The index of labour productivity is computed as the percentage difference of the labour productivity in a plant compared to the average labour productivity in all plants from the same 4-digit industry. The percentage shares of all plants for the three groups of plants do not sum to 100 percent because the few plants that export to the non-euro-zone only are omitted here. Figures *in italics* refer to a sample where the top and bottom one percent of firms from the distribution of labour productivity are dropped from all computation. The t-test does not assume identical variances for both groups. A p-value of 0.05 or less indicates that the difference between the two groups is statistically significant at an error level of 5 percent or less. The Kolmogorov-Smirnow -test tests the null-hypothesis that the distribution of labour productivity for the two groups of plants mentioned are identical against the alternative hypothesis that the distribution for plants from the second group first-order stochastically dominates the distribution for the first group. A p-value of 0.05 or smaller indicates that the null-hypothesis can be rejected in favour of the alternative hypothesis at an error level of 5 percent or better.