FIRM HETEROGENEITY, PRODUCTIVITY, AND THE EXTENSIVE MARGINS OF TRADE - DIFFERENCES BETWEEN MANUFACTURING FIRMS IN EAST AND WEST GERMANY

Astrid Krenz

GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN

Firm heterogeneity, productivity, and the extensive margins of trade - Differences between manufacturing firms in East and West Germany[*]

Astrid Krenz[†]

Abstract. I investigate the relationship between the extensive margins of imports and exports (the number of countries traded with and the number of goods traded) and firm productivity using a newly constructed and rich panel data set of German manufacturing firms for the years 2009-2014. I do for the first time construct a data set based on German trade data and firm data that accounts for the substantial change in the German register of firms statistics after 2012. The extensive margins are significantly and positively associated with firm-level productivity both for West and East German firms in cross-sectional estimations, which is in line with the previous literature. Productivity is higher in firms that import and export more goods and trade with more countries. However, results based on panel analyses reveal that especially for East German firms the relationship becomes insignificant when unobserved firm heterogeneity is controlled for. The results point to a high degree of firm heterogeneity, of factors that are relevant and differ within the firm only, for firms in East Germany.

Keywords: Extensive margins of trade, Firm Productivity, Germany, Firm Heterogeneity.
JEL: F14, L25, L60.

1. Introduction

Firms that engage in international trade are found to be generally more productive than firms that produce for the domestic market only. A reason for this relationship lies in the fixed costs that firms have to bear when they decide to trade internationally. Exporters have to be more productive because of the additional cost they have to cover, comprising of costs of transportation, of distribution, of marketing, or costs for training staff to attain foreign language skills and knowledge about foreign laws and regulations. Importers will have to bear fixed costs that are de facto sunk costs like costs for finding suppliers, checking goods for quality, learning customs procedures as well as making negotiations etc. This reasoning has found ample evidence in the empirical literature on firms' international trade (Bernard and Jensen, 1997, 1997; Bernard and Wagner, 1997; Wagner, 2002; Bernard et al. 2012). Moreover, the theory of heterogenous firms in international trade has been built upon this empirical evidence (Melitz, 2003 e.g.).

With this paper I add two dimensions to the previous literature: First, I constructed a new, large data set based on the German official trade statistics that come at a level of every bilateral international transaction and I aggregated that information up to the firm-level using the official firm statistics from the German Statistical Offices. The German register of firms has undergone a substantial change, and from the year 2013 and onwards there do now exist two separate data sets on the register of firms instead of just one in the years before that change. I accounted for that change in programming. The data set is unique and comprehensive as by German Law all firms are obliged to report to the official statistics that are maintained by the German Federal Statistical Office and the Offices of the Laender. This differentiates the firm data from the German Statistical Offices from other available German firm data sets, which are sub-samples of firms or survey data, for example from the IAB, from the ZEW or the Bundesbank. Second, in the estimations I am controlling for unobserved firm heterogeneity using a panel data set on manufacturing firms for the time span 2009-2014. I investigate the relationship between imports and exports and firm productivity along the extensive margins of trade, that is the impact on firms trading with more countries and trading more goods.

In previous studies, data from the Statistical Offices were used by Burda and Severgnini (2018) to investigate the influential factors for regional productivity differences between East and West Germany (the authors use data at the federal state level from the Working Group for State Income and Product Accounts, but no firm-level data). To the best of knowledge a merge

of the official German trade statistics and official German firm-level data - which is time- and programming-intensive - and subsequent analyses have so far only be done by Wagner. Wagner (2014) finds evidence for a positive relationship between firm productivity and the extensive margins of imports for a firm-level data set on German manufacturing firms in a cross-sectional analysis for the year 2009 and for the year 2010. He finds significant effects both for East and West German firms, but he points out that unobserved firm heterogeneity might be a problem that could bias the results. In another paper, Wagner (2012) compares productivity distributions of firms that trade different numbers of goods and with different numbers of countries using a non-parametric test and firm-level data from Germany in a cross-section for the year 2009. He finds that productivity is higher when firm trade more goods and with more countries.

When running a cross-sectional study for one year only, my analysis confirms results found in the previous literature (Wagner, 2014), that the extensive margins of trade are positively linked with higher firm productivity. When controlling for unobserved firm heterogeneity, however, using a panel data analysis, the results reveal a positive and mostly significant relationship for firms in the West of Germany but not in the East of Germany. This points to a high degree of firm heterogeneity, of factors that are relevant and differ within the firm, only, for firms in East Germany.

The rest of the paper is organized as follows. The next part describes the data and applied methodology. Section 3 presents and discusses the results from the empirical analysis. The paper ends with a conclusion.

2. Data

For the analysis I combined data from three different sources: official firm data from the panel of enterprises (*AFiD Panel Industrieunternehmen*), the register of firms (*Unternehmensregister, abbr. URS*), and the official German foreign trade statistics (*Aussenhandelsstatistik*).[1] I use the (*URS*) both in its old 95 version (*URS alt*) and since the change in 2013 in its new version on the one hand for establishments (*URS neu Niederlassungen*) and on the other hand for enterprises (*URS neu Wirtschaftseinheiten*). All the data were provided from the German Federal Statistical Office and the Offices of the Laender. The data are of high quality. Since firms are obliged to

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[1]Further information about data from the Statistical Offices can be found in Fritsch et al. 2004, or Malchin and Voshage 2009.

report by German Law the data are accurate and comprehensive, with the register of firms capturing all firms in the German economy.[2]

The official German Trade Statistics data are based on customs' records on traded goods between German firms and countries outside the European Union and on firms' information on traded goods of German firms and European Union countries. They are available from the year 2009 onwards.[3] The data contain every bilateral transaction between a German firm and its foreign counterpart. I programmed and aggregated the data up to the enterprise-level. From the trade statistics I could thus construct variables that capture the number of imported or exported goods and the number of countries that a German firm exported to or imported from, and this captures the extensive margins of trade by a firm in this analysis.

Given the tax identification number of an enterprise in the Trade Statistics, these data were merged to the respective tax identification number of an enterprise in the German register of firms. From the register of firms it was then possible to merge the firm-level trade data with the panel on enterprises, in order to get information on the number of employees, turnover and industry classification. The panel of enterprises contains information on all enterprises from manufacturing enterprises with at least 20 employees.

A particular challenge for creating a panel data set constituted the fact that the German register of firms Statistics have undergone a substantial change in the year 2013. Whereas before 2013 there was only one single dataset for the register of firms - which contains information on all plants and enterprises in the German economy - there are now for each year two datasets for the register of firms: a plant-level and an enterprise-level one. I matched the trade data and the firm-level data for the first time according to this cut in the register of firms and gained a dataset for the time span from 2009 to 2014. [4] [5]

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[2]The register of firms comprises all firms, especially all manufacturing firms, which are considered for the present analysis. Excepted are only those firms from sectors A, O, T and U according to ISIC rev. 4, which are the sectors of agriculture, forestry and fishing, public administration and defense and other services.

[3]In the German foreign trade statistics firms' trade within the EU is registered when it exceeded a value of 400000 euros in a year in 2009-2012, and when it exceeded a value of 500000 euros in 2013 and 2014. For trade with non-EU members every transaction that exceeded 1000 euros is registered.

[4]The last available wave of data was at the time of my application for the data (end of 2015) the year 2013. It took more than $2\frac{1}{2}$ years until the Statistical Offices finished their data preparation and delivery and that I could get some first access to the data. An additional wave for the year 2014 was then taken up, which involved further waiting time.

[5]A good overview on working with firm data from the German Statistical Offices, and a discussion of the time and money involved in working with this data, is provided by Wagner (2015).

For the analyses I measure productivity as labor productivity, that is total turnover per employee. This is necessary as there is no information on capital in the official firm data, and as such no more detailed measure of total factor productivity could be derived. I rely on evidence from the previous literature that regardless of how productivity is measured firms will be figured out as efficient and that measures based on revenues are highly positively correlated with quantity based measures (Syverson 2011, Foster et al. 2008). For the panel analyses the turnover value - that is used to construct the productivity measure - was deflated.

The extensive margins of trade are measured by different groups of number of goods or countries. The categories are 1 product/country, 2-5, 6-10, 11-15, 26-49 and 50 and more products or countries traded with. In the regression analyses, the impact is measured of i. the total number of goods traded, ii. the extensive margins of trade in groups of number of products traded, iii. the total number of countries traded with, and iv. the extensive margins of trade in groups of number of countries traded with. For the regressions I use the number of goods or countries traded with in per thousand values. Further, I conduct separate analyses for East and West Germany, given previous evidence from the literature that firm differences across East and West Germany matter for various performance measures (Wagner, 2008).

3. RESULTS

Table 1 shows the share of firms engaged in international trade differentiated in product and country groups between the West and East of Germany for the year 2014. The number of goods traded and the number of countries traded with differs widely across the West and the East. The descriptive statistics show that in West Germany firms import a larger number of goods and trade with a larger number of countries than firms in East Germany. Firms in West Germany import about twice as much in the category of 50 or more goods than firms in East Germany. Moreover firms in West Germany import more than twice as much from 26 and more countries than firms in East Germany. East German firms import about 38 percent in the 1-5 goods category versus 30 percent for West German firms. Firms in the East import about 50 percent from the 1-5 countries category versus 41 percent for West German firms. A similar picture emerges for the exporting activity. Firms in West Germany export about twice as much in the category of more than 26 goods and with more than 26 countries than East German firms. About 57 percent of East firms export in the category of 1-5 products versus 43 percent in West

Germany. About 44 percent of East German firms export to 1-5 countries versus 28 percent in the West. About the same picture emerges for the panel 2009-2014, which is shown in Table 2.

In the next step I investigated the productivity premium along the extensive margins of imports and exports. The dependent variable is the log of labor productivity, imports and exports are either controlled for by taking a measure of the total number of goods or countries or by 5 product and country categories. Further, the size of firms measured by the number of employees, the squared term of firm size and 2-digit industry dummies were controlled for. The reference category was 1 product or 1 country. This model does not attempt to model productivity differences at the firm-level. It is a tool to investigate different effects on productivity according to differences across the extensive margins (see e.g. Wagner, 2014).

Table 3 presents the results for the cross-section year 2014. The results show that productivity is increasing both in the extensive margins of imports and exports. Basically all coefficients are positive and the p-values indicate high significance above the 1 percent level. The impact is also economically highly significant. Labor productivity for firms in the West was 40,469 euros higher when they imported 2-5 products instead of just one product and it was 128,502 euros higher when they exported more than 50 goods instead of just one good. The premia are generally higher in the East than in the West. These results are in line with results found by Wagner (2014) for the cross-section years of 2009 and 2010.

A different picture emerges when controlling for unobserved firm heterogeneity by analysing the effects with the panel data set from 2009-2014 and accounting for firm fixed effects and time fixed effects aside from firm size, the squared term of firm size and industry dummies. The results in Table 4 show that the relationship between labor productivity and the extensive margins of importing and exporting is basically significant and important for West German firms only. The economic impact of the margins is also much lower than results from a cross-sectional analysis show. Labor productivity for firms in the West was 3,612 euros higher when they exported 2-5 products instead of just one product and it was 10,077 euros higher when they exported more than 50 goods instead of just one product. The premia coefficients are not significant for the lower product and country groups. For East Germany, however, the effects are generally not significant and do not increase along the margins, at all. Apparently, there is a high degree of firm heterogeneity present within the firms in East Germany. These factors could be, for

example, management quality, firm strategy or other institutional factor that vary across firms but not across time.

4. Conclusion

Trade activities vary still, many years after German reunification, between firms in the East and West of Germany. With a newly constructed comprehensive dataset on German manufacturing firms, this paper investigated the relationship between the extensive margins of trade and firm productivity in Germany. A major challenge has been to account for the substantial change in the German register of firms' data provision, and to match the official transaction-level trade statistics to the firm-level.

Firms in the East of Germany are about half as likely to import or export more than 25 products and to import or export from/ to more than 25 countries than West German firms. They are instead more engaged in trading with 1 to 10 countries or products. The results from the regression analyses confirm the previous literature's findings that firm productivity increases when more goods are traded and more countries are traded with albeit only in a cross-sectional analysis. When controlling for unobserved firm heterogeneity, by using a panel data analysis, the results show a general increase in firm-level productivity along the extensive margins of imports and exports only for firms in West Germany. For East German firms the results for the relationship between firm productivity and the extensive margins of trade are generally not significant.

The present analysis has shown that firms in East and West Germany are heterogenous and that this heterogeneity has to be accounted for in analyses on firm performance and trade. Apparently there is a great degree of heterogeneity for East German firms present. Firm characteristics that do not change over time and are other than the controlled factors of firm size, industry affiliation and number of goods traded and countries traded with, do exert important explanatory power to the productivity of firms operating in the East of Germany. These factors could comprise the type of management, firm strategy or other institutional factors that do not change much over time. This new finding motivates further analyses on the impact of trade across countries and products on firm performance.

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Table 1: The extensive margins of trade for German manufacturing firms in 2014

| | Imports | | Exports | |
	West Germany	East Germany	West Germany	East Germany
Number of products:				
1 product	9.57	13.98	14.16	21.58
2-5 products	20.93	24.72	29.16	35.55
6-10 products	15.03	15.56	14.82	16.46
11-25 products	24.37	25.04	17.67	14.19
26-49 products	15.94	13.30	9.82	7.28
50 and more products	14.15	7.40	14.36	4.94
Total number of firms	15406	2783	15752	2734
Number of countries:				
1 country	14.88	21.06	12.02	20.34
2-5 countries	26.55	29.03	16.37	23.81
6-10 countries	22.35	22.42	11.85	15.29
11-25 countries	28.66	24.25	27.72	24.76
26-49 countries	6.83	3.02	21.82	11.63
50 and more countries	0.72	0.22	10.21	4.17
Total number of firms	15406	2783	15752	2734

Note: The Table displays the share of firms that export or import in the East or the West of Germany according to groups of traded goods and countries. Data are taken from the Federal Statistical Office and the Offices of the Laender.

Table 2: The extensive margins of trade for German manufacturing firms in 2009-2014 panel

| | Imports | | Exports | |
	West Germany	East Germany	West Germany	East Germany
Number of products:				
1 product	9.82	14.15	14.52	22.38
2-5 products	21.57	25.68	29.99	37.17
6-10 products	15.45	16.45	15.39	15.71
11-25 products	24.55	24.75	17.51	14.34
26-49 products	15.40	12.31	9.53	6.04
50 and more products	13.20	6.65	13.06	4.35
Total number of firms	83222	14921	85160	14605
Number of countries:				
1 country	15.48	21.51	12.07	19.97
2-5 countries	26.87	29.82	16.28	24.16
6-10 countries	22.61	22.93	12.14	15.19
11-25 countries	28.21	23.01	28.08	25.02
26-49 countries	6.18	2.58	21.79	12.01
50 and more countries	0.65	0.15	9.64	3.66
Total number of firms	83222	14921	85160	14605

Note: The Table displays the share of firms that export or import in the East or West of Germany according to groups of traded goods and countries. Data are taken from the Federal Statistical Office and the Offices of the Laender.

Table 3: Extensive margins of trade and firm-level productivity - cross-section 2014

	Imports		Exports	
	West Germany	East Germany	West Germany	East Germany
1.				
Number of products	0.865	0.744	0.360	0.421
	(0.000)	(0.000)	(0.000)	(0.012)
2.				
2-5 products	40.469	2.324	31.980	35.752
	(0.000)	(0.750)	(0.000)	(0.000)
6-10 products	49.992	54.587	52.824	80.421
	(0.000)	(0.000)	(0.000)	(0.000)
11-25 products	67.862	80.889	70.288	65.249
	(0.000)	(0.000)	(0.000)	(0.000)
26-49 products	87.681	88.391	67.639	56.174
	(0.000)	(0.000)	(0.000)	(0.000)
50 and more products	128.502	116.806	90.622	96.711
	(0.000)	(0.000)	(0.000)	(0.000)
3.				
Number of countries	4.680	7.863	1.259	1.930
	(0.000)	(0.000)	(0.000)	(0.000)
4.				
2-5 countries	36.879	24.306	33.668	24.997
	(0.000)	(0.001)	(0.003)	(0.004)
6-10 countries	66.975	75.325	56.967	22.635
	(0.000)	(0.000)	(0.000)	(0.015)
11-25 countries	114.809	132.425	74.604	109.893
	(0.000)	(0.000)	(0.000)	(0.000)
26-49 countries	147.330	219.701	78.246	96.165
	(0.000)	(0.009)	(0.000)	(0.000)
50 and more countries	243.292	262.926	109.015	71.925
	(0.000)	(0.002)	(0.000)	(0.000)

Note: The Table shows the results from a regression of firm-level log labor productivity on exports or imports across the East and West of Germany 1. for the number of goods traded, 2. along the extensive margins of goods traded, 3. for the number of countries traded with, 4. along the extensive margins of countries traded with. In all models further controls include the number of employees, the squared term of number of employees, 2-digit industry dummies and a constant. The reference group is trade of 1 good or trade with 1 country. p-values are shown in parentheses, they are based on heteroskedasticity-consistent robust standard errors. Author's computations based on data from the Federal Statistical Office and the Offices of the Laender.

Table 4: Extensive margins of trade and firm-level productivity - panel analysis 2009-2014

	Imports		Exports	
	West Germany	East Germany	West Germany	East Germany
1.				
Number of products	0.819	0.521	0.188	-0.511
	(0.061)	(0.115)	(0.031)	(0.523)
2.				
2-5 products	-0.426	0.693	3.612	7.448
	(0.833)	(0.877)	(0.040)	(0.141)
6-10 products	4.472	32.865	4.983	6.349
	(0.192)	(0.103)	(0.096)	(0.316)
11-25 products	15.718	-4.912	6.442	30.985
	(0.018)	(0.862)	(0.046)	(0.093)
26-49 products	17.231	4.635	7.286	-58.970
	(0.011)	(0.834)	(0.055)	(0.368)
50 and more products	30.009	28.591	10.077	-110.892
	(0.000)	(0.113)	(0.044)	(0.406)
3.				
Number of countries	2.933	-1.203	0.682	-2.923
	(0.021)	(0.716)	(0.029)	(0.494)
4.				
2-5 countries	2.477	0.011	3.269	0.144
	(0.202)	(0.998)	(0.170)	(0.956)
6-10 countries	5.189	19.596	0.853	12.852
	(0.039)	(0.094)	(0.840)	(0.066)
11-25 countries	11.047	-16.380	6.386	46.277
	(0.001)	(0.620)	(0.222)	(0.001)
26-49 countries	69.003	24.296	6.255	-70.685
	(0.120)	(0.453)	(0.377)	(0.491)
50 and more countries	110.629	17.230	59.014	-51.104
	(0.066)	(0.838)	(0.201)	(0.570)

Note: The Table shows the results from a fixed effects panel regression of firm-level log labor productivity on exports or imports across the East and West of Germany 1. for the number of goods traded, 2. along the extensive margins of goods traded, 3. for the number of countries traded with, 4. along the extensive margins of countries traded with. In all models further controls include the number of employees, the squared term of number of employees, 2-digit industry dummies as well as year dummies, and a constant. The reference group is trade of 1 good or trade with 1 country. p-values are shown in parentheses, they are based on heteroskedasticity-consistent robust standard errors. Author's computations based on data from the Federal Statistical Office and the Offices of the Laender.