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What makes a high-quality exporter? Evidence from Germany

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Abstract

This paper uses a tailor-made newly available data set to investigate for the first time the links between the quality of input factors and the quality of exports in enterprises from manufacturing industries in Germany, one of the leading actors on the world market for goods. The paper demonstrates that in German manufacturing industries exporters of high-quality goods tend to use high-quality inputs, while the firm size is not related at all to export quality.

All computations were done at the Research Data Centre of the Statistical Office of Berlin-Brandenburg in Berlin. The firm-level data used are strictly confidential but not exclusive; see http://www.forschungsdatenzentrum.de/datenzugang.asp for information on how to access the data. To facilitate replications the Stata do-file used is available from the author on request.
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1. Motivation

High product quality is often regarded as a decisive characteristic of goods exported by German manufacturing firms. In a recent annual report published by the German Ministry of Economics and Technology it is argued that 40 percent of German exports are investment goods, and that for many of these goods quality is the most important factor, while demand is comparably price-inelastic (see Bundesministerium für Wirtschaft und Technologie 2011, p. 16). High-quality investment goods that are highly attractive for customers in foreign countries are sold for a high price. The same holds for durable consumer goods like cars or kitchens.

Given this high importance of the quality of goods for German exports it comes as a surprise that the characteristics of high-quality exporters have not been investigated econometrically in the literature.[1] Bastos and Silva (2010, p. 99) call the quality of exports and its drivers "a relatively unexplored dimension of firms' cross-border activities". While a large number of studies use firm-level data to look at the link between firm characteristics and exports of German firms in general[2], none of these papers deals with the quality of the goods exported. This paper intends to fill this gap.

A comprehensive theoretical model of a firm that maximizes profits by choosing an optimal mix of inputs of different quality to produce outputs of an optimal quality which can be used to derive a set of hypotheses for an econometric investigation of the characteristics of high-quality exporters is lacking. Therefore, the empirical models used in this study are based on hypotheses that are of a somewhat *at hoc* character and that make use of knowledge of the export performance of German manufacturing firms.

First of all, we expect that there is a positive link between the quality of inputs used in a firm and the quality of its products - "garbage in, garbage out". Here, the quality of the workforce, research and development activities by a firm that aim to improve the products, and the quality of inputs bought from other firms are expected to play a decisive role.

Another characteristic of a firm besides the quality of the inputs used that might be expected to be linked to the quality of exports is firm size. It is a stylized fact that firm size and exports are positively related. This positive link between exports and firm size is due to fixed costs of exporting and efficiency advantages of larger firms due to scale economies, advantages of specialization in management and better conditions on the markets for inputs. Large firms can be expected to have cost advantages on credit markets while small firms often face higher restrictions on the capital market leading to a higher risk of insolvency and illiquidity. Furthermore, there might be disadvantages of small firms in the competition for highly qualified employees. While these considerations point to an advantage of larger firms when it comes to the production and export of high-quality goods anecdotal evidence of German firms of small to medium size that are so-called "hidden champions" on the world market for high-quality goods abounds. The role of firm size in making a high-quality exporter, therefore, is a topic to be investigated empirically.

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[1] To the best of my knowledge there are no such econometric studies for other countries besides Germany, too. Bastos and Silva (2010) use Portuguese firm-level data on exports by product and destination market to demonstrate that export quality increases systematically with distance, and tends to be higher in shipments to richer nations. These authors do not investigate the role of firm characteristics like input quality or firm size for export quality.

[2] See Wagner (2011a) for a survey of 51 empirical studies on exports and firm characteristics based on German firm level data that were published between 1991 and 2011 and Wagner (2011b) for an econometric investigation based on new comprehensive longitudinal firm level data.

This paper uses a tailor-made newly available data set (described in detail in section 2) to investigate for the first time the links between the quality of input factors and firm size on the one hand and the quality of exports on the other hand. To anticipate the most important finding, the paper demonstrates that in German manufacturing industries exporters of high-quality goods tend to use high-quality inputs, while firm size is not related at all to export quality.

2. Data and measurement issues

The lack of empirical studies on the characteristics of high-quality exporters is due to the fact that until most recently suitable data at the level of the firm that could be used in an econometric investigation were not available. The empirical investigation here uses a tailor-made data set that combines for the first time high quality firm-level data from three official sources.

The first source is the regular survey of establishments from manufacturing industries performed by the Statistical Offices of the German federal states. The survey covers all establishments from 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 (see Malchin and Voshage (2009) for details). For this study establishment data were aggregated to the enterprise level to match the unit of observation in the other data sources (described below). From this survey information on the number of employees in the firm, the sum of wages paid, and detailed industry affiliation is taken.

The second source of data is the cost structure survey for enterprises in the manufacturing sector. This survey is carried out annually as a representative random sample survey. The sample is stratified according to the number of employees and the industries; all firms with 500 and more employees are covered by the cost structure survey (see Fritsch et al. 2004). This survey is the source for information on the sum of total sales and on the amount of spending for research and development (R&D) activities by a firm.

Information on the goods traded internationally is available from the statistic on foreign trade (*Außenhandelsstatistik*). This statistic is based on two sources. One source is the reports by German firms on transactions with firms from countries that are members of the European Union (EU); these reports are used to compile the so-called *Intrahandelsstatistik* on intra-EU trade. The other source is transaction-level data collected by the customs on trade with countries outside the EU (the so-called *Extrahandelsstatistik*).[3]

Data in the statistic of foreign trade are transaction-level data, i.e. they relate to one transaction of a German firm with a firm located outside Germany at a time. For the reporting years 2009 and 2010 these transaction-level data have been aggregated at the level of the exporting firm for the first time. Using the firms' registration number for turnover tax statistics these data were matched with the enterprise register system (*Unternehmensregister-System*) and with the enterprise level data from the two other sources discussed above. For each exporting or importing firm that reported either to the statistic on intra-EU trade, or to the statistic on trade with countries outside the EU, we know from the data the value and the volume of exports and imports for the ten most important exported goods.

With these data it is possible to investigate the relationship between the quality of goods exported and the quality of the inputs used in the production of goods inside the firm.

[3] Note that firms with a value of exports to EU-countries that does not exceed 400,000 Euro in 2009 do not have to report to the statistic on intra-EU trade. For trade with firms from non-member countries all transactions that exceed 1,000 Euro are registered. For details see Statistisches Bundesamt, Qualitätsbericht Außenhandel, Januar 2011.

The quality of exported goods is defined as the unit value of exports and computed as value of exports (measured in Euro) over quantity of exports (measured in tons). In the data set used here we have information on the value of exports and the quantity of exports for the ten most important products (measured by the value of exports) exported by a firm. For firms that exported more than one good the unit value of exports is the weighted sum of the unit values of the (up to ten) different goods exported, and the weights are the shares of the value of exports of a good in the total exports of the firm of these (up to ten) goods. The unit value of exports is expressed in percentage of the mean value of unit values in the 4digit industry to take care of differences across industries due to the nature of the products (e.g., mobile phones and cement). This is the index of the quality of exported goods used in the empirical analysis.

The quality of inputs used by a firm is measured by three variables:

Human capital intensity is measured by the wage per employee paid by the firm (in Euro). Unfortunately, there is no information on the qualification of the employees (e.g., the share of employees with a university degree, or the share of employees that successfully passed the exams following an apprenticeship) of the firms in the data used. However, Wagner (2012a) uses a unique different data set to demonstrate that in German manufacturing firms the average wage is a useful proxy variable for the qualification of the employees.

R&D intensity is measured by expenditures on research and development over total turnover (in percent). This variable is used as a measure of the innovation orientation of a firm.

The quality of imports is measured in the same way as the quality of exported goods. This index is used as a measure for the quality of imported inputs.[4]

The empirical models include the number of employees (also included in squares to take care of non-linearity) to control for any relationship between firm size and the quality of exported goods. Furthermore, a complete set of 4-digit level industry dummy variables is included to control for the role of industry-specific factors related to the link between input quality and quality of exported goods.

Given that the East German economy still differs in many respects from the West German economy, especially with regard to exporting (see Wagner (2008)), and that the number of exporting firms is small in East Germany this study looks at West German manufacturing enterprises only.

All computations are performed for two years, 2009 and 2010. In 2009, the value of German exports of goods declined by 18.4 percent compared to 2008. This was followed by an increase in exports by 18.5 percent in 2010 (Statistisches Bundesamt 2012, p. 414). Therefore, a look at these two very different years can be considered as a robustness check to make sure that the results reported are not specific for a crises or recovery period.

3. Empirical findings

Descriptive statistics for the enterprise characteristics considered in this study are reported in the Appendix in Table I[5]. Evidently, firms are rather heterogeneous. This is not surprising at all for the number of employees (where the values for the percentiles reported range from just

[4] Note that the data set at hand does not contain information about intermediate goods purchased from German firms and on the quality of these inputs.

[5] Note that minimum and maximum values cannot be reported because they refer to a single enterprise and, therefore, are confidential. The correlation matrices for the two years that are reported in Appendix-Table II do not reveal any high positive or negative values for the variables used as independent variables in the empirical models used here.

above the cut-off point of 20 employees applied in the survey the data are taken from to more than 2,600 employees), the wage per employee (that is some four times the value of the first percentile in the 99th percentile), the R&D intensity (where the majority of firms does not report any R&D spending at all) and the index of the quality of imported inputs (where some firms report no imports at all[6], and the importers report imported inputs that vary widely in their quality). However, it might come as a surprise that many exporters from manufacturing industries in Germany do export low quality goods – the median value of export quality of the firms is only half of the mean value in both years.[7]

What makes an exporter of high quality goods, and how is the quality of inputs used in a firm related to the quality of exported outputs? To investigate this question empirical models are estimated with the index of the quality of exported goods as the dependent variable and the firm characteristics discussed above (firm size, R&D intensity, human capital intensity, and quality of imported inputs) as the independent variables, controlling for industry affiliation by including a full set of 4-digit industry dummy variables. Five variants of the empirical model are estimated – the first four variants each include one enterprise characteristic only, while model 5 includes all characteristics to see the ceteris paribus relationship of each characteristic with the quality of exported goods.

Results reported in Table I for Models 1 - 4 reveal that, considered separately, the three input quality measures (R&D intensity, human capital intensity, and quality of imported inputs) are positively and statistically highly significantly related to quality of exported goods (controlling for detailed industry affiliation of the enterprise at the 4-digit industry level). Firm size (that is measured by the number of employees, and that is also included as a squared term to control for a non-linear relationship) is not related with export quality – this is in line with anecdotal evidence that some successful exporters of high-quality goods are rather small "hidden champions". Results for Model 5 show that all these results hold ceteris paribus, too, in both years irrespective of the totally different macroeconomic situation on the export market. Controlling for firm size and industry affiliation a higher quality of inputs is positively related with a higher quality of inputs used in production.

The discussion of the results from the empirical models so far only considered the statistical significance of the links between input and output quality. Evidently, statistically highly significant links can be irrelevant from an economic point of view if a ceteris paribus change of considerable size in a firm characteristic leads to a tiny change in the (estimated) quality of exported goods only. To see whether the statistically significant links are relevant from an economic point of view, too, the estimated change in export quality that is caused by a ceteris paribus increase by one standard deviation of the respective firm characteristic is computed based on the estimated regression coefficients from Model 5. For 2009, an increase by one standard deviation is linked to an increase in the index of export quality by 20 for R&D intensity, by 9 for human capital intensity and by 99 for import quality. For 2010, the respective figures are 17 (for R&D intensity), 8 (for human capital intensity) and 76 (for import quality). Given the mean value of 100 and the median value of about 50 for the index of the quality of exported goods these estimated changes are large from an economic point of view. Input quality does matter for export quality.

[6] This holds for 9 percent of the enterprises in the sample in 2009 and for 8 percent in 2010.

[7] Note that by construction only exporting firms are in the sample of firms used in this investigation.

4. Discussion

The bottom line, then, is that according to the empirical results presented in this study the exporters of high-quality goods in German manufacturing industries tend to use high-quality inputs, and that firm size is not related at all to export quality.

This link between input quality and output quality documents a correlation and should not be interpreted as a causal link from input quality to output quality. The huge and emerging literature on the links between international activities of heterogeneous firms and firm performance[8] has demonstrated that one can observe both self-selection of "better" firms on international markets and improvement of firms due to international activities. With the cross-section data at hand it is impossible to investigate whether the exporters of high-quality goods used high-quality inputs to produce high-quality products for the national market already before they started to export, or whether the export activity induced the firms to upgrade their inputs and their products (or whether both is the case).

Another open question that has not been dealt with in this paper is the potential role played by unobserved inputs like management quality for the quality of exports. If these unobserved firm characteristics are correlated with the observed characteristics that are included in the empirical model used to investigate the links between input quality and export quality, the estimated regression coefficients are biased and any conclusions based on the estimates have to take this potentially large bias into account. A standard solution to take at least those unobserved factors into account that do not change over the period under investigation is the addition of fixed firm effect to an empirical model that is estimated for panel data that covers all years from these period. This, however, is no feasible strategy here. As of today, the data used to construct the index of the quality of export goods are available for the years 2009 and 2010 only. Furthermore, both the export quality and the quality of inputs tend to be highly persistent at the level of the enterprise. Estimates from fixed effects panel data models that are based on the variation of variables over time inside a firm only, therefore, are no panacea here.

That said, the reported statistically significant and economically important correlation between the quality of observed inputs and the quality of exported goods should be regarded as an interesting new fact that might motivate further investigations of the causes and consequences of quality differences of internationally traded goods.

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[8] For surveys of this literatur see Bernard et al. (2012), Melitz and Redding (2014) and Wagner (2012b).

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Table I: Quality of exported goods and enterprise characteristics: West Germany

Entrerprise characteristic		1	2	3	4	5
2009						
Number of employees	ß	0.0031				-0.0089
	p	0.389				0.177
Number of Employees (squared)	ß	-3.03e-8				7.20e-8
	p	0.346				0.209
R&D expenditures / total sales (percent)	ß		7.706			6.164
	p		0.000			0.000
Human capital (wage per employee; Euro)	ß			0.0013		0.00085
	p			0.003		0.032
Quality of imported inputs (index)	ß				0.338	0.336
	p				0.000	0.000
Constant	ß	99.155	89.090	53.230	66.195	29.989
	p	0.000	0.000	0.000	0.000	0.055
4-digit industry controls		yes	yes	yes	yes	yes
No. of enterprises		5,933	5,933	5,933	5,933	5,933
2010						
Number of employees	ß	0.0064				-0.00127
	p	0.272				0.860
Number of Employees (squared)	ß	-5.97e-8				4.15e-9
	p	0.245				0.947
R&D expenditures / total sales (percent)	ß		6.725			5.214
	p		0.000			0.000
Human capital (wage per employee; Euro)	ß			0.0013		0.00073
	p			0.001		0.073
Quality of imported inputs (index)	ß				0.273	0.270
	p				0.000	0.000
Constant	ß	98.295	91.051	54.292	72.684	39.656
	p	0.000	0.000	0.000	0.000	0.008
4-digit industry controls		yes	yes	yes	yes	yes
No. of enterprises		6,072	6,072	6,072	6,072	6,072

Note: OLS regressions; dependent variable: Index of quality of exported goods (see section 2 for definition). ß is the estimated regression coefficient, p is the prob-value (based on heteroscedasticity-consistent standard errors).For a detailed definition of the variables see text.

Appendix - Table I: Descriptive statistics – Enterprise characteristics, West Germany

Entrerprise characteristic	Mean	sd	p1	p50	p99
2009					
No. of enterprises: 5,933					
Quality of exported goods (index)	100.00	234.03	0.353	47.40	992.82
Number of employees	343.26	2,683.88	22	110.33	2,699.3
R&D expenditures / total sales	1.416	3.271	0	0	15.358
Human capital (wage / employee)	35,343	10,447	14,915	34.577	64,128
Quality of imported inputs (index)	100	292.99	0	29.34	1,193.5
2010					
No. of enterprises: 6,072					
Quality of exported goods (index)	100.00	237.15	0.650	47.72	833.16
Number of employees	319.49	2,313.16	23	106.54	2,626.3
R&D expenditures / total sales	1.331	3.261	0	0	14.455
Human capital (wage / employee)	36,563	10,618	15,132	35,966	65,492
Quality of imported inputs (index)	100	281,71	0	28.82	1,123.4

Note: For a detailed definition of the enterprise characteristics see text. p1, p50 and p99 refer to the 1st, 50th and 99th percentile of the distribution of the characteristic (minima and maxima cannot be reported due to violation of privacy).

Appendix - Table II: Correlation matrix – Enterprise characteristics, West Germany

	Number of Employees	R&D expenditure / total sales	Human capital (wage / employee)
2009			
R&D expenditures / total sales	0.105 (0.000)		
Human capital (wage / employee)	0.093 (0.000)	0.255 (0.000)	
Quality of imported inputs (index)	0.018 (0.154)	0.039 (0.003)	0.018 (0.167)
2010			
R&D expenditures / total sales	0.086 (0.000)		
Human capital (wage / employee)	0.097 (0.000)	0.264 (0.000)	
Quality of imported inputs (index)	0.015 (0.234)	0.039 (0.003)	0.022 (0.083)

Note: For a detailed definition of the enterprise characteristics see text. Significance level (p-value) in brackets.