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Credit Constraints and the Extensive Margins of Exports: First Evidence for German Manufacturing

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Abstract
This paper uses a unique newly constructed data set to investigate for the first time the link between credit constraints and the extensive margins of exports in Germany, one of the leading actors on the international market for goods. In line with theoretical considerations and comparable results reported for a small number of other countries the author reports a negative impact of credit constraints on both the number of goods exported and the number of export destination countries that is both statistically highly significant and large from an economic point of view.

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1 Motivation

Insufficient access to credit at reasonable costs can hamper or even prevent exporting. Exporting involves extra costs to enter foreign markets (e.g., for the acquisition of information about a target market, for the adaption of products to foreign legal rules or local tastes, for instruction manuals in a foreign language and for setting up a distribution network) that often have to be paid up front and that to a large extent are sunk costs. Firms need sufficient liquidity to pay for these costs, and constraints in the credit market may be binding. Furthermore, it tends to take considerably more time to complete an export order and to collect payment after shipping compared to a domestic order, and this increases exporters' working capital requirement. The higher risk of export activities (including exchange rate fluctuations and the risk that contracts cannot be as easily enforced in a foreign country) adds to these liquidity requirements. Therefore, whether a firm is financially constrained or not can be considered as one of the characteristics of a firm that are relevant for the decision to export.

While this has been common knowledge for business managers for a long time, economists only recently started to incorporate these arguments in theoretical models of heterogeneous firms and to test the implications of these models econometrically with firm-level data. Chaney (2013), Muuls (2008) and Manova (2013) introduce credit constraints into the seminal model of heterogeneous firms and trade by Melitz (2003) to discuss the role of these frictions for the export decision.[1]

Starting with the pioneering study by Greenaway, Guariglia and Kneller (2007) a growing number of empirical papers looked at the links between financial constraints and export activities using data at the level of the firm. Wagner (2014a) surveys 32 empirical studies that cover 14 different countries plus five multi-country studies.[2] While the studies use different measures of financial constraints and apply different econometric methods to investigate the links between these constraints and export activities, the big picture can be summarized as follows:

[1] A detailed discussion of the theoretical models is far beyond the scope of this empirical paper; for a synopsis see Egger and Kesina (2013) and Minetti and Zhu (2011).

[2] See Wagner (2015) for a discussion of the (small) literature on the links between credit constraints and imports and for empirical evidence for Germany.

Financial constraints are important for the export decisions of firms – exporting firms are less financially constrained than non-exporting firms. Studies that look at the direction of this link usually report that less constraint firms self-select into exporting, but that exporting does not improve financial health of firms.

Most of these empirical studies focus on the link between credit constraints and export participation or the share of exports in total sales. Only seven studies for four countries deal with the extensive margins of exports – the number of goods exported and the number of countries exported to. Given that the extra costs of exporting often have to be paid for each good that is exported and for each destination country we expect that credit constraints will be negatively related to these extensive margins. Studies for Belgium (Muuls 2008, 2015), France (Askenazy et al. 2011), Italy (Forlani 2010, Secchi et al. 2014, Tamagni 2013) and China (Manova et al. 2011) report results that are in line with these hypotheses.

This paper contributes to the literature by reporting first evidence on the link between credit constraints on the one hand and the number of goods exported and the number of destination countries for Germany, one of the leading actors on the world market for goods.[3] To anticipate the most important results, we find that a less favorable credit rating score (that is used to measure the degree of financial constraints) is negatively related to both extensive margins of exports.

The rest of the paper is organized as follows. Section 2 discusses the data and measurement issues. Section 3 presents the results of the econometric investigation. Section 4 reports results of robustness checks that use alternative estimation methods. Section 5 concludes.

2 Data and Measurement Issues

This paper uses a unique newly constructed data set that merges high-quality data at the enterprise level from various sources. Data are based on information on exports collected for the statistics on foreign trade. These data are merged with a score that measures the credit-worthiness of the firm and that is supplied by the leading German credit-rating agency, *Creditreform*. Further control variables are

[3] For studies that look at the links between credit constraints, participation in exporting, and the share of exports in total sales see Buch et al. (2010), Arndt et al. (2012) and Wagner (2014b).

taken from regular surveys performed by the Statistical Offices. The data used are described in detail in this section.

Exports: Data on exports are based on customs' records about goods exported to countries outside the European Union and on information delivered by firms about exports to EU member countries (that exceed a reporting threshold of 400,000 Euro). These transaction-level data were aggregated at the level of the exporting enterprise by the German Statistical Office for the first time for the reporting year 2009. These data are available for the reporting year 2010, too. The data include information at the firm level about the number of different goods exported (measured at the 8-digit level of classification) and the number of destination countries of exports. These firm-level data are the basis for the aggregate figures of goods exported reported by the Statistical Office. Note that by construction the sample used in this study includes exporting firms only.

Credit rating score: The extent of financial constraints faced by a firm is measured by various variables in the literature (see Musso and Schiavo (2008) for a discussion and Wagner (2014a) for a survey of the literature that looks at financial constraints and exports). There is evidence that not all measures for financial constraints used can be considered as valid measures. Farre-Mensa and Ljungqvist (2013) recently evaluated how well five popular measures from the finance literature that are based on balance-sheet data identify firms that are financially constraint. They report that none of these five measures identifies firms that behave as if they were constrained. An alternative way to measure credit constraints that has been used in studies for Belgium (Muuls 2008 and 2015), Germany (Wagner 2014b) and Italy (Secchi, Tamagni and Tomasi 2014; Tamagni 2013) is the use of a credit rating score supplied by a credit rating agency. Compared to other widely used measures that are based on balance sheets information or subjective assessments collected in surveys, this score mirrors the credit market experts' view on the creditworthiness of a firm, and it is heavily relied upon by banks and firms in their day-to-day decisions. Usually a score is based on a number of firm characteristics, including liquidity, turnover, capital structure, information on payment behavior, legal form, industry, firm age, productivity and firm size. Although the score is clearly endogenous to the firm's performance and characteristics, it is not directly affected by its exporting behavior, given that exports are not used in constructing the index. Important

advantages are that the score is determined independently by a private firm, is firm-specific, varies over time on an annual basis and allows for a measure of the degree of credit constraints rather than classifying firms as constrained or not (see Muuls 2008, 2015).

In this study we use the credit rating score supplied by *Creditreform*, the leading credit rating agency in Germany. The score is based on 15 firm characteristics, including liquidity, turnover, capital structure, information on payment behavior, legal form, industry, firm age, productivity and firm size (for details, see Rossen 2012). The score takes values from 100 to 600, were Creditreform suggests that 100 to 149 should be considered as excellent, 150 to 199 as very good, 200 to 249 as good, 250 to 299 as medium, 300 to 349 as weak, 350 to 419 as high risk of failure, and firms with a score of 420 or more are classified as firms that should not be considered as partners in trade and credit relations.

Data on the credit rating score of manufacturing enterprises were supplied by Creditreform. For several firms the information is updated during a year. The information supplied always refers to the last update during the reporting year. In the empirical models estimated in this study the credit rating score is lagged by one year so that it refers to the creditworthiness of an exporting firm at the start of the year under consideration. To take care of a non-linear relationship between credit constraints and the extensive margins of exports the credit rating score is included in squares in the empirical models, too. These data from Creditreform are used for the first time in this paper to investigate the link between credit constraints and the extensive margins of exports.

In the econometric investigation on the relation between exports and the credit rating score information on a number of firm characteristics that are known to be related to export activities are included as control variables.[4] All control variables are lagged by one year to take care of any problems related to endogeneity. Information on these control variables are based on the report for establishments in manufacturing industries, a survey conducted regularly by the German statistical offices. This 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

[4] Given that these variables are used as control variables only they are not discussed in detail here.

law. For this study the information collected at the establishment level has been aggregated at the enterprise level (see Malchin and Voshage (2009) for details). The following control variables are included:

Firm size: The positive relationship between exports and firm size qualifies as a stylized fact. Firm size is measured here by the number of employees. To take care of a non-linear relationship the number of employees is included in squares, too.

Productivity: The positive relationship between exports and productivity is another stylized fact that has been documented in a number of recent empirical studies surveyed in Wagner (2012a). Germany is a case in point. Productivity is measured here as labor productivity and defined as total turnover per employee. Information on the capital stock of the firms is not available in the data, so more elaborate measures of total factor productivity cannot be used in this study.

Industry: Dummy variables for 2-digit-industries are included in the empirical models to control for industry specific effects like competitive pressure, policy measures, demand shocks etc.

The data from the three sources were merged inside the research data center of the statistical office. For West Germany[5] we have information on export activities in 2009 and on the credit rating score (plus information on the control variables) in 2008 for 3,449 firms; the respective number for 2010 / 2009 is 3,551 exporters.

3 Credit Rating Score and Extensive Margins of Export: Econometric Investigation

Export activities involve extra costs related to the entry into foreign markets that often have to be paid in advance, and firms have to have (access to) sufficient liquidity to cover these costs. Given that the extra costs of exporting often have to

[5] There are still large differences between enterprises from manufacturing industries in West Germany and in former communist East Germany even some 20 years after the unification back in 1990, and this holds especially for international trade (see Wagner 2014c). Both parts of Germany have to be investigated separately. Given the small number of firms from East Germany in the sample we focus on West German firms in this study only.

be paid for each good that is exported and for each destination country we expect that credit constraints will be negatively related to these extensive margins. Therefore, a better credit rating score of the type used here (described in detail in Section 2) can be expected to be positively related to export activities for three reasons: First, by construction, liquidity of the firm is used to compute the value of the credit rating score. Second, the score mirrors the credit market experts' view of the creditworthiness of the firm. Therefore, the score value plays a role in the decision over a credit application, and it influences the rate of interest a firm has to pay. Third, the score value can be used by potential trading partners in foreign countries to decide whether and to which conditions they would be willing to do business with a firm. If a bad rating keeps potential foreign business partners from trading with a firm this reduces foreign demand a firm is facing, and the negative effect of a high rating score on exports due to a shortage of credit or high credit costs will be amplified by this negative effect of the high score on foreign demand for a firm's products.

These considerations about the link between the credit rating score – a higher value of which by construction indicates a lower degree of creditworthiness and a higher degree of credit constraints – and the extensive margins of export lead to two empirically testable hypotheses:

H1: Firms with a higher credit rating score will export a smaller number of goods.

H2: Firms with a higher credit rating score will export to a smaller number of countries.

Descriptive statistics for the credit rating score, the number of goods exported and the number of destination countries of exports are reported in Table 1. While there are many firms that export only a small number of goods and to a small number of destination countries, a small number of firms trade many goods and with many countries.[6]

[6] For a detailed analysis see Wagner (2012b). Note that the maximum number of goods and countries are confidential because this information refers to one single firm and, therefore, cannot be revealed.

Table 1: Descriptive statistics for credit rating scores, number of exported goods and number of destination countries

	No. of firms	*mean*	*sd*	*p1*	*p25*	*p50*	*p75*	*p99*
Credit rating score 2008	3,449	194.5	38.27	108	172	196	211	293
Number of exported goods 2009	3,449	51.9	104.3	1	6	17	54	486
Number of destination countries 2009	3,449	31.0	23.24	1	14	26	43	106
Credit rating score 2009	3,551	200.4	41.3	113	176	200	216	306
Number of exported goods 2010	3,551	57.6	110.6	1	6	19	62	503
Number of destination countries 2010	3,551	33.4	24.65	1	15	28	47	110

Note: p1, p25 etc. are the first, twenty-fifth etc. percentile of the distribution.

H1 and H2 are each tested by using OLS to estimate four empirical models that regress either the number of exported goods or the number of destination countries of exports on the credit rating score and a set of control variables. In Model 1 the control variables include 2-digit level industry variables only, while in Model 2 firm size (measured by the number of employees, and also included in squares) and labor productivity is controlled for, too. Model 3 and Model 4 augment Model 1 and Model 2 by including the squared value of the credit rating score to test for a non-linear relationship between the extensive margin of exports and the score. These four empirical models are estimated for both extensive margins and for two years. Results from these 16 regressions are reported in Table 2.

Table 2: Credit rating score and extensive margins of exports: OLS results

		Model 1	Model 2	Model 3	Model 4
Number of goods exported					
Credit rating score 2008	ß	–0.357	–0.206	–2.360	–0.951
	P	0.000	0.000	0.000	0.002
Credit rating score 2008	ß			0.0049	0.0018
(squared)	p			0.000	0.013
Estimated average change for Increase of score by one std. dev.		–13.660	–7.896	–9.828	–6.548
(p-value)		0.000	0.000	0.000	0.000
Credit rating score 2009	ß	–0.232	–0.101	–1.410	–0.845
	P	0.000	0.024	0.000	0.000
Credit rating score 2009	ß			0.0026	0.002
(squared)	p			0.000	0.000
Estimated average change for Increase of score by one std. dev.		–9.583	–4.165	–11.005	–5.116
(p-value)		0.000	0.024	0.000	0.002
Number of destination countries					
Credit rating score 2008	ß	–0.113	–0.093	–0.514	–0.316
	P	0.000	0.000	0.000	0.000
Credit rating score 2008	ß			0.001	0.0005
(squared)	p			0.000	0.001
Estimated average change for Increase of score by one std. dev.		–4.314	–3.549	–3.547	–3.145
(p-value)		0.000	0.000	0.000	0.000
Credit rating score 2009	ß	–0.103	–0.087	–0.365	–0.292
	P	0.000	0.000	0.000	0.000
Credit rating score 2009	ß			0.0006	0.0004
(squared)	p			0.000	0.000
Estimated average change for Increase of score by one std. dev.		–4.274	–3.617	–4.591	–3.877
(p-value)		0.000	0.000	0.000	0.000

Note: ß is the estimated coefficient from an OLS regression, p is the prob-value which is based on heteroscedasticity-robust standard errors. Model 1 and Model 3 control for industry affiliation at the 2-digit level, Model 2 and Model 4 include the following control variables: labor productivity, number of employees (also included in squares), and industry dummies at the 2-digit level. All models include a constant, too. For number of cases and descriptive statistics see Table 1.

A higher credit rating score that by construction indicates a higher degree of credit constraints goes hand in hand with a smaller number of exported goods and a smaller number of destination countries. This can be seen immediately from the results reported for the regression coefficient of the credit rating score in Model 1 and Model 2. The results for Model 3 and Model 4 point to a non-linear link that is u-shaped. Here an increase in the credit rating score goes hand in hand with a smaller number of exported goods and a smaller number of destination countries up to a certain point, but with a larger number of exported goods and a larger number of destination countries if the score value increases further beyond the minimum of the estimated u-shaped relation. However, a closer inspection of the estimated regression coefficients reveals that the estimated minimum is reached for a score value that is large compared to the distribution of the score documented in Table 1. Therefore, the estimated u-shaped relation should be interpreted to indicate a decrease in both margins of exports with an increase in the credit rating score that incurs at a decreasing rate.

The statistically highly significant estimated negative effects of a higher credit rating score on both extensive margins of exports are large from an economic point of view. This can be seen from the estimated average change in the number of goods exported and in the number of destination countries that occurs when the score increases by one standard deviation.[7] According to the most complete Model 4 the number of exported goods is reduced by 5 to 6.5, while the number of destination countries is reduced by 3 to 4. Both effects are large compared to the average values reported in Table 1 for the number of exported goods (52 in 2009 and 58 in 2010) and for the number of destination countries (31 in 2009 and 33 in 2010).

The bottom line, then, is that the results of the empirical investigation are fully in line with the two hypotheses H1 and H2. Firms with a higher degree of financial constraints export a smaller number of goods and they export to a smaller number of destination countries.

[7] The average change and its prob-value are estimated using the command `mchange` that is part of the Stata-package SPost13; see Long and Freese (2014: 495f).

4 Robustness Checks: Results for Alternative Estimation Methods

The dependent variables in the empirical models used here – the number of exported goods and the number of destination countries in exports – are count data that can only take positive integer values equal to or larger than one (because by construction only firms that export to at least one country and one good are included in the sample). The use of OLS as an estimation method in Section 3 ignores this fact because both the number of destination countries and the number of goods exported are distributed over a rather broad range (see Table 1), and this justifies the application of OLS in estimating the empirical models. However, to take care of the count data nature of the dependent variables in the empirical models explicitly and as a robustness check all models were estimated by methods that are tailor made for this type of variables.

In a first step, negative binomial regression (nbreg) models were estimated that take care of the count data nature of the values for the dependent variables in the models.[8] Results are reported in Table 3. The big picture revealed by the signs and statistical significance of the estimated coefficients is identical to the one from OLS regressions in Table 2. The estimated average change for an increase in the credit rating score by one standard deviation has the same order of magnitude for model 1 in the OLS and in the nbreg regressions, and the same holds for model 3 when the number of destination countries is the dependent variable while the estimated changes are considerably larger here for model 2 and model 4. Note that the estimated average change of the number of goods exported for an increase in the credit rating score by one standard deviation is statistically insignificant for all models except model.

The negative binomial regression model applied here does not explicitly take account of the fact that by construction both dependent variables have no observations that take on the value of zero (because only firms that export at least one good to at least one country are included in the sample). In the population there are many firms that do not export at all. For these firms, both dependent

[8] A discussion of any details of this method is beyond the scope of this note; see Long and Freese (2014: 507).

Table 3: Credit rating score and extensive margins of exports: nbreg results

		Model 1	Model 2	Model 3	Model 4
Number of goods exported					
Credit rating score 2008	ß	–0.006	–0.004	–0.040	–0.018
	p	0.000	0.000	0.000	0.000
Credit rating score 2008 (squared)	ß			8.21e-5	3.53e-5
	p			0.000	0.000
Estimated average change for increase of score by one std. dev.		–10.698	–1.14e+8	3.465	–8.12e+7
(p-value)		0.000	0.476	0.811	0.475
Credit rating score 2009	ß	–0.003	–-0.001	–0.026	–0.014
	p	0.000	0.000	0.000	0.000
Credit rating score 2009 (squared)	ß			4.81e-5	2.49e-5
	p			0.000	0.000
Estimated average change for increase of score by one std. dev.		–7.553	–-1.24e+8	19.172	–1.09e+8
(p-value)		0.000	0.489	0.628	0.478
Number of destination countries					
Credit rating score 2008	ß	–0.003	–-0.003	–0.015	–0.008
	p	0.000	0.000	0.000	0.000
Credit rating score 2008 (squared)	ß			2.95e-5	1.31e-5
	p			0.000	0.005
Estimated average change for increase of score by one std. dev.		–3.741	–10.891	–3.352	–11.364
(p-value)		0.000	0.036	0.000	0.039
Credit rating score 2009	ß	–0.003	–0.002	–0.010	–0.008
	p	0.000	0.000	0.000	0.000
Credit rating score 2009 (squared)	ß			1.67e-5	1.17e-5
	p			0.000	0.000
Estimated average change for increase of score by one std. dev.		–3.520	–9.800	–4.126	–11.717
(p-value)		0.000	0.031	0.000	0.026

Note: ß is the estimated coefficient from a negative binomial regression, p is the prob-value which is based on heteroscedasticity-robust standard errors. Model 1 and Model 3 control for industry affiliation at the 2-digit level, Model 2 and Model 4 include the following control variables: labor productivity, number of employees (also included in squares), and industry dummies at the 2-digit level. All models include a constant, too. For number of cases and descriptive statistics see Table 1.

Table 4: Credit rating score and extensive margins of exports: tnbreg results

		Model 1	Model 2	Model 3	Model 4
Number of goods exported					
Credit rating score 2008	ß	–0.007	–0.004	–0.043	–0.020
	p	0.000	0.000	0.000	0.000
Credit rating score 2008 (squared)	ß			8.85e-5	3.87e-5
	p			0.000	0.000
Estimated average change for increase of score by one std. dev.		–9.906	–1.41e+9	10.645	–9.16e+8
(p-value)		0.000	0.571	0.684	0.569
Credit rating score 2009	ß	–0.004	[estimation	–0.028	[estimation
	p	0.000	not feasible]	0.000	not feasible]
Credit rating score 2009 (squared)	ß			5.30e-5	
	p			0.000	
Estimated average change for increase of score by one std. dev.		–7.145		45.796	
(p-value)		0.000		0.612	
Number of destination countries					
Credit rating score 2008	ß	–0.003	–0.003	–0.016	–0.008
	p	0.000	0.000	0.000	0.000
Credit rating score 2008 (squared)	ß			2.97e-5	1.32e+5
	p			0.000	0.006
Estimated average change for increase of score by one std. dev.		–3.755	–11.429	–3.367	–11.915
(p-value)		0.000	0.043	0.000	0.046
Credit rating score 2009	ß	–0.003	–0.002	–0.011	–0.008
	p	0.000	0.000	0.000	0.000
Credit rating score 2009 (squared)	ß			1.68e-5	1.17e-5
	p			0.000	0.000
Estimated average change for increase of score by one std. dev		–3.531	–10.210	–4.141	–12.178
(p-value)		0.000	0.037	0.000	0.031

Note: ß is the estimated coefficient from a zero-truncated negative binomial regression, p is the prob-value which is based on heteroscedasticity-robust standard errors. Model 1 and Model 3 control for industry affiliation at the 2-digit level, Model 2 and Model 4 include the following control variables: labor productivity, number of employees (also included in squares), and industry dummies at the 2-digit level. All models include a constant, too. For number of cases and descriptive statistics see Table 1.

variables are zero – but they are not in the sample. Zero-truncated count models are tailor-made for situations like this (see Long and Freese 2014, p. 519). As a further robustness check, all 16 models were estimated with a zero truncated negative binomial regression estimator.[9] Results are reported in Table 4. The big picture revealed is identical to the one based on the results for the nbreg – regressions.

The bottom line, then, is that the results from the robustness checks confirm the results from the simple OLS regressions reported in Table 2.

5 Concluding Remarks

This paper uses a unique newly constructed data set that merges high-quality data for German enterprises on the number of exported goods and the number of destination countries of exports collected for the statistics on foreign trade, a score that measures the credit-worthiness of the firm and that is supplied by the leading German credit-rating agency, *Creditreform*, and control variables taken from regular surveys performed by the Statistical Offices, to investigate for the first time the link between credit constraints and the extensive margins of exports in Germany. In line with theoretical considerations and comparable results reported for a small number of other countries we report a negative impact of credit constraints on both the number of goods exported and the number of export destination countries that is both statistically highly significant and large from an economic point of view. Access to finance and credit costs do matter for the extensive margins of exports.

Acknowledgements All computations were performed inside the research data center of the Statistical Office of Berlin-Brandenburg. The enterprise-level data from official statistics are confidential but not exclusive; see www.forschungsdatenzentrum.de for information on how to access the data. The data from the credit rating agency are proprietary; details are available from the author on request. To facilitate replication, the Stata do-file used to compute the results reported in this paper is available on request. I thank an anonymous referee for helpful comments on an earlier version of this paper.

[9] For details see Long and Freese (2014: 518ff.); the Stata command tnbreg was used.

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