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manufacturing enterprises**

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## **ABSTRACT**

This study uses newly available enterprise level data for firms from manufacturing industries in Germany to test for the link between credit constraints, measured by a credit rating score from the leading credit rating agency Creditreform, and exports. In line with hypotheses from theoretical model we find a positive link between a better credit rating score of a firm and both the probability that the firm is an exporter and a higher share of exports in total sales. This link, though statistically highly significant, is not very strong from an economic point of view. While empirical evidence for the hypothesis that credit constrained firms are less likely to start to export is at best weak, we find no evidence for a statistically significant difference in credit rating scores between firms that stopped to export and firms that continued to export.

**JEL classification:** F14

**Keywords:** Credit constraints, exports, Germany

\* All computations were performed inside the research data center of the Statistical Office of Berlin-Brandenburg. I thank Florian Köhler and Julia Höninger for preparing the project-specific data set that merges data from surveys performed by official statistics and data from a private credit rating agency. The enterprise level data from official statistics are confidential but not exclusive; see [www.forschungsdatenzentrum.de](http://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.

## 1. Motivation

Business managers are well aware of the fact that credit constraints can hamper or even prevent exporting. The reason is that 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 is common knowledge for practitioners, 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 (2005), Muuls (2008) and Manova (2010) 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.<sup>1</sup> In the Chaney (2005) model firms must pay extra costs in order to access foreign markets, and if they face liquidity constraints to

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<sup>1</sup> A detailed discussion of the theoretical models is far beyond the scope of this empirical paper; for a synopsis see Egger and Kesina (2010) and Minetti and Zhu (2011).

finance these costs, only those firms that have sufficient liquidity are able to export. The Muuls (2008) model has the same implication – firms are more likely to be exporters if they are less credit-constrained. In the Manova (2008) model firms that are more affected by credit constraints participate less likely in export markets, and if they do, they export less.

The basic idea that financial constraints matter for the export decision of a firm and the implications of the recent formal theoretical models are taken to firm level data in a number of micro-econometric studies (surveyed in section 2) for developed and developing countries. This paper contributes to this empirical literature by providing evidence for enterprises from manufacturing industries in Germany, one of the leading actors on the world market for goods. It uses a unique newly constructed data set that merges high-quality data at the enterprise level taken from surveys of the statistical offices with a credit rating score that measures the credit-worthiness of the firm (discussed in section 3) supplied by the leading German credit-rating agency Creditreform. The empirical investigation (presented in section 4) provides evidence on the links between credit constraints and exporting or not, the share of exports in total sales, starting to export, and stopping to export.

To anticipate the most important results, In line with hypotheses from theoretical model we find a positive link between a better credit rating score of a firm and both the probability that the firm is an exporter and a higher share of exports in total sales. This link, though statistically highly significant, is not very strong from an economic point of view. While empirical evidence for the hypothesis that credit constrained firms are less likely to start to export is at best weak, we find no evidence for a statistically significant difference in credit rating scores between firms that that stopped to export and firms that continued to export.

## **2. A survey of empirical studies on financial constraints and exports at the firm level**

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<sup>2</sup>. Table 1 is a tabular survey of 24 empirical studies that cover 13 different countries plus three multi-country studies.<sup>3</sup> As of today, we have evidence for countries that differ widely in the level of

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<sup>2</sup> Firm refers here to either the local production unit (establishment) or the legal unit (enterprise).

<sup>3</sup> The tabular survey does not include studies with aggregate data by Manova (2008), Jaud et al (2009), Chor and Manova (2010), Alvarez and Lopez (2011) and Felbermayr and Yalcin (2011). Furthermore, the following studies that use firm-level data to investigate related but different topics are excluded: Campa and Shaver (2002) use a sample of Spanish manufacturing firms to show that exporters' cash flows and capital investments are more stable than non-exporters' and find that liquidity constraints are less binding for exporters than for non-exporters. Bridges and Guariglia (2008) use U.K. firm level data to look at the effects of financial variables on firms' failure probabilities, differentiating firms into globally engaged (exporting or foreign owned) and purely domestic. They find that lower collateral and higher leverage result in higher failure probabilities for purely domestic than for globally engaged firms. They interpret this as evidence that global engagement shields firms from financial constraints. Buch et al. (2009) use German firm level data to analyze the impact of financial constraints on the decision to engage in foreign direct investment and on foreign affiliate sales. Damijan, Kostevc and Polanec (2010) investigate the causal relationship between the extent of external debt financing and the intensive margin of exports for firms of different size in Slovenia. They find evidence that taking on any additional finance help firms to expand exports. Guariglia and Mateut (2010) use a panel of UK firms to investigate the role of financial constraints for inventory investments. They find, inter alia, that firms that do not export and are not foreign owned exhibit higher sensitivity of inventory investments to financial constraints. Bas and Berthou (2011) study how financial constraints affect the decision of firms to import foreign technology embedded in capital goods. They use firm panel data from India and confirm the important role of financial factors. Badinger and Url (2012) use data for 178 Austrian exporting firms for the year 2008 to investigate the impact of export guarantees and find that the use of these guarantees have a large positive effect on firm-specific export performance. Eck et al. (2012) investigate the role of trade credits (that are extended bilaterally between firms and exist in the form of supplier credits and cash in advance) and find that these credits have a positive impact on German firms' exporting and importing activities. Felbermayr et al. (2012)

economic development. 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<sup>4</sup> can be summarized as follows: 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<sup>5</sup> report that less constraint firms self-select into exporting, but that exporting does not improve financial health of firms.

Two studies investigate the case of Germany that is the focus of this paper. Buch et al. (2010) combine enterprise data from a commercial data base (*Dafne*) and from the Deutsche Bundesbank's data base on foreign direct investment (*MiDi*) to investigate simultaneously the firm's decision to engage in foreign direct investment and to export. As regards exports, they report a positive link between cash flow and both the probability to export and the export volume, while the debt ratio is insignificant. The data used in this study suffer from a number of shortcomings. First,

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study the firm-level performance effects of export credit guarantees underwritten by the Federal Republic of Germany in 2000 to 2010; they report sizable positive causal effects of guarantees on sales growth and employment growth. Görg and Spaliara (2012) investigate the probability of firm survival conditional on, inter alia, financial constraints and various forms of engagement in exports (none, starter, stopper, switcher, continuous exporters) with data for the UK and France. They find that export starters and exiters experience much stronger adverse effects of financial constraints for their survival prospects. Nakhoda (2012) uses firm-level panel data from 27 countries across Central and Eastern Europe and Central Asia collected in the World Bank's Business Environment and Enterprise Performance Surveys (BEEPS). He finds that financial leverage does not inhibit firms which export only from becoming a two-way trader (exporter and importer), but it does inhibit firms which import only or operate only within the national market to become a two-way trader.

<sup>4</sup> There are a few notable exceptions, see Stibale (2011) for France, Arndt et al. (2012) for Germany, Lancheros and Demirel (2012) for India; note that other studies using data for these countries report results that are in line with the big picture of a negative link between credit constraints and export activities.

<sup>5</sup> An exception is the study by Greenaway, Guariglia and Kneller (2007) for the UK that reports an opposite result.

contrary to the population of German firms exporters are a rare species in the sample – only 5.8 percent of the firms export (see p. 11). Second, the data cover the years from 2002 to 2006, but the information about exports in Dafne does not vary over time and information for the most recent year is used (see fn. 11). Therefore, it is neither possible to identify export starters or export stoppers, nor can panel econometric techniques be used to control for unobserved time-invariant firm characteristics that may matter a lot.

Arndt et al. (2012) use establishment level data from a survey performed by the research institute of the German federal labor agency, the *IAB Establishment Panel*. They find that self-reported financial constraints have no impact on firms' export decisions. Like in the case of Buch et al. (2010) the data used in this study suffer from a number of shortcomings. First, although the data are part of a long-lasting panel study only cross-section data for 2004/2005 are used. Therefore, it is neither possible to identify export starters or export stoppers, nor can panel econometric techniques be used to control for unobserved time-invariant firm characteristics that may matter a lot. Second, data are collected at the establishment level, and they are not suited to investigate issues related to export activities and financial constraints when an establishment is part of a multi-establishment enterprise (where export activities might be concentrated in some establishment only, and financial constraints at the enterprise level should be considered, too). Third, financial constraints are measured by answers to a question whether or not firms faced problems raising external finance for investment projects and whether these difficulties have had negative implications for their investment activities. As the authors state the response to this question might be biased downward because firms may not have approached their banks in the first place because they expect their

credit application to be rejected (see Arndt et al. (2012), p. 50). Furthermore, the question on credit constraints was only asked for firms that have realized investments in the year before, and this leads to a highly selected sample made of 53 % of all firms from the survey (see Arndt et al. (2012), p. 50).

While the two studies with German data by Buch et al. (2010) and Arndt et al. (2012) provide some first evidence on links between financial constraints and exports they both have a number of severe shortcomings regarding the data used and the empirical strategy applied. Given that Germany is one of the leading actors on the world market for goods, and that exports are extremely important for the dynamics of the German economy, it seems important to dig deeper here. This paper is an attempt to do so.

### **3. Data and measurement issues**

This paper uses a unique newly constructed data set that merges high-quality data at the enterprise level taken from surveys of the statistical offices with a score that measures the credit-worthiness of the firm and that is supplied by the leading German credit-rating agency, *Creditreform*. The data used are described in detail in this section.

*Exports:* The data on exports used in this study are based on the report for establishments in manufacturing industries, a survey conducted regularly by the German statistical offices that is described in detail in Konold (2007). 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 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 unbalanced panel data set includes all firms that were active in at least one year over the period 2007 to 2009. A limitation of the data set is the absence of any information on products exported and destination countries. Therefore, it is not possible to investigate the role of credit constraints for the number of products exported or countries exported to, or other extensive margins besides starting and stopping to export, i.e. adding or dropping products or destinations.

*Credit rating score:* The extent of financial constraints faced by a firm is measured by various variables in the literature (see Table 1 and Musso and Schiavo (2008) for a discussion). In this study we use the credit rating score supplied by *Creditreform*, the leading credit rating agency in Germany. 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. 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, where 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.

Muuls (2008) uses a similar score variable (supplied by Coface for Belgian firms). She argues that 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. All this holds for the Creditreform score, too.

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. These data from Creditreform are used for the first time in this paper to investigate the link between credit constraints and 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<sup>6</sup> are included as control variables. Information on these control variables is taken from the same survey as the information on exports.

*Firm size:* The positive relationship between exports and firm size qualifies as a stylized fact for a long time. Firm size is measured 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, although of a more recent origin (see Wagner (2007) for a survey). Productivity is measured 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.

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<sup>6</sup> Given that these variables serve as control variables only, a detailed discussion is not appropriate here; see Wagner (2011) for a discussion of these firm characteristics and their role in determining exports of German manufacturing firms.

*Human capital intensity:* Given that Germany is relatively rich in human capital firms that use human capital intensively can be expected to have a comparative advantage on international goods markets. Human capital intensity is measured by the average wage per employee. Information on the qualification of the employees is not available in the data, but Wagner (2012) demonstrates that the average wage is indeed a good proxy variable for the qualification of the workforce in German manufacturing firms.

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

The data for the credit rating score and the data from the survey of official statistics were merged inside the research data center of the statistical office. To investigate the role of credit constraints for exports in year  $t$  information on the credit rating score at the end of year  $t-1$  (and on the control variables, also measured in  $t-1$ ) and on exports in  $t$  and  $t-1$  are needed. For West German<sup>7</sup> manufacturing industries the sample comprises of 5,488 firms in 2007/2008 and 5,743 firms in 2008/2009. Table 2 indicates that in each two-year period the share of firms that exported in both years is very high, while non-exporters are rare, and there are only a few export starters and export stoppers.<sup>8</sup>

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<sup>7</sup> There are still large differences between enterprises from manufacturing industries in West German and in former communist East German even some 20 years after the unification back in 1990, and this holds especially for export activities (see Wagner (2008)). 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.

<sup>8</sup> Due to the small number of export status switchers and the short time span the data are available for the application of panel econometric methods in the empirical investigation is not appropriate.

[Table 2 near here]

The distribution of exporters and non-exporters in the sample clearly indicates that this is not a random sample of the population of manufacturing firms in West Germany. In 2007, the data from official statistics used here have information on 32,010 enterprises in manufacturing industries in West Germany. For 5,593 of these firms information on the credit rating score could be merged to these data. The average number of employees in firms with credit rating score information was 462 persons compared to 102 persons in firms without this information. Figures for the other years are highly similar. Evidently, larger firms have a much higher chance to be rated by the credit rating agency. Given that firm size and export activity are highly positively related it comes as no surprise that exporters are highly overrepresented in the sample compared to the population. To control for this difference in the size composition of the population and the sample the number of employees is included as a control variable in the empirical models.

#### **4. Results of the econometric investigation**

The theoretical models of credit constraints and exports discussed in the introductory section lead to two empirically testable hypotheses (see Egger and Kesina (2010) and Minetti and Zhu (2011)):

*H1: Credit constrained firms are less likely to export.*

*H2: Credit constrained firms have a lower export to sales ratio than firms that are not affected by credit constraints.*

#### 4.1 Exporters vs. non-exporters

As a first step in the empirical investigation of H1 the credit rating scores of exporters and non-exporters are compared. Table 3 reports mean values and percentiles of the scores for both groups of firms for the two periods under investigation. The average score is smaller for exporters than for non-exporters in both years – exporters are judged to be better (because a smaller value of the score indicates a better performance). The difference in means is statistically highly different from zero according to a t-test. This result is in line with H1. The difference between the two groups, however, is only 10 score points and this is small from an economic point of view given the level of about 200 points for both groups.

[Table 3 near here]

The percentiles of the score distributions for the groups indicate that firms are highly heterogeneous within the groups. Results that point to score differences at the (unconditional) mean might not tell the whole story. As Moshe Buchinsky (1994, p.453) put it: “‘On the average’ has never been a satisfactory statement with which to conclude a study of heterogeneous populations.” An empirical study of heterogeneous firms should look at differences in the whole distribution of the variable under investigation between groups of firms, not only at differences at the mean. The empirical strategy used here, therefore, applies a non-parametric test for first order stochastic dominance of one distribution over another that was introduced into the empirical literature on exports by Delgado et al. (2002). Let  $F$  and  $G$  denote the cumulative distribution functions of credit rating scores for two groups of firms (say, firms that export and firms that do not export). First order stochastic dominance

of F relative to G is given if  $F(z) - G(z)$  is less or equal zero for all z with strict inequality for some z. Given two independent random samples of firms from each group, the hypothesis that F is to the right of G can be tested by the Kolmogorov-Smirnov test based on the empirical distribution functions for F and G in the samples (for details, see Conover 1999, p. 456ff.). Note that this tests not only for differences in the mean credit rating score of both groups but for differences in all moments of the distribution. Results for the Kolmogorov-Smirnov test reported in Table 3 clearly indicate that the distributions of the credit rating scores do indeed differ between exporters and non-exporters and that exporters have smaller (i.e., better) score values not only at the mean but over the whole score distribution. Again, the result is in favour of H1.

Results reported in Table 3 are for unconditional comparisons of mean values and distributions of the credit rating scores of exporting and non-exporting firms. In a second step H1 is tested controlling for other firm characteristics that are linked to exports. To do so an empirical model is estimated with a dummy variable that takes the value 1 if a firm is an exporter in t (and 0 otherwise) as the endogenous variable and the credit rating score at the end of t-1 plus control variables – the number of employees as a measure of firm size (also included in squares), labour productivity, the average wage per employee to proxy human capital intensity and a set of 2digit industry dummy variables – that are all measured in t-1 as exogenous variables.<sup>9</sup> Results are reported in Table 4 in column 1 for a probit model. In both years the

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<sup>9</sup> Note that the credit rating score and both the number of employees and human capital intensity are correlated (larger and more human capital intensive firms have a better score). However, the  $R^2$ -value from a regression of the credit score on the complete set of control variables is 0.026 in 2007 (and of the same order of magnitude in 2008 and 2009) only.

probability of being an exporter is higher ceteris paribus for firms with a smaller (i.e. better) credit rating score. This is again in line with H1.

The estimated marginal effects, however, are tiny. To illustrate this, consider an enterprise from a randomly selected industry with 400 employees, a labour productivity (average amount of total sales per employee, in Euro) of 100,000, and human capital intensity (average annual wage per employee, in Euro) of 60,000. Based on the estimation results for the probit model for 2008 the estimated probability that this firm is an exporter is 99.3 percent if the firm has a credit rating score of 100. It decreases to 98.9 percent if the score goes up to 200, to 98.2 percent if the score increases to 300 and to 97.1 percent if the score is as high as 400. Results based on the model for 2009 are almost identical. From an economic point of view, therefore, the statistically highly significant coefficient of the credit score variable is tiny. This, however, might be due to the fact that the share of non-exporters in the sample is small because information on the credit rating score is only available for larger firms that have a high propensity to export.<sup>10</sup>

[Table 4 near here]

We next turn to a test of H2 that states that credit constrained firms have a lower export to sales ratio than firms that are not affected by credit constraints. To do so an empirical model is estimated with the share of exports in  $t$  as the endogenous variable and the credit rating score at the end of  $t-1$  plus control variables – the number of employees as a measure of firm size (also included in squares), labour productivity, the average wage per employee to proxy human capital intensity and a

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<sup>10</sup> See the discussion at the end of section 3 above.

set of 2digit industry dummy variables – that are all measured in t-1 as exogenous variables. The endogenous variable, the share of exports in total sales, is a percentage variable that is by definition limited between zero and 100 percent, and that has a lot of observations at the lower bound because many firms do not export at all (see Table 2 for the sample used in this study). Papke and Wooldridge (1996) showed that for a fractional response variable of this type, and using cross section data, a fractional logit estimator is appropriate.<sup>11</sup>

The results from fractional logit regressions are reported in column 2 of Table 4. The estimated coefficient for the credit rating score is statistically highly significant and negative, pointing to a ceteris paribus larger share of exports in total sales in firms with a smaller (i.e. better) credit rating score. This result is in line with H2.

While the statistical significance and the direction of the relationship between the credit rating score and the share of exports in total sales can be seen from table 4 at a glance, the relevance of the score for the export intensity – the significance from an economic point of view – cannot. The estimated coefficients from the fractional logit model reported in table 4 cannot be interpreted directly in a straightforward way.

To illustrate the strength of the link between the credit rating score and the share of exports in total sales the estimated results from the fractional logit models are used to perform simulation exercises by looking at hypothetical firms and computing their estimated share of exports in total sales. Consider again an enterprise from a randomly selected industry with 400 employees, a labour

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<sup>11</sup> Wagner (2001) introduced this estimation strategy into the literature on the determinants of exporting activities of firms, and discussed the flaws related to alternative approaches like Tobit or two-step estimators. For a comprehensive recent discussion of estimation strategies for fractional response variables with a non-ignorable probability mass at zero see Ramalho, Ramalho and Murteira (2010).



productivity (average amount of total sales per employee, in Euro) of 100,000, and human capital intensity (average annual wage per employee, in Euro) of 60,000. Based on the estimation results for the fractional logit model for 2008 the estimated share of exports in total sales is 67.6 percent if the credit rating score of the firm is 100. It decreases to 63.9 percent if the score increases to 200, it goes down to 60.1 percent when the score is 300, and it is 56.1 percent if the score reaches 400. Results based on the model for 2009 are almost identical. From an economic point of view, therefore, the statistically highly significant coefficient of the credit score variable is rather small. This, however, might again be due to the fact that information on the credit rating score is only available for larger firms that tend to have a large share of exports in total sales.

The bottom line, then, is that, in line with the theoretical hypotheses, we find a positive although somewhat weak link between a better credit rating score of a firm and both the probability that the firm is an exporter and a higher share of exports in total sales.

## **4.2 Export starters vs. non-exporters**

While some of the extra costs of exporting that are discussed in the introductory paragraph of this paper and that are the reason for the link between credit constraints and exports are relevant for firms that are active on foreign markets for a longer time (higher working capital requirement due to longer time spans to collect payment, higher risk of export activities) some costs are especially relevant for firms that start to export.<sup>12</sup> These extra costs include costs for the acquisition of information about a

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<sup>12</sup> Note that these costs have to be paid by experienced exporters, too, if a firm adds a new destination country or a new product to its export portfolio. However, as stated in section 3, information on destination countries and products shipped is not available in the data used in this study.

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. These costs have to be paid up front and are, at least to a large extent, sunk costs. If firms do not have sufficient liquidity to pay for these costs, credit constraints may be binding. This leads to a third hypothesis:

*H3: Credit constrained firms are less likely to start to export.*

With the sample at hand, unfortunately, an empirical investigation of the link between the credit rating score and the probability of starting to export can only be based on a small number of export starters (see Table 2). For firms that did not export in 2007 and that started to export in 2008 we find no evidence for a difference in the credit rating score compared to firms that did not export in 2007 and 2008. The difference in the mean values of the two groups of firms is not statistically significantly different from zero and the hypothesis that the score distributions of the two groups of firms do not differ cannot be rejected at any conventional error level (see Table 5). Results from a probit model with an export starter dummy variable as the endogenous variable and the credit score plus control variables as exogenous variables point to the same direction (see Table 6).

[Table 5 and Table 6 near here]

Somewhat different results are reported for the export starters in 2009 compared to firms that neither exported in 2008 and in 2009. The average score is smaller for starters, the t-test for a difference in means of the score between the two

groups rejects the null hypothesis of no difference at an error level of 7.5 percent, and the regression coefficient from the probit model is negative and statistically significantly different from zero at an error level of 6.8 percent. While these findings are (weakly) in line with H3, results from the Kolmogorov-Smirnov test are not, because according to this test the score distributions of starters and non-starters do not differ.

Empirical evidence for the hypothesis that credit constrained firms are less likely to start to export, therefore, is at best weak.

#### **4.2 Export stoppers vs. non-stoppers**

As said, some of the extra costs of exporting that are the reason for the link between credit constraints and exports are relevant for firms that are active on foreign markets for a longer time (higher working capital requirement due to longer time spans to collect payment, higher risk of export activities). If firms do not have sufficient liquidity to pay for these costs, credit constraints may be binding. We might expect that these firms stop to export to reduce costs and concentrate their activities on the home market. This leads to a fourth hypothesis:

*H4: Credit constrained firms are more likely to stop to export*

As in the case of a comparison of export starters and non-starters with the sample at hand, unfortunately, an empirical investigation of the link between the credit rating score and the probability of stopping to export can only be based on a small number of export stoppers. Results reported in Table 7 and Table 8 indicate that there are no statistically significant differences in credit rating scores between

firms that continued to export and that stopped to export in either 2008 or 2009. H4 is not supported by the data.

[Table 7 and Table 8 near here]

## **5. Concluding remarks**

This study uses newly available enterprise level data for firms from manufacturing industries in Germany to test for the link between credit constraints, measured by a credit rating score from the leading credit rating agency Creditreform, and exports. In line with hypotheses from theoretical model we find a positive link between a better credit rating score of a firm and both the probability that the firm is an exporter and a higher share of exports in total sales. This link, though statistically highly significant, is not very strong from an economic point of view. While empirical evidence for the hypothesis that credit constrained firms are less likely to start to export is at best weak, we find no evidence for a statistically significant difference in credit rating scores between firms that stopped to export and continued to export.

To put these results into perspective two characteristics of the enterprise level data used in this study should be pointed out. First, the way credit constraints are measured can be considered as convincing. While the credit rating score used is clearly endogenous to the firm's performance and characteristic, 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 and is not based on subjective assessments, it 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. Second, while the measure for credit constraints is very suitable for the study of the links between credit

constraints and exports, the sample used is less so. As said in section 3 smaller firms are underrepresented because the credit rating score is not available for these firms. Connected to this shortcoming is the small share of non-exporting firms and the small number of export starters and export stoppers. Smaller firms are more often non-exporters and do more often switch into and out of exporting. For these firms credit constraints might be more important than for larger firms who often generate enough liquidity to cover the extra costs of exporting.

The big picture of weak evidence in favor of the hypotheses of negative effects of credit constraints on exports found in this study for German manufacturing firms, therefore, might not be found for smaller firms. As long as suitable data for the credit worthiness of these smaller firms are not available, however, this cannot be investigated. Furthermore, due to the small number of export status switchers in the sample and the short time span the data are available for the application of panel econometric methods in the empirical investigation is not appropriate and unobserved time-invariant firm characteristics cannot be controlled for. Therefore, the results presented here should not be used as a basis to discuss the need for policy measures to improve the access to credits for firms that intend to start or expand export activities.

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**Table 1: Empirical studies on exports and financial constraints with firm-level data**

Country Authors (Year )	Data	Measures of financial constraints	Methods	Important findings
<b>Argentina</b> Espanol (2007)	Data for sample of manufacturing firms, 1992, 1996, 1998, 2001	Dummy indicating whether firm was inhibited to innovate because of financial restrictions (1998-2001); proportion of innovation financed by banking system (1992-1996)	Probit	Access to financial markets and not facing financial restrictions to innovate have positive impact on export decision
<b>Belgium</b> Muuls (2008)	Trade and balance sheet data for manufacturing firms 1999 - 2005	Yearly measure of credit-worthiness of firms from a credit insurer (Coface International)	Descriptive statistics; linear probability model with / without fixed firm effects, fixed-effects OLS	Firms more likely to be exporters if they have higher productivity levels and lower credit constraints. Credit constraints important for extensive but not for intensive margin of trade in terms of destinations
<b>China</b> Du and Girma (2007)	Data for domestic private firms from manufacturing, 1999 - 2002	Bank loans normalized by total assets	IV-Tobit	Access to bank loans is associated with greater export market orientation

Li and Yu (2009)	Firm-level data from manufacturing , 2000 - 2007	Firm's interest expenditures used as proxy for firm's capacity to borrow	OLS, fixed-effects, Poisson pseudo-ML fixed-effects, IV fixed-effects	Firms with fewer credit constraints export more
Egger and Kesina (2010)	Census data for firms, 2001 – 2005 (average values over years used)	Long-run dept-to-capital ratio, financial-costs-to-liquid-funds ratio, liquid-asset-to-capital ratio, ratio of surplus of profits over long run debts to total assets	Logit, fractional logit	Credit constraint firms are less likely to export and have lower shares of exports in total sales
Manova, Wei and Zhang (2011)	Customs data for all internationally active firms, 2005	Financial vulnerability measured at sector level (average over the 1980-1999 period for median U.S. firm in each sector)	Firm fixed-effects for firms active in more than one sector	Limited credit availability hinders firms' trade flows (export sales, export product scope, number of export destinations)
<b>Czech Republik</b> Manole and Spatareanu (2010)	Sample of 365 manufacturing firms, 1994-2003	Cash flow, liquidity ratio, leverage ratio	Fixed-effects OLS, system GMM IV	Exporters less financially constrained; less constrained firms self-select into exporting, but exporting does not alleviate firms' financial constraints
<b>Egypt</b> Kiendrebeogo and Minea (2012)	Unbalanced panel of 2,387 manufacturing firms from World Bank's Enterprise Surveys database, 2003 – 2008	Self-assessment indicators of financial constraints; composite indicator of financial health, based on ratio of net income to total assets and share of new investment financed by equity; credit related variables in a robustness check	Pobit (pooled, random effects, dynamic random effects) for export participation; OLS fixed effects, Amemiya-MaCurdy, system GMM for export/sales ratio; Gamma RE and Normal RE for hazard rate of export start	Financial constraints reduce export participation, and have a negative impact on export intensity and the hazard rate of entry into exporting

**France**

Bellone, Musso, Nesta, Schiavo (2010)	Balance sheet data and DIANE database for manufacturing Firms, 1993 - 2005	Liquidity ratio, leverage ratio, index based on seven variables (size, profitability, liquidity, cash flow generating ability, solvency, trade credit over total assets, repaying ability)	OLS, random effects probit, dynamic GMM, discrete time duration model, Heckman Two-step model	Export starters have a significant ex ante financial advantage compared to non-exporters. No significant improvement in financial health of firms that started to export
Askenazy, Caldera, Gaulier and Irac (2011)	Customs data; profit and loss data; balance sheet data. Firms from manufacturing, 1995 - 2007	Liquidity ratio; inverse trade credit ratio; equity to asset ratio; dummy indicating whether firm has defaulted to its trade creditors	Negative binomial models	Credit constraints have negative influence on number of newly served destinations. Higher probability of export exit associated with credit constraints
Stiebale (2011)	Sample of firms from manufacturing from AMADEUS, 1998 – 2005	Liquidity ratio, long term debt / total assets, short term debt / current assets, cash flow / capital, earnings before interest and tax payments / interest payment	Dynamic probit, GMM, dynamic random effects Tobit	No evidence that financial constraints matter for export decision
<b>Germany</b>				
Buch, Kesternich, Lipponer and Schnitzer (2010)	Enterprise level data from Dafne and MiDi, 2002 – 2006	Cash flow, debt ratio	Probit, OLS (no fixed effects models)	Positive impact of cash flow on probability to export and export volume; debt ratio insignificant.
Arndt, Buch and Mattes (2012)	Establishment level data; cross-section for 2004/2005	Self-reported financial constraints (from interview)	Two-step Heckman selection model	Self-reported financial constraints have no impact on firms' internationalization decisions

**India**

Ito and Terada-Hagiwara (2011)	Sample of 6,000 manufacturing firms, 1996 – 2008	Cash flow / total assets, debt-to-asset ratio, ratio of retained profits to total assets	Random effects probit, OLS	Firms with higher amount of net cash flow and smaller debt-to-asset ratios are more likely to become exporters
Nagaraj (2011)	Balance sheet and financial statement data, manufacturing firms, 1989-2008	Liquidity = (Current Assets - Current Liabilities) / Total Assets; Leverage = Short term debt / Current Assets	Probit, IV-GMM, system GMM	New exporters have better financial health than non-exporters; financial health cause, not effect of exports. Share of exports in total sales not dependent on financial health.
Lancheros and Demirel (2012)	Indian service firms, 1999 – 2007	Stock of long-term debt over total assets; flow of short-term borrowing over total assets	IV Probit and Tobit; system GMM	No evidence that access to any particular source of finance influences the decision to export or the amount exported
<b>Italy</b>				
Forlani (2010)	Small and medium enterprises, 1998 - 2000, 2001-2003 (two cross sections)	Firms clustered into different groups according to their relative level of leverage	Probit, OLS	Probability of export start affected by cash stock for constrained firms. Exporters that increase number of destinations show higher liquidity. No evidence that export start improves firm's financial health
Minetti and Zhu (2011)	Sample of 4,680 manufacturing firms, 2001	Binary indicator based on answer to survey question about denied credits	Descriptive statistics, probit, bivariate probit, IV probit, OLS, 2SLS	Probability of exporting and foreign sales lower for credit rationed firms



Secchi, Tamagni and Tomasi (2011)	Customs information on exports plus register data for manufacturing firms, 2000 – 2003	Official credit rating issued by an independent institution (used after transformation into a dummy variable for constrained / unconstrained firms)	Descriptive statistics; 2-stage Heckman-type procedure for panel data models	Limited access to external capital narrows scale of foreign sales, exporters' product scope and number of trade partners
Caggese and Cunat (2011)	Sample of small and medium manufacturing firms, 1995 – 2003	Binary indicator based on answers to survey questions about credits; various instruments measuring regional financial development and based on relationship lending literature	IV regressions	Constraint firms are less likely to export when financing constraints are instrumented. Financial constraints do not affect percentage of sales exported. Financing constraints affect negatively number of export destination regions.
<b>Portugal</b> Silva (2011)	Panel of manufacturing firms, 1996 - 2003	Approximation of credit constraints by financial score built on eight variables based on balance sheet information	Propensity score matching with difference in differences	New exporters show significant improvements in their financial situation
<b>Sweden</b> Halldin (2012)	Panel of manufacturing Firms, 1997 – 2006	Degree of collateralizable assets	Probit (pooled cross-section, random effects panel probit)	Tangible assets are an important determinant of export entry
<b>Thailand</b> Cole, Elliott and Virakul (2010)	Manufacturing firms, 2001 – 2004	Liquidity ratio, leverage ratio	Pooled probit	Financial health has a significant influence on a firm's export decision

## **UK**

Greenaway, Guariglia and Kneller (2007)	Panel of 9,292 manufacturing firms, 1993 – 2003	Liquidity ratio (current assets less current liabilities over total assets); leverage ratio (ratio of short-term debt to current assets); Quiscore (likelihood of company failure over next 12 months; not used in econometric estimates)	Descriptive statistics; pooled probit, random-effects probit, fixed-effects, GMM, dynamic random effects probit, dynamic GMM	Positive link between firms' financial health and export status. No evidence that firms enjoying good ex-ante financial health are more likely to start exporting. Participation in exporting improves firms' ex-post financial health
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## **Multi-country studies**

9 developing and emerging countries Berman and Héricourt (2010)	World Bank Enterprise Survey Data, some 5,000 firms, between 1998 and 2004	Ratio of total debt over total assets; ratio of cash flow over total assets	Probit, OLS, 2SLS (Note: No investigation for single countries)	Access to finance important for export entry, but not for continue to export or for size of exports. Productivity only important for export start of firm has sufficient access to external finance
28 East European and Central Asian countries Wang (2010)	World Bank Enterprise Survey Data, 3,392 firms, between 2002 and 2009	Financially constrained firms applied for loans but got rejected, or did not apply for loans because of too high costs	Descriptive statistics, pooled Probit, random effects probit, fixed effects LPM, RE LPM, Heckman Selection model (Note: No investigation for single countries)	Probability of exporting higher among firms with no financial constraints; non-constraint firms tend to export more
18 developing countries Fauceglia (2011)	World Bank Enterprise Survey Data, 9,072 firms between 2002 and 2005	Liquidity ratio (current over total assets)	Probit, OLS, 2SLS, Heckman selection model (Note: No investigation for single countries)	Positive effect of firms' liquidity on export propensity larger for firms in financially less developed countries. Credit constraints do not constitute determinants for export revenues for existing exporters

Note: The studies are listed in alphabetical order of the countries covered and in chronological order of the publication year in a country. Studies that cover more than one country are listed at the end of the table

Table 2: Number of firms in the sample by exporter status

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	2007 / 2008	2008 / 2009
Firms with exports in both years	4,935	5,159
Firms without exports in both years	498	499
Export starter	26	53
Export stopper	29	32
All firms	5,488	5,743

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Note: Firms from manufacturing industries in West Germany with valid information for credit rating score

Table 3: Credit rating score for exporters and non-exporters

	No. of firms	Mean	sd	p1	p10	p50	p90	p99
Exporter in 2008; credit rating score at end of 2007	4,961	195	39	108	147	196	246	294
Non-exporter in 2008; credit rating score at end of 2007	527	205	38	121	157	205	256	307
H <sub>0</sub> : Mean (Exporter) = Mean (Non-exporter); prob-value of t-test	0.000							
Kolmogorov-Smirnov-tests for differences in distribution; prob-value								
H <sub>0</sub> : Distributions do not differ for exporters and non-exporters	0.000							
H <sub>0</sub> : Non-exporters have larger credit rating scores	0.998							
H <sub>0</sub> : Exporters have larger credit rating scores	0.000							
<hr/>								
	No. of firms	Mean	sd	p1	p10	p50	p90	p99
Exporter in 2009; credit rating score at end of 2008	5,212	196	39	111	149	197	246	295
Non-exporter in 2009; credit rating score at end of 2008	531	206	38	117	161	206	255	304
H <sub>0</sub> : Mean (Exporter) = Mean (Non-exporter); prob-value of t-test	0.000							
Kolmogorov-Smirnov-tests for differences in distribution; prob-value								
H <sub>0</sub> : Distributions do not differ for exporters and non-exporters	0.000							
H <sub>0</sub> : Non-exporters have larger credit rating scores	1.000							
H <sub>0</sub> : Exporters have larger credit rating scores	0.000							

Note: p1, p10 etc. is the first, tenth etc. percentile of the distribution of the credit rating score. The t-test is a two-sample test with unequal variances.

Table 4: Credit rating score and exports: Regression results

Endogenous variable		Exporter-Dummy (1 = yes)	Share of exports in total sales
Method		Probit	Fractional Logit Model
2008			
Credit rating score 2007	$\beta$	-0.0002337	-0.001628
	p	0.003	0.000
Number of firms		5,485	5,488
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2009			
Credit rating score 2008	$\beta$	-0.000282	-0.001031
	p	0.000	0.007
Number of firms		5,740	5,743

Note: The empirical models include the lagged values for labor productivity, number of employees (also included in squares), and human capital intensity (wage per employee) plus two-digit industry dummy variables and a constant.  $\beta$  is the estimated regression coefficient, p is the prob-value; for the Probit model marginal effects are reported.

Table 5: Credit rating score for export starters and non-exporters

	No. of firms	Mean	sd	p1	p10	p50	p90	p99
Export Starter in 2008; credit rating score at end of 2007	26	209	40	###	###	206	###	###
Non-exporter in 2007 and 2008; credit rating score at end of 2007	498	205	38	122	157	205	255	310
H <sub>0</sub> : Mean (Export-Starter) = Mean (Non-exporter); prob-value of t-test	0.592							
Kolmogorov-Smirnov-tests for differences in distribution; prob-value								
H <sub>0</sub> : Distributions do not differ for export starters and non-exporters	0.818							
H <sub>0</sub> : Non-exporters have larger credit rating scores	0.485							
H <sub>0</sub> : Export starters have larger credit rating scores	0.903							
<hr/>								
	No. of firms	Mean	sd	p1	p10	p50	p90	p99
Export Starter in 2009; credit rating score at end of 2008	53	197	38	###	144	200	251	###
Non-exporter in 2008 and 2009; credit rating score at end of 2008	499	206	38	117	161	206	257	310
H <sub>0</sub> : Mean (Export-Starter) = Mean (Non-exporter); prob-value of t-test	0.075							
Kolmogorov-Smirnov-tests for differences in distribution; prob-value								
H <sub>0</sub> : Distributions do not differ for export starters and non-exporters	0.192							
H <sub>0</sub> : Non-exporters have larger credit rating scores	0.997							
H <sub>0</sub> : Export starters have larger credit rating scores	0.107							

Note: p1, p10 etc. is the first, tenth etc. percentile of the distribution of the credit rating score. The t-test is a two-sample test with unequal variances. ### indicates a confidential value (due to small number of cases).

Table 6: Credit rating score and export start: Regression results

Endogenous variable Method		Export Starter-Dummy (1 = yes) Probit
2008		
Credit rating score 2007	$\beta$	0.0001077
	p	0.582
Number of firms		390
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2009		
Credit rating score 2008	$\beta$	-0.000595
	p	0.068
Number of firms		502

Note: The empirical models include the lagged values for labor productivity, number of employees (also included in squares), and human capital intensity (wage per employee) plus two-digit industry dummy variables and a constant.  $\beta$  is the estimated regression coefficient, p is the prob-value; for the Probit model marginal effects are reported.



Table 7: Credit rating score for export stoppers and non-stoppers

	No. of firms	Mean	sd	p1	p10	p50	p90	p99
Export Stopper in 2008; credit rating score at end of 2007	29	204	40	###	###	208	###	###
Exporter in 2007 and 2008; credit rating score at end of 2007	4,935	195	39	108	147	196	246	294
H <sub>0</sub> : Mean (Export-Stopper) = Mean (Exporter); prob-value of t-test	0.253							
Kolmogorov-Smirnov-tests for differences in distribution; prob-value								
H <sub>0</sub> : Distributions do not differ for export stoppers and exporters	0.077							
H <sub>0</sub> : Export stoppers have smaller credit rating scores	0.046							
H <sub>0</sub> : Exporters have smaller credit rating scores	0.882							
	No. of firms	Mean	sd	p1	p10	p50	p90	p99
Export Stopper in 2009; credit rating score at end of 2008	32	202	36	###	###	199	###	###
Exporter in 2008 and 2009; credit rating score at end of 2008	5,159	196	39	111	149	197	246	295
H <sub>0</sub> : Mean (Export-Stopper) = Mean (Exporter); prob-value of t-test	0.347							
Kolmogorov-Smirnov-tests for differences in distribution; prob-value								
H <sub>0</sub> : Distributions do not differ for export stoppers and exporters	0.207							
H <sub>0</sub> : Export stoppers have smaller credit rating scores	0.118							
H <sub>0</sub> : Exporters have smaller credit rating scores	0.775							

Note: p1, p10 etc. is the first, tenth etc. percentile of the distribution of the credit rating score. The t-test is a two-sample test with unequal variances. ### indicates a confidential value (due to small number of cases).

Table 8: Credit rating score and export stop: Regression results

Endogenous variable Method	Export Stopper-Dummy (1 = yes) Probit	
2008		
Credit rating score 2007	$\beta$	0.0000193
	p	0.396
Number of firms		3,653
-----		
2009		
Credit rating score 2008	$\beta$	5.00e-6
	p	0.793
Number of firms		4,178

Note: The empirical models include the lagged values for labor productivity, number of employees (also included in squares), and human capital intensity (wage per employee) plus two-digit industry dummy variables and a constant.  $\beta$  is the estimated regression coefficient, p is the prob-value; for the Probit model marginal effects are reported.