Export Market Risk and the Role of Public Credit Insurance

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Abstract

In this paper we analyze the impact of public export credit guarantees on firms' exports. Earlier studies have shown that export credit guarantees stimulate exports, employment and value added. Furthermore, there is evidence on the aggregate level that financial market imperfections are key to understanding the beneficial workings of the policy instrument. We use monthly firm-level survey data combined with official transaction level data on covered exports of German firms to analyze in detail the hypothesis that the public guarantees unfold their positive effects by mitigating financial constraints. Considering exporter and importer characteristics, as well as transaction-specific characteristics, we can shed light at the particular sources of financing constraints that can be alleviated by the policy instrument. Our results indicate that the positive effects on exports do indeed work through a mitigation of financial constraints. Furthermore, we find great heterogeneity. Small firms appear to benefit more, and the public guarantees matter most for contracts involving large values at risk. Our analysis contributes to a better understanding of the interplay of export credit guarantees with financial market imperfections which is crucial for an efficient design of this policy instrument.

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1 Introduction

In light of the "great trade collapse" in the aftermath of the financial crisis 2007/2008, interest in the role of finance for export business has sparked. By now, there is ample evidence that exports are more vulnerable to financing conditions than domestic sales and that financing constraints inhibit firms' exports both on the intensive margin as well as on the extensive margin.[1] Most countries of the world employ public credit guarantee programs to improve access to finance for exporting firms. Recent literature has analyzed the effectiveness of such schemes as means of stimulating exports, value added and employment. Felbermayr et al. (2012) estimate that public export credit guarantees in Germany, the so called "Hermes coverage", increase firms' sales growth by about 4.5% percentage points in the year of the grant, supporting previous evidence of a positive relationship on the aggregate level.[2] However, evidence on the working mechanism of the instrument is scarce. This is somewhat surprising, given that it touches the fundamental question of whether the instrument indeed does what it is supposed to, namely correct a market failure. This paper aims to fill that void. We use a unique transaction level data set to shed light at the channels through which Hermes guarantees unfold their effects. Our empirical analysis is guided by a small theoretical model of heterogeneous exporters that face uncertainty about export revenues and differ with respect to their needs of and access to external finance. We analyze whether and what kind of financial market frictions can be mitigated by public export credit guarantees.

Our work is motivated by the finding of positive effects of the public insurance scheme on exports and employment and the question, whether they actually bring about positive value added effects on the national level. Obviously, the answer would be no if the government provided the means of finance below social opportunity cost. Social cost are certainly hard to assess, but we can look at the profit and loss account of the program to get an idea about whether the government might potentially just be redistributing national funds by insuring projects with negative expected values. In a world with multiple distortions this would not necessarily imply a net welfare loss. Yet, rejecting this presumption makes a strong case for value added effects being net gains. A look at the cumulative (nominal) result of the agency that runs the program on behalf of the Federal Republic of Germany over the last 50 years reveals that on average returns to the credit insurance are non-negative.[3] The

[1] For studies on the firm-level see e.g. Greenaway et al. (2007) (UK), Muûls (2008) (Belgium), Manova et al. (2011) (China), Amiti and Weinstein (2011) (Japan) and Minetti and Zhu (2011) (Italy). Chor and Manova (2012) look at sectoral US imports during the financial crisis.

[2] Felbermayr and Yalcin (2011) find a positive relationship between sectoral exports and Hermes guarantees, which is particularly strong for sectors that depend more on external finance. Moser et al. (2008) also find a positive effect in a country-level study. For the case of Austria, Egger and Url (2006) report positive effects as well, Janda et al. (2012) find evidence for the Czech Republic.Auboin and Engemann (2012) find a strong positive effect of export credit insurance on bilateral trade, based on an extensive dataset covering more than 70 countries and public as well as private insurers.

[3] German public export credit guarantees are administered by a private consortium made up of *Euler Hermes Deutschland AG* and *PriceWaterhousecoopers AG*, acting on behalf of the Federal Government.

realized cumulative net gains of the period 1950 to 2010 amount to 2 billion Euro.[4] But then, if the government does not just provide insurance at below opportunity cost, why does the private capital market not offer the insurance at competitive cost? Clearly, frictions on financial markets can serve as an answer. We argue that there are three sources of market imperfection that might establish the government with a cost advantage. First, if there are cost to diversifying risk for private agents, the "deep pocket" of the government will establish it with a comparative advantage for financing or insuring projects with large values at risk.[5] Second, if coordination of creditors in case of payment default comes at a cost, then the government as a single actor will also have a cost advantage when it comes to asserting claims.[6] And thirdly, we argue that the government has greater bargaining power when it comes to debt renegotiations with entities in foreign countries, which, as we discuss below, often involve other foreign governments. Under any of those conditions, the government can offer insurance at a lower premium than private capital markets without incurring losses in the long run.

In our theoretical model with heterogeneous exporters, external finance and an optional credit guarantee scheme, we show how financial market conditions determine exporters' cost of finance, optimal sales and the entry decision into foreign markets. We borrow the basic set-up from the model by Manova (2013), yet consider default risk on the side of the importer rather than imperfect contract enforcement in the exporting country. In Manova (2013), as well as in Matsuyama (2008), Muûls (2008) and Feenstra et al. (2011), credit constraints - denoting incidents where firms cannot obtain finance for projects with positive expected values - are due to moral hazard problems. In our model, credit constraints arise from transaction cost of risk diversification in the financial sector. In line with existing literature we consider banks as being exposed to a constant risk of illiquidity that is due to the maturity mismatch of their assets and liabilities (Diamond and Dybvig, 1983) or market-based valuation of assets (Allen and Gale, 1998) and makes them prone to runs. Bank runs entail costly early liquidation of long term assets and potentially insolvency. Regulatory standards are set to reduce the probability of those events by forcing banks to engage in (costly) measures of risk diversification and contribute to deposit insurance schemes.[7] Risk neutralization in banks can be done by various means, e.g. by engaging in portfolio management, hedging, holding cash, issuing subordinate debt or equity.[8] The cost of holding risk might be considered as a measure of the

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[4] Numbers stem from the Annual Report 2010 of Euler Hermes. The report is available at *http://www.agaportal.de/en/aga/downloads/jahresberichte.html*

[5] As it is often argued, this lender-of-last-resort property provides a rationale for an active role of the government as loan guarantor or deposit insurer; see e.g. Merton (1977), Diamond and Dybvig (1983).

[6] Transaction cost of that sort have been proposed as one reason for the existence of banks, see Mayer (1988), Sharpe (1990).

[7] Current regulation requires banks to hold regulatory capital such as to achieve a constant solvency probability. Gordy and Howells (2006) show that for the Internal Ratings Based Approach of Basel II the targeted one-year solvency probability was 99.9%.

[8] See Kashyap et al. (2002) for a quantitative assessment of the cost associated with such buffer stocks for US banks.

effectiveness of financial markets. In an Arrow-Debreu world with complete contingent markets and costless transactions they would be zero. If, at the other extreme, the risk was not at all diversifiable, banks would need to hold the amount at risk in liquid assets, e.g. cash, with cost then reflecting foregone interest.

In our model, perfectly competitive banks pass on those cost to firms in terms a of higher interest on loans for more risky projects. Credit constraints thus derive from the threat of illiquidity with its detrimental consequences and the limited ability of private financial markets to diversify risk. These constraints can be mitigated by export credit guarantees to the extent that the guarantor is more efficient at dealing with risk. Based on the model, we show how the cost of credit and credit guarantees determine the financing cost of firms and, interacting with further firm characteristics, impact on their export performance. Cost advantages on the side of the government in providing credit guarantees will reflect in higher exports for projects and firms with specific characteristics.

We take the detailed predictions of our model to the data. Our empirical analysis draws on an exceptional dataset which is a joiner of all Hermes transaction of the type "Einzeldeckungen" between 2000 and 2010 with monthly survey data of 7 000 manufacturing firms from the business cycle survey of the Ifo Institute. The dataset brings together information on contract size, duration, and the importer's riskiness of the publicly insured transactions with firms' individual assessment of their export situation, their demand and financing conditions as well as employment and balance sheet information. Given the ordinal nature of our variable of interest – firms' qualitative assessment of the *stock of foreign orders* – and the structure of our econometric model, we use a binary choice model to estimate the effect of Hermes guarantees and analyze how it varies with characteristics specific to the contract, the importer, the exporter, or the time of the grant.

To preview our results, we confirm the finding of existing literature that financial constraints inhibit exports and participation in the public export credit guarantee scheme has positive effects. Furthermore, consistent with the predictions of our model, we find that there is systematic heterogeneity of the effect. We can single out characteristics of the exporting firm, the importing firm and the contract for which the effect is particularly strong. Hermes guarantees particularly benefit small firms, and the effect is stronger for projects with large values at risk or if the importer itself has the foreign government as guarantor. Those results lend support to our hypothesis that the public credit guarantee scheme does effectively mitigate frictions on private capital markets by exploiting cost advantages on the side of the government.

In the following section we present the model and derive testable predictions. In section 3 we discuss our data sources, explain our empirical strategy and discuss the results. Section 4 concludes.

2 Theory

In this section we develop a partial equilibrium model of international trade with heterogeneous firms, that are confronted with uncertain export payments. Our model builds on existing work by Manova (2013), where exporting firms differ in their needs for and access to external finance. We introduce default risk on the side of the importer into the model, allow the refinancing conditions of the banking sector to vary and show under what conditions the use of credit guarantees will affect the extensive and intensive margin of firms' exports.

2.1 Demand

Demand for variety a of a differentiated good in country i produced in country j is derived from a symmetric CES utility function over a set of available varieties A_i and results as

$$q_{ij}[a] = p_i[a]^{-\varepsilon} \frac{Y_i}{P_i^{1-\varepsilon}}, \tag{1}$$

where $p_i[a]$ is the price of variety a, Y_i is aggregate income and $P_i = \left(\int_{a \in A_i} p_i[a]^{1-\varepsilon} \mathrm{d}a \right)^{\frac{1}{1-\varepsilon}}$ is the ideal price index in country i. $\varepsilon > 1$ is the elasticity of substitution. In the following we consider a representative exporting and importing country and therefore, drop country indices.

2.2 Firm behavior

Firms pay a sunk entry cost to set up production and draw a productivity level $1/a$ from a cumulative distribution function $G[a]$ with bounded support $[a_L, a_H]$, $a_H > a_L > 0$. To produce, ship and sell q to the foreign country, firms have to pay a fixed cost f and variable cost τa per unit of q, where a is the unit cost corresponding to the firm's productivity draw and τ represents iceberg-type transportation cost.[9] Fixed and variable cost have to be borne upfront before export payments are received. We assume that firms have an amount k of liquid funds available to cover those upfront cost and furthermore, they can borrow from a perfectly competitive banking sector. Firms will use external finance if their own liquid funds are insufficient to cover all the cost of production and exporting or if the opportunity cost of investing k are higher than the cost of external finance. Export revenues $p[a]q[a]$ are uncertain, and can only be asserted with probability λ. We assume that the firm has no other sources of revenues, hence, if the importer defaults, the firm will defaults on its debt, too.[10] The default risk $(1 - \lambda)$ will thus reflect in the cost of external finance. Firms can lower the cost of external finance by making use of credit guarantees. We discuss the cases of pure

[9] Costs are expressed in terms of the price of a fixed input bundle. We scale units such that this price is normalized to one.

[10] We make this assumption for simplicity. The qualitative results of our model will be the same as long the default risk of the exporter is positively associated with the default risk of the importer.

bank financing and bank financing under a credit guarantee scheme in detail below, after we have derived the firms' optimal export behavior for an exogenously given interest rate. Let R^o denote the effective cost of external finance relative to internal finance, with $o \in [B, G]$ indicating whether the firm finances the export project only through a bank (B) or with the help of a credit guarantee (G) to eliminate default risk.

In this monopolistic competition framework firms set prices and determine the optimal share of external finance d to maximize expected profits:

$$\max_{p,d} \lambda p[a]q[a] - (1-d)(\tau a q[a] + f) - \lambda R^o d(\tau a q[a] + f) \tag{2}$$

$$\text{s.t.} \quad k \geq (1-d)(\tau a q + f), \tag{3}$$

$$d \geq 0. \tag{4}$$

and subject to demand as in (1). Appendix A shows that under plausible conditions, i.e. whenever external finance is more expensive than internal finance, the firm will use external finance only after exhausting all of its own available funds. Furthermore, we show that if $k < f$, which implies that the firm has to rely on external finance no matter how much it is going to sell, then the choice of the optimal price is independent of k (and thus independent of d). To keep the model as simple as possible, we proceed under the two assumptions that external finance is more costly than internal finance and that the amount of liquid funds is small, so that $k < f$.[11] For the firm's optimization problem (2) this implies that (3) is binding and (4) always holds.[12] The firm then only determines its price to maximize expected profits:

$$\max_{p} \lambda pq - k - \lambda R^o(\tau a q + f - k) \qquad o \in [B, G], \tag{5}$$

subject to demand as in (1). Optimal prices and quantities result as

$$p^*[a] = \frac{R^o \tau a}{\theta} \quad \text{with} \quad \frac{1}{\theta} = \frac{\varepsilon}{\varepsilon - 1}, \tag{6}$$

$$q^*[a] = \left(\frac{R^o \tau a}{\theta}\right)^{-\varepsilon} \frac{Y}{P^{1-\varepsilon}}. \tag{7}$$

Maximum expected profits are given by

$$\pi^* = \frac{\lambda}{\varepsilon} \left(\frac{R^o \tau a}{\theta}\right)^{1-\varepsilon} \frac{Y}{P^{1-\varepsilon}} + (\lambda R^o - 1)k - \lambda R^o f. \tag{8}$$

Expected profits decrease in the external financing costs R^o and, as in Melitz (2003), a higher productivity $1/a$ implies higher expected profits. Furthermore, with decreasing gross interest rates

[11] Appendix A shows that our qualitative results hold for the general case.

[12] As condition (3) becomes binding $d = \frac{\tau a q + f - k}{\tau a q + f}$ and $(1-d) = \frac{k}{\tau a q + f}$.

in λ ($\frac{\partial R^o}{\partial \lambda} < 0$) as we show below, expected profits increase in λ. Hence, conditional on their external finance situation which also depends on the probability of payment λ, firms need to be sufficiently productive to generate high enough revenues in order to break even. The break-even productivity level $1/a^o$ results implicitly from the zero-profit condition which is easily derived from equation (8) as

$$\frac{\lambda}{\varepsilon}\left(\frac{\tau a^o}{\theta}\right)\frac{Y}{P^{1-\varepsilon}} = \lambda(R^o)^{\varepsilon}(f-k) + k(R^o)^{\varepsilon-1} \tag{9}$$

Before we analyze in detail how the entry cut-off and the intensive margin of firm's export depend on its financing conditions, we first describe the properties of the competitive banking sector and derive the financing cost R^B and R^G under the two modes of financing available to firm: pure bank finance (B) and bank finance with a credit guarantee (G).

2.3 The banking sector

We assume that the banking sector is perfectly competitive and banks can refinance themselves at an exogenous (gross) interest rate $\bar{R} \geq 1$.[13] Furthermore, banks are risk-neutral, but obliged to neutralize the risk in their balance sheet to prevent runs.[14] Our approach to modeling risk-neutralization is parsimonious as we assume banks to bear a constant cost $c^B \in \left[0, \frac{\bar{R}-1}{\bar{R}}\right]$ per unit of the value at risk in their balance sheet to ensure liquidity at any point in time. We assume that c^B reflects a bank's cost minimizing choice among the possible means to do so, including portfolio management, hedging, insurance, or holding buffer stocks in terms of equity, securities, or cash. $c^B = \frac{\bar{R}-1}{\bar{R}}$ corresponds to the most expensive case where banks must hoard cash to ensure liquidity in all possible states. Furthermore, suppose that in case of default of the borrower a fraction $b^B \in [0,1]$ of the claim can be recovered from the trade partner in country i as part of insolvency proceedings.[15] We summarize the parameters characterizing the financing environment in the set $\mathcal{B} = \{\bar{R}, b^B, c^B\}$. Then, the gross interest rate that a bank facing financing conditions $\mathcal{B}$ and perfect competition can offer for lending of an amount x with default risk $1-\lambda$ is given by the following no-arbitrage condition:

$$\lambda R^B x + (1-\lambda) b^B R^B x = \bar{R}x + \bar{R}c^B(1-\lambda)(1-b^B)R^B x. \tag{10}$$

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[13] We have normalized the opportunity cost of money in the second period where profits are realized and banks are repaid (or not) to unity.

[14] Assuming that all banks comply with this obligation, a bank run, which we could think of as a case of prohibitively high refinancing cost, is ruled out. This is important to justify our normalization assumption (see previous footnote).

[15] We can consider b^B as the outcome of a cost-minimization problem of the bank with respect to the effort put into recovering claims or corporate rescues, thus capturing both the cost of coordination of creditors and the bargaining power in debt renegotiations.

It requires that the expected return – consisting of the borrower's payment $R^B x$ that arrives with probability λ and the amount $b^B R^B x$ that is recovered in case of default – equal the refinancing cost of the bank $\bar{R}x$ plus the cost of neutralizing the value at risk $(1-\lambda)(1-b^B)R^B x$ that remains in the bank's balance sheet. Solving for R^B then yields

$$R^B := R^B[\lambda, \mathcal{B}] = \frac{\bar{R}}{\lambda + (1-\lambda)b^B - \bar{R}c^B(1-\lambda)(1-b^B)} \tag{11}$$

with $R^B_{\bar{R}} > 0$, $R^B_{c^B} > 0$, $R^B_{b^B} < 0$ and $R^B_{\lambda} < 0$. The interest rate for the borrowing firms is high if refinancing cost or the cost of risk neutralization are high, or the probability of success and the recovery rate are low. Note that in a world without payment uncertainty (either λ or b^B equal one), banks would simply pass through their refinancing cost $\bar{R}$ to firms. Suppose for expositional purposes but without loss of generality that $b^B = 0$. Then, in an Arrow-Debreu world with costless risk diversification ($c^B = 0$), firms would face an interest rate $\frac{\bar{R}}{\lambda}$ reflecting banks refinancing cost augmented by an actuarially fair risk premium. If in this case $\bar{R}$ reflects the true opportunity cost of finance in the economy, then from the firms' profit maximization problem it can be seen that firms' private marginal cost are well aligned with the social marginal cost.[16]

2.4 Firms' export decision with pure bank financing

Returning to the firms' export decision, we can now show how financing conditions influence the extensive and intensive margin of exports. As in Melitz (2003), operating profits are proportional to sales. Hence, we can draw conclusion about firms' sales from looking at changes in expected optimum profits (8) and changes in the break-even productivity level (9) as induced by changes in exogenous variables. The relationships are straightforward: more default risk and lower recovery rates λ as well as higher cost to risk neutralization c^B increase the gross interest rate R^B and thus firms' expenses for financing variable and fixed cost. Higher effective variable cost lead firms to reduce export sales while higher effective fixed cost increase the productivity threshold. A lower liquidity (lower k) increases effective fixed costs and results also in a higher productivity threshold $1/a^B$. An increase in the default probability $(1-\lambda)$ has two additional effects: It decreases firms' optimal sales and at the same time increases the export entry threshold, as firms need larger sales to break even in expectation. The more firms rely on external finance (the smaller k) and the larger is the risk of default, the more strongly they are affected by an increase in financing cost. The results are summarized in the following proposition.

Proposition 1. *An increase in the firm specific interest rate due to a higher refinancing rate of banks*

[16] Note that in contrast to the work by Matsuyama (2008), Manova (2013), and Feenstra et al. (2011), moral hazard is absent from our model. Furthermore, even when there are frictions on the financial market in terms of $c > 0$, the incentives of banks and firms are well aligned, and the participation constraint of the bank defined as $pq-(1-d)(\tau aq+f) \geq R^B d(\tau aq+f)$ that is key in the aforementioned models (at times also labeled "cash-flow constraint" or "financing constraint") is never more restrictive than the firm's participation constraint (zero profit condition) (9).

$\bar{R}$, higher cost to risk diversification c^B or a lower recovery rate b^B (i) increases the productivity threshold $1/a^B$ and decreases export sales. (ii) The effect is stronger if the default probability $1-\lambda$ or the firm's dependence on external finance is high (low k). (iii) Furthermore, the effect of higher cost of risk diversification or a smaller recovery rate is stronger if refinancing cost are high.

Proof: ■

2.5 The credit guarantee scheme

Suppose that firms can insure themselves against default risk by means of a guarantee scheme, that offers payment in case of default of the importer in exchange for an insurance premium.[17] With the guarantee at hand, firms can obtain credit from the bank at the risk free rate $\bar{R}$. We assume that the agency (potentially the government, but not necessarily so) offers the following financing terms: It guarantees to pay the amount $x \leq pq$ in case of default, in exchange for a premium payment of γx. In case of default, the guarantor assumes the part x of the claim against the importer. We assume that the insurance agency which issues the guarantee is able to recover a share $b^G \in [0,1]$ in this case. Furthermore, as for banks, the insurer has to neutralize risk in her balance sheet, for which she incurs $c^G \in [0,1]$ per unit of value at risk.

The financing conditions of the guarantor are summarized in $\mathcal{G} = \{\bar{R}, b^G, c^G\}$. Except for $\bar{R}$, we allow them to be potentially different from the banks' parameters, reflecting differences in the guarantor's technology of risk diversification or effectiveness of recovering claims. In a competitive insurance market, the premium γ is then determined by the following condition

$$\gamma x + (1-\lambda)b^G x = (1-\lambda)x + c^G \bar{R}(1-\lambda)(1-b^G)$$

which states that the return from the premium γx and from acquiring the claim in case of default $(1-\lambda)b^G x$ equal the expected payment $(1-\lambda)x$ plus the cost of neutralizing the value at risk in the balance sheet. Solving for γ then yields

$$\gamma := \gamma[\lambda, \mathcal{G}] = 1 - \lambda - (1-\lambda)b^G + c\bar{R}(1-\lambda)(1-b^G) \tag{12}$$

2.6 Firms' export decision with public guarantees

In the presence of a guarantee scheme, firm behavior involves two decisions: how much to export and how much to cover by a guarantee. To keep the model as simple as possible, we proceed under the assumption that firms insure not more then the externally financed share of their exports.

[17] Generally, a guarantee is not the same as an insurance since in case of default, the guarantor acquires the claim. The two schemes are identical only if there is nothing to be recovered by the guarantor in the first place. Yet, from the perspective of the firm, whose recovery rate we have normalized to zero without loss of generality (as we can think of $\lambda = \tilde{\lambda} + (1-\tilde{\lambda})b$), the two financial products are identical in its effect. So we continue to speak of an insurance premium.

In appendix **??** we proof that this assumption reflects an endogenous outcome under plausible economic conditions, namely if the insurance premium is not actuarially favorable in that it fully covers the expected loss. Given its liquid funds k, the insured amount x is implicitly given by $x = \bar{R}(\tau aq + f - k + \gamma x)$, which takes into account that the firm spends γx of its liquids funds on the insurance premium and thus has to borrow more compared to the case of pure bank financing. Note also that under this sort of guarantee, the credit risk for the bank has been eliminated so that the competitive interest rate for the covered loan is equal to $\bar{R}$. The firms' expected profit maximization problem is then

$$\lambda pq - k - \frac{\bar{R}}{1-\gamma}(\tau aq + f - k) + (1-\lambda)\frac{\bar{R}}{1-\gamma}(\tau aq + f - k)$$

and the corresponding optimal profits under a public guarantee scheme result as

$$\pi^* = \frac{\lambda}{\varepsilon}\left(\frac{R^G \tau a}{\theta}\right)^{1-\epsilon} \frac{Y}{P^{1-\epsilon}} + (\lambda R^G - 1)k - \lambda R^G f \qquad (13)$$

$$\text{with} \quad R^G = \frac{\bar{R}}{1-\gamma}.$$

Not surprisingly, profits fall strictly in the risk premium γ. From equation (2) and (13) it is straightforward that expected profits with and without an insurance are equivalent if the financing cost with a guarantee R^G equal the cost of pure bank financing R^B. From $R^G = \frac{\bar{R}}{1-\gamma}$, (12) and (11) it follows that this is the case if risk neutralization costs ($c^B = c^G$) and recovery rates of the banks and the guarantor ($b^B = b^G$) do not differ for a given export transaction. Now suppose the guarantor is the government and it exhibits a comparative advantage in the recovery of open claims e.g. due to a stronger bargaining power or faces lower (no) cost of risk diversification. Then, expected profits turn out to be higher under the guarantee scheme, resulting in a lower productivity threshold $1/a^G < 1/a^B$ and higher export sales of a given insured transaction compared to the counterfactual situation where a public guarantor is absent.

In analogy to Proposition 1 we can establish how financial market conditions impact on the export performance of firms using credit guarantees. The results for the extensive and intensive margin follow straightforwardly from differentiating and cross-differentiating equation (13) and the corresponding implicit productivity threshold. Comparative statics results are summarized in Proposition 2.

Proposition 2. *An increase in the insurance premium γ due to a higher refinancing rate $\bar{R}$ for the government or its guarantee managing institution, higher cost to risk diversification c^G or a lower recovery rate b^G (i) increases the productivity threshold and decreases export sales. (ii) The effect is stronger if the default probability $1-\lambda$ or the firm's dependence on external finance (lower k) is high. (iii) Furthermore, the effect of higher cost of risk diversification or higher a smaller recovery rate is stronger if refinancing cost are high.*

Proof: ■

2.7 Testable hypotheses about the effects of public export credit guarantees

According to our model, positive effects from the use of a public export credit guarantee on exports materialize only if the government can for some reason offer a lower insurance premium than private agents on a competitive market.

As discussed in the introduction, the government might have a cost advantage in insuring projects with large values at risk because, thanks to its "deep pocket", it does not have to engage in costly risk diversification. Looking at yearly profit and loss accounts of the public credit guarantee agency shows that the cumulative gain masks substantial variation in annual results. For example, between 1982 and 1998, repeated annual losses were incurred, involving amounts up to 2.5 billion. In 1999, annual results turned positive and have remained so up to now.[18] With its sheer unlimited refinancing possibility, the state can withstand these repeated periodical losses associated with large risky projects, the positive expected values of which materialize potentially only in the very long run. Of course, a perfectly functioning capital market should be able to diversify those types of risks equally well. However, in the presence of cost for diversification, the above reasoning could explain a cost advantage of the state that is pronounced for very large and very risky projects.

Furthermore, the government is likely to have an advantage in asserting claims in foreign countries because of its bargaining power and because, in contrast to a dispersed set of agents that jointly finances projects through the capital market, it does not have to incur coordination cost when it comes to debt renegotiation. Since a substantial part of the default events can be attributed to political events, bargaining power seems to be very important. In 2006, about 50% of the total amount of claims (292.9 million Euro) were political risk claims.[19] Many outstanding claims in particular from developing countries are handled as part of multilateral negotiations on debt restructuring by the Paris Club.[20] In 2010, the Federal government held claims of 4.25 billion Euro, of which 1.67 billion were regulated under official rescheduling agreements. Also, the largest part of the cumulative losses before 2006 can be attributed to the Russian economic crisis in the aftermath of the collapse of the

[18] Interestingly, as Dewit (2001) points out, in 1995 the WTO Agreement on Subsidies and Countervailing Measures came into force, which strengthened the rules for provision of public export credit guarantees significantly, in particular ruling out premia policies that yield long term losses for the agency and allowing countries suffering from those policies access to the Dispute Settlement System.

[19] For a detailed description of events that are classified as political risks see *http://www.agaportal.de/en/aga/grundzuege/gedeckte_risiken.html.* All numbers in this section stem from the Annual Report 2010 of Euler Hermes, unless stated otherwise. The report is available at *http://www.agaportal.de/en/aga/downloads/jahresberichte.html.*

[20] The Paris Club is a non-institutionalized association of creditor countries that was formed to facilitate multilateral debt renegotiation, restructuring and cancellation agreements with indebted countries. The Paris Club regularly agrees to reschedule debt in favor of developing countries. In 2010, for example, Germany agreed on a total debt forgiveness of 643 million Euro under the HIPC (Heavily Indebted Poor Countries)-Initiative of the Paris Club. This of course strengthens the case of the program being operated at non-negative returns.

Soviet Union. In 2005 and 2006, Russia payed back about 13.6 million Euro,[21] reflecting in large positive annual gains and finally rendering the cumulative result positive. Negotiations with Russia were also conducted by the Paris Club. Based on those facts, we hypothesize that the government has a higher recovery rate in default cases, where bargaining power matters.

Presupposing that the government has a lower cost to diversification and a higher recovery rate in case of default, we can derive the following testable hypothesis in accordance with Propositions 1 and 2.

Testable hypotheses: *With financial markets characterized by conditions $\mathcal{B}, \mathcal{G}$ and firms having choosen profit maximizing financing modes according to* (8)
(i) more difficult refinancing conditions reduce exports.
(ii) The presence of a public export credit guarantee agency exhibiting lower cost of risk-diversification and higher recovery rates leads to higher exports and induces more firms to become exporters.
(iii) Effects at the intensive margin occur in all firms, the change in the extensive margin is ceteris paribus particularly relevant for small firms.
(iv) The positive effect on exports is particularly strong if refinancing cost are high or if the value at risk is large because the demand for external finance or the probability of default is high.

In the following section we confront these hypotheses with data. We assess whether there are positive effects of Hermes guarantees on firms' exports and whether refinancing conditions of banks captured by the interbanking rate matter for the strength of effect. In our data, we cannot differentiate whether export effects occur at the intensive or extensive margin. However, since the model implies that ceteris paribus effects at the extensive margin occur only for smaller firms, we expect them to benefit more from the use of Hermes guarantees. We also test whether firms with less internal funds, measured by the amount of working capital, or less collateral assets, measured by the stock of tangible assets, benefit more from public guarantees. Furthermore, we analyze whether the effect of the guarantee scheme on exports varies over particular contract characteristics to find support for our hypothesized cost advantages. In particular, we analyze whether the effect is stronger for larger values at risk or if the foreign government is involved as a guarantor of the importer.

3 Empirics

3.1 Data

We have obtained data on the universe of insured transactions between 2000-2010 from Euler Hermes, of which we use all guarantees of the type "Einzeldeckungen" as only those cover specific contracts in the sense that the type of good, the importer, the value of the transaction and the duration of the

[21] see the Annual Report of Euler-Hermes 2006

relationship are specified. "Einzeldeckungen" make up the largest part of the total volume of exports covered.[22] The merge with the Ifo Business Survey leaves us with 2 018 covered transactions among 668 firms in a total pool of 5 530 firms that we observe over the period January 2000 until December 2010. As we describe below, the use of lags in our preferred estimation specification reduces our estimation sample a bit further. Of each Hermes transaction we know the date when delivery of the product started. Furthermore, we have information on the risk category of the importer which includes the class of the guarantor of importer (state, bank, no guarantor) and a risk rating on the scale 1-2 for firms with a state guarantor and 1-5 for the other classes, assigned to transactions by Euler Hermes. Since the number of observations in each of these classes is very small, we collapse them into four categories: 1 "no guarantor/unknown", 2 "private guarantor", 3 "foreign bank" and 4 "foreign state".

Table 1: Summary statistics of estimation sample

	N	Mean	Min	Max
month	114845		07/2000	12/2010
foreign orders	114845	1.8	1	3
foreign orders (binary)	114845	1.6	0	1
demand	114845	2.0	1	3
expected exports	114845	2.1	1	3
production constraint	114845	1.6	1	2
employment	114845	18640	2	200000
Einzeldeckung	872	7787868	6160	$445e10^6$
guarantor	872			
interbanking rate	114845	2.9	.64	5.11
tangible assets	36335	$54e10^6$	0	$4.5e10^9$
working capital	34230	$38e10^6$	$-1.3e10^9$	$2.6e10^9$
cash flow	30653	$35e10^6$	$-1.1e10^9$	$4.7e10^9$
Firms	1906			
with Hermes	340			

The Ifo Business Survey covers about 7 000 firms which are surveyed on a monthly basis. The sample is representative for the population of German firms in the manufacturing sector. In the questionnaire, firms are asked to state their appraisal of the business conditions of their company and of the economic environment in general, choosing between three or four possible answers usually coded as 1 "worse than usual", 2 "as usual", 3 "better" or occasionally 4 "does not apply". For some variables such as *employment* the survey asks for the actual numbers. Most relevant for our analysis are the variables *stock of foreign orders*, *expected exports* and *demand* which take on the three or

[22] Other types are "Ausfuhrpauschalgewährleistungen" which are provided for a specific product and one (or sometimes more than one) destination market in a given period of time without specifying the importer. "Revolvierende Deckungen" that can be used for repeated similar transactions are quantitatively only of marginal importance.

four values mentioned above, thus capturing the firms' assessment of export sales, expected future exports and the general demand situation. Furthermore, firms indicate if they are constrained in production, stating either 1 "yes" of 2 "no". We merge (yearly) balance sheet data from the Amadeus Database, in particular we use information on firms' stock of *tangible assets*, the amount of *working capital* and the *cash flow*. Furthermore, from the Thompson/Reuters Datastream we obtain monthly averages of the *interbanking rate* (Euribor). Table 1 summarizes our estimation sample that we use in the our preferred baseline estimation. Since we use six lags, the first observation for each firm is July 2000.

3.2 Empirical strategy

Given the ordinal nature of our variable of interest, we estimate an ordered logit model to assess the effect of a Hermes guarantee on the probability that firms report exports to be better or worse than usual. We assume that the latent variable y^* describing firm i's *potential* exports can be described by the following linear specification

$$y^*_{it} = \mathbf{x}'_{it}\beta + \varepsilon_{it}$$

where $\mathbf{x}_{ij}$ is a vector of the firm's observed supply and demand conditions and unobserved shocks ε_{it} that follow a logistic distribution with mean zero. Deviations from the firms' average export level $\bar{y}_i$ are then a linear function of deviations in demand and supply conditions from their average values, i.e.

$$\hat{y}^*_{it} = y^*_{it} - \bar{y}_i = (\mathbf{x}_{it} - \bar{\mathbf{x}}_i)'\beta + \varepsilon_{it},$$

where we have employed $\mathrm{E}(\varepsilon) = 0$. In our data, we observe only the direction of the deviation, but not the magnitude. Furthermore, from the theory we know that positive exports are only observed for firms that generate sufficiently high export revenue to cover the fixed cost of production. Hence, for a firm that starts of below the threshold an increase in potential exports, for example induced by a positive demand shock, is only observed if it is sufficiently strong to move the firm over the threshold. The model also tells us that this threshold level depends on firm characteristics. Our limited dependent variable is thus

$$\hat{y}_{it} = \begin{cases} 1 \text{ “worse than usual”} & \text{if } \hat{y}^*_{it} < \tau_1 + \alpha_i \\ 2 \text{ “as usual”} & \text{if } \tau_1 + \alpha_i \leq \hat{y}^*_{it} < \tau_2 + \alpha_i \\ 3 \text{ “better than usual”} & \text{if } \tau_2 + \alpha_i \leq \hat{y}^*_{it} \end{cases}$$

where α_i is a firm specific intercept. Principally, the nature of the data calls for an ordered choice estimation. Yet, accommodating individual unobserved heterogeneity in ordered choice models is problematic, unless one can be sure that the unobserved effect is uncorrelated with the regressors. In our case, we know from the model that this will not be the case, as the threshold level clearly depends on firm characteristics that we observe only partially. As Greene and Henscher (2010) discuss, a sufficient statistic for conditioning fixed effects out of the model does not exist for the cases of ordered logit or probit estimation. Potentially, one could estimate the model by "brute force", i.e. by adding a set of firm dummies to the regressors. However, besides being computationally difficult, this introduces the "incidental parameters bias".[23] Instead, we proceed with a binary dependent variable that allows estimation of the conditional logit model. We collapse the categories 1 "worse than usual" and 2 "as usual" so that our new binary dependent variable y_{it} is determined as follows:

$$y_{it} = \begin{cases} 1 \text{ "better than usual"} & \text{if } \tau + \alpha_i \leq \hat{y}^*_{it} \\ 0 \text{ "as usual/worse than usual"} & \text{if } \tau + \alpha_i \geq \hat{y}^*_{it} \end{cases}$$

Denoting $\hat{x}_{it} = x_{it} - \bar{x}_{it}$, the probability that the firm reports higher exports than usual follows as

$$P[y=1] = P[\hat{\mathbf{x}}'_{it}\beta + \varepsilon_{it} > \tau + \alpha_i] = P[\varepsilon_{it} \leq \hat{\mathbf{x}}'_{it}\beta - \tau - \alpha_i] = \Lambda[\hat{\mathbf{x}}'_{it}\beta - \tau - \alpha_i]$$

The last inequality invokes the distributional assumption on ε. We estimate the parameters of the latent variable specification using the conditional logit model. As an alternative, we estimate the full likelihood including firm averages of the covariates instead of a fixed effect to account for correlation between unobserved characteristics and regressors. This strategy that is also known as "Mundlak method" is comparable to a random effects model. It turns out that coefficient estimates do not differ much between in the fixed effect and random effects specification. To quantify the effects of explanatory variables, we compute marginal effects of changes in covariates, i.e. the discrete changes in the probability that $y_{it} = 1$. The marginal effect of a binary variable x_1 is given by

$$DC_{it,x_1} = \Lambda(\mathbf{x}'_{it} - \tau - \alpha_i | x_{1it} = 1) - \Lambda(\mathbf{x}'_{it} - \tau - \alpha_i | x_{1it} = 0).$$

Assessing the qualitative and quantitative effect as well as statistical significance of interacted variables in non-linear models is not straightforward, see e.g. Ai and Norton (2003) and Greene (2010). Let β_{1k} denote the coefficient of the interaction $x_{1k} \times x_1$. Then, the change in the marginal effect of the binary variable x_1 when a continuous variables x_k changes is

$$\frac{\partial DC_{it,x_1}}{\partial x_{kit}} = (\beta_k + \beta_{1k}) \left[f(\mathbf{x}'_{it} - \tau - \alpha_i | x_{1it} = 1) - f(\mathbf{x}'_{it} - \tau - \alpha_i | x_{1it} = 0) \right].$$

Hence, the sign of $\hat{\beta}_{1k}$ is not indicative of the sign of the change in the marginal effect of Hermes. Furthermore, regarding inference, $\beta_k = \beta_{1k} = 0$ is sufficient but not necessary for the effect to be zero, various combinations of estimated parameters and the data can equate $\frac{\partial DC_{j,D_{it}}}{\partial x_{kit}} = 0$, irrespective of β_k, β_{1k}. Hence, the standard statistical inference results for marginal effects are difficult to interpret economically. Greene (2010) suggest to look at predicted probabilities at different values of the

[23] For a detailed discussion see Greene and Henscher (2010).

covariates instead and do inference with respect to differences in predicted probabilities. We follow his advice and assess the heterogeneity of the effect of Hermes by analyzing differences in predicted probabilities between firms with and without public insurance at different levels of the covariates. To compute predicted probabilities as well as marginal effects, we first need to back out the firm-specific intercepts α_i, that are not estimated in the conditional logit model. They can be backed out, however, as the solution to

$$p_{it} = \frac{1}{T_i} \sum_{t=1}^{T} \Lambda(\alpha_i + \mathbf{x}'_{it}\hat{\beta}) \tag{14}$$

where $\hat{\beta}$ is a consistent estimate of β obtained from the conditional logit estimation. p_{it} is the fraction of observations of firm i for which $y_{it} = 1$. Marginal effects and predicted probabilities are much easier obtained for the Mundlak method. We also estimate a linear probability model in which estimates of the coefficients for interacted variables are straightforwardly interpretable as interacted marginal effects.

3.3 Results

3.3.1 Baseline estimations

In Table 2 we present the results of our baseline estimations that assess the impact of Hermes on the probability that firms report their stock of foreign orders to be "better than usual". We also present the result from unconditional logit and linear fixed effect estimation. Our baseline estimation includes further regressors to account for changes in demand and supply conditions that might have driven selection into the guarantee program: To capture changes in demand that are common across firms we use time (year $\times$ month) fixed effect. For firm specific demand effects we use the monthly assessment of *demand* conditions and *expected exports*, as well as lags thereof.[24] Whether the firm can materialize positive demand in terms of higher exports depends also on supply side conditions. To account for potential capacity constraints, lack of material or financing constraints we include an indicator of whether the firm reports *constraints* to production. Finally, we include our main variable of interest *Hermes*. Based on the predictions of the model we expect the provision of a credit guarantee to alleviate firm's financing conditions and enhances exports.

The table reports coefficient estimates. The sign of these is indicative of the marginal effect, while the magnitude is not. In line with the predictions of our theoretical model, we find that being in the guarantee program has positive effects on firms' export. Columns (1) and (2) report estimates from the unconditional logit model, columns (3) and (4) condition on the firm, i.e., they control for firm specific thresholds. Columns (5) and (6) report results from a linear probability model with fixed effects. We find positive effects of Hermes guarantees throughout, using either a

[24] In a robustness test we include them as dummies indicating positive and negative changes to correctly account for their categorical nature. Effects are then to be interpreted relative to the baseline category, which is no change.

binary indicator *Hermes* or the log of the contract volume $\ln EZD$. We also find plausible effects of (most) of our covariates. Positive (negative) changes in demand as well as in expect expectations affect the stock of foreign orders positively (negatively). All specifications include six (three) lags of the variables *demand* and *expected exports*. Their coefficients estimates all point significantly into the same directions as the contemporaneous effects. For brevity, they have been excluded from the display. Only the sign of the *production constraint* coefficient points into an unexpected direction.

Table 2: Coefficient estimates

Dep. variable: *Stock of foreign orders*						
Model:	uncond. logit		cond. logit		lpm	
Hermes	0.563***		0.197*		0.0242***	
	(.207)		(.117)		(.0094)	
ln EZD		0.0478***		0.0149*		0.0018***
		(.0143)		(.008)		(.0006)
Demand (+)	0.54***	0.54***	0.658***	0.658***	0.0537***	0.0537***
	(.0287)	(.0287)	(.0251)	(.0251)	(.0017)	(.0017)
Demand (–)	-0.19***	-0.19***	-0.674***	-0.674***	-0.0136***	-0.0136***
	(.0338)	(.0338)	(.038)	(.038)	(.0017)	(.0017)
Exp. exports (+)	0.606***	0.606***	0.684***	0.684***	0.0699***	0.0699***
	(.034)	(.034)	(.0274)	(.0274)	(.002)	(.002)
Exp. exports (–)	-0.404***	-0.404***	-0.392***	-0.392***	-0.0057***	-0.0057***
	(.0722)	(.0722)	(.0615)	(.0615)	(.002)	(.002)
Constraint	0.0478	0.0478	0.109***	0.109***	0.0201***	0.0201***
	(.0575)	(.0575)	(.028)	(.028)	(.0017)	(.0017)
Constant	-3.226***	-3.226***			0.0789***	0.0788***
	(.198)	(.198)			(.0263)	(.0263)
year×month effects	YES	YES	YES	YES	YES	YES
sector effects	YES	YES	NO	NO	NO	NO
firm effects	NO	NO	YES	YES	YES	YES
N	183072	183072	114845	114845	183072	183072
Pseudo R^2	.20	.20				
R^2					.12	.12

Standard errors in parenthesis. *,** ,*** indicate significance on the 10,5, and 1% significance level. All estimations include 3 (6) lags of the categorical variables *Exp. exports* and *Demand*

To interpret the magnitude of the estimated effects, we compute average marginal effects of our preferred specification with time and sector dummies (Table 2, column 4). We find that Hermes increases the probability that they report the *stock of foreign orders* to be "better than usual" by 3.4 percentage points.

[table marginal effects about here]

3.3.2 Heterogeneity of the effect of Hermes

Based on the intuition of our model, we expect that higher financially constrained firms benefit more. Hence, we interact the various indicators for the *financing conditions* with the *Hermes* variable.

Table 3: Interaction terms, coefficient estimates

Dep. variable: *Stock of foreign orders* (binary); Model: cond. logit							
Hermes	1.304***	-1.355***	2.36	2.894***	2.198	.2123	
	(.665)	(.303)	(1.86)	(.682)	(1.69)	(.1318)	
× ln *Employment*	-0.162*						
	(.095)						
× *Interb. rate*		0.486***					
		(.0855)					
× ln *Working capital*			-0.129				
			(.104)				
× ln *Cash flow*				-0.158***			
				(.0418)			
× ln *Tangibles*					-0.109		
					(.1)		
Hermes × *Type of guarantor*							
× *state*						-.245	
						(.683)	
× *bank*						.3118	
						(.327)	
× *private*						-.3934	
						(.2866)	
ln *Employment*	0.0449						
	(.03436)						
ln *Working capital*			0.0147				
			(.0147)				
ln *Cash flow*				0.102***			
				(.0172)			
ln *Tangibles*					0.0845***		
					(.0248)		
ln *EZD*							-0.0821
							(.0648)
ln *EZD* × ln *EZD*							0.0065
							(.0043)
N	114671	114671	27641	24733	31722	114671	114671

Conditional logit estimation, by firm id. Standard errors in parenthesis. *,**,*** indicate significance on the 10,5, and 1% significance level. Coefficients of covariates as in baseline estimations not shown. All specification include time effects.

As described above, neither the sign nor the inference is indicative of the economic content of the interaction in logit estimations. Significance is still important though for the computation of the predicted probabilities that we use below to assess the economic content of the interactions. Table 5 shows that estimated coefficients are statistically significant for the interactions with the *interbank rate, cash flow* and the squared volume $\ln EZD \times \ln EZD$. To assess the economic content of the interactions we look at predicted probabilities next.

Firm size (employment). To test the implication of the theoretical model that the effect of Hermes should ceteris paribus be stronger for small firms, we compute predicted probabilities for

Hermes and non-Hermes firms. The difference between the solid and the dashed line in Figure 1 can be interpreted as the effect of Hermes. Shaded areas reflect 90% confidence bands. Apparently, the effect varies strongly across firm size: for small firms, Hermes significantly lowers the probability that they report worse exports (left panel) and increase the probability that better exports are reported (right panel). The finding that for large firms the effect of treatment becomes even negative is counterintuitive. However, the number of firms of this size in our sample is relatively small.

Figure 1: Predicted probabilities at different firm sizes

[figure employment about here]

Refinancing conditions. Next, we consider whether the effect of Hermes is stronger when financing conditions are worse. We find that a higher interbanking rate reduces firms' probability to report higher exports. However, this is not true for firms using Hermes. And the greater the interbanking rate, the stronger becomes the effect of Hermes.

Figure 2: Interbanking rate

[figure ibrate about here]

Firms' financial situation. Next, we look at the role of firms financial conditions. As the model suggests, firms with little cash at hand benefit more from a favorable public guarantee scheme because they rely more on external finance. We use information on *cash flow* and *working capital* to test this prediction. And we find that the effect of Hermes is indeed stronger for firms that generate small cash flows or have little working capital.

Figure 3: Contract size

[figure working capital about here]
[figure cash flow about here]

We also consider the role of collateral, by means of an interaction of *Hermes* with the firm's stock of tangible assets. We again find that firms with little collateral benefit more from the guarantee scheme.

Characteristics of the insured contract. To see whether certain characteristic of insured contracts matter for the effect on firms' exports we look at predicted probabilities for Hermes firms at different levels of contract size (Figure 4). The horizontal line in both figures represent the respective predicted probabilities for untreated firms and 90% confidence bands. We find that contract size matters strongly for the effect, as the difference between the predicted probabilities for Non-Hermes firms and Hermes firms increases with the size in favor of the latter.

We also exploit information on the type of the guarantor of the importer (if there is one) to see whether this makes a difference. Table 4 lists predicted probabilities for firms without Hermes and

Figure 4: Contract size

[figure contract size about here]

Hermes firms differentiated by guarantor type. We find that the probability to report higher exports with Hermes is only higher if the guarantor on the side of the importer is the foreign state or a bank, but not if it is a private agent. The predicted probability for a Hermes firm without a guarantor is only marginally higher than for a non-Hermes firms. Regarding precision of the estimation, it has to be noted that only in the case of a bank guarantor is the difference significantly different from zero.

Table 4: Type of guarantor of the importer

	$\widehat{\Pr}(y = 1\|X)$	
$Hermes = 0$	**.102**	[.101;.103]
$Hermes = 1$		
State	**.146**	[.074;.219]
Bank	**.176**	[.129;.223]
Private	**.072**	[.051;.093]
None	**.115**	[.100;.129]

Predicted probabilities. 90% confidence bounds in parenthesis.

For robustness, we also consider the interaction terms in a linear probability model. We find all the signs of our interaction effects confirmed, significance of the estimated coefficients is even slightly stronger.

To summarize, we find that Hermes has a positive effect on firms' exports and that this effect is stronger for smaller firms. We also find that difficult financing conditions inhibit exports, and that the public guarantee scheme has stronger effects when financing conditions are difficult and when values at risk are large.

Table 5: Interaction terms, coefficient estimates

Dep. variable: *Stock of foreign orders* (binary); Model: LPM with fixed effects							
Hermes	0.0922*	-0.280***	0.185*	0.277***	0.247***	0.0196*	
	(.0527)	(.0394)	(.101)	(.0704)	(.139)	(.0105)	
× ln *Employment*	-0.0099***						
	(.0076)						
× *Interb. rate*		0.104***					
		(.0119)					
× ln *Working capital*			-0.0098*				
			(.0057)				
× ln *Cash flow*				-0.0148***			
				(.0044)			
× ln *Tangibles*					-0.0124		
					(.0082)		
Hermes × *Type of guarantor*							
× *state*						-.026	
						(.0232)	
× *bank*						.114***	
						(.0302)	
× *private*						-.0528	
						(.0509)	
ln *Employment*	0.007***						
	(.0019)						
ln *Working capital*			0.001				
			(.0009)				
ln *Cash flow*				0.0053***			
				(.001)			
ln *Tangibles*					0.0053***		
					(.001)		
ln *EZD*							-0.007
							(0.0051)
ln *EZD* × ln *EZD*							0.0006*
							(.0203)
N	182972	182972	49745	41724	56617		182972

Linear probability model with fixed effects. Standard errors in parenthesis. *,** ,*** indicate significance on the 10,5, and 1% significance level. Coefficients of covariates as in baseline estimations included as continuous regressors (except *Constrain*) not shown. All regressions include time effects.

4 Conclusion

In this paper, we analyze the effect of German public export credit guarantees ("Hermes guarantees") on firms' export. Previous research has found evidence for a positive relationship between guarantees and exports. The use of this public instrument is commonly justified as a means of mitigating the negative consequences of financial market frictions for exporting firms. However, due to the lack of appropriate data, evidence on the channels through which the policy instrument really works is scarce, although this is crucial for an assessment of the value added effects for the economy as a whole as well as for an efficient design of the policy instrument.

We build a model with heterogeneous exporters and financing constraints following Manova (2013) and show theoretically under what conditions public export credit guarantees can mitigate financing constraints. Firms will only benefit from the presence of such a scheme if the government can provide guarantees at lower cost then private financial agents. We argue that the government has a cost advantage in financing specific types of projects, in particular such that are characterized by large values at risk or involve foreign governments. We therefore expect to find positive effects for projects of those types. In accordance with the model, the beneficial effect of such a favorable public guarantee scheme should be stronger for small firms that find it harder to finance their operations externally, and stronger at times when financing conditions on private market are tight.

We take these predictions of the model to the data. Based on a unique firm-level data set which is a joiner of the set of Hermes guarantees of type "Einzeldeckungen" provided by Euler-Hermes and the Ifo Business survey we find that Hermes guarantees indeed have a positive effect on firms export performance. Moreover, small firms appear to benefit more and refinancing conditions on private financial markets matter. For contracts of large size the effect of Hermes is particularly strong. Our results lend support to the hypothesis that Hermes guarantees do indeed unfold their positive effect through mitigating financial constraints by passing through cost advantages of the government to German firms.

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A Optimal share of external finance d

$$\max_{p,d} \ \pi = \lambda p[a]q[a] - (1-d)(\tau a q[a] + f) - \lambda R d(\tau a q[a] + f) \tag{15}$$

$$q_{ij}[a] = p_i[a]^{-\varepsilon}\frac{Y_i}{P_i^{1-\varepsilon}} \tag{16}$$

$$k \geq (1-d)(\tau a q[a] + f) \tag{17}$$

$$d \geq 0 \tag{18}$$

Karush-Kuhn-Tucker conditions:

$$\frac{\partial \pi}{\partial p} = \mu_1(1-d)\tau a q' \qquad \Leftrightarrow \qquad \lambda(pq' + q) - (1-d)\tau a q' - d\lambda R \tau a q' = \mu_1(1-d)\tau a q' \tag{19}$$

$$\frac{\partial \pi}{\partial d} = -\mu_1(\tau a q + f) - \mu_2 \qquad \Leftrightarrow \qquad \tau a q + f - \lambda R(\tau a q + f) = -\mu_1(\tau a q + f) - \mu_2 \tag{20}$$

$$\mu_1\left(k - (1-d)(\tau a q[a] + f)\right) = 0 \qquad \& \qquad \mu_1 \geq 0 \tag{21}$$

$$\mu_2 d = 0 \qquad \& \qquad \mu_2 \geq 0 \tag{22}$$

Suppose $k > f$ and define $\bar{q} = \frac{k-f}{\tau a}$.

Case 1): $d^* = 0$**,** $q^* < \bar{q}$

- from (22): $\mu_2 \geq 0$
- from (21): $\mu_1 = 0$
- from (19): $\frac{\partial \pi}{\partial p} = 0 \qquad \Leftrightarrow \qquad \lambda(pq' + q) = \tau a q' \qquad \Leftrightarrow \qquad p^* = \frac{\tau a}{\lambda \theta}$
- Optimum profits:

$$\begin{aligned}\pi_1 &= \lambda p q - \tau a q - f \\ &= \frac{\lambda}{\varepsilon}\left(\frac{\tau a}{\theta}\right)^{1-\varepsilon} - f\end{aligned}$$

Case 2): $d^* = 0$**,** $q^* = \bar{q}$

- from (22): $\mu_2 \geq 0$
- from (21): $\mu_1 \geq 0$
- from (19): $\frac{\partial \pi}{\partial p} \leq 0$
- from (20): $\frac{\partial \pi}{\partial d} \leq 0$

- from (1): $p^* = \left(\frac{k-f}{\tau a}\right)^{-\frac{1}{\varepsilon}} \left(\frac{Y}{P^{1-\varepsilon}}\right)^{\frac{1}{\varepsilon}}$
- Optimum profits:

$$\begin{aligned}\pi_2 &= \lambda p\bar{q} - \tau a q - f \\ &= \lambda \left(\frac{\tau a}{k-f}\right)^{\frac{1-\varepsilon}{\varepsilon}} \left(\frac{Y}{P^{1-\varepsilon}}\right)^{\frac{1}{\varepsilon}} - k\end{aligned}$$

Case 3): $d^* > 0$, $q^* > \bar{q}$

- from (22): $\mu_2 = 0$
- from (21): $\mu_1 \geq 0 \quad \text{if} \quad d^* = 1 - \frac{k}{\tau a q^* + f}$
- from (20): $\mu_1 = 1 - \lambda R$
- from (19): $\frac{\partial \pi}{\partial p} = \mu_1 (1-d)\tau a q' \qquad \Leftrightarrow \qquad \lambda(pq' + q) = \lambda R \tau a q' \qquad \Leftrightarrow \qquad p^* = \frac{R\tau a}{\theta}$
- Optimum profits:

$$\begin{aligned}\pi_3 &= \lambda p q - (1-d^*)(\tau a q + f) - d^* \lambda R(\tau a q + f) \\ &= \frac{\lambda}{\varepsilon}\left(\frac{R\tau a}{\theta}\right)^{1-\varepsilon} + (\lambda R - 1)k - \lambda R f\end{aligned}$$

Case 4): $d^* > 0$, $q^* > \bar{q}$

- from (22): $\mu_2 = 0$
- from (21): $\mu_1 = 0 \quad \text{if} \quad d^* \neq 1 - \frac{k}{\tau a q^* + f}$
- from (20): $\frac{\partial \pi}{\partial d} = 0 \qquad$ a contradiction

If $k < f$, reasonable solutions ($q^* > 0$) do not exist for cases 1 and 2.

B Equivalent maximization structure

The firm insures a share δ of exports. To stay in the example, δ is equal to the residual externally financed costs. Furthermore, we assume that the liquidity constraint is binding:

$$\begin{aligned}k &= (1-d)(\tau a q + f) \\ \rightarrow \quad (1-d) &= \frac{k}{\tau a q + f} \\ \rightarrow \quad d &= \frac{\tau a q + f - k}{\tau a q + f}\end{aligned}$$

Therefore, the covered share can be expressed as

$$\delta = \frac{\bar{R}d(\tau aq + f)}{pq} = \frac{(\tau aq + f - k)}{pq} \tag{23}$$

Hence the maximization problem for this special case can be formulated as:

$$\pi = \max_{p} \lambda pq + (1-\lambda)(1+\gamma)\bar{R}(\tau aq + f - k) - k - \bar{R}(\tau aq + f - k) - \gamma\bar{R}(\tau aq + f - k \tag{24}$$

$$= \lambda pq + (1-\lambda)(1+\gamma)\bar{R}(\tau aq + f - k) - (1+\gamma)(\tau aq + f - k) - k \tag{25}$$

$$= \lambda pq - \lambda(1+\gamma)\bar{R}(\tau aq + f - k) - k, \tag{26}$$

with γ representing the risk premium for the public guarantees. Hence $R^G = (1+\gamma)\bar{R}$.