
**BGPE Discussion Paper**

**No. 116**

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March 2012

ISSN 1863-5733

Editor: Prof. Regina T. Riphahn, Ph.D.
Friedrich-Alexander-University Erlangen-Nuremberg


B G P E Discussion Paper Series

# How Trade Credits Foster International Trade

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March 7, 2012

**Abstract**

Internationally active firms rely intensively on trade credits even though they are considered particularly expensive. This phenomenon has been little explored so far. Our theoretical analysis shows that trade credits can alleviate financial constraints arising from asymmetric information because they serve as a quality signal and reduce the uncertainty related to international transactions. We use unique survey data on German enterprises to test the effect of the use of trade credits on firms' exporting and importing behavior, both at the extensive and intensive margins. Our results support the assertion that trade credits have a positive impact on firms' exporting and importing activities.

*Keywords:* trade credits, international trade, financial constraints, export, import, BEEPS

*JEL:* F10, G30

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The authors would like to thank the Bavarian Graduate Program in Economics and the Deutsche Forschungsgemeinschaft (German Science Foundation) under SFB-Transregio 15 for financial support. We are grateful to Kalina Manova, Ralph Ossa, Till von Wachter and several conference and seminar participants for helpful comments and suggestions.

## 1. Introduction

Aggravated trade finance conditions have been suggested as one of the reasons why trade flows collapsed in the wake of the 2008-2009 financial crisis as well as in past crises (Amiti and Weinstein (2011)). Indeed, up to 90% of all trade transactions are supported by some form of trade finance (Auboin (2009)). Surprisingly, though, the main part of trade finance takes the form of trade credits, which are considered a particularly expensive form of financing: implicit annual trade credit interest rates can amount to up to 40% (Petersen and Rajan (1997)).

Trade credits are extended bilaterally between firms and exist in the form of supplier credits and cash in advance. Cash in advance (CIA) refers to payments made in advance by the buyer of a good to the seller. In contrast, a supplier credit (SC) is granted from the seller of a good to the buyer such that the payment of the purchasing price can be delayed for a certain period of time.[4] Why trade credits are so prevalent in international trade, despite their high cost, has been little studied so far.

This paper aims at closing this gap. We argue that international transactions are inherently subject to more uncertainty than domestic transactions and that trade credits serve as a quality signal that helps reduce this high uncertainty. Thus, our paper provides a rationale for the use of expensive trade credits to finance international trade. For this purpose we develop a model of financially constrained firms that need outside finance to be able to either export or import. Financial constraints arise from asymmetric information problems that deter less productive firms from trading and lead to lower trade volumes if only bank financing is available. Access to trade credits reduces the asymmetric information problem and thus promotes trade at the extensive and intensive margins.

We test our predictions with data from the Business Environment and Enterprise Performance Surveys (BEEPS) for German firms in 2004. This dataset is ideal for our purposes since it contains data on the use of trade credits and a direct measure of financial constraints. We find evidence for trade credits' fostering exporting and importing at both margins.

The contribution of our paper is thus twofold. First, we are the first to explicitly analyze the effects of trade credits on the extensive and intensive margins of international trade in a theoretical framework. In our model, we show that the productivity threshold to profitably export is lower if a firm is provided with CIA by its foreign trading partner. Moreover, the firm exports higher volumes with CIA financing. Similarly, we show that access to SC can facilitate importing.

[4] In the literature, the term trade credit is sometimes used for credits extended by a bank to support a trade transaction. When using the term trade credit, we exclusively refer to inter-firm credits that are extended between firms without any financial intermediation.

Second, using survey data, we can provide direct evidence of the beneficial effects on exporters and importers of access to trade credits. This is particularly interesting because the margins of importing have been little explored so far. In the survey, firms report how much CIA and SC they give and receive. Furthermore, they provide information on the extent of their financial constraints. Thus, we need not rely on proxies for trade credit availability and we avoid problems arising from using indirect measures of financial constraints such as balance sheet information.[5] We apply a two-part model to test the effects of trade credits on both margins of exporting and importing. Our results for the extensive margin show that financially constrained firms are less likely to export or to import. CIA availability fosters exporting for all firms, not only for financially constrained firms. The effect of SC availability on the probability of importing is also positive, but only for financially constrained firms. At the intensive margin, while financial constraints have no significant effect, CIA and SC availability promote export and import volumes.

Our analysis is related to three strands of literature. First, it builds on the literature on trade credits such as Lee and Stowe (1993). In Lee and Stowe (1993) firms extend trade credits to signal product quality to their (domestic) customers.[6] This signalling motive should hold *a fortiori* for international transactions that suffer from an even higher degree of uncertainty. As we show in our model, even though trade credits are intrinsically more costly than bank credits, this disadvantage is more than compensated for by the reduction of uncertainty, so financially constrained firms benefit from access to trade credits.

Only recently has the literature on trade credits taken international transactions into its focus, investigating the optimal choice of trade credit. In Schmidt-Eisenlohr (2010)'s model financial market characteristics and contractual environments of both the foreign and domestic market influence the choice of trade credit by firms. Similarly, Antràs and Foley (2011) study how a firm's choice of using CIA versus SC depends on the extent of contractual frictions in the foreign trading partner's country. The authors find empirical support using data from a large US exporting firm. Ahn (2011) investigates which side of the transaction should provide a trade credit and finds that it should be the trade partner that disposes of the larger amount of collateral. Furthermore, he provides an explanation for how a lack of trade finance could have contributed to the drop in global trade during the financial crisis. Olsen (2011) focuses on the role of banks in international trade. He shows that by issuing letters of credit, banks can help to overcome enforcement problems between exporters and importers. Glady and

[5] See Kaplan and Zingales (1997) and Fazzari et al. (2000) for a discussion.

[6] Another paper on the warranty by quality hypothesis was simultaneously developed by Long et al. (1993). In a more recent paper, Klapper et al. (2012) provide empirical evidence of the quality signalling motive for a small sample of US and European firms.

Potin (2011) provide empirical evidence on the importance of letters of credit when country default risk is high. Our focus is not on the choice of the trade credit form as a function of the level of uncertainty. Instead, we investigate why firms choose trade credit financing instead of the cheaper bank financing. We argue that this is because trade credits serve as quality signals in international trade that help alleviate financial constraints. In addition, we show that trade credits foster international trade at both margins.[7]

The second strand of literature explores the influence of financial constraints on exporting behavior. Chaney (2005) and Manova (2010) incorporate financial constraints into the Melitz (2003) model and show that these constraints can prevent less productive firms from exporting. In firm-level studies for Italian and Belgian firms, Minetti and Chun Zhu (2011) and Muûls (2008) confirm that less financially constrained firms are more likely to export. Buch et al. (2010) analyze the export and FDI decisions of German firms. They find that less credit-constrained and more productive firms are more likely to export and invest abroad and that financial constraints affect FDI relatively more than exports. Feenstra et al. (2011) argue theoretically that exporters are more severely affected by financial constraints than domestic firms, due to the higher risks and longer financing periods in international trade. We add trade credits to the choice of financing instruments for an internationally active firm. Whereas some firms cannot profitably export if only bank financing is available, we show that with the help of trade credits, financially constrained firms can also export.

Finally, our paper is related to a small but growing strand of literature that analyzes the importing behavior of firms. Kasahara and Lapham (2008) extend the Melitz (2003) model for intermediate goods and argue that only the more productive firms will be able to import because of the fixed costs of importing. They find supportive evidence in a sample of Chilean plants. Vogel and Wagner (2010) report selecting into importing for German manufacturing firms. Similar results are observed for Swedish, Belgian, and Italian firms (see Andersson et al. (2008), Muûls and Pisu (2009), and Castellani et al. (2010)). Our model and the empirical results are consistent with the selecting-into-importing hypothesis. In addition, we look at the effects of financial constraints and trade credit availability on the intensive margin of importing.

The rest of the paper is organized as follows: In Section 2 we take a first look at trade credit use in international trade. In Section 3 we develop two variants of a model for a financially constrained firm, one for an exporter receiving CIA and one for an importer receiving SC. Section 4 provides further information on the dataset and the

[7] In a companion paper, Engemann et al. (2011), we use a similar theoretical framework to focus on the relationship between bank credits and SC for exporting firms. We provide empirical evidence of the complementary relationship between SC and bank credits for German exporters that are financially constrained.

empirical strategy applied to test the predictions derived from our model. In Section 5 we present our empirical analysis. Section 6 concludes.

## 2. A First Look at Trade Credit Use in International Trade

In this section, we take a first look at the use of trade credits to illustrate that they are indeed intensively used by internationally active firms. We use data from the Business Environment and Enterprise Performance Survey (BEEPS) on 1196 German firms in 2004. This survey provides us with all four relevant measures of trade credit use by firms: CIA given, CIA received, SC given, and SC received. In addition, it contains data on export and import shares and a self-reported measure of financial constraints. In the survey, firms indicate whether access to financing is no obstacle, a minor obstacle, a moderate obstacle, or a major obstacle to their operations. We classify a firm as financially constrained if access to financing is at least a moderate obstacle to the firm.[8]

Panel A of Table 2 displays differences in trade credit use by exporters versus non-exporters. Strikingly, exporters distinctly exhibit a higher use of trade credits than non-exporters. First, a higher percentage of all exporters receive CIA on sales and give SC on sales than non-exporters. For example, about 44% of all exporters receive a positive share of their sales in advance, whereas only 34% of all non-exporters receive CIA. Second, average shares given and received are higher for exporters than non-exporters. For example, exporters grant delayed payment on 65% of their sales to customers on average, whereas non-exporters do so on only about 49% of their sales (SC given). This implies that exporters use trade credits more actively and more intensively than non-exporters. We also apply a mean difference test to determine whether the displayed differences in trade credit use are statistically significant. We find that except for the difference in the average share of CIA received, all differences are statistically significant. Other well-known characteristics of exporters are reflected in the data as well: exporters are significantly larger in terms of sales and employees and are less financially constrained.

In Panel B, we compare trade credit use by importers versus non-importers. We consider only CIA given on input purchases and SC received on input purchases since CIA received (on sales) and SC given (on sales) apply to selling instead of purchasing activities. For the importers in our sample, we also document interesting differences in trade credit use, but they are less pronounced than for exporters. More importers give CIA and receive SC than non-importers and the average share of CIA given by importers is also higher than by non-importers. In contrast, the average share of SC

[8]For a more detailed description of the dataset and the variables used in the analysis, please refer to subsection 4.1.

received by importers is lower than by non-importers. When testing for statistical significance, we only find a significant difference in the share of firms giving CIA. Apart from that, we find that importers are significantly larger and less financially constrained than non-importers.

Finally, we display mean differences in trade credit use for financially constrained versus unconstrained firms in Panel C of Table 2. Financially constrained firms receive higher average shares of both trade credit forms. Furthermore, relatively more firms that are financially constrained receive CIA and SC. All differences except for the average share of SC received are statistically significant.

These descriptive statistics suggest that trade credits play a very important role for internationally active and financially constrained firms. In the following theoretical model, we provide an explanation for these findings which is then put to a test in our empirical analysis.

## 3. Theoretical Framework

We develop two variants of a model, one for financially constrained exporters and one for financially constrained importers. Firms differ in their level of productivity and require external finance to export or import goods. A firm will be able to export (import) only if its productivity level lies above a threshold that allows it to break even. In our model, this threshold varies with different financing options that are available to the firm.[9]

### *3.1. Financially Constrained Exporters and Cash in Advance*

Consider a two-period economy, $t = 0, 1$, in which a firm considers whether to produce for the foreign market.[10] When producing the quantity $x$ in $t = 0$, a firm faces the convex cost function $k = \frac{x^2}{2(1+\beta)}$. $(1 + \beta)$ denotes the productivity level of the firm so that more productive firms produce at lower variable costs, $\beta > 0$. Following the current literature, we characterize a firm by its productivity level which determines its decision to become internationally active (see Melitz (2003)). Additionally, the firm has to incur a fixed cost $F_{Ex}$ associated with foreign market entry, e.g., costs related to the establishment of a distribution network or market research in the foreign market. At the end of $t = 0$, the firm sells its good at price $p$ in the foreign market to an importing firm. In $t = 1$, the importing firm can resell the good to final customers in the foreign market at the exogenous market price $\hat{p}$ and generate revenue.

[9]The idea of varying thresholds for different financing options can also be found in Mateut et al. (2006) and Burkart and Ellingsen (2004) who focus on trade credit extension without reference to international transactions.

[10]Since we are interested only in whether a firm can export at all, we exclude domestic transactions from our analysis.

We assume that the exporting firm does not possess any internal funds and has to finance all costs of production externally in $t = 0$, before any revenues are generated. The importing firm does not possess any cash, either, to pay for the exporter's good. There are two possibilities of how payment by the importer to the exporter can occur: either after delivery in $t = 1$, as soon as the importer has generated own revenues, or upfront before the exporter starts to produce. In the former scenario, the exporter has to finance all production costs via a bank credit. In the latter scenario, the importer has to access external finance to be able to pay in advance. We do not consider payment at delivery (at the end of $t = 0$) because this implies that both trading partners have to use costly external finance instead of only one of the partners. Therefore, payment at delivery is strictly dominated.

When payment occurs after delivery, the exporter faces two sources of uncertainty. The first one is an adverse selection problem with regard to the importer's type. With probability $\mu$, $0 < \mu < 1$, the importer is of high quality (H) and so is able to successfully market the exporter's good in the foreign market. With probability $1 - \mu$ the importer is of low quality (L) which means that positive revenues cannot be generated and hence the exporter is not paid.

Second, a moral hazard problem can occur, due to the long distances in international trade and difficulties of tracing the importer's behavior. Instead of selling the good in the foreign market, the importer can divert the good and derive a private payoff of $\phi x$, blaming adverse market conditions for not generating positive revenues. To fix ideas, we assume that the market demand for the exporter's good in the foreign market is uncertain: demand in the foreign market is positive with probability $\lambda$, $0 < \lambda < 1$ and it is zero with probability $1 - \lambda$. No revenues are generated in the latter case and the importer cannot repay the exporter, even if he is of high quality. We assume that diverting the good is inefficient, i.e. $0 < \phi < \lambda\hat{p}$. Whether or not the high-quality importer diverts the good depends on the price he is supposed to pay to the exporter in case of successfully marketing the good. The low-quality importer always diverts the good since he cannot successfully market it.[11] Hence, positive export revenues are generated only if the importer is of high quality, market demand is positive, and the high-quality importer does not divert the good.[12]

*3.1.1. Pure Bank Credit Financing*

In the following, we consider the case in which payment occurs after delivery and the exporter has to apply for a bank credit to finance all costs of production. The bank

[11] Including moral hazard is necessary to have type uncertainty in our model. Without any possibility to divert the good, a low-quality importer would not take part in trade.

[12] Araujo and Ornelas (2007) also model type uncertainty of exporters and importers in international trade. They focus on improvements in institutional quality to overcome asymmetric information.

credit can be repaid only if the importer pays for the goods as agreed on. This depends on the type of the importer, the demand in the foreign market, and the decision whether to divert or resell the good.

To prevent problems related to moral hazard, for each unit of $x$ sold to the high-quality importer, the exporting firm demands a price $p$ such that

$$\lambda(\hat{p}x - px) \geq \phi x.$$

The high-quality importer's expected revenues from selling the good and repaying the exporter in case of positive market demand must be at least as high as the gain from diversion. We assume that the exporter has full market power in setting the price for the good, so $p$ is given by

$$p = \hat{p} - \frac{\phi}{\lambda}. \tag{1}$$

Assuming instead that the importer has some, but less than full, market power changes our results only quantitatively but not qualitatively.

Banks operate under perfect competition and make zero profits. The bank faces the same uncertainty as the exporter concerning the quality type of the importer and the market risk, so credit repayment by the exporter is uncertain. For simplicity, we assume that there is no asymmetric information with regard to the exporter's quality.[13] For the bank to break even, the following condition has to hold

$$\lambda\mu D(1 + r_B) = (1 + \bar{r}_B)D,$$

where $D$ stands for the amount lent by the bank which is repaid with probability $\lambda\mu$, i.e., if the importer is of high quality and market demand is positive. The bank's expected revenues have to be equal to the refinancing costs of the bank. $(1+r_B)$ denotes the gross interest rate the bank charges and $(1 + \bar{r}_B)$ refers to the gross refinancing interest rate of the bank. The collateral in case of non-repayment is normalized to 0. Solving for $(1 + r_B)$ yields the gross interest rate the bank requires to break even:

$$(1 + r_B) = \frac{(1 + \bar{r}_B)}{\lambda\mu}. \tag{2}$$

The higher the certainty about the foreign market demand and the importer quality, the lower the interest rate the bank demands. In the case of complete certainty, $\lambda = \mu = 1$, the bank demands exactly its gross refinancing rate.

[13] Including exporter uncertainty does not change our results qualitatively.

With pure bank credit financing the exporter faces the following profit function:

$$\pi_{Ex}^{BC} = \lambda\mu px - \lambda\mu \frac{1+\bar{r}_B}{\lambda\mu}\left(\frac{x^2}{2(1+\beta)} + F_{Ex}\right). \tag{3}$$

The exporter receives expected revenues of $\lambda\mu px$ and finances the total costs of production via a bank credit. The exporter repays the amount borrowed only in case of positive revenues ($\lambda\mu$) and is charged an interest rate that takes into account the risk of the international transaction.

Maximizing the exporter's profit function with regard to $x$, we can derive the optimal quantity exported with pure bank credit financing:

$$x_{Ex}^{BC} = \frac{(1+\beta)}{\frac{1+\bar{r}_B}{\lambda\mu}}\left(\hat{p} - \frac{\phi}{\lambda}\right). \tag{4}$$

Plugging (4) into the exporter's profit function (3) and setting the profit equal to zero yields the minimum productivity level required to make at least zero profit:

$$(1+\beta)_{Ex}^{BC} \equiv \left(\frac{1+\bar{r}_B}{\lambda\mu}\right)^2 \frac{2F_{Ex}}{\left(\hat{p} - \frac{\phi}{\lambda}\right)^2}. \tag{5}$$

Firms with a productivity level $(1+\beta) < (1+\beta)_{Ex}^{BC}$ will not be able to export since the expected costs of external finance are too high for the firm to be able to break even. We refer to these firms as **financially constrained**. This definition perfectly matches the measure of financial constraints given in our dataset. Recall that, in the survey, firms report the extent to which access to finance is an obstacle to their business operations. We then classify those firms as financially constrained that indicate that access to finance is at least a moderate obstacle.

The productivity threshold decreases with lower refinancing costs incurred by the bank and increases with higher fixed costs of exporting. Firms that can charge a higher price $p$, e.g., if the moral hazard problem is less severe (lower $\phi$), can be relatively less productive to start exporting since their expected revenues are higher.

*3.1.2. Pure CIA Financing*

Next, we consider payment before delivery. If the exporter can enforce advance payment of the total invoice before production takes place in $t = 0$, moral hazard and adverse selection can be eliminated completely. Low-quality importers reveal their type by not agreeing to pay in advance and problems related to moral hazard are irrelevant from the exporter's point of view. Moreover, an additional bank credit is not needed as the total costs of production can be paid out of the revenues received up-front.

When paying the invoiced amount in advance, the importer faces refinancing costs of $(1+\bar{r}_{Im})$. We assume that $\bar{r}_{Im} >> \bar{r}_B$ since banks are specialized financial interme-

diaries and are more efficient in providing credits. We can interpret $\bar{r}_{Im}$ as a measure of the financial constraint of the importer, i.e., the higher is $\bar{r}_{Im}$, the less able is the importer to provide CIA. Recall our assumption that the exporter has full bargaining power. Hence, with pure CIA financing, the exporter demands a price $\tilde{p}$ such that the importer just breaks even:

$$\lambda\hat{p}x - \tilde{p}x(1+\bar{r}_{Im}) = 0.$$

Consequently,

$$\tilde{p} = \frac{\lambda\hat{p}}{1+\bar{r}_{Im}}. \tag{6}$$

The exporter's profit function with pure CIA financing is

$$\pi_{Ex}^{CIA} = \tilde{p}x - \left(\frac{x^2}{2(1+\beta)} + F_{Ex}\right). \tag{7}$$

This leads to

$$(1+\beta)_{Ex}^{CIA} \equiv \left(\frac{1+\bar{r}_{Im}}{\lambda}\right)^2 \frac{2F_{Ex}}{\hat{p}^2}. \tag{8}$$

Comparing the minimum productivity level required for pure CIA financing to the one for pure bank credit financing, we find that pure CIA financing requires a higher minimum productivity level if

$$(1+\bar{r}_{Im})(\lambda\hat{p}-\phi) > \lambda\hat{p}\frac{(1+\bar{r}_B)}{\mu}. \tag{9}$$

The above condition is fulfilled if the refinancing costs of the importer are high relative to the refinancing costs of the bank. If $\bar{r}_{Im}$ is high, firms that cannot export in the case of pure bank credit financing still cannot with pure CIA financing, either. This is due to the fact that the higher the refinancing costs the lower the price $\tilde{p}$ exporters can demand for their goods. In contrast, if the adverse selection problem is acute (low $\mu$), pure CIA financing is attractive for financially constrained firms because the elimination of the adverse selection problem is very valuable.

To simplify our presentation, in the following we restrict attention to parameter cases where pure CIA is dominated by pure bank credit financing. This seems to be the most relevant case since full pre-payments are very rare in practice.

*3.1.3. Partial Cash in Advance and Bank Credit Financing*

Consider now a combination of bank credit and CIA where only a fraction $\alpha$ of the invoice payment is made in advance. This enables the importing firm to save some of the high refinancing costs while it still allows the exporter to solve the adverse selection and the moral hazard problem. The payment made in advance is used to pay a part of the total production costs, the rest is financed via bank credit.

The fraction paid in advance can now serve as a signal of the importer's quality

type to the bank and the exporter. Three cases can occur after observing a certain $\alpha$: first, if the bank believes that the importing firm is of high quality ($Prob(H) = 1$) it will provide an additional bank credit at a lower interest rate to the exporting firm. Second, if the bank believes that the importer is of low quality ($Prob(H) = 0$), it will not provide any bank credit at all because the exporter is not able to repay the bank when trading with a low-quality importer. Third, if the bank cannot infer the quality type from the amount paid in advance ($Prob(H) = \mu$), it will demand the same interest rate as in the case of pure bank credit financing.

The timing of the game is as follows:

1. Nature determines the importer's quality where $Prob(H) = \mu$ and $Prob(L) = 1 - \mu$. The importer learns their type.
2. In $t = 0$, the exporting firm specifies a price $\check{p}$ for the good to be exported and demands CIA payment of a fraction $\alpha$ of the total amount from the importer. The importer decides whether to extend the fraction $\alpha$ in advance or not, depending on the importer's type.
3. The bank observes the CIA payment by the importer in $t = 0$ and decides on additional bank credit.
4. After observing the decisions made by the importer and the bank, the firm decides whether to produce and export or not.
5. In $t = 1$, pay-offs are realized.

We consider two types of equilibria in this game, separating and pooling equilibria. In a separating equilibrium, an informative signal is given, in a pooling equilibrium the signal sent by the importer is not informative. Proposition 1 describes the separating perfect Bayesian equilibrium that maximizes the exporter's pay-off.

**Proposition 1.** *There exists a separating perfect Bayesian equilibrium with*

$$\left[\left(\alpha^H = \alpha^{Sep}, \alpha^L = 0\right), \left(\frac{1+\bar{r}_B}{\lambda}, NoBC\right), Prob\left(H|\alpha \geq \alpha^{Sep}\right) = 1,\right.$$
$$\left. Prob\left(H|0 \leq \alpha < \alpha^{Sep}\right) = 0\right]$$

*where* $\alpha^{Sep} = \frac{\phi/(1+\bar{r}_{Im})}{\hat{p}+\frac{\phi}{(1+\bar{r}_{Im})}-\frac{\phi}{\lambda}}$ *and the price demanded for the exported good is* $\check{p} = \hat{p} - \frac{\phi}{\lambda} + \frac{\phi}{(1+\bar{r}_{Im})}$. *In this separating equilibrium, the high-quality importer extends the share* $\alpha^H = \alpha^{Sep}$ *in advance and the low-quality importer chooses not to extend CIA at all. When observing* $\alpha = \alpha^{Sep}$, *the bank updates its belief according to Bayes Rule such that* $Prob\left(H|\alpha = \alpha^{Sep}\right) = 1$ *and extends additional bank credit at a lower interest rate,* $\frac{1+\bar{r}_B}{\lambda}$. *When observing* $\alpha = 0$, *the bank's belief is* $Prob\left(H|\alpha = 0\right) = 0$ *and it denies additional bank credit.*

*Proof:* See Appendix A.

In the separating equilibrium, the exported quantity $x^{Sep}$ and the minimum productivity threshold for exporting $(1+\beta)_{Ex}^{Sep}$ equal:

$$x_{Ex}^{Sep} = \frac{(1+\beta)}{1+\bar{r}_B}\left[\lambda\hat{p} - \phi + \frac{\phi(1+\bar{r}_B)}{(1+\bar{r}_{Im})}\right] \tag{10}$$

$$(1+\beta)_{Ex}^{Sep} \equiv \frac{2(1+\bar{r}_B)^2 F_{Ex}}{\left[\lambda\hat{p} - \phi + \frac{\phi(1+\bar{r}_B)}{(1+\bar{r}_{Im})}\right]^2}. \tag{11}$$

Firms with a productivity level lower than $(1+\beta)_{Ex}^{Sep}$ cannot export since they have negative expected profits. As before, the productivity threshold increases with higher fixed costs and higher bank refinancing costs. It also increases with higher importer refinancing costs and a higher marginal benefit from diversion.

In addition, we consider the following pooling equilibrium.

**Proposition 2.** *There exists a pooling perfect Bayesian equilibrium with*

$$\left[\alpha^{Pool}, \left(\frac{1+\bar{r}_B}{\lambda\mu}\right), Prob\left(H|\alpha = \alpha^{Pool}\right) = \mu, Prob\left(H|\alpha < \alpha^{Pool}\right) = 0, Prob\left(H|\alpha > \alpha^{Pool}\right) \in [0,1]\right]$$

*where* $\alpha^{Pool} = \frac{\phi/(1+\bar{r}_{Im})}{\hat{p}+\frac{\phi}{(1+\bar{r}_{Im})}-\frac{\phi}{\lambda}}$ *and the price demanded by the exporter is* $\breve{p} = \hat{p} - \frac{\phi}{\lambda} + \frac{\phi}{(1+\bar{r}_{Im})}$. *In this pooling equilibrium, both high- and low-quality importers extend the same share of CIA. The bank is unable to infer the type of the importer from this signal and sticks to its ex-ante belief,* $Prob(H) = \mu$. *It extends additional bank credit at the interest rate* $\frac{1+\bar{r}_B}{\lambda\mu}$.

*Proof:* See Appendix A.

For the pooling equilibrium in which $\alpha^{Pool} = \frac{\phi/(1+\bar{r}_{Im})}{\hat{p}+\frac{\phi}{(1+\bar{r}_{Im})}-\frac{\phi}{\lambda}}$, we can derive the following production quantity and productivity threshold:

$$x_{Ex}^{Pool} = \frac{(1+\beta)}{1+\bar{r}_B}\left[\mu(\lambda\hat{p} - \phi) + \frac{\phi(1+\bar{r}_B)}{(1+\bar{r}_{Im})}\right] \tag{12}$$

$$(1+\beta)_{Ex}^{Pool} \equiv \frac{2(1+\bar{r}_B)^2 F_{Ex}}{\left[\mu(\lambda\hat{p} - \phi) + \frac{\phi(1+\bar{r}_B)}{(1+\bar{r}_{Im})}\right]^2}. \tag{13}$$

Comparing the minimum productivity thresholds in the different financing scenarios, we derive the following proposition.

**Proposition 3.** *The productivity thresholds can be uniquely ranked:*

$$(1+\beta)_{Ex}^{Sep} < (1+\beta)_{Ex}^{Pool} < (1+\beta)_{Ex}^{BC}$$

*Thus, we can identify four groups of firms. (1) Firms with* $(1+\beta) \geq (1+\beta)_{Ex}^{BC}$ *can export in every financing scenario. (2) Firms with* $(1+\beta)_{Ex}^{Pool} \leq (1+\beta) < (1+\beta)_{Ex}^{BC}$

*can export if CIA is given, either in the separating or the pooling equilibrium. (3) Firms with* $(1+\beta)_{Ex}^{Sep} \leq (1+\beta) < (1+\beta)_{Ex}^{Pool}$ *can export only in the separating equilibrium if the signal via CIA is informative. (4) Firms with* $(1+\beta) < (1+\beta)_{Ex}^{Sep}$ *cannot export at all.*

*Proof:* See Appendix A.

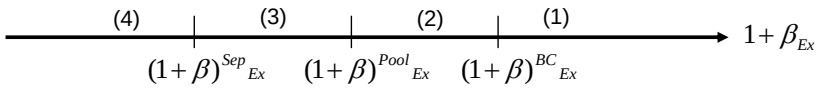


Figure 1: Ranking of productivity thresholds required for exporting

Figure 1 gives a graphical representation of the productivity threshold ranking for the three different financing options.

Proposition 3 implies that if CIA financing is available, financially constrained firms in the second and third group can export that would not have been able to do so with pure bank financing only. These firms benefit from the availability of CIA at the extensive margin. Firms in the fourth group cannot export even if CIA is available. Firms in the third group depend on an informative signal that eliminates the adverse selection problem. Therefore, these firms play the separating perfect Bayesian Equilibrium. In contrast, firms in the second group have a high enough productivity level to export even if the adverse selection problem is not eliminated and can export under both equilibria. However, they cannot export with pure bank financing only. This is due to the fact that incentives for opportunistic behavior are stronger without CIA so that an exporter has to set a lower price for his good to prevent moral hazard by the importer. Firms in the first group do not depend on CIA availability since they are productive enough to export with pure bank financing only. Interestingly, even these firms which have access to bank financing benefit from using CIA. This is shown in the following proposition.

**Proposition 4.** *Even if firms are able to export using pure bank financing, i.e. if* $(1+\beta) \geq (1+\beta)_{Ex}^{BC}$*, they prefer partial CIA financing to pure bank financing.*

*Proof:* See Appendix A.

Very productive firms generate strictly lower expected profits with pure bank financing than with partial CIA financing. This is due to the fact that any small amount of CIA provided reduces the importer's incentive to divert the good. Consequently, the exporter can set a higher price and generate higher expected profits from partial CIA financing.

**Proposition 5.** *Firms with* $(1+\beta) \geq (1+\beta)_{Ex}^{Pool}$ *can export under both the separating and the pooling equilibrium. They prefer to play the separating (pooling) equilibrium if*

*quality uncertainty is low (high) and the importer's refinancing costs are high (low). The higher the productivity of the firm, the greater the parameter space in which the pooling equilibrium is preferred by the exporters.*

*Proof:* See Appendix A.

If the importer's refinancing costs are high, the exporter's expected profits are higher in the separating equilibrium since the informative signal compensates for the relatively lower price firms receive from the importer. In contrast, expected profits are higher in the pooling (separating) equilibrium if uncertainty is high (low). This result seems counterintuitive at first. However, it is due to the fact that trade with an informative signal takes place with probability $\mu$ only. With probability $1-\mu$ the importer is of low quality and hence not willing to send the informative signal which means that the transaction does not take place. An uninformative signal in a pooling equilibrium is sent by both types of importers, instead. Therefore, firms prefer receiving at least a small (uninformative) share of CIA upfront than receiving nothing if it is very likely that they trade with a low-quality importer ($\mu$ is low). This effect is reinforced for more productive firms since more productive firms have lower production costs and can better absorb losses when trading with a low-quality importer.

Finally, we compare the exported volumes in the case of partial CIA financing to pure bank financing and summarize our findings for the intensive margin in the following proposition.

**Proposition 6.** *Exported volumes are strictly higher if firms receive CIA than if firms use pure bank credit financing.*

*Proof:* See Appendix A.

Proposition 6 points out that gains from using CIA occur not only at the extensive margin but also at the intensive margin of exporting.

From these results we derive three important implications. First, the provision of CIA by an importing trading partner can alleviate the financial constraints of an exporting firm. Without CIA, only very productive firms are able to export, whereas with CIA provision also less productive firms are able to do so. Second, CIA is beneficial to all firms since profits are always higher with partial CIA financing. Therefore, all firms are expected to use a combination of CIA and bank credit. Third, exported volumes are always higher when CIA is provided than with pure bank financing. All in all, CIA availability fosters exporting at the extensive and intensive margins.

### *3.2. Financially Constrained Importers and Supplier Credit*

Consider again a two-period economy, $t = 0, 1$, in which a firm produces a final good and sells it to customers in the domestic market. To produce the final good, the firm needs to buy an intermediate good. We assume that this intermediate good is

offered by a foreign supplier (exporter) and has attractive characteristics such that the domestic firm prefers to import the input. The final good is produced in $t = 0$ and revenues are generated in $t = 1$.

The importer faces the following Cobb-Douglas production function:

$$f(q_1, \bar{q}_2) = x = \left[(1 + \beta)\, q_1\right]^{\frac{1}{2}} \bar{q}_2^{\frac{1}{2}}. \tag{14}$$

To produce the quantity $x$ of the final good, two inputs $q_1$ and $\bar{q}_2$ are needed: $q_1$ is the quantity of the intermediate good imported from the exporter at price $p_1$ and $\bar{q}_2$ is a fixed input requirement which cannot be adjusted in the short-run and comes at cost $p_2$. The firm's productivity is captured by $(1 + \beta)$. From (14) we can derive the variable cost function of the firm via cost minimization:

$$k(x) = p_1 \frac{x^2}{(1 + \beta)\bar{q}_2}. \tag{15}$$

The fixed costs of production amount to $F = p_2\bar{q}_2$. We abstract from fixed costs of importing because additional fixed costs simply imply level-shifts in all the results derived.

To capture the riskiness of international transactions, we assume that the importing firm faces uncertainty with regard to the supplier's quality type when ordering the intermediate good. With probability $\sigma$ the exporter is a high-quality supplier and produces a high-quality intermediate good. The high-quality exporter faces marginal costs of production of $\bar{c}$. With a high-quality input, the importer is able to produce a high-quality final good and sell it to customers at market price $\hat{p}$. With probability $1 - \sigma$ the exporter is of low quality and produces a low-quality input which cannot be successfully used as an input by the importer. The low-quality exporter faces marginal costs of production of $\underline{c}$, $\underline{c} < \bar{c}$. No revenues are generated by the importer from selling a low-quality final good. We abstract from type uncertainty with regard to the importer as this does not change our results qualitatively. We do not consider problems related to moral hazard in this setting because adverse selection is sufficient to create quality uncertainty with regard to the input.

We assume that the importing firm does not have any internal funds and has to pledge for outside finance to produce the final good. Payment to the exporter can occur either at delivery or after delivery. We normalize the exporter's production costs $\underline{c}$ and $\bar{c}$ such that the exporter breaks even if paid these costs at delivery (including any financing of production costs). Payment at delivery means that the importer has to pledge for a bank credit. Payment after delivery implies that the exporter delivers the input in $t = 0$ but payment of $p_1 q_1$ is delayed to $t = 1$. We call this a supplier credit, SC. In this case, the exporter needs to refinance at $\bar{r}_{Ex}$ until payment occurs.

We assume again that $\bar{r}_{Ex} >> \bar{r}_B$ for the same reasons as above and interpret $\bar{r}_{Ex}$ as a measure of the financial constraint of the exporter.

*3.2.1. Pure Bank Credit Financing*

If the importer pays at delivery and has to rely on pure bank credit financing his profit function is

$$\pi_{Im}^{BC} = \sigma \hat{p} x - \sigma \frac{1+\bar{r}_B}{\sigma} \left[ p_1 \frac{x^2}{(1+\beta)\bar{q}_2} + F \right]. \tag{16}$$

The bank demands a gross interest rate of $\frac{1+\bar{r}_B}{\sigma}$ to break even.

Like in the previous section we assume that the firm under consideration, here the importer, has full market power. Assuming a different balance of market power affects our results only quantitatively, not qualitatively. Due to asymmetric information, the importer cannot condition the price on the quality of the imported good. Thus, the importer has to pay at least $p_1 = \bar{c}$ to make sure that the high-quality exporter breaks even.[14] The following terms describe the optimal quantity produced of the final good, the optimal quantity imported of the input, and the minimum productivity level required for importing with pure bank credit financing:

$$x_{Im}^{BC} = \frac{\hat{p}(1+\beta)\bar{q}_2}{2\bar{c}\left(\frac{1+\bar{r}_B}{\sigma}\right)}; \quad q_1^{BC} = \frac{\hat{p}^2(1+\beta)\bar{q}_2}{4\bar{c}^2\left(\frac{1+\bar{r}_B}{\sigma}\right)^2}; \quad (1+\beta)_{Im}^{BC} \equiv \left(\frac{1+\bar{r}_B}{\sigma}\right)^2 \frac{4F\bar{c}}{\hat{p}^2\bar{q}_2}. \tag{17}$$

Like above, firms are called **financially constrained** if they cannot import with pure bank credit financing.

*3.2.2. Maximal Supplier Credit Financing*

Instead of pure bank credit financing, the importer can ask for the extension of a SC by the exporter over the total variable input costs (maximal SC possible). This eliminates the adverse selection problem since low-quality exporters do not grant full SC because they know that this supplier credit will never be repaid. However, maximal SC financing is, like pure CIA financing, a very expensive alternative since the importer has to compensate the exporter for the refinancing costs on the full amount of the input costs. Therefore, we restrict attention to partial SC financing where a SC is granted on only a part of the total invoice. This allows the importer to save on the high exporter refinancing costs while still eliminating the adverse selection problem.

*3.2.3. Partial Supplier and Bank Credit Financing*

With partial SC financing, the payment of a fraction $\alpha$ of the total input costs $p_1 q_1$ is delayed, where $0 \leq \alpha < 1$. The fraction granted as SC by the exporter serves as a

[14] If we assume that the importer does not have full market power our results do not change qualitatively.

signal of the exporter's quality type to the bank and the importer. The fixed costs $F$ and $(1-\alpha)p_1q_1$ of the variable input costs not covered by SC have to be financed via bank credit.[15]

The timing of the game is as follows:

1. Nature determines the exporter's quality: $Prob(H) = \sigma$, $Prob(L) = 1-\sigma$. The exporter learns their quality type.
2. In $t = 0$, the importer demands a SC from the exporter by choosing $\alpha$ and $\check{p}_1$. The exporter decides whether to grant the fraction $\alpha\check{p}_1$ as SC or not, depending on their quality type.
3. The bank observes the fraction of SC extended by the exporter in $t = 0$ and decides on additional bank credit.
4. After observing the decisions made by the exporter and the bank, the firm decides whether to import and produce or not.
5. In $t = 1$, pay-offs are realized.

We restrict attention to the separating equilibrium since pooling equilibria are strictly Pareto-dominated by the separating equilibrium for financially constrained firms (See Appendix B). Proposition 7 describes the separating perfect Bayesian equilibrium that maximizes the importer's pay-off.

**Proposition 7.** *There exists a separating perfect Bayesian equilibrium with*

$$\Big[\left(\alpha^H = \alpha^{Sep}, \alpha^L = 0\right), \left((1+\bar{r}_B), NoBC\right), Prob\left(H|\alpha \geq \alpha^{Sep}\right) = 1,$$
$$Prob\left(H|0 \leq \alpha < \alpha^{Sep}\right) = 0\Big]$$

*where* $\alpha^{Sep} = \frac{(\bar{c}-\underline{c})(1+\bar{r}_{Ex})}{\underline{c}+(\bar{c}-\underline{c})(1+\bar{r}_{Ex})}$ *and the price paid for the imported input is* $\check{p}_1 = \underline{c} + (\bar{c} - \underline{c})(1+\bar{r}_{Ex})$. *In this separating equilibrium, the high-quality exporter grants delayed payment on the share* $\alpha^H = \alpha^{Sep}$ *and the low-quality exporter chooses not to grant delayed payment at all. When observing* $\alpha = \alpha^{Sep}$*, the bank updates its belief according to Bayes Rule such that* $Prob\left(H|\alpha = \alpha^{Sep}\right) = 1$ *and extends additional bank credit at a lower interest rate,* $(1+\bar{r}_B)$. *When observing* $\alpha = 0$*, the bank's belief is* $Prob\left(H|\alpha = 0\right) = 0$ *and it denies additional bank credit.*

*Proof:* See Appendix B.

[15] Usually, a SC is not granted on a fraction of the invoice but on the total invoice as described in 3.2.2. The time span of a SC can vary, however. If the time span, e.g. 30 days, is too short for the firm to realize revenues, additional bank credit is needed for day 30 to 60. Therefore, SC granted on a fraction of the total invoice can also be interpreted as full SC but for a too short time period to cover all operational costs. This again implies that a (maximal) SC extended for the total time period can be very expensive for firms.

In the separating equilibrium, the optimal quantity produced of the final good and the optimal quantity imported of the intermediate good are

$$x_{Im}^{Sep} = \frac{\hat{p}(1+\beta)\bar{q}_2}{2\left[(1+\bar{r}_B)\underline{c} + (\bar{c}-\underline{c})(1+\bar{r}_{Ex})\right]} \tag{18}$$

$$q_1^{Sep} = \frac{\hat{p}^2(1+\beta)\bar{q}_2}{4\left[(1+\bar{r}_B)\underline{c} + (\bar{c}-\underline{c})(1+\bar{r}_{Ex})\right]^2}. \tag{19}$$

The minimum productivity level required for importing is

$$(1+\beta)_{Im}^{Sep} \equiv \frac{4(1+\bar{r}_B)F\left[(1+\bar{r}_B)\underline{c} + (\bar{c}-\underline{c})(1+\bar{r}_{Ex})\right]}{\hat{p}^2\bar{q}_2}. \tag{20}$$

Comparing the minimum productivity thresholds in both financing scenarios, we derive the following proposition.

**Proposition 8.** *There exists no unique ranking of the productivity thresholds* $(1+\beta)_{Im}^{Sep}$ *and* $(1+\beta)_{Im}^{BC}$. *There exist parameter cases for which* $(1+\beta)_{Im}^{Sep} < (1+\beta)_{Im}^{BC}$. *This is more likely to be the case if uncertainty is high (low* $\sigma$*) and the exporter refinancing costs are low.*

*Proof:* See Appendix B.

Proposition 8 implies that financially constrained firms benefit from SC access only if the signal sent via SC is valuable (the adverse selection problem is severe). If SC financing is very expensive, however, financially constrained firms that cannot import with pure bank financing cannot do so with SC financing, either. High exporter refinancing costs reflect a higher price for the intermediate input the importer has to pay, which decreases the importer's profits.

**Proposition 9.** *Consider firms with* $(1+\beta) \geq (1+\beta)_{Im}^{BC}$ *and* $(1+\beta) \geq (1+\beta)_{Im}^{Sep}$. *They can import using either pure bank financing or partial SC financing. For very productive firms, pure bank financing yields higher profits than partial SC financing if uncertainty is low (high* $\sigma$*) and the exporter's refinancing costs are high, and vice versa.*

*Proof:* See Appendix B.

Very productive firms generate higher profits from using pure bank financing if the signal sent via SC is not valuable and if SC financing is very expensive such that firms have to pay a high price for the intermediate input. They are better off with supplier credits in the separating perfect Bayesian equilibrium if quality uncertainty is high and if the exporter's refinancing costs are low.

**Proposition 10.** *Firms import higher volumes with partial SC and bank credit financing than with pure bank credit financing if* $\sigma$ *and* $\bar{r}_{Ex}$ *are low.*

*Proof:* See Appendix B.

To sum up, partial SC financing can foster importing at the extensive and intensive margin. This depends on whether the signal provided by SC is informative and valuable (if the adverse selection problem is severe) and on the additional SC costs (exporter's refinancing costs).

### *3.3. Model Predictions and Hypotheses*

Both models show that trade credits can foster trade at the extensive and intensive margins. Comparing the outcomes for partial CIA financing to partial SC financing, we find three interesting differences:

First, CIA financing unambiguously fosters the extensive margin of exporting. There are firms that can start exporting if they receive CIA and that would not have been able to do so with pure bank financing. For some constrained firms even an uninformative signal is sufficient to start exporting. In contrast, SC financing is beneficial to financially constrained importers only if the signal via SC is valuable such that it reduces type uncertainty considerably and if SC financing is not too expensive. Otherwise, financially constrained firms that cannot import with pure bank financing cannot do so with SC financing, either.

Second, the benefits of CIA accrue not only to financially constrained firms. Even firms that do not depend on CIA financing prefer partial CIA financing to pure bank financing. SC financing, however, benefits mainly financially constrained importers, since very productive importers prefer pure bank financing, depending on the parameters.

Third, for the intensive margins we find that exported volumes are always higher with combined CIA financing, whereas with SC financing imported volumes are higher only for the above stated conditions.

From these results we derive two hypotheses about the effects of trade credits on the margins of exporting and importing:

**Hypothesis 1**

*(a) Firms that receive CIA are more likely to be exporting.*

*(b) Exporters that receive CIA export higher volumes.*

**Hypothesis 2**

*(a) Firms that receive SC are more likely to be importing if the adverse selection problem is severe and SC financing is not too expensive. The fostering effect of SC is particularly strong for financially constrained firms.*

*(b) Importers that receive SC import higher volumes than under pure bank financing if the adverse selection problem is severe and SC financing is not too expensive.*

## 4. Empirical Methodology

### *4.1. Data*

BEEPS was developed jointly by the European Bank for Reconstruction and Development and the World Bank Group to analyze the business environment of firms in transition countries and to link it with firm performance. In 2004, cross-sectional data on German firms was collected to perform benchmark analyses. By using stratified random sampling, a high representativeness of the sample is achieved.[16] The median number of 12 employees per firm and the median of expected sales of 1,200,000 Euro in the sample correspond quite well to the German population averages: according to data from the Statistical Yearbook 2007 for the Federal Republic of Germany, the average number of employees was 13 and average sales amounted to 1,230,000 Euro in Germany in 2004.

The main advantage of this dataset is that it provides precise measures of trade credit use by firms. More specifically, firms are asked what percentage of their purchases of material inputs or services they pay before delivery (CIA given), what percentage of these purchases they pay late (SC received), what percentage of their own sales revenues they receive before delivery (CIA received), and what percentage of their own sales revenues they receive late (SC given). Thus, we do not have to rely on proxies such as trade accounts payables and trade accounts receivables which are often used when only balance sheet data is available. However, we cannot single out trade credit related to exporting (importing) activities compared to domestic activities because this kind of detailed measurement is not captured in the data. Therefore, we can only analyze the influence of overall trade credit given and received on the extensive and intensive margin of trade.

Panel D of Table 2 provides average sample characteristics. A look at the average use of trade credits in the sample reveals that firms use SC more intensively than CIA. On average, firms pay 4% of their total input purchases in value terms before they receive the inputs (CIA given). 7% of sales in value terms are received on average by firms before delivery (CIA received). The low usage intensity may reflect there being only a few firms able to provide others with CIA, as CIA involves high refinancing costs for the extending firms. The mean percentages of SC given and received are considerably higher. On average 52% of firms' total sales in value terms are paid late

[16] Specifically, the sample is designed so that the population composition with regard to industries, firm size, ownership, foreign activity, and location is captured. Industries included in the sample are mining and quarrying, construction, manufacturing, transportation, storage and communications, wholesale, retail and repairs, real estate and business service, hotels and restaurants, and other community, social and personal activities. Industries that are subject to government price regulation and prudential supervision like banking, electric power, rail transport, and water and waste water are excluded.

by customers (SC given). In contrast, firms pay 65% of their input purchases in value terms late themselves (SC received).

The survey includes data on export shares of total sales and import shares of total material inputs bought so that we can analyze both the exporting and importing behavior of firms. We define a dummy variable, $Exp$ ($Imp$), which is equal to one if the firm exports (imports) a positive share of its total sales (total material inputs bought) in 2004. For the level of exports (imports), $Expvol$ ($Impvol$), we multiply the export (import) shares with total sales (total material inputs bought) to estimate the effects on the intensive margin of trade. In our sample, about 16% of all firms export products, 18% import inputs from abroad. The sample averages are slightly higher than the population averages for 2004 (12% and 13%, respectively, according to data from the Institut für Mittelstandsforschung).

We also include a measure of financial constraints on the firm-level. This enables us to estimate different effects of trade credit use for financially constrained firms versus non-financially constrained firms. BEEPS provides us with a direct measure of the financial constraints experienced by firms. Specifically, firms are asked whether access to financing is no obstacle, a minor obstacle, a moderate obstacle, or a major obstacle for the operation and growth of their business. We classify firms as financially constrained, $DFin$, if access to financing is at least a moderate obstacle to the firm. This frees us from using indirect and imprecise measures such as cash flow or the debt ratio from firms' balance sheets. 40% of all firms in the sample indicate that access to financing was at least a moderate obstacle.

According to our model, the productivity level of a firm crucially determines whether a firm is able to trade and how much to trade. We compute firm productivity, $TFP$, as the residual from a regression of firm sales on firm size, input costs, and capacity utilization:

$$\begin{aligned} Log(Sales)_i =& \alpha_0 + \beta_1 Log(Size)_i + \beta_2 Log(Mat)_i + \beta_3 Log(Cap)_i \\ &+ \beta_4 Capacity_i + \epsilon_i, \end{aligned} \tag{21}$$

where the subscript $i$ refers to the firm, $Size$ is the number of employees, $Mat$ is the value of material input costs, $Cap$ is the replacement value of capital, and $Capacity$ is the current capacity utilization of the firm.[17]

[17]This measure of productivity is rather simple and is often criticized for not capturing the true level of firm productivity. The standard semi-parametric approach introduced by Olley and Pakes (1996) to estimate firm productivity consistently cannot be applied to cross-sectional data. Therefore, we carefully interpret this measure and are aware that it delivers only an approximation of the true productivity level of a firm.

*4.2. Empirical Strategy*

We use a two-part approach to test our model predictions. Thus, we analyze the effects of trade credit on the extensive margin separately from its effects on the intensive margin. In a first step, we explore the 0/1 decision of a firm whether to export (import) at all via a linear probability model. This facilitates the interpretation of our results compared to a probit estimation.[18] In a second step, we only look at exporters (importers) and analyze how trade credits affect the traded volume of these firms via an OLS regression. We estimate all regressions with bootstrapped robust standard errors since we are using a generated regressor ($TFP$) in our estimations.

We argue that treating both stages independently is justified in our case: in our model, only the most productive firms will be able to trade when firms face financial frictions. Less productive or financially constrained firms are also able to trade internationally if they receive trade credits. Therefore, when controlling for these variables we hope to capture the main variables that influence both decisions jointly so that selection into trading is based on observables and the error terms of both equations are not correlated.[19] As a robustness check, we assume dependence and estimate both decisions jointly via the Heckman selection model.

*4.2.1. Trade Credit Effects on the Extensive Margin of Exporting and Importing*

We estimate the following linear probability model to explore the effects of trade credit availability on the decision of a firm to export or to import.

$$y_{is} = a + \beta_1 TFP_{is} + \beta_2 TCrec_{is} + \beta_3 DFin + \boldsymbol{\gamma}\mathbf{C_{is}} + \lambda_s + \epsilon_{is}. \tag{22}$$

The dependent variables are $Exp$ and $Imp$, as defined above. Our main coefficient of interest is $\beta_2$. We expect a positive influence of firm-level productivity ($\beta_1 > 0$) and a negative effect of financial constraints ($\beta_3 < 0$).

$TCrec$ measures the availability of trade credit. We expect CIA received to positively influence $Exp$ (Hypothesis 1a). It is measured either in percentage shares, $PCIArec$, or as a dummy variable, $DCIArec$, equal to one if the firm receives a positive percentage share of CIA. SC received by firms is expected to have a positive influence on $Imp$ if quality uncertainty is high and SC financing is not too expensive (Hypothesis 2a). SC received is measured in percentage of total input costs paid, $PSCrec$, or as a dummy variable, $DSCrec$, equal to 1 if at least 20% of the total input costs are paid late by the firm.[20] We are unable to capture the degree of quality

[18] Our main results remain unchanged when using a probit model to estimate the extensive margin.

[19] The two-part model is also more appealing if many zeros are observed in the participation decision, i.e. the amount of censoring is very high (Leung and Yu (1996)). This is the case in our sample.

[20] Since only about 8% of all firms do not receive SC we set the threshold indicative of SC availability higher than for CIA received.

uncertainty and SC costs faced by firms in our sample. Therefore, we keep in mind that Hypothesis 2a is weaker and may not hold throughout for all firms.

In a second specification, we include an interaction term between $TCrec$ and $DFin$:

$$y_{is} = a + \beta_1 TFP_{is} + \beta_2 TCrec_{it} + \beta_3 DFin + \beta_4 TCrec_{is} * DFin_{is} + \boldsymbol{\gamma}\mathbf{C_{is}} + \lambda_s + \epsilon_{is}. \quad (23)$$

This allows us to test whether trade credit availability is especially beneficial to financially constrained firms. We expect different results for $Exp$ and $Imp$. We do not expect a significant positive effect of $\beta_4$ for the exporting decision of firms. CIA fosters exports of all firms as shown by our model and thus, CIA availability is not expected to be particularly important for financially constrained (compared to unconstrained) firms. In contrast, we expect a significant positive effect of SC availability for financially constrained firms at the extensive margin of importing. In our model, financially constrained firms depend on SC financing whereas unconstrained importers may not benefit overall from SC access and use pure bank financing instead

As a robustness check, we replace the former interaction term with an interaction term between trade credit received and our measure of firm productivity, $TFP$. Our model predicts that more productive firms are less dependent on trade credit, so that we expect trade credit availability to become less important with increasing firm productivity. Therefore, the interaction term is expected to have no significant influence on the extensive margin of exporting or importing.

$\mathbf{C}$ contains several control variables such as the log of firms' age, (Greenaway et al. (2007)), current capacity utilization of the firm, i.e., the current output relative to the maximum output possible (Gorodnichenko and Schnitzer (2012)), the percentage of the workforce with a university education or higher, to control for human capital effects (Bellone et al. (2010)), and a dummy variable that indicates whether a firm is influenced by competition from foreign competitors. For $Exp$, we also include the markup over operating costs for the main product, and the percentage share of SC received by the firm, $PSCrec$. The provision of SC to firms from input suppliers also improves the financial situation of potential exporters since it provides firms with extra liquidity and reduces uncertainty with regard to unknown suppliers (see Engemann et al. (2011) for a theoretical underpinning). For $Imp$, we leave out the markup of a firm since a firm's pricing policy mainly relates to selling and not to buying decisions. Instead, we suggest that the relationship with a firm's main supplier influences the importing decision of a firm. We construct a dummy variable $DSudep$ that indicates whether the firm is supplier dependent so that it sticks with the supplier even if the price of the main input is raised. The sign of the variable is unclear: supplier dependent firms could be more likely to import if they want to decrease supplier dependency from a domestic supplier or they could be less likely to import if they cannot find suitable alternatives

abroad.[21] Industry specific effects are captured by $\lambda_s$.

*4.2.2. Trade Credit Effects on the Intensive Margin of Exporting and Importing*

The effects of trade credit on the volumes of exports and imports by firms are estimated in two basic regressions via OLS:

$$Log(Volume)_{is} = a + \beta_1 TFP_{is} + \beta_2 TCrec_{is} + \beta_3 DFin_{is} + \beta_5 TCgiv_{is} + \boldsymbol{\gamma}\mathbf{C_{is}} + \lambda_s + \epsilon_{is} \quad (24)$$

$$Log(Volume)_{is} = a + \beta_1 TFP_{is} + \beta_2 TCrec_{it} + \beta_3 DFin_{is} + \beta_4 TCrec_{is} * DFin_{is} + \beta_5 TCgiv_{is} + \boldsymbol{\gamma}\mathbf{C_{is}} + \lambda_s + \epsilon_{is}. \quad (25)$$

The dependent variables are $Log(Expvol)$ and $Log(Impvol)$, respectively. We expect the same signs for our coefficients of main interest as above. We exclude $DPressure$ and $Workforce\ Univ$ from the control variables since both variables should only influence a firm's decision or ability whether to become internationally active. The volume of the international transaction, however, is more likely to be affected by firms' capacities and their productivity level.

Additionally, we include $TCgiv$, credits given by internationally active firms to other firms. For exporters, this is $PSCgiv$, the percentage of SC given out of own-sales. Exporters that give a higher share of SC to other firms should export a higher volume since they help other financially constrained firms to buy their products. For importers, we include a dummy whether a positive share of CIA is given on purchases, $DCIAgiv$, since importers should be able to import more if they provide other firms with CIA. One could argue that both the volume that firms are able to trade and their capacity to extend TC themselves, could be driven by unobserved factors, so that $PSCgiv$ or $DCIAgiv$ are endogenous variables. However, how much a firm can trade and its capacity to extend TC itself should be mainly influenced by its own productivity level and whether it is financially constrained. In our regressions, we control for both influences, so that the endogeneity of $TCgiv$ should not be an issue. We do not face reverse causality between the exported volume and the percentage of SC given either, since we include the percentage of SC given of total sales and not its level. Firms with higher export volumes should have higher SC levels but should not necessarily give a higher percentage of SC to others.

[21] Table 1 provides a detailed overview of all variables and their definitions.

## 5. Empirical Results

### *5.1. Trade Credit Effects on the Exporting Behaviour of Firms*

#### *5.1.1. Extensive Margin of Exporting*

The results from estimating Equation (22) are given in Table 3, columns (1) and (2). As expected, a higher level of $TFP$ increases the probability of exporting. The effect is significant in all specifications. The overall effect of CIA availability on the exporting decision of firms is positive and significant. Firms that receive a positive share of CIA have an 8% higher probability of exporting than firms that do not receive CIA at all (column (1)). Likewise, if firms receive a 10 percentage point higher share of CIA, the probability of exporting increases by 1%. These results confirm Hypothesis 1a. A similar fostering effect can be found for SC availability.

In contrast, financially constrained firms have a 5% lower probability of exporting compared to non-financially constrained firms. The previous literature on financial constraints and exporting has been concerned with a potential endogeneity problem of the self-reported measure of financial constraints (Gorodnichenko and Schnitzer (2012)). Firms that intend to export usually have higher financing needs and therefore might more likely report financial constraints. This may lead to a significant positive impact of $DFin$ on the export participation decision. We, instead, observe a significant negative influence of our measure. If endogeneity played indeed a role, instrumenting $DFin$ would lead to an even stronger negative impact and therefore, we consider our point estimates as very conservative estimates.

In columns (3) and (4), we include the interaction term between $DFin$ and the corresponding variable of CIA received. The interaction terms are positive but not significant. This confirms our former guess: the positive sign implies that CIA has a fostering effect for financially constrained firms but this effect is not statistically relevant since all firms benefit from CIA availability. In contrast, the effect of $DCIArec$ is positive and highly significant: firms that are not financially constrained but receive CIA are more likely to export than comparable firms without CIA. Both results support our hypothesis that CIA strongly fosters exporting of all firms at the extensive margin.

In the last two columns we provide the results for both regressions when an interaction term between $TFP$ and CIA received is included. We do not find a significant influence in either specification. This lends support to our conjecture that with an increasing productivity level, firms do not particularly benefit from CIA provision. More productive firms have lower variable costs and generate higher profits. Therefore, they find it easier to export and do not depend on CIA financing.

Concerning further firm characteristics, we find that older firms and firms with a higher capacity utilization or a higher markup are more likely to be exporters. Firms that are substantially influenced by pressure from foreign competitors when making

key decisions about developing new products or markets are also more likely to be exporters. This may mirror the need to react to foreign competitors by becoming internationally active oneself. A higher share of highly educated workers increases the probability of exporting which underlines the importance of human capital.

*5.1.2. Intensive Margin of Exporting*

The findings in Table 4 confirm Hypothesis 1b. Firms that receive CIA have a 48% higher export volume than firms that do not receive CIA, column (1). This effect is quite large and shows that CIA availability has overall a tremendously fostering effect on export volumes. Likewise, an increase in the percentage of CIA received significantly increases export volumes, column (2). In terms of our model, this is due to (informative) signals of the trading partner's quality and decreased incentives for moral hazard. Interestingly, the share of SC given, $PSCgiv$, has a highly significant and positive influence on the exporting volume. This mirrors the results with regard to importers that receive SC. Firms can stimulate demand for their exports by helping financially constrained importers to buy their products. The coefficient of $DFin$ is positive but not significant which seems to indicate that financial constraints do not play a role at the intensive margin of exporting. Neither the corresponding interaction term nor $DFin$ has a statistically significant influence on the exported volume in columns (3) and (4). The interaction term between CIA received and $TFP$ is not significant, as before.

Our findings suggest that already exporting firms seem not to be influenced by financial constraints, thus there is no fostering effect of CIA availability for financially constrained exporters over and above that of unconstrained exporters. However, CIA availability has a positive influence on the exported volume for unconstrained firms which underlines the overall beneficial effect of CIA.

*5.2. Trade Credit Effects on the Importing Behaviour of Firms*

*5.2.1. Extensive Margin of Importing*

As in the case of the extensive margin of exporting, $TFP$ has a significantly positive and $DFin$ a significantly negative influence on the decision to become an importer (Table 5). Interestingly, the effect of SC on the import decision of firms is negative and only weakly significant (columns (1) and (2)). This result reflects our model outcome that SC financing does not have an overall fostering effect on importing.

Including the interaction term between $SCrec$ and $DFin$ we find slightly different results. The probability of importing decreases by about 14.8% for financially constrained firms that do not receive SC (column (3)). However, part of this negative influence can be cushioned by SC availability by firms. The coefficient of the interaction term is positive and significant and almost compensates for the negative effect of financial constraints. Firms that are financially constrained but receive SC have

a 12.2% higher probability of importing than financially constrained firms without SC. Overall, financially constrained firms with SC have a 2.6% lower probability of importing than the base category, non-financially constrained firms without SC (but the negative effect is smaller than for financially constrained firms without SC). Using the percentage of SC received in column (4) leads to less precise estimates with high standard errors.

These findings confirm Hypothesis 2a. We do not find an overall enhancing effect of SC received for all importers. However, we find that financially constrained firms benefit from SC access. This is in line with our model predictions that quality signals sent via SC are especially fostering for financially constrained firms whereas unconstrained firms do not necessarily benefit from using SC financing and may choose bank financing, instead.

In columns (5) and (6), we provide results from including an interaction term between $TFP$ and SC received. Both interaction terms are weakly negatively significant which indicates that SC availability has a weakly negative effect on the extensive margin of importing with increasing total factor productivity. This reflects that SC financing becomes less relevant for higher-productivity firms at the extensive margin of importing.

We find a positive influence of capacity utilization, presence of foreign pressure and the dummy that indicates supplier dependency. The last outcome may reflect supplier dependent firms' trying to decrease their high dependency by looking for alternative suppliers abroad.

*5.2.2. Intensive Margin of Importing*

The results in Table 6 confirm Hypothesis 2b. SC received has a positive and significant influence on the import volume of firms if measured in percentage shares, column (2). We also include a dummy variable $DCIAgiv$ which is equal to 1 if the firm pays a positive share of its input purchases in advance. According to our predictions, giving CIA to others should help exporters to sell their products abroad. Indeed, firms that give CIA have a 63% to 83% higher import volume than firms that do not extend CIA to others. Financial constraints do not seem to play a role at the intensive margin of importing.

The inclusion of interaction terms between SC received and $DFin$ or $TFP$ in columns (3) to (6) does not result in a more differentiated picture. Since financial constraints do not seem to be present, importers that are financially constrained but receive SC (or a higher percentage of SC) do not significantly import higher volumes. Firms that are not financially constrained but receive a higher share of SC import higher volumes than non-financially constrained firms without SC. This indicates that, at the intensive margin, SC fosters imported volumes even for unconstrained firms.

*5.3. Heckman selection model*

As a robustness check, we estimate both stages jointly via the Heckman selection model. This accounts for the possibility that firms that export (import) are not selected randomly from the population of exporters (importers). We use the dummy variable indicating that a firm is influenced by foreign pressure when making key decisions and the share of highly educated workforce as exclusion restrictions in the case of exporting and importing. Firms that reveal that they are at least fairly influenced by pressure from foreign competitors when making key decisions about developing new products or markets should be more likely to trade internationally in order to react to foreign pressure. However, traded volumes should be unaffected by this firm-specific attitude since volume decisions should depend mainly on capacity and productivity. The same argument should apply to the share of highly educated workforce employed by the firm.

We only provide the results for the first four regressions of each regression table since these results are most relevant. Usually, the coefficients of the first stage and the selection equation of the Heckman selection model are identical since both equations are estimated via probit. In our case, this is not true since we estimate the first stage via a linear probability model to be able to interpret the interaction terms. We can interpret neither the direction of the influence nor the magnitude of the effect of the interaction terms in the selection equation without further assumptions since the model is nonlinear (see Ai and Norton (2003)). Therefore, we restrict our comparison to the signs and the significance for coefficients of non-interaction terms. Table 7 shows the results in the case of exporting. Columns (1) and (2) in Table 7 correspond to column (1) of Table 4 and column (1) of Table 3, and so forth. The estimation results of the Heckman Selection Model are very similar to the results of the two-part approach in terms of the direction of the influence and significance. The Mill's ratio is insignificant throughout all specifications. Therefore, we reject selection based on unobservables and assume independence of both export decisions.

In Table 8 results are presented for the extensive and intensive margin of importing. In two specifications, the Mill's ratio is significant at the 10% level. This weakly indicates that the decision how much to import and whether to import at all might not be independent of each other. Therefore, a closer look at the results is required.

With regard to the signs and the significance of most variables there is no difference between the outcomes of the two-part model and the Heckman selection model. The direction of the influence of $DSCrec$ is the same no matter which estimation approach is used, the same is true for $PSCrec$. In the outcome equations, SC received always has a positive influence on the imported volume while it negatively affects the probability of importing in the selection equations. This is what we also observed in the two-part model. The only difference is that $TFP$ and $DFin$ are insignificant in two selection equations, columns (2) and (6). This is counterintuitive since according to our model,

firms' decision whether to import or not should crucially depend on their productivity level and the extent of financial constraints they face.

We take this result and the fact that the outcome of the Heckman selection model is very sensitive to using the correct specification and reasonable exclusion restrictions as grounds to adhere to our preferred estimation method, the two-part approach.

## 6. Conclusion

Our findings lead to two major inferences. First, we confirm previous studies that financial constraints matter in international trade. Our analysis has shown that firms are substantially influenced by financial constraints when deciding on exporting and importing activities. Thus, in theoretic or empiric work, it is advisable to take into account the effects of financial constraints on firms' behavior in international trade. Second, trade credits can help to alleviate financial constraints experienced by firms in international trade despite higher implied costs. If external funds are not sufficiently available, firms can still overcome financial frictions if other firms redistribute their funds in form of trade credits. Moreover, trade credits can serve as credible signals of quality and reduce part of the high uncertainty in international trade. Consequently, policy actions that ensure and foster trade finance and in particular the extension of SC and CIA are highly recommendable. This is especially relevant in a situation of global monetary contractions when firms experience difficulties in extending trade credit.

## Acknowledgements

The authors would like to thank the Bavarian Graduate Program in Economics and the Deutsche Forschungsgemeinschaft (German Science Foundation) under SFB-Transregio 15 for financial support. We are grateful to Kalina Manova, Ralph Ossa, Till von Wachter and several seminar and conference participants for helpful comments and suggestions.

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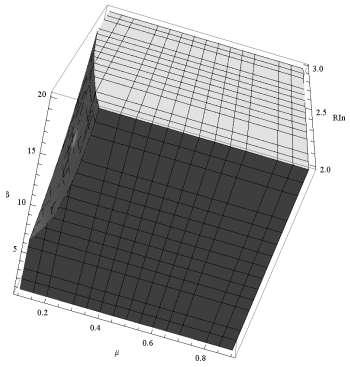


Figure 2: Comparison of profits in the separating and pooling equilibrium

The dyed area in the graph gives all combinations of $(1+\beta)_{Ex}$, $\mu$ and $(1+\bar{r}_{Im})$ for which $\mu\pi_{Ex}^{Sep} > \pi_{Ex}^{Pool}$
Parameters are set at $1+\bar{r}_B = 1.08$, $F_{Ex} = 2$, $\lambda = 0.8$, $\hat{p} = 5$, $\phi = 2$.

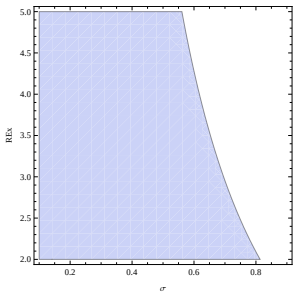


Figure 3: Comparison of profits from partial SC with pure bank credit financing

The shaded area in the graph gives all combinations of $\sigma$ and $(1+r_{Ex})$ for which $(1+\beta)_{Im}^{Sep} < (1+\beta)_{Im}^{BC}$.
Parameters are set at $1+\bar{r}_B = 1.08$, $\underline{c} = 2$, $\bar{c} = 5$.

Table 1: Description of Variables

| Variable | Definition |
|---|---|
| Age | Age of the firm in years |
| Cap[a] | Projected estimate of the replacement value of physical production assets (in 1000 Euros) |
| Capacity[a] | Current output over maximum output possible |
| DCIAgiv | 0/1 dummy for firms that paid a positive share of their input or services purchases before delivery |
| DCIArec | 0/1 dummy for firms that received a positive share of their sales before delivery |
| DFin | 0/1 dummy for firms for which access to finance is a moderate or major obstacle |
| DPressure | 0/1 dummy for firms for which pressure from international competitors is fairly or very important when making key decisions about their business with regard to developing new products or services and markets |
| DSCrec | 0/1 dummy for firms that pay at least 20% of their input or services purchases late to suppliers (after delivery) |
| DSudep | 0/1 dummy for firms that continue to buy the same or slightly lower quantities when their main supplier raises prices by 10% |
| Exp | 0/1 dummy for firms that sell a positive share of their sales abroad |
| Expvol | Amount of sales that are sold abroad (in 1000 Euros) |
| Imp | 0/1 dummy for firms that buy a positive share of their material input or services purchases abroad |
| Impvol | Amount of material input or services purchases that are bought abroad (in 1000 Euros) |
| Mat[a] | Projected estimate of material input costs and bought-in components/services corresponding to the firm's total sales (in 1000 Euros) |
| Markup | Sales price divided by operating costs (in percent) |
| Sales[a] | Projected estimate of total sales (in 1000 Euros) |
| PCIArec | Percentage of sales in value terms received before the delivery of products and services |
| PSCgiv | Percentage of sales in value terms sold on credit (received after the delivery of products and services) |
| PSCrec | Percentage of purchases of material inputs or services in value terms purchased on credit (paid after the delivery of products or services) |
| Size[a] | Number of full-time employees |
| TFP | Total factor productivity, own calculations, see Equation (21) |
| Workforce Univ. | Percentage of workforce that has university education or higher |

All variables are measures or projected estimates of firm characteristics for the year 2004. [a]Variable is used to calculate total factor productivity.

Table 2: Descriptive Statistics

*Panel A: Exporters vs. Non-Exporters*

| | Exporters | Non-Exporters | Difference |
|---|---|---|---|
| Sales (1000 Euros) | 66,971 | 6,419 | 60,552*** |
| Number of employees | 293 | 39 | 254*** |
| Share of fin. constrained firms (%) | 31.3 | 40.8 | -9.5** |
| Share of firms receiving CIA[a] (%) | 43.5 | 33.7 | 9.8** |
| Share of firms giving SC[a] (%) | 93.8 | 79.9 | 13.9*** |
| Share of firms receiving SC[a] (%) | 96.0 | 91.8 | 4.2** |
| Av. Share of CIA received (%) | 7.4 | 7.2 | 0.2 |
| Av. Share of SC given (%) | 64.5 | 49.2 | 15.3*** |
| Av. Share of SC received (%) | 75.4 | 62.7 | 12.7*** |

*Panel B: Importers vs. Non-Importers*

| | Importers | Non-Importers | Difference |
|---|---|---|---|
| Sales (1000 Euros) | 51,152 | 5,945 | 45207*** |
| Number of employees | 233 | 39 | 194*** |
| Share of fin. constrained firms (%) | 33.5 | 41.2 | -7.7** |
| Share of firms giving CIA[a] (%) | 36.5 | 22.1 | 14.4*** |
| Share of firms receiving SC[a] (%) | 94.2 | 92.6 | 1.6 |
| Av. Share of CIA given (%) | 6.1 | 4.4 | 1.7 |
| Av. Share of SC received (%) | 63 | 65.7 | -2.7 |

*Panel C: Financially Constrained vs. Non-Financially Constrained Firms*

| | DFin=1 | DFin=0 | Difference |
|---|---|---|---|
| Share of firms receiving CIA[a] (%) | 38.5 | 32.3 | 6.2** |
| Share of firms receiving SC[a] (%) | 96.3 | 89.7 | 6.6*** |
| Av. Share of CIA received (%) | 8.2 | 6.6 | 1.6* |
| Av. Share of SC received (%) | 66.2 | 64.7 | 1.5 |

*Panel D: Summary Statistics on Firm Characteristics*

| | Mean | Median | Observations |
|---|---|---|---|
| Sales (1000 Euros) | 15,862 | 1,200 | 1,135 |
| Number of employees | 86 | 12 | 1,196 |
| Share of Exporters (%) | 16 | - | 188 |
| Share of Importers (%) | 18 | - | 213 |
| Share of CIA given (%) | 4 | 0 | 1,196 |
| Share of CIA received (%) | 7 | 0 | 1,196 |
| Share of SC given (%) | 52 | 60 | 1,196 |
| Share of SC received (%) | 65 | 70 | 1,196 |
| Share of fin. constrained firms (%) | 40 | - | 481 |

Panel A and B provide results from mean difference tests of firm characteristics for exporters vs. non-exporters and importers vs. non-importers using Welch's formula to allow for unequal variances in both groups (Welch (1947)). Firms are defined as exporters if they sell a positive share of their sales abroad. Firms are defined as importers if they buy a positive share of their material inputs abroad. Panel C shows mean difference test results in trade credit use for financially constrained and non-financially constrained firms. A firm is considered to be financially constrained if it reports that access to finance is a moderate or major obstacle to its current operations. Panel D provides average firm characteristics. ***, **, and * represent coefficients significant at the 1%, 5% and 10% level, respectively. [a]The share of firms that gives or receives a certain form of trade credit is defined as all firms that give or receive a share greater than zero over all firms.

Table 3: Trade Credit Influence on the Extensive Margin of Exporting

| | Exp | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| TFP | 0.0464** | 0.0462** | 0.0465** | 0.0463** | 0.0367* | 0.0551*** |
| | (0.0196) | (0.0197) | (0.0207) | (0.0210) | (0.0214) | (0.0209) |
| DCIArec | 0.0764*** | | 0.0722*** | | 0.0763*** | |
| | (0.0205) | | (0.0280) | | (0.0205) | |
| PCIArec | | 0.00125** | | 0.00109 | | 0.00145** |
| | | (0.000630) | | (0.000783) | | (0.000670) |
| DCIArec*DFin | | | 0.0102 | | | |
| | | | (0.0409) | | | |
| PCIArec*DFin | | | | 0.000359 | | |
| | | | | (0.00118) | | |
| DCIArec*TFP | | | | | 0.0284 | |
| | | | | | (0.0375) | |
| PCIArec*TFP | | | | | | -0.001286 |
| | | | | | | (0.001109) |
| DFin | -0.0501*** | -0.0474** | -0.0538** | -0.0500** | -0.0499*** | -0.0478*** |
| | (0.0187) | (0.0186) | (0.0224) | (0.0196) | (0.0187) | (0.0185) |
| PSCrec | 0.000992*** | 0.000880*** | 0.000992*** | 0.000881*** | 0.000991*** | 0.000883*** |
| | (0.000284) | (0.000290) | (0.000275) | (0.000272) | (0.000285) | (0.000288) |
| LogAge | 0.0291** | 0.0290** | 0.0290** | 0.0289** | 0.0290** | 0.0290** |
| | (0.0142) | (0.0141) | (0.0132) | (0.0132) | (0.0142) | (0.0141) |
| Markup | 0.00161** | 0.00177** | 0.00163** | 0.00178** | 0.00164** | 0.00179** |
| | (0.000821) | (0.000830) | (0.000822) | (0.000802) | (0.000822) | (0.000826) |
| Capacity | 0.00320*** | 0.00292*** | 0.00321*** | 0.00292*** | 0.00319*** | 0.00292*** |
| | (0.000785) | (0.000777) | (0.000764) | (0.000768) | (0.000784) | (0.000779) |
| DPressure | 0.221*** | 0.223*** | 0.221*** | 0.223*** | 0.222*** | 0.222*** |
| | (0.0262) | (0.0265) | (0.0258) | (0.0257) | (0.0262) | (0.0264) |
| Workforce Univ. | 0.00127** | 0.00139*** | 0.00127** | 0.00139** | 0.00125*** | 0.00140*** |
| | (0.000538) | (0.000536) | (0.000551) | (0.000546) | (0.000541) | (0.000536) |
| Indus. FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 1,078 | 1,078 | 1,078 | 1,078 | 1,078 | 1,078 |
| R-squared | 0.329 | 0.322 | 0.329 | 0.322 | 0.319 | 0.323 |

This table reports the estimated coefficients of various influences on firms' export decision via a linear probability model. The dependent variable is an export decision dummy which is equal to 1 if the firm exported a positive amount in 2004. Columns (1) to (2) present results for the basic regression when CIA received is either measured as dummy or share variable. In columns (3) and (4) interaction terms between the CIA variables and the financial constraints dummy are included, in columns (5) and (6) the same is done for interactions between CIA received and TFP. For the definitions of the independent variables please refer to Table 1. Industry fixed effects are included with respect to all relevant industries. Bootstrapped robust standard errors are in parentheses. ***, **, and * denote significance at 0.01, 0.05, and 0.10 levels, respectively.

Table 4: Trade Credit Influence on the Intensive Margin of Exporting

| | LogExpvol | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| TFP | 1.852*** | 1.885*** | 1.827*** | 1.877*** | 1.939*** | 1.785*** |
| | (0.289) | (0.286) | (0.309) | (0.311) | (0.419) | (0.337) |
| DCIArec | 0.479* | | 0.607* | | 0.476* | |
| | (0.268) | | (0.325) | | (0.272) | |
| PCIArec | | 0.0272*** | | 0.0297** | | 0.0275*** |
| | | (0.00892) | | (0.0126) | | (0.00927) |
| DCIArec*DFin | | | -0.436 | | | |
| | | | (0.557) | | | |
| PCIArec*DFin | | | | -0.00636 | | |
| | | | | (0.0158) | | |
| DCIArec*TFP | | | | | -0.191 | |
| | | | | | (0.566) | |
| PCIArec*TFP | | | | | | 0.0142 |
| | | | | | | (0.0253) |
| DFin | 0.183 | 0.124 | 0.374 | 0.175 | 0.170 | 0.154 |
| | (0.284) | (0.288) | (0.427) | (0.369) | (0.284) | (0.290) |
| PSCrec | -0.00205 | -0.00301 | -0.00190 | -0.00312 | -0.00191 | -0.00332 |
| | (0.00645) | (0.00633) | (0.00617) | (0.00591) | (0.00650) | (0.00623) |
| PSCgiv | 0.0185*** | 0.0207*** | 0.0181*** | 0.0208*** | 0.0181*** | 0.0213*** |
| | (0.00561) | (0.00566) | (0.00628) | (0.00634) | (0.00551) | (0.00549) |
| LogAge | 1.145*** | 1.130*** | 1.143*** | 1.129*** | 1.143*** | 1.127*** |
| | (0.182) | (0.164) | (0.192) | (0.172) | (0.186) | (0.169) |
| Markup | -0.00832 | -0.0108 | -0.00794 | -0.0110 | -0.00854 | -0.0116 |
| | (0.0125) | (0.0121) | (0.0114) | (0.0116) | (0.0126) | (0.0125) |
| Capacity | 0.0413*** | 0.0404** | 0.0406** | 0.0407** | 0.0415** | 0.0410*** |
| | (0.0160) | (0.0158) | (0.0168) | (0.0165) | (0.0161) | (0.0158) |
| Indus. FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 165 | 165 | 165 | 165 | 165 | 165 |
| R-squared | 0.516 | 0.529 | 0.518 | 0.529 | 0.516 | 0.530 |

This table reports the estimated coefficients of an OLS regression of the log of export volume. Export volumes are calculated as the share of exports of total sales times the value of total sales in 2004. Columns (1) to (2) present results for the basic regression when CIA received is either measured as dummy or share variable. In columns (3) and (4) interaction terms between the CIA variables and the financial constraints dummy are included, in columns (5) and (6) the same is done for interactions between CIA received and TFP. For the definitions of the independent variables please refer to Table 1. Industry fixed effects cannot be included due to data limitations. Bootstrapped robust standard errors are in parentheses. ***, **, and * denote significance at 0.01, 0.05, and 0.10 levels, respectively.

Table 5: Trade Credit Influence on the Extensive Margin of Importing, LPM

| | Imp | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| TFP | 0.0469* | 0.0500** | 0.0445* | 0.0503** | 0.137*** | 0.113*** |
| | (0.0250) | (0.0253) | (0.0250) | (0.0252) | (0.0515) | (0.0434) |
| DSCrec | -0.0598* | | -0.0994** | | -0.0641* | |
| | (0.0329) | | (0.0406) | | (0.0331) | |
| PSCrec | | -0.000598* | | -0.000558 | | -0.000605* |
| | | (0.000337) | | (0.000397) | | (0.000337) |
| DSCrec*DFin | | | 0.122* | | | |
| | | | (0.0673) | | | |
| PSCrec*DFin | | | | -0.000121 | | |
| | | | | (0.000656) | | |
| DSCrec*TFP | | | | | -0.105* | |
| | | | | | (0.0541) | |
| PSCrec*TFP | | | | | | -0.000955* |
| | | | | | | (0.000540) |
| DFin | -0.0401* | -0.0425** | -0.148** | -0.0346 | -0.0387* | -0.0410** |
| | (0.0209) | (0.0209) | (0.0644) | (0.0501) | (0.0208) | (0.0209) |
| LogAge | 0.0103 | 0.0119 | 0.00982 | 0.0120 | 0.0103 | 0.0120 |
| | (0.0155) | (0.0154) | (0.0155) | (0.0154) | (0.0156) | (0.0155) |
| Capacity | 0.00196** | 0.00198** | 0.00198** | 0.00198** | 0.00189** | 0.00197** |
| | (0.000859) | (0.000866) | (0.000857) | (0.000865) | (0.000862) | (0.000867) |
| DPressure | 0.185*** | 0.185*** | 0.187*** | 0.185*** | 0.184*** | 0.185*** |
| | (0.0292) | (0.0292) | (0.0292) | (0.0294) | (0.0292) | (0.0291) |
| DSudep | 0.0646*** | 0.0643*** | 0.0651*** | 0.0643*** | 0.0661*** | 0.0648*** |
| | (0.0234) | (0.0232) | (0.0235) | (0.0232) | (0.0234) | (0.0231) |
| Workforce Univ. | -0.000120 | -8.53e-05 | -5.42e-05 | -9.43e-05 | -0.000149 | -8.80e-05 |
| | (0.000499) | (0.000495) | (0.000498) | (0.000500) | (0.000510) | (0.000501) |
| Indus. FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 1,093 | 1,093 | 1,093 | 1,093 | 1,093 | 1,093 |
| R-squared | 0.145 | 0.145 | 0.147 | 0.145 | 0.148 | 0.147 |

This table reports the estimated coefficients of various influences on firms' import decision via a linear probability model. The dependent variable is an import decision dummy which is equal to 1 if the firm directly imported a positive amount of its inputs in 2004. Columns (1) to (2) present results for the basic regression when SC received is either measured as dummy or share variable. In columns (3) and (4) interaction terms between the SC variables and the financial constraints dummy are included, in columns (5) and (6) the same is done for interactions between SC received and TFP. For the definitions of the independent variables please refer to Table 1. Industry fixed effects are included with respect to all relevant industries. Bootstrapped robust standard errors are in parentheses. ***, **, and * denote significance at 0.01, 0.05, and 0.10 levels, respectively.

Table 6: Trade Credit Influence on the Intensive Margin of Importing

| | LogImpvol | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| TFP | 2.115*** | 2.081*** | 2.108*** | 2.041*** | 1.872 | 1.472 |
| | (0.358) | (0.355) | (0.357) | (0.346) | (1.560) | (0.979) |
| DSCrec | 0.565 | | 0.500 | | 0.549 | |
| | (0.414) | | (0.489) | | (0.402) | |
| PSCrec | | 0.0119** | | 0.00986* | | 0.0113** |
| | | (0.00468) | | (0.00553) | | (0.00452) |
| DSCrec*DFin | | | 0.338 | | | |
| | | | (1.059) | | | |
| PSCrec*DFin | | | | 0.00778 | | |
| | | | | (0.00941) | | |
| DSCrec*TFP | | | | | 0.272 | |
| | | | | | (1.591) | |
| PSCrec*TFP | | | | | | 0.00870 |
| | | | | | | (0.0124) |
| DFin | 0.0219 | 0.107 | -0.286 | -0.408 | 0.0175 | 0.0694 |
| | (0.380) | (0.370) | (0.992) | (0.685) | (0.383) | (0.372) |
| DCIAgiv | 0.629* | 0.833** | 0.631* | 0.808** | 0.621* | 0.783** |
| | (0.328) | (0.347) | (0.332) | (0.352) | (0.330) | (0.351) |
| LogAge | 1.043*** | 1.001*** | 1.042*** | 0.987*** | 1.043*** | 0.982*** |
| | (0.244) | (0.236) | (0.246) | (0.242) | (0.244) | (0.243) |
| Capacity | 0.0336** | 0.0337** | 0.0335** | 0.0339** | 0.0333* | 0.0338** |
| | (0.0170) | (0.0165) | (0.0171) | (0.0165) | (0.0173) | (0.0165) |
| DSudep | -0.205 | -0.0413 | -0.210 | -0.0573 | -0.200 | -0.0479 |
| | (0.293) | (0.299) | (0.297) | (0.301) | (0.301) | (0.299) |
| Indus. FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 184 | 184 | 184 | 184 | 184 | 184 |
| R-squared | 0.438 | 0.453 | 0.438 | 0.455 | 0.438 | 0.456 |

This table reports the estimated coefficients of an OLS regression of the log of import volumes. Import volumes are calculated as the share of imports of total inputs bought times the value of total inputs bought in 2004. Columns (1) to (2) present results for the basic regression when SC received is either measured as dummy or share variable. In columns (3) and (4) interaction terms between the SC variables and the financial constraints dummy are included, in columns (5) and (6) the same is done for interactions between SC received and TFP. For the definitions of the independent variables please refer to Table 1. Industry fixed effects are included. Bootstrapped robust standard errors are in parentheses. ***, **, and * denote significance at 0.01, 0.05, and 0.10 levels, respectively.

Table 7: Heckman Selection Model - Trade Credit Effects on the Exporting Behaviour of Firms

| | (1) Outcome | (2) Selection | (3) Outcome | (4) Selection | (5) Outcome | (6) Selection | (7) Outcome | (8) Selection |
|---|---|---|---|---|---|---|---|---|
| TFP | 1.802*** | 0.378*** | 1.850*** | 0.366*** | 1.767*** | 0.378*** | 1.838*** | 0.366*** |
| | (0.302) | (0.140) | (0.305) | (0.140) | (0.300) | (0.141) | (0.307) | (0.140) |
| DCIArec | 0.392 | 0.536*** | | | 0.526 | 0.522*** | | |
| | (0.378) | (0.143) | | | (0.391) | (0.159) | | |
| PCIArec | | | 0.0261** | 0.00779** | | | 0.0290* | 0.00781 |
| | | | (0.0125) | (0.00375) | | | (0.0150) | (0.00481) |
| DCIArec*DFin | | | | | -0.499 | 0.0359 | | |
| | | | | | (0.588) | (0.267) | | |
| PCIArec*DFin | | | | | | | -0.00763 | -6.10e-05 |
| | | | | | | | (0.0215) | (0.00784) |
| DFin | 0.215 | -0.237* | 0.150 | -0.246* | 0.438 | -0.252 | 0.213 | -0.246 |
| | (0.295) | (0.138) | (0.293) | (0.137) | (0.440) | (0.181) | (0.360) | (0.151) |
| PSCrec | -0.00248 | 0.00774*** | -0.00315 | 0.00671*** | -0.00237 | 0.00773*** | -0.00330 | 0.00671*** |
| | (0.00669) | (0.00205) | (0.00657) | (0.00201) | (0.00680) | (0.00205) | (0.00677) | (0.00202) |
| PSCgiv | 0.0177*** | | 0.0201*** | | 0.0172*** | | 0.0202*** | |
| | (0.00590) | | (0.00600) | | (0.00596) | | (0.00605) | |
| LogAge | 1.114*** | 0.149 | 1.111*** | 0.119 | 1.108*** | 0.148 | 1.108*** | 0.119 |
| | (0.196) | (0.0933) | (0.182) | (0.0894) | (0.199) | (0.0944) | (0.183) | (0.0898) |
| Markup | -0.0107 | 0.00907* | -0.0127 | 0.0103** | -0.0106 | 0.00911* | -0.0131 | 0.0103** |
| | (0.0141) | (0.00527) | (0.0136) | (0.00521) | (0.0141) | (0.00533) | (0.0136) | (0.00522) |
| Capacity | 0.0363* | 0.0258*** | 0.0370** | 0.0232*** | 0.0349* | 0.0258*** | 0.0371** | 0.0232*** |
| | (0.0195) | (0.00719) | (0.0186) | (0.00668) | (0.0195) | (0.00718) | (0.0187) | (0.00668) |
| DPressure | | 1.089*** | | 1.080*** | | 1.089*** | | 1.080*** |
| | | (0.124) | | (0.124) | | (0.125) | | (0.125) |
| Workforce Univ. | | 0.00935*** | | 0.00992*** | | 0.00933*** | | 0.00993*** |
| | | (0.00361) | | (0.00346) | | (0.00361) | | (0.00346) |
| Observations | 1,078 | 1,078 | 1,078 | 1,078 | 1,078 | 1,078 | 1,078 | 1,078 |
| Censored Observations | 913 | 913 | 913 | 913 | 913 | 913 | 913 | 913 |
| Mill's Ratio | | -0.278 | | -0.208 | | -0.316 | | -0.225 |
| | | (0.388) | | (0.380) | | (0.395) | | (0.384) |
| $\rho$ | | -0.173 | | -0.132 | | -0.196 | | -0.142 |

This table reports the estimated coefficients of estimating firm decisions made at the extensive and intensive margin of exporting jointly via the two-step Heckman selection model. The dependent variable is the log of exported volumes in 2004. Industry fixed effects are included. Bootstrapped robust standard errors are in parentheses. ***, **, and * denote significance at 0.01, 0.05, and 0.10 levels, respectively.

Table 8: Heckman Selection Model - Trade Credit Effects on the Importing Behaviour of Firms

| | (1) Outcome | (2) Selection | (3) Outcome | (4) Selection | (5) Outcome | (6) Selection | (7) Outcome | (8) Selection |
|---|---|---|---|---|---|---|---|---|
| TFP | 1.884*** | 0.203 | 1.878*** | 0.220* | 1.891*** | 0.194 | 1.830*** | 0.226* |
| | (0.392) | (0.127) | (0.380) | (0.129) | (0.387) | (0.127) | (0.370) | (0.128) |
| LogAge | 0.987*** | 0.0316 | 0.953*** | 0.0404 | 0.990*** | 0.0289 | 0.936*** | 0.0425 |
| | (0.247) | (0.0717) | (0.243) | (0.0718) | (0.246) | (0.0712) | (0.246) | (0.0720) |
| Capacity | 0.0234 | 0.00895* | 0.0250 | 0.00908* | 0.0236 | 0.00895* | 0.0250 | 0.00907* |
| | (0.0180) | (0.00485) | (0.0172) | (0.00491) | (0.0181) | (0.00484) | (0.0173) | (0.00492) |
| DPressure | | 0.720*** | | 0.723*** | | 0.727*** | | 0.719*** |
| | | (0.111) | | (0.111) | | (0.112) | | (0.112) |
| DSudep | -0.367 | 0.300*** | -0.194 | 0.290*** | -0.369 | 0.301*** | -0.213 | 0.291*** |
| | (0.344) | (0.102) | (0.355) | (0.103) | (0.344) | (0.103) | (0.356) | (0.103) |
| Workforce Univ. | | -0.00113 | | -0.00108 | | -0.000850 | | -0.00119 |
| | | (0.00353) | | (0.00354) | | (0.00355) | | (0.00357) |
| DSCrec | 0.684 | -0.276** | | | 0.726 | -0.411*** | | |
| | (0.440) | (0.141) | | | (0.457) | (0.158) | | |
| PSCrec | | | 0.0122** | -0.00289* | | | 0.00979* | -0.00234 |
| | | | (0.00516) | (0.00153) | | | (0.00542) | (0.00173) |
| DSCrec*DFin | | | | | -0.0837 | 0.477 | | |
| | | | | | (1.259) | (0.368) | | |
| PSCrec*DFin | | | | | | | 0.00931 | -0.00181 |
| | | | | | | (0.0105) | (0.00313) | |
| DFin | 0.0912 | -0.154 | 0.161 | -0.171 | 0.152 | -0.575 | -0.451 | -0.0559 |
| | (0.380) | (0.107) | (0.361) | (0.107) | (1.248) | (0.354) | (0.767) | (0.235) |
| DCIAgiv | 0.577* | | 0.760** | | 0.581* | | 0.734** | |
| | (0.302) | | (0.329) | | (0.305) | | (0.328) | |
| Observations | 1,093 | 1,093 | 1,093 | 1,093 | 1,093 | 1,093 | 1,093 | 1,093 |
| Censored Observations | 909 | 909 | 909 | 909 | 909 | 909 | 909 | 909 |
| Mill's Ratio | | -1.210* | | -1.026 | | -1.182* | | -1.040 |
| | | (0.661) | | (0.652) | | (0.654) | | (0.662) |
| $\rho$ | | -0.562 | | -0.496 | | -0.552 | | -0.503 |

This table reports the estimated coefficients of estimating firm decisions made at the extensive and intensive margin of importing jointly via the two-step Heckman selection model. The dependent variable is the log of imported volumes in 2004. Industry fixed effects are included. Robust standard errors are in parentheses. ***, **, and * denote significance at 0.01, 0.05, and 0.10 levels, respectively.

## Appendix

NOT INTENDED FOR PUBLICATION

## Appendix A. CIA and Financially Constrained Exporters

### Proof of Proposition 1

Consider the strategies and beliefs specified in Proposition 1. For these strategies and beliefs to form a separating Perfect Bayesian Equilibrium, the following conditions have to hold. Recall that $\check{p}$ denotes the price the exporter demands for the good.

(1) $\lambda\hat{p}x - \alpha^H\check{p}x(1+\bar{r}_{Im}) - \lambda(1-\alpha^H)\check{p}x \geq 0$

(2) $-\alpha^L\check{p}x(1+\bar{r}_{Im}) + \phi x \geq 0$

(3) $\lambda\hat{p}x - \alpha^H\check{p}x(1+\bar{r}_{Im}) - \lambda(1-\alpha^H)\check{p}x \geq \lambda\hat{p}x - \alpha^L\check{p}x(1+\bar{r}_{Im}) - \lambda(1-\alpha^L)\check{p}x$

(4) $-\alpha^L\check{p}x(1+\bar{r}_{Im}) + \phi x \geq -\alpha^H\check{p}x(1+\bar{r}_{Im}) + \phi x$

(5) $\lambda\hat{p}x - \alpha^H\check{p}x(1+\bar{r}_{Im}) - \lambda(1-\alpha^H)\check{p}x \geq -\alpha^H\check{p}x(1+\bar{r}_{Im}) + \phi x.$

Conditions (1) and (2) describe the participation constraints of the high- and the low-quality importer when extending the share $\alpha$ of the purchasing price $\check{p}x$ in advance. Conditions (3) and (4) are the corresponding incentive compatibility constraints of both types. Condition (5) rules out moral hazard by the high-quality importer guaranteeing that the high-quality importer breaks even when paying an informative amount of CIA. It is easily verified that by choosing

$$\alpha^H = \alpha^{Sep} = \frac{\phi/(1+\bar{r}_{Im})}{\hat{p} + \frac{\phi}{(1+\bar{r}_{Im})} - \frac{\phi}{\lambda}}, \quad \alpha^L = 0, \quad and \quad \check{p} = \hat{p} - \frac{\phi}{\lambda} + \frac{\phi}{(1+\bar{r}_{Im})},$$

all five conditions are fulfilled in such a way that the exporter's pay-off is maximized.

If the bank observes the share $\alpha = \alpha^{Sep}$ given in advance it updates its belief according to Bayes Rule such that $Prob(H|\alpha^{Sep}) = 1$ and extends additional bank credit at the cheaper interest rate $\frac{(1+\bar{r}_B)}{\lambda}$. If $\alpha \leq \alpha^{Sep}$ the bank's best response is to deny bank credit, as otherwise $\pi_B < 0$ because its updated belief is that it faces the low-quality importer.

The high-quality importer's best response is to choose $\alpha^H = \alpha^{Sep}$ and the low-quality importer's best response is to set $\alpha^L = 0$. The high-quality importer does not deviate to $0 \leq \alpha < \alpha^{Sep}$ since the bank does not extend any bank credit in this case, $Prob\left(H|0 \leq \alpha < \alpha^{Sep}\right) = 0$. Thus, the export transaction does not take place and the high-quality importer pays the amount of CIA in vain, i.e., $\pi^H_{Im} \leq 0$. The high-quality type does not have an incentive to set $\alpha > \alpha^{Sep}$, because given $\check{p}$ and $x^{Sep}_{Ex}$,

the importer makes negative profits when extending a higher amount of CIA. Hence, the high-quality importer does not have an incentive to deviate from $\alpha^{Sep}$.

The low-quality importer does not have an incentive to choose $0 < \alpha^L < \alpha^{Sep}$, since the bank does not extend an additional bank credit in this case and $\pi^L_{Im} \leq 0$. Neither does it choose $\alpha^L \geq \alpha^{Sep}$ since $\pi^L_{Im} \leq 0$, as well.

**Derivation of $x^{Sep}_{Ex}$ and $(1+\beta)^{Sep}_{Ex}$**

In the separating equilibrium, the exporter's profit function with partial CIA and bank credit financing is

$$\pi^{Sep}_{Ex} = \alpha^{Sep}\check{p}x + \lambda(1-\alpha^{Sep})\check{p}x - \lambda\frac{(1+\bar{r}_B)}{\lambda}\left(\frac{x^2}{2(1+\beta)} + F_{Ex} - \alpha^{Sep}\check{p}x\right) - \alpha^{Sep}\check{p}x. \tag{A.1}$$

Part of the total invoice amount is received with certainty up-front, the rest is received with probability $\lambda$ in $t = 1$. The amount paid in advance is used to pay a part of the total costs of production, the rest is financed via bank credit. Bank credit is available at a lower interest rate since uncertainty with regard to the importer's quality type has vanished.

Combining $\alpha^{Sep} = \frac{\phi/(1+\bar{r}_{Im})}{\hat{p}+\frac{\phi}{(1+\bar{r}_{Im})}-\frac{\phi}{\lambda}}$ and $\check{p} = \hat{p} - \frac{\phi}{\lambda} + \frac{\phi}{(1+\bar{r}_{Im})}$ to maximize the exporter's profit given in (A.1), we can derive the optimal quantity exported and the minimum productivity level necessary for exporting:

$$x^{Sep}_{Ex} = \frac{(1+\beta)}{1+\bar{r}_B}\left[\lambda\hat{p} - \phi + \frac{\phi(1+\bar{r}_B)}{(1+\bar{r}_{Im})}\right]$$

$$(1+\beta)^{Sep}_{Ex} \equiv \frac{2(1+\bar{r}_B)^2 F_{Ex}}{\left[\lambda\hat{p} - \phi + \frac{\phi(1+\bar{r}_B)}{(1+\bar{r}_{Im})}\right]^2}.$$

**Proof of Proposition 2**

Consider the strategies and beliefs specified in Proposition 2. It is easily verified that with the share $\alpha^{Pool} = \frac{\phi/(1+\bar{r}_{Im})}{\hat{p}+\frac{\phi}{(1+\bar{r}_{Im})}-\frac{\phi}{\lambda}}$ and $\check{p} = \hat{p} - \frac{\phi}{\lambda} + \frac{\phi}{(1+\bar{r}_{Im})}$ the participation constraints and the incentive compatibility constraints are satisfied for both types of importers and the pay-off of the exporter is maximized. Note that only for $\alpha^{Pool} = \frac{\phi/(1+\bar{r}_{Im})}{\hat{p}+\frac{\phi}{(1+\bar{r}_{Im})}-\frac{\phi}{\lambda}}$ and $\check{p} = \hat{p} - \frac{\phi}{\lambda} + \frac{\phi}{(1+\bar{r}_{Im})}$ the exporter can set the profits of both importer types equal to 0.

Neither type of importer has an incentive to deviate from $\alpha^{Pool} = \frac{\phi/(1+\bar{r}_{Im})}{\hat{p}+\frac{\phi}{(1+\bar{r}_{Im})}-\frac{\phi}{\lambda}}$. They will not deviate to $\alpha > \alpha^{Pool}$ since, given the price $\check{p}$ for the exporter's good, importer profits decrease in $\alpha$. Furthermore, they will not unilaterally decrease $\alpha$ as the transaction will not take place then. This holds independently for any equilibrium belief of the bank, $Prob\left(H|\alpha > \alpha^{Pool}\right) \in [0,1]$ since $\check{p}$ is given. For $Prob\left(H|\alpha > \alpha^{Pool}\right) = 1$, the bank offers the cheaper bank credit to the exporter. However, the exporter will charge

the same price and thus the high-quality type does not have an incentive to deviate to $\alpha^H > \alpha^{Pool}$. For $Prob\left(H|\alpha > \alpha^{Pool}\right) = 0$, the bank does not extend any bank credit and the transaction does not take place. For every belief $Prob\left(H|\alpha > \alpha^{Pool}\right) \in [0,1]$, the exporter will charge the same price. Hence, neither the high-quality importer nor the low-quality importer has an incentive to deviate to $\alpha^H > \alpha^{Pool}$.

**Derivation of $x_{Ex}^{Pool}$ and $(1+\beta)_{Ex}^{Pool}$**

In the pooling equilibrium with $\alpha^{Pool} = \alpha^{Sep}$, the bank has the belief $Prob(H|\alpha^{Pool}) = \mu$ and $(1+r_B) = \frac{(1+\bar{r}_B)}{\lambda\mu}$. The price for the export good is given by $\check{p}$. The exporter's profit function with partial CIA and bank credit financing is

$$\pi_{Ex}^{Pool} = \alpha^{Pool}\check{p}x + \lambda\mu(1-\alpha^{Pool})\check{p}x - \lambda\mu\frac{(1+\bar{r}_B)}{\lambda\mu}\left(\frac{x^2}{2(1+\beta)} + F_{Ex} - \alpha^{Pool}\check{p}x\right) - \alpha^{Pool}\check{p}x. \tag{A.2}$$

The optimal quantity exported and the minimum productivity level required for exporting are

$$x_{Ex}^{Pool} = \frac{(1+\beta)}{1+\bar{r}_B}\left[\mu(\lambda\hat{p} - \phi) + \frac{\phi(1+\bar{r}_B)}{(1+\bar{r}_{Im})}\right]$$

$$(1+\beta)_{Ex}^{Pool} \equiv \frac{2(1+\bar{r}_B)^2 F_{Ex}}{\left[\mu(\lambda\hat{p} - \phi) + \frac{\phi(1+\bar{r}_B)}{(1+\bar{r}_{Im})}\right]^2}.$$

**Proof of Proposition 3**

A comparison of (11) with (13), reveals that $(1+\beta)_{Ex}^{Sep} < (1+\beta)_{Ex}^{Pool}$ since $\mu < 1$. Similarly, from comparing (13) with (5) we find that $(1+\beta)_{Ex}^{Pool} < (1+\beta)_{Ex}^{BC}$ since $0 < \frac{\phi(1+\bar{r}_B)}{(1+\bar{r}_{Im})}$. Therefore,

$$(1+\beta)_{Ex}^{Sep} < (1+\beta)_{Ex}^{Pool} < (1+\beta)_{Ex}^{BC}.$$

**Proof of Proposition 4**

Firms in the first category can export with pure bank credit financing or combined CIA financing. Partial CIA financing allows the exporter to charge a higher price than in the case of pure bank financing. It is straightforward to see that

$$p < \check{p}.$$

A higher price leads to higher expected revenues and higher expected profits since the total costs of production remain constant.

Consider, e.g., the case of partial CIA financing in the pooling equilibrium. The exporter faces the same type uncertainty as with pure bank financing and pays the

same bank interest rate. However, the exporter receives a higher price from partial CIA financing and therefore makes higher profits than with pure bank financing.

**Proof of Proposition 5**

Whether exporters with $(1+\beta) \geq (1+\beta)_{Ex}^{Pool}$ prefer to play the pooling or the separating equilibrium depends on the expected profits in both equilibria. A transaction with an informative signal in the separating equilibrium occurs with probability $\mu$ since with probability $1-\mu$ the importer is of low quality and is not willing to extend an informative signal. Thus expected profits in the separating equilibrium amount to $\mu\pi_{Ex}^{Sep}$. A transaction with an uninformative signal in the pooling equilibrium always takes place since every importer type is able to provide the uninformative fraction of CIA. Exporting firms in the first and second group receive a higher payoff in a separating equilibrium if

$$\mu\pi_{Ex}^{Sep} > \pi_{Ex}^{Pool}.$$

This is fulfilled if

$$2\left(1-\mu\right)\left(1+\bar{r}_B\right)^2 F_{Ex} > \left(1+\beta\right)\left[\left[\mu\left(\lambda\hat{p}-\phi\right)+\phi\frac{1+\bar{r}_B}{1+\bar{r}_{Im}}\right]^2-\mu\left[\lambda\hat{p}-\phi+\phi\frac{1+\bar{r}_B}{1+\bar{r}_{Im}}\right]^2\right]. \quad \text{(A.3)}$$

For given values of $(1+\beta)$ and $\mu$, (A.3) holds if

$$1+\bar{r}_{Im} > \pm\sqrt{\frac{\phi^2(1+\bar{r}_B)^2}{\frac{2(1+\bar{r}_B)^2F_{Ex}}{(1+\beta)}+\mu\left(\lambda\hat{p}-\phi\right)}}.$$

We can rule out the negative value since $(1+\bar{r}_{Im}) \in [1,\infty)$. Thus, there exists a unique threshold of $(1+\bar{r}_{Im})$.

For given values of $(1+\beta)$ and $(1+\bar{r}_{Im})$, (A.3) holds if

$$\mu > \frac{(1+\bar{r}_B)^2(1+\beta)\phi^2-2F_{Ex}(1+\bar{r}_B)^2(1+\bar{r}_{Im})^2}{(1+\bar{r}_{Im})^2(1+\beta)(-\hat{p}\lambda+\phi)^2}.$$

Consequently, these exporters prefer playing the separating perfect Bayesian equilibrium if quality uncertainty is low (high $\mu$) and the importer's refinancing costs are high. They prefer playing the pooling perfect Bayesian equilibrium if quality uncertainty is high (low $\mu$) and the importer's refinancing costs are low.

Note further that for given values of $\mu$ and $(1+\bar{r}_{Im})$, (A.3) holds if

$$(1+\beta) < \frac{2\left(1-\mu\right)\left(1+\bar{r}_B\right)^2F_{Ex}}{\left[\left[\mu\left(\lambda\hat{p}-\phi\right)+\phi\frac{1+\bar{r}_B}{1+\bar{r}_{Im}}\right]^2-\mu\left[\lambda\hat{p}-\phi+\phi\frac{1+\bar{r}_B}{1+\bar{r}_{Im}}\right]^2\right]}.$$

Thus, the pooling equilibrium becomes more preferable, the higher is the productivity

of the firm.

Figure 2 depicts the comparison of expected profits in both equilibria for different values of $(1+\beta)$, $\mu$, and $(1+\bar{r}_{Im})$. The pooling equilibrium yields higher profits than the separating equilibrium in parameter spaces with low values of $\mu$ and $(1+\bar{r}_{Im})$. This effect is reinforced for more productive firms (higher $\beta$).

**Proof of Proposition 6**

Comparing (4) with (10) and (12), it is straightforward to see that the following relationship holds:

$$x_{Ex}^{Sep} > x_{Ex}^{Pool} > x_{Ex}^{BC}.$$

Therefore, the exported volume is strictly higher if firms use a combination of CIA and bank credit financing compared to pure bank credit financing.

## Appendix B. Supplier Credit and Financially Constrained Importers

**Proof of Proposition 7**

Consider the strategies and beliefs specified in Proposition 7. For these strategies and beliefs to form a separating Perfect Bayesian Equilibrium, the following conditions have to hold. Recall that $\check{p}_1$ denotes the price the importer pays for the imported input.

(1) $\alpha^H \check{p}_1 q_1 - \left[\bar{c}q_1 - (1-\alpha^H)\check{p}_1 q_1\right](1+\bar{r}_{Ex}) \geq 0$

(2) $-\left[\underline{c}q_1 - (1-\alpha^L)\check{p}_1 q_1\right](1+\bar{r}_{Ex}) \geq 0$

(3) $\alpha^H \check{p}_1 q_1 - \left[\bar{c}q_1 - (1-\alpha^H)\check{p}_1 q_1\right](1+\bar{r}_{Ex}) \geq \alpha^L \check{p}_1 q_1 - \left[\bar{c}q_1 - (1-\alpha^L)\check{p}_1 q_1\right](1+\bar{r}_{Ex})$

(4) $-\left[\underline{c}q_1 - (1-\alpha^L)\check{p}_1 q_1\right](1+\bar{r}_{Ex}) \geq -\left[\underline{c}q_1 - (1-\alpha^H)\check{p}_1 q_1\right](1+\bar{r}_{Ex})$.

The first and second condition are the participation constraints of the high- and low-quality exporter. The high-quality exporter is repaid the SC of $\alpha^H \check{p}_1 q_1$ by the importer since final good revenues are generated. The fraction $(1-\alpha^H)$ of $\check{p}_1 q_1$ is received upfront to pay a part of the production costs $\bar{c}q_1$. $\bar{c}q_1 - (1-\alpha^H)\check{p}_1 q_1$ has to be self-financed by the exporter at the refinancing costs $\bar{r}_{Ex}$. The low-quality exporter receives payment of $(1-\alpha^L)\check{p}_1 q_1$ of the input costs upfront and pays $\underline{c}$ per unit produced of the low-quality intermediate good. The low-quality exporter is not repaid the SC extended, $\alpha^L \check{p}_1 q_1$, since the importer is not able to generate revenues. The third and fourth condition give the incentive compatibility constraints of both types, respectively. It is easily verified that by choosing

$$\alpha^H = \alpha^{Sep} \equiv \frac{(\bar{c}-\underline{c})(1+\bar{r}_{Ex})}{\underline{c}+(\bar{c}-\underline{c})(1+\bar{r}_{Ex})}, \quad \alpha^L = 0, \quad and \quad \check{p}_1 = \underline{c}+(\bar{c}-\underline{c})(1+\bar{r}_{Ex})$$

all four conditions are fulfilled and the importer's pay-off is maximized.

The high-quality exporter sets $\alpha^H = \alpha^{Sep}$ and the low-quality exporter chooses a SC of $\alpha^L = 0$. Both exporters do not have an incentive to deviate from their choices. The high-quality type does not set $0 \leq \alpha^H < \alpha^{Sep}$, since the bank does not provide additional bank credit in this case and the transaction does not take place, $\pi^H_{Ex} \leq 0$. Likewise, the high-quality exporter does not choose $\alpha^H > \alpha^{Sep}$ because at a given quantity, higher refinancing costs for a higher amount of SC extended are not compensated for by a higher price $p_1$. The low-quality exporter does not choose $\alpha^L > 0$, since $\pi^L_{Ex} < 0$.

The bank updates its belief according to Bayes Rule such that $Prob\left(H|\alpha^{Sep}\right) = 1$. If $\alpha = 0$ the bank's best response is to deny bank credit, as otherwise $\pi_B < 0$. The bank cannot increase its profits by choosing a higher interest rate due to perfect competition.

**Derivation of $x^{Sep}_{Im}$, $q^{Sep}_1$, and $(1+\beta)^{Sep}_{Im}$**

The importer's profit function with partial SC and bank credit financing in the separating case is

$$\pi^{Sep}_{Im} = \hat{p}x - \left[(1-\alpha^{Sep})\check{p}_1(1+\bar{r}_B) + \alpha^{Sep}\check{p}_1\right]\frac{x^2}{(1+\beta)\bar{q}_2} - (1+\bar{r}_B)F. \tag{B.1}$$

Using $\alpha^{Sep} \equiv \frac{(\bar{c}-\underline{c})(1+\bar{r}_{Ex})}{\underline{c}+(\bar{c}-\underline{c})(1+\bar{r}_{Ex})}$ and $\check{p}_1 = \underline{c}+(\bar{c}-\underline{c})(1+\bar{r}_{Ex})$ to maximize the importer's profit given in (B.1), we derive the optimal quantity produced of the final good and the optimal quantity imported of the intermediate good as

$$x^{Sep}_{Im} = \frac{\hat{p}(1+\beta)\bar{q}_2}{2\left[(1+\bar{r}_B)\underline{c}+(\bar{c}-\underline{c})(1+\bar{r}_{Ex})\right]}$$

$$q^{Sep}_1 = \frac{\hat{p}^2(1+\beta)\bar{q}_2}{4\left[(1+\bar{r}_B)\underline{c}+(\bar{c}-\underline{c})(1+\bar{r}_{Ex})\right]^2}.$$

The minimum productivity level required for importing when producing $x^{Sep}_{Im}$ is

$$(1+\beta)^{Sep}_{Im} \equiv \frac{4(1+\bar{r}_B)F\left[(1+\bar{r}_B)\underline{c}+(\bar{c}-\underline{c})(1+\bar{r}_{Ex})\right]}{\hat{p}^2\bar{q}_2}.$$

**Proof of Proposition 8**

Comparing (20) with (17) we find that $(1+\beta)^{Sep}_{Im} < (1+\beta)^{BC}_{Im}$ only if

$$(1+\bar{r}_B)\underline{c}+(\bar{c}-\underline{c})(1+\bar{r}_{Ex}) < \frac{1+\bar{r}_B}{\sigma^2}\bar{c}. \tag{B.2}$$

For a given $\sigma$ B.2 is fulfilled if

$$(1+\bar{r}_{Ex}) < \frac{\frac{1+\bar{r}_B}{\sigma^2}\bar{c} - (1+\bar{r}_B)\underline{c}}{(\bar{c}-\underline{c})}.$$

For a given $1+\bar{r}_{Ex}$ B.2 is fulfilled if

$$\sigma < \pm\sqrt{\frac{(1+\bar{r}_B)^2\bar{c}}{(1+\bar{r}_B)\underline{c} + (\bar{c}-\underline{c})(1+\bar{r}_{Ex})}}.$$

We can rule out the negative value since $\sigma \in [0,1]$. Thus, there exists a unique threshold of $\sigma$.

Therefore, partial SC financing leads to a lower productivity threshold than pure bank financing if $(1+\bar{r}_{Ex})$ is not too high and if $\sigma$ is rather low (the signal sent via SC is not trivial). This is also illustrated in Figure 3.

If these conditions hold, firms with $(1+\beta)_{Im}^{Sep} \leq (1+\beta) < (1+\beta)_{Im}^{BC}$ can import when receiving an informative signal via SC and play the unique separating perfect Bayesian equilibrium.

**Exclusion of Pooling equilibria**

The bank has the belief $Prob(H|\alpha \leq \alpha^{Pool}) = \sigma$ and the off-equilibrium belief is free, $Prob\left(H|\alpha > \alpha^{Pool}\right) \in [0,1]$. It chooses $(1+r_B) = \frac{1+\bar{r}_B}{\sigma}$. Again, we consider the case in which $\alpha^{Pool} = \alpha^{Sep} = \frac{(\bar{c}-\underline{c})(1+\bar{r}_{Ex})}{\underline{c}+(\bar{c}-\underline{c})(1+\bar{r}_{Ex})}$ and the input price paid by the importer is given by $\check{p}_1 = \underline{c} + (\bar{c}-\underline{c})(1+\bar{r}_{Ex})$ as the profits of both types of exporters are set to 0 then.

If an uninformative signal is given, type uncertainty is not eliminated and the importer's profit function is

$$\pi_{Im}^{Pool} = \sigma\hat{p}x - \left[\sigma(1-\alpha^{Pool})\check{p}_1\frac{(1+\bar{r}_B)}{\sigma} + \sigma\alpha^{Pool}\check{p}_1\right]\frac{x^2}{(1+\beta)\bar{q}_2} - \sigma\frac{(1+\bar{r}_B)}{\sigma}F. \quad \text{(B.3)}$$

The quantity produced of the final good, the imported quantity of the input, and the minimum productivity level required for importing are

$$x_{Im}^{Pool} = \frac{\sigma\hat{p}(1+\beta)\bar{q}_2}{2\left[(1+\bar{r}_B)\underline{c} + \sigma(\bar{c}-\underline{c})(1+\bar{r}_{Ex})\right]} \quad \text{(B.4)}$$

$$q_1^{Pool} = \frac{(\sigma\hat{p})^2(1+\beta)\bar{q}_2}{4\left[(1+\bar{r}_B)\underline{c} + \sigma(\bar{c}-\underline{c})(1+\bar{r}_{Ex})\right]^2} \quad \text{(B.5)}$$

$$(1+\beta)_{Im}^{Pool} = \frac{4(1+\bar{r}_B)F\left[(1+\bar{r}_B)\underline{c} + \sigma(\bar{c}-\underline{c})(1+\bar{r}_{Ex})\right]}{(\sigma\hat{p})^2\bar{q}_2}. \quad \text{(B.6)}$$

It is straightforward to see that $(1+\beta)_{Im}^{Sep} < (1+\beta)_{Im}^{Pool}$, since

$$(\sigma^2 - \sigma)(\bar{c} - \underline{c})(1 + \bar{r}_{Ex}) < (1 + \bar{r}_B)(1 - \sigma^2)\bar{c}.$$

This implies that, importers with $(1+\beta)_{Im}^{Pool} < (1+\beta)_{Im} < (1+\beta)_{Im}^{BC}$ can play the separating or the pooling equilibrium. However, the pooling equilibrium is Pareto-dominated for financially constrained importers. To see this, compare the expected profits in both equilibria. Import transactions in a separating equilibrium take place with probability $\sigma$ since only high-quality exporters can provide an informative signal in form of SC. Contrarily, import transactions with an uninformative signal take place with every type of exporter. An importer receives a higher payoff in case of a pooling equilibrium if

$$\sigma \pi_{Im}^{Sep} < \pi_{Im}^{Pool}$$

This is fulfilled if

$$(1 - \sigma)(1 + \bar{r}_B)F < \frac{1}{2}\sigma\hat{p}\left(x_{Im}^{Pool} - x_{Im}^{Sep}\right). \tag{B.7}$$

For every productivity level, $x_{Im}^{Pool} < x_{Im}^{Sep}$ since $\sigma < 1$. Therefore, (B.7) does not hold since the RHS is negative and the LHS is positive. Furhermore, recall that the exporter's profit is always set to 0. Hence, the separating equilibrium Pareto-dominates the pooling equilibrium.

**Proof of Proposition 9**

Firms with $(1+\beta)_{Im} \geq (1+\beta)_{Im}^{BC}$ prefer using pure bank financing to playing the separating perfect Bayesian equilibrium if $\pi_{Im}^{BC} > \sigma\pi_{Im}^{Sep}$. We find that this holds if

$$\frac{\sigma}{\bar{c}(1+\bar{r}_B)} - \frac{1}{(1+\bar{r}_B)\underline{c} + (\bar{c}-\underline{c})(1+\bar{r}_{Ex})} > \frac{4(1-\sigma)(1+\bar{r}_B)F}{\sigma\hat{p}^2(1+\beta)\bar{q}_2}. \tag{B.8}$$

For given values of $\sigma$ and $(1+\beta)$, B.8 holds if

$$1 + \bar{r}_{Ex} > \frac{1}{\bar{c} - \underline{c}}\left[\frac{1}{\frac{\sigma}{\bar{c}(1+\bar{r}_B)} - \frac{4(1-\sigma)(1+\bar{r}_B)F}{\sigma\hat{p}^2(1+\beta)\bar{q}_2}}\right].$$

For given values of $(1+\bar{r}_{Ex})$ and $(1+\beta)$, B.8 holds if

$$\sigma > \frac{\left[\frac{\bar{c}(1+\bar{r}_B)^2\hat{p}^2(1+\beta)\bar{q}_2}{(1+\bar{r}_B)\underline{c}+(\bar{c}-\underline{c})(1+\bar{r}_{Ex})} - 4(1+\bar{r}_B)^2F\bar{c}\right] \pm \sqrt{\left[4\underline{c}(1+\bar{r}_B)^2F - \frac{\bar{c}(1+\bar{r}_B)^2\hat{p}^2(1+\beta)\bar{q}_2}{(1+\bar{r}_B)\underline{c}+(\bar{c}-\underline{c})(1+\bar{r}_{Ex})}\right]^2 - 16\hat{p}^2(1+\beta)\bar{q}_2(1+\bar{r}_B)^2\bar{c}}}{2\hat{p}^2(1+\beta)\bar{q}_2}.$$

Since $\sigma \in [0,1]$, the case of subtracting the square root is not defined as $\sigma < 0$ in this case, so there is a unique threshold of $\sigma$ for which $\pi_{Im}^{BC} > \sigma\pi_{Im}^{Sep}$.

For given values of $\sigma$ and $(1+\bar{r}_{Ex})$, B.8 holds if

$$1+\beta > \frac{4(1-\sigma)(1+\bar{r}_B)F}{\sigma\hat{p}^2\bar{q}_2\left[\frac{\sigma}{\bar{c}(1+\bar{r}_B)} - \frac{1}{(1+\bar{r}_B)\underline{c}+(\bar{c}-\underline{c})(1+\bar{r}_{Ex})}\right]}.$$

Therefore, the above equation is fulfilled for high values of $\sigma$, $\bar{r}_{Ex}$, and $(1+\beta)$. If the informative signal is required, both types of exporters lack an incentive to deviate, for the same reasons as above.

If pure bank financing is played by the importer, both exporters do not deviate. Pure bank financing is the most preferred financing option for the low-quality type since she then makes positive profits instead of zero profits.

**Proof of Proposition 10**

Comparing the imported quantities, we find that $q_1^{Sep} > q_1^{BC}$ if

$$(1+\bar{r}_B)\underline{c} + (\bar{c}-\underline{c})(1+\bar{r}_{Ex}) < \frac{1+\bar{r}_B}{\sigma}\bar{c}. \tag{B.9}$$

This is fulfilled for a given value of $\sigma$ if

$$1+\bar{r}_{Ex} < \frac{1}{\bar{c}-\underline{c}}\left[\frac{1+\bar{r}_B}{\sigma}\bar{c} - (1+\bar{r}_B)\underline{c}\right].$$

For a given value of $(1+\bar{r}_{Ex})$ this is fulfilled if

$$\sigma < \frac{(1+\bar{r}_B)\bar{c}}{(1+\bar{r}_B)\underline{c} + (\bar{c}-\underline{c})(1+\bar{r}_{Ex})}.$$

Therefore, imported quantities are higher from partial SC financing than pure bank financing if uncertainty is high (low $\sigma$) and if the exporter refinancing costs are low.