Internationally Active Firms' Financing, Wage Setting, and Investment Decisions

A Theoretical and Empirical Analysis

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Introduction

Over the last decades, the world economy has become considerably more connected across borders. International trade and foreign direct investment (FDI) have increased dramatically. The value of world merchandise exports rose from $3,676 billion in 1993 to $17,816 billion in 2011 (see WTO, 2012a). Worldwide FDI stock increased in the last two decades by a factor of 10 from about $2 trillion in 1990 to about $20 trillion in 2011 (see UNCTAD, 2012). As a direct consequence, internationally active firms, i.e., exporters, importers, and multinational enterprises (MNEs) gain in importance. The number of MNEs worldwide has more than doubled from about 35,000 in 1990 to about 82,000 in 2008 (see UNCTAD, 1992, 2010). This is important from a microeconomic perspective, since internationally active firms differ from purely domestic firms. With the availability of firm level data, researchers have started to analyze these differences. The results have shown that internationally active firms are on average larger and more productive (Bernard, Jensen, Redding, and Schott, 2007; Helpman, Melitz, and Yeaple, 2004). These firms are an important driver of countries' economic growth. Therefore, it is of high relevance to conduct in-depth studies of the behavior of internationally active firms.

Taking into account their importance and different character compared to domestic firms, this dissertation analyzes internationally active firms' financing, wage setting, and investment decisions. In the first and second chapter, we analyze theoretically and empirically why internationally active firms rely heavily on trade credits despite their high costs. The first chapter focusses on the role of trade credits to alleviate financial constraints, while the second chapter explores in how far trade credits foster exporting. In the third chapter, we model theoretically the role of labor unions to explain exporters' and MNEs' wage setting behavior. The last chapter provides an empirical analysis of the determinants of firms' decisions where to locate production in foreign countries and how this relates to the sector of the affiliate that is to be set up abroad. In the remainder of this introduction, we will summarize the main contribution of each chapter. All four chapters of this dissertation are self-contained such that they can be read independently.

The first two chapters of this dissertation analyze why internationally active firms use trade credits intensively. Trade credits are credits extended between two firms, either from a supplier to its customer, i.e., supplier credit, or from a customer to its supplier, i.e., cash-in-advance (CIA). When a firm extends a supplier credit, it allows the buyer to pay the good after delivery, usually with a delay of 30 to 90 days. In contrast, paying in advance means that the buyer pays before the delivery of the good and thus provides the producer with working capital. According to the IMF (2009), about 40% of international transactions are financed via supplier credits and about 20% via CIA. At the same time, trade credits are generally considered to be more expensive than bank credits (see Petersen and Rajan, 1997). Therefore, it is puzzling that they are used intensively by internationally active firms.

In order to solve this puzzle, we start from the observation that, despite the fact that internationally active firms are found to be more productive than domestic firms (Melitz, 2003; Bernard, Jensen, Redding, and Schott, 2007), they are more prone to financial constraints (Berman and Héricourt, 2010). This may be due to two reasons: First, firms active in international trade have higher financing needs than purely domestic firms. They have higher outlays and there is a longer time span between the production of the goods and the payment. Second, cross-border transactions are considered to be more risky (e.g., due to exchange rate risk, different legal systems, and less knowledge about the foreign market and the foreign trading partner). Thus, internationally active firms and banks financing these firms face a high degree of uncertainty. Banks have difficulties to judge the profitability of an international transaction. This information asymmetry may impede internationally active firms' access to bank credits.

In the first chapter, we focus on the case of supplier credits and develop a theoretical model of a potential exporter who needs external finance for the production of export goods.[1] In a world without asymmetric information, bank credits are cheaper than supplier credits because banks, being specialized financial intermediaries, are more efficient in providing credits. With asymmetric information on the quality of the supplier, however, bank credits are more expensive. A supplier credit can provide a signal about the quality of the supplier (e.g., the quality of the supplier's product), which may lead to a reduction in the uncertainty the bank faces. Via the supplier credit, the exporter has time to check the quality of the input delivered before paying the supplier. Therefore, only suppliers of high quality intermediate products have an incentive to give a supplier credit. Hence, the uncertainty about the quality of the supplier is reduced and the bank charges a lower interest rate for any complementary bank credit. This may enable firms to obtain additional bank credit financing that could not afford it before. Consequently, supplier credits are most beneficial for financially constrained exporters.

In order to test the signaling hypothesis, we analyze whether supplier credits and bank credits are complements or substitutes. For this purpose, we use the Business Expectations Panel of the ifo Institute for Economic Research. This is a panel data set for the years 1994 to 2009 which has merged balance sheet data and data of the ifo Business Tendency survey for 3,974 German companies. Our results indicate that bank credit and supplier credit are substitutes for financially unconstrained firms. For financially constrained firms, however, we find evidence that the two forms of credit tend to be complements. As our theory suggests, we find this effect to be even stronger for financially constrained exporters. Thus, our results support our theoretical predictions of the quality signal conveyed by supplier credits, which explains the intensive use of supplier credits by internationally active firms.

[1] This chapter is based on the article "Trade Credits and Bank Credits in International Trade: Substitutes or Complements?" which is joint work with Katharina Eck and Monika Schnitzer.

The second chapter looks into whether trade credits, by reducing information asymmetries, also foster trade.[2] The reduction of information asymmetries may imply that firms get bank credit financing that did not receive bank credit before, whereby alleviating financial constraints. Therefore, trade credits may enable more firms to become exporters. In this chapter, we focus on the case of an exporter who receives CIA by the importer.

For this purpose, we develop a theoretical model of firms that need external finance to be able to export. Financial constraints arise from asymmetric information problems, both adverse selection and moral hazard, that deter less productive firms from exporting if only bank financing is available. Access to CIA reduces the asymmetric information problem as it is a signal on the importers quality and reduces the importers' incentive to divert the good. Thus, CIA increases the profitability of exporting and hence promotes the export participation of firms, in particular for financially constrained firms. We test our prediction with data from the Business Environment and Enterprise Performance Surveys (BEEPS) for German firms in 2004. Using an instrumentation strategy, we are able to identify a causal effect of CIA on exporting. We find that firms that receive CIA from their trading partners have on average a 27% higher probability to export than firms that do not receive CIA financing. In line with our theoretical prediction, we find that the export fostering effect of CIA is particularly strong for financially constrained firms.

Chapter one and two contribute to the literature by providing an explanation for the intensive use of supplier credits by internationally active firms. Furthermore, in the first chapter we provide empirical evidence that supports our hypothesis of trade credits being used as a signaling device. The second chapter contributes to the literature by proposing the first model on the effects of CIA financing on international trade. In addition, we provide empirical evidence on the beneficial effects of CIA financing on exporting derived in our model.

[2]This chapter is based on the article "How Trade Credits Foster Exporting" which is joint work with Katharina Eck and Monika Schnitzer.

The third chapter deals with the question whether MNEs pay higher or lower wages than exporters.[3] Empirical studies have produced inconclusive findings as to whether MNEs pay their employees more than domestically owned firms, which are potential exporters. Heyman, Sjöholm, and Tingvall (2007) estimate that the individual worker's wage level is 2 to 6% higher in MNEs compared to domestically owned firms (see Huttunen, 2007; Chen, Ge, and Lai, 2011, for similar findings). Other studies, however, do not find an MNE wage premium (see Conyon, Girma, Thompson, and Wright, 2002; Almeida, 2007; Andrews, Bellmann, Schank, and Upward, 2009). A potential explanation for the inconclusive empirical evidence is the existence of labor unions. On the one hand, MNEs have a bargaining advantage when negotiating with unions. As they have a production plant in a foreign country, they can threaten the union to relocate production in case the MNE and the union cannot agree on a wage. Therefore, MNEs may pay lower wages than exporters. On the other hand, if unions have preferences that exhibit rent sharing, i.e., they want to partake in firms' profits, wages depend on the firms' profits. Thus, MNEs may pay higher wages than exporters, as they are found to be more productive and to yield higher profits (Helpman, Melitz, and Yeaple, 2004).

In order to analyze these opposing forces, we develop a theoretical model of firm-union wage bargaining of exporters and MNEs introducing the fair wage approach of Egger and Kreickemeier (2012a) into the heterogeneous firms wage bargaining model of Eckel and Egger (2009). We find that whether MNEs pay higher or lower wages than exporters depends on the strength of the union, the competitive environment, trade costs, and the degree of rent sharing, i.e., how closely aligned unions' wage claims are to firms' profits. MNEs pay higher wages when unions' bargaining power is relatively low or relatively high as in these cases MNEs benefit less from their bargaining advantage. For weak unions, wage claims are low anyway and for strong unions the firms' contribution and, hence, the disagreement profit matters less. For intermediate bargaining power, MNEs pay lower wages than exporters as they can profit most from their bargaining advantage.

[3] This chapter is based on the article "Multinational Enterprises, Exporters, and Unions: Bargaining Advantage vs. Rent Sharing".

Furthermore, MNEs' wage payments relative to exporters' increase with trade costs and with the competitive situation in an economy.

The contribution of this chapter is to offer a theoretical explanation for the inconclusive empirical evidence. The model can serve as guidance for future empirical studies on what should be included in the estimation of the wage equation. Moreover, we can show that MNEs have positive effects on the labor market, despite their rather bad reputation in public debate. They may either pay higher wages than exporters or, if they pay lower wages, we show that a higher share of MNEs in an economy decreases the unemployment rate.

Finally, the fourth chapter turns to the question which country characteristics determine firms' decisions where to locate production in foreign countries and how this is connected to the stage of the production process that shall be placed abroad.[4] Most of today's production processes involve several stages which can be performed simultaneously or sequentially. Firms may split these stages across several countries.

We adopt the idea of Kremer (1993) and Costinot, Vogel, and Wang (2012) to the case of FDI. These papers implement a sequential production process involving several stages which are subject to mistakes. For the product to have full value, all stages have to be completed successfully. Hence, most value can be lost at stages at the end of the value chain. Kremer (1993) and Costinot, Vogel, and Wang (2012) find that countries with higher productivities specialize in later stages of production, which Kremer (1993) has called the O-ring theory of economic development. In line with these results, our hypothesis is that firms locate affiliates that produce goods that are positioned at later stages in the production process in countries with lower propensities to making mistakes, i.e., more productive countries.

In order to test this hypothesis, we use firm level panel data for the years 1999 to 2006 on the universe of German multinationals and their activities abroad, which is provided by

[4] This chapter is based on the article "Testing the O-Ring Theory for FDI" which is joint work with Henrike Lindemann.

the Deutsche Bundesbank (2012). To capture the affiliate sector's position in a value chain we employ the measure of upstreamness by Antràs, Chor, Fally, and Hillberry (2012). It considers the number of stages at which a sector enters production processes before the final use of a product. Furthermore, we add countries' productivity as key explanatory variable. We find that a destination country's productivity becomes more important for a firm's investment decision if the affiliate sector is positioned more toward the end of the value chain. Hence, we can confirm the implications of the O-ring theory for FDI.

This chapter provides the first empirical test of the sorting pattern predicted by Kremer (1993) and Costinot, Vogel, and Wang (2012) using data on FDI. Our results can explain the role of FDI for rising income inequalitites between countries as later stages of the production process are also the ones yielding the highest value added (Fally, 2012). Additionally, our analysis may serve as clear guidance for poor and less productive countries' policy makers to recognize this sorting pattern of FDI and to increase productivity enhancing investments in order to attract more downstream affiliates.

Summarizing the four chapters, this dissertation provides new insights on internationally active firms' behavior, focussing on financing, wage setting, and investment decisions. These are three of the main fields that need to be analyzed in order to improve our understanding of internationally active firms which most likely gain even more importance in the future.

Chapter 1

Trade Credits and Bank Credits in International Trade: Substitutes or Complements?*

* This chapter is based on joint work with Katharina Eck and Monika Schnitzer.

1.1 Introduction

The financing of international transactions is a very important determinant of international trade, as the recent financial crisis has forcefully shown. According to WTO Trade Statistics, world merchandise exports declined by 12% in 2009, whereas world GDP declined by only 2.5% (WTO, 2010). A lack of finance during 2009 has been blamed as one of the reasons for this pronounced decrease in global trade (Amiti and Weinstein, 2011).

Apart from internal finance, firms have two options for financing their international transactions. They can ask for a bank credit or they can make use of supplier credits, also called trade credits.[1] In the latter case, they delay paying their supplier, usually between 30 to 60 days. Supplier credits are typically more expensive than bank credits, with a real interest rate of 40% (Petersen and Rajan, 1997). *Prima facie* this suggests that supplier credits are expensive substitutes, only attractive for those firms that cannot obtain bank credit. Interestingly, supplier credits are used intensively by internationally active firms. About 40% of international transactions are financed via supplier credits (IMF, 2009). Internationally active firms are also larger and more productive than domestic ones, as firm level studies confirm (see e.g., Bernard, Jensen, Redding, and Schott, 2007, for a survey). This raises the question why internationally active firms rely to such a large extent on supplier credits and how this relates to their use of bank credits. In this chapter, we address this question both theoretically and empirically.

We start from the observation that firms active in international trade have higher financing needs than purely domestic firms. They generally have higher outlays (e.g., the establishment of a distribution network abroad) and there is a longer delay between the production of the goods and the payment. Moreover, cross-border transactions are considered to be more risky (e.g., due to exchange rate risk, different legal systems, and less knowledge about the foreign market and the foreign trading partner). Thus, internationally active firms and banks financing these firms face a high uncertainty. Banks

[1] In the prevailing literature, the term trade credit is often used interchangeably for a supplier credit and does not exclusively refer to the financing of an international trading transaction.

encounter difficulties to judge the profitability of international transactions. These information asymmetries may hinder internationally active firms from obtaining bank credits. Most models of international trade consider a world without financial frictions so that these facts are insufficiently taken into account. We show that supplier credits can alleviate financial constraints as they can reduce information asymmetries via a quality signal. Therefore, supplier credits and bank credits are complements for financially constrained firms.

For this purpose, we develop a model of a potential exporter who needs external finance for the production of export goods. In a world without asymmetric information, bank credits are cheaper than supplier credits, because banks are more efficient in providing credits. With asymmetric information on the quality of the supplier, however, bank credits become more expensive, even prohibitively so. If this is the case, a supplier credit can provide a signal about the quality of the supplier which may lead to an additional provision of bank credit. The uncertainty the bank faces is reduced, so the bank charges a lower interest rate for any complementary bank credit. Thus, the use of supplier credits can facilitate the provision of additional bank credits due to a reduction in uncertainty.

To test our signaling hypothesis, we analyze whether supplier credits and bank credits are complements or substitutes. We use the Business Expectations Panel of the ifo Institute for Economic Research. This is a panel data set for the years 1994 to 2009 which has merged balance sheet data and data of the ifo Business Tendency survey for 3,974 German companies. The data includes information on trade accounts payable and receivable and on bank debt from the balance sheet data. Additionally, it contains variables indicating a firm's export status and whether a firm is financially constrained or not. Thus, we have a direct measure of financial constraints and can avoid the problems arising from indirect measures such as balance sheet information.[2]

We estimate the relationship between supplier credits and bank credits with the two-step

[2]See Fazzari, Hubbard, and Petersen (1988) and Kaplan and Zingales (1997) for an extensive discussion.

GMM estimator for panel data proposed by Arellano and Bond (1991). As bank credit influences supplier credit and vice versa, we face a reverse causality problem. Therefore, we assume sequential exogeneity and instrument supplier credit with its second lag. This is admissible because the second lag of supplier credit influences bank credit today, but bank credit today does not influence supplier credit two periods ago. The results indicate that bank credit and supplier credit are substitutes for financially unconstrained firms. For financially constrained firms, however, we find evidence that the two forms of credit tend to be complements. As our theory suggests, we find this effect to be even stronger for financially constrained exporters. Thus, our results confirm our theoretical predictions of the quality signal conveyed by supplier credit.

This chapter is related to three strands of the literature. First, it is related to the theoretical and empirical literature on trade credits. There are several theoretical articles which explain the existence and use of trade credits (see Fisman and Love, 2003, for a review). Closest to our approach is the warranty for product quality theory by Lee and Stowe (1993). The authors argue that certain industries require trade credits as a guarantee for product quality, because the choice of trade credit terms offered by the supplier can serve as a signal of product quality. Klapper, Laeven, and Rajan (2012) find empirical evidence on the warranty for product quality hypothesis. This chapter contributes to the literature by explaining the intensive use of supplier credits by internationally active firms. In international trade, quality uncertainty is even higher. Therefore, we incorporate the warranty for product quality as a motivation for the extension of trade credit into our model of international trade. We show that supplier credits are an important financing tool for financially constrained exporters.

Second, we build on the literature on the relation between bank credit and trade credit. Up to now, papers which have dealt with the relation between bank credits and trade credits have focused only on national transactions. Biais and Gollier (1997) develop a model where the firm that extends the trade credit signals its belief in the credit worthiness of the firm it provides with trade credit. This in turn helps the firm receiving the trade credit obtain additional bank credits.[3] Their argument requires that the trade partner has an information advantage relative to the bank. This seems to be at odds with the empirical evidence by Giannetti, Burkart, and Ellingsen (2011) who find that suppliers have no persistent informational advantage. In contrast to Biais and Gollier (1997), in our model we assume that the firm extending trade credit signals its own quality, which seems to be the more natural and realistic assumption.[4] A closely related paper is the one by Burkart and Ellingsen (2004) who develop a model in which trade credits and bank credits are substitutes for firms with unconstrained access to external finance, whereas firms that do not receive sufficient bank funding, use bank and trade credits complementarily. Their reasoning for the complementary relationship is that lending goods is less prone to diversion than lending cash, which has been termed the diversion theory of trade credit financing. Banks are more willing to extend additional bank credit to trade credit receiving firms since these are less likely to commit moral hazard. We develop a different model, in which trade credits help to solve an adverse selection problem. In addition, we provide empirical evidence of our results.

Empirically, Matias Gama and Mateus (2010) find that in general, bank credits and supplier credits are substitutes. For smaller and younger firms, the substitution and complementary hypothesis are not mutually exclusive, however. Their interpretation of this result is that supplier credits signal the creditworthiness of a small firm to the bank, which can increase its bank credit supply. Yang (2011) finds that supplier credits and bank credits are complements for financially constrained firms, where financial constraints are measured by a firm's bond rating status and its size. Hence, Yang (2011)

[3] Aktas, de Bodt, Lobez, and Statnik (2012) show that supplier credits are a signal not only to lenders but also to investors. Fabbri and Menichini (2010) study the use of trade credits for rationed and non-rationed firms, arguing that suppliers not only have an information advantage over other creditors, but are also better in liquidating the assets in case of default.

[4] Huang, Shi, and Zhang (2011) set up a mechanism-design model in which they can show that when firms' production efficiency crosses a low threshold supplier credits and bank credits are substitutes. This is, according to the authors, almost always the case. In contrast, we find that supplier credits and bank credits can be complements and that this complementary effect is of special importance for financially constrained exporters.

also strengthens the complementary effect for smaller firms.[5] Additionally, Giannetti, Burkart, and Ellingsen (2011) find that trade credits help firms secure financing from relatively uninformed banks or get better deals from their banks. Thus, they also confirm the complementary relationship of supplier credits and bank credits. We go beyond their analysis by focusing on exporters for whom we expect the information problem for banks to be even larger. In contrast to previous findings, we show that the complementary relationship between supplier credits and bank credits also holds for large firms. Most noteworthy, our results show that it is not a firm's size that determines the relationship between supplier credits and bank credits, but whether a firm is financially constrained and whether it is internationally active.

The third strand of literature we build on deals with financial constraints in international trade. Manova (2012) shows that firms that are productive enough to export in the absence of financial constraints may not be able to do so if they are financially constrained. Bellone, Musso, Nesta, and Schiavo (2010) and Feenstra, Li, and Yu (2011) provide empirical evidence for the importance of financial constraints in international trade. While these studies have focused only on bank credit as a source of external finance, other recent papers also add supplier credits to the analysis (Ahn, 2011; Antràs and Foley, 2011; Schmidt-Eisenlohr, 2012). These studies focus on the optimal choice of financing modes in international trade considering supplier credits. This chapter extends this literature by showing that supplier credits and bank credits are not necessarily substitutes among which exporters have to choose but can also be complements.

The remainder of the chapter proceeds as follows: In section 1.2, we present the basic model and compare different forms of financing. Furthermore, we derive empirical hypotheses from the model. Section 1.3 presents the data and gives summary statistics.

[5]While the findings in Yang (2011) suggest that trade credit can alleviate financial constraints that are due to asymmetric information between banks and firms, the paper cannot explain the intensive use of supplier credits in international trade. As exporters are generally larger than non-exporters, they would be classified as unconstrained by Yang (2011). Our data allow us to look at financially constrained exporters using the self-reported measure of financial constraints. As predicted by our model, we find that financially constrained exporters are more likely to benefit from the positive signaling effect of supplier credits.

In section 1.4, we explain the estimation strategy and provide empirical results. Finally, section 1.5 draws a conclusion.

1.2 Theoretical Framework

1.2.1 Basic Setup

Consider a firm that decides whether or not to export depending on its productivity level.[6] The productivity level may differ across firms. The firm needs to buy inputs to produce its final good that it can sell on the foreign market at an exogenously given market price p.[7]

The firm has the following Cobb-Douglas production function

$$f(q_1, \bar{q}_2) = x = [(1+\beta)q_1]^{\frac{1}{2}} \, \bar{q}_2^{\frac{1}{2}}, \tag{1.1}$$

where x is the quantity produced and q_1 and $\bar{q}_2$ are the input factors. $\bar{q}_2$ is a fixed input requirement. It can be interpreted as machines the quantity of which cannot be adjusted in the short run. $(1+\beta)$ denotes the productivity level, where $\beta > 0$. Thus, an increase in the productivity level leads to a larger output given a fixed quantity of inputs.

The firm has to buy the inputs q_1 from a supplier at price p_1. Minimizing costs for a given x leads to variable costs of production $k(x) = p_1 \frac{x^2}{(1+\beta)\bar{q}_2}$. The variable costs are marginally increasing in the quantity produced and are decreasing in the firm's productivity level and the fixed input requirement. Furthermore, the firm faces fixed costs. The fixed costs consist of fixed input costs ($F = p_2\bar{q}_2$) on the one hand and fixed costs of exporting (F_{EX}) on the other hand. The fixed costs of exporting can stem from the establishment of a distribution network or the acquirement of knowledge about the foreign market, for example.

[6] Note that we do not take into account the firm's domestic activities.

[7] We assume that the effect of the firm's production decision on the market price is negligible.

The input good is subject to a quality risk.[8] With probability σ the supplier produces a product which is of good quality at marginal production costs $\bar{c}$. With probability $(1-\sigma)$ she produces low quality, at marginal costs $\underline{c}$, where $\bar{c} > \underline{c}$. The final good of the exporter can be sold only if the input used in the production process is of good quality, which is in line with the O-ring theory (Kremer, 1993). The supplier knows her own quality, but the exporter does not.

The price to be paid for the input good, p_1, is determined in a bargaining procedure between the exporter and the input supplier. In the following, we assume that the exporter has all the bargaining power, which means that he can choose the input price p_1 and the supplier only can choose whether or not to supply the input.

Production takes place in period $t = 0$. This is when the potential exporter has to incur the variable and the fixed costs. The revenues of the international transaction are generated in period $t = 1$. We assume that the potential exporter has no internal funds, thus, external finance is needed to bridge the time lag. Our assumption on the distribution of bargaining power implies that the financing need of the exporter is minimized. It is straightforward to extend our analysis to cases when this assumption is relaxed. In the following, we analyze different financing scenarios and derive the minimum productivity level necessary for successful exporting under these different financing scenarios.

1.2.2 Pure Bank Credit Financing

Consider first the case in which the firm asks the bank for a credit to cover the production costs. Like the exporter, the bank cannot judge the quality of the supplier. The banking sector is perfectly competitive. Thus, if the quality of the input good is unknown, it is necessary that

$$\sigma D(1 + r_B) = (1 + \bar{r}_B)D, \tag{1.2}$$

[8]For simplicity, we do not consider quality uncertainty with respect to the exporter.

for the bank to break even. σ represents the probability that the input is of good quality such that the exporter generates positive revenues and repays his credit. D stands for the amount of credit demanded, $(1 + r_B)$ is the gross interest rate charged by the bank and $\bar{r}_B$ are the refinancing costs incurred by the bank. Therefore the gross interest rate charged by the bank amounts to

$$(1 + r_B) = \frac{(1 + \bar{r}_B)}{\sigma}. \tag{1.3}$$

It is increasing in the refinancing costs and the quality risk (decrease of σ).

The exporter's profit function then is

$$\pi_{EX}^{BC} = \sigma px - \sigma \frac{(1 + \bar{r}_B)}{\sigma} \left[p_1 \frac{x^2}{(1 + \beta)\bar{q}_2} + F + F_{EX} \right]. \tag{1.4}$$

The exporter has expected revenues of σpx. The total costs are financed via bank credit which is repaid with probability σ.

The exporter chooses the input price p_1 such that his profits are maximized. This implies choosing the smallest possible price p_1 that satisfies the incentive constraint of the high quality input supplier so that the input good is delivered:

$$p_1 q_1 - \bar{c} q_1 \geq 0. \tag{1.5}$$

Thus, the exporter pays $p_1 = \bar{c}$ to the supplier.

Maximizing the exporter's profits with respect to the quantity and plugging in p_1 yields

$$x^{BC} = \frac{\sigma p (1 + \beta)\bar{q}_2}{2\bar{c}(1 + \bar{r}_B)}. \tag{1.6}$$

Plugging this into the profit function and setting it equal to zero gives the minimum productivity level necessary for successful exporting with bank credit financing

$$(1+\beta)^{BC} \equiv \frac{4(1+\bar{r}_B)^2(F+F_{EX})\bar{c}}{(\sigma p)^2\bar{q}_2}. \tag{1.7}$$

Firms with a productivity level $1+\beta \geq (1+\beta)^{BC}$ are able to export as they make at least zero profits. Firms with a productivity level smaller than the threshold level are not able to start exporting.

Doing simple comparative statics, it is easy to see that the higher the costs, the higher the productivity a firm has to have in order to break even. In contrast, the higher the market price, the higher the revenues, so that the productivity threshold is lower. Moreover, the higher the quality uncertainty the firm faces, the lower the expected revenues are and the higher the productivity level has to be in order to export successfully. In case of no information asymmetries, $\sigma = 1$, firms need to be less productive to enter the foreign market.

1.2.3 Full Supplier Credit and Bank Credit Financing

Firms with a productivity level below the minimum threshold necessary to afford bank credit financing may turn to supplier credit financing instead. The supplier delivers the input, but the potential exporter can pay for it later. Usually, the payment can be made up to 30 to 60 days after delivery. By definition, the maximum amount of supplier credit extended are the costs of the input good ($p_1 q_1$). The rest has to be financed via bank credit. To capture the idea that banks are inherently more efficient in supplying credits, we assume that the refinancing costs of suppliers, $(1+\bar{r}_{SC})$, are higher, i.e., $(1+\bar{r}_{SC}) > (1+\bar{r}_B)$. Note that the refinancing costs $(1+\bar{r}_{SC})$ can also be interpreted as a measure of the financial constraint of the supplier.

Consider first the case where the supplier credit covers the total input good costs, $p_1 q_1$. In this case, the exporter conditions the payment of the input on the success of resale. Only if the final goods can be sold on the foreign market successfully, the exporter pays the supplier. Note that our assumption that the exporter has no internal funds to finance production precludes paying the supplier if there are no revenues from selling the good on the export market. Consequently, only good suppliers have an incentive to participate in the transaction. For the good supplier to be willing to do so, it is necessary that

$$p_1 q_1 - \bar{c} q_1 (1 + \bar{r}_{SC}) \geq 0. \tag{1.8}$$

Thus, the exporter pays the supplier $p_1 = \bar{c}(1 + \bar{r}_{SC})$ if the export goods are successfully sold.

As only the good supplier participates in the transaction, the quality uncertainty is eliminated. The bank, therefore, sets $\sigma = 1$ and is willing to finance the fixed costs at the interest rate $(1 + \bar{r}_B)$.

The exporter's profit function then looks as follows

$$\pi_{EX}^{SC} = px - \bar{c}(1 + \bar{r}_{SC}) \frac{x^2}{(1+\beta)\bar{q}_2} - (1 + \bar{r}_B)(F + F_{EX}). \tag{1.9}$$

Applying the same procedure as before, we can derive the minimum productivity level necessary for successful exporting with supplier credit financing for the variable costs and bank credit financing for the fixed costs

$$(1+\beta)^{SC} \equiv \frac{4(1+\bar{r}_B)(F+F_{EX})\bar{c}(1+\bar{r}_{SC})}{p^2 \bar{q}_2}. \tag{1.10}$$

Comparing (1.10) with (1.7) yields that firms who cannot afford bank credit financing are able to obtain supplier credit financing for the full variable costs and bank credit only for the fixed costs if and only if

$$(1+\beta)^{SC} \leq (1+\beta) < (1+\beta)^{BC}.$$

Note that there exist parameter cases for which the supplier credit threshold is below the bank credit threshold if and only if

$$(1 + \bar{r}_{SC}) < \frac{(1 + \bar{r}_B)}{\sigma^2}. \tag{1.11}$$

This is summarized in the following Proposition.

Proposition 1 *The higher the quality uncertainty (lower σ), the more attractive is supplier credit financing relative to pure bank credit financing. Furthermore, the higher the refinancing costs of the supplier, the more expensive supplier credit financing is.*

1.2.4 Partial Supplier Credit

Consider now the case where the exporter uses a supplier credit only for a fraction of the input costs, to save on the high interest rates of supplier credit. In the following, we determine the minimum amount of supplier credit necessary to solve the adverse selection problem. The rest of the production costs has to be covered by a bank credit.

The timing of the game is as follows:

1. Nature determines the supplier's type, ($T = \{G, B\}$). The supplier is of the good type ($T = G$) with probability σ and of the bad type ($T = B$) with probability $(1 - \sigma)$. The supplier learns her type.

2. The exporter chooses the amount of supplier credit as a fraction $\alpha(T)$ of the costs of the input good $\left(p_1 \frac{x^2}{(1+\beta)\bar{q}_2}\right)$ and chooses the price he pays for the input (p_1).

3. The bank observes the amount of supplier credit extended to the exporter by the supplier (but not the supplier's quality) and makes an offer to the exporter about an additional bank credit, choosing either a high $\left(\frac{1+\bar{r}_B}{\sigma}\right)$, a low $(1 + \bar{r}_B)$ interest rate, or no credit offer at all.

4. Depending on the decisions by the bank and the supplier, the firm decides whether to export or not in period $t = 0$.

5. In period $t = 1$, payoffs are realized.

Note that we assume that a fraction of the input costs can be paid later. Generally, the supplier credit equals the whole amount of an invoice, but the terms of payment vary, i.e., whether the invoice amount can be paid 30 or 60 days after delivery. It is straightforward to reinterpret the fraction α as a temporal instead of a quantitative fraction.

The profit function of the supplier is

$$\pi_{SU}(T) = \begin{cases} \alpha p_1 q_1 - (\bar{c}q_1 - (1-\alpha)p_1 q_1)(1+\bar{r}_{SC}) & \text{if } T = G, \\ [(1-\alpha)p_1 q_1 - \underline{c}q_1](1+\bar{r}_{SC}) & \text{if } T = B. \end{cases}$$

The good supplier gets paid the fraction α $(0 \leq \alpha \leq 1)$ of the input costs in period $t = 1$. This reflects the repayment of the supplier credit. The rest of the input costs is paid at delivery in $t = 0$. The difference between the production costs of the input and the amount paid at delivery, $(\bar{c}q_1 - (1-\alpha)p_1 q_1)$, has to be financed at the interest rate $(1 + \bar{r}_{SC})$.

The profit function of the bad supplier differs in that she never receives the rest of the purchasing price, which is supposed to be paid later, because the exporter generates no revenues. If the bad supplier extends a supplier credit, she delivers the good and receives only the amount which has to be paid immediately at delivery in $t = 0$.

We consider two types of equilibria, separating and pooling equilibria. In a separating equilibrium, the exporter chooses the amount of supplier credit and the input price such that he effectively screens the suppliers and only the good type participates in the transaction. In a pooling equilibrium, the amount of supplier credit and the input price are chosen such that both types participate in the transaction and so the type of the supplier is not revealed.

Separating Equilibrium

When does the supplier credit provide a credible signal that the input is of good quality? The signal is credible if the amount of supplier credit extended is large enough so that the supplier yields positive profits if she is of the good type and her profits equal zero if she is of the bad type. This guarantees that the bad type has no incentive to mimic the good type by granting a supplier credit. The amount of supplier credit necessary for a credible signal is given by

$$(1-\alpha)p_1 \leq \underline{c} \qquad \Rightarrow \qquad \alpha^{sep} \geq 1 - \frac{\underline{c}}{p_1}. \tag{1.12}$$

Furthermore, the participation constraint of the good supplier has to be fulfilled:

$$\alpha p_1 q_1 - (\bar{c} q_1 - (1-\alpha) p_1 q_1)(1 + \bar{r}_{SC}) \geq 0. \tag{1.13}$$

From this we can derive

$$p_1 = \underline{c} + (\bar{c} - \underline{c})(1 + \bar{r}_{SC}), \tag{1.14}$$

$$\alpha^{sep} = \frac{(\bar{c} - \underline{c})(1 + \bar{r}_{SC})}{\underline{c} + (\bar{c} - \underline{c})(1 + \bar{r}_{SC})}. \tag{1.15}$$

Consider the following belief structure of the bank. The bank believes that a supplier which extends a level of supplier credit of $\alpha \geq \alpha^{sep}$ is of the good type, $Pr(G|\alpha \geq \alpha^{sep}) = 1$, and a supplier which extends a level of supplier credit of $0 \leq \alpha < \alpha^{sep}$ is of the bad type, $Pr(G|0 \leq \alpha < \alpha^{sep}) = 0$. If the bank believes that the supplier is good, it sets $\sigma = 1$. If instead the bank believes that the supplier is of the bad type, it does not extend any bank credit at all. Using this belief structure of the bank we can check whether there exists a separating equilibrium in which the good supplier extends a fraction $\alpha(G) = \alpha^{sep}$ of supplier credit and the bad supplier chooses not to extend a supplier credit at all, $\alpha(B) = 0$.

The profit function of an exporter who finances the costs via a supplier credit ($\alpha(G) = \alpha^{sep}$) and a bank credit has the following form

$$\pi_{EX}^{SC/BC} = px - [(1-\alpha^{sep})p_1(1+\bar{r}_B) + \alpha^{sep}p_1]\frac{x^2}{(1+\beta)\bar{q}_2} - (1+\bar{r}_B)(F+F_{EX}). \quad (1.16)$$

The exporter has higher expected revenues compared to a situation with pure bank financing because he knows that the supplier is of good quality. Additionally, the bank charges a lower interest rate as it believes that the supplier is of good quality and sets $\sigma = 1$.

Again, the exporter maximizes profits with respect to the quantity. Plugging the optimal quantity into the exporter's profits and setting it equal to zero, we obtain the minimum productivity level necessary to export successfully with a combination of supplier credit and bank credit financing:

$$(1+\beta)^{SC/BC} \equiv \frac{4(1+\bar{r}_B)(F+F_{EX})\left[\underline{c}(\bar{r}_B - \bar{r}_{SC}) + \bar{c}(1+\bar{r}_{SC})\right]}{p^2\bar{q}_2}. \quad (1.17)$$

Proposition 2 *For firms with* $(1+\beta) \geq (1+\beta)^{SC/BC}$ *there exists a separating perfect Bayesian equilibrium in which only the good suppliers extend supplier credits and the bank charges the low interest rate as it believes in the quality signal. The strategies and beliefs of this separating equilibrium are given by*
$[(\alpha(G) = \alpha^{sep}, \alpha(B) = 0)$*, (gives bank credit at interest rate* $(1+\bar{r}_B)$*, gives no bank credit),* $Pr(G|\alpha \geq \alpha^{sep}) = 1$ *and* $Pr(G|0 \leq \alpha < \alpha^{sep}) = 0]$.

Proof. See Appendix A.1. ■

For firms with a productivity level $(1+\beta) < (1+\beta)^{BC}$, i.e., who cannot afford a bank credit, supplier credit helps them overcome their financial constraints and realize the international transaction if and only if

$$(1+\beta)^{SC/BC} \leq (1+\beta) < (1+\beta)^{BC}.$$

Inserting the corresponding expressions (1.7) and (1.17), it is straightforward to see that there exist parameter cases for which the supplier credit threshold is below the bank credit threshold if condition (1.18) holds

$$\underline{c}(\bar{r}_B - \bar{r}_{SC}) + \bar{c}(1+\bar{r}_{SC}) < \frac{(1+\bar{r}_B)\bar{c}}{\sigma^2}. \quad (1.18)$$

This is summarized in the following Proposition.

Proposition 3 *Consider firms with $(1+\beta) < (1+\beta)^{BC}$. It is the more likely that the combination of supplier credit and bank credit yields a positive payoff for exporters who would not be able to receive pure bank financing*

(1) the lower the refinancing costs of the supplier ($\bar{r}_{SC}$),

(2) the higher the refinancing costs of the bank ($\bar{r}_B$),

(3a) if $(1+\bar{r}_{SC})\sigma^2 > (1+\bar{r}_B)$: the lower the difference in production costs of the suppliers,

(3b) if $(1+\bar{r}_{SC})\sigma^2 < (1+\bar{r}_B)$: the higher the difference in production costs of the suppliers,

(4) the higher the quality uncertainty (lower σ) and hence importance of the signal. For $\sigma = 1$, pure bank credit financing is cheaper than supplier credit financing.

In Appendix A.1, we provide a graphical illustration of different parameter combinations for which $(1+\beta)^{SC/BC} < (1+\beta)^{BC}$. We have shown that a supplier credit can ease financial constraints due to two mechanisms. First, there is the direct channel. Supplier credits provide the firm with liquidity. Consequently, the amount of credit which has to be financed by the bank is reduced. Additionally, there is the indirect channel of supplier credit. The supplier can signal her quality via the extension of supplier credit. The supplier delivers the good, but the firm needs only pay for it later. This means that in fact the exporter can condition the payment of the input good on the quality delivered. Accordingly, the risk of the transaction is reduced. Hence, the higher the risk of the transaction, the more attractive supplier credits become. As we have argued before, in our model suppliers can be national or international. However, supplier credits will be of higher importance for international suppliers as the uncertainty faced by the exporter and the bank will be higher than with a national supplier.

Pooling Equilibrium

Consider next the possibility of a pooling equilibrium where both suppliers give the same amount of supplier credit, $\alpha(G) = \alpha(B)$, with $0 \leq \alpha(T) < \alpha^{sep}$. In such a pooling equilibrium, the bank does not learn anything about the supplier's type. Hence, the same credit rate applies as in the case without supplier credit.

The exporter's profit function in a pooling equilibrium equals

$$\pi_{EX}^{pool} = \sigma p x - [(1-\alpha)p_1(1+\bar{r}_B) + \sigma\alpha p_1] \frac{x^2}{(1+\beta)\bar{q}_2} - (1+\bar{r}_B)(F+F_{EX}), \tag{1.19}$$

where the fraction of the input costs extended in form of supplier credit is $0 \leq \alpha < \alpha^{sep}$.

From the participation constraint of the good supplier we can derive that for a given α, the exporter sets the price p_1 in a pooling situation such that

$$\alpha p_1 q_1 \geq (\bar{c} - \underline{c})(1+\bar{r}_{SC}). \tag{1.20}$$

Furthermore, for both suppliers to extend the same amount of supplier credit it has to hold that

$$(1-\alpha)p_1 \geq \underline{c}.$$

We can again derive the minimum productivity level necessary for successful exporting:

$$(1+\beta)^{Pool} \equiv \frac{4(1+\bar{r}_B)(F+F_{EX})\left[\sigma(\bar{c}-\underline{c})(1+\bar{r}_{SC})+\underline{c}(1+\bar{r}_B)\right]}{(\sigma p)^2 \bar{q}_2}. \tag{1.21}$$

Proposition 4 *For firms with* $(1+\beta) \geq (1+\beta)^{Pool}$ *there exists a pooling equilibrium with the following strategies*
$[(\alpha(G) = \alpha(B)$*, where* $0 \leq \alpha(T) < \alpha^{sep})$*, (gives bank credit at interest rate* $(1+\bar{r}_B)/\sigma$*, gives bank credit at interest rate* $(1+\bar{r}_B)/\sigma$*),* $Pr(G|\alpha \geq \alpha^{sep}) = 1$*,* $Pr(G|0 \leq \alpha < \alpha^{sep}) = 0$ *and* $Pr(G|\alpha(G) = \alpha(B)) = \sigma]$.

Proof. See Appendix A.1. ■

For firms with a productivity level $(1+\beta) < (1+\beta)^{BC}$, i.e., who cannot afford a bank credit, supplier credit in a pooling equilibrium helps them to realize the international transaction if and only if

$$(1+\beta)^{Pool} \leq (1+\beta) < (1+\beta)^{BC}.$$

Using (1.7) and (1.21) we can show that there exist parameter cases for which the supplier credit threshold is below the bank credit threshold if and only if

$$\sigma(1+\bar{r}_{SC}) < (1+\bar{r}_B). \tag{1.22}$$

If this condition holds, firms are enabled to export using supplier credit even though it provides an uninformative signal. The uninformative signal does not reduce the uncertainty, however. Comparing the separating cutoff with the pooling cutoff yields that the parameter range for which there exists a separating equilibrium is larger than the parameter range for the pooling equilibrium. Comparing the expected profits of the exporter, supplier, and bank, we can derive that firms prefer playing the separating rather than the pooling equilibrium.

Proposition 5 *The separating equilibrium Pareto-dominates the pooling equilibrium.*

Proof. See Appendix A.1. ∎

Thus, in our empirical predictions we restrict attention to the separating equilibrium.

1.2.5 Empirical Hypotheses

To sum up, our findings deliver the following hypotheses:

Hypothesis 1: In general, bank credit and supplier credit are substitutes.

Hypothesis 2: For financially constrained firms, supplier credit and bank credit are complements.

Hypothesis 3: The complementary effect is stronger for internationally active firms.

Our theoretical model illustrates the ambivalent nature of supplier credits. Proposition 1 implies that bank credit financing can be substituted for by supplier credits for the variable costs. Firms with a high enough productivity level can afford a bank credit to finance their international transaction. Therefore, they are not financially constrained. To them, supplier credits and bank credits are substitutes, as they have the option to finance the variable costs via a supplier credit or a bank credit (Hypothesis 1). Proposition 2 and 3 state that due to the reduction in risk, supplier credits can enable the extension of a bank credit for firms that are financially constrained, which otherwise could not afford pure bank credit financing. For these firms, supplier credits and bank credits can be complements (Hypothesis 2). Although we cannot test directly whether supplier credits provide a quality signal to the bank, we can test whether supplier credits lead to more bank credits for financially constrained firms. Since exporters have higher financing needs and generally face a higher uncertainty, the complementary effect of supplier credit financing should be particularly strong for exporters (Hypothesis 3).

1.3 Data

We use the Business Expectations Panel of the ifo Institute for Economic Research provided by the Economic and Business Data Center (EBDC). It contains balance sheet data and data of the ifo Business Tendency Survey for 3,974 German companies from the manufacturing sector for the years 1994 to 2009. The balance sheet data is taken from Amadeus and Hoppenstedt on a yearly basis. The ifo Business Tendency Survey is conducted on a monthly basis and contains mainly questions on the firms' business situation, expectations, and demand situation.[9] The panel is unbalanced. On average, firms are four years in the dataset. The balance sheet data includes information on trade accounts payable and receivable and on bank debt. Additionally, the ifo Business Tendency Survey contains variables indicating whether a firm exports or not and whether a firm is financially constrained or not.

Supplier Credit

Consistent with Petersen and Rajan (1997) and Fisman and Love (2003), we measure supplier credit taken by a firm by trade accounts payable scaled by total assets from the balance sheet data. Our measure of supplier credit can, thus, be interpreted as the ratio of total assets financed via interfirm loans.[10] We take the logarithm as trade accounts payable divided by total assets is highly skewed. The disadvantage of trade accounts payable is that they include not only voluntarily granted supplier credits but also delayed payments not agreed to by the supplier ex ante. One could argue that involuntarily extended supplier credits do not provide a quality signal. However, trade accounts payable are frequently used as a proxy for supplier credits and it is the best

[9]For an overview of the collected variables, see Becker and Wohlrabe (2008) and for the methodological background of the survey, see Goldrian (2007).

[10]Scaling is necessary since the supplier credit volume of a firm is directly linked to the size and the sales volume of a firm. Furthermore, it allows us to abstain from price effect adjustments in each year.

measure available to us.[11]

Bank Credit

The amount of bank credit a firm has is measured by the variable bank debt, which includes short-term and long-term debt. We also scale bank credit by total assets from the balance sheet data and take the logarithm.

Export Status

In the ifo Business Tendency Survey, firms are asked about their export status. From this we construct a dummy variable. As the firms are asked each month and we conduct our analysis on a firm-year basis, we collapse the data. We classify a firm as internationally active if it exports its product in at least two months per year.[12]

Financial constraints

The ifo Business Tendency Survey also contains two questions concerning the financial situation of a firm. In one question the firms are asked whether they are constrained in their production due to financial constraints (yes/no). The second question asks how the firms judge the willingness of banks to give credits to firms (cooperative/normal/restrictive). The latter question is general in nature. However, we argue that firms will answer this question based on their own experience and thus, the answer reflects their financial situation.[13] We combine both measures and classify a firm as financially constrained if it answers at least once a year that it is hindered in production due to financial constraints

[11] Alternatively, we could take supplier credit use as a dummy variable. The idea is that the extension of supplier credit provides the signal and there is no linear effect from more supplier credit used to more bank credit received. But the volume of trade accounts payable consists of several supplier credits from different suppliers, which all signal their quality. Consequently, there may indeed be a linear effect. Furthermore, we do not observe any zeros in our data since all firms have trade accounts payable in their balance sheet.

[12] Note that we cannot use export intensities as this information is not included in our data.

[13] These questions are not asked on a monthly basis. The question on whether the firm was constrained in production due to financial constraints is asked in January, April, July and October. The question on the willingness of banks to extend credits is asked in March and August.

or that it judges the willingness of banks to extend credits as restrictive or both. This variable, thus, provides us with a direct measure of financial constraints. Hence, we can overcome the problems raised by the discussion between Fazzari, Hubbard, and Petersen (1988) and Kaplan and Zingales (1997) concerning the use of indirect measures of financial constraints such as investment-cash flow sensitivities.

Other control variables

We control for the productivity of a company which we measure as the logarithm of sales over the number of employees (Helpman, Melitz, and Yeaple, 2004). Due to strong collinearity we do not simultaneously include the number of employees or sales. In a robustness check, however, we use the logarithm of sales instead of the productivity measure. Additionally, we include the logarithm of the firm's tangible assets scaled by total assets (Matias Gama and Mateus, 2010). Furthermore, we control for the sales growth of the firm to capture firm-specific growth prospects.

Panel A of Table 1.1 provides summary statistics for the variables we use in our analysis.[14] The average number of employees per firm is 2,489. The fraction of firms that are exporting is 93%. The high export participation can be explained by the fact that primarily large firms are included in the dataset. The ifo Business Tendency Survey mainly addresses large firms. For large German firms, a fraction of exporters of about 80%–90% is reasonable (see Burg, Dittrich, Vogel, and Wagner, 2009). 15% of the firms report that they are financially constrained. The share of trade accounts payable relative to total assets is 8%. In comparison, the share of bank credit relative to total assets is 17%. Thus, we see that firms use a larger share of bank credits to finance their costs. However, the share of trade accounts payable is also quite high compared to the bank credit share. Hence, supplier credit is a significant source of financing.[15]

Comparing exporters to non-exporters in Panel B of Table 1.1, we find that exporters

[14] These summary statistics are pooled over all the years of the regression sample.

[15] Fisman and Love (2003) find a similar result for the share of trade accounts payable used for the US.

Table 1.1: Descriptive Statistics

Panel A: Summary Statistics of Firm Characteristics

	Mean	SD
Number of employees	2,489	10,999
Trade accounts payable (1000 Euros)	26,800	122,000
Bank credit (1000 Euros)	53,300	400,000
Tangible assets (1000 Euros)	74,100	185,000
Trade accounts payable/total assets (%)	8	6
Bank credit/total assets (%)	17	15
Tangible assets/total assets (%)	27	18
Salesgrowth (%)	28	630
Sales/number of employees	267,792	475,664
Share of exporters (%)	93	-
Share of financially constrained firms (%)	15	-

Panel B: Exporters vs. Non-Exporters

	Exporters	Non-Exporters	Difference
Number of employees	2,583	1,293	1,290***
Trade accounts payable/total assets (%)	8	8	0
Bank credit/total assets (%)	17	15	2
Tangible assets/total assets (%)	26	42	-16***
Salesgrowth (%)	30	4	26
Share of financially constrained firms (%)	15	20	-5

Panel C: Constrained vs. Unconstrained Exporters

	Constrained Exporters	Unconstrained Exporters	Difference
Number of employees	1,928	2,697	-769*
Trade accounts payable/total assets (%)	9	7	2***
Bank credit/total assets (%)	23	16	7***
Tangible assets/total assets (%)	25	26	-1
Salesgrowth (%)	8	34	-26

Panel A provides average firm characteristics pooled over all years for the regression sample. The number of observations is 1,720. Panels B and C provide mean comparison tests for various firm characteristics between exporters and non-exporters and financially-constrained exporters and non financially-constrained exporters, respectively, using Welch's formula to allow for unequal variances in both groups (Welch, 1947). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

are significantly larger than non-exporters. This is the usual result stated in various studies (see Bernard, Jensen, Redding, and Schott, 2007, for a survey) and is the basis for the selection into exporting theory modeled by Melitz (2003). We also see that slightly fewer exporters are financially constrained than non-exporters. 15% of the exporters report being financially constrained compared to 20% of the non-exporters. However, there is no difference in the use of trade accounts payable relative to total assets between exporters and non-exporters. But when we compare financially constrained exporters to non-financially constrained exporters in Panel C of Table 1.1, we find that financially constrained exporters use a significantly higher share of trade accounts payable than non-financially constrained exporters at the 1% significance level. This finding supports the theoretical results of our model. Those firms which do not receive bank credit in the first place and are thus financially constrained use supplier credit. Furthermore, supplier credit financing is even more important for internationally active firms. This explains the difference in the use of supplier credit between financially constrained exporters and non-financially constrained exporters.

Note that we have a missing data problem both in the survey data as well as in the balance sheet data. As mostly large firms answer the ifo Business Tendency Survey and have balance sheet data available our empirical analysis focuses on large firms. Therefore, we do not claim to have a representative sample of German manufacturing firms overall, but of large German manufacturing firms.

1.4 Estimation Strategy and Results

1.4.1 The Effect of Supplier Credit on Bank Credit for Financially Constrained and Unconstrained Firms

To test the hypotheses derived above, we analyze the effect of supplier credit on bank credit. The first hypothesis considers the general relation between bank credit and supplier credit and the second hypothesis focuses on the effect of supplier credit on bank credit for financially constrained firms. To analyze the relationship for both financially constrained and unconstrained firms the corresponding estimation equation is

$$BC_{it} = \beta_0 + \beta_1 SC_{it} + \beta_2 constrain_{it} + \beta_3 SC_{it} * constrain_{it} + \beta_{\mathbf{4}} \mathbf{x_{it}} + \eta_i + \lambda_t + \epsilon_{it}. \quad (1.23)$$

Our dependent variable is the share of bank credit in total assets of firm i in period t (BC_{it}). Supplier credit is the explanatory variable of interest (SC_{it}). $constrain_{it}$ is a dummy variable indicating whether a firm is financially constrained or not. We also include an interaction term of supplier credit received and the financial constraints dummy. The variable $\mathbf{x_{it}}$ includes a vector of control variables. As control variables, we use firm productivity, salesgrowth, a dummy whether the firm is exporting, and tangible assets. Furthermore, we control for firm fixed effects (η_i) and time fixed effects (λ_t).

As bank credit influences supplier credit and vice versa, we face a reverse causality problem. Given its total financing needs, the firm decides simultaneously on how much to finance via bank credit and how much to finance via supplier credit. If the firm does not get enough or any bank credit at all, it will approach its supplier and ask for a supplier credit instead. Vice versa, if the firm gets supplier credit, this might enable it to get an additional bank credit. We estimate this equation with the two-step generalized method of moments (GMM) estimator for panel data proposed by Arellano and Bond (1991). We use the finite sample correction of the asymptotic variance estimates derived by Windmeijer (2005). Generally, the two-step GMM estimator uses heteroskedasticity-robust standard errors, but in small samples the estimated standard errors tend to be too small. This is due to the presence of estimated parameters in the weight matrix.

We assume sequential exogeneity and instrument supplier credit with its second lag, that is supplier credit received two years ago which is the Anderson and Hsiao (1982) estimator. In addition, we also apply its second- and third-lag (supplier credit received two and three years ago) which is the Arellano and Bond (1991) estimator and allows to exploit more of the available moment conditions. This is admissible because supplier credit received two years ago (SC_{it-2}) influences bank credit in period today (BC_{it}), but bank credit received today does not influence supplier credit received two years ago. Like this, instrumenting SC_{it} with SC_{it-2} and SC_{it-3} solves our simultaneity problem. SC_{it-2} is strongly correlated with SC_{it} (correlation coefficient of 0.82), thus it is relevant. Furthermore, SC_{it-2} has an influence on BC_{it} only via SC_{it}. Additionally, we use all the right-hand-side variables as instruments, except for the financial constraints dummy. As we would argue that the amount of bank credit the firm receives depends on whether the firm feels financially constrained but the reverse is also plausible, we instrument the financial constraints dummy also by its second and third lag, as well as the interaction term of supplier credit and the financial constraints dummy.

The Anderson and Hsiao (1982) and the Arellano and Bond (1991) estimators use first-differences. Thus, we account for the fact that the relation between bank credit and supplier credit might be a spurious relationship attributed to unobservable specific heterogeneity among firms. The two-step GMM estimator is only consistent if there is no second-order serial correlation of the errors. We provide a direct test of the second-order residual serial correlation coefficient proposed by Arellano and Bond (1991). Furthermore, we also use the Hansen test of over-identifying restrictions to test the validity of our instruments. The Hansen test can be weakened by instrument proliferation. Therefore, instead of using one instrument for each time period, variable and lag distance, we use one instrument for each variable and lag distance. The idea is that the moment conditions are summed over the years for each lag distance. Another study which uses this technique is, among others, Beck and Levine (2004).

The fact that we have an unbalanced panel does not prevent the use of the two-step GMM estimator. Arellano and Bond (1991) argue that no fundamental changes occur provided that a minimal number of continuous time periods is available for each firm. This is the case in our dataset. The average number of years in which the firms in our sample report is four. The maximal number of years is 13. However, in order to avoid losing observations we use the orthogonal deviations transformation instead of first-differencing as proposed by Arellano and Bover (1995). Instead of subtracting the previous observation, the orthogonal deviations transformation subtracts the average of all available future observations. Like differencing, this removes fixed effects, but preserves the sample size in panels with gaps.

In equation (1.23), we expect supplier credit as such to have a negative effect on bank credit and the interaction term of supplier credit and the financial constraints dummy to have a positive effect. In this estimation, we cannot separately identify the different motives for the use of supplier credit and their effects on the use of bank credit. Certainly, there is the positive effect on bank credit included in the volume of supplier credit due to the signal, but this effect probably does not compensate for the general substitution effect.

In column 1 of Table 1.2, the results of the two-step GMM estimator are provided using Windmeijer finite sample corrected standard errors where we use the second- and the third-lag as instruments for the endogenous variables. As explained above, we collapse the instruments and use orthogonal deviations. This gives us a sample of 1,720 observations for 410 companies and we use 23 instruments. We find that for financially unconstrained firms the fraction of supplier credits used indeed has a negative influence on the fraction of bank credits used which is significant at the 10% level. As both measures are in logs the coefficient indicates that 1% more supplier credit leads to 4% less bank credit. This finding confirms our first hypothesis. Furthermore, we find weak support for our second hypothesis. The coefficient of the interaction term of the share of supplier credit used and the financial constraints dummy is positive. It is marginally significant with a p-value of 0.126. This indicates that although bank credit and supplier credit are substitutes for unconstrained firms, supplier credit has a positive impact on bank credit for financially constrained firms.

The coefficient of the variable tangible assets is positive as one would expect, though insignificant. Tangible assets can serve as collateral and hence should enable firms to get more bank credit. Salesgrowth is negative but its effect is close to zero. The dummy indicating whether a firm feels financially constrained has a large positive coefficient, which is significant at the 10% level. This is surprising as one would expect that firms that feel financially constrained should get less bank credit. However, this reasoning only considers the supply of bank credit and not the demand for bank credit. It may be that financially constrained firms are those firms that have a lot of investment possibilities and therefore a higher demand for bank credit. The export dummy has a negative coefficient which is insignificant. Being an exporter reduces the amount of bank credit you have. This may reflect the higher risk due to international transactions which reduces the willingness of banks to extend credit. Additionally, although internationally active firms usually need to finance more investments and transactions, they also generally have higher profits and may use them to build up internal funds. The coefficient of productivity is positive, which implies that more productive firms can get more bank credit as they are supposed to be more reliable creditors.

In Table column 2 of 1.2, we conduct the same estimation with only the second lag as instrument for the endogenous variables. The coefficients change slightly in size but the signs remain the same. Now, the coefficient of supplier credit is significantly negative at the 5% level. The coefficient of tangible assets also becomes significant at the 10% level. The financial constraints dummy remains significantly positive at the 10% level. The coefficient of supplier credit for financially constrained firms remains positive and marginally significant with a p-value of 0.133. Furthermore, the coefficient of labor productivity becomes significant at the 10% level.

The test for serial correlation in both specifications shows that we have first-order serial correlation of the errors but no second-order or third-order serial correlation. Hence, the Arellano-Bond (1991) estimator is consistent. This supports our sequential exogeneity assumption. The Hansen test of overidentifying restrictions for the specification in column 1 is fulfilled. The Null that the instruments as a group are exogenous cannot be rejected. We also test whether subsets of instruments are exogenous by using difference-in-Hansen

Table 1.2: The Relation Between Supplier Credits and Bank Credits

Dep. Var.	(1) BC	(2) BC	(3) BC	(4) BC
SC	-3.981*	-4.626**	-3.849**	-4.101*
	(2.311)	(2.331)	(1.682)	(2.215)
tangibles	1.215	1.457*	1.216**	1.291
	(0.788)	(0.856)	(0.603)	(0.797)
salesgrowth	-0.020	-.0215	-0.0181	-0.0191
	(0.0199)	(0.0193)	(0.0141)	(0.0151)
constrain	7.689*	7.359*	6.684*	6.252
	(4.321)	(3.964)	(3.507)	(3.822)
constrain*SC	2.118	1.9763		
	(1.385)	(1.315)		
constrain*SC*EXP			1.854**	1.720*
			(0.9371)	(1.044)
EXP	-0.454	-0.479	-0.3056	-0.3137
	(0.737)	(0.7258)	(0.6639)	(0.6877)
labprod	1.183	1.409*	1.116*	1.223
	(0.804)	(0.832)	(0.569)	(0.767)
year dummies	yes	yes	yes	yes
Observations	1720	1720	1720	1720
No. of companies	410	410	410	410
No. of instruments	23	20	25	21
Lags used	2+3	2	2+3	2
AR(1)	0.005	0.007	0.002	0.005
AR(2)	0.290	0.288	0.199	0.248
AR(3)	0.989	0.774	0.824	0.909
Hansen (p-value)	0.851	.	0.953	.

In columns 1 and 3, we use the two-step GMM estimator with Windmeijer finite sample corrected standard errors using the second and the third lag as instruments for the endogenous variables. In columns 2 and 4, we only use the second lag as instrument.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

statistics. We find that all subsets of instruments are exogenous. In column 2, we do not report the Hansen test of overidentifying restrictions as the system is just identified. Thus, we can conclude that we have an indication for the signaling effect of supplier credit in our data. Although supplier credits and bank credits are substitutes for unconstrained firms, they are complements for financially constrained firms.

1.4.2 The Importance of Supplier Credit for Internationally Active Firms

Bellone, Musso, Nesta, and Schiavo (2010) and Feenstra, Li, and Yu (2011) show that financial constraints play an important role in international trade. This is the case because the costs and the risks faced by firms are higher in international transactions. Therefore, supplier credits, as an additional source of finance, are especially vital in international trade. We now test whether the complementarity between supplier credit and bank credit for financially constrained firms is particularly important for internationally active firms (Hypothesis 3). We use the following estimation equation

$$\begin{aligned} BC_{it} =& \gamma_0 + \gamma_1 SC_{it} + \gamma_2 constrain_{it} + \gamma_3 EXP_{it} + \gamma_4 SC_{it} * constrain_{it} * EXP_{it} \\ &+ \gamma_{\mathbf{5}} \mathbf{x_{it}} + \eta_i + \lambda_t + \epsilon_{it}. \end{aligned} \tag{1.24}$$

This equation only differs from equation (1.23) in the triple interaction term we add instead of the interaction term of supplier credit with the financial constraints dummy. We interact supplier credit used with the dummy for whether a firm is financially constrained and a dummy indicating export status. Thus, γ_4 displays the effect of supplier credit on bank credit for financially constrained exporters. γ_1 is the effect of supplier credit on bank credit for non-financially constrained firms, both exporters and non-exporters and financially constrained non-exporters. We could also include the interaction term of supplier credit and the financial constraints dummy. This would then explicitly capture the group of financially constrained non-exporters. However, due to the high share of exporters and the small fraction of financially constrained firms in our data this group is so small such that it does not make sense to include it separately. Similarly, we do not add the interaction term of financial constraints and export status, as we see in our data that the within-variation is very small and thus is mainly captured by taking the first differences. Furthermore, we are interested in comparing the group of financially constrained exporters to all other firms. Following our model, we also do not add an interaction term for supplier credits for unconstrained exporters as unconstrained exporters are able to obtain bank credit in the first place without relying on the signal extended by supplier credit. Again, we also use the interaction terms lagged two or three times as instruments.

In column 3 of Table 1.2, the share of supplier credit used again has a significantly negative effect on the share of bank credit used (5% significance level). The coefficient of supplier credit for financially constrained exporters is significantly positive at the 5% level. Thus, the signaling effect of supplier credit seems to be significant for financially constrained exporters which confirms our third hypothesis. The underlying theoretical argument is that for exporters the uncertainty is higher and thus the signaling effect is more important. For those exporters with a very high productivity level that nevertheless get bank credit financing, the signal provided by supplier credits is of no great importance. For those exporters with a lower productivity level whose bank credit financing is constrained, however, the signaling effect of supplier credit plays a significant role. The coefficient of tangible assets has a significantly positive effect on bank credit at the 5% significance level. The financial constraints dummy remains significantly positive at the 10% level as well as labor productivity.

The results using only the second lag as instruments shown in column 4 are similar. The coefficient of supplier credit is significantly negative at the 10% level. Furthermore, the effect of supplier credit for financially constrained exporters remains significantly positive at the 10% level. The tests for serial correlation and the Hansen test for overidentification again yield that the estimator is consistent and the instruments are valid.

1.4.3 Robustness Checks

Using sales over employees is the best productivity measure we can use. Alternatively, we rerun the estimations using the logarithm of sales of a firm as a proxy for its size (Desai, Foley, and Hines, 2006). In Table A.2 the results are shown. The signs remain the same for all coefficients. Only the size of the coefficients differs slightly. In columns

1 and 2, one sees that the effect of supplier credit as such remains significantly negative. The effect of supplier credit for financially constrained firms is positive, but insignificant. However, the estimation results in column 3 also support our results obtained using our productivity measure. Again, supplier credit for financially constrained exporters has a positively significant effect at the 5% level. In column 4, this effect is also positive but insignificant, with a *p*-value of 0.159. The tests for serial correlation and the Hansen test for overidentification are again fulfilled.

In a second robustness check, we scale trade accounts payable and bank debt by total liabilities instead of total assets. Hence, we consider the effect of the importance of supplier credits considering the whole amount of external finance on the importance of bank credits in the financing portfolio. As bank credits and supplier credits are not the only forms of external finance this effect can again be positive or negative. In columns 1 and 2 of Table A.3, the substitutive relation between supplier credits and bank credit is confirmed. The coefficient of supplier credit for financially constrained firms is positive but insignificant. In columns 3 and 4, we find again supportive evidence for the positive effect of supplier credits for financially constrained exporters.

Summing up all results, we have seen that the share of supplier credit used has a negative effect on the share of bank credit used for financially unconstrained firms (Hypothesis 1). However, if we only look at financially constrained firms the share of supplier credit used tends to affect the share of bank credit used positively, although the overall effect is still negative but less so (Hypothesis 2). This positive effect seems to play a more significant role, though, for financially constrained exporters. The coefficient of the interaction term is positively significant (Hypothesis 3). The empirical results, therefore, provide supporting evidence for our theoretical model.

1.5 Conclusion

Supplier credits are an important financing tool, especially for internationally active firms. This is surprising given that supplier credits are generally considered to be more expensive than bank credits, with an annual real interest rate of 40% or higher.

We show that even though supplier credits can involve high implicit interest rates, they are attractive to financially constrained exporters. Supplier credits not only provide additional liquidity to a firm, but they serve as a signal of the quality of purchased intermediates. Access to supplier credit financing is particularly relevant for firms that cannot afford to export if only pure bank financing is available. They use supplier credits complementary to bank credits. In contrast, firms that can export with pure bank financing do not necessarily rely on supplier credit financing. To them, bank credits and supplier credits are substitutes. We confirm our predictions for a sample of German manufacturing firms.

Chapter 2

How Trade Credits Foster Exporting*

*This chapter is based on joint work with Katharina Eck and Monika Schnitzer.

2.1 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, a great part 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 (CIA). CIA refers to payments made in advance by the buyer of a good to the seller. In contrast, a supplier credit 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.[2] Why trade credits are so prevalent in international trade, despite their high cost, has been little studied so far.

This chapter 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. In our analysis, we focus on CIA financing and provide 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 export. Financial constraints arise from asymmetric information problems that deter less productive firms from exporting if only bank financing is available. Access to CIA reduces the asymmetric information problem and thus promotes the export participation of firms that are constrained in their access to traditional bank financing.

We test our prediction with data from the Business Environment and Enterprise Performance Surveys (BEEPS) for German firms in 2004. This dataset is ideal for our purposes

[2] 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.

since it contains data on the use of CIA and the export activity of firms. We find that firms that receive CIA from their trading partners have on average a 27% higher probability to export than firms that do not receive CIA financing. Likewise, a 1% increase in CIA financing increases the export probability of firms on average by 13%. We find that the export fostering effect of CIA is particularly strong for financially constrained firms.

The contribution of this chapter is twofold. First, we are the first to explicitly analyze the effects of CIA financing on 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. Second, using survey data, we can provide direct evidence of the beneficial effects of CIA financing on exporting. In the survey, firms report how much of their sales are paid in advance by customers. Thus, we need not rely on proxies for CIA availability such as trade payables from balance sheet data. Since the use of CIA by firms is very likely related to unobserved firm characteristics we apply an instrumental variable approach to establish a causal effect of CIA financing on exporting. Accounting for endogeneity, we find that CIA availability strongly fosters the export participation of firms. In addition, we analyze the differential impact of CIA financing on exporting for firms that are constrained in their access to finance. We find that firms that have higher financing needs and firms that experience difficulties in accessing bank finance more strongly benefit from CIA financing in terms of their export participation.

Our analysis is related to two 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 which is the so called warranty by quality hypothesis.[3] This signaling 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 fi-

[3] Another paper on the warranty by quality hypothesis was simultaneously developed by Long, Malitz, and Ravid (1993). In a more recent paper, Klapper, Laeven, and Rajan (2012) provide empirical evidence of the quality signaling motive for a small sample of US and European firms.

nancially constrained firms benefit from access to trade credits. Biais and Gollier (1997) develop a model where the firm that extends the trade credit signals its belief in the creditworthiness of the firm it provides with trade credit. Their argument requires that the trade partner has an information advantage relative to the bank. Giannetti, Burkart, and Ellingsen (2011), however, find that the trading partners have no persistent informational advantage. In contrast to Biais and Gollier (1997), in our model we assume that the firm extending CIA signals its own quality, which seems to be a more natural and realistic assumption. Furthermore, this literature focuses on supplier credits. Instead, we analyze CIA. This is especially interesting since Mateut (2012), e.g., shows that prepayment financing is intensively used by firms across all industries. Thus, CIA, similar to supplier credit financing, provides an alternative to bank-intermediated trade finance.

Only recently has the literature on trade credits taken international transactions into its focus, investigating the optimal choice of trade credit. In Schmidt-Eisenlohr (2012)'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 supplier credit 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 possesses 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 Potin (2011) provide empirical evidence on the importance of letters of credit when country default risk is high. While the focus of these papers is primarily on the choice of the trade credit form as a function of the level of uncertainty, we focus instead on the rationale for using CIA as an alternative or as a complement to cheaper bank financing. We show how CIA solves both a moral hazard and an adverse selection problem for an exporter. Hence, we find that CIA fosters international trade.

The second strand of literature explores the influence of financial constraints on exporting behavior. Chaney (2005) and Manova (2012) show that financial constraints can prevent less productive firms from exporting in a Melitz (2003)-type model. Feenstra, Li, and Yu (2011) argue that exporters are more severely affected by financial constraints than domestic firms, due to the higher risks and longer financing periods in international trade. Firm-level studies confirm the adverse effect of financial constraints on exporting (see e.g., Minetti and Zhu, 2011; Muûls, 2008; Buch, Kesternich, Lipponer, and Schnitzer, 2010). We add CIA 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 CIA, financially constrained firms can also export.

The rest of the chapter is organized as follows: In section 2.2, we develop a model for an exporter receiving CIA. Section 2.3 introduces the dataset and provides summary statistics. In section 2.4, we set out the empirical strategy to test our model predictions and present our results. Section 2.5 concludes.

2.2 Theoretical Framework

Consider a two-period economy, $t = 0, 1$, in which a firm considers whether to produce for the foreign market.[4] 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

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

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 revenues.

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 μ, $0 < \mu < 1$, 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 ϕx, 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 λ, $0 < \lambda < 1$ 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, $0 < \phi < \lambda\hat{p}$. 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.[5] 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.[6]

2.2.1 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 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

$$p = \hat{p} - \frac{\phi}{\lambda}. \tag{2.1}$$

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

[5]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.

[6]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.

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. 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:

$$(1 + r_B) = \frac{(1 + \bar{r}_B)}{\lambda\mu}. \tag{2.2}$$

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

$$\pi_{Ex}^{BC} = \lambda\mu px - (1 + \bar{r}_B)\left(\frac{x^2}{2(1 + \beta)} + F_{Ex}\right). \tag{2.3}$$

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:

$$x_{Ex}^{BC} = \frac{(1+\beta)}{\frac{1+\bar{r}_B}{\lambda\mu}} \left(\hat{p} - \frac{\phi}{\lambda}\right). \tag{2.4}$$

Plugging (2.4) into the exporter's profit function (2.3) and setting the profit equal to zero yields the minimum productivity level required to make at least zero profit:

$$(1+\beta)_{Ex}^{BC} \equiv \left(\frac{1+\bar{r}_B}{\lambda\mu}\right)^2 \frac{2F_{Ex}}{\left(\hat{p} - \frac{\phi}{\lambda}\right)^2}. \tag{2.5}$$

Firms with a productivity level $(1+\beta) < (1+\beta)_{Ex}^{BC}$ are not able to export since at this level of uncertainty, they are unable to break even.[7] We refer to these firms as **financially constrained** implying that they are not productive enough to export with pure bank financing. A similar concept is used in Manova (2012) where imperfect financial contract enforcement abroad precludes less productive firms from exporting. Better contractual enforcement, which can be seen as a reduction in uncertainty, leads to a lower export threshold.

In our model, the productivity threshold is lower the lower the uncertainty with regard to the type of the foreign customer (higher μ) and positive market demand (higher λ). It 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 ϕ), can be relatively less productive to start exporting since their expected revenues are higher.

2.2.2 Pure Cash-in-Advance 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

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

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 intermediaries 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,

$$\tilde{p} = \frac{\lambda \hat{p}}{1 + \bar{r}_{Im}}. \tag{2.6}$$

The exporter's profit function with pure CIA financing is

$$\pi_{Ex}^{CIA} = \tilde{p} x - \left(\frac{x^2}{2(1+\beta)} + F_{Ex} \right). \tag{2.7}$$

This leads to

$$(1+\beta)_{Ex}^{CIA} \equiv \left(\frac{1 + \bar{r}_{Im}}{\lambda} \right)^2 \frac{2F_{Ex}}{\hat{p}^2}. \tag{2.8}$$

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

$$(1 + \bar{r}_{Im})(\lambda \hat{p} - \phi) > \lambda \hat{p} \frac{(1 + \bar{r}_B)}{\mu}. \tag{2.9}$$

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 μ), 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 more expensive than pure bank credit financing, i.e., condition (9) is fulfilled. This seems to be the most relevant case since full prepayments are very rare in practice.

2.2.3 Partial Cash-in-Advance and Bank Credit Financing

Consider now a combination of bank credit and CIA where only a fraction α 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 α: 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 its 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 α of the total amount from the importer. The importer decides whether to extend the fraction α 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. The first bracket contains the importers' strategies, the second bracket contains the strategies of the bank. The equilibrium and off-equilibrium beliefs are stated in the last two brackets.

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* $Prob\,(H|\alpha = 0) = 0$ *and it denies additional bank credit.*

Proof. See Appendix B.1. ∎

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

$$x^{Sep}_{Ex} = \frac{(1+\beta)}{1+\bar{r}_B}\left[\lambda\hat{p} - \phi + \frac{\phi(1+\bar{r}_B)}{(1+\bar{r}_{Im})}\right], \tag{2.10}$$

$$(1+\beta)^{Sep}_{Ex} \equiv \frac{2(1+\bar{r}_B)^2 F_{Ex}}{\left[\lambda\hat{p} - \phi + \frac{\phi(1+\bar{r}_B)}{(1+\bar{r}_{Im})}\right]^2}. \tag{2.11}$$

Firms with a productivity level lower than $(1+\beta)^{Sep}_{Ex}$ 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*

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

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* $\check{p} = \hat{p} - \frac{\phi}{\lambda} + \frac{\phi}{(1+\bar{r}_{Im})}$. *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 B.1. ∎

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:

$$x^{Pool}_{Ex} = \frac{(1+\beta)}{1+\bar{r}_B}\left[\mu(\lambda\hat{p} - \phi) + \frac{\phi(1+\bar{r}_B)}{(1+\bar{r}_{Im})}\right], \tag{2.12}$$

$$(1+\beta)_{Ex}^{Pool} \equiv \frac{2(1+\bar{r}_B)^2 F_{Ex}}{\left[\mu(\lambda\hat{p}-\phi)+\frac{\phi(1+\bar{r}_B)}{(1+\bar{r}_{Im})}\right]^2}. \tag{2.13}$$

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 B.1. ■

Figure 2.1 gives a graphical representation of the ranking of the productivity thresholds 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. Firms in the fourth group cannot export even if CIA is

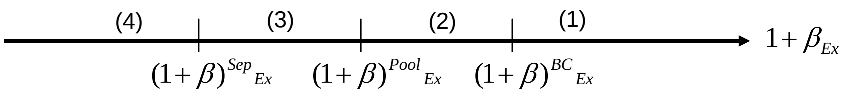

Figure 2.1: Ranking of Productivity Thresholds Required for Exporting

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 prefer to use CIA. This is shown in the following proposition.

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

Proof. See Appendix B.1. ■

Even 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* $(1+\beta) \geq (1+\beta)^{Pool}_{Ex}$ *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 B.1. ■

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 μ 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 (μ 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. To summarize, what emerges from our model is the following.

Prediction

The availability of CIA increases the profitability of exporting and hence increases the probability of exporting, in particular for financially constrained firms.

CIA is beneficial to firms since it reduces uncertainty with regard to foreign trading partners and it makes moral hazard less attractive to the firm paying in advance. Both effects increase the profits from exporting which implies that all firms prefer to use a combination of CIA and bank credit. However, considering a firm's ability to export, the provision of CIA is particularly beneficial to financially constrained firms since these firms cannot export in the absence of CIA. Therefore, we expect the positive effect of CIA on the export probability of firms to work mainly through the effect of financially constrained firms.

2.3 Data and Summary Statistics

To test our prediction, we use data from the Business Environment and Enterprise Performance Survey (BEEPS) on 1,196 German firms in 2004. BEEPS was developed jointly by the European Bank for Reconstruction and Development and the World Bank Group to analyze the business environment of firms and to link it with firm performance. In 2004, cross-sectional data on German firms was collected. By using stratified random sampling, a high representativeness of the sample is achieved. Specifically, the sample is designed so that the population composition with regard to sectors, firm size, ownership, foreign activity, and location is captured.[8] In Table B.1 in Appendix B.2 the decomposition of firms according to sectors for our sample can be found. Panel A of Table 2.1 provides average sample characteristics. 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 for the Federal Republic of Germany, the average number of employees is 13 and average sales amount to 1,230,000 Euro in 2004 (Federal Statistical Office, 2007).

The main advantage of this dataset is that it provides us with a precise measure of the use of CIA by firms. More specifically, firms are asked what percentage of their sales' in value terms were paid before delivery from their customers over the last 12 months. Thus, we do not have to rely on a proxy such as trade payables which is often used in the trade credit literature when only balance sheet data is available. However, we cannot single out CIA related to exporting activities compared to domestic activities since transaction level data is not available in the survey. Thus, we restrict our analysis to linking the overall use of CIA by firms to their export participation decision. Data on the exporting activities by firms is given in terms of export shares of total sales which range from 0% to 90% in our dataset. We classify a firm as an exporter if it sells a positive amount of its sales abroad. A detailed description of all variables included in our analysis can be found in Table B.2 in Appendix B.2.

About 16% of all firms generate a positive share of their sales abroad (Panel A of Table 2.1), a share that is slightly higher than the population average for 2004 which is 12% (Haunschild, Hauser, Günterberg, Müller, and Sölter, 2007). A look at the average use of CIA in the sample reveals that more than one third of all firms receive prepayments from their customers. In contrast, the mean share of prepayments received is rather low:

[8] Sectors included in the sample are mining and quarrying, construction, manufacturing, transportation, storage and communications, wholesale, retail and repairs, real estate, renting, and business service, hotels and restaurants, and other community, social and personal activities. Sectors that are subject to government price regulation and prudential supervision like banking, electric power, rail transport, and water and waste water are excluded.

Table 2.1: Descriptive Statistics

Panel A: Summary Statistics on Firm Characteristics

	Mean	Median	SD	Obs.
Sales (1,000 Euros)	15,862	1,200	88,486	1,135
Age	19.4	14	16.7	1,196
Number of employees	85.8	12	443.3	1,195
LogLabprod	4.76	4.61	0.77	1,135
CompNum	3.51	4	1.03	1,196
ForPressure (%)	28.0	-	-	1,196
Univeduc (%)	12.36	5	20.58	1,195
Foreign (%)	9.0	-	-	1,196
Share of Exporters (%)	16	-	-	188
Share of firms receiving CIA (%)	35	-	-	418
Share of CIA received (%)	7	0	16	1,196
PublicInfo (%)	27.4	-	-	1,184
Specificity	2.2	2	0.95	1,196

Panel B: Exporters vs. Non-Exporters

	Exp	Obs.	Non-Exp	Obs.	Mean diff.
Share of firms receiving CIA (%)	43.5	188	33.7	1,008	9.8***
Av. Share of CIA received (%)	7.4	188	7.2	1,008	0.2
Sales (1,000 Euros)	66,971	177	6,419	958	60,552***
LogSize	4.06	188	2.42	1,008	1.64***
LogAge	3.0	188	2.61	1,008	0.39***
LogLabprod	5.0	177	4.7	958	0.3***
Foreign (%)	37.0	188	4.0	1,008	33.0***
Lowest Size Quartile					
Share of firms receiving CIA (%)	33.3	24	27.9	305	5.4
Second-Lowest Size Quartile					
Share of firms receiving CIA (%)	52.4	21	28.5	291	23.9**
Second-Highest Size Quartile					
Share of firms receiving CIA (%)	48.3	29	34.8	230	13.5
Highest Size Quartile					
Share of firms receiving CIA (%)	43.0	114	48.4	182	-5.4

Panel A provides average firm characteristics. Panel B displays results from mean difference tests of firm characteristics for exporters vs. non-exporters 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. The share of firms that receives CIA is defined as all firms that receive a share greater than zero over all firms. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

on average, only 7% of total sales in value terms is paid by customers before delivery. This implies that the remaining part, about 93% of total sales, is either paid on time or after delivery by customers. The low average share of use of CIA may reflect the high refinancing costs for the extending firms.

Panel B of Table 2.1 displays differences in CIA use by exporters versus non-exporters. Strikingly, exporters distinctly use CIA more extensively than non-exporters. About 44% of all exporters receive a positive share of their sales in advance, whereas only 34% of all non-exporters obtain advance payment. The average share of CIA received is very similar for both groups and only marginally higher for exporters. Since our data does not allow us to determine whether CIA is used to finance a domestic or an export transaction, we are concerned that the higher use of CIA by exporters is simply driven by the significantly larger size of exporters in terms of number of employees and scope of operations. Therefore, we split firms into size quartiles according to their number of employees and check whether exporters still use CIA more extensively than non-exporters within the same size quartiles. We find that within the same size quartile, relatively more exporters than non-exporters receive CIA payments except within the highest size quartile. Note that the low number of exporters in each size quartile makes it difficult to observe significant positive differences although the differences are quite large. Other well-known characteristics of exporters are reflected in the data as well: exporters are older, have higher sales per worker (labor productivity), and rather tend to be foreign owned.

These descriptive statistics suggest that CIA financing plays a very important role for internationally active firms. Our theoretical model provides an explanation for these findings which we put to an empirical test in the following section.

2.4 Empirical Analysis

2.4.1 Empirical Strategy

Our main prediction from our theoretical model states that access to CIA financing facilitates entry into exporting since asymmetric information problems are reduced. This effect should be driven through the higher export performance of financially constrained firms since unconstrained firms can export even in the absence of CIA. As stated in our model, a firm is able to participate in exporting if it generates positive profits from exporting, $\pi_{Ex} > 0$. The firm's profits from exporting depend on the financing options available to the firm, partial CIA versus pure bank financing, its own productivity level as well as other firm characteristics. Thus, we rewrite π_{Ex} as

$$\pi_i^* = \alpha + \beta_1 CIArec_i + \beta_2 LogLabprod_i + \gamma \mathbf{C_i} + \epsilon_i, \tag{2.14}$$

where $CIArec_i$ measures firm i's use of CIA financing. We employ two measures of CIA financing. The first is a binary indicator, $DCIArec$, equal to 1 if the firm receives a positive amount of CIA and equal to 0 otherwise. In this case, the firm receives its sales either on time or after delivery which implies that the firm has to rely on other sources of financing such as bank credit financing. The second is the log percentage share of total sales received in advance, $LogCIArec$. A lower value of $LogCIArec$ implies that the firm has to rely on other financing sources to a greater extent. Log labor productivity, $LogLabprod$, is defined as the log of sales over employees and proxies for the firm's own level of efficiency. Additional firm level controls that influence the export decision of a firm are included in the vector $\mathbf{C_i}$. ϵ_i denotes the error term. We do not observe the true profits from exporting π_i^* of a firm, but its export status Exp_i. It is defined as a binary indicator equal to 1 if firm i generates positive profits from exporting and 0 otherwise:

$$Exp_i = \begin{cases} 1, & \text{if } \pi_i^* > 0, \\ 0, & \text{if } \pi_i^* \leq 0. \end{cases} \tag{2.15}$$

Assuming a standard normal distribution of ϵ_i we can write the probability to export of firm i as:

$$\begin{aligned} Prob(Exp_i = 1) &= Prob(\alpha + \beta_1 CIArec_i + \beta_2 LogLabprod_i + \gamma \mathbf{C_i} + \epsilon_i > 0) \\ &= \Phi(\alpha + \beta_1 CIArec_i + \beta_2 LogLabprod_i + \gamma \mathbf{C_i}), \end{aligned} \tag{2.16}$$

where Φ denotes the standard normal cumulative distribution function of the error term. According to our model, the availability of CIA increases the profits from exporting π_i^* and thus, we expect the effect of CIA on the export probability to be positive, $\beta_1 > 0$. The same holds true for the productivity level of the firm, $\beta_2 > 0$.

A simple test of our hypothesis can be conducted via regressing Exp on $CIArec$ and further controls. The estimated coefficient β_1 is unbiased if we can assume that whether a firm receives CIA (or how much CIA it receives) is assigned randomly across firms. However, this assumption is very likely not to hold true due to unobserved factors that affect both the export decision of a firm and the decision whether to use CIA financing. Consider for example uncertainty with regard to the importer's type, captured by the parameter μ in our model. Higher uncertainty with regard to the trading partner's ability to repay hinders entry into exporting since exporting becomes less profitable. Likewise, higher uncertainty makes the use of CIA more attractive in order to alleviate asymmetric information. Consequently, not controlling for the level of uncertainty may lead to a downward bias of our results. A second example is manager motivation. More motivated managers may be more successful in leading their enterprises into exporting and they may also be more able to enforce CIA payment from their customers. Thus, omitted manager motivation can lead to an upward bias of our results. We address endogeneity in our key variable by employing two instruments that are unrelated to the export decision of a firm but influence CIA financing.

To find suitable instruments that strongly influence whether a firm receives CIA payment from its customers but that are unrelated to the export decision, we make use of information on the relationship between firms and their customers. The first instrument comes from a question on the sources that firms use to acquire new customers. In the survey, firms are asked whether trade fairs and other public sources of information are not, slightly, fairly, very, or extremely important sources of information about new customers to the firm. We construct the dummy $PublicInfo$, which is equal to 1 if the firm indicates that trade fairs and other public sources of information are extremely important sources of information about new customers. This is true for about 27% of firms in our dataset. $PublicInfo$ proxies for the closeness between firms and their customers. Firms that deem information collected and made available by official authorities as extremely valuable very likely experience difficulties in acquiring new customers. These firms should be more likely to ask for CIA (or for a higher share of sales paid in advance) to be compensated for the difficulties in finding the customers. $PublicInfo$ can also be seen as a proxy for the range of applications that the product can be used for. Firms that produce goods that can be used for a smaller range of applications usually tend to face a smaller circle of potential customers than firms that produce widely applicable goods. Consequently, they have to exert more effort to find new customers which makes using CIA more attractive. We do not expect the closeness between firms and customers to directly impact on the export decision of firms. If the degree of closeness to customers influences a firm's export decision, the observed influence would be very likely negative since less knowledge on customers should rather impede exporting than facilitate it. IV estimation in that case would then lead to a lower and thus more conservative estimate for the effect of CIA on exporting.

The second question addresses the specificity of the main product or service sold by the firm. Firms are asked how their customers react if the firm raises the price of its main product or service line by 10%. Possible responses are: (i) customers buy from competitors, (ii) customers continue to buy at much lower quantities, (iii) customers continue to buy at slightly lower quantities, or (iv) customers continue to buy from the firm in the same quantities as before. Out of these answers, we construct the ordinal variable $Specificity$ that measures the price elasticity of demand that the firm faces or, in other words, the bargaining power that the firm has vis-à-vis its customers. $Specificity$ takes the value 1 if (i) is chosen by the firm, 2 if (ii) is chosen, and so forth. A higher value of the variable indicates a higher bargaining power or a lower elasticity of demand. We expect a positive relationship between $Specificity$ and the use of CIA. A low elasticity of demand reflects a high specificity of the good or service sold such that customers depend on the input. Consequently, these customers have a higher incentive to comply with CIA requirements by the firm. Mateut (2012) provides empirical evidence on the relationship between goods' characteristics and customer prepayments for French firms. She finds that downstream firms that sell a differentiated good receive larger prepayments from their customers than firms that sell standardized goods.

Since a high market bargaining power may also reflect the competitiveness of the firm, we are worried that our instrument does not only capture the specificity of the relationship between firms and customers but that it might also pick up the degree of competition the firm faces. Low competition can allow firms to raise prices without losing customers and enable firms to enter the export market more easily since they obtain higher profits. Therefore, we directly control for the level of competition that the firm experiences in the national and the international market. This ensures that $Specificity$ only captures customer dependence with regard to product characteristics and, thus, is exogenous to the export decision of a firm. Firms that produce very specific goods should be more able to enforce CIA payment but producers of more specific goods should not be more likely to export than producers of less specific goods, once the competition level is controlled for.

Since our first measure $DCIArec$ for $CIArec$ is binary, we apply the recursive bivariate probit model to estimate the effect of CIA on export participation in our first specification.

Given valid instruments, the recursive bivariate probit model allows to determine the causal effect of a potentially endogenous binary regressor on a binary dependent variable. Specifically, it simultaneously estimates two probit models via maximum likelihood. The first equation models the effect of the binary endogenous regressor and potential controls on the outcome. The second equation models the endogenous regressor as a function of the instruments and other controls. The error terms of both equations are assumed to be correlated due to unobserved factors, e.g., manager motivation. The causal effect of the binary endogenous regressor can be estimated if instruments are available that strongly influence the endogenous regressor but are exogenous to the outcome equation.[9] In our case, we jointly estimate the export probability and the probability of a firm to receive CIA by its customers. The first equation is given in (2.16). The second equation describes the probability to receive CIA as follows:

$$\begin{aligned} Prob(DCIArec_i = 1) &= Prob(a + \mathbf{b_1 Z_i} + b_2 LogLabprod_i + \mathbf{cC_i} + u_i > 0) \\ &= \Phi(a + \mathbf{b_1 Z_i} + b_2 LogLabprod_i + \mathbf{cC_i}), \end{aligned} \tag{2.17}$$

where u_i is assumed to be standard normally distributed. ϵ_i and u_i are jointly normally distributed with mean zero, a variance of 1, and a correlation coefficient of ρ. Alternatively, we can estimate the causal effect of CIA on exporting via a two-stage least squares linear regression model (2SLS). This approach loosens the restrictive assumptions on the joint distribution of the error terms but it does not take into account the binary nature of both the dependent variable and the endogenous regressor.

Z denotes our set of instrumental variables, $PublicInfo$ and $Specificity$. By jointly estimating equation (2.16) and (2.17) via maximum likelihood, we can identify a causal effect of the use of CIA on the export participation of a firm. We employ our instruments consecutively and also jointly in one specification.

In addition, we apply the continuous measure of CIA received, $LogCIArec$ to measure

[9] The recursive bivariate probit model has also been used by Minetti and Zhu (2011) to address potential endogeneity in a trade context.

the intensity of CIA financing. In doing so, we replace equation (2.17) with the following reduced form specification:

$$LogCIArec_i = a + \mathbf{b_1 Z_i} + b_2 LogLabprod_i + \mathbf{c_2 C_i} + v_i. \tag{2.18}$$

Equation (2.16) and (2.18) are jointly estimated via maximum likelihood under the assumption that $\epsilon_i, v_i \sim N(\mathbf{0}, \sum)$ and $\sigma_{11} = 1$.

$\mathbf{C_i}$ contains several control variables that influence the export decision of firms and are commonly used in the literature. We follow Minetti and Zhu (2011) and control for reputation and size effects by including the log of firms' age, *LogAge*, and the log number of employees, *LogSize*. Moreover, the percentage of the workforce with a university education or higher, *Univeduc*, is added to control for human capital effects. Older and larger firms are usually expected to have a higher export probability, as well as firms that possess a more highly educated workforce. We take the competitive environment of the firm into account by controlling for the degree of national and international competition that the firm faces. *CompNum* gives the number of national competitors of the firm which can take values from 0 to 4 where 4 is coded as 4 or more competitors in the national market. *ForPressure* captures the extent of foreign competition. It is defined as a binary indicator equal to 1 if the firm states to be fairly or very much influenced by competition from foreign competitors when making key decisions with regard to developing new products, services or entering new markets. It is equal to 0 if foreign pressure is not at all or only slightly important to the decision process of the firm. The influence of competition on the export decision is ambivalent. On the one hand, stronger competition may deter firms from entering the export market. On the other hand, it might hint at the existence of a larger market and growth opportunities to the firm by going international. The inclusion of both controls ensures that our instrumental variable *Specificity* only reflects the specificity of the firm-customer relationship and no competition effects. Last but not least, we control for foreign ownership since foreign owned firms are more likely to export (Greenaway, Guariglia, and Kneller, 2007). *Foreign* is a dummy equal to 1 if at least 10% of the firm are owned by a foreign entity. Sector specific effects are included in all specifications, as well.

2.4.2 Effect of Cash-in-Advance Financing on Export Participation

Table 2.2 provides the results from estimating the effect of CIA financing, measured as a binary indicator, on the export participation decision of firms. In the first column, we consider CIA received as randomly granted to firms by their customers and estimate equation (2.16) via a simple probit model. The effect of $DCIArec$ on the probability to export is positive and highly significant. To grasp the economic impact of positive CIA received, we calculate the average marginal effect for $DCIArec$ on the export probability: on average, firms that receive a positive amount of their sales in advance from their customers have a 6% higher probability to export than firms that either receive the payment on time or after delivery of their goods or services. With regard to the other estimates, we confirm prior findings of the literature. Larger and more productive firms have a higher export probability, as well as foreign owned firms and firms equipped with a more highly educated workforce. In contrast, older firms do not participate significantly more often in exporting. The effect of the number of domestic competitors is positive but not significant, either. Instead, we find a strong positive influence of pressure from foreign competitors on the export participation decision of firms. Firms indicating that pressure from foreign competitors is fairly or very important when making key decisions about developing new products or entering new markets have a higher probability to export. This may reflect growth opportunities available in the foreign market and firms making use of scale effects.

In columns (2) and (3), we jointly estimate equations (2.16) and (2.17), taking into account potential endogeneity of our key regressor. To instrument the use of CIA by firms,

Table 2.2: Effect of *DCIArec* on Export Participation - Simple and Bivariate Probit Model

Dep.Var.	(1) Exp	(2) DCIArec	(3) Exp	(4) DCIArec	(5) Exp	(6) DCIArec	(7) Exp
	Probit	Bivariate probit		Bivariate probit		Bivariate probit	
DCIArec	0.402***		1.301***		1.404***		1.504***
	(0.124)		(0.413)		(0.301)		(0.258)
LogAge	0.025	-0.127**	0.046	-0.135**	0.065	-0.126**	0.052
	(0.087)	(0.058)	(0.082)	(0.058)	(0.080)	(0.058)	(0.079)
LogSize	0.205***	0.131***	0.146***	0.137***	0.129***	0.128***	0.125***
	(0.041)	(0.029)	(0.053)	(0.029)	(0.047)	(0.029)	(0.045)
LogLabprod	0.326***	0.085	0.267***	0.110**	0.252***	0.0890*	0.246***
	(0.080)	(0.053)	(0.080)	(0.053)	(0.076)	(0.053)	(0.074)
Univeduc	0.008*	0.008***	0.002	0.008***	0.004	0.008***	0.001
	(0.004)	(0.002)	(0.004)	(0.002)	(0.004)	(0.002)	(0.004)
CompNum	0.015	-0.015	0.014	0.002	0.020	0.009	0.013
	(0.058)	(0.039)	(0.054)	(0.039)	(0.053)	(0.040)	(0.052)
ForPressure	0.747***	-0.043	0.695***	0.011	0.667***	-0.023	0.660***
	(0.121)	(0.093)	(0.131)	(0.093)	(0.126)	(0.094)	(0.123)
Foreign	1.358***	-0.099	1.273***	-0.134	1.248***	-0.099	1.213***
	(0.171)	(0.144)	(0.195)	(0.142)	(0.182)	(0.144)	(0.181)
PublicInfo		0.283***				0.278***	
		(0.087)				(0.084)	
Specificity				0.130***		0.130***	
				(0.044)		(0.043)	
AME/ATE	0.057		0.220		0.248		0.275
(SE) / SD	(0.018)		0.153		0.161		0.169
Observations	1,070	1,124		1,135		1,124	
$\hat{\rho}$		-0.550*		-0.620***		-0.681***	
Log-Likelihood	-274.0	-966.4		-975.5		-961.7	

Sector fixed effects are included in all regressions. Heteroskedastic robust standard errors are in parentheses. In column 1, we provide the average marginal effect of *DCIArec* on exporting. In column, 3, 5, and 7 we calculate the average treatment effect of *DCIArec* on exporting. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

we employ *PublicInfo* in column (2), which indicates whether the firm regards information on new customers acquired from trade fairs and other public sources as extremely important. The instrument highly significantly enters the equation for use of CIA. As conjectured, firms with a high demand for officially collected information on new customers are more likely to require CIA payment. Younger firms are more likely to use CIA reflecting that these firms probably do not have built up a reputation with banks and are more constrained in their access to traditional forms of finance. The size of a firm increases its likelihood to receive CIA. Both findings are in line with results for CIA use by French firms (see Mateut, 2012). In addition, we find that firms with a more highly educated workforce also tend to use prepayment financing more often. In column (3), the estimates for equation (2.16) are displayed. We observe a strong and positive influence of CIA received on the export participation decision of firms. Calculating the average treatment effect of CIA received on the export probability of firms, we find that CIA financing increases the likelihood of firms to export by 22%.[10] The effect has more than tripled compared to the simple probit model estimate which is 6%. The Wald test of zero correlation between ϵ_i and u_i yields a significant negative correlation $\hat{\rho}$ at the 10% level suggesting that we cannot consider the use of CIA by firms as exogenous. Thus, not accounting for omitted variables greatly underestimates the true effect of CIA financing on exporting. A potential reason is omitted variable bias due to unobserved customer uncertainty which negatively impacts on exporting but makes CIA financing more necessary. The main findings for our other covariates basically hold true except that we fail to find a significant positive influence of a more highly skilled workforce.

In column (4), we use $Specificity$ as instrument which gauges the firm's bargaining power with regard to enforcing CIA payment from its customers. We expect firms with increasing bargaining power (decreasing price elasticity) to be more likely to enforce CIA payments from their customers. Looking at the results in column (4), we find that this is indeed the case. $Specificity$ has a strong and positive impact on firms' probability to receive CIA suggesting that the higher the bargaining power of the firm, the more likely it is to receive CIA. Exogeneity of the use of CIA can be rejected at the 1% level. The effect of advance payments on the exporting decision of firms increases when instrumented with pricing power information. On average, receiving CIA raises the export participation of firms by about 25%.

In the last specification, we use both instruments jointly to increase the precision of

[10]The average treatment effect of CIA received on exporting is given by the following formula in Wooldridge (2010), p. 594: $\Phi(\alpha + \beta + \gamma \mathbf{C_i}) - \Phi(\alpha + \gamma \mathbf{C_i})$.

our estimates. Both instruments are again highly significant and exogeneity of our key regressor is strongly rejected. Making use of a larger part of the exogenous variation in $DCIArec$ leads to a decrease in the estimated standard errors in column (7) and to an even higher effect on exporting: receiving prepayments increases the probability to export by 27%.

Next, we provide the results when measuring use of CIA as continuous variable in log percentage shares of total sales in Table 2.3. Instead of the bivariate probit model, we estimate equation (2.16) and (2.18) jointly via an instrumental variable probit model. We employ the same set of instruments in turn. When neglecting endogeneity in $LogCIArec$, we observe a small positive and significant effect on the export probability of firms. A 1% increase in the share of CIA received leads to a 2% increase in the export probability. Considering only the exogenous variation in our key regressor instead leads to more precise and larger coefficients that are highly significant: a 1% increase in the share of CIA received on total sales raises firms' export participation probability between 10% and 15%, depending on the set of instruments. However, $Publicinfo$ seems to be a rather weak instrument for $LogCIArec$. Applying it as single instrument in column 2, we cannot reject exogeneity of our key regressor which points to a weak instrument. Therefore, our preferred specification is the last specification in which we use both instruments jointly.

To ensure that the considerable increase in the estimated effect of CIA financing on exporting does not stem from non-linearities underlying the recursive bivariate probit or the instrumental probit model, we additionally provide the results from 2SLS estimations in Tables B.3 and B.4 in Appendix B.2. The effect of $DCIArec$ on exporting is even larger when estimated via 2SLS in Table B.3. Moreover, the magnitude of the effect widely varies from an insignificant point estimate of 24% to an increase by 77%. These findings clearly illustrate that 2SLS is less suited for estimating the effect of a binary endogenous regressor on a binary outcome since it neglects the binary nature of both endogenous variables. One consequence is that predicted probabilities of export participation can lie outside the unit interval. Minetti and Zhu (2011) note that this shortcoming also

Table 2.3: Effect of *LogCIArec* on Export Participation - Simple Probit and IV Probit

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dep. Var.	Exp	LogCIA-rec	Exp	LogCIA-rec	Exp	LogCIA-rec	Exp
	Probit	IV probit		IV probit		IV probit	
LogCIArec	0.107**		0.552***		0.691***		0.635***
	(0.043)		(0.204)		(0.074)		(0.098)
LogAge	0.013	-0.127**	0.059	-0.133**	0.094	-0.122**	0.072
	(0.086)	(0.060)	(0.078)	(0.060)	(0.062)	(0.060)	(0.070)
LogSize	0.210***	0.111***	0.114	0.115***	0.036	0.107***	0.075
	(0.040)	(0.029)	(0.084)	(0.029)	(0.059)	(0.029)	(0.059)
LogLabprod	0.331***	0.081	0.215*	0.102*	0.113	0.085	0.164*
	(0.080)	(0.056)	(0.118)	(0.056)	(0.083)	(0.056)	(0.086)
Univeduc	0.008*	0.008***	0.0002	0.008***	-0.001	0.008***	-0.001
	(0.004)	(0.002)	(0.005)	(0.002)	(0.003)	(0.002)	(0.003)
CompNum	0.016	-0.032	0.023	-0.014	0.034	-0.001	0.022
	(0.058)	(0.042)	(0.051)	(0.043)	(0.042)	(0.042)	(0.046)
ForPressure	0.747***	-0.056	0.607***	-0.003	0.418***	-0.024	0.514***
	(0.121)	(0.098)	(0.207)	(0.097)	(0.162)	(0.097)	(0.161)
Foreign	1.334***	0.018	1.044***	-0.013	0.714***	0.013	0.869***
	(0.170)	(0.162)	(0.361)	(0.159)	(0.274)	(0.161)	(0.268)
PublicInfo		0.292***				0.254***	
		(0.096)				(0.094)	
Specificity				0.154***		0.163***	
				(0.046)		(0.041)	
AME	0.015		0.100		0.146		0.125
(SE)	(0.006)		(0.055)		(0.027)		(0.030)
Observations	1,070	1,059	1,059	1,070	1,070	1,059	1,059
$\hat{\rho}$		0.140		0.002***		0.004***	
Log-Likelihood	-276.1	-2,073		-2,090		-2,064	

Sector fixed effects are included in all regressions. In column 1, 3, 5, and 7 we provide the average marginal effect of *LogCIArec* on exporting. Heteroskedastic robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

affects the first stage if the share of firms with an outcome of 1 is rather low, as it is the case in our setting. This may also explain why the first stage F-Statistic is below the recommended value of 10 (Staiger and Stock, 1997) although both instruments enter the first stage highly significantly and although the Hansen test statistic confirms that the overidentifying restrictions are valid. Therefore, estimation via the recursive bivariate probit model seems to be more appropriate to us.

When using the continuous measure of CIA received by firms as key regressor in Table

B.4, the 2SLS results come closer to the estimates of the instrumental variable probit model and also the first stage F-Statistic improves. The estimated effects vary widely, though: a 1% increase in the share of CIA received leads to an increase in the export probability between 13% and 22%. The Hansen test statistic again confirms that the overidentifying restrictions are valid.

Taken together, our results strongly support our hypothesis that CIA financing fosters the export participation at the firm level. If we do not control for potential endogeneity, the effect of CIA on exporting is considerably smaller hinting at a downward bias due to omitted variables that jointly influence firms' decisions to export and to use CIA. Applying instruments that account for non-random use of CIA by firms we establish a statistically and economically meaningful effect of CIA financing on exporting.

2.4.3 Effect of Cash-in-Advance Financing on Export Participation for Financially Constrained Firms

So far, we have assumed that the effect of CIA financing on the export participation decision of firms is constant across firms. According to our model, we expect the positive effect of CIA financing to be driven mainly through the effect for financially constrained firms since unconstrained firms can export even in the absence of CIA. In this subsection, we explicitly test for heterogeneous effects of prepayment financing on exporting for constrained and unconstrained firms. We apply several different concepts that express firms' difficulties in accessing bank credit and their financial needs. In doing so, we rely on the specification with the continuous measure of CIA as key regressor (equations (2.16) and (2.18)) because the recursive bivariate probit model becomes less computationally feasible if the number of observations drops. Furthermore, we use the specification including both instrumental variables since it provides us with the most precise and efficient estimates. The results of this exercise can be found in Table 2.4.

We first split firms according to their number of employees with the median number of

Table 2.4: Effect of *LogCIArec* on Export Participation for Different Subgroups of Firms, IV Probit

	IV probit: Dep. Var. Exp				
	Coeff. *LogCIArec*	SE	AME	SE	N
Heterogeneity According to Access to Finance					
LogSize					
(1) below median	0.778***	(0.046)	0.156	(0.023)	503
(2) above median	0.258	(0.421)	0.048	(0.085)	549
Firms with demand					
(3) and no access to loan	0.952***	(0.129)	0.266	(0.064)	71
(4) and access to loan	0.593***	(0.147)	0.115	(0.041)	723
Heterogeneity According to Financing Needs					
Material input growth					
(5) below median	0.540*	(0.300)	0.081	(0.073)	738
(6) above median	0.609***	(0.155)	0.141	(0.045)	313
(7) Manufacturing, Mining, and Construction	0.800***	(0.050)	0.204	(0.024)	443
(8) Services	0.489**	(0.198)	0.083	(0.048)	681
Instruments applied: *PublicInfo*, *Specificity*					

Sector fixed effects are included in all regressions except for the last two sample splits according to the firm's main economic activity. Heteroskedastic robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

employees as cutoff. Assuming that smaller firms experience stronger difficulties in securing bank finance, we expect a stronger fostering effect of CIA on the export probability for firms below the median size level. The results in Table 2.4, rows 1 and 2, confirm our conjecture and suggest that the effect of CIA on the export participation is mainly driven by small firms: small firms that experience a 1% increase in CIA shares can increase their export probability by about 16%. In constrast, larger firms do not significantly benefit from additional CIA financing.

We then divide firms according to their access to bank financing in rows 3 and 4. The survey allows to identify firms that do not receive a bank loan although they have a positive demand for it. In the survey, firms are asked whether they recently obtained a bank loan. Firms that state that they do not currently possess a bank loan are asked to name the reasons: potential answers are no need for a loan, downturn of the loan application, or discouragement from applying for the loan for several reasons. We follow Hainz and Nabokin (2012) and divide firms into two subgroups according to their demand and access to credit. In doing so, we only consider firms that state a demand for credit, which is true for 78% of all firms in our sample. We then split these firms according to whether they currently possess a loan or not. Firms that do not possess a loan have either faced a downturn of their application or did not apply for a loan because they were discouraged from applying due to high interest rates, burdensome application procedures or because they thought the loan application would be turned down anyways. We expect firms that do not possess a loan but have demand for a loan to benefit more from additional CIA financing than firms whose loan application was successful. Our results strongly confirm this conjecture: firms that require external finance but do not obtain a bank loan can raise their export probability by about 27% if CIA received increases by 1%. In contrast, the partial effect for firms with access to a bank loan is only half of that for firms without access. This strongly points to substitutional CIA financing by customers in order to facilitate entry into exporting.

To gauge the extent of firms' financial needs, we next split the sample according to the real growth rate of material input costs. Firms with above median material input cost growth very likely require additional financing to cover their higher input costs. We expect these firms to benefit more strongly from additional CIA financing. Firms with above median input cost growth experience a rise in their export probability by about 14% for every 1% increase in CIA financing, row 6. In contrast, the average marginal effect for low growth firms is smaller and only marginally statistically significant, row 5.

Finally, we analyze heterogeneous effects across different sectors. We lump together firms from the manufacturing sector, mining, and construction and compare them to firms from the service sector. We expect the former to benefit more from CIA financing since manufacturing and construction goods rather tend to be capital intensive goods that have higher financing requirements than services. We find that the marginal effect of 1% increase in CIA financing on the export probability more than doubles when moving from service to non-service firms (rows 7 and 8). Thus, the strong effect of CIA financing on firms' export decision is mainly driven by firms in presumably more capital intensive sectors.

2.5 Conclusion

Our findings strongly suggest that prepayment financing between firms can be highly beneficial. CIA can serve as a credible signal of quality and reduce part of the high uncertainty in international trade. This in turn 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 CIA. We confirm our predictions for a sample of German firms. Although the German credit market is rather well-developed, German firms greatly benefit from access to CIA financing in terms of their export participation. We expect the positive effects of CIA financing to be especially relevant in a situation of global monetary contractions when firms experience severe difficulties in obtaining bank-intermediated trade finance.

Chapter 3

Multinational Enterprises, Exporters, and Unions: Bargaining Advantage vs. Rent Sharing

3.1 Introduction

The empirical evidence on whether multinational enterprises (MNEs) pay higher wages than domestically owned firms is inconclusive. Heyman, Sjöholm, and Tingvall (2007) estimate that the individual worker's wage level is 2 to 6% higher in MNEs compared to domestically owned firms (see Huttunen, 2007; Chen, Ge, and Lai, 2011, for similar findings). Other studies, however, do not find an MNE wage premium (see Conyon, Girma, Thompson, and Wright, 2002; Almeida, 2007; Andrews, Bellmann, Schank, and Upward, 2009).[1] One potential explanation for these opposing findings is the role unions play in negotiations with domestically and foreign-owned firms.

Despite the fact that union membership steadily decreases, the share of workers covered by union wage agreements still amounts to about 50% in Germany (see Ellguth and Kohaut, 2007). In France, approximately 80% of workers are covered by collective bargaining (Delacroix, 2006). These numbers illustrate that unions still play an important role in the determination of wages. MNEs may negotiate higher or lower wages with unions compared to domestically owned firms. On the one hand, MNEs have a bargaining advantage as they can relocate production, which may result in lower wage payments. On the other hand, MNEs may pay higher wages as they are on average more profitable and unions may want to partake in the profits.

Anecdotal evidence suggests that unions take into account firms' profits when formulating their wage claims. Take as examples the following statements of newspaper articles: Referring to upcoming negotiations of the IG-Metall (the largest German union), its head of county was cited in the newspaper *Die ZEIT* (25.12.2011): "*It will be a hot debate. A lot of workers have high expectations due to high profit margins and large profits in 2011.*". Similarly, *The Guardian* (18.01.2012) wrote that Unilever now wants to transfer its entire workforce to a less costly career average earnings plan (Care). *The Guardian* stated: "*But the unions point to huge profits and generous treatment of executives, and*

[1]For a more detailed review of the literature see section 3.2.

fear that the Care proposal will lead to much less dependable pensions arrangements."

This chapter develops a general equilibrium model of firm-union wage bargaining behavior for both exporters and MNEs which can explain the inconclusive empirical findings. In line with the anecdotal evidence, the labor union in our model does not only consider what can be earned outside the firm but also takes into account the firm's economic performance. We introduce the fair wage approach of Egger and Kreickemeier (2012a) into the heterogeneous firms wage bargaining model of Eckel and Egger (2009). Firms choose whether to serve a foreign market via exports or foreign direct investment (FDI). Besides the traditional proximity-concentration trade-off, the firm has an additional incentive to become an MNE due to a better bargaining position as it can relocate production to foreign plants.

The contribution of the chapter is two-fold. First, by introducing fair-wage preferences into wage bargaining we can derive firm-specific wages in a well tractable way. Homogeneous workers earn different wages depending on the firm they are employed at. This pattern was first found by Slichter (1950) who termed this rent sharing behavior, i.e., more profitable firms pay equally skilled workers more than less profitable firms. Summarizing the empirical findings on rent sharing, Goos and Konings (2001) state that the overall elasticity of wages with respect to rent, found for US, Canada, UK and some European firms, lies between 0.1 and 0.3. Thus, among other factors, wages depend on the firm's economic performance. Furthermore, the model can explain the findings of the empirical literature on residual wage inequality, i.e., wage inequality that cannot be explained by observable worker characteristics. Residual wage inequality is found to account for about two thirds of the increase in total wage inequality (see, e.g., Fuchs-Schuendeln, Krueger, and Sommer, 2010, for Germany).

Second, the chapter can reconcile the inconclusive empirical evidence on MNE wage premia. On the one hand, MNEs may pay lower wages because they have a better bargaining position vis-à-vis the unions as they can relocate production. On the other hand, MNEs are on average more profitable than exporters and workers want their part of the profits.

Combining these two effects, MNEs may pay higher or lower wages than exporters. MNEs pay higher wages than exporters if unions' bargaining power is relatively low or relatively high as in these cases MNEs can benefit less from their bargaining advantage. For weak unions wage claims are low anyway and for strong unions the firm's contribution and hence the disagreement profit matters less. For intermediate bargaining power, MNEs pay lower wages than exporters as they can profit most from their bargaining advantage. Furthermore, MNEs' wage payments relative to exporters' increase with trade costs and with the competitive situation in an economy. In addition, we can show that the unemployment rate in the open economy decreases with the share of MNEs if MNEs pay on average lower wages than exporters. MNEs have the possibility to relocate production, which has a direct negative effect on employment. Conversely, MNEs can negotiate lower wages relative to their profits which has an indirect positive effect on employment. This leads to an increase in employment.

This chapter builds on two strands of the literature. First, there is the literature on MNEs and wage bargaining. We build on the model of Eckel and Egger (2009) who first introduced the bargaining advantage of MNEs into a heterogeneous firm model, where firms decide whether to serve a foreign market via exports or FDI. They show that MNEs always pay lower wages than exporters. O'Farrell (2012) and Clougherty, Gugler, and Sørgard (2011) add possible spill-over effects to the bargaining advantage of MNEs. These may have a positive effect on MNEs' wage payments. Ranjan (2010) constructs a Pissarides-style search model of unemployment with collective bargaining to study the impact of offshoring on domestic wages and unemployment. The paper finds that more offshoring is always associated with a decrease in wages. These papers analyze MNEs' wage payments in models in which either firms do not differ in their economic performance or, if they differ, they still pay the same wage across all firms. As empirical studies have shown that wages depend on firms' profitability and since this can change the results of the models described above, we analyze MNEs' repercussions on the labor market in a model with firm-specific wages.

Second, this chapter is related to other papers in which firm-specific wages are derived. Egger and Kreickemeier (2012a) use the fair wage approach to show that wages depend on the firm's economic performance and exporters pay higher wages than purely domestic firms. Another paper that uses the fair wage approach is the one by Amiti and Davis (2012) who also analyze exporters' wage setting behavior. Davis and Harrigan (2011) adopt an efficiency wage model to heterogeneous firms in international trade to include firm-specific wages. Sethupathy (2010) uses the Melitz and Ottaviano (2008) demand function in a heterogeneous firm model with individual bargaining. Then, wages also depend on firm profits. Furthermore, Kaas and Kircher (2011) use directed search with convex vacancy costs to derive that more productive firms pay higher wages. Finally, Helpman, Itskhoki, and Redding (2010) also derive firm-specific wages in a heterogeneous firm model with heterogeneous workers and firms which differ in their screening ability. All of these models do not consider union wage bargaining, the bargaining advantage of MNEs or MNEs as such, focusing on exporters instead. Therefore, we develop a heterogeneous firm model that derives firm-specific wages and contains the bargaining advantage of MNEs. The model is analytically well tractable and can explain the inconclusive evidence on MNE wage premia.

The only other study analyzing MNEs in a framework with firm-specific wages is Egger and Kreickemeier (2012b). In their model, MNEs pay higher wages than purely domestic firms as they are more productive (composition effect) and exhibit cross-border profit sharing (firm level wage effect). However, Egger and Kreickemeier (2012b) do not consider union wage bargaining. In our model, MNEs also have a bargaining advantage in the collective bargaining process in addition to the composition and the firm level wage effect. Hence, there must not be an MNE wage premium. Furthermore, instead of comparing MNEs to purely domestic firms, we compare MNEs and exporters because domestically owned firms with a similar productivity as an MNE are most likely active as exporters.

The remainder of the chapter is structured as follows. Section 3.2 gives an overview of the empirical evidence on MNEs' repercussions on the labor market. Section 3.3 explains the model in the closed economy and gives first results. In section 3.4, we analyze the open economy where the exporters' wage, the MNEs' wage and the unemployment rate are derived. We evaluate and summarize the explanatory power of the fair wage approach in section 3.5. Finally, section 3.6 concludes.

3.2 Empirical Evidence on MNEs' Repercussions on the Labor Market

There exists a growing body of literature that empirically analyzes MNEs' repercussions on the labor market, especially on wages. The studies have found inconclusive evidence as to whether an MNE wage premium exists. Several studies find that foreign ownership leads to higher wages using industry-level or cross-section plant-level data (see Aitken, Harrison, and Lipsey, 1996; Feliciano and Lipsey, 2006; Lipsey and Sjöholm, 2004). These datasets, however, do not allow to examine whether these findings are due to unobservable differences between domestically and foreign-owned plants or whether ownership status itself influences wages.

Therefore, several other studies use establishment-level panel data. Almeida (2007) and Andrews, Bellmann, Schank, and Upward (2009) find that for Portugal and Germany most of the MNE wage premium can be explained by foreigners cherry-picking domestic firms. The firms that are most profitable and pay the highest wages are acquired by foreign firms whereas the less productive firms remain domestically owned. For the United Kingdom, Conyon, Girma, Thompson, and Wright (2002) find that firms acquired by foreign companies pay on average 3.4% higher wages than domestic firms. However, controlling for productivity the foreign wage premium disappears. Also using UK data, Girma and Görg (2007) find that the wage payments depend on the nationality of the foreign acquirer. Skilled workers experience an increase in wages following an acquisition by a US firm, while no such effect is found for other nationalities.

Also controlling for firm and worker characteristics, Heyman, Sjöholm, and Tingvall (2007) estimate that the individual worker's wage level is 2 to 6% higher in MNEs using matched employer-employee data on the entire Swedish private sector. Similarly, Huttunen (2007) reports evidence for an MNE wage premium using panel data on Finnish establishments. For China, Chen, Ge, and Lai (2011) find a significant foreign premium both in wage and non-wage compensation.

Most of these studies do not explicitly compare MNE to exporter wages but rather wages paid by foreign and domestically owned firms, where the latter may serve only the domestic market or the domestic and the foreign market. To the best of our knowledge, there is only one study which explicitly analyzes the difference between MNE and exporter wages (Villarreal and Sakamoto, 2011). Using data on Mexican firms, the authors find that foreign-owned and export-oriented firms pay considerably more than domestically owned firms engaged in the production of goods for sale in the domestic market. This premium is found to be larger for MNEs than for exporters.

Additionally, there are studies on the role of MNEs in wage bargaining. Using Danish matched employer-employee data, Braun (2008) finds a foreign wage premium, but this premium goes to zero in highly unionized firms. Similarly, Choi (2001) and Braun and Scheffel (2007) find that the positive effect of plant level unionization on wages vanishes in foreign-owned firms. Clougherty, Gugler, and Sørgard (2011) report for the US that higher unionization rates make it more likely that cross-border mergers generate wage decreases. Moreover, outward cross-border mergers are more likely to involve wage decreases than inward cross-border mergers where positive spill-over effects may dominate.

To summarize, the empirical findings on the repercussions of MNEs on wages are diverse. In unionized sectors, MNEs are found to pay lower wages. Overall, there is evidence that MNEs pay higher wages than purely domestic firms or exporters. However, the evidence on a residual MNE wage premium, i.e., firms with MNE status pay higher wages for the same worker than firms with exporter status, is inconclusive.

3.3 Closed Economy

3.3.1 Model Setup

The general setup of the model is based on Eckel and Egger (2009). Consider an economy with two types of sectors, a homogeneous good sector Y and a horizontally differentiated goods sector x. The representative consumer has the following Cobb-Douglas preferences

$$U = X^{\alpha} Y^{1-\alpha}, \quad 0 < \alpha < 1 \tag{3.1}$$

where

$$X \equiv \left[\int_{v \in V} x(v)^{\frac{\epsilon-1}{\epsilon}} dv \right]^{\frac{\epsilon}{\epsilon-1}}. \tag{3.2}$$

V is the set of available varieties v of good x. ϵ is the elasticity of substitution between the varieties of the differentiated good x, and $\epsilon > 1$.

Demand for variety v can be derived by utility maximization such that

$$x(v) = \frac{\alpha E}{P} p(v)^{-\epsilon}, \tag{3.3}$$

where E are total consumption expenditures, which are equal to total income in the economy as we consider a general equilibrium. The price index P is defined as

$$P \equiv \int_{v \in V} p(v)^{1-\epsilon} dv.$$

Regarding the production side, the horizontally differentiated goods x are sold in a monopolistically competitive market. Firms in the differentiated goods sector need both capital and labor as inputs. Capital is inelastically supplied at level K in a perfectly competitive factor market. Labor is supplied at level L, where wages are negotiated between firms and labor unions. Firms face fixed costs f, paid in units of capital, to set up a production plant. In order to produce, firms have to employ labor. Output x is linear in labor input l with $x = \phi l$, where ϕ is the firm-specific productivity level (see Melitz, 2003). The homogeneous good Y is sold in a perfectly competitive market. Production requires the input of capital, where the production function $Y = K_Y$ is assumed (see Eckel and Egger, 2009). Good Y is taken as the numeraire which implies that the price of good Y and the factor price of capital are equal to one.

3.3.2 The Bargaining Game

Wages in the differentiated goods sector are negotiated at the firm level, where union activities are restricted to a single producer.[2] The bargaining game between the firm and the union involves three stages:

1. Firms decide upon entry which involves the investment of f units of capital to set up a production plant.
2. The firm and the union bargain about wages.
3. Firms choose employment, produce, and sell their goods in a monopolistically competitive market.

Note that *right-to-manage bargaining* instead of *efficient bargaining* is assumed (see also Eckel and Egger, 2009; Sethupathy, 2010). This means that firms and unions bargain about wages but the firm chooses its optimal employment level given the negotiated wage. In contrast, in *efficient bargaining* models firms and unions bargain about wages and employment. As most unions primarily focus on wages and are often blamed to consider employment insufficiently in their negotiations, the *right-to-manage approach* can be considered as the more realistic one. Moreover, empirical support for the *efficient bargaining* approach is weak at best (see Cahuc and Zylberberg, 2004). The game is solved via backward induction.

[2] One could, for example, think of the union as a work council.

Stage 3

In the differentiated goods sector, according to the monopolistic competition assumption each firm produces its own variety and takes aggregate variables as given. First, take the case that an agreement in the wage bargain of stage 2 is reached. Then, each firm hires workers until the marginal revenue product of labor equals the wage rate. Profit maximization yields that each firm charges a price including a constant markup over its marginal production costs $\frac{w(\phi)}{\phi}$ with $w(\phi)$ as the wage per worker

$$p(\phi) = \frac{\epsilon w(\phi)}{(\epsilon - 1)\phi}, \tag{3.4}$$

where $\frac{\epsilon}{\epsilon-1}$ is the constant markup over marginal costs, which depends on the elasticity of substitution ϵ. Hence, the lower is the degree of substitution, the higher is the markup charged by each firm. Firm revenues and profits are

$$r(\phi) = \frac{\alpha E}{P} p(\phi)^{1-\epsilon}, \quad \pi(\phi) = \frac{\alpha E}{\epsilon P} p(\phi)^{1-\epsilon} - f. \tag{3.5}$$

Second, if no agreement in the wage bargain of stage 2 is reached, firms' profits are $\bar{\pi} = -f$, as the firms' investment costs f are sunk and no production takes place.

Stage 2

Workers are assumed to have fair wage concerns which implies that they want to capture a share of their employer's economic success. The worker's utility from working is

$$U_w = w(\phi) - \hat{w}(\phi), \tag{3.6}$$

where $\hat{w}$ is a fair wage function taken from Egger and Kreickemeier (2012a):

$$\hat{w}(\phi) = (\pi(\phi) + f)^{\theta} \left[(1 - u)\tilde{w}\right]^{1-\theta}. \tag{3.7}$$

Remember that $\pi(\phi)$ are firm profits. Hence, $\pi(\phi) + f$ are the firms operational profits. u stands for the unemployment rate and $\tilde{w}$ is the average wage of employed workers. $\theta \in [0, 1]$ can be interpreted as a rent sharing parameter. Thus, the fair wage is a weighted average of two factors: a firm-internal component and a firm-external component. This takes into account two empirical facts found in the literature on worker behavior (see Howitt, 2002; Bewley, 2005). First, workers want to capture a share of the firm's economic performance - the firm-internal component, which is included in the first term of (3.7). For the firm-internal component, we follow Egger and Kreickemeier (2012a) by using the firm's operational profits. The costs of building up a production plant f should be considered as sunk from the workers' perspective.[3] Second, workers compare their wage payments to those paid by other firms - the firm-external component, which is reflected in the second term of (3.7). The firm-external component is captured by the average wage income per worker which equals the average wage of employed workers multiplied by the employment rate $(1 - u)$. The higher the rent sharing parameter θ, the more the fair wage depends on the firm's operational profits. Egger, Egger, and Kreickemeier (2011) report estimates of the rent sharing parameter of about 0.1 for France, Croatia, Serbia, and Slovenia. The worker's utility function implies that a worker is willing to work only if the wage paid exceeds the wage he just considers as fair, which is firm-specific.

In order to derive union preferences a utilitarian approach where the union aims at maximizing the sum of its members' utilities is used (see Booth, 1995). Hence, union preferences are given by

$$W(\phi) = l(\phi)\left[w(\phi) - \hat{w}(\phi)\right] \tag{3.8}$$

where $l(\phi)$ is the firm's employment level. Aggregating union members' utilities leads to the inclusion of the employment level into the union's utility function (see also Eckel and Egger, 2009). This may seem to disregard the insider-outsider problem which implies that unions often do not consider the employment level but only care about the wages and

[3] Amiti and Davis (2012) use total profits. Using total profits would not change the main results qualitatively, but it complicates the analytical tractability.

working conditions of their employed members (Lindbeck and Snower, 1988). However, using the same utility function without multiplying a single worker's utility by the overall employment leads to qualitatively similar results.[4]

In case of disagreement, the firm does not employ any workers. Hence, the union's utility is zero, $\bar{W} = 0$. This implies that the union is not able to start negotiations with another firm in case of disagreement in the same time period. The firm's profit is $\bar{\pi} = -f$ in case of disagreement. Similar to the union, the firm cannot negotiate with another union in case of disagreement.

The Nash product is given by

$$\Omega = \left\{ W(\phi) - \bar{W} \right\}^{\gamma} \left\{ \pi(\phi) - \bar{\pi} \right\}^{1-\gamma} . \tag{3.9}$$

γ can be interpreted as the union's bargaining power and $(1-\gamma)$ is the firm's bargaining power, where $\gamma \in [0,1]$. Maximizing (3.9) subject to (3.4) and (3.5) as well as the usual non-negativity constraints yields the solution to the firm-union bargaining problem. The bargained wage is given by

$$w(\phi) = \left\{ \frac{\epsilon + \gamma - 1 + \gamma\theta(\epsilon - 1)}{(\epsilon - 1)} \left[\frac{\alpha E}{\epsilon P} \left(\frac{(\epsilon - 1)\phi}{\epsilon} \right)^{\epsilon - 1} \right]^{\theta} \left[(1-u)\tilde{w} \right]^{1-\theta} \right\}^{\frac{1}{1+\theta(\epsilon-1)}} . \tag{3.10}$$

Note that the wage is firm-specific.[5] The wage depends on the firm-specific productivity level (ϕ) and the rent sharing parameter (θ) which can be seen as country- or union-specific. Due to monopolistic competition, the individual firm takes the aggregate income (E), the price index (P), the unemployment rate (u) and the average wage ($\tilde{w}$) as given.

[4]The unemployment level does not necessarily increase leaving out the employment level. If the elasticity of substitution is high and the bargaining power of unions is low, the unemployment rate can even be lower compared to a situation in which employment is included into the union's utility function.

[5]This is in contrast to most other studies using CES preferences (see Eckel and Egger, 2009; Helpman and Itskhoki, 2010). Helpman, Itskhoki, and Redding (2010) also have firm-specific wages. These, however, differ due to the firm's ability to screen workers and more productive firms are able to employ more able workers. Hence, firms do not vary in the residual wage payments. Conversely, this model assumes homogeneous workers and can thus provide an explanation for different residual wages. For Mexican exporting firms, Frias, Kaplan, and Verhoogen (2012) find rent sharing rather than compositional effects of the firm-specific workforce to be an important determinant of wage differences across firms.

Proposition 1 *The wage increases with*

- *the firm's productivity,* $\partial w/\partial\phi > 0$*,*
- *the union's bargaining power,* $\partial w/\partial\gamma > 0$*,*
- *a higher average wage paid outside the firm,* $\partial w/\partial\tilde{w} > 0$*,*
- *total income,* $\partial w/\partial E > 0$*,*
- *the constant share spent on the differentiated good sector,* $\partial w/\partial\alpha > 0$*.*

The wage decreases with

- *the unemployment rate,* $\partial w/\partial u < 0$*.*

The wage may increase or decrease with

- *the rent sharing parameter,* $\partial w/\partial\theta \lesseqgtr 0$*. The higher the firm's productivity level compared to the average productivity, the more likely the wage is to increase with the rent sharing parameter.*

Proof. See Appendix C.1. ■

The fact that the wage increases with the firm's productivity level is due to the fair wage assumption. Hence, the model is able to explain the empirical evidence on rent sharing (see Goos and Konings, 2001). Furthermore, the wage increases with the union's bargaining power (γ) as the union's utility gets a bigger weight in the Nash product and the union can, thus, make higher wage claims. The wage increases with a lower unemployment rate (u) and a higher average wage paid outside the firm ($\tilde{w}$). This also increases the union's bargaining power due to an improved outside option. Finally, the wage also increases if the total income (E) or the constant share spent on the differentiated goods sector (α) is higher. More income or a higher share of income spent on the differentiated goods sector leads to higher revenues, which will induce higher wages as these are related to the operational profits.

An increase in the rent sharing parameter may lead to an increase or a decrease in the wage. This is the case since within the fair wage more weight is put on the firm-internal component. Therefore, the wage is more aligned with the firm's operational profits. Whether this raises or lowers the wage depends on the firm's productivity. For firms with a productivity level below the average, $\phi < \tilde{\phi}$, the wage may decrease as more weight is put on the firm's profits which are also below average. Hence, putting less weight on the firm-internal component and more weight on the average wage of employed workers would be more beneficial for workers in firms with low productivity levels. Whereas workers in high productivity firms can increase their wages by demanding more rent sharing.

Stage 1

There is a mass N of potential entrants into the differentiated goods sector, whose productivities are distributed according to the cumulative distribution function $G(\phi)$ with density $g(\phi)$ (following Do and Levchenko, 2009). As in Eckel and Egger (2009), we assume firms' productivities to be drawn from a Pareto distribution:

$$G(\phi) = 1 - \phi^{-k}, \quad g(\phi) = k\phi^{-(k+1)}.$$

This assumption has been shown to be plausible for different size and productivity measures of firms in reality (see Axtell, 2001).

In order to enter, firms must make an investment of $f > 0$ units of capital. Only those firms with a sufficiently high productivity level will enter the market (see Melitz, 2003). This cutoff productivity level will be termed ϕ^*. It can be derived from the zero profit condition, $\pi(\phi^*) = 0$.

3.3.3 Aggregation

As in all heterogeneous firm models following Melitz (2003), aggregate product market variables can be characterized by looking at the firm with the average productivity level

$\tilde{\phi}$. To calculate $\tilde{\phi}$, recall that

$$P = \int_0^\infty p(\phi)^{1-\epsilon} M \frac{g(\phi)}{1 - G(\phi^*)} d\phi.$$

Including $\frac{p(\tilde{\phi})}{p(\phi)} = \left(\frac{\tilde{\phi}}{\phi}\right)^{\frac{1}{\theta(\epsilon-1)-1}}$ and using $P = Mp(\tilde{\phi})^{1-\epsilon}$ yields

$$\tilde{\phi} = \left[\frac{k}{k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}}\right]^{\frac{1+\theta(\epsilon-1)}{\epsilon-1}} \phi^*. \tag{3.11}$$

Hence, the average productivity is a function of the cutoff productivity level (ϕ^*) and depends on the shape parameter of the Pareto distribution (k), the preference parameter (ϵ), and the rent sharing parameter (θ). For a positive and finite value of $\tilde{\phi}$, it must hold that $k > \frac{\epsilon-1}{1+\theta(\epsilon-1)}$ given that $\phi^* \geq 1$.

Using $\tilde{\phi}(\phi^*)$, $r(\phi^*) = \epsilon f$, $p(\phi) = \frac{\epsilon w(\phi)}{(\epsilon-1)\phi}$, $r(\phi) = \frac{\alpha E}{P} p(\phi)^{1-\epsilon}$, and $\pi(\phi) = \frac{\alpha E}{\epsilon P} p(\phi)^{1-\epsilon} - f$, average revenues can be calculated as

$$r(\tilde{\phi}) = \frac{k\epsilon f}{k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}}. \tag{3.12}$$

Furthermore, the mass of competitors can be derived using the capital market clearing condition, $K = Y + Mf$, and the implication of the Cobb-Douglas preferences, $Y = (1-\alpha)E$, i.e., consumers spend a constant share $(1-\alpha)$ of their income (E) on the consumption of the homogeneous good (Y). The mass of competitors is given by

$$M = \frac{K}{f} \frac{\alpha\left(k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)}{(1-\alpha)k\epsilon + \alpha\left(k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)}. \tag{3.13}$$

The cutoff productivity level can be determined by $M = (1 - G(\phi^*))N$ and (3.13).[6]

The mass of competitors M, the average productivity level $\tilde{\phi}$, and the cutoff productivity level ϕ^* are independent of the strength of unions in the Nash bargaining. However, they depend on the rent sharing parameter θ. The higher the rent sharing parameter, the larger

[6]See Appendix C.1 for the exact expression of ϕ^*.

the number of successful entrants. As more productive firms have to pay higher wages, less productive firms can also enter the market compared to a situation without rent sharing. This can also be seen from the fact that the cutoff productivity level decreases with the rent sharing parameter θ, $\frac{\partial \phi^*}{\partial \theta} < 0$.

Proposition 2 *The productivity cutoff for successful entry, ϕ^*, decreases with the rent sharing preference of unions, θ. Consequently, the mass of successful entrants, M, increases.*

Proof. See Appendix C.1. ■

The labor income per worker in terms of the numeraire good can be determined using $l(\phi)w(\phi) = \frac{\epsilon-1}{\epsilon} r(\phi)$ and $L\bar{w} = Mr(\tilde{\phi})\frac{\epsilon-1}{\epsilon}$. Thus,

$$\bar{w} = (1-u)\tilde{w} = \frac{M}{L} \frac{kf(\epsilon-1)}{k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}}. \tag{3.14}$$

From this one can derive the unemployment rate. We know that $\bar{w} = (1-u)\tilde{w}$, where $\tilde{w}$ is the average wage of employed workers. The average wage paid equals the wage paid by the firm with the average productivity, $\tilde{w} = w(\tilde{\phi})$. Thus, the unemployment rate is given by

$$u = 1 - \left\{ \frac{M}{L} \frac{kf(\epsilon-1)}{k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}} \right\}^{\frac{\theta\epsilon}{1+\theta(\epsilon-1)}} \left\{ \frac{\epsilon+\gamma-1+\theta\gamma(\epsilon-1)}{\epsilon-1} \left(\frac{\alpha E}{\epsilon P}\right)^{\theta} \left(\frac{(\epsilon-1)\tilde{\phi}}{\epsilon}\right)^{\theta(\epsilon-1)} \right\}^{\frac{1}{\theta(1-\epsilon)-1}}. \tag{3.15}$$

Proposition 3 *The unemployment rate increases with*

- *the union's bargaining power, $\frac{\partial u}{\partial \gamma} > 0$.*
- *the average productivity, $\frac{\partial u}{\partial \tilde{\phi}} > 0$.*
- *the union's preference for rent sharing, $\frac{\partial u}{\partial \theta} > 0$, if the operational profits of the average firm are larger than the average wage of employed workers. Otherwise, the unemployment rate decreases.*

The unemployment rate decreases with

- *the number of successful entrants,* $\frac{\partial u}{\partial M} < 0$.

Proof. See Appendix C.1. ■

The unemployment rate increases with an increase in the union's bargaining power (γ). Thus, stronger unions lead to higher unemployment. This is the case despite the fact that the employment level is included in the union's utility function. A union always faces the trade-off between higher wage claims for the employed members or more employment. This is consistent with the observation that stronger unions make higher wage claims, which leads to a reduction in employment. The unemployment rate increases with average productivity ($\tilde{\phi}$). The more productive firms are on average, the higher are the wages paid. As the aggregate income (E) is constant, firms will decrease employment. The higher the rent sharing parameter (θ), the higher the unemployment rate if the wage of the average firm increases when the union puts more weight on the firm-internal component. In this case, the average wage increases and employment decreases. Finally, the more firms are able to enter the market successfully (M), the lower the unemployment rate.[7]

3.4 Open Economy

In the open economy, there are two symmetric countries. The two factors of production, capital and labor, are internationally immobile. For the homogeneous good, there are no barriers to trade. In the heterogeneous goods sector, firms have to incur iceberg-type trade costs in order to serve the foreign market via exports. This means that $\tau > 1$ units of the differentiated goods have to be shipped for one unit to arrive. Alternatively, the foreign market can be served via a foreign affiliate. Setting up a foreign production facility involves the investment of $f_m > 0$ units of capital in the host country. Thus, there exists a proximity-concentration trade-off (Brainard, 1997): an exporter bears higher variable

[7]Note that for interpretation purposes the endogenous values M and $\tilde{\phi}$ are not inserted. For the unemployment rate u depending only on exogenous variables please refer to Appendix C.1.

costs but lower fixed costs compared to an MNE.[8] Hence, we analyze the export versus horizontal FDI decision.

3.4.1 The Bargaining Game in the Open Economy

A multinational firm negotiates with two independent unions at the plant level.[9] The bargaining game involves the following stages:

1. Firms decide upon their investment at home (f) and abroad (f_m), determining whether they are an exporter or an MNE.
2. All plant-union bargaining pairs simultaneously negotiate on wages.
3. Firms decide upon employment, produce, and sell their goods in monopolistically competitive markets at home and abroad.

Hence, firms decide on how they want to serve foreign markets before wages are negotiated. Their investment decisions are not driven by differences in factor costs. Note that countries are symmetric, hence, the average wage level does not differ. Therefore, the export versus horizontal FDI decision is driven by the classical proximity-concentration trade-off and its implications on wage bargaining (see Eckel and Egger, 2009, for the same timing of the bargaining game). The game is solved via backward induction.

Stage 3

Let us first consider the case of exporters. Exporters charge higher prices in the foreign market because of higher marginal costs of serving foreign consumers, $p_n^F = \tau p_n(\phi)$. The superscript F indicates foreign market variables in the following. Due to the assumption

[8]Note that there are no additional fixed costs of exporting assumed. This implies that there are no purely domestic firms in the open economy.

[9]Unions are assumed not to cooperate internationally. Eckel and Egger (2012) analyze when it is beneficial for unions to cooperate internationally. This is only the case if unions' preferences are well aligned.

of symmetric markets, total employment and profits of an exporter with productivity level (ϕ) are given by $l_n^t(\phi) = (1+\tau^{1-\epsilon})l_n(\phi)$ and $\pi_n^t(\phi) = (1+\tau^{1-\epsilon})\frac{r_n(\phi)}{\epsilon} - f$, if an agreement with the domestic union is reached. If no agreement is reached, profits equal $\bar{\pi}_n = -f$.

Consider then the case of MNEs. The MNE produces at home and abroad if an agreement in both Nash bargains with the domestic and the foreign union is reached. Total employment is then given by $l_m^t(\phi) = l_m(\phi) + l_m^F(\phi)$, with $l_m(\phi) \neq l_m^F(\phi)$, if $w_m(\phi) \neq w_m^F(\phi)$. Total profits are given by $\pi_m^t(\phi) = \frac{r_m(\phi)}{\epsilon} + \frac{r_m^F(\phi)}{\epsilon} - f - f_m$. If no agreement with the domestic union is reached, total profits equal $\bar{\pi}_m^F(\phi) = (1+\tau^{1-\epsilon})\frac{r_m^F(\phi)}{\epsilon} - f - f_m$. The MNE has a better bargaining position due to a higher outside option compared to the exporter. It can threaten the domestic union to move total production to the foreign plant in case of disagreement at home and then export to the home country. Vice versa, if no agreement with the foreign union is reached, total profits are $\bar{\pi}_m(\phi) = (1+\tau^{1-\epsilon})\frac{r_m(\phi)}{\epsilon} - f - f_m$. If neither an agreement with the domestic union nor with the foreign union is reached, total profits are $\bar{\pi}_m^{NA}(\phi) = -f - f_m$. We follow Eckel and Egger (2009) in the determination of the disagreement profits. The assumption under which the disagreement profits of the MNE are derived is that any firm-union or rather plant-union pair takes the negotiated wage in the other country as given, just accounting for adjustments in the output level if an agreement is not reached. This assumption is also key to solving the two plant-union bargaining problem with interdependent payoff functions following Davidson (1988) and Horn and Wolinsky (1988).

Stage 2

Exporter-union wage bargaining Compared to the wage in the autarky situation the exporter wage in the open economy only differs with respect to the firm-internal component as exporter profits are larger than profits of a purely domestic firm:

$$w_n(\phi) = \left\{ \frac{\epsilon + \gamma - 1 + \gamma\theta(\epsilon-1)}{(\epsilon-1)} \left[\frac{\alpha E}{\epsilon P} \left(\frac{(\epsilon-1)\phi}{\epsilon} \right)^{\epsilon-1} (1+\tau^{1-\epsilon}) \right]^{\theta} [(1-u)\tilde{w}]^{1-\theta} \right\}^{\frac{1}{1+\theta(\epsilon-1)}}. \tag{3.16}$$

Thus, the exporter wage is higher than the wage paid by purely domestic firms, $w_n(\phi) > w(\phi)$ as $\tau^{1-\epsilon} > 0$.

MNE-domestic union wage bargaining The MNE negotiates with the domestic and the foreign union symmetrically and simultaneously. Although the general bargaining problem is quite complex, Davidson (1988) and Horn and Wolinsky (1988) have shown for similar bargaining problems that the solution is a pair of wages w_m and w_m^F such that w_m is the Nash solution to the bargaining problem between the MNE and the domestic union, given that both anticipate correctly that the foreign wage will be w_m^F.[10] Due to symmetry, it is admissible to focus on the MNE bargaining with the domestic union. For the MNE case, the Nash product differs from the autarky case with respect to the firms' profits in case of agreement and in case of disagreement. Although the union negotiates only with the domestic plant, total MNE's profits are included. This acknowledges the empirical evidence on profit sharing of workers within an MNE, e.g., a greater profitability of parent companies raises wages in foreign affiliates (see Budd, Konings, and Slaughter, 2005; Villarreal and Sakamoto, 2011; Martins and Yang, 2010). The Nash product is given by:

$$\Omega_m = \left\{W(\phi) - \bar{W}\right\}^{\gamma} \left\{\pi_m^t(\phi) - \bar{\pi}_m^F(\phi)\right\}^{1-\gamma}, \tag{3.17}$$

where the plant-union bargaining pair under consideration takes the bargaining outcome in the other country, i.e., $w_m^F(\phi)$, as given. The Nash product in (3.17) is maximized such that $l_m(\phi) = \frac{x_m(\phi)}{\phi}$, $x(v) = \frac{\alpha E}{P} p(v)^{-\epsilon}$, $p(\phi) = \frac{\epsilon w(\phi)}{(\epsilon-1)\phi}$, $r(\phi) = \frac{\alpha E}{P} p(\phi)^{1-\epsilon}$ and $\pi(\phi) = \frac{\alpha E}{\epsilon P} p(\phi)^{1-\epsilon} - f$ as well as the usual non-negativity constraints hold. Taking the symmetry assumption regarding the two countries into account, i.e., using $w_m(\phi) = w_m^F(\phi)$ in the first-order condition, the maximization yields

$$w_m(\phi) = \left\{ \frac{\epsilon - 1 + \gamma(1 - \epsilon\tau^{1-\epsilon}) + \gamma\theta(1 - \tau^{1-\epsilon})(\epsilon - 1)}{(\epsilon - 1)(1 - \gamma\tau^{1-\epsilon})} \left[2\frac{\alpha E}{\epsilon P} \left(\frac{(\epsilon-1)\phi}{\epsilon} \right)^{\epsilon-1} \right]^{\theta} \left[(1-u)\tilde{w}\right]^{1-\theta} \right\}^{\frac{1}{1+\theta(\epsilon-1)}}. \tag{3.18}$$

[10] Davidson (1988) develops a model of labor union bargaining in a homogeneous good industry in which a union negotiates simultaneously with two firms. Horn and Wolinsky (1988) analyze simultaneous bargaining of a supplier with two firms in an oligopolistic market.

The MNE pays the same wage in its home and its foreign plant. In case of asymmetric countries, an MNE would, for example, pay a lower wage in a country with a lower average wage. The exporter's and the MNE's wage both depend on the same parameters.

Note that the wage in (3.18) has been derived assuming that an MNE does not export if an agreement with the union is reached. A natural concern is that unions may foresee that they can expand local production by also serving foreign consumers if they negotiate a sufficiently low wage, $w_m(\phi) < \frac{w_m^F(\phi)}{\tau}$. In order to rule out this incentive for "strategic underbidding" one has to focus on a sufficiently high level of iceberg trade costs. If $w_m^F(\phi) < \tau\hat{w}(\phi)$, the union has no incentive to deviate from the wage determined in (3.18) (see Eckel and Egger, 2009, for a similar line of reasoning).

Stage 1

In the open economy, the firm has to decide whether to enter and, once having entered, how to serve the foreign market. In addition to the proximity-concentration trade-off, firms also consider the difference between exporter and MNE wages (ω), when they decide upon exporting or conducting FDI:

$$\frac{w_n(\phi)}{w_m(\phi)} = \left\{ \frac{(\epsilon + \gamma - 1 + \gamma\theta(\epsilon - 1))(1 - \gamma\tau^{1-\epsilon})(1 + \tau^{1-\epsilon})^{\theta}}{(\epsilon + \gamma - 1 - \gamma\epsilon\tau^{1-\epsilon} + \gamma\theta(1 - \tau^{1-\epsilon})(\epsilon - 1))2^{\theta}} \right\}^{\frac{1}{1+\theta(\epsilon-1)}} \equiv \omega.$$

Thus, more firms may choose to become an MNE, if exporters pay higher wages than MNEs, as due to the lower wage, firms with a lower productivity can also afford the fixed costs of building up a foreign plant, f_m. Yet, firms above a certain productivity threshold generally yield higher profits by becoming MNEs than by exporting. Due to rent sharing, MNEs may also pay higher wages than exporters. The exporter-MNE wage differential will be discussed in the following section.

In order to derive the cutoff productivity level for successful entry in the open economy, $\pi_n^t(\phi_t^*) = 0$ is used. To enter the market, a firm has to have a productivity level $\phi \geq \phi_t^*$.[11]

[11] See Appendix C.2 for the derivation of the cutoff productivity level.

For the decision between exporting and FDI, the difference between the profits as an MNE and as an exporter, $\Delta\pi^t(\phi) = \pi^t_m(\phi) - \pi^t_n(\phi)$, matters:

$$\Delta\pi^t(\phi) = \left(2\omega^{1-\epsilon} - (1+\tau^{1-\epsilon})\right)\frac{r_n(\phi)}{\epsilon} - f_m.$$

To guarantee that not every firm has an incentive to invest abroad, $\Delta\pi^t(\phi^*_t) < 0$ has to be assumed, i.e., the marginal producer making just zero profits from exporting has no incentive to invest abroad. This is equivalent to assuming a sufficiently high f_m for selection into exporting and FDI still to exist for any γ and θ:

$$f_m > \left[\frac{2\omega^{\epsilon-1}}{1+\tau^{1-\epsilon}} - 1\right] f, \tag{3.19}$$

which implies that MNEs are on average more productive than exporters (see Helpman, Melitz, and Yeaple, 2004, for the same sorting pattern). Thus, we can also derive the cutoff productivity level of an MNE, ϕ^*_m.[12]

The fact that a firm may pay higher wages as an MNE than as an exporter influences the decision how to serve the foreign market. The share of MNEs can be determined by $\mu = \left(\frac{\phi^*_m}{\phi^*_t}\right)^{-k}$:

$$\mu = \left[\frac{f}{f_m}\left(\frac{2\omega^{\epsilon-1}}{1+\tau^{1-\epsilon}} - 1\right)\right]^{k\left(\frac{1+\theta(\epsilon-1)}{\epsilon-1}\right)}. \tag{3.20}$$

The share of MNEs not only depends on the bargaining power parameter (γ), which is included in the wage differential (ω), but also on the rent sharing parameter (θ). The share of MNEs reaches its maximum for a medium level of union bargaining power. This follows from the changes in the exporter MNE wage differential due to changes in the union's bargaining power. This will be explained in detail below. Furthermore, the share of MNEs increases the higher the exporter wages are relative to MNE wages. In addition, the higher the freeness of trade, i.e., the lower iceberg trade costs, the lower the share of MNEs due to the proximity-concentration trade-off for given relative wages

[12] See Appendix C.2 for the derivation.

(ω). However, as τ also influences ω the effect is not clear (see Eckel and Egger, 2009, for the same finding). A reduction in τ may also lead to an increase in the share of MNEs as their fallback profits in case of disagreement with the union increase because of the reduced transportation costs. Therefore, MNEs may be able to negotiate relatively lower wages, which induces an increase in the relative wage (ω).

3.4.2 Is There an MNE Wage Premium?

The model shows that there is no unambiguous MNE wage premium, it rather depends on a country's institutional environment, e.g., the strength of unions and their willingness to partake in firm profits. Comparing exporter and MNE wages, ω can be smaller or larger than 1 (see Appendix C.2 for the proof):

$$\omega \equiv \frac{w_n(\phi)}{w_m(\phi)} = \left\{ \frac{(\epsilon+\gamma-1+\gamma\theta(\epsilon-1))(1-\gamma\tau^{1-\epsilon})(1+\tau^{1-\epsilon})^{\theta}}{(\epsilon+\gamma-1-\gamma\epsilon\tau^{1-\epsilon}+\gamma\theta(1-\tau^{1-\epsilon})(\epsilon-1))2^{\theta}} \right\}^{\frac{1}{1+\theta(\epsilon-1)}} \lesseqgtr 1.$$

If $\gamma = 0$ or $\gamma = 1$, $\omega < 1$ for $\theta > 0$. This implies that if the union has no bargaining power or if there is a monopoly union, MNEs' wages are always higher than exporters' wages. The intuition is clear: if either the firm or the union has full bargaining power, there is no bargaining advantage of becoming an MNE.

In order to see further how ω changes with the union's bargaining power, we use $\frac{\partial \omega}{\partial \gamma} = 0$ to obtain an implicit solution for γ where ω is maximized. Exporters pay higher wages than MNEs for medium levels of bargaining power of unions. On the one hand, a higher γ leads to higher wage claims for both exporters and MNEs. But as MNEs have a higher disagreement profit than exporters, they pay lower wages than exporters. Thus, the exporter MNE wage differential ω tends to go up with an increase in γ. On the other hand, an increase in the bargaining power of unions lowers the weight of a firm's contribution to the Nash product. Hence, the gap between the disagreement profits of exporters and MNEs becomes less important with an increase in γ. Figure 1 shows how the wage premium changes with the union's bargaining power. Using the implicit function

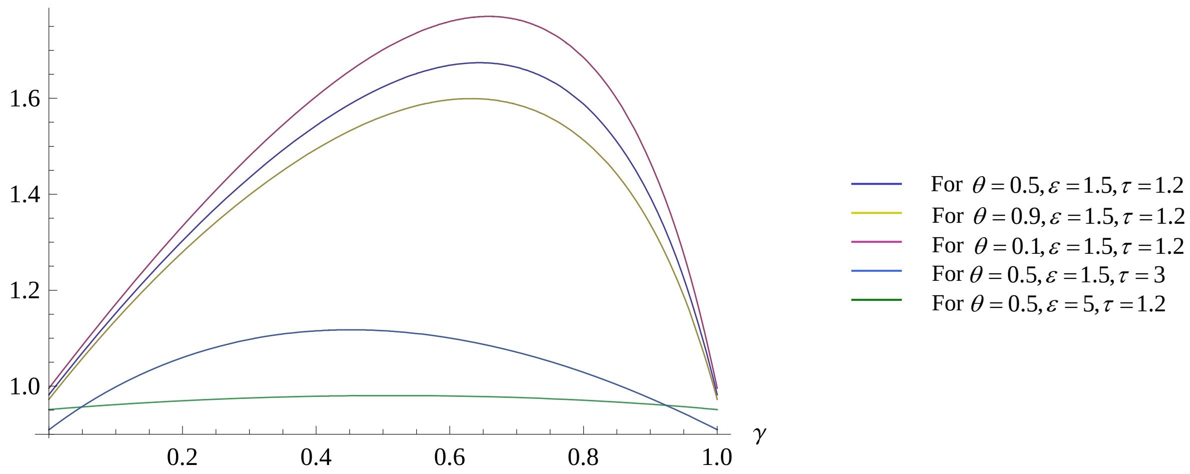

Figure 3.1: How the Wage Premium Changes with the Union's Bargaining Power

theorem, we can show that the optimal γ is decreasing in θ. The more important rent sharing becomes, the larger the union's contribution to the Nash product for an MNE compared to an exporter. Therefore, the bargaining power of the union has to be lower such that an exporter pays higher wages than an MNE.[13]

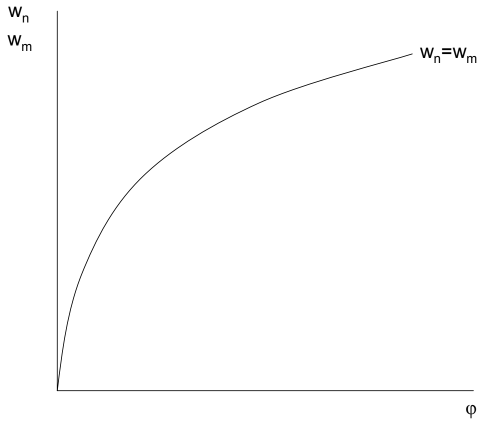

Figure 3.2: Wages as a Function of Productivity if $\omega = 1$

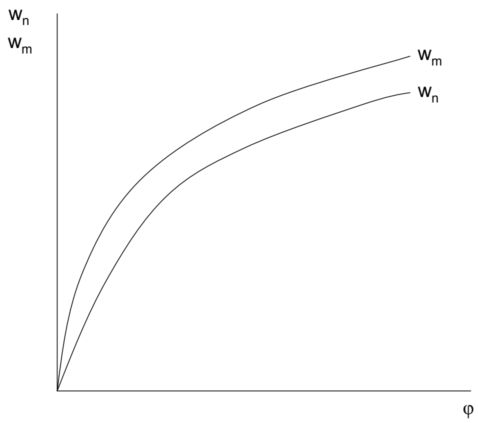

Figure 3.3: Wages as a Function of Productivity if $\omega < 1$

The wage differential is independent of the firm's productivity level. Thus, there is no cutting point. Either the wages are the same for all productivity levels or they are different for all productivity levels as shown in Figure 2 and 3. Both wages are concave functions of productivity, $\frac{\partial w_n}{\partial \phi} > 0$ and $\frac{\partial^2 w_n}{\partial \phi^2} < 0$ as well as $\frac{\partial w_m}{\partial \phi} > 0$ and $\frac{\partial^2 w_m}{\partial \phi^2} < 0$. Whether the

[13]For the detailed derivations see Appendix C.2.

exporter or MNE wage increases more with productivity again depends on the parameter values, γ, ϵ, τ, and θ. Focusing on γ, we can derive a unique $\gamma = \gamma^*$ for which $\omega = 1$ holds. For $\gamma \neq 1$, MNEs can pay higher or lower wages than exporters.[14]

With regard to the rent sharing parameter (θ), both w_n and w_m may increase or decrease in θ. The probability that the wage will increase with the rent sharing parameter rises with the firm's productivity. Whether ω increases or decreases with θ depends on the bargaining power of the union (γ), the competitive situation (ϵ), and the iceberg transport costs (τ). The relation between ω and θ is illustrated in Figure 4. The wage premium

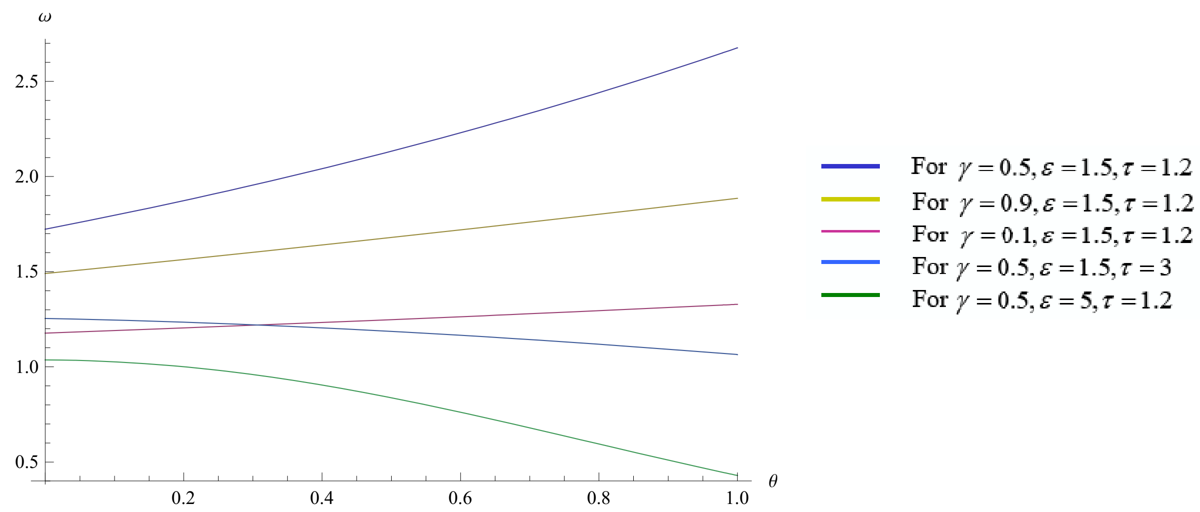

Figure 3.4: How the Wage Premium Changes with the Degree of Rent Sharing

increases with the union's preference for rent sharing, i.e., the weight the union puts on the firm-internal component, if transport costs and the degree of competition are low. This implies that an increase in the rent sharing parameter increases the exporter wage by more than the MNE wage. On the contrary, if the degree of competition is high (high elasticity of substitution) or transport costs are high, the MNE's wage increases by more than the exporter's wage. For example, if transport costs are high, exporters' profits are generally lower and, thus, the increase in rent sharing changes exporter wages less than MNE wages. Similarly, if the degree of competition is high, the markup firms can charge

[14] For the explicit solution of γ^* see Appendix C.2.

is low. Hence, the least productive firms have to exit and market shares increase. As the market shares increase with the productivity level, profits of MNEs increase by more than exporters' profits. Accordingly, the increase in rent sharing changes exporter wages less than MNE wages.

Proposition 4 *MNEs pay higher wages than exporters if unions either have a relatively low or a relatively high bargaining power (γ), if trade costs are high (τ) and if the degree of competition is high (ϵ). The influence of the union's preference for rent sharing on the exporter-MNE wage differential also depends on the union's bargaining power, trade costs, and the degree of competition.*

As empirical studies yield results on average wage premia, we also compare the average wages paid by exporters and by MNEs. The average wage paid by an exporter can be derived by averaging over all the wages paid by firms with a productivity level between ϕ_t^* and ϕ_m^*[15]:

$$\bar{w}_n = (G(\phi_m^*) - G(\phi_t^*)) \int_{\phi_t^*}^{\phi_m^*} w_n(\phi) g(\phi) d\phi. \tag{3.21}$$

The average wage paid by an MNE is the average of all the wages paid by firms with a productivity level larger than ϕ_m^*:

$$\bar{w}_m = (1 - G(\phi_m^*)) \int_{\phi_m^*}^{\infty} w_m(\phi) g(\phi) d\phi. \tag{3.22}$$

Comparing the average wages yields

$$\frac{\bar{w}_n}{\bar{w}_m} = \omega \left[\mu^{\frac{\theta\epsilon}{k(1+\theta(\epsilon-1))}-1} - 1 \right] \left(\frac{1-\mu}{\mu} \right). \tag{3.23}$$

The result for the comparison of the average wages paid by exporters and MNEs is ambiguous. The higher is the share of MNEs, μ, the lower is $\frac{\bar{w}_n}{\bar{w}_m}$. The higher is ω, the higher is $\frac{\bar{w}_n}{\bar{w}_m}$. For $\omega = 1$, i.e., the wage paid by exporters and by MNEs is the same, MNEs pay

[15] See Appendix C.2 for the productivity cutoffs ϕ_t^* and ϕ_m^* depending on exogenous variables only.

on average higher wages as they are more productive.[16]

3.4.3 Aggregation

Again, aggregate product market variables can be characterized by looking at the firm with the average productivity level, $\hat{\phi}$. $\hat{\phi}$ is determined in a way to ensure $P = 2Mp_n(\hat{\phi})^{1-\epsilon}$. Looking at the aggregate product market variables one now has to account for $2M$ firms with productivity $\hat{\phi}$, as they produce for the domestic and the foreign market, which are assumed to be completely symmetric. The average productivity level $\hat{\phi}$ is derived in Appendix C.2.

With the zero profit condition $r_n(\phi_t^*) = \epsilon f$ and $\frac{r_n(\hat{\phi})}{r_n(\phi_t^*)} = \left(\frac{\hat{\phi}}{\phi_t^*}\right)^{\frac{\epsilon-1}{1+\theta(\epsilon-1)}}$ the revenues of the average firm can be obtained as

$$r_n(\hat{\phi}) = \frac{\epsilon k(1+\tau^{1-\epsilon})}{k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}}(f + \mu f_m). \tag{3.24}$$

The mass of competitors M has to be determined using the capital market clearing condition $K = Y + M(f + \mu f_m)$ and the optimal expenditure allocation $Y = (1-\alpha)E$ which yields

$$M = \frac{K}{(f+\mu f_m)} \frac{\alpha\left(k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)}{\alpha\left(k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}\right) + (1-\alpha)2\epsilon k(1+\tau^{1-\epsilon})}. \tag{3.25}$$

The number of successful entrants is higher in a situation with rent sharing compared to a situation without rent sharing, $\theta = 0$, if $k < \frac{\theta(\epsilon-1)^2}{1+\theta(\epsilon-1)}$.[17] As $k > \frac{\epsilon-1}{1+\theta(\epsilon-1)}$ for $\hat{\phi} > 0$, $\theta(\epsilon-1) > 1$ has to hold for both conditions to be fulfilled. This is the more probable the higher θ and ϵ are. The reasoning is that firms with a lower productivity level pay less for the same quality of labor than firms with a higher productivity level and thus have a relative advantage. The number of active firms (M) also depends on the share of multinationals (μ). If μ increases, M decreases. Compared to the closed economy, the

[16] The exact expressions of $\bar{w}_n$ and $\bar{w}_m$ are given in Appendix C.2.

[17] In a situation without rent sharing, $\theta = 0$, the number of entrants would be $M = \frac{K}{(f+\mu f_m)} \frac{\alpha(k-(\epsilon-1))}{\alpha(k-(\epsilon-1))+\epsilon k(1+\tau^{1-\epsilon})(1-\alpha)}$.

number of active firms is smaller in the open economy.[18] This is the typical selection process introduced in Melitz (2003).

Similar to the closed economy, per worker labor income is proportional to aggregate revenues, i.e.,

$$\begin{aligned}\bar{w} = (1-u)\tilde{w} &= \frac{\epsilon-1}{\epsilon} 2\frac{M}{L} r_n(\hat{\phi}) \\ &= \frac{2(\epsilon-1)Mk(1+\tau^{1-\epsilon})}{L\left(k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)}(f+\mu f_m) \\ &= \frac{K}{L}\frac{2\alpha(\epsilon-1)k(1+\tau^{1-\epsilon})}{\alpha\left(k-\frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)+(1-\alpha)2\epsilon k(1+\tau^{1-\epsilon})}.\end{aligned}$$

The per worker labor income is higher in the open economy than in the closed economy.[19] This is due to higher aggregate revenues. Hence, on average, workers profit from globalization in this framework. As $\tilde{w} = (1-\mu)\bar{w}_n + \mu\bar{w}_m$, the unemployment rate is:

$$u = 1 - \frac{2(\epsilon-1)Mk(1+\tau^{1-\epsilon})}{L\left(k-\frac{\epsilon-1}{1-\theta+\theta\epsilon}\right)((1-\mu)\bar{w}_n+\mu\bar{w}_m)}(f+\mu f_m). \tag{3.26}$$

The unemployment rate of the domestic country in the open economy decreases with the mass of competitors (M). In contrast, the unemployment rate increases with the aggregate amount of labor (L), the average wages paid by exporters and by MNEs ($\bar{w}_n$ and $\bar{w}_m$). The more workers are paid, the less workers can be employed. Thus, there is the traditional trade-off between wages and employment that unions face when negotiating with firms.

Another interesting question is how the unemployment rate changes with an increase in the share of MNEs (μ). Public opinion often claims that the unemployment rate will increase with more MNE activity as part of the production can be shifted to foreign countries. However, a higher share of MNEs may lead to lower unemployment at home if MNEs pay on average lower wages than exporters. The possibility to shift production

[18] See Appendix C.2 for the derivation.
[19] See Appendix C.2 for the derivation.

gives MNEs a bargaining advantage. Therefore, they may pay lower wages than exporters, which enables them to employ more workers.

Proposition 5 *An increase in the share of MNEs leads to a decrease in the unemployment rate, if the average wage paid by MNEs is lower than the average wage paid by exporters.*

Proof. See Appendix C.2. ■

3.5 Explanatory Power of the Fair Wage Approach

In this chapter, we introduce the fair wage approach to a heterogeneous firm model with firm-union bargaining. The model contains two important mechanisms which can have contradictory effects on the MNE wage premium. First, MNEs have a bargaining advantage over exporters. Second, MNEs are on average the more productive firms and should, thus, pay higher wages if wages are bound to the firm's economic performance. Embedding fair wages in the labor union's utility function is a tractable way of deriving firm-specific wages. In Eckel and Egger (2009) wages do not vary with productivity. This is due to CES demand which produces the result that firms do not differ in their elasticity of revenues with respect to employment and thus pay wages which are independent of productivity.

In order to derive firm-specific wages without assuming fair wages, one can either use a different demand framework (such as the one by Melitz and Ottaviano, 2008) combined with wage bargaining or introduce search frictions into a Melitz-type model assuming convex vacancy costs (see Koeniger and Prat, 2007; Holzner and Larch, 2011). However, both alternatives hamper analytical solutions such that one has to rely on numerical solutions.

Including the fair wage approach, the model explains several empirical findings. First, one can derive firm-specific wages. Assuming homogeneous workers, the model therefore includes intra-group wage inequality which has been found in several empirical studies (see, e.g., Schank, Schnabel, and Wagner, 2007). Second, whether MNEs pay higher or lower wages on average is ambiguous, which is in line with the inconclusive empirical evidence (see section 3.2). The model shows that whether MNEs pay higher or lower wages than exporters depends on the strength of the union, the competitive environment, the degree of rent sharing, and on trade costs. Therefore, to test empirically whether there exists an MNE wage premium besides controlling for firm and worker characteristics one should also include country and sectoral characteristics. In order to obtain a measure of rent sharing, one would have to estimate the wage equation and use the coefficient of the operating profits. Thus, the model can give clear predictions and guidance for empirical studies on what has to be included in the estimation of the wage equation. Estimating the model of Egger and Kreickemeier (2009) structurally, Egger, Egger, and Kreickemeier (2011) show that the model including fair wages has a high predictive power. Using firm level data for five European countries, the model can explain more than 70% of the variation in wages across firms in their dataset. Hence, using the fair wage approach in the present study also helps to explain a large part of the empirical findings and may serve as guidance for future empirical analyses.

3.6 Conclusion

This chapter presents an analytically tractable model of heterogeneous firms in international trade with collective bargaining that incorporates both intra-group wage inequality and an MNE bargaining advantage. For this purpose, we embed the fair wage approach of Egger and Kreickemeier (2012a) into the heterogeneous firm model with collective bargaining of Eckel and Egger (2009). With firm-specific wages depending on a firm's economic performance, MNEs may pay higher or lower wages than exporters as there are two opposing effects. First, MNEs have a bargaining advantage and, therefore, should pay lower wages. Second, on average, MNEs yield higher operating profits than exporters and should, thus, pay higher wages if these are dependent on the firm's economic performance. Which effect dominates depends on the bargaining power of unions, their rent sharing preferences, the competitive situation, and on trade costs. The model can explain the inconclusive empirical findings on the MNE wage premium and may serve as guidance for further empirical research.

In the public opinion, MNEs are mainly associated with negative labor market effects due to the fear of a relocation of production. However, we can show that even if MNEs have the possibility to relocate production and, hence, a bargaining advantage, they may still pay higher wages than exporters. Conversely, if they pay lower wages on average, a higher share of MNEs in the economy decreases the unemployment rate.

Chapter 4

Testing the O-Ring Theory for FDI*

*This chapter is based on joint work with Henrike Lindemann.

4.1 Introduction

Most of today's production processes involve several stages which have to be performed sequentially and firms may split them across several countries. Countries, in turn, specialize in particular stages of the production process, which Hummels, Ishii, and Yi (2001) term *vertical specialization*. This type of specialization has constantly grown over the last decades. Hummels, Ishii, and Yi (2001) find that it grew by almost 30% between 1970 and 1990.[1] Notably, vertical specialization does not only affect trade flows between countries but it is also of importance for foreign direct investment (FDI). A firm may decide to relocate a production stage to a country that has specialized in this particular stage.

In this chapter, we therefore adopt the idea of Kremer (1993) and Costinot, Vogel, and Wang (2012) to the case of FDI. They model a sequential production process involving several stages, which are subject to mistakes. For the product to have full value all stages have to be completed successfully. Hence, the highest value can be lost at stages at the end of the value chain. Kremer (1993) termed this the O-ring theory referring to the space shuttle Challenger which broke apart due to a problem of one of its thousands of components, the O-ring. Kremer (1993) and Costinot, Vogel, and Wang (2012) find that countries with lower probabilities of making mistakes specialize in later stages of production.[2] In line with these results, our hypothesis is that firms locate affiliates that produce goods that are positioned at later stages in the production process in countries with lower propensities to making mistakes.

To test this hypothesis, we use firm level panel data for the years 1999 to 2006 on the universe of German multinationals and their activities abroad, which is provided by the Deutsche Bundesbank (2012). To capture the affiliate sector's position in a value chain we employ the measure of upstreamness introduced by Antràs, Chor, Fally, and Hillberry (2012). It considers the number of stages at which a sector enters production processes

[1] The countries analyzed are Australia, Canada, Denmark, France, Germany, Italy, Japan, the Netherlands, United Kingdom, United States, Ireland, Korea, Taiwan, and Mexico.

[2] Another paper which needs to be mentioned in line with Kremer (1993) and Costinot, Vogel, and Wang (2012) is Jones (2011), which also implements a production process that exhibits complementarities.

before the final use of a product. We compute this measure using input-output tables for Germany from the OECD STAN database for the periods of early 2000 and mid 2000. Furthermore, Costinot, Vogel, and Wang (2012) argue that a country's propensity to making mistakes can be approximated by the inverse of a country's total factor productivity (TFP). Therefore, we use a country's TFP to test our hypothesis. Each parent firm faces a 0/1-decision whether to invest in a certain country at a certain time. To capture this in our data, we inflate the dataset over countries and over year for every affiliate the parent firm has once invested in. Using a linear probability model (LPM), we estimate the effect of TFP, the affiliate sector's upstreamness, and an interaction term of the two on the parent firm's FDI location decision while also controlling for parent firm, country and year fixed effects.

The results confirm the O-ring theory for FDI. We find that a destination country's productivity is more important for a firm's investment decision if the affiliate sector is positioned more toward the end of the value chain. We can show that this effect is not only statistically but also economically significant and that it is of about the same size as the effect of a country's productivity as such. To make sure that we do not capture market-seeking motives, i.e., more downstream sectors are located in more attractive markets, we conduct the same estimations including absolute GDP as an additional control. Moreover, we run our basic regression for vertical FDI only. The results remain robust and we even observe an increase in the coefficients. Furthermore, we control for other sector characteristics, we look at new entrants only and we use an alternative productivity measure. The results remain robust throughout all of these additional tests.

To the best of our knowledge, we are the first to relate the idea of Kremer (1993) and Costinot, Vogel, and Wang (2012) to the FDI location decision. Using a production function in which production consists of a number of sequential tasks, all of which have to be successfully completed for the product to have full value, we can explain the attractiveness of certain countries for certain investment projects. More developed countries attract FDI in those sectors which are located at later stages of the production process.

As shown by Fally (2012), over the last 50 years there has been a large shift of value added towards more downstream industries, i.e., those located more at the end of the production process. Therefore, we can give a potential explanation for the widening gap of economic development between high-income and low-income countries and how FDI explicitly contributes to this.

Two other papers also combine the concept of complementary production processes and FDI. First, Chang and Lu (2012) introduce risk into a model of whether to conduct FDI by extending the idea of Kremer (1993). The risk of FDI increases with a firm's production technology. The latter is measured in terms of the number of stages, which constitute the production process. Chang and Lu (2012) find that only firms of intermediate technology levels find FDI profitable. Their study focuses on the firm level determinants of the FDI decision whereas our study analyzes the country level determinants of the firm's location decision.

Second, Antràs and Chor (2012) develop a property-rights model of the firm including a similar production function as Kremer (1993). They analyze the optimal allocation of ownership rights along the value chain, i.e., whether the incentives to integrate increase or decrease for earlier or later stages of the value chain. They also test their model empirically. Although the authors apply the same production function of FDI their focus is different. While Antràs and Chor (2012) analyze why only some stages are integrated, we look at why certain affiliates are located in certain countries.

The remainder of this chapter is organized as follows. In section 4.2, we present the data used in the estimation and show summary statistics. Section 4.3 explains our empirical strategy. In section 4.4, we then present our estimation results. Section 4.5 discusses our robustness checks. Section 4.6 concludes.

4.2 Data

4.2.1 FDI Data

We use firm level data on the universe of German multinationals and their activity abroad, which is provided by the Deutsche Bundesbank (2012) in the Microdatabase Direct investment (MiDi). This is a panel dataset for the years 1996 to 2010 of which we consider the years 1999 to 2006.[3] We only consider German outward FDI. As the reporting thresholds have changed over this period of time, we consider all firms which hold at least 50% of the shares or voting rights of a foreign enterprise, which has a balance sheet total of more than 3 million Euro.[4] These firms are legally required to report to the Deutsche Bundesbank information on the sector, legal form as well as the number of employees and balance sheet information of the foreign affiliate (Lipponer, 2009). Furthermore, we only consider countries in which at least five affiliates are located. Thereby, we can exclude small countries in which only very few affiliates are located that play a dominant role and therefore may influence country characteristics. Our sample comprises a total of 3919 parent firms holding foreign affiliates in at least one of the 33 host countries and in at least one of the years from 1999 to 2006.[5] The countries included in our estimation sample are listed in Table D.3 in Appendix D. With these, we cover 67.5% of total German outward FDI activities.[6]

4.2.2 Upstreamness Measure

In order to capture at which stage of a production process an affiliate sector is located, we employ the measure of *upstreamness* developed by Antràs, Chor, Fally, and Hillberry (2012). The variable considers the number of stages at which the sector enters into

[3]We cannot use more years due to computational limitations.

[4]We also deflate the balance sheet total to make the data comparable over time.

[5]For a more detailed description of the estimation sample refer to Appendix D.

[6]Unfortunately, due to data limitations with respect to country characteristics, the regression sample does not comprise, *inter alia*, the destination countries China and Switzerland as well as the Eastern European countries.

a production process before final use of the resulting product. Antràs, Chor, Fally, and Hillberry (2012) present three approaches which they prove to yield equivalent measures of industry upstreamness. We present one of the approaches to demonstrate the construction of the measure of upstreamness. Considering an open economy, the value of gross output for each industry (Y_i, with $i \in 1, 2, ..., N$) equals the sum of its use as a final good (F_i), its use as an intermediate input to other industries and exports (X_i) minus imports (M_i). The use as an intermediate input is measured as the Euro amount of sector i's output (d_{ij}) needed to produce one Euro worth of industry j's output (Y_j):

$$Y_i = F_i + \sum_{j=1}^{N} d_{ij} Y_j + X_i - M_i.$$

In the input-output tables we do not observe d_{ij} as the data does not distinguish between domestic and international flows of goods. What can be observed is

$$\delta_{ij} = \frac{d_{ij} Y_j + X_{ij} - M_{ij}}{Y_i}.$$

However, to disentangle $d_{ij} Y_i$, we lack information on international inter-industry trade flows, M_{ij} and X_{ij}. Therefore, as in Antràs, Chor, Fally, and Hillberry (2012) we have to assume that the share of industry i's exports (imports) that are used in industry j (be it at home or abroad) is the same as the share of industry i's output used in industry j. d_{ij} then has to be replaced by

$$\hat{d}_{ij} = d_{ij} \frac{Y_i}{Y_i - X_i + M_i},$$

where the denominator is the domestic absorption of industry i's output.

Hence, we can compute the average position of a sector's output in the value chain as

$$U_i = 1 \cdot \frac{F_i}{Y_i} + 2 \cdot \frac{\sum_{j=1}^{N} \hat{d}_{ij} F_j}{Y_i} + 3 \cdot \frac{\sum_{j=1}^{N} \sum_{k=1}^{N} \hat{d}_{ik} \hat{d}_{kj} F_j}{Y_i} + ..., \tag{4.1}$$

where the use of the industry's output at different positions in the value chain, starting with final use, is multiplied by their distance from final use plus one and divided by Y_i.

Note that $U_i \geq 1$. The interpretation of this measure is straightforward: the larger U_i the more upstream the industry.

We compute this measure using input-output tables for Germany from the OECD STAN database (OECD, 2012) for the periods of early 2000 and mid 2000.[7] Table 4.1 shows the mean upstreamness over the two periods for several sectors. In order to gain a better intuition for the measure, we present the five least upstream sectors and the five most upstream sectors. Among the five least upstream sectors are two service sectors (hotels and restaurants and the construction sector) as well as the manufacture of textiles, food products, and furniture.[8] The five most upstream sectors are water transport, renting of machinery, other business activities, supporting and auxiliary transport activities, and the manufacture of basic metals.[9]

Table 4.1: Summary Statistics of Upstreamness Measure

Sector	Upstreamness
Least Upstream Sectors	
Hotels and restaurants	1.3410
Construction sector	1.4041
Manufacture of textiles	1.4792
Manufacture of food products and beverages	1.4792
Manufacture of furniture	1.5596
Most Upstream Sectors	
Water transport	2.9793
Renting of Machinery and Equipment	3.0677
Other business activities	3.0938
Supporting and auxiliary transport activities	3.0969
Manufacture of basic metals	3.6734

The table contains the five least and the five most upstream sectors according to the mean upstreamness measure over the two time periods early 2000 and mid 2000.

[7]The data for early 2000 is used for the period 1999 to 2002, and mid 2000 is used for 2003 to 2006.

[8]We would have expected the retail sector to be under the five least upstream sectors. However, in the OECD STAN input-output tables the wholesale and retail sector are aggregated. Therefore, the two combined are ranked eighth of the least upstream sectors.

[9]Note that we have excluded activities related to the extraction of natural resources, such as mining. These belong to the most upstream activities.

Figure D.1 in Appendix D shows the average upstreamness measure over the two time periods of early and mid 2000 for each sector. The measure of upstreamness ranges from 1.34 to 3.67. An upstreamness measure of 1 would imply that the sector's output is used only in final consumption. The maximum value of about 4 means that the sector's ouput is used in some industries (at least one) as an input in the first stage of a production process involving four stages. Its mean value across the 47 industries in our regression sample is 2.14 with a standard deviation of 0.54. This result is similar to Fally (2012) who finds that production chains involve on average less than two stages. Table D.1 in Appendix D shows how the upstreamness variable varies over time. We compare the rankings of the ten least upstream and the ten most upstream sectors over the two time periods early 2000 and mid 2000. As we can see from Table D.1, the upstreamness measure varies over time, but the variation is not very strong. Out of the 20 sectors listed, six sectors do not vary in their ranking over time. The rest varies between one to three places. Therefore, if we identify an effect of a sector's upstreamness on the investment probability, it is mainly driven by the variation across sectors and not by the variation of the upstreamness measure over time.

In order to get a first impression on whether our hypothesis, that more upstream affiliates are more likely to be located in less productive countries, holds true, we look at the average upstreamness of affiliates located in different country groups. We categorize countries according to their GDP per capita using the World Bank classification of country incomes (World Bank, 2011). In Figure 1, the country-income group 2 comprises lower-middle income countries, group 3 upper-middle income countries, group 4 high-income OECD countries, and group 5 high-income non-OECD countries.[10] Figure 1 clearly shows that the average upstreamness is lower in more developed countries. As the more developed countries generally are also the more productive ones, this can be taken as first suggestive evidence for our hypothesis.

[10]Note that our sample does not include low-income countries, i.e., country-income group 1.

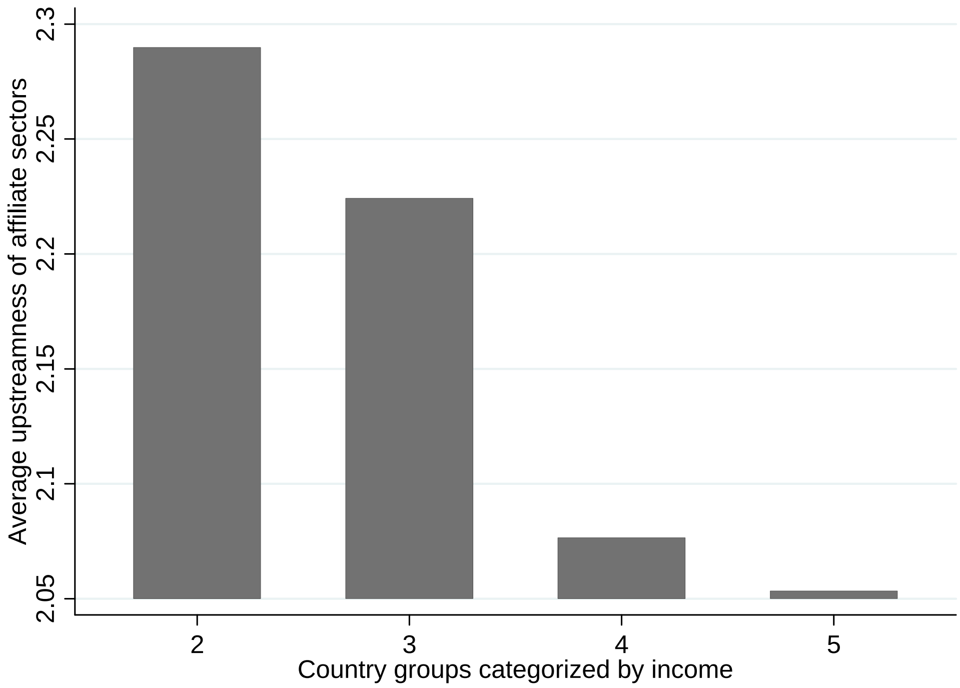

Figure 4.1: Average Upstreamness of Affiliate Sectors in Different Country-Income Groups

4.2.3 Country Characteristics

We seek to analyze whether a country's overall propensity to making mistakes plays a more important role for more downstream industries. Therefore, we need a measure of a country's failure rate. Following the argument of Costinot, Vogel, and Wang (2012) that a country's propensity to making mistakes can be interpreted as the inverse of a country's TFP, we use TFP obtained from the World Productivity Database (UNIDO, 2012).[11] In our basic specification we use TFP, *upstreamness*, and an interaction term of the two, i.e., *upstreamness∗TFP*.[12]

We run the basic specification also controlling for various other country characteristics

[11] The database offers ten-year forecasts of TFP growth which are then used to forecast TFP levels, which we use. Note that TFP level forecasts are calculated for different measures of capital stock. Because of data availability issues (i.e., the number of year-country data points) we use the one based on capital stock calculated in terms of physical efficiency. I.e., capital is assumed to underlie a time-varying depreciation rate. The TFP measure is scaled relatively to the US. See Isaksson (2007) for a detailed technical documentation.

[12] Our measure of TFP is country-specific but does not vary across sectors. We would like to use a country- and sector-specific measure of productivity as we would presume to get even more clear-cut results. However, this data is very limited. The EU Klems data contains a measure of productivity which varies across sectors. Unfortunately, it is only available for six countries.

in order to see whether the effect of the interaction term of *upstreamness* with TFP persists. As a geography measure we use a country's *remoteness*. This variable measures the distance of the host country from all other countries in the world weighted by those other countries' share of world GDP (see Blonigen and Piger, 2011). It captures export-platform motives, i.e., a firm invests in a country to export to other surrounding countries (Ekholm, Forslid, and Markusen, 2007).

To control for factor endowments, we use *average years of schooling*, *average wages*, and *capital intensity*. *Average years of schooling* is obtained from the Barro and Lee (2010) table of educational attainment. We use the measure for male and female persons aged 25 years and older. This data is available in five-year intervals from 1950 to 2010. In order to be able to use the data for our panel analysis, starting with 2000 we replace the missing two years before and after the year for which the data is available with the value of that year. Further, we include *monthly average wages* as a factor-cost measure. The wage dataset was prepared by Harsch and Kleinert (2011) making use of the October Inquiry database of the International Labor Organization (ILO). Average wages may capture conventional cost-saving motives associated with vertical FDI. In order to capture the countries' capital endowment, we calculate *capital intensity* as log physical capital per worker using Penn World Table data following Antràs, Chor, Fally, and Hillberry (2012).

To control for a country's institutional environment, we include the variable *rule of law* from the World Bank, which measures contract enforceability and protection of property rights.[13] As a measure of a country's *financial development* we include the ratio of private credit to GDP from Beck, Demirgüç-Kunt, and Levine (2010). In order to control for the fixed cost of setting up a foreign affiliate, we include the variable *market entry*. It is an index computed in five-year intervals since 1970 and annually since 2000. The latest update is published in the 2011 Economic Freedom of the World annual report (Gwartney, Lawson, and Hall, 2011). It measures the performance of countries in terms of the cost

[13] The actual values range from -2.5 (worst governance) to 2.5 (best governance). As the variable is skewed and in order to take the logarithm, we add 2.5 to each value such that it goes from 0 to 5, a higher value implying better governance.

of starting a new business. As such, it captures the time (measured in days) necessary to comply with regulations when starting a limited liability company, money costs of the fees paid to regulatory authorities (measured as a share of per-capita income), and funds that must be deposited into a company bank account (measured as a share of per capita income).

In several robustness checks, we include different sector or country level controls and an alternative productivity measure. First, we add absolute GDP obtained from the World Bank to control for market size. Second, we include a dummy variable indicating whether a country has a comparative advantage in a specific sector using data from the WTO trade statistics (WTO, 2012b) and following Mayda and Rodrik (2005) who have proposed this measure of comparative advantage. Third, we replace TFP by an alternative measure of productivity. Kremer (1993) focuses in his theoretical model on the skill level of workers. The line of reasoning is that more highly skilled workers are less likely to make mistakes. Therefore, we include a measure of labor productivity, i.e., output per worker, measured as an annual average at the country level, which we obtain from the Total Economy Database (The Conference Board, 2012).

Table D.2 in Appendix D summarizes all variables (dependent and explanatory) used in our regressions. Means and standard deviations are also reported. We have sufficient variation in the country characteristics in our estimation sample, which is mostly cross-sectional and not so much over time.

4.3 Empirical Strategy

The analysis of the effect of a sector's upstreamness on the firm's investment location decision and how this is related to a country's propensity to making mistakes entails an intriguing question: where will the affiliate be located, i.e., are affiliates at later stages of the value chain more likely to be located in countries with higher productivity? In order to find an answer to this question, we estimate a binary choice model. We inflate the dataset such that each firm may invest in each country, in each year, and in each sector it has been observed to invest in at least once before. Due to the inflation of our dataset we have 96% zeros in our data.

Let y_{ijst} be the outcome of firm i in host country j in sector s in year t ($i = 1, ..., N$, $j = 1, ..., J$, $s = 1, ..., S$, and $t = 1, ..., T$). The binary choice model for y_{ijst} is then given by

$$\begin{aligned} P(y_{ijst}|.) =& \beta_0 + \beta_1 productivity_{jt-1} + \beta_2 upstreamness_{st} \\ & + \beta_3 productivity_{jt-1} * upstreamness_{st} + \alpha_i + \eta_j + \delta_t + \epsilon_{ijst}. \end{aligned} \tag{4.2}$$

y_{ijst} is a binary variable taking on the value of 1 if firm i holds an affiliate in sector s in host country j in year t and 0 otherwise. α_i is a time-invariant parent firm-specific effect, η_j is a country fixed effect and δ_t are time dummies. We control for a country's productivity, the sector's upstreamness and an interaction term of the productivity and the sector's upstreamness.

We estimate the investment location decision by specifying $Pr(y_{ijst}|.)$ as a linear probability model (LPM). Hence, we can directly interpret the regression coefficients, even of interaction effects. Using the LPM compared to nonlinear methods such as a random effects probit model has a distinct advantage: it neither requires a distributional assumption regarding the unobserved effect conditional on the covariates nor does it necessitate the assumption of independence of the responses conditional on the explanatory variables and the unobserved effect (Wooldridge, 2010). However, the linear functional form is almost certainly false. Therefore, in order to test the fit of the linear functional form we calculate the share of predicted probabilities below 0 or above 1. In almost all of our regressions this share amounts to about 5%. Accordingly, estimating an LPM seems to be a reasonable choice as it frees us from making other untestable assumptions.

We include all country characteristics lagged once. First, this acknowledges the duration of an investment decision. We assume that it will probably take about one year from the point when the firm considers investing up to the actual effectuation of the investment. Therefore, the country characteristics at the time when the firm decides upon the investment should matter, and not at the time of the realization of the investment. Second, using lags ensures that there are no unobserved year-specific shocks influencing both, the country's characteristics as well as the firm's investment in the country. Additionally, by including firm-, country-, and year-specific effects we can control for various time-invariant unobserved effects.

We exclude those affiliate sectors that are related to agricultural and mining activities. This way, we make sure that our results are not driven by the availability of natural resources, where firms do not exactly face a choice where to locate an affiliate in order to extract or refine these resources.[14]

We use standard errors clustered at the country level. Hence, we account for the fact that the error terms will probably be correlated within a country but not across countries.[15]

4.4 Results

4.4.1 Basic Specification

In our basic specification we regress the binary indicator whether a firm has invested in a particular country on the destination country's total factor productivity, on the affiliate sector's position in the value chain, and on an interaction term of the two. This specification follows closely the model of Costinot, Vogel, and Wang (2012) where a country's productivity determines the allocation of sectors with respect to their position in the value chain. In addition, we control for year and country fixed effects. As most country characteristics do not vary a lot over time we, thus, control for observed and unobserved

[14] We provide a list of the excluded sectors in the description of the estimation sample in the Appendix D.

[15] Cameron and Miller (2010) have pointed out that cluster-robust inference asymptotics are based on the assumption that the number of clusters goes to infinity. In our sample we have 33 clusters. Therefore, we also use bootstrap standard errors proposed by Cameron and Miller (2010) as a finite-sample adjustment. The results do not differ significantly.

time-constant country effects. The results are reported in Table 4.2. Columns 1 and 2 show the results for our estimation sample of 33 countries with and without including firm fixed effects. Including firm fixed effects, we control for time-constant firm characteristics that presumably have a high explanatory power for the firm's investment location decision. Only about one third of the parent firms in our estimation sample have affiliates in varying sectors. As firm fixed effects, thus, absorb some of the variation across sectors of the upstreamness variable, we also run the regressions without firm fixed effects. Columns 3 and 4 show the results of the same regression for all countries for which we have data on TFP (52 countries). We run the regressions on these different samples because the estimation sample does not include, for example, China and Switzerland for which not all of our country controls are available.

For both samples and with or without including firm fixed effects, we find that firms are more likely to invest in countries with higher TFP. Controlling for firm fixed effects the coefficient becomes slightly smaller but remains positively significant. We also calculate the overall effect of TFP which can be derived from (4.2) as

$$\frac{\partial P(y_{ijst}|.)}{\partial log(TFP)_{jt-1}} = \beta_1 + \beta_3 upstreamness_{st},$$

at the mean of the upstreamness variable. The overall effect of TFP remains positive but is smaller with a value of 0.0026 for the regression without firm fixed effects in column 1 and remains about the same with a value of 0.0262 for the regression with firm fixed effects in column 2. The overall effect of TFP remains almost unchanged for the regression with firm fixed effects, because we eliminate a lot of variation of the upstreamness variable by including parent fixed effects. In contrast, in the regression without firm fixed effects we keep the full variation of the upstreamness variable across sectors. This explains the difference in the overall coefficients between the regressions with and without firm fixed effects. Keeping the full variation of the upstreamness variable, the overall effect of TFP is smaller. For a sector in an average position in the value chain, TFP only plays a minor role for the firm's investment decision.

Table 4.2: The Influence of a Sector's Position in the Value Chain on the FDI Location Decision I

	(1)	(2)	(3)	(4)
Dep. Var.	y_{ijst}	y_{ijst}	y_{ijst}	y_{ijst}
	Estimation Sample		Larger Sample	
log (TFP)	0.0309**	0.0262	0.0152**	0.0148**
	(0.0144)	(0.0161)	(0.0072)	(0.0071)
Upstreamness	-0.0126***	-0.0235***	-0.0070**	-0.0151***
	(0.0044)	(0.0049)	(0.0033)	(0.0037)
Upstreamness*log(TFP)	-0.0133**	-0.0130**	-0.0069**	-0.0068**
	(0.0052)	(0.0061)	(0.0032)	(0.0032)
Firm FE	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Sector FE	No	No	No	No
Observations	674,833	674,833	1,322,007	1,322,007
Countries	33	33	52	52
Parent firms	3,919	3,919	3,920	3,920
R^2	0.0481	0.0500	0.0510	0.0527

The dependent variable is the binary variable y_{ijst}, taking on the value of 1 if a firm has invested in country j in sector s at time t, and 0 otherwise. Columns 1 and 2 include the basic regression for the estimation sample. Columns 3 and 4 include the basic specification for the larger sample of 52 countries. In all of the regressions we control for country and year fixed effects. We estimate the regressions with and without firm fixed effects. Standard errors clustered at the country level are given in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Furthermore, affiliate sectors that are located more at the beginning of the value chain are less likely to be invested in (see columns 1 to 4). This result seems to be surprising. As we analyze German outward FDI and Germany is a country with high TFP, more upstream sectors should be more likely located in less productive countries while more downstream sectors should remain in Germany. In addition, it could also be argued that sectors where less value can be lost, i.e., the ones at the beginning of the value chain, are more likely to be relocated as monitoring them is less crucial. However, in line with Antràs and Chor (2012) one could then argue that these stages may rather be outsourced than being kept within the firm, which is something we cannot observe in our data. Furthermore, an intuition for the negative coefficient may be that more upstream sectors such as the manufacture of basic metals entail large initial fixed investment costs, which could reduce the likelihood of investing at all. The overall effect of upstreamness, evaluated at the mean of TFP, is also negative.

For the interaction of upstreamness and TFP the theoretical intuition is clear. Following Costinot, Vogel, and Wang (2012), more upstream sectors should be located in less productive countries. In our estimation, we can confirm this hypothesis. The interaction term of upstreamness and TFP is negatively significant for both samples with or without firm fixed effects. This implies that the more upstream an affiliate sector, the less a destination country's productivity matters for the investment decision. Putting it differently, a destination country's productivity becomes more important for a firm's investment decision if the affiliate sector is positioned more toward the end of the value chain. Hence, we find the O-ring idea to be confirmed for FDI: the more upstream an affiliate sector, the less the productivity of a destination country appears to matter for the decision whether to invest. One might argue that there could be skill spillovers between a parent and its affiliate. Consequently, the host country's productivity should be less important. Nevertheless, we find a country's productivity to be important and even more so for more downstream affiliates. Hence, the effect of a country's productivity on its sectoral specialization may be even stronger for domestically owned firms.

Including firm fixed effects does not alter our results. The signs and significance levels remain unchanged. Only the size of the coefficients varies, but not significantly. Interestingly, controlling for firm fixed effects increases the R-squared by less than 1 percentage point. Hence, time-constant firm characteristics seem to matter less for the decision where to locate an affiliate than we would have expected.

The results are the same for the two samples, except for the size of the coefficients which is smaller in the larger sample including 52 countries. However, the signs of the coefficients remain unchanged and the explanatory variables are still significant.

Table 4.3: Economic Significance

Dep. Var.	(1) y_{ijst}	(2) y_{ijst}
log(TFP)	0.0651**	0.0606*
Upstreamness	-0.0339***	-0.0633***
Upstreamness*log(TFP)	-0.0628**	-0.0614**

The table contains the *beta coefficients* of columns 1 and 2 of Table 4.2. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

These effects are not only statistically but also economically significant. In order to discuss economic significance and to be able to compare the coefficients we calculate *standardized coefficients*, also called *beta coefficients*. Table 4.3 gives the *beta coefficients* of our basic specification in columns 1 and 2 of Table 4.2. An increase in TFP by one standard deviation significantly increases the investment probability by about 0.06 standard deviations. If the affiliate sector moves one standard deviation up the value chain, the firm's investment probability decreases by about 0.03 to 0.06 standard deviations. Finally, an increase in the interaction term of TFP and upstreamness by one standard deviation decreases the investment probability by about 0.06 standard deviations. Hence, for the firm's investment location decision the effect of TFP interacted with the affiliate sector's position in the value chain is as important as the effect of TFP itself.

4.4.2 Controlling for the Number of Affiliates

Following the theory of Costinot, Vogel, and Wang (2012), an increase in country j's productivity should make country j more attractive for investments in more downstream sectors. Take the example of three countries: country 1, country 2, and country 3. Country 1 is the most productive, country 2 is less productive, and country 3 is least productive.

Table 4.4: The Influence of a Sector's Position in the Value Chain on the FDI Location Decision II

	(1)	(2)	(3)	(4)
Dep. Var.	y_{ijst}	y_{ijst}	y_{ijst}	y_{ijst}
	Estimation Sample		Estimation Sample	
log (TFP)	0.0276**	0.0257*	0.0561	0.0569
	(0.0121)	(0.0141)	(0.0405)	(0.0417)
Upstreamness	-0.0126***	-0.0236***	-0.0128***	-0.0238***
	(0.0044)	(0.0049)	(0.0044)	(0.0050)
Upstreamness*log(TFP)	-0.0134**	-0.0130**	-0.0139**	-0.0133**
	(0.0053)	(0.0062)	(0.0052)	(0.0061)
Affiliate Number	0.0184***	0.0193***		
	(0.0043)	(0.0044)		
Average Schooling			-0.0039	-0.0037
			(0.0060)	(0.0060)
log (wage)			0.0219	0.0206
			(0.0222)	(0.0216)
Market entry			-0.0018	-0.0024
			(0.0038)	(0.0030)
log (remoteness)			-0.0416	-0.0411
			(0.0248)	(0.0245)
Rule of Law			-0.0179	-0.0170
			(0.0156)	(0.0147)
log (Fin. Dev.)			0.0257*	0.0259*
			(0.0141)	(0.0141)
log (Capital Intensity)			-0.0130	-0.0134
			(0.0171)	(0.0173)
Firm FE	No	Yes	No	Yes
Country FE	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	Yes
Sector FE	No	No	No	No
Observations	674,833	674,833	674,833	674,833
Countries	33	33	33	33
Parent firms	3,919	3,919	3,919	3,919
R^2	0.0478	0.0497	0.0165	0.0174

The dependent variable is the binary variable y_{ijst}, taking on the value of 1 if a firm has invested in country j in sector s at time t, and 0 otherwise. Columns 1 and 2 contain the basic specification including the number of affiliates. Columns 3 and 4 include the basic specification controlling for other country characteristics. In all of the regressions we control for country and year fixed effects (except for columns 3 and 4, where we do not control for country fixed effects). We estimate the regressions with and without firm fixed effects. Standard errors clustered at the country level are given in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

If country 3's productivity increases, the most upstream affiliate sectors in country 2 may be relocated to country 3. This leads to a decrease in the average upstreamness measure of both, country 2 and country 3. Hence, in country 3 the productivity increase has induced a decrease in the average upstreamness of the sectors located in country 3. However, the average upstreamness has also decreased in country 2 while country 2's productivity has remained the same. Therefore, we also control for the number of affiliates per country.[16] This should increase the coefficient of the interaction term as those changes in the average upstreamness caused by an exit of the most upstream sectors are accounted for separately.

Indeed, we find our results to remain stable and our coefficients to increase slightly (see columns 1 and 2 of Table 4.4). Affiliates in more downstream sectors are more likely to be located in more productive countries. The number of affiliates as such has a positive significant effect on the investment probability. Affiliates seem to be located in countries where already other affiliates are located. This may hint at agglomeration effects.

4.4.3 Additional Country Controls

In columns 3 and 4 of Table 4.4, we insert additional country characteristics as covariates in our baseline regression: in addition to TFP, upstreamness and the interaction term between the two, we now also control for a country's endowment with human capital *(average years of schooling)* and with physical capital *(capital intensity)*, the labor cost in a country *(average wages)*, the cost of *market entry*, the GDP-weighted distance of the destination country from all other countries in the sample *(remoteness)* as well as a set of factors capturing a country's institutional development *(rule of law, financial development)*.[17]

Except for TFP which becomes insignificant, we find that in our set of original covariates neither the significance levels, nor the sign of the coefficients is altered by adding the

[16] Note that we only control for the number of German affiliates per country. This is the relevant category as the average upstreamness is also based on German affiliates.

[17] Note that when including these additional country characteristics, we have to leave out the country fixed effects due to the new covariates' insufficient variation over time.

additional variables. Only the coefficients' magnitude decreases slightly compared to our regression results in columns 1 to 4 in Table 4.2 and columns 1 and 2 in Table 4.4. Looking at the new regressors, we see that only financial development significantly influences the investment decision. Firms are more likely to invest in countries that are more financially developed. A potential reason for the insignificance of most of the country characteristics may be that most of the variables are highly correlated. Nonetheless, controlling for other country characteristics the affiliate sector and the country's TFP still seem to be the drivers of the FDI location choice.

4.5 Robustness Checks

4.5.1 Closing the Market-Seeking Channel

In a first robustness check, we test whether our results are driven by market-seeking arguments. The idea is that more downstream sectors are located in more attractive markets which are generally also the more productive ones. Therefore, we rerun our basic regression including a country's absolute gross domestic product (GDP) as a covariate in a first test and analyze only vertical FDI in a second test. First, affiliates are more likely to be located in richer countries if the location decision is driven by market-seeking arguments. Hence, absolute GDP should control for this channel. Second, vertical FDI is by definition not driven by market-seeking motivations but can be explained by cost-saving arguments, i.e., the search for the most cost-efficient production location. Thus, if our results still hold for vertical FDI only, it can be argued that they are not driven by the market-seeking channel.

Columns 1 and 2 of Table 4.5 report the results when including absolute GDP as an additional control. Our results remain robust. TFP has a positive effect on the investment probability. The more upstream a sector is, the lower the investment probability is. Most importantly, the more downstream the affiliate the more likely the firm is to invest in

Table 4.5: Robustness Check: Excluding Market-Seeking

	(1)	(2)	(3)	(4)
Dep. Var.	y_{ijst}	y_{ijst}	y_{ijst}	y_{ijst}
	Estimation Sample		Ver. FDI	
log (TFP)	0.0327**	0.0258	0.0553**	0.0660**
	(0.0160)	(0.0168)	(0.0248)	(0.0305)
Upstreamness	-0.0126***	-0.0234***	-0.0296***	-0.0398***
	(0.0044)	(0.0049)	(0.0081)	(0.0079)
Upstreamness*log(TFP)	-0.0133**	-0.0129**	-0.0227**	-0.0269**
	(0.0052)	(0.0061)	(0.0087)	(0.0112)
log(Absolute GDP)	0.0029	-0.0070		
	(0.0036)	(0.0061)		
Firm FE	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Sector FE	No	No	No	No
Observations	674,833	674,833	338,342	338,342
Countries	33	33	33	33
Parent firms	3,919	3,919	2,348	2,348
R^2	0.0481	0.0501	0.0520	0.0529

The dependent variable is the binary variable y_{ijst}, taking on the value of 1 if a firm has invested in country j in sector s at time t, and 0 otherwise. In columns 1 and 2 we run the basic regression including *log(Absolute GDP)*. In columns 3 and 4 the basic regression is run for vertical FDI only. In all of the regressions we control for country and year fixed effects. We estimate the regressions with and without firm fixed effects. Standard errors clustered at the country level are given in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

more productive countries. The size of the coefficients also remains about the same. Absolute GDP is not significant. We would have expected it to be positively significant. Presumably, the variation over time is not sufficient to identify a significant effect as we control for country fixed effects in our regressions. This stresses the validity of our results, as controlling for country fixed effects seems to rule out omitted variable bias, such as absolute GDP influencing TFP and the firm's probability to invest in a country.

The regression results for vertical FDI only are shown in columns 3 and 4 of Table 4.5. We define vertical FDI as those investments where the parent firm's sector differs from the affiliate's.[18] We find our results to remain robust. Moreover, the coefficients actually increase. Hence, for vertical investments a country's TFP is more important if the sector of the investment project is more downstream.

4.5.2 Controlling for Other Sectoral Characteristics

One objection to including upstreamness as the only sectoral characteristic may be that this way our results capture various sectoral factors and may, thus, be explained by different theories. Hence, we do two things to alleviate this concern. First, we include a variable that indicates whether country j has a comparative advantage in sector s. We construct this measure following Mayda and Rodrik (2005) who term it *revealed comparative advantage*. The comparative advantage variable is an indicator variable and defined as follows

$$CA_{sj} = \begin{cases} 1, & \text{if } M_{sj} - X_{sj} - \lambda M_{sj} < 0, \\ 0, & \text{if } M_{sj} - X_{sj} - \lambda M_{sj} > 0 \text{ or non-tradable sector.} \end{cases}$$

λ is an adjustment factor which should take into account the existence of overall trade imbalances. Mayda and Rodrik (2005) define it as:

$$\lambda = \frac{\sum_s (M_s - X_s)}{\sum_s M_s}.$$

The adjustment factor illustrates by which fraction imports would have to be reduced or increased in order to balance the trade account. λ is negative for countries with a trade surplus and positive for those with a trade deficit. Therefore, a sector is defined as a comparative advantage sector if its adjusted net imports are less than zero. The sector is no comparative advantage sector if the adjusted net imports are larger than zero or the sector is non-tradable. We calculate the measure using sectoral trade data from the

[18]Due to a lack of data we cannot use the standard identification of vertical FDI where, in addition to the different parent and affiliate sectors, we would also control for trade flows from the affiliate to the parent.

WTO trade statistics (WTO, 2012b).

Columns 1 and 2 of Table 4.6 report the results when including the comparative advantage measure. Again, our results remain robust. Whether a country has a comparative advantage in a sector does not seem to influence a firm's FDI location decision. Controlling for whether a sector is a comparative advantage sector even increases the coefficients of TFP, upstreamness, and the interaction term of the two.

Table 4.6: Robustness Check: Controlling for Other Sectoral Characteristics

	(1)	(2)	(3)	(4)
Dep. Var.	y_{ijst}	y_{ijst}	y_{ijst}	y_{ijst}
	Estimation Sample		Estimation Sample	New Entrants
log (TFP)	0.0429**	0.0361**	0.0306**	0.0433***
	(0.0163)	(0.0158)	(0.0144)	(0.0031)
Upstreamness	-0.0164***	-0.0290***		-0.0045***
	(0.0046)	(0.0064)		(0.0012)
Upstreamness*log(TFP)	-0.0178***	-0.0176***	-0.0131**	-0.0063***
	(0.0048)	(0.0049)	(0.0052)	(0.0014)
Comp. adv.	-0.0009	-0.0009		
	(0.0009)	(0.0009)		
Firm FE	No	Yes	No	No
Country FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	No
Sector FE	No	No	Yes	No
Observations	272,625	272,625	674,833	157,149
Countries	29	29	33	33
Parent firms	3,919	3,919	3,919	3,294
R^2	0.0481	0.0502	0.0545	0.0051

The dependent variable is the binary variable y_{ijst}, taking on the value of 1 if a firm has invested in country j in sector s at time t, and 0 otherwise. In columns 1 and 2 we run the basic regression including *Comp. adv.*. In column 3 the results of the basic regression including sector fixed effects are reported. In column 4 we run the basic regression for new entrants only. In all of the regressions (except for column 4) we control for country and year fixed effects. We estimate the regressions in columns 1 and 2 with and without firm fixed effects. Standard errors clustered at the country level are given in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

Second, we include sector dummies in order to control for time-constant sector characteristics, such as its skill-intensity, and specificity, which can be assumed to be rather constant over time. As upstreamness also hardly varies over time, we exclude the upstreamness variable in this regression. Column 3 of Table 4.6 shows that the interaction term of upstreamness and TFP remains significantly negative. Therefore, even controlling for other sector characteristics, the link between a country's productivity and a sector's position in the value chain is a significant explanatory determinant of a firm's FDI location decision.

4.5.3 New Entrants

Once an affiliate has been set up in a country, it is quite likely that it will remain in that country for a few years. Although we have entry and exit of affiliates in countries over the years, the variation over time is not very large. Therefore, we run our basic specification for new entrants only. This means that we look at the influence of a country's productivity on the initial entry decision for different affiliate sectors. Earlier, we have assumed that the firm decides each year whether to invest in a country if it has not invested in the country before and whether to stay or exit if it already has invested in the country before. Looking only at new entrants implies that we have a cross section. Therefore, we run a LPM without fixed effects.

Column 4 of Table 4.6 reports the results for the sample with new entrants only. In line with our previous findings, TFP has a significantly positive effect on the initial investment decision. Affiliates in more upstream sectors are less likely to be established in a foreign country. Furthermore, firms are more likely to conduct the initial investment in more upstream affiliates in less productive countries and more downstream affiliates in more productive countries.

4.5.4 Alternative Measure of a Country's Productivity

In addition to TFP as a measure of a country's productivity, we also use labor productivity (*labprod*), measured as GDP per person employed. Hence, we test the robustness of our results with respect to the productivity measure used.

Table 4.7: Robustness Check: Alternative Productivity Measure

	(1)	(2)
Dep. Var.	y_{ijst}	y_{ijst}
	Estimation Sample	
log (labprod)	0.0263**	0.0167
	(0.0107)	(0.0107)
Upstreamness	0.1075***	0.0837**
	(0.0265)	(0.0308)
Upstreamness*log(labprod)	-0.0111***	-0.0099***
	(0.0027)	(0.0031)
Firm FE	No	Yes
Country FE	Yes	Yes
Year FE	Yes	Yes
Sector FE	No	No
Observations	674,833	674,833
Countries	33	33
Parent firms	3,919	3,919
R^2	0.0482	0.0501

The dependent variable is the binary variable y_{ijst}, taking on the value of 1 if a firm has invested in country j in sector s at time t, and 0 otherwise. In all of the regressions we control for country and year fixed effects. In column 2 firm fixed effects are included. Standard errors clustered at the country level are given in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

In Table 4.7, the results using labor productivity are reported. As TFP, labor productivity has a significantly positive effect on the investment probability. Thus, countries with a higher labor productivity are more likely to attract FDI. Furthermore, the interaction between an affiliate sector's position in the value chain and a country's labor productivity remains significantly negative. Hence, affiliates located at later stages in the value chain are more likely to be placed in countries with a higher labor productivity. One important difference with respect to the results of our baseline specification is that the coefficient of the upstreamness measure is now significantly positive. This implies that investments are more likely to take place in more upstream sectors. As we have argued above, from the German parents' point of view this makes sense as downstream sectors may also remain in Germany. To conclude, the main hypothesis that those sectors that are located at later stages in the production process are more likely to be located in more productive countries can be confirmed irrespective of the productivity measure used.

In summary, our results allow us to make a strong case for the relevance of a sector's position in the value chain for a firm's decision of whether and where to invest. Further, our robustness checks have shown that the results are robust to using various measures of a country's productivity, they are not driven by market-seeking motives, and remain robust when we include other country characteristics.

4.6 Conclusion

The position in the value chain of a production stage matters for the decision of where to set up a foreign affiliate. In our empirical analysis we have shown that a country's productivity, which can also be thought of as a lower propensity to making mistakes, is more important if the affiliate's sector is at a later stage in the production process.

With respect to Kremer (1993) and Jones (2011), our results underline the role of complementary production processes as a potential explanation for pronounced inequalities between countries in terms of development also for FDI. It is not only domestic firms producing more upstream goods in less developed countries but also foreign firms establishing affiliates in upstream sectors in less developed countries and more downstream affiliates in more developed countries. Hence, later stages of production processes are located in more developed countries which again leads to stronger economic growth, as these stages contribute most value added (see Fally, 2012).

Global supply chains are increasingly subject to public debate. Especially policy makers of developing and emerging countries aim at participating in global supply chains and then moving down towards those stages, which yield higher value added (see discussion at the WTO Public Forum 2012, Session 22).[19] Therefore, it is of high relevance for policy makers

[19] http://www.wto.org/english/forums_e/public_forum12_e/programme_e.htm#session22

which country characteristics matter for attracting FDI in more downstream sectors. This study stresses the importance of becoming more productive in order to attract investment in those sectors which yield a higher value added.

Appendices

A Appendix to Chapter 1

A.1 Theoretical Appendix

Proof of Proposition 2:

Given the belief of the bank, $Pr(G|\alpha \geq \alpha^{sep}) = 1$ and $Pr(G|0 \leq \alpha < \alpha^{sep}) = 0$, both suppliers have no incentive to deviate. The exporter sets α, p_1 and q_1. Given p_1 and q_1, the good supplier could choose a higher α, but she has no incentive to do so, since $\frac{\partial \pi_{SU}(G)}{\partial \alpha} < 0$:

$$\frac{\partial \pi_{SU}}{\partial \alpha} = [\underline{c} + (\bar{c} - \underline{c})(1 + \bar{r}_{SC})]\, q_1 - [\underline{c} + (\bar{c} - \underline{c})(1 + \bar{r}_{SC})]\, q_1 (1 + \bar{r}_{SC}) < 0.$$

Likewise, the good type has no incentive to lower α, as the exporter would not obtain a bank credit then and the export transaction does not take place which means that the supplier would make losses.

The bad type does not have an incentive to choose $0 < \alpha(B) \leq \alpha^{sep}$, because the transaction does not take place as the bank does not give a bank credit and hence she makes losses. For $\alpha(B) = \alpha^{sep}$, the supplier still makes zero profits and thus has no incentive to deviate to α^{sep}.

The bank updates its belief according to Bayes' rule and sets $\sigma = 1$ when $\alpha = \alpha^{sep}$. If $\alpha = 0$, the bank updates its belief according to Bayes' rule and sets $\sigma = 0$ and hence denies a credit. Thus, $[(\alpha(G) = \alpha^{sep}, \alpha(B) = 0)$, (gives bank credit at interest rate $\frac{1+\bar{r}_B}{\lambda}$, gives no bank credit), $Pr(G|\alpha \geq \alpha^{sep}) = 1$ and $Pr(G|0 \leq \alpha < \alpha^{sep}) = 0]$ is a perfect Bayesian equilibrium.

Illustration of Proposition 3:

Note that condition (1.18) requires the suppliers' refinancing costs not to be too high

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

and the adverse selection problem to be severe

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

In Figure A.1, the shaded area gives all the parameter combinations satisfying (1.18).

```
In[6]:= RegionPlot[1.08 * 2 / σ^2 > 2 * (1 + RSU) - 1 (RSU - 0.08), {σ, 0.1, 0.9}, {RSU, 0.5, 6
         }, FrameLabel → {σ, RSU}]
```

Out[6]=

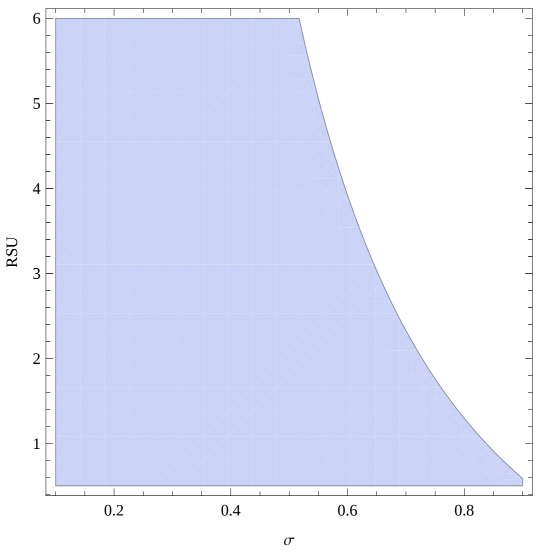

Figure A.1: Graphical Illustration of Proposition 3

This shows by example that the parameter set for which $(1+\beta)^{SC/BC} < (1+\beta)^{BC}$ is non-empty. In fact, for reasonable parameter constellations the productivity threshold for supplier credit and bank credit financing is almost always below the one for pure bank credit financing.

Proof of Proposition 4

Given the belief of the bank $Pr(G|\alpha \geq \alpha^{sep}) = 1$, $Pr(G|0 \leq \alpha < \alpha^{sep}) = 0$ and $Pr(G|\alpha(G) = \alpha(B)) = \sigma$ both suppliers have no incentive to deviate. They will not deviate to a higher α as their profits decrease in α (see above). Furthermore, they will not unilaterally decrease α as they will not get any bank credit then. Thus, in this case the bank does not learn anything.

Proof of Proposition 5

Comparing (1.17) with (1.21), we can derive that the minimum productivity level in the separating equilibrium lies below the one in the pooling equilibrium:

$$\frac{4(1+\bar{r}_B)(F+F_{EX})\left[\underline{c}(\bar{r}_B-\bar{r}_{SC})+\bar{c}(1+\bar{r}_{SC})\right]}{p^2\bar{q}_2} < \frac{4(1+\bar{r}_B)F\left[\sigma(\bar{c}-\underline{c})(1+\bar{r}_{SC})+\underline{c}(1+\bar{r}_B)\right]}{(\sigma p)^2\bar{q}_2}$$
$$\sigma^2(\bar{c}-\underline{c})(1+\bar{r}_{SC})+\sigma^2\underline{c}(1+\bar{r}_B) < \sigma(\bar{c}-\underline{c})(1+\bar{r}_{SC})+\underline{c}(1+\bar{r}_B)$$

Firms with a productivity level $(1+\beta) \in \left[(1+\beta)^{pool}, (1+\beta)^{BC}\right]$ with $(1+\beta)^{pool} < (1+\beta)^{BC}$, can play both the separating or the pooling equilibrium. To say which equilibrium they prefer, we have to compare the expected profits of both equilibria. In the separating equilibrium, only the good suppliers participate. Therefore, we have to multiply the profits of the separating equilibrium with the probability that the supplier is good (σ). Only if the supplier is good, the costs are incurred and the revenues are realized. In the pooling equilibrium, both types of suppliers participate. The pooling equilibrium is never played by the exporter if:

$$\sigma\pi_{EX}^{sep} > \pi_{EX}^{pool}$$
$$(1-\sigma)(1+\bar{r}_B)(F+F_{EX}) > \frac{1}{2}p\sigma\left[x^{pool}-x^{sep}\right].$$

This is always fulfilled, as the quantity produced by the exporter is always smaller in the pooling equilibrium than in the separating equilibrium. Thus, the separating equilibrium Pareto-dominates the pooling equilibrium. Playing the pooling equilibrium only has disadvantages. The exporter incurs the fixed costs and pays part of the variable costs to the supplier but does not get any revenues from selling its products if the supplier is of bad quality. It can still be better than using only bank credit financing as the exporter only pays a part of the variable costs and not the whole variable costs to the supplier.

Every pooling equilibrium where $0 \leq \alpha(T) < \alpha^{sep}$ is Pareto-dominated by the separating equilibrium independent of beliefs. Furthermore, there does not exist any other pooling equilibrium with $\alpha > \alpha^{sep}$ as the bad supplier will always make negative profits.

A.2 Empirical Appendix

Table A.1: Description of Variables

Variable	Definition
SC	Logarithm of trade accounts payable divided by total assets
BC	Logarithm of bank debt divided by total assets
Tangibles	Logarithm of tangible assets divided by total assets
Salesgrowth	Sales of period t divided by sales of period $t-1$ minus 1, $((sales_t/sales_{t-1})-1)$
Constrain	0/1 dummy indicating whether firms feel financially constrained or not This is the case if either the question whether the firm is constrained in its production due to financial constraints is answered with "yes" or if the question on how the firm judges the willingness of banks to give credits to firms is answered with "restrictive".
EXP	0/1 dummy indicating whether a firm exports or not A firm is classified as an exporter if it exports its product at least 2 months in a year.
Labprod	Productivity of a firm measured as $\ln(sales/employees)$
Sales	Logarithm of sales
SCliab	Logarithm of trade accounts payable divided by total liabilities
BCliab	Logarithm of bank debt divided by total liabilities

Table A.2: Robustness Check: Using Sales as a Size Measure

Dep. Var.	(1) BC	(2) BC	(3) BC	(4) BC
SC	-3.431*	-4.145**	-3.572**	-3.896**
	(1.889)	(2.024)	(1.417)	(1.871)
tangibles	0.946	1.184*	1.003**	1.101*
	(0.615)	(0.698)	(0.491)	(0.641)
salesgrowth	-0.027	-0.0307*	-0.0277*	-0.0293*
	(0.0184)	(0.0185)	(0.0147)	(0.016)
constrain	7.212*	6.651*	6.336**	5.724
	(4.218)	(3.953)	(3.131)	(3.567)
constrain*SC	1.876	1.611		
	(1.332)	(1.307)		
constrain*SC*EXP			1.6548**	1.424
			(0.8354)	(1.0100)
EXP	-0.495	-0.548	-0.3792	-0.4058
	(0.738)	(0.734)	(0.6883)	(0.708)
sales	1.321	1.635*	1.383**	1.538*
	(0.815)	(0.908)	(0.609)	(0.817)
year dummies	yes	yes	yes	yes
Observations	1,720	1,720	1,720	1,720
No. of companies	410	410	410	410
No. of instruments	23	20	25	21
Lags used	2+3	2	2+3	2
AR(1)	0.003	0.007	0.001	0.004
AR(2)	0.327	0.327	0.233	0.263
AR(3)	0.812	0.912	0.706	0.829
Hansen (p-value)	0.832	.	0.970	.

BC stands for bank credit, which is our dependent variable. The variable bank credit is divided by total assets and the logarithm is taken. *SC* stands for supplier credit. Supplier credit is measured by trade accounts payable divided by total assets and the logarithm is taken. *sales* stands for the logarithm of sales. *tangibles* stands for the share of tangible assets a firm has relative to total assets. Again the logarithm is taken. *salesgrowth* is calculated as sales of period t divided by sales of period $t-1$ minus 1 ($(sales_t/sales_{t-1})-1$). *SC*constrain* is an interaction term of the fraction of supplier credit used and a dummy variable indicating whether a firm feels financially constrained. *SC*constrain*EXP* is a triple interaction term of supplier credit used, the financial constraints dummy and a dummy variable indicating whether a firm is an exporter. In columns 1 and 3, we use the two-step GMM estimator with Windmeijer finite sample corrected standard errors using the second and the third lag as instruments for the endogenous variables. In columns 2 and 4, we only use the second lag as instrument.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A.3: Robustness Check: Scaling Supplier Credit and Bank Credit by Total Liabilities

	(1)	(2)	(3)	(4)
Dep. Var.	BCliab	BCliab	BCliab	BCliab
SCliab	-3.549**	-3.657**	-3.102**	-3.881**
	(1.720)	(1.633)	(1.291)	(1.532)
tangibles	1.153*	1.195*	1.008**	1.270**
	(0.634)	(0.856)	(0.498)	(0.609)
salesgrowth	-0.020	-0.020	-0.017	-0.019
	(0.013)	(0.012)	(0.012)	(0.013)
constrain	3.395	4.093	4.458*	3.479
	(4.009)	(3.214)	(2.663)	(2.764)
constrain*SCliab	1.121	1.186		
	(1.350)	(1.091)		
constrain*SCliab*exp			1.356*	0.993
			(0.813)	(0.905)
exp	0.309	0.332	0.271	0.352
	(0.335)	(0.338)	(0.321)	(0.344)
labprod	1.037*	1.063*	0.839	1.124**
	(0.609)	(0.589)	(0.442)	(0.552)
year dummies	yes	yes	yes	yes
Observations	1,720	1,720	1,720	1,720
No. of companies	410	410	410	410
No. of instruments	23	20	25	21
Lags used	2+3	2	2+3	2
AR(1)	0.005	0.005	0.002	0.003
AR(2)	0.330	0.340	0.305	0.292
AR(3)	0.998	0.869	0.754	0.785
Hansen (p-value)	0.666	.	0.656	.

BCliab stands for bank credit, which is our dependent variable. The variable bank credit is divided by total liabilities and the logarithm is taken. *SCliab* stands for supplier credit. Supplier credit is measured by trade accounts payable divided by total liabilities and the logarithm is taken. *labprod* is measured by the logarithm of sales over the number of employees. *tangibles* stands for the share of tangible assets a firm has relative to total assets. Again the logarithm is taken. *salesgrowth* is calculated as sales of period t divided by sales of period $t-1$ minus 1 $((sales_t/sales_{t-1})-1)$. *SCliab*constrain* is an interaction term of the fraction of supplier credit used and a dummy variable indicating whether a firm feels financially constrained. *SCliab*constrain*EXP* is a triple interaction term of supplier credit used, the financial constraints dummy and a dummy variable indicating whether a firm is an exporter. In columns 1 and 3, we use the two-step GMM estimator with Windmeijer finite sample corrected standard errors using the second and the third lag as instruments for the endogenous variables. In columns 2 and 4, we only use the second lag as instrument.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

B Appendix to Chapter 2

B.1 Theoretical Appendix

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.

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

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

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

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

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

Conditions (1) and (2) describe the participation constraints of the high- and the low-quality importer when extending the share α of the purchasing price $\check{p}x$ in advance. Conditions (3) and (4) are the incentive compatibility constraints of both importer 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

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

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 α^{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

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

Part of the total invoice amount is received with certainty up front, the rest is received with probability λ 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 (B.1), we can derive the optimal quantity exported and the minimum productivity level necessary for exporting:

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

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

Proof of Proposition 2

Consider the strategies and beliefs specified in Proposition 2. For these strategies and beliefs to form a pooling perfect Bayesian equilibrium, the following conditions have to hold:

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

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

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

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

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

where α denotes any share of CIA extended by the importer except α^{Pool}. 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 α. Furthermore, they will not unilaterally decrease α 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

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

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

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

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

Proof of Proposition 3

A comparison of (2.11) with (2.13), reveals that $(1+\beta)_{Ex}^{Sep} < (1+\beta)_{Ex}^{Pool}$ since $\mu < 1$. Similarly, from comparing (2.13) with (2.5) 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 partial 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 μ 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

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

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

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

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 $(1+\bar{r}_{Im})$, (B.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 μ) and the importer's refinancing costs are high. They prefer playing the pooling perfect Bayesian equilibrium if quality uncertainty is high (low μ) and the importer's refinancing costs are low.

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

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

Thus, the pooling equilibrium becomes more preferable, the higher the productivity of the firm.

B.2 Empirical Appendix

Table B.1: Decomposition of Firms According to Sectors

Sector	Number of firms	Share of firms (%)
Mining and quarrying	10	0.84
Construction	239	19.98
Manufacturing	221	18.48
Transportation, storage, and communication	73	6.10
Wholesale, retail, and repairs	267	22.32
Real estate, renting and business services	244	20.40
Hotels and restaurants	66	5.52
Other services	76	6.35
Total number of firms	1,196	100

Table B.2: Description of Variables

Outcome variable	
Exp	0/1 dummy for firms that sell a positive share of their sales abroad
Independent endogenous regressors	
DCIArec	0/1 dummy for firms that receive a positive share of their sales before delivery of the products or services
LogCIArec	Log percentage share of total sales received before delivery of the products or services
Independent exogenous regressors	
LogAge	Log firm age in years
LogSize	Log number of full-time employees
LogLabprod	Log(total sales/number of employees)
CompNum	Number of competitors in the national market with regard to the main product line or main line of services (range 0, 1, 2, 3, or 4 and more, coded as 4)
ForPressure	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
Univeduc	Percentage of workforce that has a university education or higher
Foreign	0/1 dummy for firms of which 10% or more is foreign owned
Instruments	
PublicInfo	0/1 dummy for firms for which trade fairs and other public sources of information are extremely important as potential source about new customers
Specificity	Ordinal variable that is equal to: *1* for firms whose customers buy from competitors instead if the firm raises the price of the main product line or main service line by 10% *2* for firms whose customers continue to buy from the firm but at much lower quantities if the firm raises the price of the main product line or main service line by 10% *3* for firms whose customers continue to buy from the firm but at slightly lower quantities if the firm raises the price of the main product line or main service line by 10% *4* for firms whose customers continue to buy from the firm in the same quantities if the firm raises the price of the main product line or main service line by 10%

All variables are measures or projected estimates of firm characteristics for the year 2004.

Table B.3: Effect of *DCIArec* on Export Participation - 2SLS

Dep. Var.	(1) DCIArec	(2) Exp	(3) DCIArec	(4) Exp	(5) DCIArec	(6) Exp
	2SLS		2SLS		2SLS	
DCIArec		0.236		0.774**		0.438**
		(0.233)		(0.392)		(0.206)
LogAge	-0.0422**	0.0129	-0.0448**	0.0388	-0.0415**	0.0214
	(0.0203)	(0.0164)	(0.0201)	(0.0267)	(0.0203)	(0.0174)
LogSize	0.0475***	0.0299**	0.0501***	0.00234	0.0469***	0.0198
	(0.0103)	(0.0145)	(0.0103)	(0.0229)	(0.0103)	(0.0137)
LogLabprod	0.0310	0.0391**	0.0391**	0.0175	0.0318*	0.0317**
	(0.0189)	(0.0152)	(0.0191)	(0.0232)	(0.0190)	(0.0159)
Univeduc	0.00290***	0.000305	0.00286***	-0.00104	0.00282***	-0.000305
	(0.000801)	(0.000845)	(0.000777)	(0.00138)	(0.000790)	(0.000832)
CompNum	-0.00463	0.00400	-0.000142	0.00923	0.00234	0.00488
	(0.0140)	(0.00855)	(0.0142)	(0.0132)	(0.0143)	(0.00977)
ForPressure	-0.0140	0.144***	0.00308	0.147***	-0.00712	0.145***
	(0.0333)	(0.0260)	(0.0333)	(0.0350)	(0.0333)	(0.0284)
Foreign	-0.0320	0.342***	-0.0455	0.371***	-0.0325	0.348***
	(0.0516)	(0.0452)	(0.0508)	(0.0591)	(0.0515)	(0.0484)
PublicInfo	0.0966***				0.0941***	
	(0.0326)				(0.0328)	
Specificity			0.0376**		0.0372**	
			(0.0152)		(0.0153)	
Constant	0.0929	-0.0904	0.169	-0.142	0.170	-0.108
	(0.114)	(0.0783)	(0.120)	(0.116)	(0.120)	(0.0874)
Observations	1,124	1,124	1,135	1,135	1,124	1,124
R^2	0.060	0.322	0.059	-0.484	0.065	0.123
F-Stat		36.05		19.27		28.99
First Stage F-Stat	8.76		6.09		7.57	
Hansen J-Stat	-		-		1.84	
χ^2 p-value	-		-		(0.1753)	

Sector fixed effects are included in all regressions. Heteroskedastic robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table B.4: Effect of *LogCIArec* on Export Participation - 2SLS

	(1) LogCIArec	(2) Exp	(3) LogCIArec	(4) Exp	(5) LogCIArec	(6) Exp
	2SLS		2SLS		2SLS	
LogCIArec		0.0702		0.216**		0.130**
		(0.0691)		(0.0987)		(0.0585)
LogAge	-0.117**	0.0112	-0.124**	0.0310	-0.114*	0.0181
	(0.0585)	(0.0154)	(0.0582)	(0.0220)	(0.0585)	(0.0162)
LogSize	0.123***	0.0325***	0.130***	0.0131	0.121***	0.0247**
	(0.0283)	(0.0124)	(0.0284)	(0.0166)	(0.0282)	(0.0117)
LogLabprod	0.0825	0.0406***	0.107*	0.0246	0.0852	0.0347**
	(0.0547)	(0.0145)	(0.0552)	(0.0192)	(0.0549)	(0.0151)
Univeduc	0.00871***	0.000379	0.00850***	-0.000660	0.00841***	-0.000160
	(0.00237)	(0.000784)	(0.00229)	(0.00110)	(0.00233)	(0.000750)
CompNum	-0.0349	0.00536	-0.0208	0.0136	-0.0103	0.00737
	(0.0420)	(0.00902)	(0.0424)	(0.0130)	(0.0422)	(0.0101)
ForPressure	-0.0853	0.147***	-0.0309	0.156***	-0.0611	0.150***
	(0.0955)	(0.0259)	(0.0952)	(0.0323)	(0.0956)	(0.0277)
Foreign	0.000447	0.334***	-0.0289	0.342***	-0.00142	0.334***
	(0.153)	(0.0451)	(0.151)	(0.0540)	(0.153)	(0.0481)
PublicInfo	0.325***				0.316***	
	(0.0947)				(0.0948)	
Specificity			0.135***		0.131***	
			(0.0444)		(0.0447)	
Constant	0.237	-0.0851	0.532	-0.125	0.508	-0.0976
	(0.327)	(0.0768)	(0.347)	(0.102)	(0.342)	(0.0836)
Observations	1,124	1,124	1,135	1,135	1,124	1,124
R^2	0.063	0.333	0.061	-0.177	0.071	0.188
F-Stat		36.30		24.49		31.03
First Stage F-Stat	11.76		9.20		10.33	
Hansen J-Stat	-		-		1.78	
χ^2 p-value	-		-		(0.1818)	

Sector fixed effects are included in all regressions. Heteroskedastic robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

C Appendix to Chapter 3

C.1 Theoretical Appendix Closed Economy

Proof of Proposition 1

Comparative statics of the wage rate in the closed economy:

- The higher the bargaining power parameter of unions, the higher the wage:

$$\frac{\partial w(\phi)}{\partial \gamma} = \frac{1}{1-\theta+\theta\epsilon}\left\{\frac{1-\gamma-\epsilon+\gamma\theta(1-\epsilon)}{1-\epsilon}\left(\frac{\alpha E}{\epsilon P}\right)^{\theta}\left(\frac{\epsilon}{(\epsilon-1)\phi}\right)^{\theta-\theta\epsilon}\left[(1-u)\tilde{w}\right]^{1-\theta}\right\}^{\frac{\theta-\theta\epsilon}{1-\theta+\theta\epsilon}}$$
$$\frac{\theta(1-\epsilon)-1}{1-\epsilon}\left(\frac{\alpha E}{\epsilon P}\right)^{\theta}\left(\frac{\epsilon}{(\epsilon-1)\phi}\right)^{\theta-\theta\epsilon}\left[(1-u)\tilde{w}\right]^{1-\theta} > 0.$$

- The higher the productivity of the firm, the higher the wage:

$$\frac{\partial w(\phi)}{\partial \phi} = \frac{1}{1-\theta+\theta\epsilon}\left\{\frac{1-\gamma-\epsilon+\gamma\theta(1-\epsilon)}{1-\epsilon}\left(\frac{\alpha E}{\epsilon P}\right)^{\theta}\left(\frac{\epsilon}{(\epsilon-1)\phi}\right)^{\theta-\theta\epsilon}\left[(1-u)\tilde{w}\right]^{1-\theta}\right\}^{\frac{\theta-\theta\epsilon}{1-\theta+\theta\epsilon}}$$
$$(\theta-\theta\epsilon)\phi^{\theta\epsilon-\theta-1}\frac{1-\gamma-\epsilon+\gamma\theta(1-\epsilon)}{1-\epsilon}\left(\frac{\alpha E}{\epsilon P}\right)^{\theta}\left(\frac{\epsilon}{\epsilon-1}\right)^{\theta-\theta\epsilon}\left[(1-u)\tilde{w}\right]^{1-\theta} > 0.$$

- The lower the unemployment rate, the higher the wage:

$$\frac{\partial w(\phi)}{\partial u} = \frac{1}{1-\theta+\theta\epsilon}\left\{\frac{1-\gamma-\epsilon+\gamma\theta(1-\epsilon)}{1-\epsilon}\left(\frac{\alpha E}{\epsilon P}\right)^{\theta}\left(\frac{\epsilon}{(\epsilon-1)\phi}\right)^{\theta-\theta\epsilon}\left[(1-u)\tilde{w}\right]^{1-\theta}\right\}^{\frac{\theta-\theta\epsilon}{1-\theta+\theta\epsilon}}$$
$$(1-\theta)\left[(1-u)\tilde{w}\right]^{-\theta}(-\tilde{w}) < 0.$$

- The higher the average wage paid outside the firm, the higher the wage:

$$\frac{\partial w(\phi)}{\partial \tilde{w}} = \frac{1}{1-\theta+\theta\epsilon}\left\{\frac{1-\gamma-\epsilon+\gamma\theta(1-\epsilon)}{1-\epsilon}\left(\frac{\alpha E}{\epsilon P}\right)^{\theta}\left(\frac{\epsilon}{(\epsilon-1)\phi}\right)^{\theta-\theta\epsilon}\left[(1-u)\tilde{w}\right]^{1-\theta}\right\}^{\frac{\theta-\theta\epsilon}{1-\theta+\theta\epsilon}}$$
$$(1-\theta)\left[(1-u)\tilde{w}\right]^{-\theta}(1-u) > 0.$$

- The higher the aggregate income or the share of income used for the differentiated good sector, the higher the wage:

$$\frac{\partial w}{\partial(\alpha E)} = \frac{1}{1-\theta+\theta\epsilon}\left\{\frac{1-\gamma-\epsilon+\gamma\theta(1-\epsilon)}{1-\epsilon}\left(\frac{\alpha E}{\epsilon P}\right)^{\theta}\left(\frac{\epsilon}{(\epsilon-1)\phi}\right)^{\theta-\theta\epsilon}[(1-u)\tilde{w}]^{1-\theta}\right\}^{\frac{\theta-\theta\epsilon}{1-\theta+\theta\epsilon}}$$
$$\theta(\alpha E)^{\theta-1}(\epsilon P)^{-\theta}\frac{1-\gamma-\epsilon+\gamma\theta(1-\epsilon)}{1-\epsilon}\left(\frac{\epsilon}{(\epsilon-1)\phi}\right)^{\theta-\theta\epsilon}[(1-u)\tilde{w}]^{1-\theta} > 0.$$

- The higher the rent sharing parameter, the higher or the lower the wage.

  In order to simplify the derivation, we first take the logarithm of (3.10):

$$ln(w(\phi)) = ln\left[\frac{\epsilon-1+\gamma+\gamma\theta(\epsilon-1)}{\epsilon-1}\right]\frac{1}{1+\theta(\epsilon-1)} + ln\left[\frac{\alpha E}{\epsilon P}\left(\frac{(\epsilon-1)\phi}{\epsilon}\right)^{\epsilon-1}\right]\frac{\theta}{1+\theta(\epsilon-1)}$$
$$+ ln\left[(1-u)\tilde{w}\right]\frac{1-\theta}{1+\theta(\epsilon-1).} \qquad \text{(C.1)}$$

  Hence, differentiating (C.1) with respect to θ yields

$$\frac{\partial ln(w(\phi))}{\partial\theta} = \frac{\gamma(\epsilon-1)+\gamma\theta(\epsilon-1)^2}{\epsilon+\gamma-1+\gamma\theta(\epsilon-1)} - ln\left[\frac{\epsilon+\gamma-1+\gamma\theta(\epsilon-1)}{\epsilon-1}\right](\epsilon-1)$$
$$ln\left[\frac{\alpha E}{\epsilon P}\left(\frac{(\epsilon-1)\phi}{\epsilon}\right)^{\epsilon-1}\right] - ln\left[(1-u)\tilde{w}\right]\epsilon \lesseqgtr 0.$$

  We cannot say whether $\frac{\partial ln(w(\phi))}{\partial\theta}$ is smaller or larger than zero. However, it can be shown that $\frac{\partial ln(w(\phi))}{\partial\theta}$ increases with the productivity

$$\frac{\partial ln(w(\phi))}{\partial\theta\partial\phi} = \frac{\epsilon-1}{\phi} > 0.$$

  Hence, the higher the productivity level, the more likely the wage increases with a higher rent sharing parameter.

Derivation of ϕ^* in the closed economy

Using $M = (1 - G(\phi^*))N$ and (3.13), ϕ^* is given by

$$\phi^* = \left[\frac{K}{Nf}\frac{\alpha\left(k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)}{(1-\alpha)k\epsilon + \alpha\left(k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)}\right]^{-\frac{1}{k}}. \tag{C.2}$$

Proof of Proposition 2

The cutoff productivity level decreases with the rent sharing parameter:

$$\begin{aligned}\frac{\partial\phi^*}{\partial\theta} =& -\frac{1}{k}\left[\frac{K}{Nf}\frac{\alpha\left(k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)}{(1-\alpha)k\epsilon + \alpha\left(k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)}\right]^{-\frac{1}{k}-1} \\ & \frac{K}{Nf}\frac{\frac{(\epsilon-1)^2}{(1+\theta(\epsilon-1))^2}\left[(1-\alpha)k\epsilon + \alpha\left(k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)\right] - \alpha\left(k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)\alpha\frac{(\epsilon-1)^2}{(1+\theta(\epsilon-1))^2}}{\left[(1-\alpha)k\epsilon + \alpha\left(k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)\right]^2} < 0.\end{aligned}$$

The number of successful entrants in the economy increases with the rent sharing parameter:

$$\frac{\partial M}{\partial\theta} = \frac{K}{f}\frac{\alpha\frac{(\epsilon-1)^2}{[1+\theta(\epsilon-1)]^2}(1-\alpha)k\epsilon}{\left[(1-\alpha)k\epsilon + \alpha\left(k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)\right]^2} > 0.$$

The unemployment rate depending only on exogenous variables

Inserting (3.11) and (3.13) into (3.15) yields

$$\begin{aligned}u =& 1 - \left\{\frac{K}{L}\frac{\alpha k(\epsilon-1)}{(1-\alpha)k\epsilon + \alpha\left(k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)}\right\}^{\frac{\theta\epsilon}{1+\theta(\epsilon-1)}}\left\{\frac{\epsilon+\gamma-1+\gamma\theta(\epsilon-1)}{\epsilon-1}\left(\frac{\alpha E}{\epsilon P}\right)^{\theta}\right. \\ & \left.\left(\frac{\epsilon-1}{\epsilon}\right)^{\theta(\epsilon-1)}\left(\frac{k}{k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}}\right)^{\theta(1+\theta(\epsilon-1))}\left[\frac{K}{Nf}\frac{\alpha\left(k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)}{(1-\alpha)k\epsilon + \alpha\left(k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)}\right]^{\frac{\theta(1-\epsilon)}{k}}\right\}^{\frac{1}{\theta(1-\epsilon)-1}}.\end{aligned}$$

Proof of Proposition 3

- The unemployment rate increases with an increase in the union's bargaining power. Thus, stronger unions lead to higher unemployment:

$$\frac{\partial u}{\partial \gamma} = \left\{ \frac{M}{L} \frac{kf(\epsilon-1)}{k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}} \right\}^{\frac{\theta\epsilon}{1+\theta(\epsilon-1)}} \frac{1}{1+\theta(\epsilon-1)}$$
$$\left\{ \frac{\epsilon - 1 + \gamma + \theta\gamma(\epsilon-1)}{\epsilon-1} \left(\frac{\alpha E}{\epsilon P}\right)^{\theta} \left(\frac{(\epsilon-1)\tilde{\phi}}{\epsilon}\right)^{\theta(\epsilon-1)} \right\}^{\frac{2+\theta(\epsilon-1)}{\theta(1-\epsilon)-1}} \left(\frac{\alpha E}{\epsilon P}\right)^{\theta}$$
$$\left(\frac{(\epsilon-1)\tilde{\phi}}{\epsilon}\right)^{\theta(\epsilon-1)} \frac{1+\theta(\epsilon-1)}{\epsilon-1} > 0.$$

- The unemployment rate increases with the average productivity (wage effect dominates):

$$\frac{\partial u}{\partial \tilde{\phi}} = \left\{ \frac{M}{L} \frac{kf(\epsilon-1)}{k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}} \right\}^{\frac{\theta\epsilon}{1+\theta(\epsilon-1)}} \frac{1}{1+\theta(\epsilon-1)}$$
$$\left\{ \frac{\epsilon - 1 + \gamma + \theta\gamma(\epsilon-1)}{\epsilon-1} \left(\frac{\alpha E}{\epsilon P}\right)^{\theta} \left(\frac{(\epsilon-1)\tilde{\phi}}{\epsilon}\right)^{\theta(\epsilon-1)} \right\}^{\frac{2+\theta(\epsilon-1)}{\theta(1-\epsilon)-1}} \left(\frac{\alpha E}{\epsilon P}\right)^{\theta}$$
$$\left(\frac{(\epsilon-1)}{\epsilon}\right)^{\theta(\epsilon-1)} \frac{\epsilon - 1 + \gamma + \gamma\theta(\epsilon-1)}{\epsilon-1} \tilde{\phi}^{\theta(\epsilon-1)-1}\theta(\epsilon-1) > 0.$$

- The higher the number of successful entrants, the lower the unemployment rate:

$$\frac{\partial u}{\partial M} = -\frac{\theta\epsilon}{1+\theta(\epsilon-1)} \left\{ \frac{1}{L} \frac{kf(\epsilon-1)}{k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}} \right\}^{\frac{\theta\epsilon}{1+\theta(\epsilon-1)}} M^{\frac{\theta\epsilon}{1+\theta(\epsilon-1)}-1}$$
$$\left\{ \frac{\epsilon - 1 + \gamma + \theta\gamma(\epsilon-1)}{\epsilon-1} \left(\frac{\alpha E}{\epsilon P}\right)^{\theta} \left(\frac{(\epsilon-1)\tilde{\phi}}{\epsilon}\right)^{\theta(\epsilon-1)} \right\}^{\frac{1}{\theta(1-\epsilon)-1}} < 0.$$

- The higher the rent sharing parameter, the higher the unemployment rate, if the operational profits of the average firm are larger than the average wage of employed workers:

$$\frac{\partial u}{\partial \theta} = -\frac{1}{M}\frac{\partial M}{\partial \theta} + \frac{(\epsilon-1)^2}{\left[k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}\right]\left[1+\theta(\epsilon-1)\right]^2} - ln\left[\frac{M}{L}\frac{kf(\epsilon-1)}{k-\frac{\epsilon-1}{1+\theta(\epsilon-1)}}\right]\frac{1}{1+\theta(\epsilon-1)}$$
$$+ \frac{\gamma(\epsilon-1)}{\epsilon+\gamma-1+\gamma\theta(\epsilon-1)} + (\epsilon-1)\frac{1}{\tilde{\phi}}\frac{\partial\tilde{\phi}}{\partial\theta}\theta + ln\left[\frac{\alpha E}{\epsilon P}\left(\frac{(\epsilon-1)\tilde{\phi}}{\epsilon}\right)^{\epsilon-1}\right]\frac{1}{1+\theta(\epsilon-1)}$$
$$- ln\left[1+\frac{\gamma(1+\theta(\epsilon-1))}{\epsilon-1}\right]\frac{\epsilon-1}{1+\theta(\epsilon-1)} > 0.$$

As $\bar{w} = \frac{M}{L}\frac{kf(\epsilon-1)}{k-\frac{\epsilon-1}{1+\theta(\epsilon-1)}}$ and $\frac{\pi(\tilde{\phi})+f}{w(\tilde{\phi})}$, this is fulfilled if

$$\pi(\tilde{\phi}) + f > (1-u)\tilde{w}^2,$$

as $\frac{\partial M}{\partial \theta} > 0$ and $\frac{\partial \tilde{\phi}}{\partial \theta} < 0$ as well as the other terms being in a negligible order of magnitude (smaller or close to 1) compared to the operational profits and the average wage.

C.2 Theoretical Appendix Open Economy

Determination of ϕ_t^*

To determine ϕ_t^* we use:

$$\pi_n^t(\phi_t^*) = 0$$
$$(1+\tau^{1-\epsilon})\frac{r_n(\phi_t^*)}{\epsilon} - f = 0$$
$$\frac{r_n(\phi_t^*)}{\epsilon} = \frac{f}{1+\tau^{1-\epsilon}}$$

$$\frac{r_n(\phi_t^*)}{\epsilon} = \frac{f}{1+\tau^{1-\epsilon}}$$
$$\frac{\alpha E}{P}\left(\frac{\epsilon w_n(\phi_t^*)}{(\epsilon-1)\phi_t^*}\right)^{1-\epsilon} = \frac{\epsilon f}{1+\tau^{1-\epsilon}}$$

Plugging in $w_n(\phi_t^*)$ yields:

$$\phi_t^* = \left\{ \frac{(\epsilon-1)^{1-\epsilon} f}{\epsilon^{-\epsilon}\left(1+\tau^{1-\epsilon}\right)} \frac{P}{\alpha E} \right\}^{\frac{1-\theta+\theta\epsilon}{\epsilon-1}} \left\{ \frac{1-\gamma-\epsilon+\gamma\theta(1-\epsilon)}{1-\epsilon} \left[\frac{\alpha E}{\epsilon P} \left(\frac{\epsilon}{\epsilon-1}\right)^{1-\epsilon} \left(1+\tau^{1-\epsilon}\right) \right]^{\theta} ((1-u)\tilde{w})^{1-\theta} \right\}. \tag{C.3}$$

Determination of ϕ_m^*

To determine ϕ_m^* we use:

$$\begin{aligned} \Delta\pi^t(\phi_m^*) &= 0 \\ \frac{r_n(\phi_m^*)}{\epsilon} &= \frac{f_m}{2\omega^{\epsilon-1} - (1+\tau^{1-\epsilon})} \\ \left(\frac{w_n(\phi_m^*)}{\phi_m^*}\right)^{1-\epsilon} &= \frac{P f_m (\epsilon-1)^{1-\epsilon}}{\alpha E (2\omega^{\epsilon-1} - (1+\tau^{1-\epsilon}))\epsilon^{-\epsilon}} \end{aligned}$$

Plugging in $w_n(\phi_m^*)$ yields:

$$\phi_m^* = \left\{ \frac{(\epsilon-1)^{1-\epsilon} f_m P}{\epsilon^{-\epsilon}\left[2\omega^{\epsilon-1} - (1+\tau^{1-\epsilon})\right]\alpha E} \right\}^{\frac{1-\theta+\theta\epsilon}{\epsilon-1}} \left\{ \frac{1-\gamma-\epsilon+\gamma\theta(1-\epsilon)}{1-\epsilon} \left[\frac{\alpha E}{\epsilon P} \left(\frac{\epsilon}{\epsilon-1}\right)^{1-\epsilon} \left(1+\tau^{1-\epsilon}\right) \right]^{\theta} ((1-u)\tilde{w})^{1-\theta} \right\}. \tag{C.4}$$

Is There an MNE Wage Premium?

$$\omega \equiv \frac{w_n(\phi)}{w_m(\phi)} = \left\{ \frac{(\epsilon+\gamma-1+\gamma\theta(\epsilon-1))(1-\gamma\tau^{1-\epsilon})(1+\tau^{1-\epsilon})^{\theta}}{(\epsilon+\gamma-1-\gamma\epsilon\tau^{1-\epsilon}+\gamma\theta(1-\tau^{1-\epsilon})(\epsilon-1))2^{\theta}} \right\}^{\frac{1}{1+\theta(\epsilon-1)}} \lesseqgtr 1$$

Reformulating it, we obtain

$$\underbrace{\left[\left(1+\tau^{1-\epsilon}\right)^{\theta}-2^{\theta}\right]}_{<0}\underbrace{\left[\epsilon+\gamma-1-\gamma\theta-\gamma\epsilon\tau^{1-\epsilon}+(\gamma+1)\left[\gamma\theta\tau^{1-\epsilon}-\gamma\theta\epsilon\tau^{1-\epsilon}\right]\right]}_{>0}$$
$$+\underbrace{\left[\gamma\theta\epsilon-\gamma^{2}\tau^{1-\epsilon}+\gamma\tau^{1-\epsilon}\right]\left(1+\tau^{1-\epsilon}\right)}_{>0}\lesseqgtr 0 \quad \text{cannot be clearly shown}$$

How does ω change with γ?

If $\gamma = 0$: $\omega = \left\{\frac{(1-\epsilon)(1+\tau^{1-\epsilon})^{\theta}}{(1-\epsilon)2^{\theta}}\right\}^{\frac{1}{1-\theta+\theta\epsilon}} < 1$, as $2^{\theta} > (1+\tau^{1-\epsilon})^{\theta}$ for $\tau > 1$ and $\epsilon > 1$.
If $\gamma = 1$: $\omega = \left\{\frac{(-\epsilon+\theta(1-\epsilon))(1-\tau^{1-\epsilon})(1+\tau^{1-\epsilon})^{\theta}}{(-\epsilon+\theta(1-\epsilon))(1-\tau^{1-\epsilon})2^{\theta}}\right\}^{\frac{1}{1-\theta+\theta\epsilon}} < 1$.
From $\frac{\partial\omega}{\partial\gamma} = 0$, one can obtain an implicit solution for γ

$$A = \gamma^{2}\left[\tau(\epsilon+\epsilon\theta-\theta)-\tau^{\epsilon}(1+\epsilon\theta-\theta)\right]+2\gamma\tau^{\epsilon}(1-\epsilon)+\tau^{\epsilon}(\epsilon-1)=0.$$

The second derivative is negative:

$$\frac{\partial A}{\partial\gamma} = 2\gamma\left[\tau(\epsilon+\theta(\epsilon-1))-\tau^{\epsilon}(1+\theta(\epsilon-1))\right]-2\tau^{\epsilon}(\epsilon-1) < 0,$$

as

$$2\tau\gamma(\epsilon+\theta(\epsilon-1)) < 2\tau^{\epsilon}(\gamma+\gamma\theta(\epsilon-1)+\epsilon-1)$$
$$\underbrace{(\tau^{\epsilon-1}-1)}_{>0}\underbrace{(\epsilon\gamma\theta-\gamma\theta)}_{>0}+\underbrace{(1-\gamma)(\epsilon-1)}_{>0} > 0.$$

Thus, $\frac{\partial A}{\partial\gamma} < 0$.

Using the implicit function theorem we can show that the optimal γ is decreasing in θ:

$$\frac{\partial\gamma}{\partial\theta} = -\frac{\frac{\partial A}{\partial\theta}}{\frac{\partial A}{\partial\gamma}} < 0,$$

as $\frac{\partial A}{\partial\theta} = (\tau(\epsilon-1)-\tau^{\epsilon}(\epsilon-1))\gamma^{2} < 0$. Thus, the optimal γ decreases with θ.

Derivation of γ^*

We can derive a solution for γ where $\omega = 1$ holds:

$$\gamma_{1/2} = -\frac{(-1+\theta-\theta\epsilon-\tau^{1-\epsilon}+\epsilon\tau^{1-\epsilon})\left[(1+\tau^{1-\epsilon})^{\theta}-2^{\theta}\right]}{(1+\tau^{1-\epsilon})^{\theta}2(\tau^{1-\epsilon}-\theta\tau^{1-\epsilon}+\theta\epsilon\tau^{1-\epsilon})}$$
$$\pm\sqrt{\left(\frac{(-1+\theta-\theta\epsilon-\tau^{1-\epsilon}+\epsilon\tau^{1-\epsilon})\left[(1+\tau^{1-\epsilon})^{\theta}-2^{\theta}\right]}{(1+\tau^{1-\epsilon})^{\theta}2(\tau^{1-\epsilon}-\theta\tau^{1-\epsilon}+\theta\epsilon\tau^{1-\epsilon})}\right)^{2}-\frac{(1-\epsilon)\left[(1+\tau^{1-\epsilon})^{\theta}-2^{\theta}\right]+1}{(1+\tau^{1-\epsilon})^{\theta}2(\tau^{1-\epsilon}-\theta\tau^{1-\epsilon}+\theta\epsilon\tau^{1-\epsilon})}}.$$

As $\frac{(-1+\theta-\theta\epsilon-\tau^{1-\epsilon}+\epsilon\tau^{1-\epsilon})\left[(1+\tau^{1-\epsilon})^{\theta}-2^{\theta}\right]}{(1+\tau^{1-\epsilon})^{\theta}2(\tau^{1-\epsilon}-\theta\tau^{1-\epsilon}+\theta\epsilon\tau^{1-\epsilon})} > 0$, there is only one solution for γ where $\omega = 1$:

$$\gamma^{*} = -\frac{(-1+\theta-\theta\epsilon-\tau^{1-\epsilon}+\epsilon\tau^{1-\epsilon})\left[(1+\tau^{1-\epsilon})^{\theta}-2^{\theta}\right]}{(1+\tau^{1-\epsilon})^{\theta}2(\tau^{1-\epsilon}-\theta\tau^{1-\epsilon}+\theta\epsilon\tau^{1-\epsilon})}$$
$$+\sqrt{\left(\frac{(-1+\theta-\theta\epsilon-\tau^{1-\epsilon}+\epsilon\tau^{1-\epsilon})\left[(1+\tau^{1-\epsilon})^{\theta}-2^{\theta}\right]}{(1+\tau^{1-\epsilon})^{\theta}2(\tau^{1-\epsilon}-\theta\tau^{1-\epsilon}+\theta\epsilon\tau^{1-\epsilon})}\right)^{2}-\frac{(1-\epsilon)\left[(1+\tau^{1-\epsilon})^{\theta}-2^{\theta}\right]+1}{(1+\tau^{1-\epsilon})^{\theta}2(\tau^{1-\epsilon}-\theta\tau^{1-\epsilon}+\theta\epsilon\tau^{1-\epsilon})}}.$$

If $\gamma^* > 0$, then w_n and w_m have the same slope.

Determination of ϕ_t^*

Using $M = (1 - G(\phi_t^*))N$ and (3.25) the cutoff productivity level is given by:

$$\phi_t^{*} = \left[\frac{K}{N(\mu f + f_m)}\frac{\alpha\left(k-\frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)}{\alpha\left(k-\frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)+(1-\alpha)2\epsilon k(1+\tau^{1-\epsilon})}\right]^{-\frac{1}{k}}.$$

Determination of ϕ_m^*

Using (3.20) and $\mu = \left(\frac{\phi_m^*}{\phi_t^*}\right)^{-k}$ the cutoff productivity level for an MNE is given by:

$$\phi_m^{*} = \left[\frac{f}{f_m}\left(\frac{2\omega^{\epsilon-1}}{1+\tau^{1-\epsilon}-1}\right)\right]^{\frac{1+\theta(\epsilon-1)}{1-\epsilon}}\left[\frac{K}{N(\mu f + f_m)}\frac{\alpha\left(k-\frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)}{\alpha\left(k-\frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)+(1-\alpha)2\epsilon k(1+\tau^{1-\epsilon})}\right]^{-\frac{1}{k}}.$$

Exact expressions of $\bar{w}_n$ and $\bar{w}_m$

(3.21) yields

$$\begin{aligned}\bar{w}_n =& k\left\{\frac{1-\gamma-\epsilon+\gamma\theta(1-\epsilon)}{1-\epsilon}\left[\frac{\alpha E}{\epsilon P}\left(\frac{\epsilon-1}{\epsilon}\right)^{\epsilon-1}(1+\tau^{1-\epsilon})\right]^{\theta}[(1-u)\tilde{w}]^{1-\theta}\right\}^{\frac{1}{1+\theta(\epsilon-1)}} \\ & \frac{1+\theta(\epsilon-1)}{\theta(\epsilon-1)-k(1-\theta(\epsilon-1)}\left[\phi_m^{*\frac{\theta\epsilon}{1+\theta(\epsilon-1)}-k}-\phi^{*\frac{\theta\epsilon}{1+\theta(\epsilon-1)}-k}\right]\left(\phi^{*-k}-\phi_m^{*-k}\right).\end{aligned}$$

(3.22) yields

$$\begin{aligned}\bar{w}_m =& k\left\{\frac{\epsilon-1+\gamma(1-\epsilon\tau^{1-\epsilon})-\gamma\theta(1-\tau^{1-\epsilon})}{(\epsilon-1)(1-\gamma\tau^{1-\epsilon})}\left[2\frac{\alpha E}{\epsilon P}\left(\frac{\epsilon-1}{\epsilon}\right)^{\epsilon-1}\right]^{\theta}[(1-u)\tilde{w}]^{1-\theta}\right\}^{\frac{1}{1+\theta(\epsilon-1)}} \\ & \frac{\theta(1-\epsilon)-1}{\theta(\epsilon-1)-k(1-\theta(\epsilon-1)}\phi_m^{*\frac{\theta\epsilon}{1+\theta(\epsilon-1)}-k}\phi_m^{*-k}.\end{aligned}$$

Derivation of $\hat{\phi}$

The price index in the open economy is given by:

$$P = M(1+\tau^{1-\epsilon})\int_{\phi_t^*}^{\phi_m^*} p_n(\phi)^{1-\epsilon}\frac{g(\phi)}{1-G(\phi_t^*)}d\phi + M2\omega^{\epsilon-1}\int_{\phi_m^*}^{\infty} p_n(\phi)^{1-\epsilon}\frac{g(\phi)}{1-G(\phi_t^*)}d\phi.$$

Using $\frac{p_n(\phi)}{p_n(\hat{\phi})} = \frac{\hat{\phi}}{\phi}$ yields:

$$P = \frac{Mp(\hat{\phi})^{1-\epsilon}}{\hat{\phi}^{\frac{1-\epsilon}{\theta-\theta\epsilon-1}}}\left[1+\tau^{1-\epsilon}\int_{\phi_t^*}^{\phi_m^*}\phi^{\frac{1-\epsilon}{\theta-\theta\epsilon-1}}\frac{g(\phi)}{1-G(\phi_t^*)}d\phi + \omega^{\epsilon-1}\int_{\phi_m^*}^{\infty}\phi^{\frac{1-\epsilon}{\theta-\theta\epsilon-1}}\frac{g(\phi)}{1-G(\phi_t^*)}d\phi\right].$$

Substituting $1-G(\phi_t^*) = \phi^{*-k}$ and $g(\phi) = k\phi^{-k-1}$ gives:

$$\hat{\phi}^{\frac{1-\epsilon}{\theta-\theta\epsilon-1}} = \frac{k}{k-\frac{1-\epsilon}{\theta-\theta\epsilon-1}}\phi^{*\frac{1-\epsilon}{\theta-\theta\epsilon-1}}\left(\frac{f_m}{f}\mu+1\right),$$

which yields

$$\hat{\phi} = \left[\frac{k(1+\tau^{1-\epsilon})}{k-\frac{1-\epsilon}{\theta-\theta\epsilon-1}}\left(1+\mu\frac{f_m}{f}\right)\right]^{\frac{1-\theta+\theta\epsilon}{\epsilon-1}}\phi_t^*.$$

Comparison of the number of active firms in the closed and the open economy

$$M^c < M^o$$

$$f\left[(1-\alpha)k\epsilon + \alpha\left(k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)\right] < (f+\mu f_m)\left[(1-\alpha)2k\epsilon(1+\tau^{1-\epsilon}) + \alpha\left(k - \frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)\right]$$

Comparison of the per worker labor income in the closed and the open economy

$$\bar{w}^o > \bar{w}^c$$

$$2(1+\tau^{1-\epsilon})(f+\mu f_m)\frac{K}{f+\mu f_m}\frac{\alpha\left(k-\frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)}{(1-\alpha)2k\epsilon(1+\tau 11-\epsilon)+\alpha\left(k-\frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)} > f\frac{K}{f}\frac{\alpha\left(k-\frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)}{(1-\alpha)k\epsilon+\alpha\left(k-\frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)}$$

$$2(1+\tau^{1-\epsilon}) > 1$$

Proof of Proposition 6

Plugging (3.25) into (3.26) and substituting $(1-\mu)\bar{w}_n + \mu\bar{w}_m = \tilde{w}$, the derivative of the unemployment rate with respect to μ yields

$$\frac{\partial u}{\partial \mu} = \frac{K}{L}\frac{2(\epsilon-1)k(1+\tau^{1-\epsilon})\alpha}{\alpha\left(k-\frac{\epsilon-1}{1+\theta(\epsilon-1)}\right)+(1-\alpha)2\epsilon k(1+\tau^{1-\epsilon})}\tilde{w}^{-2}\frac{\partial\tilde{w}}{\partial\mu}.$$

$\frac{\partial u}{\partial \mu} < 0$ if $\frac{\partial \tilde{w}}{\partial \mu} < 0$, therefore, $\bar{w}_m + \mu\frac{\partial\bar{w}_m}{\partial\mu} < \bar{w}_n + \mu\frac{\partial\bar{w}_m}{\partial\mu} - \frac{\partial\bar{w}_m}{\partial\mu}$ has to hold.

D Appendix to Chapter 4

Description of the Estimation Sample

Our estimation sample comprises all firms that have at least one affiliate, in at least one of the years between 1999 and 2006, and in at least one of the 33 countries listed in Table D.3. Hence, we consider only German outward FDI. Furthermore, we exclude indirect FDI from our estimation sample. We only consider countries in which at least 5 affiliates are located. We do not consider holding companies. Furthermore, we exclude all non-firms from the estimation sample, meaning the public sector. As the reporting thresholds have changed over this period of time, we consider all firms which hold 50 percent or more of the shares or voting rights of a foreign enterprise with a balance sheet total of more than 3 million Euro. We also deflate the balance sheet total to make the data comparable over time. Moreover, we exclude those affiliate sectors that are related to natural resources in order to rule out resource driven location decisions. Therefore, we drop affiliates that are in the following sectors: agriculture, hunting and related service activities; forestry, logging and related service activities; fishing, operation of fish hatcheries and fish farms, service activities incidental to fishing; Mining of coal and lignite, extraction of peat; extraction of crude petroleum and natural gas, service activities incidental to oil and gas extraction; mining of uranium and thorium ores; mining; mining and quarrying, other mining.

We inflate the dataset such that each parent firm for every existing affiliate can invest in every country in every year. Our regression sample contains 47 affiliate sectors. The list of affiliate sectors can be found in Table D.4. The number of countries in our sample is limited to 33 due to limited data availability of our country characteristics.

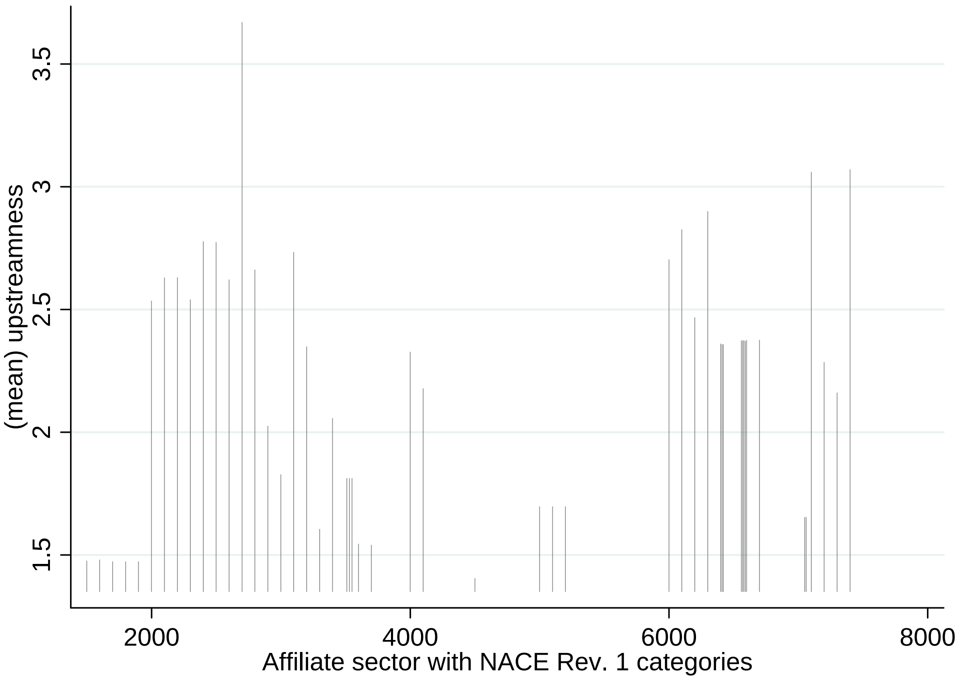

Figure D.1: Average Upstreamness over Early and Mid 2000 for Each Affiliate Sector

Table D.1: Variation over Time of Upstreamness Variable

Sector	Upstr. early 2000	Ranking	Sector	Upstr. mid 2000	Ranking	Difference
Least Upstream Sectors			*Least Upstream Sectors*			
Hotels and restaurants	1.377689	1	Hotels and restaurants	1.304348	1	0
Construction sector	1.403966	2	Construction sector	1.404301	2	0
Manufacture of food products and beverages	1.46033	3	Manufacture of textiles	1.473903	3	1
Manufacture of textiles	1.471855	4	Manufacture of food products and beverages	1.498023	4	-1
Manufacture of furniture, manufacturing n.e.c.	1.496699	5	Manufacture of furniture, manufacturing n.e.c.	1.622484	5	0
Manufacture of medical, precision and optical instruments	1.552934	6	Housing enterprises	1.650911	6	1
Housing enterprises	1.655782	7	Manufacture of medical, precision and optical instruments	1.66992	7	-1
Wholesale trade and comission trade	1.698581	8	Wholesale trade and comission trade	1.69424	8	0
Manufacture of office machinery and computers	1.726448	9	Building and repairing of ships and boats	1.814354	9	1
Building and repairing of ships and boats	1.80522	10	Manufacture of office machinery and computers	1.954503	10	-1
Most Upstream Sectors			*Most Upstream Sectors*			
Manufacture of other non-metallic mineral products	2.58185	38	Manufacture of wood and wood products	2.653881	38	-2
Manufacture of metal products	2.588107	39	Manufacture of other non-metallic mineral products	2.690833	39	-1
Manufacture of pulp, paper and paper products	2.644286	40	Land transport; transport via pipelines	2.698803	40	2
Manufacture of electrical machinery and apparatus n.e.c.	2.658266	41	Manufacture of chemicals and chemical products	2.713494	41	3
Land transport; transport via pipelines	2.705867	42	Manufacture of metal products	2.773042	42	-3
Manufacture of rubber and plastic products	2.713238	43	Manufacture of electrical machinery and apparatus n.e.c.	2.834763	43	-2
Manufacture of chemicals and chemical products	2.826606	44	Manufacture of rubber and plastic products	2.861197	44	-1
Other business activities	3.012105	45	Renting of equipment and of personal and household goods	3.117577	45	1
Renting of equipment and of personal and household goods	3.01784	46	Other business activities	3.17558	46	-1
Manufacture of basic metals	3.648685	47	Manufacture of basic metals	3.698032	47	0

Table D.2: List of Dependent and Explanatory Variables

Variable	Description	Mean	Std. Dev.
FDI Dummy	Dummy variable indicating whether a parent firm has invested in a specific sector in a country in a year	0.0414	0.1991
Average Schooling	Variable measuring country's endowment with human capital	9.1501	2.2769
Total Factor Productivity	Variable measuring a country's TFP level relative to the United States	0.6996	0.2463
log Total Factor Productivity	Logarithm of TFP as variable is skewed	-0.4332	0.4190
Wage	Variable measuring factor costs	1,954.881	1,278.548
log Wage	Logarithm of wage as variable is skewed	7.2317	0.9833
Market Entry	Variable measuring the performance of countries in terms of the cost of starting a new business	7.9044	1.8317
Remoteness	Variable measuring the distance of the host country from all other countries in the world weighted by their share of world GDP	842,949.9	265,602.4
log Remoteness	Logarithm of remoteness as variable is skewed	13.6008	0.2878
Upstreamness	Variable capturing at which stage of a production process an affiliate sector is located	2.1354	0.5373
Rule of Law	Variable measuring contract enforceability and protection of property rights in a country	3.4664	0.9090
Financial Development	Variable measuring a country's financial development as the ratio of private credit to GDP	0.8832	0.4814
log Financial Development	Logarithm of financial development as variable is skewed	-0.3455	0.7542
Capital Intensity	Variable measuring capital intensity as the log physical capital per worker	1,219,008	650,990.4
log Capital Intensity	Logarithm of capital intensity as variable is skewed	13.7353	0.9062
absolute GDP	Variable measuring a country's absolute GDP	1.01e+12	2.22e+12
Log absolute GDP	Logarithm of absolute GDP as variable is skewed	26.58	1.29
Affiliate Number	Number of German Affiliates in a country in a year	150.79	159.23
Log Affiliate Number	Logarithm of Affiliate Number as variable is skewed	4.43	1.21
Comparative Advantage	Dummy indicating whether a country has a comparative advantage in a sector	0.39	0.49
Labor productivity	Labor productivity measured as output per person employed	36,733	15,909
Log Labor productivity	Logarithm of Labor productivity as variable is skewed	10.35	0.66

Table D.3: List of Countries in the Estimation Sample

Argentina	Sweden
Australia	Thailand
Austria	Turkey
Belgium	United Kingdom
Brazil	United States
Cyprus	Venezuela
Denmark	
Egypt	*Additional countries (52 sample):*
Finland	Switzerland
France	Morocco
Greece	Tunisia
Hong Kong	Nigeria
India	Kenya
Ireland	South Africa
Israel	Canada
Italy	Guatemala
Japan	Panama
Luxembourg	Columbia
Mexico	Ecuador
Netherlands	Chile
Norway	Uruguay
Pakistan	Iran
Peru	Sri Lanka
Philippines	Indonesia
Portugal	Malaysia
Singapore	China
Spain	Republic of Korea

Table D.4: List of Affiliate Sectors in the Estimation Sample with Nace Rev. 1 categories

1500	Manufacture of food products and beverages
1600	Manufacture of tobacco products
1700	Manufacture of textiles
1800	Manufacture of textile products
1900	Manufacture of leather and leather products
2000	Manufacture of wood and wood products
2100	Manufacture of pulp, paper and paper products
2200	Publishing, printing and reproduction or recorded media
2300	Manufacture of coke, refined petroleum products and nuclear fuel
2400	Manufacture of chemicals and chemical products
2500	Manufacture of rubber and plastic products
2600	Manufacture of other non-metallic mineral products
2700	Manufacture of basic metals
2800	Manufacture of metal products
2900	Manufacture of machinery and equipment
3000	Manufacture of office machinery and computers
3100	Manufacture of electrical machinery and apparatus
3200	Manufacture of radio, television and communication equipment and apparatus
3300	Manufacture of medical, precision and optical instruments, watches and clocks
3400	Manufacture of motor vehicles, trailers and semi-trailers
3500	Manufacture of other transport equipment
3600	Manufacture of furniture, manufacturing n.e.c.
3700	Recycling
4000	Electricity, gas, steam and hot water supply
4100	Collection, purification and distribution of water
4500	Construction
5000	Sale, repair of motor vehicles, retail sale of automotive fuel
5100	Wholesale trade and commission trade
5200	Retail trade
5500	Hotels and restaurants
6000	Land transport, transport via pipelines
6100	Water transport
6200	Air transport
6300	Supporting and auxiliary transport activities; activities of travel agencies
6400	Post and telecommunications
6560	Other credit institutions
6570	Financial leasing
6580	Other financial intermediaries
6590	Investmentfunds
6600	Insurance and pension funding
6700	Activities auxiliary to financial intermediation
7050	Housing enterprises
7060	Other real estate activities
7100	Renting of machinery and equipment without operator and of personal and household goods
7200	Computer and related activities
7300	Research and development
7400	Other business activities

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