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EUI Working Papers

TOWARDS A THEORY OF TRADE FINANCE

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EUI Working Paper **ECO** 2009/43

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December 7, 2009

Abstract

Cross border transactions are conducted using different payment contracts, the usage of which varies across countries and over time. In this paper I build a model that can explain this observation and study implications from this for international trade. In the model exporters optimally choose payment contracts, trading off differences in enforcement and efficiency between financial markets in different countries. I find that the ability of firms to switch contracts is central to the reaction of trade to variations in financial conditions. Numerical experiments with a two-country version of the model suggest that limiting the choice between payment contracts reduces traded quantities by up to 60 percent.

1   Introduction

Transactions in international trade are conducted using different payment contracts. These can be broadly classified into Cash in Advance, Open Account and bank intermediated contracts. Evidence suggests that usage of payment contracts varies both across countries and over time. Current trade theory does not address these contracts. To understand why different payment contracts are used by different firms and what effects these have on international trade, a suitable model is needed.

In this paper I develop a theory of trade finance that explains the co-existence of the different financing forms depending on enforcement and cost of financing, and analyze the trade-offs faced by exporters. The model shows that the impact of variations in financial conditions on trade significantly depends on the ability of firms to switch contracts. Furthermore, it predicts that the choice of payment contract shapes variable trade costs and that FOB prices vary systematically with payment contracts and financial market conditions. In a two-country version of the model numerical experiments are conducted. I find that limiting the choice between payment contracts reduces traded quantities by up to 60 percent. In an extension I introduce repeated transactions and show that these can explain the empirical observation that trade credit intensive industries are less affected by a financial crisis.

While several recent papers have analyzed the effect of the exporter's financial market on participation decisions or exported quantities, none have examined the interaction of financial conditions in the sending and receiving countries. A setup featuring the choice of payment contract between an importer and an exporter has not been studied before. Taking into account characteristics of both financial markets gives rise to interesting interactions. Depending on which payment contract is chosen by an exporter, different parameters of the two financial markets are relevant. Choosing a payment contract allows to substitute away from the least favorable conditions. In a model taking into account the exporter financial market only, this substitution is not possible. Then, exporters are fully affected by any changes of financial conditions in their market.

I model three types of payment contracts: Cash in Advance (CIA), Open Account (OA) and Letter of Credit (LC). With Cash in Advance, the importer pays the trade before receiving the goods. Under Open Account the importer only pays after receiving the goods. The third payment contract considered is a Letter of credit, in which banks act as intermediaries resolving

the enforcement problem.[1]

The main findings are as follows. CIA is more likely to be used if enforcement at home is strong and if financing costs abroad are low. OA is more likely if enforcement abroad is strong and financing costs at home are low. LC is used if enforcement is relatively weak and interest rate costs are relatively low in both countries. Costs arising from trade finance take the form of variable costs that are proportional to the value traded, i.e. they correspond to the iceberg formulation often used in international trade. When financing costs or enforcement probabilities change, firms can react by switching payment contracts. In this respect, the time horizon in which firms are able to switch payment contracts is important. In the very short run switching contract might be difficult. It could imply a fixed cost, which would limit the switching. However, in the short run it could still be easier to switch to a different payment contract between two trading partners than to switch bank for any of them.

When repeated transactions are considered, under certain conditions, trigger strategies can improve on the one shot equilibria when CIA or OA are used. These trigger strategies are more likely to be optimal when the expected number of repeated transactions is large and when enforcement probabilities are high. In this case CIA and OA become more attractive relative to a LC. This prediction is in line with the notion that LCs are used relatively more when trade relationships have a shorter time horizon, whereas especially OA is more common in long term relationships. It can also explain the finding that trade relationships, in which more trade credit, i.e CIA and OA, is used, might be less affected by financial crisis than relationships using trade credit less intensively, as reported by Levchenko, Lewis, and Tesar (2009).

The model predicts asymmetric reactions of trade flows to financial turmoil. If there is country-specific financial turmoil, firms are able to partially mitigate adverse effects by switching payment contracts. If there is global financial turmoil that affects both the financial markets of the exporter and the importer, this possibility does no longer exist and trade flows react more strongly to a crisis. This suggests that in the current global financial crisis trade finance might have a stronger effect on aggregate trade flows than in former more locally concentrated ones. The model predicts differences between South-North and South-South trade volumes that are absent in models on financing constraints in which only the exporter's financial market conditions play a role. There is an additional effect of the choice of payment contract on FOB

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[1]I represent all bank intermediated transactions by the LC. They usually involve banks both in the importer's and exporter's country and the usage of some form of documentation upon which payment is being made by a bank to the exporter. For an introduction to the different types of trade finance payment contracts see U.S. Department of Commerce (2008).

prices besides determining a part of variable trade costs. As the payment contract arranges who has to bear financing costs, the payment to be paid by the importer can be discounted depending on the timing of the transaction.

There are several theoretical papers that have addressed the issue of financial market conditions and international trade. Kletzer and Bardhan (1987) show how sovereign default risk and credit market imperfections can result in differences in interest rates and tightness of credit rationing in equilibrium respectively and thus create comparative advantage. In Matsuyama (2005) the share of revenues an entrepreneur can pledge towards wage payments differs between countries leading to comparative advantage.[2]

Chaney (2005) develops a theoretical model analyzing financial constraints in a heterogenous firms trade model based on Melitz (2003). Firms have to finance their fixed entry cost into foreign markets through own liquidity and domestic operating profits. Liquidity is introduced as a second type of heterogeneity. He derives conditions on productivity and liquidity under which a firm exports. Manova (2008) extends this model and estimates it using the methodology suggested by Helpman, Melitz, and Rubinstein (2008). She introduces a default probability similar to the one used in this paper. While in her model there is a domestic enforcement problem between a bank and a firm, in this paper the enforcement problems arise between firms in different countries.

Her model has been further extended to a dynamic setting taking into account capital accumulation by Suwantaradon (2008). In Chaney (2005), Manova (2008) and Suwantaradon (2008) only domestic financial market conditions are relevant for the exporting decisions of firms. In this paper in contrast the effects of conditions in the financial markets of both the exporter and the importer, determined by the optimal choice between payment contracts, are analyzed.

Some articles study empirically the interaction between financial conditions and trade. The role of financial development for trade in manufactures is studied in Beck (2002) and Beck (2003). Using data from 65 and 56 countries respectively he finds that financial development of a country has a strong effect on export volumes of manufactures and that this effect is stronger in external finance intensive industries.[3]

Some recent papers test for effects of financial constraints on the extensive margin of trade using firm level data. Greenaway, Guariglia, and Kneller (2007) use UK manufacturing firm level

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[2]The broader issue of institutional constraints, trade and outsourcing has been studied extensively. For a survey see Helpman (2006).

[3]Svaleryd and Vlachos (2005) find evidence on patterns of industrial specialization and financial market condition that point in the same direction.

data and find no evidence for a causal effect of ex-ante financial health on export participation. French firm level data analyzed by Berman and Héricourt (2008) seems to point in the opposite direction.[4]

There is a policy debate on the effects an importance of trade finance in general and during a financial crisis.[5] The effects of financial crisis on trade have been assessed empirically by several papers. Ronci (2004) analyzes data from 10 financial crises and finds evidence for a negative effect of financial crises both on imports and exports. Iacovone and Zavacka (2009) analyze data from 23 banking crises. They find a differential effect of a banking crisis on firms that rely on bank finance versus firms that rely on inter-bank credit. This supports the prediction of the model that inter-firm credit relations are an important factor for mitigating financial crisis. Evidence on firm level trade finance of African exporters is documented by Humphrey (2009). Berman and Martin (2009) analyze how financial crisis affects trade and find that disruption from financial crisis is stronger and longer lasting for African than for other countries. Using data on U.S. imports, Levchenko, Lewis, and Tesar (2009) analyze causes of the current international trade decline and argue that trade credit did not play a role. I discuss in Section 5 on repeated contracts how this finding can be explained and why trade finance might be more important than suggested by this result. Amiti and Weinstein (2009) use data on Japanese exporters matched with Japanese banks to study the transmission of financial shocks during the financial crisis in the 1990s. They find that one third of the decline in Japanese exports in that period can be explained by the a bank firm trade finance channel. This confirms the relevance of financing conditions on the side of the exporter. The theory proposed here suggests, that in addition to this, there are effects arising from the financing conditions of the importer and the interaction of the two.

The rest of the paper is organized as follows. Section 2 develops a microeconomic model of the choice of payment contract. Section 3 puts this model into an intra-industry trade framework. Section 4 derives the general equilibrium and studies a quantitative example. Section 5 extends the analysis to repeated transactions. Section 6 discusses implications of payment contracts during financial crisis, on trade patterns, and on FOB prices. Section 7 concludes.

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[4]Other papers analyzing this are Berthou (2007), Espanol (2007), Berthou (2008), Stiebale (2008) and Bellone, Musso, Nesta, and Schiavo (2008). Zia (2008) analyzes the effects of export subsidies on exporting behavior. Baltensperger and Herger (2007) test the effects of export insuring schemes.

[5]See Stephens (1998), Auboin and Meier-Ewert (2003) and Auboin (2007). In the context of the current financial crisis trade finance has received a renewed attention. See Chauffour and Farole (2009) and Dorsey (2009).

2 Payment Forms

2.1 Overview

There are three types of payment contracts available to finance trade transactions: Cash-in Advance, Open Account and Bank Intermediated transactions.

Figure 1 based on data from IMF (2009) illustrates some survey evidence on the usage of these different payment forms.[6] While Open Account seems to be the dominant financing form, the share of the other two groups is also quantitatively important. The survey suggests that during the current financial crisis the usage of open account has declined, whereas the two payment forms that limit the risk of exporters have increased their shares. This evidence is in line with the prediction of the model that changes in financial market conditions cause switches of payment contracts. Evidence on the effect of the crisis on the choice of payment forms in ICC (2009) suggests that the current crisis might lead to a renaissance of the Letter of Credit. That is, given rising uncertainty, firms rely more on the safest payment contract available, which is the Letter of Credit. It is also stated there that 50-60 percent of China's foreign trade is financed with LCs. This indicates that in a less financially developed country like China bank intermediated transactions are used relatively more often.

Here figure 1

2.2 Micro Model

The following section introduces a simple microeconomic model for the choice of finance of an exporter. Besides transport costs, I consider two additional cost factors in international trade relative to domestic trade. First, the time delay between production and the realization of sales is longer for international than domestic transactions. Hummels (2001) discusses the effect of physical transport time while Djankov, Freund, and Pham (2006) analyze the effect of time delay from the factory gate to the means of transportation on international trade. Both show that international trade has a relevant time dimension. The latter document that procedures specific to trade across international borders are responsible for additional delays. Second, enforcement at the international level is more difficult than domestically.[7] This can be due to differences in

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[6]Unfortunately to my knowledge currently only survey data is available. Thus the numbers should be seen as a reference point.

[7]Enforcement might also be a problem at the domestic level. In the model I abstract from this and analyze only international enforcement problems. The enforcement probability is thus best interpreted as representing

legal traditions, working languages or the limited willingness of countries to enforce international contracts to the same extent as national ones.[8] Due to the two additional sources of costs in international trade, time delay and enforcement problems, the choice of a payment contract is a determinant of variable trade costs.

Timing   The three payment contracts differ in the timing of payments relative to the delivery of goods and the amount of risk that is incurred by the exporter and the importer respectively. Suppose there is one exporter and one importer. The exporter can make a take it or leave it offer to the importer.[9] There are two points in time. One before production, transport and sales and one afterwards. If producing, the exporter incurs production cost K at $t = 1$. If importing the importer realizes sales revenues of R at $t = 2$.[10]

First consider only CIA and OA. The difference between these two forms of finance is whether the payment is made before or after realization of the revenues. If the importer pays before the exporter delivers the goods, I call it CIA. If the importer pays after receiving the goods and realizing sales revenues, I call it OA.[11] A third option is a bank-intermediated payment contract. As discussed above, I represent all contracts belonging to this group by a Letter of Credit. This is an instrument offered by financial institutions to improve security in international trade. First the importer pays the amount due in advance to a local bank.[12] This bank then transfers the money to the bank of the exporter, which upon receipt of delivery documents pays out the money received. Assuming full enforcement at the bank level, a LC completely solves the enforcement

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the additional enforcement problems arising in the international context.

[8]A complementary factor to the enforcement risk could be individual firm default. As counter-party risks can be hard to observe across borders, whether a trading partner will turn out to be insolvent or illiquid can be seen as a random variable from the point of view of the other party. Different to international enforcement risk though, the probability of failure of a firm would have an effect on the interest rate a firm is charged.

[9]In my analysis I give all negotiation power to the exporter. This leads to the result that under open account there are positive expected profits for the importer. If the importer would have all negotiation power then there would be positive expected exporter profits under CIA. There could also be some type of intermediate surplus sharing rules. The main mechanism of the model is driven by financing costs and enforcement and should not be affected by the distribution of negotiation power.

[10]In this part of the paper trade transactions in the model are one shot games. There is a large literature analyzing advantages of trade credit due to repeated transactions and supply-chain relationships. See Petersen and Rajan (1997), Biais and Gollier (1997), Wilner (2000), Burkart and Ellingsen (2004), Cunat (2007) and Fabbri and Menichini (forthcoming). In section 5, I introduce a survival probability of trade relationships and analyze under which conditions a simple trigger strategy can be implemented to improve upon the equilibrium of the one shot game.

[11]One could also think about intermediate types of contracts combining elements of both CIA and OA. Evidence does not suggest that these are used very much though. In the official brochure of the U.S. Department of Commerce (U.S. Department of Commerce (2008)) e.g. no intermediate forms are mentioned. One reason for a limited usage of these might be legal considerations, as ownership claims would be less clear.

[12]Often firms do not actually pay the amount to the bank in cash, but receive a credit for the amount and period of the LC against a fee. As I assume perfect enforcement in the domestic financial market, the two are equivalent as long as firms discount at the lending rate.

problem.[13] A LC implies additional costs as there are advance finance requirements for both the exporter and the importer plus any additional fees charged by the banks for offering LCs.[14]

The choice between these three forms of financing is relevant because of two imperfections in financing costs and enforcement.

Interest rates I assume that financial markets to finance international trade are segmented between countries and that the efficiencies of financial intermediaries in these countries differ. As a result interest rates to finance trade faced by firms in different countries can differ. In Appendix B I discuss a simple model rationalizing the different interest rates. There, both countries are small open economies facing a world interest rate. Due to segmented markets regarding credit at the firm level, differences in the efficiency of the financial intermediaries lead to differences between interest rates faced by firms in the two countries. Given this imperfection, ceteris paribus, it is optimal for the firm located in the country with the lower interest rate to finance a transaction.

Enforcement There is limited enforcement of contracts in two ways. First, there is an exogenous country-specific probability that a contract will be enforced, in the case that a firm does not want to fulfill it voluntarily.[15] In the case of CIA, it is the probability that the exporter is forced to deliver the goods after receiving the payment. In the case of OA, it is the probability that an importer has to pay the agreed upon price for the goods after receiving and selling them.[16] Second, the amount specified in the contract to be paid by the importer for the goods imported cannot exceed their total value at market prices.[17] The imperfection of limited enforcement leads, ceteris paribus, to finance being optimally done by the firm in the country with lower

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[13]This assumption will be relaxed in section 6 where changes in the national default risk will be explicitly allowed for.

[14]In the current version of the model I do not introduce any additional fees on top of the interest rates being charged to firms. Introducing a fee would make LCs less attractive. If during a crisis this fee changed to a different degree than interest rates, this would have an effect on the optimal choice of payment contracts and thus on outcomes of the model.

[15]This captures the reduced form of an enforcement game played between the importer and the exporter, which is affected by the legal institutions of the two countries. This could be extended to a model in which firms choose their legal expenditures to achieve or prevent enforcement. In that case the enforcement probability would change with the value at stake.

[16]For simplicity these two enforcement probabilities are assumed to be equal. It would be an interesting extension to consider an asymmetry here. This could be rationalized by the difference between the in-kind nature of an OA trade credit versus the cash nature of a CIA credit. For a formalization of this argument see Burkart and Ellingsen (2004).

[17]In order to enforce a trade contract in court the value specified in the contract has to be in some proportion to the real value of the goods traded. Technically this assumption is necessary in order for imperfect enforcement to have an effect on outcomes in the open account case. If this condition does not bind, any changes in enforcement risk would be offset by a proportional increase in the period 2 payment C^{OA}.

7

enforcement. Finally, LCs are used when enforcement problems are so large that they outweigh financing costs in the form of interest payments.

Thus, for moderate levels of enforcement problems, trade is, ceteris paribus, financed by the country with the lower interest rate and with the lower contract enforcement. If the two factors, interest rate costs and enforcement probabilities, can be found in different combinations across countries, this makes the choice of the financing form non-trivial. In the following I formally describe the three mentioned financing forms and derive conditions under which firms choose one of them over the others.

Cash in advance Under cash in advance the importer first pays an amount C^{CIA} to the exporter. Then with probability λ the contract is enforced. In this case the exporter produces the goods at cost K and delivers them to the importer, who sells them for R. The exporter makes a take it or leave it offer and has to respect the limited value of contract and the importer participation constraint. The expected profit maximization problem is:

$$\max_{C} \mathrm{E}\left[\Pi_E^{CIA}\right] = C^{CIA} - \lambda K,$$

$$\text{s.t. } C^{CIA} \leq R, \qquad\qquad\qquad\qquad\qquad \text{(limited value of contract)}$$

$$\text{and } \mathrm{E}\left[\Pi_I^{CIA}\right] = \lambda R - (1 + r^*)C^{CIA} \geq 0. \qquad \text{(participation constraint importer)}$$

Under CIA the trade transaction is financed by the importer. The exporter receives the payment before production and delivery of the product. There is the possibility that the exporter keeps the money and does not deliver the good. This happens with the exogenous probability of non-enforcement $1 - \lambda$. The participation constraint of the importer assures that taking the default probability into account, the expected profits of the importer are non-negative and thus the importer is willing to agree on the trade and to pre-finance it. As all negotiation power lies with the exporter and the limited value of contract never binds under CIA, the participation constraint binds under the optimal contract. The optimal payment C^{CIA} and optimal expected profits of the exporter are:

$$C^{CIA} = \frac{\lambda}{1 + r^*}R, \qquad \mathrm{E}\left[\Pi_E^{CIA}\right] = \frac{\lambda}{1 + r^*}R - \lambda K. \tag{1}$$

Note that λ appears in the optimal payment C^{CIA}. Thus the importer's payment is discounted by the probability of non-payment by the exporter. Under CIA production and delivery only takes place with probability λ.

Open account   Under open account first the exporter produces the goods at cost K and then delivers them to the importer. Next, the importer sells the goods for R. With probability λ^* the contract is enforced and the importer pays the amount C^{OA} to the exporter.

The profit maximization problem of the exporter is:

$$
\max_C \mathrm{E}\left[\Pi_E^{OA}\right] = \frac{1}{1+r}(\lambda^* C^{OA} - K(1+r)),
$$

$$
\text{s.t. } C^{OA} \leq R, \qquad\qquad\qquad\qquad\qquad \text{(limited value of contract)}
$$

$$
\text{and } \mathrm{E}\left[\Pi_I^{OA}\right] = \frac{1}{1+r^*}(R - \lambda^* C^{OA}) \geq 0, \qquad \text{(participation constraint importer)}
$$

assuming that the exporter and importer discount profits with their local interest rates.[18]

Now, the exporter pre-finances the trade interaction. The importer receives the goods before payment. With probability $1 - \lambda^*$ the importer is not forced to pay the exporter. Due to the limited value of contract constraint the maximum payment C^{OA} that is contractible is the sales value of the product R. Under this maximum payment the exporter is not able to extract all rents from the importer. Thus under open account the importer has positive ex-ante expected profits. There is no contract that allows the exporter to extract all surplus.[19]   The optimal payment amount C^{OA} and the optimal discounted expected exporter profits can be derived as:

$$
C^{OA} = R, \qquad \mathrm{E}\left[\Pi_E^{OA}\right] = \frac{\lambda^*}{1+r}R - K. \tag{2}
$$

Letter of credit   Under LC the financial transaction is secured via a bank in the country of the exporter and the importer, respectively. Under the assumption of no default at the bank level, this completely resolves the enforcement problem at the individual contract level[20]. The

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[18]In order to be able to compare profits between CIA and OA they have to be discounted to the same time period.

[19]This is true for any finite upper bound on the contractible payment level. Without an upper bound any change in enforcement probability could be offset by a proportional increase in C^{OA}. It is conceivable though that courts would not enforce amounts too disconnected from the real value of the trade.

[20]It is conceivable that full enforcement at the banking level is more likely than at the firm level. As banks tend to have more long-term relationships, reputation building and repeated transactions ease enforcement between them.

maximization problem of the exporter is:

$$\max_{C} \mathrm{E}\left[\Pi_E^{LC}\right] = \frac{1}{1+r}(C^{LC} - K(1+r)),$$

$$\text{s.t. } C^{LC} \leq R, \qquad\qquad\qquad\qquad\qquad\qquad \text{(limited value of contract)}$$

$$\text{and } \mathrm{E}\left[\Pi_I^{LC}\right] = \frac{1}{1+r^*}(R - (1+r^*)C^{LC}) \geq 0. \qquad \text{(participation constraint importer)}$$

With LCs both the exporter and the importer pre-finance the transaction and incur costs due to interest rate payments. The contract enforcement problem is resolved by an indirect transaction with banks as intermediaries. The importer does not directly pay the exporter, but first pays the amount C^{LC} to a local bank. The bank cooperates with a bank in the country of the exporter. The latter guarantees payment upon proof of delivery. Thus the exporter knows for certain that the payment will be made, but only receives it after production and delivery. In the case of LCs the participation constraint of the importer is binding. The optimal payment C^{LC} and discounted expected exporter profits are:

$$C^{LC} = \frac{R}{1+r^*}, \qquad \mathrm{E}\left[\Pi_E^{LC}\right] = \frac{1}{(1+r)(1+r^*)}R - K. \tag{3}$$

Note that as pre-financing takes place on both sides the interest rates from both markets affect profits. As enforcement risk is completely resolved, profits are independent of the enforcement parameters λ and λ^*.

Comparison   At this point, before an explicit demand structure is imposed, some statements on the optimality of the different payment contracts can be made. The four financial market parameters $r, r^*, \lambda, \lambda^*$ together with the production cost K and sales revenue R determine a unique ordering of the different payment forms as stated below[21]:

Proposition 1 *The optimal choice of payment contract is uniquely determined by the following*

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[21]Here I assume K and R to be exogenous and the same for all payment contracts. When introducing an explicit demand in the next section, different payment contracts imply different optimal levels of K and R.

three conditions:

$$i) \qquad OA \prec CIA \Longleftrightarrow \qquad \frac{K}{R} < \frac{\lambda^*(1+r^*) - \lambda(1+r)}{(1+r)(1+r^*)(1-\lambda)},$$

$$ii) \qquad OA \prec LC \Longleftrightarrow \qquad \lambda^*(1+r^*) > 1,$$

$$iii) \qquad LC \prec CIA \Longleftrightarrow \qquad \frac{K}{R} < \frac{1-\lambda(1+r)}{(1+r)(1+r^*)(1-\lambda)}.$$

Proof. Follows directly from comparing optimal discounted expected profits, Equations (1)-(3). ∎

Proposition 1 summarizes the different effects of the parameters on expected profits under the different financing forms. The usage of open account is increasing in enforcement abroad λ^* and decreasing in financing costs at home r. CIA is more likely to be used if enforcement at home λ is strong and if financing costs abroad r^* are high. LCs are used if enforcement is relatively weak (low λ, λ^*) and if financing costs are relatively low (low r, r^*).

3 The trade model

In the following I introduce a CES demand structure that is standard in intra-industry trade models. I analyze the effects of trade finance at the firm level in partial equilibrium. This allows to derive predictions of the model in a trade framework that could be taken to the data.

3.1 Basic Setup

Preferences Assume the following preferences:

$$U = Q^\mu q_0^{1-\mu} \quad \text{with } Q = \left(\int_\Omega q(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right)^{\frac{\sigma}{\sigma-1}}. \tag{4}$$

Q is a CES basket of a continuum of differentiated goods and q_0 is a homogenous good. There is a Cobb-Douglas utility function between the homogeneous good and the differentiated goods implying constant shares of income spent on differentiated goods and the homogeneous good, respectively. The demand for a single variety of the differentiated good has the standard form:

$$q(\omega) = p(\omega)^{-\sigma} P^\sigma Q.$$

11

ω denotes a variety of the differentiated goods. $P = \left(\int_{\omega \in \Omega} p(\omega)^{1-\sigma} \right)^{1-\sigma}$ is the price index of the optimal CES basket. $\sigma > 1$ is the elasticity of substitution between varieties and Q is the total demand for differentiated goods.

Technology   Labor is the only input factor. Firms in the homogenous goods sector face perfect competition. They operate a constant returns to scale technology requiring one unit of labor per unit of output. The homogenous good is freely traded. I only consider equilibria in which every country produces the homogenous good. This equalizes wages, which I normalize to one making the homogenous good the Numeraire. In the differentiated goods sector firms face monopolistic competition. Each variety is produced by only one firm. There is a fixed cost of entry into the market f. The production of one unit of the differentiated product requires a units of labor input. Thus the total labor requirement of a firm operating and producing quantity q is $l(a) = f + aq$. When selling a differentiated good abroad, a firm incurs iceberg type trade costs. In order for one unit of a differentiated product to arrive in the destination country, $\tau > 1$ units have to be shipped.

3.2   Optimal behavior of firms

Differentiated sector   Firms in the differentiated sector maximize their expected profits. Given CES utility and monopolistic competition firms optimally do markup pricing. Domestic prices, quantities and profits can be derived as:

$$ p_d = \frac{\sigma}{\sigma - 1} a, \qquad q_d = (p_d)^{-\sigma} P^\sigma Q, \qquad \Pi_d = q_d \left[\frac{a}{\sigma - 1} \right]. \tag{5} $$

Next, I derive the optimal behavior of firms on the export market. Optimal profits under all financing forms can be represented by the general expression:

$$ \mathrm{E}\left[\Pi_x \right] = \alpha R - \beta K. $$

This problem can be rewritten to $\mathrm{E}\left[\tilde{\Pi}_x \right] = \mathrm{E}\left[\frac{\Pi_x}{\alpha} \right] = R - \frac{\beta}{\alpha} K$. Maximizing the original objective function $\mathrm{E}\left[\Pi \right]$ implies the same optimal decisions as maximizing the new function $\mathrm{E}\left[\tilde{\Pi} \right]$. This price setting problem is equivalent to the standard case with new per unit production

12

costs of $\frac{\beta}{\alpha}a$.

Thus the optimal export decision of a firm implies:

$$p_x = \frac{\beta}{\alpha}\tau p_d^*, \qquad \mathrm{E}\left[q_x\right] = A\tau^{1-\sigma}q_d^*, \qquad \mathrm{E}\left[\Pi_x\right] = A\tau^{1-\sigma}\Pi_d^*, \tag{6}$$

with $A = \alpha^\sigma \beta^{1-\sigma}$.[22]

The finance profit factor A fully summarizes the effects of payment contracts on expected profits and expected quantities at the factory gate. $A = 1$ corresponds to no financing frictions, which would be the case if $r = r^* = 0$ and $\lambda = \lambda^* = 1$. Then expected profits are the same as in the standard model. Note that the parameters α and β enter the problem in a multiplicative form with the value of exports. Thus the model endogenizes some of the variable trade costs of trade arising from financing costs and the enforcement problem.[23]

Now that the explicit demand structure is defined, I can derive new conditions for the optimal financing forms. The profits and quantities under financing form 1 are larger than under financing form 2 iff:

$$A^1 > A^2.$$

Plugging in the different values for α and β delivers:[24]

Corollary 1 *The optimal choice of payment contract is uniquely determined by the following three conditions:*

     i) $OA \prec CIA \Longleftrightarrow$ $\dfrac{(\lambda^*)^\sigma}{\lambda}\left(\dfrac{1+r^*}{1+r}\right)^\sigma > 1,$

     ii) $OA \prec LC \Longleftrightarrow$ $\lambda^*(1+r^*) > 1$ *(as before)*,

     iii) $LC \prec CIA \Longleftrightarrow$ $\lambda(1+r)^\sigma < 1.$

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[22]$\mathrm{E}\left[q_x\right]$ is the expected quantity at the factory gate, i.e. including iceberg trade costs and taking into account that under CIA only a fraction λ of export contracts is enforced. That is: $\mathrm{E}\left[q_x\right] = \tau\beta(p_x^*)^{-\sigma}(P^*)^\sigma Q^*$.

[23]It would be interesting to combine the value-dependant variable costs introduced in this model with some unit-dependent transport costs.

[24]In the case of CIA the parameters are: $\alpha = \frac{\lambda}{1+r^*}$ and $\beta = \lambda$, under OA $\alpha = \frac{\lambda^*}{1+r}$ and $\beta = 1$ and und LC $\alpha = \frac{1}{(1+r)(1+r^*)}$ and $\beta = 1$

Proof. These conditions follow directly from a comparison of expected profits.[25] ■

The expressions simplify, but the same factors as in the general case can be identified: CIA is more likely to be used if enforcement at home λ is strong and financing costs abroad r^* are low. OA is more likely used if enforcement abroad λ^* is strong and financing costs at home r^* are low. LCs are used if enforcement is relatively weak (low λ, λ^*) and if financing costs are relatively low (low r, r^*).

3.3 Payment Contract Switching

Optimal switching An exporter switches payment contract when this maximizes expected profits. Maximizing expected profits is equivalent to maximizing expected quantities at the factory gate. In this subsection I discuss how the ability to switch contracts allows a firm to mitigate partially adverse effects from financial markets. First, note that for any financial variable $\theta \in \{r, r^*, \lambda, \lambda^*\}$ there is at least one payment contract under which expected profits, revenues and quantities are independent of this variable. Thus if there is a deterioration of one of these variables at some point a firm will switch its payment contract. There are also pairs of financial variables of which some payment contracts are independent.

Thus there are cases when the possibility of a payment contract switch can at some point completely mitigate any adverse effects on trade. However, there can be changes in several financial variables for which there is no financing form that completely mitigates the effects. Nevertheless, a switch of payment contract can reduce the impact of financial market changes.

Effects of contract switching In the following I illustrate these different cases with some graphs for trade between firms in different countries.[26]

Figure 2 illustrates the difference between a change in only one financial variable, the effects of which can be fully mitigated, and a simultaneous change in two financial variables, the negative effects of which cannot be fully eliminated by switching contracts.

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[25]Prices and profits for the three financing forms are:

$$p^{CIA} = (1+r^*)\tau p_d^* \qquad\qquad \mathrm{E}\left[\Pi_E^{CIA}\right] = \left(\frac{1}{1+r^*}\right)^\sigma \lambda \tau^{1-\sigma} \Pi_d^*$$

$$p^{OA} = \frac{1+r}{\lambda^*}\tau p_d^* \qquad\qquad \mathrm{E}\left[\Pi_E^{OA}\right] = \left(\frac{\lambda^*}{1+r}\right)^\sigma \tau^{1-\sigma} \Pi_d^*$$

$$p^{LC} = (1+r)(1+r^*)\tau p_d^* \qquad\qquad \mathrm{E}\left[\Pi_E^{LC}\right] = ((1+r)(1+r^*))^{-\sigma} \tau^{1-\sigma} \Pi_d^*$$

[26]All graphs are calculated in partial equilibrium, i.e. keeping foreign demand fixed. In Section 4 the same experiments are studied under general equilibrium. For all graphs the following baseline calibration is used: $1 + r^N = 1.02, 1 + r^S = 1.04, \lambda^N = 0.98, \lambda^S = 0.95$.

Here figure 2

In the left graph, $r^N = 1.02$ is constant and only the Southern interest rate varies. The initial payment contract is Cash in Advance. When the interest rate in the South passes a threshold, there is a switch of payment contract to Open Account. From that point on changes in the Southern interest rate do not affect trade volumes. In the right graph, $r^N = r^S - 0.02$ is a constant value below the southern interest rate. Initially both interest rates are low and a Letter of Credit is used. When both interest rates increase beyond a certain point, there is a switch to Cash in Advance. Note that the switch reduces the impact of the financial changes, but cannot fully eliminate them.

A switch of payment contract takes place when the ordering of the finance profit factors A changes. This is illustrated in Figure 3, which shows the values of profit factors in the experiment discussed above for the different payment forms. Quantities depend only on the factor A specific to the payment form actually used, which is the maximum of the three lines.

Here figure 3

Figure 4 illustrates the case where two financial parameters change and it is still possible to fully eliminate effects on trade from some point onwards. Now enforcement in the South and in the North and South are changed respectively.

Here figure 4

In the left graph, $\lambda^N = 0.98$ is constant and only the Southern enforcement probability changes. For low values of enforcement, Cash in Advance is used. When the enforcement rate in the South gets very close to the Northern one, then the payment contract is switched to Open Account in order to profit from the lower interest rate in the North. In the right graph, $\lambda^N = \lambda^S + 0.03$ is a constant value above the enforcement value in the South. For low values of enforcement, Letter of Credit is chosen, which fully eliminates any effect of the enforcement probabilities on trade quantities. For higher values of enforcement, there is a switch to Cash in Advance and trade rises with enforcement in the North.

Effects of no contract switching in the short run   The ability of an exporter to switch to a different payment contract is important to optimally adjust to the changes in financial efficiencies and enforcement probabilities. When an exporter is not able to switch payment contracts in the short run, this has an adverse affect on traded quantities and expected profits. This is illustrated in Figure 5. In the example, interest rates are relatively low to begin with and a Letter of Credit is used. Now suppose there is a change in the Northern interest rate. Then at

some point the exporter would like to switch to Cash in Advance. The solid line represents the standard case when the firm can switch contracts. Then reductions in profits and quantities are limited to about 10 percent. The dashed line represents the case when the firm is not able to substitute away and the effect of the interest rate change cannot be mitigated. In the example the change of 10 percentage points in the interest rates leads to a 30 percent drop in profits and quantities. Thus the ability to switch payment contracts is crucial for an exporter to mitigate the effects of adverse financial conditions. As a consequence, the time horizon, in which a switch is possible, is an important determinant of the reaction of trade flows to changes in financial market conditions.

Here figure 5

4 General Equilibrium

In the following the trade model is analyzed in general equilibrium. First, the equilibrium is derived. Second, a numerical example is studied to evaluate the quantitative importance of payment contracts. Third, some graphs are presented, illustrating additional effects arising in general equilibrium.

4.1 Equilibrium

Suppose there are two countries H and F.[27] As derived in the previous sections, domestic and foreign profits of firms in the differentiated goods sector are:

$$\Pi_d^i = q_d^i \frac{a}{\sigma - 1} \text{ and } \Pi_x^i = A^i \Pi_d^j,$$

with $A^i = (\alpha^i)^\sigma (\beta^i)^{1-\sigma} \tau^{1-\sigma}$.

Free entry As in Krugman (1980), a free entry condition pins down both the number and the size of firms in equilibrium. It requires that fixed cost of entry have to equal expected profits from domestic sales and exports:

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[27]For subsequent equations I always use $i, j \in \{H, F\}, i \neq j$

$$f = \Pi_d^i + \Pi_x^i.$$

Next, I combine the two equations resulting from free entry and solve for domestic quantities:[28]

$$q_d^i = \frac{\sigma - 1}{a} f \frac{1 - A^i}{1 - A^i A^j}.$$

Export quantities at the factory gate are given by:

$$q_x^i = A^i q_d^j = \frac{\sigma - 1}{a} f \frac{A^i (1 - A^j)}{1 - A^i A^j}.$$

Note that due to the Cobb Douglas structure in preferences the expenditure share on differentiated products is fixed. Thus output in the differentiated sector, measured in labor, is constant.

Taking partial derivatives allows to analyze effects of A on quantities:

$$\frac{\partial q_d^i}{\partial A^j} = -\frac{\partial q_x^i}{\partial A^j} = \frac{\sigma - 1}{a} f \frac{(1 - A^i) A^i}{(1 - A^i A^j)^2} > 0,$$

and

$$\frac{\partial q_d^i}{\partial A^i} = -\frac{\partial q_x^i}{\partial A^i} = -\frac{\sigma - 1}{a} f \frac{1 - A^j}{(1 - A^i A^j)^2} < 0.$$

Lemma 1 *In the two country trade model exported (domestic) quantities are*

i) increasing (decreasing) in profit factor A^i,

ii) decreasing (increasing) in profit factor A^j.

Thus in the two country model domestic quantities are decreasing in the own export profit parameter A and increasing in the foreign export parameter A^*. Due to the choice of payment contracts all financial parameter $r, r^*, \lambda, \lambda^*$ can affect both A and A^*. Thus while the effect of the profit parameters A and A^* on quantities is unambiguous, no general result can be established for the effect of the four financial parameters on traded and domestic quantities.

Total (expected) quantities at the factory gate are constant:[29]

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[28]Plugging in the values derived for profits from before delivers:

$$f = \frac{a}{\sigma - 1} \left[q_d^i + A^i q_d^j \right].$$

[29]Quantities are:

$$q^i = \frac{\sigma - 1}{a} f.$$

Labor market clearing The number of firms in both countries is determined by labor market clearing.[30] Given the CD preferences, a constant fraction of labor is employed by the differentiated sector:

$$L_Q^i = \mu L^i.$$

Labor in the differentiated sector is used for entry and production:

$$L_Q^i = L_E^i + L_P^i = n^i (f + aq).$$

From this the following result for the number of firms can be derived:

$$n = \frac{\mu L^i}{f + aq} = \frac{\mu L^i}{\sigma f}.$$

4.2 Numerical Example

In the following, properties of the model are illustrated using a numerical example. The quantitative importance of payment contract switches is evaluated.

Country Types Suppose there are three types of countries. Type I has a very efficient financial market and strong enforcement. Type II has a relatively efficient financial market, but enforcement is weak. Type III has a less efficient financial market, but relatively strong enforcement. The countries are characterized by the parameters in Table 1:

$$q^i = q_d^i + q_d^j A^i.$$

Plugging in domestic quantities delivers total quantities per firm:

$$q^i = \frac{\sigma - 1}{a} f \frac{1}{1 - A^S A^N} \left[(1 - A^N) + (1 - A^S) A^N \right].$$

The last expressions can be simplified to obtain the standard result as stated above.

[30]For tractability, I assume that the positive expected profits of importers under Open Account do not enter the demand for differentiated good. These profits occur under Open Account as only a share of importers fulfill the contract and payment C^{OA} is limited to be smaller or equal to R. It would be interesting to analyze these 'informal' profits explicitly in the general equilibrium. This could be relevant for countries with very low enforcement rates.

here table 1

Optimal Contracts   As shown before these country characteristics can be mapped uniquely into the optimal choice of payment contract for each exporter-importer country combination. The optimal payment contracts chosen are:

here table 2

The rows correspond to the country type of the exporter, the columns to the country type of the importer. On the diagonal the countries are symmetric. In this case an exporter would never choose OA as this is dominated by CIA. Thus given symmetric countries either CIA or LC is chosen depending on the domestic interest rate and domestic enforcement. For trade between countries of type II where enforcement is low, LC is chosen, whereas country I and III choose CIA. Country type II has low enforcement. Therefore, its exporters choose contracts that circumvent this problem, i.e. OA and LC. The main factor for the choice of an exporter in a country of type III is the relatively high home interest rate. The only payment contract that is independent of this interest rate is CIA, which is the dominant payment contract for trade with all three types of trading partners. Given these payment contracts, traded quantities can be calculated:

here table 3

To evaluate quantitatively the effects of the choice of payment contracts on trade, two experiments are studied. First, the differences in trade volumes between the optimal contract and the worst contract are calculated. Second, the differences in trade volumes between the optimal contract and any of the three available contracts are calculated.[31]

Worst contracts   The contracts that minimize quantities and profits for exporter-importer pairs are:

here table 4

The percentage decreases in quantities relative to the optimal payment contracts are:

here table 5

If, for example, an exporter in a country of type I trading with an importer in country type II

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[31]For both experiments I assume that exporters in the home country are constrained, while exporters in the country abroad choose the optimal payment contract. I do not report the reverse trade flows (from abroad to home) here. Nevertheless, they have an impact on price levels and thus on traded quantities of home country exporters.

would be forced to use OA instead of CIA, this would reduce the traded quantity by 49.4 percent. The table shows that the choice of payment contract has a quantitatively important effect on traded volumes. Furthermore, this effect is heterogeneous across country pairs. Some trade, like trade between type I countries, does not depend very much on the payment contract in use. Trade between countries of type II on the other hand, which have low enforcement, benefits a lot from the ability of exporters to avoid OA. Note that, whether symmetric or asymmetric countries trade with each other, is not a good predictor of potential losses from non-optimal payment contracts. Which country-pair combinations profit most from a free choice of payment contracts depends on the interaction of all four financial parameters as shown in the previous sections.

The percentage decreases in traded quantities relative to the optimal contract if exporters are forced to use one specific contract are:

here table 6

4.3 Graphical Illustrations

In the following, additional effects arising in the two country general equilibrium model are discussed. The experiments shown in Figures 2 to 5 are repeated in Figures 6 to 8. The dashed lines represent the previously discussed partial equilibrium responses. The solid lines represent the full general equilibrium results. There are two new general equilibrium effects. Changes in financial efficiency and enforcement affect the finance profit factor A of Northern exporters and thus their prices and quantities. This has an effect on price level in the South and thus affects the export decision of Northern exporters. A second effect arises from the Southern exporters. Their finance profit factor is also affected by changes in the efficiency and enforcement parameters, altering export quantities and prices and thus price levels. Furthermore, when financial parameters change, exporters in the South might optimally switch payment contracts. These switches have an impact on the Northern exporters through price levels, too. Note that the switching decisions of Northern exporters is independent of general equilibrium effects as it only depends on exogenous financial parameters.

Figure 6 illustrates changes in interest rates. It corresponds to Figure 2 in partial equilibrium. In the left graph, Northern exporters switch from CIA to OA at the same point as before. Now there is a new effect from a switch by exporters in the South, though. The vertical

solid line marks the threshold at which they switch their payment contract from LC to CIA in order to substitute away from the rising Southern interest rate. Now with a further rise in r^*, Northern exports become relatively more expensive. Thus exports fall steeper than in partial equilibrium. At the vertical dashed line, the Northern exporters switch as well and all trade becomes independent of the Southern interest rate.

In the right graph, when both Northern and Southern interest rates rise jointly, there is no switch by Southern exporters who use CIA. The fall of Northern exports is less steep in general equilibrium as also Southern exporters are affected by the changes in interest rates. Thus the relative price of Northern exporters rises less quickly and trade decreases by less than in partial equilibrium.

Here figure 6

Figure 7 illustrates changes in enforcement. It corresponds to Figure 4 in partial equilibrium. In the left graph as before Northern exporters switch from CIA to OA. Exporters in the South use CIA and do not switch. In the left part of the figure, the solid line is now decreasing as Southern exporters become more competitive with a rise in λ^*, i.e. the relative price of Northern exporters rises and their quantities decrease. In the right graph, initially exporters in both countries use a LC and then at some point switch to CIA. Southern exporters do so first as the interest rate in the North is lower. From the point of the switch onwards, they become relatively more competitive and quantities of Northern exporters decrease. This is the case until Northern exporters themselves switch to CIA and their sales increase with the further rise of Northern enforcement.

Here figure 7

Figure 8 illustrates the case of no contract switching in the short run. It corresponds to Figure 5 in partial equilibrium. As before, if they can do so in the short run, Northern exporters switch from LC to CIA. Exporters in the South first use CIA and then later switch to OA. After the Northern exporters switch contracts and before the Southern exporters change their choice, all exporters use CIA. Then, only exporters in the South are affected by the increase in the Northern interest rate. This makes Northern exporters relatively more competitive and their exports rise. When Southern exporters switch as well, trade becomes independent of the Northern interest rate. If exporters in the North cannot switch contracts, their exports decrease in the whole range. First, when also exporters in the South are affected by the interest rate, the decrease is relatively smaller. Then, when Southern exporters switch contracts and their sales

become independent of the Northern interest rate, the slope of the line representing trade gets steeper and the competitiveness of Northern exporters deteriorates more quickly.

Here figure 8

5 Repeated Transactions

In the previous sections the relationship between an exporter and an importer consisted of only one transaction. Often though, trade relationships are longer lasting, i.e. there is the possibility that the two trading partners interact again in subsequent periods. Repeated transactions give rise to a continuation value of a trade relationship, which makes the non-fulfillment of a contract less desirable. In this section I introduce the possibility of repeated transactions between an exporter and an importer and study under which conditions a simple trigger strategy can be implemented to improve upon the equilibrium of the one shot game. I find that the ability to sustain a trigger strategy equilibrium increases with enforcement probabilities and with the survival probability of the trade relationship. Under CIA the ability also increases in the markup $\frac{\sigma}{\sigma-1}$ and iceberg trade costs τ.

Suppose that trade can happen more than once between two trading partners. Let γ denote the probability that a given trade relationship can be continued in the next period. That is γ is the the trade relationship survival rate. As before a match between an exporter and an importer is analyzed. No new trading relationships are created, i.e. there are no outside options to trade with another partner.[32]

CIA First, I analyze the case of Cash in Advance. Consider the following trigger strategy. The importer pays the full revenue amount discounted by the interest rate, i.e. $C = \frac{R}{1+r^*}$. If the exporter ever fails to deliver, the importer punishes by ending the trade relationship. The exporter always pays the money and never runs away. The equilibrium exists if the exporter has no incentive to deviate, i.e. to take the money and not deliver the good. Yet, even when deviating, with probability λ the exporter is forced to fulfill the contract. That is, the higher the enforcement probability at home, the less likely the exporter does profit from a deviation.

In order for the trigger strategy to be an equilibrium, the value of the relationship for

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[32]It would be an interesting extension to allow for the creation of new relationships via searching and matching. This would increase the value of the outside option and make it more difficult to sustain a trigger strategy equilibrium.

the exporter V_E has to be larger than the one period deviation payoff. The trigger strategy equilibrium exists iff:

$$V_E = \sum_{n=0}^{\infty} \left(\frac{\gamma}{1+r}\right)^n (C-K) = \frac{C-K}{1-(\gamma/(1+r))} > (1-\lambda)C.$$

Using $C^{CIA} = \frac{R}{1+r^*}$ this condition holds iff:[33]

$$\frac{\sigma}{\sigma-1}\tau \left[1 - \left(1 - \frac{\gamma}{1+r}\right)(1-\lambda)\right] > 1$$

There are different factors, which make the condition more likely to hold. It holds more likely for a higher λ. As the expected gain from a deviation decreases in domestic enforcement, implementation of the trigger strategy is the easier, the better enforcement. Furthermore, the trigger strategy equilibrium is easier to sustain when the ratio R/K increases, i.e. when revenues are relatively large compared to production costs. This is the case when the markup and iceberg trade costs are higher. Finally, the higher γ, the higher the value of the trade relationship, the easier it is to implement the trigger strategy.[34]

OA Under OA the relevant deviation is by the importer. When OA is used an importer has positive expected profits in the one shot game:

$$\Pi_I^{OA} = \frac{R(1-\lambda^*)}{1+r^*}.$$

In a trigger strategy equilibrium the importer has to receive at least as large expected profits as in the one shot game. The equilibrium considered is as follows: The importer always pays amount C. If the importer ever fails to pay the amount, the exporter stops the relationship. First note that for the importer to have positive expected profits, the payment C has to be strictly below the revenues R for any $\lambda^* < 1$. The amount C that makes the importer indifferent between adhering to the trigger strategy equilibrium and deviating is characterized by:

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[33]

$$C - K > (1-(\gamma/(1+r)))(1-\lambda)C \Leftrightarrow C\left[1 - \left(1 - \frac{\gamma}{1+r}\right)(1-\lambda)\right] > K$$

Next use $C^{CIA} = \frac{R}{1+r^*}$ to get:

$$\frac{R}{K}\left[1 - \left(1 - \frac{\gamma}{1+r}\right)(1-\lambda)\right] > (1+r^*)$$

Plugging in $\frac{R^{CIA}}{K^{CIA}} = (1+r^*)\frac{\sigma}{\sigma-1}\tau$ delivers the result.

[34]Note that so far only one specific trigger strategy is considered. In future research, it would be interesting to look at a wider set of strategies featuring different forms of punishment.

23

$$V_I = \sum_{n=0}^{\infty} \left(\frac{\gamma}{1+r^*} \right)^n \left(\frac{R-C}{1+r^*} \right) = \frac{R-C}{(1+r^*)(1-(\gamma/(1+r^*)))} = \frac{R(1-\lambda^*)}{1+r^*}.$$

This condition corresponds to the equilibrium chosen by the exporter, who has all negotiation power. It determines the highest incentive compatible C and thus maximizes expected profits of the exporter. The maximum payment C is:

$$C^{TR,OA} = R \left[1 - \left(1 - \frac{\gamma}{1+r^*} \right) (1-\lambda^*) \right].$$

The amount increases in the survival probability γ and the enforcement probability abroad λ^*. Under OA a trigger strategy always improves on the one shot game whenever $\gamma > 0$. To see this note that the expected payment in the one shot game is $\lambda^* R$. The expected payment under a trigger strategy with open account is $C^{TR,OA}$. The latter is larger iff:

$$R \left[1 - \left(1 - \frac{\gamma}{1+r^*} \right) (1-\lambda^*) \right] > \lambda^* R.$$

This condition can be simplified to obtain $\gamma > 0$.[35]

LC versus other Payment Contracts As shown above, under the discussed conditions, trigger strategies can improve upon one shot equilibria in the cases of CIA and OA. A LC on the other hand already resolves all enforcement problems. Trigger strategies can thus not improve upon the one shot equilibrium in this case. As a result, the introduction of trigger strategies and repeated transactions makes CIA and OA more attractive while leaving the LC unaffected, implying a worsening of the relative attractiveness of LCs. This is especially the case when transaction horizons are long, characterized by high relationship survival probabilities γ, and when enforcement probabilities λ and λ^* are high. Thus long lasting relationships and trade between countries with high enforcement imply a higher usage of trigger strategies and less reliance on the LC.

Levchenko, Lewis, and Tesar (2009) find that trade credit intensive industries are not more strongly affected by the financial crisis than others. This finding might be explained by the presence of both one shot equilibria and repeated games equilibria in the data. Inter-firm trade credit usually corresponds to CIA and OA. The model predicts that these two payment contracts

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[35]

$$\lambda^* < 1 - \frac{\gamma}{1+r^*}(1-\lambda^*) \Leftrightarrow 1 > 1 - \frac{\gamma}{1+r^*}$$

are used more intensively when trigger strategies can be implemented more easily. In a successful trigger strategy equilibrium, only one financial variable affects the traded quantities, i.e. r^* for CIA and r for OA. Thus trade credit intensive industries, which use relatively more CIA and OA, should be less affected by shocks to financial markets than industries that rely more on the LC.[36]

6   Implications of Endogenous Payment Contracts

6.1   Financial and Economic Turmoil

In the following I analyze the effects of different forms of financial and economic turmoil on trade profits and quantities.

Enforcement and Country level risk   Suppose that the enforcement probability λ is a combination of national risk and individual firm level risk. National risk corresponds to risk of expropriation, risk of sovereign or bank level default while individual risk is the probability that a specific contract is enforced. The important difference between the two is that banks are only affected by national risk. Before, a Letter of Credit could fully resolve the problem of enforcement for the exporter. Now, with national risk, the only way to fully mitigate changes in λ is to switch to Open Account. Let overall risk be the product of national risk and individual contract risk:

$$\lambda = \lambda^N \lambda^I$$

Given this, trade finance reacts differently depending on the source of the enforcement problems. An decrease of enforcement at the contract level in the exporter's country implies a shift towards Open Account or Letter of Credit. A decrease in the importer's country contract enforcement leads to a shift towards Cash in Advance and Letter of Credit. An increase in national risk, however, cannot be solved by switching to a Letter of Credit. In this case an exporter can only switch to Open Account and an importer can only switch to a Cash in Advance to fully eliminate the effect of domestic enforcement problems. In the following I discuss different types of turmoil that can be observed in reality and elaborate on some predictions of the model.

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[36]Trade using a trigger strategy is less affected by changes in financial parameters as long as the trigger strategy equilibrium can be sustained, i.e. as long as changes in parameters to not lead to a breakdown of the trigger strategy equilibrium.

Interest rate changes   There are two potential sources of interest rate changes. First, due to events that might take place outside the two trading countries, the world interest rate r^w can change, moving both interest rates simultaneously. Second, there can be some problems of banks in one or both of the countries so that their efficiency parameters φ_i change, which affects interest rates.[37] The effect of these changes crucially depends on the time horizon in which firms are able to switch their payment contracts. If they are fully flexible in their choice of payment contracts, then the effects of interest rates changes are captured by Figure 2 as discussed above. If firms are not flexible in the short run, the effects of interest rate changes might be stronger as shown in Figure 5. If an exporter can change the payment contract in the time horizon studied, then a unilateral change in the interest rate can, from some point on, be fully mitigated while a change in both interest rates cannot. If there is a short run inability to switch contracts, then we should not observe a differential effect of unilateral and multilateral changes in interest rates.

Contract level enforcement changes   As introduced above there are enforcement problems at the national and at the contract level. From these two, the national risk seems to be more susceptible to turmoil. The individual contract enforcement is mainly determined by legal institutional factors, which should in general not change in the short run.[38] Yet, perceived national risk like sovereign default or expropriation probabilities can change relatively quickly. As discussed above, national risk cannot be mitigated by a Letter of Credit. Thus the only way two trading partners can react to a deterioration in national risk in one of the two countries, is to switch to the one contract that is not affected by this change: Open Account in case of a deterioration in the exporter country and Cash in Advance in case of a worsening in the importer country. Note, though, that this depends on the effect of changes in national risk on the interest rate in the affected country. An increase in sovereign default could imply a proportional increase in the national interest rate. That is, the risk free interest rate would then be scaled up by the national risk. In this case no contract switching is possible to mitigate the effect. However, any deviations from a proportional change in interest rates to changes in national risk allow improvements through the choice of the optimal payment contract.

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[37]For details on r^w and φ_i see the interest rate model in Appendix B.

[38]If one would extend the individual contract enforcement by factors changing expected firm level insolvency and illiquidity this would be different. Then, an economic crisis in a country could change contract fulfillment expectations at the firm level.

6.2 Trade Patterns

One aspect of trade that has been analyzed are differences in trade flows and trade volumes between developed countries, between developed and developing countries and between developing countries. Taking into account that for trade both the financial conditions in the importer and exporter country are relevant can help explain differences in trade patterns. A model that looks at exporter financial markets only can e.g. not predict differences between South-South and South-North trade as a result of financial conditions. All differences in such a framework would be attributed to the demand side of trade. The new feature of my model, namely, that the importer's financial market and enforcement conditions matter, leads to the following two propositions about trade volumes, export participation and importing country conditions:

Intensive margin

Proposition 2 *For given domestic financial conditions r, λ and foreign demand conditions P^* and Q^*, exports of a firm increase in foreign financial market conditions.*

    i) strictly if both r^* decreases and λ^* increases

    ii) weakly if r^* decreases or λ^* increases

    Proof. See Appendix A. ∎

Exports of a country increase if the financial conditions in the country it is exporting to improve. Thus, in order to predict trade flows, it is not sufficient to look at financial market conditions in the country of the exporter alone, but one has to take into account the conditions in both countries jointly. Analyzing payment contracts allows to understand how these conditions interact and influence trade quantities.

Extensive margin   Similar effects arise in a model with an extensive margin, where firms decide whether to export or not to another country. To see this suppose for this paragraph that there is a fixed cost f_x of serving a foreign market, which has to be incurred by any firm which wants to export. Then a firm will only export if the expected profits from entering the foreign market are at least as large as the fixed cost that have to be incurred. Suppose that the fixed cost can be financed without any additional financial problems. Then:

Proposition 3 *For given domestic financial conditions r, λ and foreign demand conditions P^* and Q^*, a firm is more likely to export if foreign financial market conditions are better.*

i) strictly if both r^* decreases and λ^* increases

ii) weakly if r^* decreases or λ^* increases

Proof. See Appendix A. ∎

Not only do trade volumes depend on the conditions in financial markets in the countries of the exporter and the importer, but also the decision of firms to export, the extensive margin. That is, the probability of exporting cannot be fully predicted by conditions in the financial market of the exporter. Conditions in the financial market of the importer play a role, too.

6.3 FOB Prices

Given per unit cost a and iceberg transportation costs τ, different payment contracts imply different FOB prices. To see this, note that from before the agreed on payment amounts C differ by payment contract, i.e.:

$$C^{CIA} = \frac{\lambda}{1+r^*}R^{CIA}, \quad C^{OA} = R^{OA}, \quad C^{LC} = \frac{R^{LC}}{1+r^*}.$$

R is the amount of sales revenues in the importing country when trade takes place:

$$R = \left(\frac{\beta}{\alpha}\tau\right)^{1-\sigma} r_d^*.$$

The following payment amounts corresponding to FOB prices can be derived:

$$C^{CIA} = \lambda(1+r^*)^{-\sigma}\tilde{r}, \quad C^{OA} = (\lambda^*)^{\sigma-1}(1+r)^{1-\sigma}\tilde{r}, \quad C^{LC} = (1+r)^{1-\sigma}(1+r^*)^{-\sigma}\tilde{r},$$

with $\tilde{r} = \tau^{1-\sigma}r_d^*$.

From this it can be seen that the amounts specified to be payed for the traded goods vary with financial market parameters in a systematic way. Depending on the payment form used financial parameters affect FOB prices differentially. In an empirical analysis of FOB price data it might thus be relevant to control for differences in payment contracts. Estimates regarding FOB prices and financial indicators might otherwise be biased.

7   Conclusions

In this paper I propose a new theory explicitly modeling the choice of different payment contracts in international trade. I analyze the trade-offs taken into account by an exporter choosing between these different forms of payment, determined by enforcement probabilities and financing costs. The model shows that the choice of payment contracts is quantitatively important. Financing decisions of trade transactions are driven by factors in the financial markets of the exporter and the importer. The ability to freely choose and switch between payment contracts is central for firms to adapt to different constellations of financial conditions in different country pairs and over time. Limiting this choice can reduce traded quantities significantly, increase prices, and reduce the ability of exporters to react to short term fluctuations in financial conditions.

The model maps enforcement probabilities and financial market efficiencies of an exporter-importer country pair into an optimal payment contract. In a richer model that could be brought to the data one might want to include extensions concerning heterogeneity both in the firm and in the product dimension. Product differences could imply different degrees of enforceability in court or different time horizons of trade relationships (high or low γ). Firm differences in size could affect relative negotiation power between the exporter and the importer, the ability to enforce contracts in court, the ability to punish deviations from a trigger strategy and the ability to switch contracts in the face of fixed costs. Another extension would be to explicitly introduce currencies and to study the interaction of the payment contract decision with exchange rate risk. This would give a suitable framework to study different aspects: first, which new effects arise from payment contracts for the optimal decision in which currency to price exports, and second, how this affects the transmission mechanism of international shocks.

There is little data available on the usage of the different payment contracts across countries, firms and time. To assess the model empirically, available firm level data, that does not contain direct evidence on payment contracts, could be used to test predictions of the model. Furthermore, a new data set on payment contracts could be built to directly test for determinants of the choice of payment contracts.

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A Proofs

Proposition 1 Proof. The statement is true for trade measured both in expected quantities and in expected revenues at factory gate. Note that:

$$\mathrm{E}\left[q_x\right] = A\tau^{1-\sigma}q_d^* = \alpha^\sigma \beta^{1-\sigma}\tau^{1-\sigma}q_d^*$$

and

$$\mathrm{E}\left[r_x\right] = \frac{\beta\tau}{\alpha}A\tau^{1-\sigma}r_d^* = \alpha^{\sigma-1}\beta^{2-\sigma}\tau^{2-\sigma}r_d^*$$

Taking partial derivatives delivers the following signs for $A = \alpha^\sigma \beta^{1-\sigma}$:

	CIA	OA	LC
$A = \alpha^\sigma \beta^{1-\sigma}$	$(1+r^*)^{-\sigma}\lambda$	$(1+r)^{-\sigma}(\lambda^*)^\sigma$	$((1+r)(1+r^*))^{-\sigma}$
$\partial A/\partial r^*$	$-$	0	$-$
$\partial A/\partial \lambda^*$	0	$+$	0

As $\sigma > 1$ the expression for revenues $\alpha^{\sigma-1}\beta^{2-\sigma}$ delivers the same signs:

	CIA	OA	LC
$\alpha^{\sigma-1}\beta^{2-\sigma}$	$(1+r^*)^{1-\sigma}\lambda$	$(1+r)^{1-\sigma}(\lambda^*)^{\sigma-1}$	$((1+r)(1+r^*))^{1-\sigma}$
$\partial A/\partial r^*$	$-$	0	$-$
$\partial A/\partial \lambda^*$	0	$+$	0

If r^* decreases, both quantities and revenues increase under CIA and LC. If λ^* increases, quantities and revenues increase under OA. ∎

Proposition 2 Proof. The extensive margin is determined solely by expected profits. Thus it is sufficient to consider expected profits.

Note that:

$$\mathrm{E}\left[\Pi_x\right] = A\tau^{1-\sigma}\Pi_d^* = \alpha^\sigma \beta^{1-\sigma}\tau^{1-\sigma}\Pi_d^*$$

Thus profits are monotonously increasing in A. This combined with the partial derivatives above proves Proposition 2. ∎

B Interest rates

Suppose the importer and the exporter are in a small open economy and take the world interest rate r^w as given. In both countries there is a competitive sector of financial intermediation. Due to technological and legal differences, the efficiency of the intermediation technology of banks in different countries can differ. The intermediation technology displays constant returns to scale. Let $\varphi_i \leq 1$ be the efficiency of banks in country i for handling transactions, such that the cost of lending one unit is $1/\varphi_i$. Zero profit implies that the interest rate of a country charged to a firm is $r^i = \frac{r^w}{\varphi_i}$. Thus both interest rates change with changes in r^w. Furthermore, the interest rate of a country changes with the efficiency parameter φ. This parameter captures both short - and long-run effects. When there is financial turmoil in a single country and the domestic interest rate rises, this is captured by a change in φ in that country.

When extending the model to the two types of enforcement problems, national and contract level, the interest rate in a country will likely react to the former, i.e. the risk free world interest rate will most likely be scaled up, reflecting national default risk. Let γ be the transmission factor measuring the effect of changes in national risk on the local interest rate. That is, $r^i = \frac{r^w}{(\lambda^N)^\gamma \varphi_i}$. If $\gamma = 0$, then national risk has no effect on the interest rate. If on the other hand $\gamma = 1$, the interest rate perfectly adjusts to any changes in national risk.

C Tables

Table 1: Country Types

Country Type	I	II	III
λ	0.99	0.85	0.97
$1+r$	1.02	1.03	1.08

Table 2: Optimal Payment Contracts

from / to	I	II	III
I	CIA	CIA	OA
II	OA	LC	OA
III	CIA	CIA	CIA

Table 3: Traded Quantities

Country	I	II	III
I	2.94	2.9	2.6
II	2.76	2.64	2.53
III	3.02	2.93	2.45

Table 4: Worst Payment Contracts

from / to	I	II	III
I	LC	OA	LC
II	CIA	OA	CIA
III	LC	OA	LC

Table 5: Optimal vs. Worst Payment Contract, percentage changes of quantities

from / to	I	II	III
I	-8.0	-49.4	-19.4
II	-9.3	-44.6	-23.2
III	-27.4	-59.2	-26.3

Table 6: Optimal vs. Only 1 Payment Contract, percentage changes of quantities

	Only CIA			Only OA			Only LC		
from / to	I	II	III	I	II	III	I	II	III
I	0	0	-12.8	-3.6	-49.4	0	-8.0	-7.8	-19.4
II	-9.3	-4.9	-23.2	0	-44.6	0	-4.5	0	-19.2
III	0	0	0	-24.1	-59.2	-9.7	-27.4	-27.1	-26.3

D Figures
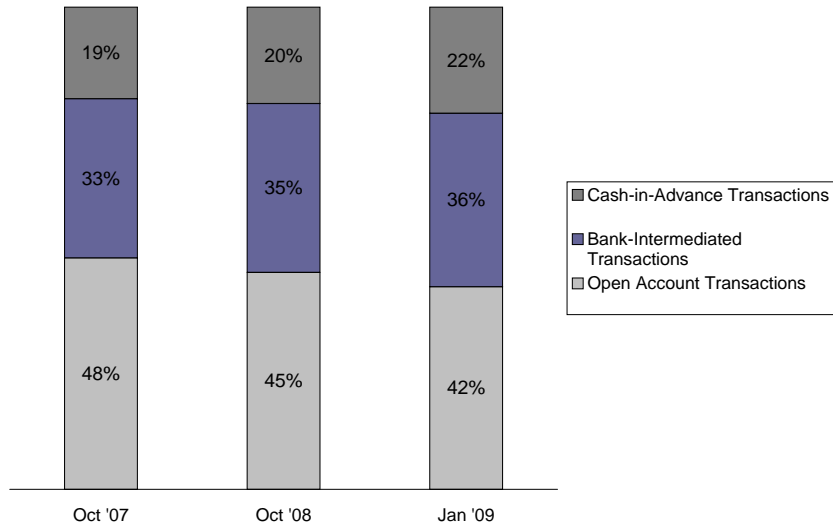
Figure 1: Source: IMF World Economic Outlook
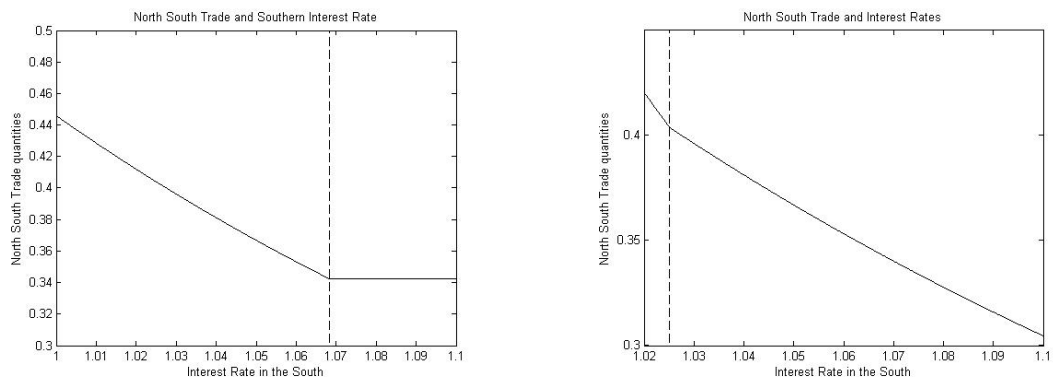
Figure 2: The effect of a change in interest rates on North-South trade flows. Solid line: traded quantities. Vertical dashed line: change of payment contract.
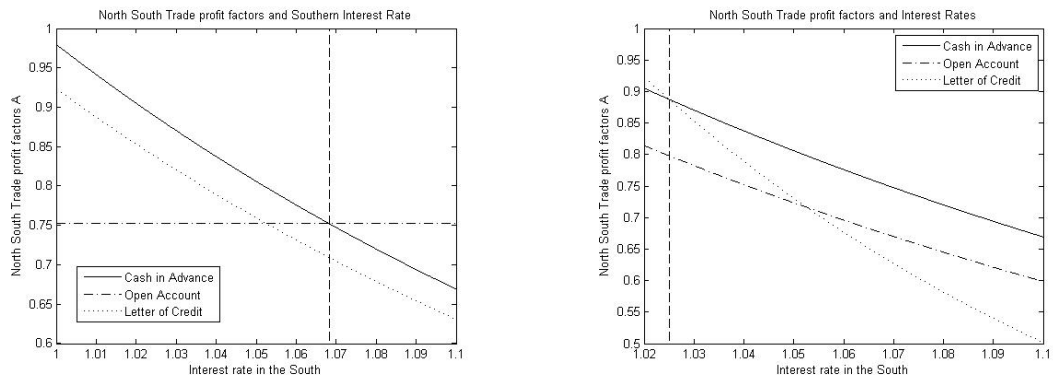
Figure 3: The effect of a change in interest rates on the finance profit factor A. Vertical dashed line: change of payment contract.
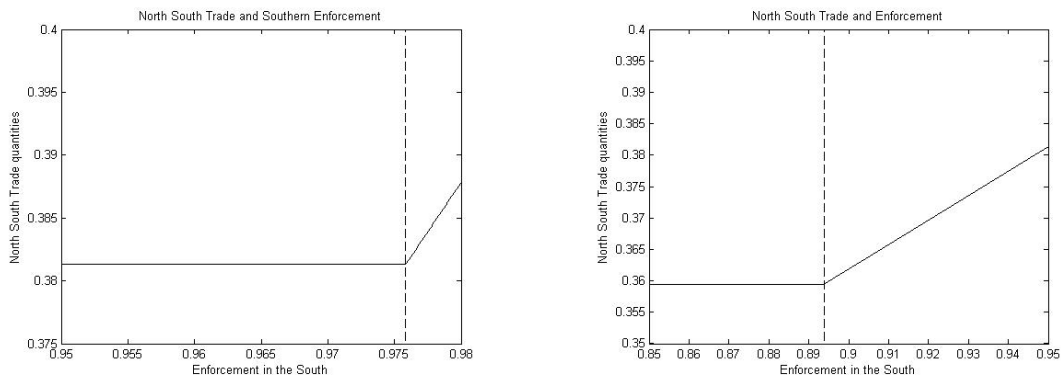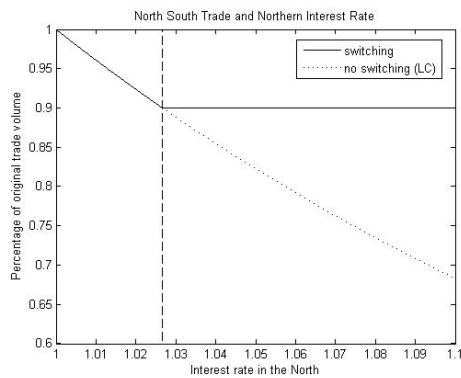

Figure 4: The effect of a change of enforcement probabilities on North-South Trade flows. Solid line: traded quantities. Vertical dashed line: change of payment contract.

Figure 5: Percentage effect of a change in the interest rate in the North on North-South trade flows with and without payment contract change. Dashed line: trade change with contract change. Solid line top: trade change without contract change. Vertical dashed line: change of payment contract.
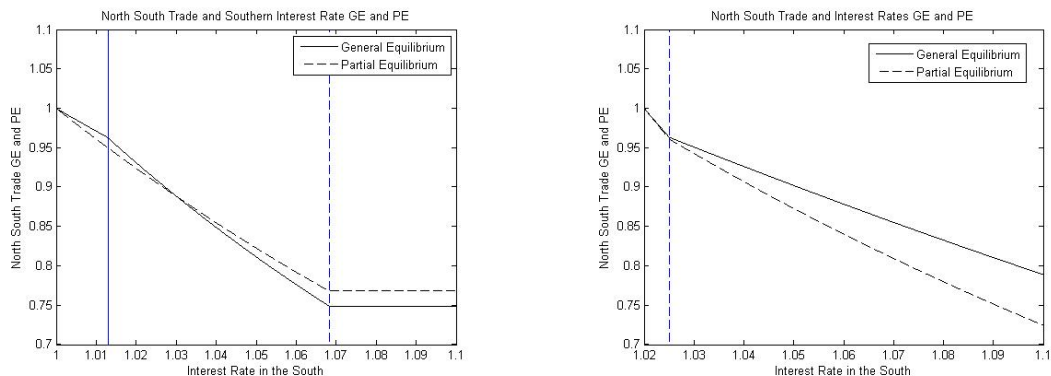
Figure 6: The effect of a change in interest rates on North-South trade flows, GE versus PE. Vertical dashed line: change of contract foreign exporter. Vertical solid line: change of contract domestic exporter. Solid line: traded quantities general equilibrium. Dashed line: traded quantities partial equilibrium.
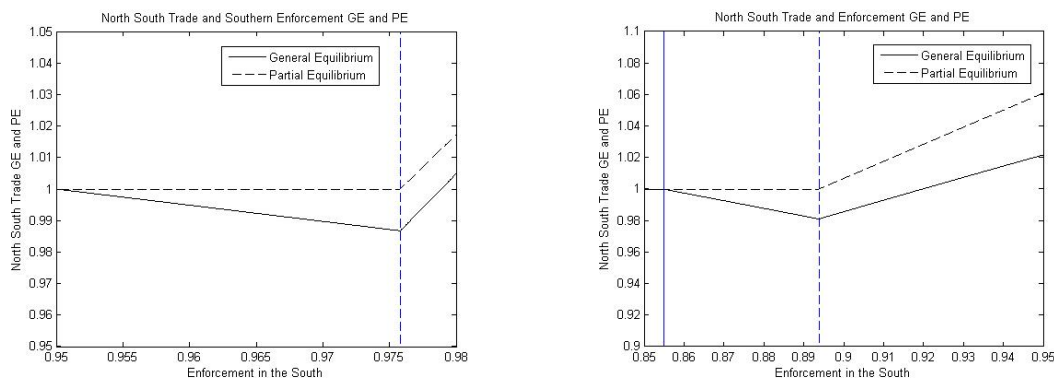

Figure 7: The effect of a change of enforcement probabilities on North-South trade flows, GE versus PE. Vertical dashed line: change of contract foreign exporter. Vertical solid line: change of contract domestic exporter. Solid line: traded quantities general equilibrium. Dashed line: traded quantities partial equilibrium.
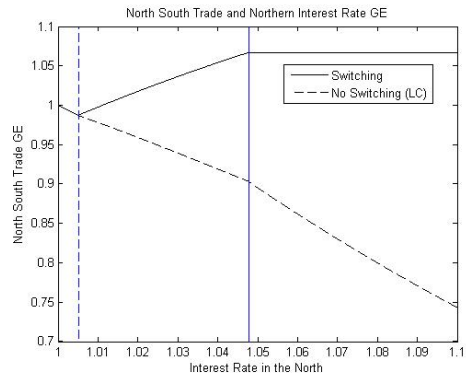
Figure 8: Percentage effect of a change in the interest rate in the North on North-South trade flows with and without payment contract change in general equilibrium. Vertical dashed line: change of contract foreign exporter. Vertical solid line: change of contract domestic exporter. Dashed line: trade change with contract change. Solid line: trade change without contract change.