Towards a Theory of Trade Finance*

Tim Schmidt-Eisenlohr†

University of Oxford

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Abstract

Shipping goods internationally is risky and takes time. To allocate risk and to finance the time gap between production and sale, a range of payment contracts is utilized. I study the optimal choice between these payment contracts considering one shot transactions, repeated transactions and implications for trade. The equilibrium contract is determined by financial market characteristics and contracting environments in both the source and the destination country. Trade increases in enforcement probabilities and decreases in financing costs proportional to the time needed for trade. Empirical results from gravity regressions are in line with the model, highly significant and economically relevant.

Keywords: trade finance, payment contracts, trade patterns, distance interaction

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†Centre for Business Taxation, Saïd Business School, University of Oxford, Park End Street, Oxford, OX1 1HP, UK; Tim.Schmidt-Eisenlohr@sbs.ox.ac.uk

1 Introduction

Shipping goods internationally is risky and takes time. Therefore, trading partners not only have to agree on the specification and the price of a good, but also need to decide on the timing of payments. To allocate risk and to finance the time gap between production and sale, a range of different payment contracts is utilized. These can be broadly classified into exporter finance (Open Account), importer finance (Cash in Advance) and bank finance (Letter of Credit).[1]

In this paper, I study the optimal choice between these three types of payment contracts, considering one shot transactions, repeated transactions and implications for trade. The equilibrium contract is determined by financial market characteristics and contracting environments in the source and the destination country. A transaction should, in general, be financed by the firm in the country with the lower financing costs and the weaker contract enforcement. This minimizes interest rate costs and the probability that the trading partner which did not pre-finance the transaction defaults on its contractual obligations. When two firms in countries with weak contract enforcement trade with each other, bank finance (Letter of Credit) is most useful as it resolves the moral hazard problem of defaulting.[2] Repeated transactions are an alternative way to reduce trade risk as the continuation value of a trading relationship gives firms an additional incentive to fulfill contracts. Therefore, they make exporter finance (Open Account) and importer finance (Cash in Advance) relatively more attractive compared to bank finance (Letter of Credit).

Through the payment contract choice, financing costs and contracting environments in the source and the destination country interact to shape trade finance costs. These are variable trade costs proportional to the value of goods exported, isomorphic to the iceberg trade cost formulation as introduced by Samuelson (1954). Being an obstacle to trade, trade finance costs affect trade patterns. Exports increase in enforcement probabilities and decrease in financing costs. The latter effect is the larger, the longer it takes from

[1] According to survey evidence reported in IMF (2009), 42-48 percent of transactions are done through Open Account, which corresponds to pure exporter financing. Cash in Advance, which represents pure importer financing, accounts for 19-22 percent and bank intermediated transactions account for the rest of transactions. The wide use of different working capital practices is also documented by Wagner Ricci and Morrison (1996), who surveyed Fortune 200 companies.

[2] I also study the case of intermediate type contracts with a partial pre-payment. They are a means to reduce financing costs, but cannot resolve the moral hazard problem of the importer.

production to sale.

The availability of different payment contracts can be beneficial if financial conditions change. Suppose, for example, a country experiences a financial crisis that leads to a rise in interest rates. Then, a payment contract switch can limit adverse effects by moving the financing activity to the country of the trading partner. This is not possible if financial conditions in both countries deteriorate at the same time. Therefore, multilateral crises should have a larger impact on trade flows than national crises.

I illustrate in a numerical example that the choice between payment contracts is economically relevant. In a baseline calibration, export quantities of a country decrease by up to 20.1 percent, when all firms are forced to use exporter finance (Open Account) only.

In the empirical part of the paper, I test key predictions of the model using a panel of bilateral trade flows. I run gravity regressions including interaction terms between distance and financing costs in the source and the destination country to identify the effect of trade finance on trade flows. I find that two countries trade less with each other if their financing costs are higher. As predicted, this effect is the larger, the more time is needed for trade.[3] Results are highly significant and economically relevant.

The paper is related to two strands of theoretical literature. First, there is a large number of papers that study the use of trade credit between firms. Trade credit usually refers to downstream lending between firms in a supply chain, both inside a country and across borders. International trade credit therefore corresponds to one of the three payment contracts considered in this paper, namely Open Account. The literature has concentrated on the relationship of two firms inside a country and has studied under which circumstances trade credit is used as a substitute for bank credit and what the underlying costs and benefits are.[4] In this paper, the focus is instead on the trade-off between financing costs and contracting environments in different countries to optimally finance trade transactions. The analysis abstracts from any frictions that could imply a wedge between bank and firm finance inside a country, which is the central issue studied in the trade credit literature.

[3]As no direct time to trade data is available, I use geographical distance as a proxy for the time needed for trade.

[4]See Biais and Gollier (1997), Petersen and Rajan (1997), Wilner (2000), Burkart and Ellingsen (2004), Cunat (2007) and Giannetti et al. (forthcoming).

Second, there are theoretical papers that have considered the relationship between 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 create a comparative advantage. In Matsuyama (2005), the share of revenues an entrepreneur can pledge towards wage payments differs between countries leading to a comparative advantage.[5] Chaney (2005) develops a theoretical model analyzing financial constraints in a heterogeneous 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 (2008b) extends this model to a setting where also export volumes can be affected by financial constraints. In Chaney (2005) and Manova (2008b) only domestic financial market conditions in the form of financial constraints are relevant for the export decisions of firms. In particular, there is no role for financial market conditions and the contracting environment in the destination country and for the costs of trade finance.

While there is no paper that formally studies the choice of payment contracts for trade finance, some other aspects of trade finance are discussed in policy papers.[6] Finally, my paper relates to two, more recent contributions on theoretical aspects of trade finance. Ahn (2010) studies why international transactions might get relatively riskier and why credit supply constraints might affect international trade loans relatively more in a financial crisis. Olsen (2010) elaborates on the idea also discussed in this paper, that enforcement between banks might be easier than between two trading partners, as the former interact more frequently.

There is a large empirical literature that has provided evidence on the relationship between the financial development of a country and the sectoral concentration of its exports.

[5]The broader issue of institutional constraints, trade and outsourcing has been studied extensively. Recent contributions include Nunn (2007), Levchenko (2007) and Antràs et al. (2009). For a survey see Helpman (2006).

[6]Menichini (2009) discusses inter-firm trade finance. She emphasizes the possibility that shocks are propagated through credit chains. Furthermore, she argues that the use of trade finance might be restricted if institutions like contract enforcement and bankruptcy laws are not sufficiently developed. Ellingsen and Vlachos (2009) develop a model of trade credit in a liquidity crisis. They show that in the presence of liquidity hoarding, targeted support of trade finance might be better than increasing the general supply of credit in an economy. Evidence on firm level trade finance of African exporters is documented by Humphrey (2009).

The general finding is that financial development creates a comparative advantage in industries that are more financially dependent and in which assets are less tangible.[7] The question whether financial constraints affect the decision to export and export volumes is the focus of a growing number of papers. This literature has so far been inconclusive on the question of causality from financial conditions to exporting decisions as endogeneity remains a key concern.[8] Amiti and Weinstein (2009) resolve the endogeneity problem using Japanese matched firm-bank data. They identify a bank-firm trade finance channel and find that it accounts for about one third of the decline in exports during the crisis in Japan in the 1990s.[9]

Several authors have studied factors that led to the large drop in international trade in the recent financial crisis. Besides demand side and composition effects (see Eaton et al. (2009), Levchenko et al. (2009), Behrens et al. (2010), Yi et al. (2010)) and inventory adjustments (Alessandria et al. (2010)), some research also provides evidence for the role of financial factors. Berman and Martin (2009) analyze how a financial crisis affects trade and find that its effects are stronger and longer lasting for African than for other countries. They find furthermore that African countries with a higher than median trade credit over exports ratio are hit harder. Bricongne et al. (2010) study french firm level data. While they find effects of credit constraints at the firm level, they argue that, as the share of constrained firms is small, aggregate effects through this channel are limited. Chor and Manova (2010) study US imports and find a negative relationship between interbank rates in a country and its exports in more financially dependent sectors during the recent crisis. Using data from a private trade insurance company, van der Veer (2010) estimates that about 5 to 9 percent of the drop in world exports was due to a reduction in trade insurance coverage. In a recent paper, Paravisini et al. (2010) use Peruvian bank credit data at the firm-level and find that credit supply shocks can explain 15 percent of the decline in exports during the financial crisis.

The empirical part of the paper differs from the existing literature in three aspects. First, motivated by the theoretical results, I consider financing costs both in the source

[7] See Beck (2002), Beck (2003), and Manova (2008b).

[8] Using firm level data, this question has been addressed for example by Greenaway et al. (2007), Muûls (2008), and Berman and Héricourt (2010). Manova (2008a) and Manova (2008b) studies credit constraints using sectoral level data.

[9] The effects of previous crises on trade have also been studied by Ronci (2004) and Iacovone and Zavacka (2009).

and the destination country.[10] Second, a financial market efficiency measure, the net interest margin, is used, to study the effects of financing costs on trade flows.[11] Finally, a distance interaction is employed to test for an effect of financial conditions proportional to the time needed for trade.[12]

The rest of the paper is organized as follows. Section 2 introduces a model of payment contracts. Section 3 extends the analysis to repeated contracts. Section 4 sets the model into a standard intra-industry trade framework, derives implications for trade patterns, evaluates the quantitative importance of payment contracts and discusses payment contract switches. Section 5 presents empirical results. Section 6 concludes.

2 Payment Contracts

To allocate risk and to finance the time gap between the production and the sale of a product, a wide range of payment contracts is utilized. I study the optimal choice of trading partners between these contracts, considering three representative types. These are Open Account (exporter finance), Cash in Advance (importer finance) and Letter of Credit (bank finance). Furthermore, an analysis of an intermediate type contract, combining exporter finance and importer finance, is provided.

The choice between different payment contracts is relevant for two reasons. First, the time gap between the production of goods and the realization of sales revenues is longer for international trade than for domestic sales. As Hummels (2001) reports, physical transport times can be substantial in international trade, in particular, when goods are transported by sea. Additionally, Djankov et al. (2010) document that formal procedures necessary for international trade transactions can be extensive, implying a delay from the factory gate to the means of transportation as well as at the border of the importer. Amiti

[10] An exception is Manova (2008b), who, in a recent revision mentions results from a regression with destination country variables. She finds effects about one third of the size of the exporter variables.

[11] While the net interest rate margin has not been used in this context, empirical work by Chor and Manova (2010) and Korinek et al. (2010) studies the relationship of trade flows with interbank rates and the US high yield spread during the recent financial crisis, respectively.

[12] As discussed in detail in Section 5, the distance interaction provides a new and direct identification of variable trade costs due to financing requirements. In this, my results contribute to the literature estimating trade costs. See among others Eaton and Kortum (2002), Anderson and van Wincoop (2003), Hummels (2007), Jacks et al. (2008) and Irarrazabal et al. (2010). In contemporaneous empirical work on the financial crisis, Paravisini et al. (2010) include an interaction term between distance and credit supply of a firm but do not find any significant effects.

and Weinstein (2009) calculate that these two causes of delay add up to approximately two months for the median case.[13] This implies that working capital requirements for international trade are larger than for domestic sales.

Second, it is more difficult to enforce contracts across borders. This can be due to differences in legal systems or working languages and a limited willingness of governments to enforce international contracts to the same degree as national ones. Whereas domestic sales naturally take place in a common contracting environment, international trade in general does not. Furthermore, in international trade, a firm might not have a permanent representation in the country of the trading partner, making litigation more difficult and costly. Consequently, international trade is more risky and the allocation of risk more important.

2.1 Setup

Suppose there is one exporter and one importer. The exporter can make a take it or leave it offer to the importer. There are two points in time. At $t = 0$ firms agree on a payment contract and the exporter can produce and send goods off to the destination country. After t time units, goods can arrive and sales revenues can be realized. Denote production costs by K and revenues by R. Assume further that $R > K$.

There are two imperfections in the economy. First, markets to finance international trade transactions are segmented and efficiencies of financial intermediaries differ across countries. As a result the interest rate a firm faces depends on its location. Second, there is limited enforcement of contracts, modeled as an exogenous country-specific probability that a contract will be enforced, in case that a firm does not want to fulfill it voluntarily.[14] Under Cash in Advance, it is the probability that the exporter is forced to deliver the goods after receiving the payment. Under Open Account, it is the probability that an importer has to pay the agreed price for the goods after receiving and selling them.[15]

[13]The median numbers they quote are 21 days from factory to ship in the exporting country and 23 days from the ship to the warehouse in the importing country. Average sea transport time to the US accounts for another 20 days in their calculation.

[14]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 and there would be an explicit role for firm heterogeneity.

[15]For simplicity these two enforcement probabilities are assumed to be equal. It would be an interesting

Furthermore, assume that the amount to be paid by the importer for the goods traded cannot exceed their total value at market prices.[16] In the following, I formally describe the three financing forms and derive conditions under which each of them is chosen. Let λ and r denote the enforcement probability and the interest rate in the source country, respectively. Variables for the destination country are marked with asterisks.

2.2 Cash in Advance, Open Account and Letter of Credit

Cash in Advance Under Cash in Advance (CIA) the importer first pays the amount C^{CIA} to the exporter. 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:

$$\max_{C} \mathrm{E}\left[\Pi_E^{CIA}\right] = C^{CIA} - \lambda K, \tag{1}$$

$$\text{s.t. } C^{CIA} \leq R, \qquad \text{(limited value of contract)} \tag{2}$$

$$\text{and } \mathrm{E}\left[\Pi_I^{CIA}\right] = \lambda R - (1+r^*)^t C^{CIA} \geq 0. \qquad \text{(participation constraint importer)} \tag{3}$$

Under CIA, the trade transaction is financed by the importer. Her participation constraint requires that, taking the default probability into account, her expected profits are non-negative. As the exporter has all negotiation power and the limited value of contract constraint 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:

$$C^{CIA} = \frac{\lambda}{(1+r^*)^t} R, \qquad \mathrm{E}\left[\Pi_E^{CIA}\right] = \frac{\lambda}{(1+r^*)^t} R - \lambda K. \tag{4}$$

Note that the optimal payment C^{CIA} is proportional to λ, i.e. the payment is discounted by the probability of non-delivery by the exporter. Despite the fact that there are strictly

extension to consider an asymmetry here. This could be rationalized by the difference between the in-kind nature of Open Account and the cash nature of Cash in Advance. For a formalization of this argument see Burkart and Ellingsen (2004).

[16] This limited value of contract assumption corresponds to a special case of a model with wealth constraints, where the wealth of the importer is assumed to be zero. In principle, the model could be solved for non-zero wealth levels, but the analysis would be substantially less tractable. For details see Appendix B.

positive gains from trade, under CIA, production and delivery only take place with probability λ.

Open Account Under Open Account (OA), the exporter first produces the goods at cost K and delivers them to the importer. Then, 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 maximization problem of the exporter is:

$$\max_C \mathrm{E}\left[\Pi_E^{OA}\right] = \frac{1}{(1+r)^t}(\lambda^* C^{OA} - K(1+r)^t), \tag{5}$$

$$\text{s.t. } C^{OA} \leq R, \qquad \text{(limited value of contract)} \tag{6}$$

$$\text{and } \mathrm{E}\left[\Pi_I^{OA}\right] = \frac{1}{(1+r^*)^t}(R - \lambda^* C^{OA}) \geq 0, \qquad \text{(participation constraint importer)} \tag{7}$$

assuming that the exporter and importer discount profits with their local interest rates.[17] Now, the exporter pre-finances the trade transaction. Due to the limited value of contract constraint the maximum payment C^{OA} that is contractible is R. If $\lambda^* < 1$ this implies that the exporter is not able to extract all rents from the importer, who consequently has positive expected profits. The optimal payment amount C^{OA} and the optimal discounted expected exporter profits can be derived as:

$$C^{OA} = R, \qquad \mathrm{E}\left[\Pi_E^{OA}\right] = \frac{\lambda^*}{(1+r)^t}R - K. \tag{8}$$

Letter of Credit Under a Letter of Credit (LC), 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.[18] The bank cooperates with a bank in the country of the exporter. The latter guarantees payment upon proof of delivery. Under the assumption of no default at the bank level and perfect third party verifiability, this completely resolves the enforcement

[17] To compare profits between CIA and OA they have to be discounted to the same time period.

[18] 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 at the individual contract level.[19] The maximization problem of the exporter is:

$$\max_{C} \mathrm{E}\left[\Pi_E^{LC}\right] = \frac{1}{(1+r)^t}(C^{LC} - K(1+r)^t), \tag{9}$$

$$\text{s.t. } C^{LC} \leq R, \qquad \text{(limited value of contract)} \tag{10}$$

$$\text{and } \mathrm{E}\left[\Pi_I^{LC}\right] = \frac{R}{(1+r^*)^t} - C^{LC} \geq 0. \qquad \text{(participation constraint importer)} \tag{11}$$

In the case of LC, the limited value of contract constraint never binds while the participation constraint of the importer is binding. The optimal payment C^{LC} and discounted expected exporter profits are:

$$C^{LC} = \frac{R}{(1+r^*)^t}, \qquad \mathrm{E}\left[\Pi_E^{LC}\right] = \frac{1}{[(1+r)(1+r^*)]^t}R - K. \tag{12}$$

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 CIA, OA and LC The four 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:[20]

Proposition 1 *Suppose R and K exogenously given. Then, the optimal choice of payment contract is uniquely determined by the following three conditions:*

$$\begin{aligned}
&\textit{i)} && OA \prec CIA \iff && \frac{K}{R} < \frac{\lambda^*(1+r^*)^t - \lambda(1+r)^t}{[(1+r)(1+r^*)]^t(1-\lambda)},\\
&\textit{ii)} && OA \prec LC \iff && \lambda^*(1+r^*)^t > 1,\\
&\textit{iii)} && LC \prec CIA \iff && \frac{K}{R} < \frac{1-\lambda(1+r)^t}{[(1+r)(1+r^*)]^t(1-\lambda)}.
\end{aligned}$$

Proof. Follows directly from comparing expected discounted profits from Equations 4, 8 and 12. ■

[19] 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. Recently, this idea has been looked at in detail by Olsen (2010).

[20] Assume for now K and R to be exogenous and the same for all payment contracts. When introducing an explicit demand, different payment contracts imply different optimal levels of K and R.

Several predictions, which could be tested with transaction level data, can be derived:

Proposition 2 *The usage of*

i) CIA increases in λ*,* r *and* t *and decreases in* λ^* *and* r^**.*

ii) OA increases in λ^**,* r^* *and* t *and decreases in* λ *and* r*.*

iii) LC decreases in r*,* r^**,* λ*,* λ^* *and* t*.*

Proof. Follows from comparing Equations 4, 8 and 12. ■

2.3 Intermediate Type Contracts

An intermediate type contract refers to the case when part of the payment is done in advance whereas the remainder is payed after delivery. Let $\phi \in (0, 1)$ denote the share of advance payment, i.e. $C_0 = \phi C$. Such a contract could be motivated by the possibility to reduce moral hazard or by potential savings in interest rate costs compared to CIA and OA. While under CIA and OA there is only a moral hazard problem of the exporter or the importer, respectively, with an intermediate type contract both moral hazard problems are present. In the following I show that under an intermediate type contract, choosing a sufficiently small pre-payment share ϕ can resolve the moral hazard problem of the exporter. In the one shot game, the importer, in contrast, as the last mover, never has an incentive to voluntarily pay the exporter the remaining amount after delivery. Therefore, in order to fully resolve the moral hazard problem of the importer, repeated contracts are necessary.[21] I find that under certain conditions, intermediate type contracts can improve upon OA by reducing interest rate costs, whereas they cannot improve upon CIA.

[21] This would not be true if a (pecuniary or non-pecuniary) cost of breaking the contract was introduced. Then the advance payment could prevent moral hazard by reducing the gain from deviating.

Two sided moral hazard If both sides behave opportunistically then:

$$\mathrm{E}\left[\Pi_E^{IM}\right] = \phi C + \frac{\lambda^*}{(1+r)^t}(1-\phi)C - \lambda K, \tag{13}$$

$$\mathrm{E}\left[\Pi_I^{IM}\right] = \frac{\lambda}{(1+r^*)^t}R - \phi C - \frac{\lambda^*}{(1+r^*)^t}(1-\phi)C \geq 0, \tag{14}$$

$$\mathrm{E}\left[\Pi_{tot}^{IM}\right] = \lambda\left(\frac{R}{(1+r^*)^t} - K\right) + \lambda^*(1-\phi)C\left[\frac{(1+r^*)^t - (1+r)^t}{[(1+r)(1+r^*)]^t}\right], \tag{15}$$

where $\mathrm{E}\left[\Pi_{tot}^{IM}\right]$ denotes total expected profits, discounted to $t = 0$. This case can never be optimal as both moral hazard problems remain, while unnecessarily high interest costs are incurred.

Importer moral hazard In order for the exporter not to behave opportunistically, the late payment has to be sufficiently large to outweigh the gains from running away with the advance payment. Assume that if indifferent, the exporter fulfills the contract. Then, the exporter does not deviate whenever the expected second period payment is at least as high as expected evaded production costs:

$$\frac{\lambda^*}{(1+r)^t}(1-\phi)C \geq (1-\lambda)K. \tag{16}$$

This implies an upper bound on the prepayment share ϕ:

$$\phi \leq 1 - (1+r)^t\frac{1-\lambda}{\lambda^*}\frac{K}{C} \equiv \phi^E. \tag{17}$$

Under this condition the moral hazard problem of the exporter is resolved and expected profits are:

$$\mathrm{E}\left[\Pi_E^{IM}\right] = \phi C + \frac{\lambda^*}{(1+r)^t}(1-\phi)C - K, \tag{18}$$

$$\mathrm{E}\left[\Pi_I^{IM}\right] = \frac{R}{(1+r^*)^t} - \phi C - \frac{\lambda^*}{(1+r^*)^t}(1-\phi)C, \tag{19}$$

$$\mathrm{E}\left[\Pi_{tot}^{IM}\right] = \frac{R}{(1+r^*)^t} - K + \lambda^*(1-\phi)C\left[\frac{(1+r^*)^t - (1+r)^t}{[(1+r)(1+r^*)]^t}\right]. \tag{20}$$

When are intermediate type contracts better than CIA or OA? Consider the two possible cases. First, if OA is optimal in the absence of intermediate type contracts, a necessary condition for an intermediate type contract to improve the outcome is $r^* < r$. Then,

financing costs can be reduced by introducing some advance payment up to the point where the incentive constraint of the exporter is binding, i.e. $\phi = \phi^E = 1-(1+r)^t \frac{1-\lambda}{\lambda^*}\frac{K}{C}$. Combining this with Equation 19, the optimal payment amount can be derived as:

$$C = \frac{R}{(1+r^*)^t} + \left(\frac{1+r}{1+r^*}\right)^t \frac{1-\lambda}{\lambda^*}[(1+r^*)^t - \lambda^*]K. \tag{21}$$

Second, if, in the absence of intermediate contracts, CIA is optimal, a necessary condition for an intermediate contract to be preferred is $r < r^*$. Note that expected profits of the exporter are linear in $\frac{\lambda^*}{(1+r)^t}$. Furthermore, as discussed earlier, the moral hazard problem of the importer cannot be resolved with an intermediate type contract in the one shot game. Consequently, an interior solution, that is an intermediate type contract, cannot be optimal in this case.

To summarize, an intermediate type contract can reduce interest rate costs if in its absence OA is optimal. No improvement is possible if in its absence CIA is optimal. In the one shot game, a partial pre-payment is not sufficient to resolve the moral hazard problem of the importer. For this, repeated contracts are necessary.

3 Repeated Contracts

In the baseline model, a one shot game between an exporter and an importer is analyzed. Often though, trade relationships are longer lasting. 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 repeated contracts between an exporter and an importer and study under which conditions a simple trigger strategy improves 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 R/K. By providing an alternative way to resolve the moral hazard problem, trigger strategies make CIA and OA more attractive compared to LCs.

Let γ denote the probability that a given trade relationship can be continued in the next period. As before a match between one exporter and one importer is analyzed. No new trading relationships are created, i.e. there is no outside option to trade with another

partner.[22]

3.1 Repeated Cash in Advance

Consider the following trigger strategy: The importer pays the full revenue amount discounted by the interest rate, i.e. $C = \frac{R}{(1+r^*)^t}$. This implies that the importer participation constraint binds. If the exporter ever fails to deliver, the importer punishes her by ending the trade relationship. The exporter always delivers the goods. The equilibrium exists if the exporter has no incentive to deviate, i.e. to take the money and not deliver. Note that even when deviating, the exporter is forced to fulfill the contract with probability λ. That is, the higher the enforcement probability at home, the less likely the exporter profits from a deviation. In order for the trigger strategy to be an equilibrium, the discounted expected value of future trade for the exporter V_E has to be larger than the expected payoff from a deviation. The trigger strategy equilibrium exists iff:

$$V_E = \sum_{n=0}^{\infty} \left(\frac{\gamma}{(1+r)^t} \right)^n (C-K) = \frac{C-K}{1-(\gamma/(1+r)^t)} > C - \lambda K. \tag{22}$$

Using $C^{CIA,RC} = C^{CIA} = \frac{R}{(1+r^*)^r}$ this condition holds iff:

$$\gamma > \frac{\frac{K}{R}(1-\lambda)[(1+r)(1+r^*)]^t}{1-\frac{K}{R}\lambda(1+r^*)^t}. \tag{23}$$

The condition is more likely to hold for a higher λ.[23] 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 less difficult to sustain when the ratio R/K increases, i.e. when revenues are relatively large compared to production costs. As the exporter discounts the future by $1+r$, a higher interest rate makes the trigger strategy more difficult to sustain. Finally, the higher is

[22] 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.

[23] Re-substituting $(1+r^*)^t/R = 1/C$ delivers:

$$\gamma > \frac{\frac{K}{C}(1-\lambda)(1+r)^t}{1-\lambda\frac{K}{C}}.$$

As $C \geq K$, the right hand side is decreasing in λ.

γ, the higher is the value of the trade relationship and the easier is implementing the trigger strategy. As it resolves the moral hazard problem without changing the payment amount C, a CIA trigger strategy, if implementable, always improves upon the one shot CIA contract.

3.2 Repeated Open Account

Under OA the relevant deviation is by the importer. The equilibrium considered is as follows: The importer always pays C. If the importer ever fails to pay, the exporter stops the relationship. The amount C that makes the importer indifferent between adhering to the trigger strategy equilibrium and deviating is characterized by:

$$V_I = \sum_{n=0}^{\infty} \left(\frac{\gamma}{(1+r^*)^t} \right)^n \left(\frac{R-C}{(1+r^*)^t} \right) = \frac{R-C}{(1+r^*)^t(1-(\gamma/(1+r^*)^t))} = \frac{R-\lambda^* C}{(1+r^*)^t}. \quad (24)$$

This condition determines the highest incentive compatible C that maximizes expected profits of the exporter:

$$C^{OA,RC} = R\left[\frac{\gamma}{(1-\lambda^*)(1+r^*)^t + \lambda^*\gamma} \right]. \quad (25)$$

The amount increases in the survival probability γ and the enforcement probability abroad λ^*. A trigger strategy improves on the one shot game if:[24]

$$\gamma > \frac{\lambda^*}{1+\lambda^*}(1+r^*)^t. \quad (26)$$

3.3 LC versus CIA and OA

The following proposition summarizes the results on repeated contracts above:

Proposition 3 *A trigger strategy improves upon its one shot game equivalent in the case*

[24]To see this, note that the expected payment in the one shot game is $\lambda^* R$. Therefore, the trigger strategy increases expected profits if:

$$R\left[\frac{\gamma}{(1-\lambda^*)(1+r^*)^t + \lambda^*\gamma} - \lambda^* \right] > 0$$

$$\Leftrightarrow \gamma(1-(\lambda^*)^2) > \lambda^*(1-\lambda^*)(1+r^*)^t.$$

of

i) CIA if $\gamma > \frac{\frac{K}{R}(1-\lambda)[(1+r)(1+r^*)]^t}{1-\frac{K}{R}\lambda(1+r^*)^t}$

ii) OA if $\gamma > \frac{\lambda^*}{1+\lambda^*}(1+r^*)^t$

Proof. See derivation of Equations 23 and 26. ■

As a LC already resolves all enforcement problems, trigger strategies cannot improve this payment contract. Therefore, 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 the relationship survival probability γ and enforcement probabilities λ and λ^* are high. Thus longer lasting trade relationships and trade between countries with better international contract enforcement should rely more on CIA and OA trigger strategies and less on LCs.

3.4 Repeated Intermediate Type Contracts

When repeated transactions are considered, a pre-payment can be much more effective in preventing moral hazard of the importer. Suppose both the exporter and the importer play the following trigger strategy: fulfill contract until trading partner deviates; then, stop the trade relationship. The exporter can credibly play this trigger strategy if and only if the sum of the post-delivery payment by the importer and her continuation value are at least as large as the expected gain from a deviation:

$$(1-\phi)\frac{C}{(1+r)^t} + \sum_{n=1}^{\infty}\left(\frac{\gamma}{(1+r)^t}\right)^n\left(\phi C - K + (1-\phi)\frac{C}{(1+r)^t}\right) \geq (1-\lambda)K. \quad (27)$$

$$\Leftrightarrow (1-\phi)\frac{C}{(1+r)^t} + \frac{\phi C - K + (1-\phi)\frac{C}{(1+r)^t}}{1-(\gamma/(1+r)^t)}\frac{\gamma}{(1+r)^t} \geq (1-\lambda)K.$$

This can be solved for the general condition:[25]

$$\phi \leq \frac{1}{1-\gamma} - \frac{(1+r)^t(1-\lambda)+\gamma\lambda}{1-\gamma}\frac{K}{C} \equiv \phi^{E,RC}. \quad (28)$$

[25]For $\gamma = 0$ this simplifies to Condition 17 from the one shot game, corrected for the fact that the importer is playing a trigger strategy and always pays the outstanding amount due after delivery.

The importer plays the trigger strategy if and only if her continuation value is at least as large as the expected gain from a deviation:

$$\sum_{n=1}^{\infty}\left(\frac{\gamma}{(1+r^*)^t}\right)^n\left(\frac{R-(1-\phi)C}{(1+r^*)^t}-\phi C\right)\geq(1-\lambda^*)(1-\phi)C. \tag{29}$$

This equation shows that in the absence of continued trading ($\gamma=0$), a pre-payment alone cannot solve the importer's moral hazard problem. Rearranging delivers:

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

Assuming $\gamma<\frac{(1+r^*)^{2t}(1-\lambda^*)}{r^*+(1-\lambda^*)(1+r^*)^t}$ implies:

$$\phi\geq\frac{(1+r^*)^t((1+r^*)^t-\gamma)(1-\lambda^*)}{\Lambda}-\frac{\gamma}{\Lambda}\left(\frac{R}{C}-1\right)\equiv\phi^{I,RC}, \tag{30}$$

with $\Lambda=\gamma-\gamma(1+r^*)^t+(1+r^*)^t((1+r^*)^t-\gamma)(1-\lambda^*)$.

$\phi^{I,RC}$ represents the lower bound at which the incentive constraint of the importer is binding. If the interval $[\phi^{I,RC},\phi^{E,RC}]$ is non-empty, then a trigger strategy can be implemented. Given the possibility of an intermediate type contract, the set of parameters for which a trigger strategy can be used increases.

Proposition 4 *Suppose* $0<\phi^{I,RC}\leq\phi^{E,RC}<1$. *Then, repeated intermediate type contracts can resolve the moral hazard problems of the exporter and the importer.*

Proof. Omitted. ■

For the exporter incentive constraint to be binding, the pre-payment share ϕ has to be smaller or equal to the threshold $\phi^{E,RC}$, whereas for the importer incentive constraint to be binding, the pre-payment share has to be greater or equal than $\phi^{I,RC}$.

4 Trade Model

What are the implications from payment contracts for quantities, revenues and profits at the firm level and in the aggregate? To address this question, I incorporate the baseline model from Section 2 into a standard international trade framework as in Helpman and Krugman (1985). The analysis delivers new predictions for the patterns of international

trade flows and shows that effects from the payment contract choice can be substantial. It furthermore reveals how the ability to switch between different payment contracts implies differential effects of unilateral and multilateral financial crises on trade flows.

4.1 Setup

Preferences There are L representative consumers in the economy, each supplying inelastically one unit of labor. The individual utility function is:

$$U = Q^{\mu} q_0^{1-\mu} \quad \text{with } Q = \left(\int_{\Omega} q(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right)^{\frac{\sigma}{\sigma-1}}. \tag{31}$$

Q is a CES (constant elasticity of substitution) basket of a continuum of differentiated goods and q_0 is a homogenous good. Utility is Cobb-Douglas in the homogeneous good and the differentiated goods. The demand for the differentiated good is:

$$q(\omega) = p(\omega)^{-\sigma} P^{\sigma} Q, \tag{32}$$

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

Technology Labor is the only input factor. Firms in the homogenous goods sector face perfect competition and operate a constant returns to scale technology that requires one unit of labor per unit of output. The homogenous good is freely traded. Only equilibria in which every country produces the homogenous good are considered. This equalizes wages, which are normalized to one, making the homogenous good the numeraire. In the differentiated goods sector firms operate under monopolistic competition. Each variety is produced by only one firm. There is a fixed cost of entry f. The production of one unit of the differentiated product requires a units of labor. Firms are risk neutral.

4.2 Optimal Behavior of Firms

Given CES demand and monopolistic competition, firms in the differentiated sector charge a constant markup over marginal costs to maximize profits. Domestic prices, quantities and profits are:

$$p_d = \frac{\sigma}{\sigma - 1} a, \qquad q_d = (p_d)^{-\sigma} P^{\sigma} Q, \qquad \Pi_d = q_d \left[\frac{a}{\sigma - 1} \right]. \tag{33}$$

From before the expected profits for the three financing forms are:

$$\begin{aligned} \mathrm{E}\left[\Pi_E^{CIA}\right] &= \lambda(1 + r^*)^{-t} R - \lambda K, \\ \mathrm{E}\left[\Pi_E^{OA}\right] &= \lambda^*(1 + r)^{-t} - K, \\ \mathrm{E}\left[\Pi_E^{LC}\right] &= \left[(1 + r)(1 + r^*)\right]^{-t} R - K. \end{aligned}$$

Note that these can be represented by the general expression:

$$\mathrm{E}\left[\Pi_x\right] = \alpha R - \beta K. \tag{34}$$

Optimization implies the following export prices, quantities and profits:[26]

$$p_x = \frac{\beta}{\alpha} p_d^*, \qquad \mathrm{E}\left[q_x\right] = A q_d^*, \qquad \mathrm{E}\left[\Pi_x\right] = A \Pi_d^*, \tag{35}$$

with A=$\alpha^{\sigma} \beta^{1-\sigma}$.[27]

The factor A fully summarizes the effects of payment contracts on expected profits and expected quantities. $A = 1$ corresponds to the frictionless case, where $r = r^* = 0$ and $\lambda = \lambda^* = 1$. The parameters α and β, which represent the costs of trade finance, enter the problem proportional to the value of exports. Thus, in the model, variable trade costs that arise from the financing requirement and the enforcement problem correspond to the iceberg trade cost formulation.[28] The profits and quantities under financing form

[26] Expected profits can be normalized 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 $\mathrm{E}[\Pi]$ implies the same optimal decisions as maximizing the new function $\mathrm{E}\left[\tilde{\Pi}\right]$. Therefore, the price setting problem is equivalent to the standard case with new per unit production costs of $\frac{\beta}{\alpha} a$.

[27] $\mathrm{E}[q_x]$ is the expected quantity, taking into account that under CIA only a fraction λ of export contracts is enforced.

[28] Per unit trade costs can lead to very different predictions than iceberg type trade costs as first discussed by Alchian and Allen (1964) and shown empirically by Hummels and Skiba (2004). While

1 are larger than under financing form 2 iff:

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

The following proposition summarizes the optimal payment contract choice:

Proposition 5 *The optimal choice of payment contract is uniquely determined by the following three conditions:*

$$\begin{aligned}
&i) && OA \prec CIA \iff && \frac{(\lambda^*)^\sigma}{\lambda}\left(\frac{1+r^*}{1+r}\right)^{\sigma t} > 1,\\
&ii) && OA \prec LC \iff && \lambda^*(1+r^*)^t > 1,\\
&iii) && LC \prec CIA \iff && \lambda(1+r)^{\sigma t} < 1.
\end{aligned}$$

Proof. These conditions follow directly from a comparison of expected profits.[29] ■

While expressions simplify compared to Proposition 1, the testable predictions in Proposition 2 remain valid.

4.3 Implications for Trade Patterns

Taking into account payment contracts delivers new results for international trade patterns. In particular, as trade finance can be obtained from financial markets in the source and the destination country, financial conditions and contracting environments in both countries affect trade flows. The model implies the following testable predictions on trade patterns:

Proposition 6 *For given foreign (home) financial conditions r^*, λ^* (r, λ) and foreign demand conditions P^* and Q^*, exports of a home firm increase in home (foreign) financial market conditions,*

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

trade finance costs represent an important case of pure iceberg type trade costs, arguably many other costs such as physical transport costs can be much better represented by per unit costs. For more recent contributions to this line of research see Irarrazabal et al. (2010) and Wood (2011).

[29] Expected profits for the three financing forms are:
$\mathrm{E}\left[\Pi_E^{CIA}\right] = \lambda\,(1+r^*)^{-\sigma t}\,\Pi_d^*, \quad \mathrm{E}\left[\Pi_E^{OA}\right] = (\lambda^*)^\sigma (1+r)^{-\sigma t}\Pi_d^*, \quad \mathrm{E}\left[\Pi_E^{LC}\right] = [(1+r)(1+r^*)]^{-\sigma t}\,\Pi_d^*.$

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

iii) the more, the larger t.

Proof. See Appendix A. ■

Exports of a firm decrease in interest rates and increase in enforcement probabilities in the source and the destination country.[30] To bring the model to the data, the following Corollary is useful.

Corollary 1 *For given foreign (home) financial conditions r^*, λ^* (r, λ) and foreign demand conditions P^* and Q^*, the log of exports of a home firm increases in home (foreign) financial market conditions.*

i) strictly if both $\ln(1+r)$ *(*$\ln(1+r^*)$*) decreases and λ (λ^*) increases*

ii) weakly if $\ln(1+r)$ *(*$\ln(1+r^*)$*) decreases or λ (λ^*) increases*

iii) the more in $\ln(1+r)$ *(*$\ln(1+r^*)$*), the larger t and therefore also, the larger* $\ln t$

Proof. See Appendix A. ■

Corollary 1 implies that the effect of interest rates on trade flows is increasing in t, the time it takes to transport goods abroad and sell them in the destination country, and therefore increasing in $\ln t$. This provides the theoretical basis for the distance interactions employed in the next section.[31]

4.4 Economic Relevance of Payment Contracts

Is the choice between payment contracts economically relevant? To answer this question, I present a numerical example and calculate trade flows in a two country general equilibrium version of the model.[32] Suppose there are three types of countries as described in Table 1. 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

[30] It would be straightforward to extend the model to a heterogenous firms framework featuring selection into exporting. Then, analog propositions for the extensive margin could be derived.

[31] Payment contracts also imply testable prediction for observed FOB prices. For details see Appendix D.

[32] See Appendix C for the formal derivation.

a less efficient financial market, but relatively strong enforcement.[33] As shown earlier,

Table 1. Country Types

This table reports the values for contract enforcement λ and interest rates $1+r$ for the numerical example in Section 4.4. Time to trade t is assumed to be 2 months. Annualized rates for working capital financing are 1.05, 1.07 and 1.14 for the three country types, respectively.

Country Type	I	II	III
λ	0.99	0.94	0.98
$1+r$	1.0082	1.0113	1.0221

these country characteristics determine the optimal payment contract for each exporter-importer country combination. The optimal payment contracts chosen are reported in table 2. Suppose firms can choose Open Account, whereas Cash in Advance and Letter

Table 2. Optimal Payment Contracts

This table reports the optimal payment contracts chosen for trade between the three types of countries. Available contracts are Cash in Advance (CIA), Open Account (OA) and Letter of Credit (LC).

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

of Credit are not available. This case corresponds to exporter finance only. Below, I report the percentage decrease in traded quantities implied by this restriction of the payment contract choice. Table 3 therefore quantifies the difference in predicted trade flows between this model and previous models that abstract from the full choice of payment contracts available.[34] If, for example, an exporter in a country of Type I trading with an importer in a country of Type II is forced to use OA instead of CIA, this reduces her exported quantity by 16.1 percent. The results show that the choice between payment contracts is economically relevant and that its effects are heterogeneous across country pairs. Some trade, like trade between Type I countries, does not depend very much on

[33]For this example, t is assumed to be 2 months. Interest rates in the table are adjusted to this short time horizon. Annualized rates for working capital financing in this example are 1.05, 1.07 and 1.14 for the three country types, respectively.

[34]The calculations are done solving the two country model for every country type combination separately. Exporters both in the home country and the foreign country are assumed to be constrained to use Open Account only. Reverse trade flows (from abroad to home), which are not reported here, have an impact on price levels and thus on traded quantities of home country exporters. Due to general equilibrium effects, restricting payment contracts can therefore increase exports by home firms.

Table 3. Optimal Contract vs. Open Account

This table reports the percentage changes of home export quantities for all combinations of country types, when every firm is restricted to use Open Account instead of using its optimal payment contract. The elasticity of substitution is assumed to be $\sigma = 4$.

	Only OA		
from / to	I	II	III
I	-2.3	-16.1	1.0
II	0.7	-13.6	2.9
III	-7.1	-20.1	-4.1

the payment contract in use. Trade between countries of Type II, in contrast, which have weak contract enforcement, benefits a lot from the ability of trading partners to avoid OA. Note that whether symmetric or asymmetric countries trade with each other is not a good predictor of the loss from restricting the choice set. Which country-pair combination profits the most from a free choice of payment contracts depends on the interaction of all four parameters that characterize financial conditions and contractual environments in the source and the destination country as shown in the previous sections.

4.5 Contract Switching and Financial Crisis

When financing costs change, firms can react by switching payment contracts to optimally substitute between financial conditions at home and abroad.[35] Suppose for example that initially CIA is used. Then, if the interest rate abroad r^* rises, at some point, it is optimal for the exporter to switch to OA, the cost of which is independent of the foreign interest rate.

The ability to limit the adverse effects from changes in financial markets through payment contracts switches implies asymmetric reactions of trade flows to financial turmoil. If there is country-specific financial turmoil, firms can constrain costs by switching payment contracts as described. If instead there is global financial turmoil that affects the financial markets of both the source and the destination country, this possibility no longer exists and trade flows react more strongly to a crisis. This suggests that in the recent global financial crisis trade finance might have had a stronger effect on aggregate trade flows than in former more locally concentrated crises.

[35] A more detailed analysis can be found in Schmidt-Eisenlohr (2009).

5 Empirical Tests

The model predicts that financing costs affect trade flows. An increase in interest rates in the source and the destination country makes trade finance more costly, implying higher export prices and lower export quantities and revenues. Proposition 6 states that the size of this effect should be proportional to the time needed for trade. I use a panel of bilateral trade data to test these predictions.

The analysis proceeds in four steps. First, the baseline regression is presented, providing evidence for a negative relationship between financing costs and trade flows. I find that the size of the effect of financing costs on trade flows is increasing in the geographical distance between trading partners. Second, based on the results of the baseline regression, I study comparative statics and show that the relationship is economically relevant. Next, I check the robustness of my results. The introduction of interaction terms between geographical distance and measures of contract enforcement (rule of law) and economic development (log of GDP per capita) to the regression does not change the main findings. Results also hold when I introduce exporter $\times$ year and importer $\times$ year fixed effects and estimate a fixed effects model. Replacing the net interest margin by private capital over GDP as the variable capturing financial conditions delivers very similar results. Finally, I address the question of causality.

5.1 Data

I use data on bilateral trade flows for the years 1980 to 2004 from the CEPII trade and production database. Data on geographical distance and other bilateral indicators is from the CEPII gravity dataset collected by Head et al. (2010). The financial market efficiency (net interest margin) and financial market development measures (private credit over GDP) are taken from Beck et al. (2009). The net interest margin is the ratio between the accounting value of the net interest revenues of banks and their total earning assets. It measures the average ex-post markup of the lending activities of banks in a country and therefore represents a measure of financial sector efficiency. This measure differs from ex-ante spreads as it also captures losses on non-performing loans. The alternative measure, private credit over GDP, is a much broader indicator of general financial development.

While the latter seems more appropriate for studying financial constraints, the former seems better suited for addressing the question of trade finance and its effects on variable costs studied here. Data on GDP per capita and population are taken from the Penn World Tables (Heston et al. (2009)). The measure for contract enforcement is extracted from the World Bank Worldwide Governance Indicators. The final sample contains 150 exporting countries over the period 1980-2004. When including the net interest rate margin the number of countries reduces to 144 and the period to 1987-2004. With contract enforcement the years covered are 1998, 2000, and 2002-2004.

5.2 Estimation and Results

The baseline regression tests the relationship between bilateral trade flows and financing costs (log of (1+ net interest rate margin)) in the source and the destination country. It tests both for the direct effect of financing costs and for the effect of their interaction terms with geographical distance.

$$\ln Y_{ijt} = \zeta_0 + \zeta_1 \ln(1+r_i) + \zeta_2 \ln(1+r_j) + \zeta_3 \ln(dist_{ij}) \cdot \ln(1+r_i) \tag{36}$$
$$+\zeta_4 \ln(dist_{ij}) \cdot ln(1+r_j) + \sum_{k=5}^{K} \zeta_k X + \zeta_{K+1} \ln(dist_{ij}) + \chi_i + \chi_j + \chi_t + \epsilon_{ijt}.$$

An observation $\ln Y_{ijt}$ is the log trade flow from country i to country j in year t. The regression controls for importer, exporter and year fixed effects and for a set of control variables X. r_i and r_j are the net interest margins in the source and the destination country, respectively, and $dist_{ij}$ is the geographical distance between the two main cities of country i and j. The control variables are the log of exporter and importer GDP per capita, exporter and importer population, GATT membership status and several bilateral indicators.[36]

[36]These are: common currency, regional trade agreement, agreements conferring preferential treatments (EU to ACP and ACP to EU), contiguity, common official language, common language (at least 9% spoken), colonial history, common colonizer, current colonial relationship, colonial relationship post 1945 and whether countries are or were the same country.

Table 4. Financing Costs, Distance and Export Volumes

This table analyzes the effects of financing costs in the exporting and importing country and their interactions with distance on export volumes. The dependent variable is the log of exports from country i to country j in year t, 1987-2004. Financing costs are measured by the net interest margin. Time to trade is proxied by the geographical distance between the main cities of two countries. Contract enforcement is proxied by Rule of Law. Regressions in columns 1 and 2 control for the log of GDP per capita, population and GATT status for exporter and importer, respectively. Regressions include a constant and columns 1 through 4 control for a set of bilateral controls as discussed in the text. Column 2 also controls for contract enforcement in both countries. Errors are clustered by exporter-importer pairs. Standard errors are in parenthesis. Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Dependent variable	ln bilateral exports					
Specification	(1)	(2)	(3)	(4)	(5)	(6)
Ln exp int	39.105***	12.088***				
	(2.94)	(3.99)				
Ln imp int	47.159***	21.649***				
	(3.06)	(3.86)				
Ln exp int x ln dist	-4.783***	-1.670***	-5.241***	-2.147***	-0.469**	-0.082
	(0.35)	(0.46)	(0.37)	(0.49)	(0.21)	(0.37)
Ln imp int x ln dist	-5.752***	-2.654***	-6.275***	-2.955***	-1.432***	-2.341***
	(0.36)	(0.45)	(0.38)	(0.48)	(0.21)	(0.37)
Exp law x ln dist		0.220***		0.215***		-0.049
		(0.03)		(0.03)		(0.03)
Imp law x ln dist		0.104***		0.091***		0.014
		(0.03)		(0.03)		(0.03)
Ln GDPE x ln dist		-0.058**		-0.057**		0.007
		(0.03)		(0.03)		(0.06)
Ln GDPI x ln dist		0.164***		0.173***		0.119**
		(0.03)		(0.03)		(0.06)
Ln dist	-0.883***	-2.200***	-0.844***	-2.251***		
	(0.03)	(0.29)	(0.03)	(0.30)		
R-squared	0.798	0.794	0.807	0.801	0.182	0.145
N	142761	78742	142761	78742	142761	78742
# exporter-importer clusters	18260	17924	18260	17924	18260	17924
# exporters	144	144	144	144	144	144
Country controls	y	y	-	-	-	-
Country pair controls	y	y	y	y	y	y
Importer, exporter, year FE	y	y	n	n	n	n
Imp $\times$ year, exp $\times$ year FE	n	n	y	y	y	y
Country pair FE	n	n	n	n	y	y

Distance effect The regression reported in Column 1 of Table 4 provides evidence that financial conditions are correlated with trade flows. Countries with higher net interest rate margins trade less with each other. The size of this effect is increasing in the geographical distance between trading partners. This can be seen by noting that, in line with Corollary 1, both coefficients on the distance interaction ζ_3 and ζ_4 are highly significant and negative. The preferred specification is presented in column 3, where exporter $\times$ year and importer $\times$ year fixed effects are included. In this specification ζ_3 and ζ_4 are larger and also highly significant.

Economic relevance The marginal effects of financing costs evaluated at the mean log bilateral distance (8.6) for the regressions in columns 1 and 2 are reported in Table 5. They imply that a one percent higher financing cost in a country is associated with 2.0 percent lower exports and 2.3 percent lower imports by that country. To evaluate the

Table 5. Marginal effects of change in financing costs

This table reports the marginal effects for the regression results in Table 4. The values represent the percentage changes of exports and imports, respectively, resulting from a one percent increase in financing costs (1+net interest margin) evaluated at the sample mean bilateral distance (8.6). Columns (1) and (2) correspond to columns (1) and (2) in Table 4. Standard errors are in parenthesis. Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Effects from 1 % increase in financing costs

Specification	(1)	(2)
Exports	-2.002***	-2.270***
	(0.31)	(0.39)
Imports	-2.280***	-1.174***
	(0.30)	(0.38)
Mean ln dist	8.595	8.599
N	142761	78742

economic relevance of the distance interaction, consider the following comparative statics. Compare trade between Spain and Egypt (25 percentile by distance, 3355 km) with trade between Spain and South Korea (75 percentile by distance, 10013km). Suppose the net interest margin in Spain was one percent higher. Then we should expect Spain to have a 5.2 percent larger drop of its exports and a 6.3 percent larger drop of its imports when trading with South Korea instead of Egypt due to the larger geographical distance. Table 6 reports comparative statics for all specifications from Table 4.

Table 6. Comparative statics for change in financing costs

This table reports comparative statics for the regression results in Table 4. I compare trade between a country pair at the 25 distance percentile (e.g. Spain - Egypt, 3355km) with trade between a country pair at the 75 distance percentile (e.g. Spain - South Korea, 10013km). Values report the reaction of trade to a one percent increase in financing costs (1+net interest margin). Standard errors are in parenthesis. Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Effects from 1 % increase in financing costs

Specification	(1)	(2)	(3)	(4)	(5)	(6)
			Exports			
25 distance	0.278	-1.468***	-	-	-	-
percentile	(0.33)	(0.44)	-	-	-	-
75 distance	-4.951***	-3.293***	-	-	-	-
percentile	(0.40)	(0.48)	-	-	-	-
Difference	-5.230***	-1.826***	-5.730***	-2.347***	-0.512**	-0.089
	(0.38)	(0.51)	(0.40)	(0.54)	(0.23)	(0.40)
			Imports			
25 distance	0.463	0.102	-	-	-	-
percentile	(0.33)	(0.42)	-	-	-	-
75 distance	-5.827***	-2.800***	-	-	-	-
percentile	(0.39)	(0.48)	-	-	-	-
Difference	-6.289***	-2.902***	-6.861***	-3.231***	-1.566***	-2.560***
	(0.39)	(0.49)	(0.42)	(0.53)	(0.23)	(0.41)
N	142761	78742	142761	78742	142761	78742

Robustness One concern is potential omitted variable bias. If there are variables that are correlated with the net interest rate margin and bilateral trade flows that are not included in the regression, the estimate of the distance interaction can be biased. To address this issue, Columns 2, 4 and 6 introduce two additional interaction terms. A measure of contract enforcement (rule of law) and its interaction with distance are added to the regression to control for institutional factors. An interaction between the log of GDP per capita and distance is added to control for effects from the general economic development of countries. Comparing column 2 to column 1, the introduction of these additional regressors reduces the point estimates for ζ_3 and ζ_4 to about a half of their previous values. They remain highly significant and economically relevant.

Columns 5 and 6 estimate a fixed effects model, where effects are identified from within country pair variation over time.[37] ζ_3 and ζ_4 become smaller but remain highly significant with the exception of ζ_4 in column 6.[38]

Another concern might be the measure for financial conditions employed in the re-

[37]This resolves the time-invariant part of the omitted variable bias discussed in Anderson and van Wincoop (2003). An alternative would be to follow Baier and Bergstrand (2009) and explicitly introduce exogenous multilateral-resistance terms.

[38]This might be due to collinearity, that is the high correlation between the net interest margin and per capita GDP (-.47) and contract enforcement (-.54), respectively.

gressions so far. The choice of the net interest margin is motivated by the theoretical part of the paper, which focuses on financing costs of international trade. An alternative is to use private credit over GDP as a general measure for financial development, first introduced to the literature by Beck (2002). This is the standard measure used as a proxy for financial conditions, in particular, in papers that study the role of financial constraints. As a robustness check, I rerun the regressions shown in Table 4 Columns 1 to 4, using private credit over GDP instead of the net interest margin. The results are reported in Table 7. They support the findings from the previous regressions. Note that financial development increases in the ratio of private credit over GDP. That is, the higher the ratio, the better are financial conditions. Therefore, all coefficients on the financial measure have exactly the opposite sign from the regressions in Table 4. Can we interpret the relationship identified by the interaction terms between distance and the measures of financial conditions as causal? The main concern in this context is reverse causality. If a country conducts a lot of international trade, this increases its demand for financial services. A larger demand in turn can lead to efficiency gains in the provision of finance, reducing the net interest rate margin.[39] As discussed earlier, the distance interaction identifies effects proportional to the geographical distance between trading partners. Therefore, the relevant reverse causality to be considered is the following. Suppose there is an increase in the demand from a destination country. This increases the demand for trade finance in the source country proportional to the geographical distance from this trading partner. Reverse causality is a problem if international trade working capital financing is sufficiently large to have a first-order effect on the overall demand for finance in a country. While lending related to international trade finance is certainly an important activity in many countries, it can be argued that in most cases it represents a relatively small share of overall finance. A first-order effect from trade finance on the borrowing rate of firms therefore seems unlikely. This suggests that there is a causal effect of financing costs on trade, proportional to distance.

[39]Do and Levchenko (2007) and Braun and Raddatz (2008) find evidence for reverse causality from trade flows and trade openness, respectively, to financial development.

Table 7. Financial Development, Distance and Export Volumes

This table analyzes the relationship between financial development in the source and the destination country and export volumes. The regressions test for a direct effect of financial development and for an effect of its interaction with distance. The dependent variable is the log of exports from country i to country j in year t, 1980-2004. Financial development is proxied by private credit over GDP. Time to trade is proxied by the geographical distance between the main cities of two countries. Contract enforcement is proxied by rule of law. Regressions in columns 1 and 2 control for the log of GDP per capita, population and GATT status for exporter and importer, respectively. Regressions include a constant and columns 1 through 4 control for a set of bilateral controls as discussed in the text. Column 2 also controls for contract enforcement in both countries. Errors are clustered by exporter-importer pairs. Standard errors are in parenthesis. $*$, $**$ and $***$ denote significance at the 10%, 5% and 1% level.

Dependent variable	ln bilateral exports			
Specification	(1)	(2)	(3)	(4)
Exp fin devt	-4.465***	-3.211***		
	(0.29)	(0.37)		
Imp fin devt	-5.327***	-2.260***		
	(0.30)	(0.41)		
Exp fin devt x ln dist	0.523***	0.360***	0.552***	0.371***
	(0.03)	(0.04)	(0.03)	(0.04)
Imp fin devt x ln dist	0.606***	0.256***	0.618***	0.263***
	(0.03)	(0.05)	(0.04)	(0.05)
Exp law x ln dist		0.143***		0.156***
		(0.03)		(0.03)
Imp law x ln dist		0.022		0.009
		(0.03)		(0.03)
Ln GDPE x ln dist		-0.095***		-0.104***
		(0.03)		(0.03)
Ln GDPI x ln dist		0.161***		0.172***
		(0.03)		(0.03)
ln dist	-1.981***	-2.365***	-2.024***	-2.390***
	(0.03)	(0.27)	(0.03)	(0.28)
R-squared	0.772	0.786	0.788	0.792
N	228045	82812	228045	82812
# exporter-importer clusters	19253	18262	19253	18262
# exporters	150	150	150	150
Country controls	y	y	-	-
Country pair controls	y	y	y	y
Importer, exporter, year FE	y	y	n	n
Imp $\times$ year, exp $\times$ year FE	n	n	y	y

6 Conclusions

Firms in international trade utilize different payment contract to optimally trade off differences in financing costs and contractual environments between source and destination countries. Financial conditions have large effects on bilateral trade flows, with costs in the destination country being more important than those in the source country. This is in stark contrast to most of the literature on finance and trade which almost exclusively focused on the role of conditions in the source country. While standard trade theory abstracts from the explicit modeling of importers, the theory and empirical results in this paper show that it can be important to consider the actual trade relationships between firms in two countries; in particular, to consider an exporter and an importer as well as potentially other actors such as banks. In this, my paper is related to a growing literature departing from the view of exporters selling directly to customers in the foreign market.[40]

The model could be extended allowing for 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. Firm differences in size could affect the relative negotiation power between the exporter and the importer, the ability to enforce contracts in court, to punish deviations from a trigger strategy and to switch contracts in the face of fixed costs. In an extension, currencies could be introduced to study the interaction of the payment contract decision with exchange rate risk.

While the aggregate regressions in this paper constitute a first step, more empirical work is desirable. A dataset containing information on payment contracts, for example, could be used to test the predictions from Sections 2 and 3.

Finally, following Greif (1993), historical trade patterns could be studied in light of the trade-off between financial market characteristics and contracting environments between source and destination country derived in the model. Improvements in institutions over time should be related to the types of payment contracts utilized.

[40] See for example Bernard et al. (2010), Antràs and Costinot (forthcoming) and Ahn et al. (forthcoming).

A Proofs

Proof of Proposition 6 Expected quantities are $\mathrm{E}[q_x] = Aq_d^* = \alpha^\sigma \beta^{1-\sigma} q_d^*$, and expected revenues are $\mathrm{E}[R_x] = p_x \mathrm{E}[q_x] = \frac{\beta}{\alpha} A R_d^* = \alpha^{\sigma-1}\beta^{2-\sigma} R_d^*$. As q_d^* and R_d^* are held constant, it remains to be shown that A and $\frac{\beta}{\alpha}A$ behave has stated in the Proposition. For the three different financing forms we have:

$$
\begin{aligned}
A^{CIA} &= \lambda(1+r^*)^{-\sigma t} & \frac{\beta^{CIA}}{\alpha^{CIA}} A^{CIA} &= \lambda(1+r^*)^{(1-\sigma)t} \\
A^{OA} &= (\lambda^*)^\sigma (1+r)^{-\sigma t} & \frac{\beta^{OA}}{\alpha^{OA}} A^{OA} &= (\lambda^*)^{\sigma-1}(1+r)^{(1-\sigma)t} \\
A^{LC} &= [(1+r)(1+r^*)]^{-\sigma t} & \frac{\beta^{LC}}{\alpha^{LC}} A^{LC} &= [(1+r)(1+r^*)]^{(1-\sigma)t}.
\end{aligned}
$$

First, note that whenever a firm changes its payment contract, this implies that its expected profits, quantities and profits under the new contract are at least as large as under the old contract. Therefore, to prove the Proposition, it is sufficient to show that the statements on export revenues and quantities hold when there is no contract change. Hence, noting that $\sigma > 1$, i) and ii) follow directly from taking derivatives with respect to r, r^*, λ and λ^*, respectively. Taking cross-derivatives with respect to t and r, r^*, λ and λ^*, respectively, proves iii).

Proof of Corollary 1 The log of expected quantities is $\ln \mathrm{E}[q_x] = \ln A + \ln q_d^*$ and the log of expected revenues is $\ln \mathrm{E}[R_x] = ln\left(\frac{\beta}{\alpha}A\right) + \ln R_d^*$. As q_d^* and R_d^* are held constant, it remains to be shown that $\ln A$ and $ln\left(\frac{\beta}{\alpha}A\right)$ behave as stated in the Corollary. For the three different financing forms we have:

$$
\begin{aligned}
\ln A^{CIA} &= \ln\lambda - \sigma t \ln(1+r^*) & ln\left(\frac{\beta^{CIA}}{\alpha^{CIA}} A^{CIA}\right) &= \ln\lambda - (\sigma-1)t\ln(1+r^*) \\
\ln A^{OA} &= \sigma \ln\lambda^* - \sigma t \ln(1+r) & ln\left(\frac{\beta^{OA}}{\alpha^{OA}} A^{OA}\right) &= (\sigma-1)\ln\lambda^* - (\sigma-1)\ln t(1+r) \\
\ln A^{LC} &= -\sigma t[\ln(1+r) + \ln(1+r^*)] & ln\left(\frac{\beta^{LC}}{\alpha^{LC}} A^{LC}\right) &= -(\sigma-1)t[\ln(1+r) + \ln(1+r^*)].
\end{aligned}
$$

The statement in the Proof of Proposition 6 on contract switching remains valid. Again, i) and ii) follow from taking derivatives with respect to r, r^*, λ and λ^*, respectively. iii) follows from taking cross-derivatives with respect to t and r, r^*, λ and λ^*, respectively.

B Wealth constraints

This section shows that a model with a limited value of contract constraint represents a special case of a model with wealth constraints, where the wealth of the importer is set to zero. Let W_i denote the level of wealth of a firm, which it can use to pay for any transactions additional to any cash flow created arising from its economic activities.[41] Assume for now that exporters have sufficient wealth to finance production, i.e. $W_E > K$.[42] Assume that (under CIA and LC) the importer can borrow against her expected future cash-flow from the trade transaction. Then, under CIA, the new expected profit maximization problem is:

$$\begin{aligned}
&\max_C \mathrm{E}\left[\Pi_E^{CIA}\right] = C^{CIA} - \lambda K, \\
&\text{s.t. } C^{CIA} \leq W_I + \frac{\lambda R}{1+r^*}, && \text{(wealth constraint)} \\
&\text{and } \mathrm{E}\left[\Pi_I^{CIA}\right] = \lambda R - (1+r^*)C^{CIA} \geq 0. && \text{(participation constraint importer)}
\end{aligned}$$

The wealth constraint never binds and results do not change. Under OA the new expected profit maximization problem is:

$$\begin{aligned}
&\max_C \mathrm{E}\left[\Pi_E^{OA}\right] = \frac{1}{1+r}(\lambda^* C^{OA} - K(1+r)), \\
&\text{s.t. } C^{OA} \leq R + W_I, && \text{(wealth constraint)} \\
&\text{and } \mathrm{E}\left[\Pi_I^{OA}\right] = \frac{1}{1+r^*}(R - \lambda^* C^{OA}) \geq 0, && \text{(participation constraint importer)}
\end{aligned}$$

[41] The model could be extended to allow firms to borrow using their wealth as collateral. Then, the amount of credit accessible would be increasing in the level of wealth and affected by institutional factors such as enforcement and bankruptcy procedures.

[42] This assumption is to exclude some cases, which seem to be less interesting for the current analysis. Note though, that payment contracts can indeed be a way to circumvent financial constraints for exporters. This point is related to the use of foreign FDI to finance production in countries with stronger financing constraints. In a Melitz (2003) type heterogeneous firms setup, payment contracts may be also used to shift the financing of sunk fixed costs of exporting towards the importer's financial market.

Note that the wealth constraint binds whenever $\lambda^* \leq \frac{R}{W_I+R}$. The optimal payment amount C^{OA} and the optimal discounted expected exporter profits can be derived as:

$$
\begin{aligned}
&C^{OA} = \min\left\{\frac{R}{\lambda^*}, R + W_I\right\}, \\
&\mathrm{E}\left[\Pi_E^{OA}\right] = \frac{R}{1+r} - K, && \text{(if wealth constraint not binding)} \\
&\mathrm{E}\left[\Pi_E^{OA}\right] = \frac{\lambda^*}{1+r}(R + W_I) - K. && \text{(if wealth constraint binding)}
\end{aligned}
$$

Under LC the new expected profit maximization problem is:

$$
\begin{aligned}
&\max_C \mathrm{E}\left[\Pi_E^{LC}\right] = \frac{1}{1+r}(C^{LC} - K(1+r)), \\
&\text{s.t. } C^{LC} \leq W_I + \frac{R}{1+r^*}, && \text{(wealth constraint)} \\
&\text{and } \mathrm{E}\left[\Pi_I^{LC}\right] = \frac{1}{1+r^*}(R - (1+r^*)C^{LC}) \geq 0. && \text{(participation constraint importer)}
\end{aligned}
$$

The wealth constraint never binds and results do not change. It is straightforward to see that for $W_I = 0$ the model reduces to the model with limited value of contract constraint analyzed in the main part.

C General Equilibrium

In the following the two country general equilibrium model is specified and solutions are derived. Suppose there are two countries H and F.[43] As derived in the previous sections, domestic and foreign profits of firms in the differentiated goods sector are:

$$\Pi_d^i = q_d^i \frac{a}{\sigma - 1} \text{ and } \Pi_x^i = A^i \Pi_d^j, \tag{37}$$

with $A^i = (\alpha^i)^\sigma (\beta^i)^{1-\sigma}$. The free entry condition pins down both the number and the size of firms in equilibrium. It requires the fixed cost of entry to equal expected profits from domestic sales and exports:

$$f = \Pi_d^i + \Pi_x^i \quad \forall i \in H, F. \tag{38}$$

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

The two free entry conditions can be solved for domestic and export quantities:[44]

$$q_d^i = \frac{\sigma - 1}{a} f \frac{1 - A^i}{1 - A^i A^j}, \qquad q_x^i = A^i q_d^j = \frac{\sigma - 1}{a} f \frac{A^i (1 - A^j)}{1 - A^i A^j}. \tag{40}$$

Total expected quantities are constant:

$$q^i = \frac{\sigma - 1}{a} f. \tag{41}$$

Labor market clearing The number of firms in both countries is determined by the labor market clearing condition.[45] Given the CD preferences, a constant fraction of labor is employed by the differentiated sector:

$$L_Q^i = \mu L^i. \tag{42}$$

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

$$L_Q^i = L_E^i + L_P^i = n^i (f + aq). \tag{43}$$

The number of firms can be derived as:

$$n = \frac{\mu L^i}{f + aq} = \frac{\mu L^i}{\sigma f}. \tag{44}$$

D FOB Prices

Given per unit cost a, different payment contracts imply different FOB prices. To see this, note that from before the agreed on payment amounts C differ by payment contract,

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

$$f = \frac{a}{\sigma - 1} \left[q_d^i + A^i q_d^j \right]. \tag{39}$$

[45] For tractability, I assume that the positive expected profits of importers under Open Account do not enter the demand for differentiated good. 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.

i.e.:

$$C^{CIA} = \frac{\lambda}{1+r^*} R^{CIA}, \quad C^{OA} = R^{OA}, \quad C^{LC} = \frac{R^{LC}}{1+r^*}. \tag{45}$$

This implies the following testable prediction:

Proposition 7 *Suppose* $R^{CIA} = R^{OA} = R^{LC}$, $\lambda < 1$ *and* $r^* > 0$. *Then,*

$$C^{OA} > C^{LC} > C^{CIA}.$$

Proof. Follows directly from Equations 45. ■

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

$$R = \left(\frac{\beta}{\alpha}\right)^{1-\sigma} r_d^*. \tag{46}$$

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

$$C^{CIA} = \lambda(1+r^*)^{-\sigma} r_d^*, \quad C^{OA} = (\lambda^*)^{\sigma-1}(1+r)^{1-\sigma} r_d^*, \quad C^{LC} = (1+r)^{1-\sigma}(1+r^*)^{-\sigma} r_d^*. \tag{47}$$

From this it can be seen that the amounts specified to be paid 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.

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