Quality Guarantee and Trade Credit

Evidence from Chilean Exporters*

Santiago Justel†

Job Market Paper

November 13, 2019

See latest version

Abstract

What explains the provision and maturity of trade credit contracts? The existing literature has focused mainly on explaining the empirical regularity that firms consistently use trade credit, but has struggled to explain why one side of the market – sellers – systematically provide most of the credit. This paper develops a model where trade credit is used by sellers to signal product quality and documents empirical support for predictions of the model. In an equilibrium of the model, by offering products on credit, the producer is signaling that her products are of high quality. In addition, through the duration of credit, the seller provides a quality guarantee by allowing the buyer to certify the quality of the product before payment. The theory predicts a positive relationship between product quality, the likelihood of providing credit, and the maturity of trade credit. Furthermore, the model predicts positive correlations between credit maturity and other factors such as better legal institutions, product market competition , and difficulty of quality assessments. Using the universe of Chilean transaction-level customs data, I confirm these predictions. Finally, the paper considers the model's implications for recent policy changes in the U.S., France, and Chile to limit the maturity of trade credit.

*I thank Lee Ohanian, Ariel Burstein, Pablo Fajgelbaum, Jonathan Vogel and Álvaro García-Marín for their helpful comments. I also thank UCLA Trade Proseminar and Macro Proseminar participants.

†Ph.D. Candidate, Department of Economics, University of California, Los Angeles. All errors are mine. Please email me to sjustel@ucla.edu

1 Introduction

Trade credit (delayed payment) is widely used among firms domestically, and internationally[1], and is one of the primary sources of short-term financing for both small and large firms.[2] Despite its ubiquity and importance, there is not a clear understanding of the reasons that firms provide credit to each other when there is a financial sector that specializes in the provision of funding.

Most existing theories explain the use of trade credit as an efficient mechanism that helps to reduce a financial/transaction cost or to address some form of uncertainty. Although these theories are not mutually exclusive, some of their implications are at odds with the empirical evidence. For example, the financial motive is hard to square with the fact that small firms that have no financial advantage in credit provision - due to being more credit and liquidity constrained - commonly extend trade credit to large buyers who are not financially restricted.[3]

More importantly, all existing theories focus on the provision of trade credit (extensive margin), while being are silent on the maturity of said credit (intensive margin). The maturity of trade credit is a relevant dimension for many reasons. First, the number of days of credit can explain part of the financial constraints that a firm faces. Secondly, studying the different maturities can help to favor or disregard a particular theory of trade credit. For example, theories based on inventory costs or delayed-sales motive for trade credit suggest a trade credit maturity of similar duration to average inventory cycles, while observed trade credit periods are generally longer.[4]. Related to this, trade credit is used extensively in the service sector, where inventories play no role.[5]

To address this gap in our understanding of trade credit, in this paper, I propose a theory where sellers use trade credit because it acts as a signal and a guarantee of the product's quality. The mechanism, similar to Long, Malitz, and Ravid (1993), is as follows: by offering products on credit, two things happen. On the one hand, through the provision of credit, the producer is signaling to a buyer that her products are of high quality since the producer is

[1]According to Parlhem (2016), 97 percent of the transactions are conducted under trade credit. Internationally, Antras and Foley (2015) for a single US exporter, Demir and Javorcik (2018) Turkish data, Ahn (2011) Colombia and García-Marín, Justel, and Schmidt-Eisenlohr (2019) for Chilean exporters and importers, report that around 90% of international trade involves some form of delayed payment

[2]See Demirguc-Kunt and Maksimovic (2002) and Petersen and Rajan (1997)

[3]See Justel (2019), Klapper, Laeven, and Rajan (2011), Marotta (2005), and McMillan and Woodruff (1999) for evidence of size and trade credit

[4]In the sample of international transactions that I use, the average trade credit maturity is around 130 days for exports 80 days for imports. However, the average number of days of inventory in tradable sectors is between 50 to 80 days according to Chen, Frank, and Wu (2005, 2007)

[5]In my sample, exported services have, on average, 80 days of trade credit.

saying "pay me only if you are satisfied". Given this costly commitment, the buyer believes the product is of high quality. Besides, through the duration of the credit itself, the buyer is better able to certify the quality of the product before paying, allowing trade credit to also act as a quality guarantee.[6]

To formalize this idea, I propose a model where product quality is known to sellers but not known to buyers ex-ante, while buyers can (eventually) obtain a signal of product quality after delivery. Because of this, firms can use a combination of pricing and trade credit terms to signal the quality of their products, even when, from a strictly financial perspective, it is more costly for sellers to provide credit directly. The model predicts that high-quality goods are more likely to be traded under trade credit and also that higher quality goods will have longer maturities. Additionally, the theory also implies that countries with better legal institutions and industries with higher levels of competition will receive longer trade credit periods. Finally, the model predicts that products in which quality is hard to verify experience longer trade credit maturities.

These theoretical implications are tested using the universe of Chilean transaction-level trade data from the Chilean Customs Administration. This data set includes a trade credit maturity measure for each transaction, namely, the number of days in which a given purchase will be paid. To compute product quality, I will use two approaches. Following Fan, Li, and Yeaple (2015) and Khandelwal, Schott, and Wei (2013), I will infer product quality from prices and quantities directly from the data. Alternatively, due to endogeneity concerns and measurement errors, I will focus on the Chilean wine industry. This specific sector has several measures that are commonly accepted as indicators of product quality (e.g., ratings, awards). In the empirical exercise, I will use these metrics as proxies of product quality.

My empirical results are consistent with the predictions of the model. In particular, I find that high-quality goods are 8% more likely to be traded under trade credit and high-quality products have, on average, 20 more days of trade credit.[7] Moreover, countries with better institutions have trade credit periods that are 5 days longer, firms that face higher competition provide 20 to 50 more days of trade credit, and products for which quality is harder to assess are sold with trade credit maturities that are 5 to 20 days longer.

Since many different data sets are used for studying trade credit, I check to see if previously documented regularities are present in the Chilean data. Following the existing literature, I compute the implied interest rate embedded in trade credit-mediated shipments and the effect of repeated transactions on the provision and maturity of trade credit. I obtain an implied annual interest rate of 25%, which is similar to other estimates. Also,

[6] It is worth noting that this mechanism is analog to a money-back guarantee.

[7] In the sample, 7% of transactions are paid in advance, while the rest is paid under some form of trade credit. Additionally, the average maturity for a trade credit contract is 130 days.

I find that repeated interactions increase the likelihood of providing trade credit; however, repeated interaction does not significantly affect the maturity of the loan.

This paper contributes to the growing literature that tries to explain the motives for trade credit. These theories can be broadly grouped into financial, transaction costs, and asymmetric information models.[8] My model fits into the asymmetric information strand of the literature by expanding on the non-financial reasons for trade credit.

This paper also adds to the empirical evidence on trade credit. Most articles focus the empirical analysis on domestic firm-level data obtained through surveys e.g. Ng, J. Smith, and R. Smith (1999), using the Survey of Small Business Finances (SSBF) e.g Giannetti, Burkart, and Ellingsen (2011) and Petersen and Rajan (1997) or proprietary data e.g Cuñat (2006) and Klapper, Laeven, and Rajan (2011). In general, they find support for financial and asymmetric information theories of trade credit.

My paper, through the use of international trade data, also contributes to growing literature on international trade finance. Authors like Ahn (2011), Antras and Foley (2015), Hoefele, Schmidt-Eisenlohr, and Yu (2016), Niepmann and Schmidt-Eisenlohr (2017), and Schmidt-Eisenlohr (2013) study how payment choices depend on country-specific characteristics such as financing cost, limited contract enforcement, capital controls and on industry complexity. Demir and Javorcik (2018) study the positive effect of competition on trade credit provision. García-Marín, Justel, and Schmidt-Eisenlohr (2019) propose and test a theory where trade credit is used to minimize transaction costs related to the presence of markups, and interest rate spreads. This paper includes some of the previous mechanisms, but it additionally studies the role of asymmetric information at the firm-product level and how it rationalizes the provision of trade credit and its maturity.

The model in this paper fits in the broader literature on quality signaling and the use of different types of signaling mechanisms. For example, firms can signal quality through: ***prices*** as in Bagwell and Riordan (1991), Balachander and Srinivasan (1994), Tirole (1988), and Wolinsky (1983); ***advertising*** like in Bagwell and Ramey (1988), Milgrom and Roberts (1986), and Nelson (1974); ***warranties*** as in Dybvig and Lutz (1993), Lutz (1989), Moorthy and Srinivasan (1995), and Spence (1977); ***branding*** e.g. Wernerfelt (1988), the reputation of the retailer as in Chu and Chu (1994). Authors have explored the use of trade credit also a signal for quality e.g. Lee and Stowe (1993), Long, Malitz, and Ravid (1993), and J. K. Smith (1987). The model presented in this paper builds on the existing theoretical literature by highlighting the maturity of the credit as a signal of quality, in addition to the offering of credit and interest rate terms. Most importantly, I offer micro-level evidence to support the novel mechanism suggested by the theory.

Given that it is costly for sellers to provide trade credit (accept delayed payment), and

[8]Next section will provide more details and references for each approach.

the near-ubiquity of this practice in international trade despite the credit constraints faced by many exporters, this paper contributes to the vast literature on credit constraints and international trade[9] since it provides a rationale for the existence of these restrictions.[10]

From a policymaking perspective, there is not much discussion about the importance of trade credit. However, the insights of this model are crucial since it implies that trade credit is not purely a financial tool. Therefore, trade credit facilitates trade for sellers, even when it is costly. This concern has policy relevance, as countries including the U.S., France, and Chile have recently implemented regulations setting a limit on the maturity of trade credit, based in part on the idea that long trade credit periods increase the financial burden for producers. My model predicts, however, that reducing trade credit maturity will reduce both the likelihood and volume of trade, a prediction consistent with recent empirical work in Breza and Liberman (2017).

In the next section, I present a review of the existing theories that explain the use of trade credit. In section 3, I develop the theoretical model of trade credit terms and establish the predictions of the model regarding correlates of trade credit maturity and product quality. In section 4, I introduce some definitions and the data that I will use to validate the predictions of the model. In section 5, I test empirically for the predictions of the model in the Chilean trade data. Finally, section 6 presents a discussion of the results and suggests avenues for further research.

2 Trade credit motives

The reasons why firms provide credit has been studied for more than 30 years. Because trade credit is one of the most important sources of short-term finance for a firm, one question commonly arises: What are the motives for a firm to lend to another firm, even in the presence of a developed financial sector? Four main theories explain the use and provision of trade credit.

2.1 Financial Motives

This theory says that the producer may have an advantage over traditional lenders. The most basic one is, as in Schwartz (1974), that the producer has access to credit whereas the seller does not. Therefore the producer extends credit, in the form of trade credit, to the

[9]See Amiti and Weinstein (2011), Leibovici (2018), Manova (2012), Muûls (2015), and Paravisini, Rappoport, Schnabl, and Wolfenzon (2014) for some examples.

[10]For domestic trade, there are market solutions to obtain liquidity from trade credit transactions (e.g., invoice factoring). This short-term financing mechanism is not available for international transactions. Thus exporters need to rely on financial markets or own funds for short-term financing.

buyer. This financial advantage may come from the fact that the producer has better access to buyer's information (Biais and Gollier (1997) and J. K. Smith (1987)), has better ability to monitor the buyer (Burkart and Ellingsen (2004) and Cuñat (2006)) or has advantage in liquidating collateral over the financial sector (Maksimovic and Frank (2005) and Mian and Smith Jr (1992)).

2.2 Transaction Cost Motive

An alternative theory states that trade credit can reduce the transaction/inventory costs that can result from demand or delivery uncertainty as in Daripa and Nilsen (2011), Emery (1987), and Ferris (1981). The key mechanism is that in the presence of uncertainty on the delivery of goods, if the buyer pays them as they arrive, the buyer incurs in additional costs of money holdings. Alternatively, if there is uncertainty on the demand side, a buyer that pays earlier has a cash flow mismatch and bares the inventory costs (or missing sales). Therefore, trade credit might mitigate these problems since it helps to coordinate cash inflows and outflows.

2.3 Asymmetric Information Motives

Related, in part, to the financial motives is the theory that the producers have information that the buyers do not, in this case, the provision of trade credit may ease the "lemons problem". The asymmetry could be that the producer knows the quality of the product, and the seller does not (Lee and Stowe (1993) and Long, Malitz, and Ravid (1993)), or there are some "bad" firms that have incentives to default in the presence of limited commitment (Antras and Foley (2015) and Schmidt-Eisenlohr (2013)). In both cases, trade credit alleviates the problem since it acts as a contract enforcement mechanism.

2.4 Price Discrimination Motive

Because trade credit implies late payment of a product, it is natural to expect that cash prices are lower than trade credit prices.[11] Because of this, firms can use trade credit as a way of providing a menu of prices for the same good when buyers have different valuations or when some buyers are credit constraint therefore since they cannot take advantage of the discount, they are willing to pay higher prices to buy the product. Brennan, Maksimovics, and Zechner (1988) and Schwartz and Whitcomb (1979) are some examples of this theory.

[11] This can be achieved implicitly through volume discounts and payment plans or explicitly offering discounts for early payment

From the empirical perspective, as surveyed in Cuñat and Garcia-Appendini (2012), the evidence seems to favor theories of information asymmetries and financial motives, but do not favor a particular mechanism. Giannetti, Burkart, and Ellingsen (2011) explicitly argue that the product quality theory finds limited support in the data.[12] One issue is that they conclude this using aggregate indicators of trade credit at the firm level (accounts receivable/payable) and indirect measures of quality/reputation (firm size). Alternatively, Pike, Cheng, Cravens, and Lamminmaki (2005), through a survey conducted to 700 firms in the US, UK, and Australia, explore the different theories and uses for trade credit. They also find support for models of information asymmetries; in particular, the authors find evidence for the product quality theory.

To the best of my knowledge, this is the first paper that studies empirically the direct relationship between trade credit and product quality at the transaction-level for a broad class of firms.

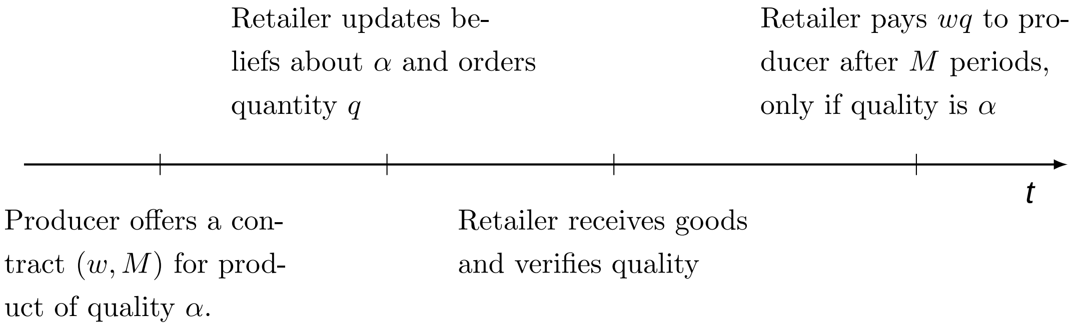
3 Model

To motivate my empirical analysis and shed light on the mechanisms that drive my results, I consider a partial equilibrium model of payment choices in international trade in the spirit of Antras and Foley (2015) and Schmidt-Eisenlohr (2013). The key difference with these models is that I will include quality as a distinctive characteristic of the good. Moreover, the quality will not be observable. However, it can be verifiable over time. Thus trade credit, particularly the maturity of the credit, will have two functions: a signal of the quality of the good and a quality guarantee. A similar mechanism is proposed by J. K. Smith (1987) and Long, Malitz, and Ravid (1993).

In a nutshell, the model consists of a profit-maximizing producer (hereafter referred to as 'he') who supplies a variety s of a differentiated good to a profit-maximizing retailer (hereafter referred to as 'she'). The traded good will differ in its quality, which is known by the producer but is not observable immediately by the retailer. The producer offers a trade credit contract specifying a wholesale price $w > 0$ and a trade credit period $M \geq 0$, at which the retailer will pay back the total value of the transaction after M days. The timing of the decisions is as follows. The producer chooses the terms of the trade credit contract. The retailer chooses the quantity and the final price, taking the contract as given. Figure 1 describes sequence of events.

[12] Particularly, they say that according to this theory producers with established reputation should extend less trade credit since it is likely that they produce high-quality goods, whereas, in reality, large, well-known firms extend more trade credit.

Figure 1: Sequence of events



3.1 Consumers

For tractability and clarity, I assume a specific linear demand system as in Antoniades (2015), Di Comite, Thisse, and Vandenbussche (2014), and Foster, Haltiwanger, and Syverson (2008)[13] for a particular product. This demand structure delivers simple analytical expressions. However, the main theoretical result does not rely on this particular demand since it also can be obtained through alternative demands systems.

I will assume the economy is endowed with a unit mass of consumers with the following preferences:

$$U = q_0 + \int_S \; _s q_s ds - \frac{}{2} \int_S [q_s]^2 \, ds - \frac{}{2} \left[\int_S q_s ds \right]^2 ; \tag{1}$$

where q_0 and q_s correspond to the individual level consumption of the numeraire and the variety $s \in S$ respectively. As stressed out by Di Comite et al. (2014), the parameter $\; _s > 0$ reflects the vertical differentiation between varieties (with respect to the numeraire).[14] From now on, I will refer to $\; _s$ as quality.[15] The parameter $\;\; > 0$ indexes the degree of product differentiation between varieties. Finally, $\;\; > 0$ represents the degree of substitutability between varieties. The inverse demand for a variety s implied by these preferences is given by

$$p_s = \; _s - \;\; q_s - \;\; Q; \quad Q \equiv \int_S q_s ds: \tag{2}$$

Inverting (2), total quantity Q of differentiated variety can be defined as a function of aggregates as

$$Q = \left(\frac{N}{\;\; + \;\; N} \right) [^- - \bar{p}]$$

[13] Although many other authors have used a similar specification. The cited authors explicitly include a demand shifter or 'quality' characteristic.

[14] To be precise, α_s reflects the willingness-to-pay for the first unit of variety of s.

[15] Antoniades (2015) assumes more structure on the preferences for quality, in any case, these preferences deliver a similar demand system.

where $N \equiv \int_S ds$ is the number of varieties consumed, $\bar{} \equiv \frac{1}{N}\int_S \ {}_s ds$ and $\bar{p} \equiv \frac{1}{N}\int_S p_s ds$ are the average quality and price respectively.

3.2 Firms

There are two types of firms. Retailers and Producers. Retailers buy from Producers and sell directly to consumers. The trade credit decision comes from solving the problem between these two types of firms when product quality is not observable.

3.2.1 Retailers

Retailers are profit-maximizers that take the demand defined by (2), the quality of the product, and the cost of the product as given to choose retail prices and quantities.

For a given variety s, producers offered the following contract to the retailers: a wholesale price w and a trade credit maturity M, which means the retailer will pay the producer after M periods.[16] Taking this contract and the total quantity Q as given, the retailer buys amount q_s and sets a final price p_s such that profits are maximized. Additionally, following Antras and Foley (2015) and Schmidt-Eisenlohr (2013), I will assume that in every period, the retailer can face a liquidity shock such that if this shock is realized the retailer exits the market with zero profits. This liquidity shock will be modeled as a Poisson process with a rate of . Therefore, in a trade credit contract with a period of M, the probability of staying in the market is $e^{\quad M}$. Finally, I will assume that there is no strategic default, in other words, in the absence of a liquidity shock, if the retailer bought and received a quality product, she will honor the contract $(w; M)$.

In the absence of additional costs, the retailer's expected profits as a function of quantity for a given quality ${}_s$ are defined as

$$\Pi^R(q_s| \ {}_s; w; M) = e^{\quad M}\left(p_s - we^{\ r \ M}\right)q_s = e^{\quad M}\left(\ {}_s - \ q_s - \ Q - we^{\ r \ M}\right)q_s \tag{3}$$

where I substituted the final price by the expression obtained in (2) and r is the interest rate relevant for the retailer. Notice that, for simplicity, I assumed that the retailer sells all the goods at the beginning of the period, but pays back to the producer after M periods. Naturally, the demand for variety s is obtained maximizing (3), thus final price, demand for variety s and total profits as functions of quality are defined by[17]

$$p_s\left(w; M| \ {}_s\right) = \frac{{}_s \quad Q + we^{\ r \ M}}{2} \tag{4}$$

$$q_s\left(w; M| \ {}_s\right) = \frac{{}_s \quad Q \quad we^{\ r \ M}}{2} \tag{5}$$

$$\Pi^R_s\left(w; M| \ {}_s\right) = \frac{e^{\quad M}}{}\left[\frac{{}_s \quad Q \quad we^{\ r \ M}}{2}\right]^2 : \tag{6}$$

[16] w and M depend on the variety s, but I omitted the sub-index for clarity purposes.

[17] Notice that the shock plays no role in the price and quantity. It affects only the profits.

As expected, prices and quantities are increasing in quality, prices (quantities) are increasing (decreasing) in the wholesale prices, but most importantly, since trade credit decreases the present value of the payment, it effectively decreases (increases) the price (quantity).

3.2.2 Producers

Similarly, producers, who know the quality of their products, take the demand from the retailer as given and set wholesale prices and trade credit to maximize expected profits.

In particular, producers of a variety s maximize their profits using the demand from the retailer given by (5). A producer of variety s will have a marginal cost of c_s and no additional costs. Thus, a producer of variety s of quality $\ _s$ has expected profits of

$$\Pi^P(w; M \mid \ _s) = \left(we^{\ (r+\ \ )M} - c_s\right)\left(\frac{\ _s - \ \ Q - we^{\ r\ M}}{2}\right): \tag{7}$$

Where r is the interest rate relevant for the producer and , again, is the liquidity shock rate of the retailer. The assumption is that if the retailer exits the market, she defaults on her contract. When taking the model to the data, I will assume that is a country characteristic. Notice that is analogous to the inclusion of imperfect contracting friction, as in Antras and Foley (2015) and Schmidt-Eisenlohr (2013), since it captures the likelihood of the retailer honoring the contract that depends, among other things, on the destination country legal institutions.

3.3 Equilibrium

To characterize the equilibrium, I will examine the perfect information benchmark and conclude that in this framework, trade credit will not be provided unless there are financial incentives. However, in the asymmetric-information equilibrium, trade credit will be provided as a signal for product quality, acting effectively as a quality guarantee, even in the case that it is not financially efficient to provide it.

3.3.1 Perfect information contract

Under the *symmetric-information* setting, where quality $\ _s$ is known by the retailer. The producer solves:

$$\max_{w;M\ \ 0} \Pi^P(w; M \mid \ _s) \tag{8}$$

Thus, under perfect information, wholesale prices, quantities and producer expected profits as a function of trade credit maturity and quality are defined by

$$w(M|\ _s) = \frac{(\ _s\ \ Q)e^{r\ \ M} + c_s e^{(r+\ \ )M}}{2} \tag{9}$$

$$q_s(M|\ _s) = \frac{\ _s\ \ Q\ \ c_s e^{(r+\ \ \ r\ )M}}{4} \tag{10}$$

$$\Pi_s^P(M|\ _s) = \frac{e^{\ (r+\ \ \ r\ )M}}{2}\left[\frac{\ _s\ \ Q\ \ c_s e^{(r+\ \ \ r\ )M}}{2}\right]^2 \tag{11}$$

Lemma 1. ***(Symmetric-information benchmark)*** *In the symmetric-information contract, if $r+\ \ > r$ then the optimal provision of trade credit will be $M = 0$ and the wholesale prices, quantities and producer pro ts are*

$$w(\ _s) = \frac{\ _s\ \ Q + c_s}{2} \tag{12}$$

$$q_s(\ _s) = \frac{\ _s\ \ Q\ \ c_s}{4} \tag{13}$$

$$\Pi_s^P(\ _s) = \frac{1}{2}\left[\frac{\ _s\ \ Q\ \ c_s}{2}\right]^2 \tag{14}$$

The proof is direct from (11). This lemma states that, under perfect information, the motive for the provision (and maturity) of trade credit is purely financial. Therefore, if the producer has no financial incentives, due to the fact of credit being more expensive or riskier compared to the credit that the retailer can obtain, he will not provide trade credit to the retailer.

The condition $r+\ \ > r$ resembles the condition for the provision of trade credit over prepayment obtained by Antras and Foley (2015) and Schmidt-Eisenlohr (2013).[18]

3.3.2 Asymmetric-information contract

I turn to the case where the producer has private information about the quality of the variety he produces. I will focus my attention on the separating equilibrium since I want to study the case where prices and trade credit maturity may include information about the quality of the product.[19]

To ease exposition, I will assume that each variety s can have two possible qualities, high or low. Suppressing the index s, this means that $\ \in \{\ ^L;\ ^H\}$. Additionally, as it is standard in this literature, I will assume that producing a high-quality variety is more costly than producing a low-quality one, then $c^H > c^L$. Defining $\Delta\ \equiv\ ^H -\ ^L$ and $\Delta c \equiv c^H - c^L$, I assume that $\Delta\ > \Delta c$. This last assumption implies that, under perfect information, profits are increasing in quality or, equivalently, larger firms produce higher quality products.

[18] In their models, given the mismatch between delivery and payment, they also include the possibility of default for the producer, so they also include a home country-risk variable

[19] In the appendix A.2 I explore the pooling equilibrium and conditions for its existence.

To isolate the role of quality signaling of the trade credit, I will assume that $r + \quad > r \;$, that is, producers have no financial incentives to provide trade credit. Finally, the critical assumption of the model is that after delivery but before payment, the retailer may receive a signal of the quality of the product. For simplicity, this signal will be a *perfect bad news* signal, which means a single signal arrival conclusively indicates low quality. This signal will be a Poisson process with an arrival rate of . Moreover, if the retailer receives this signal, but she did not buy a low-quality product, she will default on her contract, and these products become worthless. Intuitively, trade credit maturity acts as product quality guarantee, since a more extended credit period implies a higher chance to verify the actual quality of the product.

Proposition 1. *Under asymmetric-information about product quality, a separating equilibrium will be characterized by the low-quality producer o ering the symmetric-information contract* $(w^L; 0)$ *with* $w^L \equiv \frac{^L \quad Q + c^L}{2}$*. Whereas the high-quality producer deviates and o ers a contract* $(w; M)$ *such that* $w > w^H$ *and* $M \geq 0$*, where* w^H *is the wholesale price of the high-quality product under perfect information.*

The proof of the existence of a separating equilibrium has been extensively discussed in the literature, see for example Bagwell (1992), Overgaard (1993), and Wolinsky (1983), where firms signal product quality exclusively through prices. Because through the provision of trade credit, I am just broadening the space of signals, the separating equilibrium still exists. The key assumption needed for the existence of the separating equilibrium is the single-crossing property, guaranteed in this case by the assumption $\Delta \quad > \Delta c$. Intuitively, if both types of producers offer their symmetric-information contract, the high-quality producer does not have the incentive to deviate to the low-quality contract since it implies a lower wholesale price ($w^H > w^L$) and he pays a higher marginal cost.

On the other hand, the low-quality producer has incentives to mimic the high-quality firm since he will receive higher prices and pays the lower marginal cost. Therefore high-quality producer will pay the signaling cost through higher prices and trade credit (which is costly) to separate themselves from the low-quality firm. In that case, the low-quality producer will offer the full information price.

As it has been stated in the literature, there are many separating equilibria. The one that survives the Intuitive Criterion, as defined by Cho and Kreps (1987), corresponds to the most efficient separating equilibrium[20] characterized by the solution of the following problem

$$
\begin{aligned}
&\max_{w;M \quad 0} && \left(we^{\quad (r+ \quad)M} - c^H\right) q\left(w;M| \quad ^H\right) \\
&\text{subject to} && \left(e^{\quad M} we^{\quad (r+ \quad)M} - c^L\right) q\left(w;M| \quad ^H\right) \leq \Pi^L
\end{aligned}
\tag{15}
$$

Where the $q\left(w;M| \quad ^H\right)$ is given by (5), Π^L represents the profits of the low quality producer under the symmetric-information equilibrium and the constraint corresponds to the local incentive compatibility, where wholesale prices and trade credit maturity deter the low quality firm from mimicking the high-quality producer. The first part of this restriction correspond to the expected revenue of the low quality producer when he tries to pass as a high-quality firm and he is not caught, the second part is the total production cost $c^L q$. The following proposition describes the optimal trade credit contract.

Proposition 2. *Under asymmetric-information about product quality, the contract* $(w;M)$ *that satis es the Intuitive Criterion is the most e cient separating equilibrium that solves (15). Moreover, for large enough, this contract* $(w;M > 0)$ *solves the following system:*

$$
w = \frac{(\quad ^H \quad Q)e^{r \quad M} + c^H e^{(r+ \quad)M}}{2} + \frac{r+ \quad r}{2}(c^H - c^L \mathrm{e}^{\quad M})e^{(r+ \quad)M} \tag{16}
$$

$$
\Pi^L = \left(e^{\quad M} we^{\quad (r+ \quad)M} - c^L\right) q\left(w;M| \quad ^H\right) \tag{17}
$$

Otherwise, the optimal contract is de ned by the system:

$$
M = 0 \tag{18}
$$

$$
\Pi^L = \left(w - c^L\right) q\left(w;0| \quad ^H\right) \tag{19}
$$

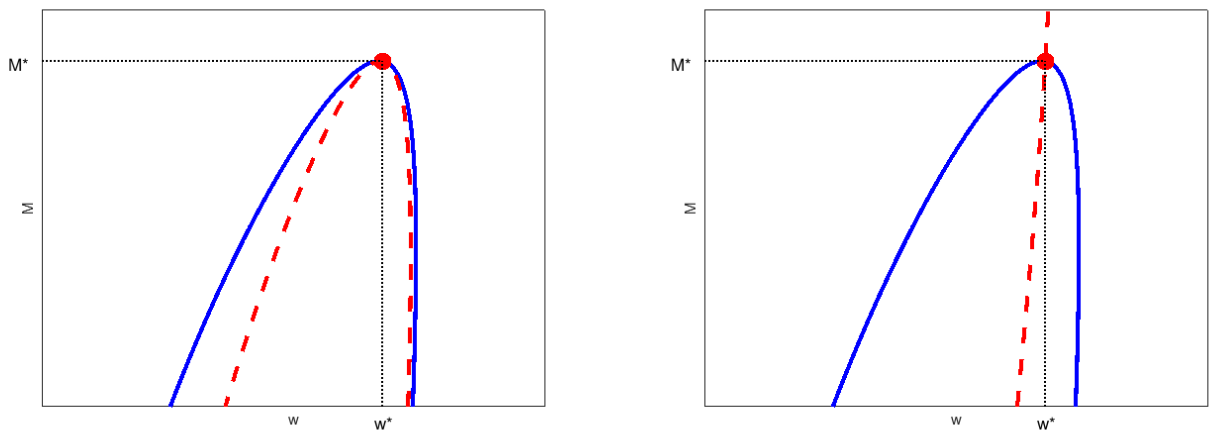
Proof can be found in the Appendix. Proposition 2 characterizes the optimal contract and shows that the parameter is essential for the use of trade credit. If the rate of the verification of quality is low, there is no use in the provision of trade credit, since it is an expensive and ineffective signal. Therefore quality will be signaled only through prices. As long as is large enough, the high-quality producer will use wholesale prices and trade credit maturity to signal the quality of the product. Figure 2 shows a graphical representation of the optimal contract as the solution of the maximization problem or as the solution of the non-linear system of equations described in proposition 2.

3.4 Increasing quality

Proposition 2 delivers the fact that high-quality goods are more likely to be traded under trade credit. Now the question is, what happens in the case of multiple quality levels?

[20]Most efficient equilibrium in the sense that producer maximizes profits using the lowest price/trade credit maturity possible. Both are costly signals.

Figure 2: Characterization of optimal contract.



(a) Solution given by (15)

(b) Solution characterized by Proposition 2

Note: Solid line corresponds to the IC constraint. Dashed line, on the left panel, corresponds to the objective function in (15). On the right panel dashed line corresponds to equation (16) in Proposition 2

To easily answer this question, I conduct a comparative static analysis by increasing ^{H} and c^H, while still assuming $\Delta \quad > \Delta c$.[21] This delivers the following result:

Proposition 3. *In the most efficient separating, the wholesale price w and trade credit maturity M increase with quality.*

Although a formal proof in a simplified version of the model is provided in Appendix A.3, this result is intuitive. Increasing quality makes mimicking more attractive for low-quality firms, thus both signals: wholesale price and trade credit maturity must increase to deter this behavior. Figure 3 exemplifies the contract and some of the outcomes as ^{H} and c^H increase.

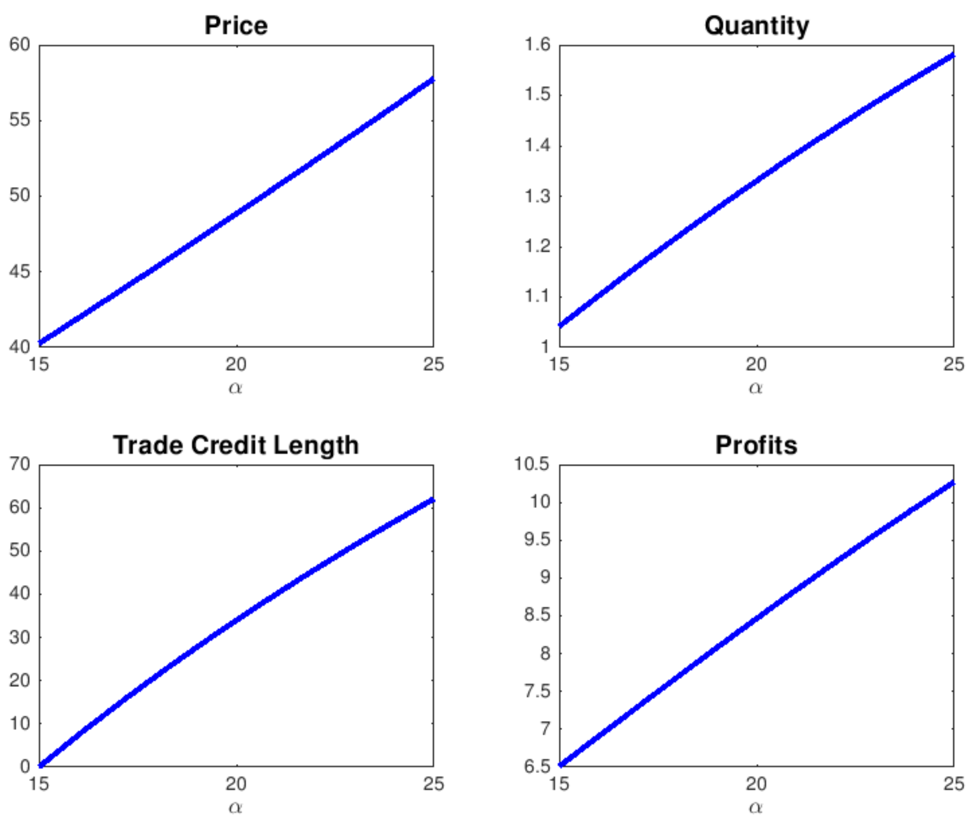
3.5 Predictions

This model, and its extension, delivers 3 testable predictions. First, from the optimal contract, propositions 2 and 3 state the main testable result of this paper.

Prediction 1. *High-quality firms are more likely to extend trade credit. Moreover, higher quality goods are traded under longer trade credit periods.*

[21] Alternatively, one can assume a set of different quality levels and their corresponding costs. The problem with this is that the most efficient contract becomes increasingly complicated since all the IC constraints must be checked.

Figure 3: Contract as a function of quality



The mechanism is very intuitive. Trade credit acts as a quality guarantee. Delaying the payment decision gives itself an enforcement tool to the retailer. In this model, a contract does not consist only in the delivery of a product, which a short trade credit period can also enforce. A contract describes the delivery of a product of a certain quality, and since quality is hard to asses, longer maturities are needed to enforce the contract.

Secondly, because of the presence of financial motives ($r; r$ and) and other demand factors (Q), this model also delivers the following predictions with respect to the relationship between trade credit provision and market-specific characteristics.

Prediction 2. *Trade credit maturity will be longer in countries with:*

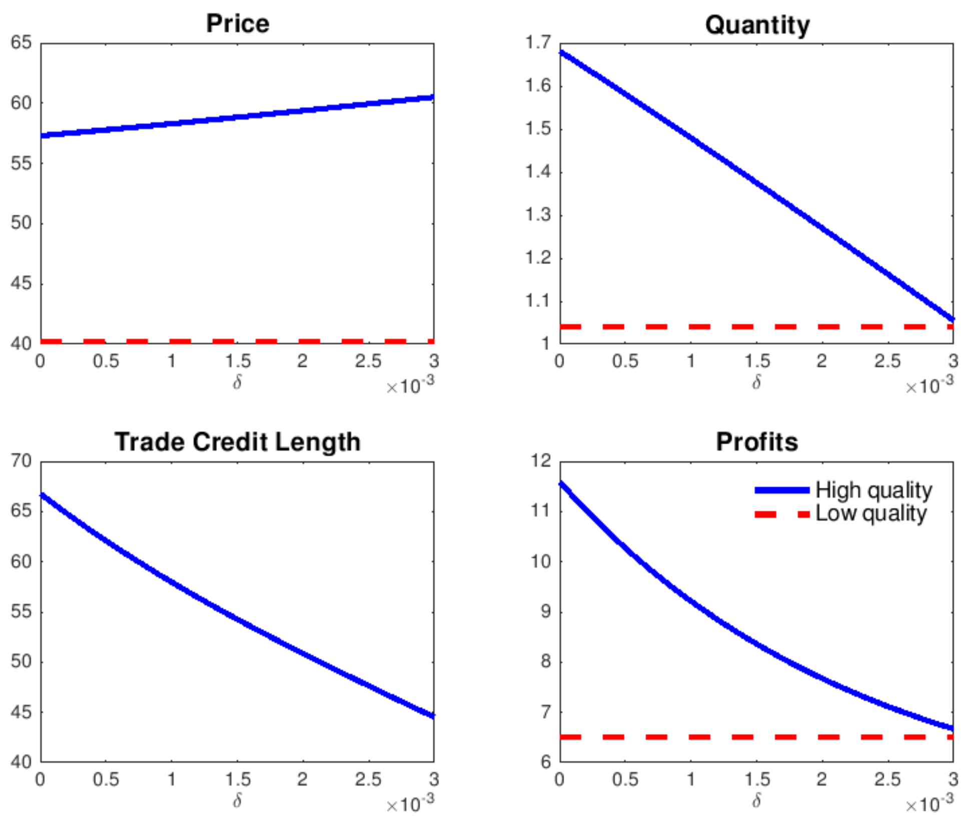
1. *better institutions (low)*
2. *higher level of competition (high Q)*

The first part of the prediction is intuitive. captures an exogenous default rate on the contract. Better legal institutions imply that this default probability is lower, the credit becomes cheaper. Then if is lower, the transaction under credit will be more likely to be paid, reducing the cost of providing trade credit. Therefore the producer has more incentives to use trade credit as a signal for quality. Figure 4 shows the effect of over some of the outcomes of the model. As risk increases, the price also increases. Consequently, quantities and profits decrease.

The competition effect is not as intuitive because, as competition increases, two things happen: low-quality firm's profits decreases and expected revenue when deviating also decreases. While the former tightens the incentive compatibility constraint, the latter relaxes the restriction. The effect that dominates depends on the parametrization, as Appendix A.3 shows, under very mild conditions, namely, a significant difference between high quality and low quality or a high rate of , the overall effect will be non-monotonic. For small enough levels of competition, the low-quality profit effect dominates. Thus the IC constraint becomes tighter, forcing an increase in the maturity of trade credit. On the other hand, for high levels of competition, the low-quality profits are so low that the revenue effect dominates. The IC constraint is relaxed, decreasing the incentives for more extended trade credit periods.

This relationship and the corresponding intuition can be seen in figure 5, particular in the last panel, where profits for low and high-quality firms are plotted. When low-quality firm profits are low (close to 0) is when the relationship of trade credit maturity and competition changes direction. The overall positive relationship between competition and trade credit provision is documented by Fisman and Raturi (2004), Hyndman and Serio (2010), and Singh (2017). Moreover, the inverted U-shape resembles the one that Hyndman and Serio (2010)

Figure 4: Contract as a function of



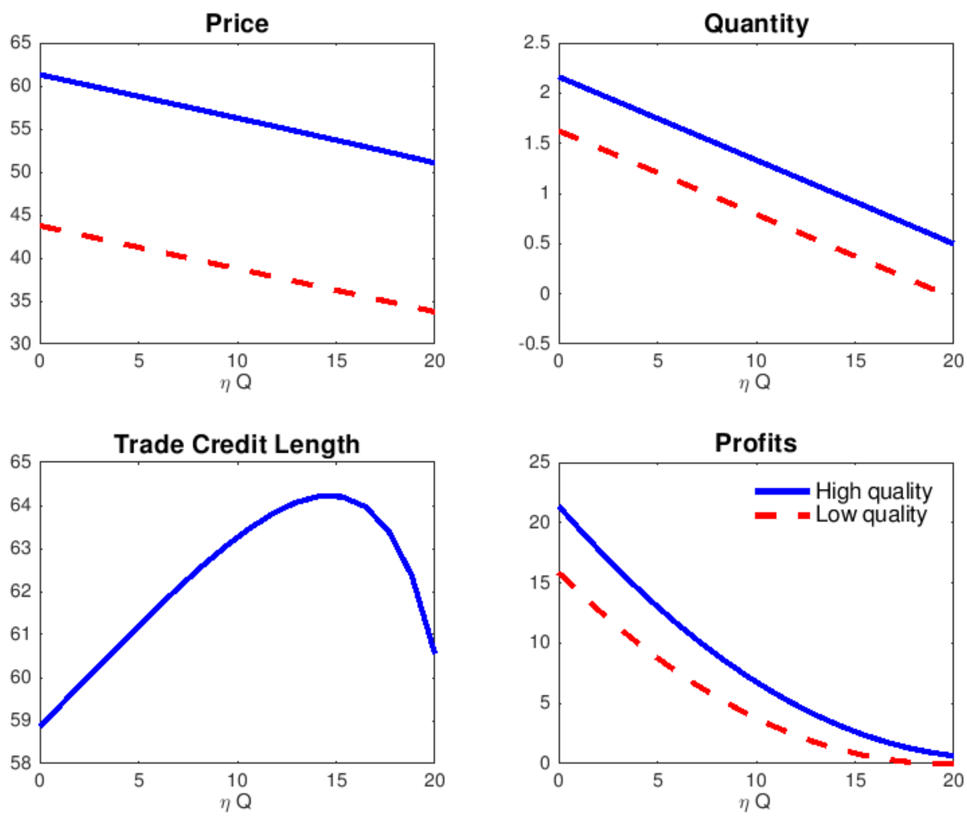
find empirically. In their paper, they find that the provision of trade credit and competition has an inverted U-shape.

Finally, one of the key aspects of this model is the quality verification dimension, captured by the parameter . Therefore I can test an additional prediction.

Prediction 3. *Trade credit maturity will be longer for products where quality is hard to assess (low).*

Since is the rate at which the importer receives the signal that verifies the quality of the product. A product with a higher is akin to a product in which quality is easy to establish, therefore if a product's quality is easy to asses, a shorter trade credit period will be necessary to verify the quality and deter the low-quality firm from deviating. Figure 6 describes this intuition. As previously discussed, for a very low , trade credit will not be used as a signal. Therefore the separating equilibrium will be sustained only through prices, which in turn implies that high-quality firm has lower profits compared to the low-quality firm. Notice that the prediction of a negative relationship between and trade credit length is true only when high-quality firm profits are greater than the low-quality firm, which is

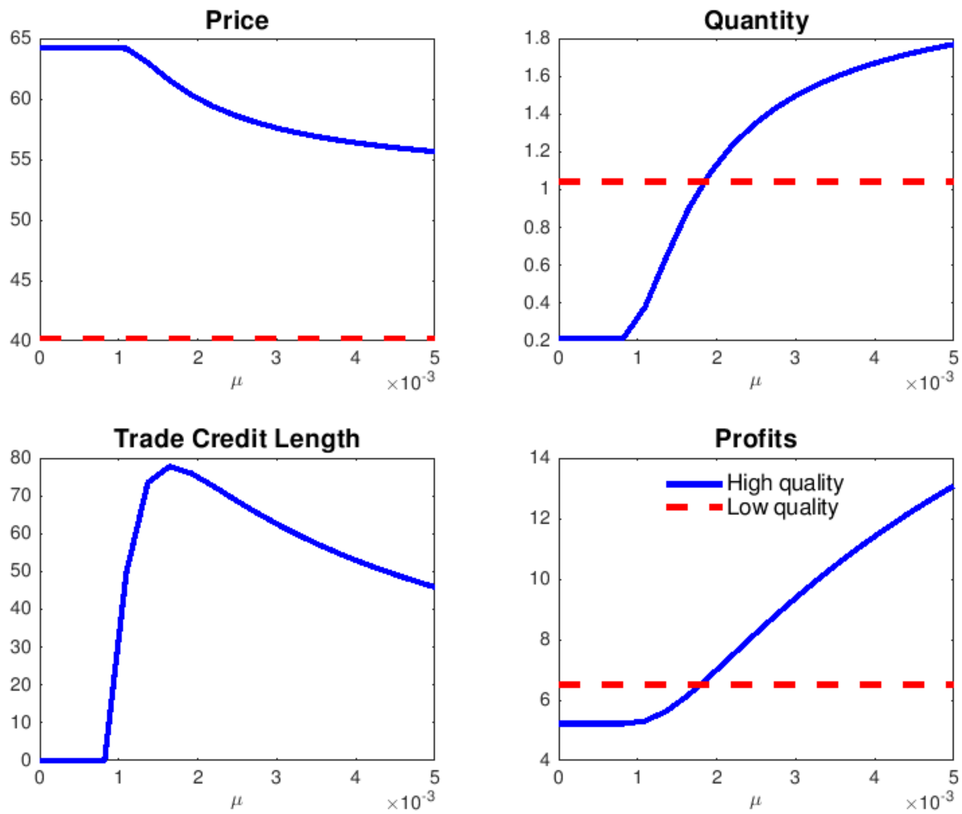
Figure 5: Contract as a function of Q



not an implausible assumption.[22]

[22]This outcome can be obtained in an extension where there are two sets of firms: one with access only to low-quality technology and the other one with access to both high and low-quality technology. Under this setting, the separating equilibrium exists, thus high and low quality will simultaneously be offered, only if high-quality profits are greater than low quality.

Figure 6: Contract as a function of



4 Payment Contracts and Data

To test the predictions of the model, I will use a detailed transaction-level from Chilean customs. This data set that allows me to study the relationship between quality and trade credit includes information on destination/origin, prices, quantities, and the type of payment contract that was used in a given transaction.

4.1 Payment contracts

Before describing the data, it might be useful to outline the type of payment contracts used in international trade. Following the literature, these contracts are Open Account, Cash-in-Advance, Letter of Credit, Documentary Collection, and a Two-Part agreement that combines any two of the previous ones.

An *Open Account* (OA) transaction in the trade finance literature, corresponds to an operation that the importer pays directly to the exporter after shipment/arrival of the product. This type of arrangement is the closest to a standard trade credit contract.

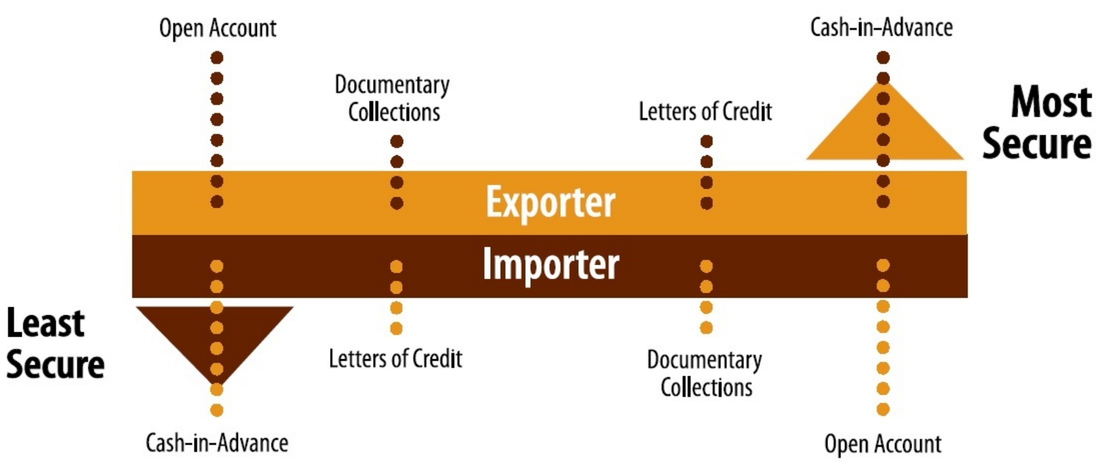
The opposite in terms of payment risk is the case where the importer pays to the exporter before shipment(arrival) of the goods. This arrangement is known as ***Cash-in-Advance*** (CIA).

Somewhere in the middle, in terms of risk, is the case where banks can intermediate through documentation that acts as a payment guarantee. One of these mechanisms is called ***Letter of Credit*** (LC). In this arrangement, the importer agrees to pay the transaction to his bank, said bank issues a letter to the exporter's bank that serves as a guarantee for payments under specified conditions.[23] After these conditions are met, the exporter's bank releases the payment to the exporter. Exporter's bank collects the money from the importer's bank and finally, the importer pays to his bank.[24]

Similar to the letter of credit, there is the ***Documentary Collection*** (DC). The critical distinction is that under LC, the bank is required to give the money to the exporter if the conditions are satified; in other words, payment is almost guaranteed. Under DC, there is no guarantee. The importer can decide not to honor the contract, hence the exporter will not receive the payment.[25]

The final type of contract is a combination of any of the previous four in the form of a two-part contract (e.g., 20% CIA, 80% OA). Figure 7 summarizes the types of arrangements and their relationship with risk.

Figure 7: Payment methods and risk



[23]These conditions consist of the presentation of documents by the exporter to his bank. The documentation needed can vary but consists of: bill of lading, certificate of origin, commercial invoice, inspection documents, among others.

[24]The importer pays a fee to his bank for this service. Between fixed charges and a percentage of the value, these fees may vary between 1 and 10% of the total amount of the transaction.

[25]In this case, the importer also pays a fee to the bank, but since the bank faces almost no risk, the fees are lower. They correspond to 1% or less of the face value of the transaction.

As figure 7 shows and what the literature has stressed, there is a tension in how risk is shared between parties, particularly the default risk. CIA is the safest for the exporter, since he will receive the payment early, but is the riskiest for the importer since the exporter might not deliver the goods. Similarly, OA is the safest for the importer, but most uncertain for the exporter since the importer might not pay the agreed transfer, even after the arrival of the products.

Notice that, aside from the risk-sharing problem, financially speaking OA, LC and DC contracts are very similar in the sense that the exporter will receive the payment after the arrival of the goods. Hence all these arrangements look like a standard trade credit contract. Therefore, the credit period plays an important role, since longer maturities imply that the exporter must fund his working capital through the financial system for a more extended period, incurring additional costs.

4.2 Data

My empirical analysis that relates trade credit and product quality is mainly based on transaction-level data provided by the Chilean Customs Agency.

The data set, available for exports and imports, includes standard information such as the firm's tax number, 8-digit HS product code, destination/origin country, value, quantities, etc. There are two unique features of these data sets. First, for both exports and imports, the data sets include information about the trade finance contract for each shipment. In particular, if the transaction was paid in advance (CIA), post-shipment (OA), with some bank documentation (LC/DC)[26], through a two-part contract or if the purchase actually was not paid. Secondly, and key for my analysis, both data sets also include a measure that captures how many days later will the exporter (importer) collect (make) the payment. In the case of exporters, they need to report to Customs the exact date that they will receive the payment (or last payment in the case of a two-part contract). Similarly, importers need to report directly the number of days in which they will make the payment (or final payment). This data is available for 2009 to 2017 for the case of exports and 2007 to 2017 for imports.

As table 1 shows, the most predominant form of trade finance is OA, with around 85% of exports (weighted by transaction or FOB value) and 70% of imports being paid after arrival with no intermediation. Moreover, trade credit, in the sense of late payment (OA+LC/DC), accounts for 90% of the exports and more than 70% of imports. Also, it is essential to note that the two-part contracts are almost non-existent, accounting for less than 1% of the trade flows.[27]

[26] From the data, I cannot disentangle if a transaction was paid using DC or LC.

[27] Among the two-part agreements, the most frequent is the 50% CIA, 50% OA.

Table 1: Shares by type of contract

	Exports		Imports	
	Transaction	FOB	Transaction	FOB
OA	87.1	83.7	66.6	75.9
LC/DC	2.0	12.7	5.6	9.3
CIA	6.9	3.0	25.2	13.3
Two-part	0.4	0.2	0.6	1.0
No payment	3.6	0.4	2.0	0.5

Note: Column Transaction computes average weighting by transaction. Column FOB, weighting by value.

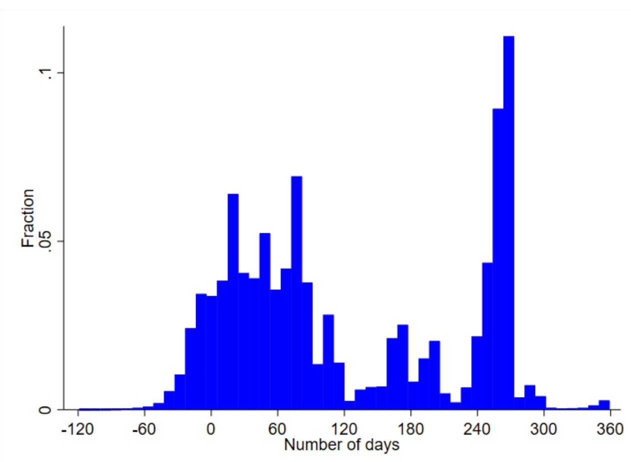
Table 2: Average number of days by contract

	Exports		Imports	
	Transaction	FOB	Transaction	FOB
OA	132.7	148.7	73.8	78.0
LC/DC	159.6	197.4	133.1	131.3
CIA	-20.6	-28.3	-	-
Two-part	84.1	110.8	75.8	115.9

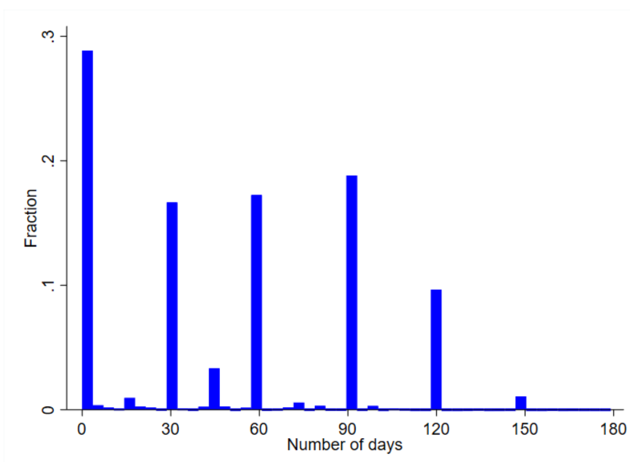
Note: Column Transaction computes average weighting by transaction. Column FOB, weighting by value. In the case of Imports, when transaction is CIA, importers report 0 days.

In the case of exports, I proxy the maturity of each type of contract as the difference between the reported payment date and the shipment date. For imports, I use the direct report of the number of days. Table 2 shows the number of days on average that each contract is paid. In the case of exports, trade credit transactions are paid after 4 and a half months on average. Trade credit related to imports is shorter, with an average maturity of 2 and a half months. Notice that regardless of LC/DC being considerably safer options compared to an OA contract, LC/DC contracts have similar credit periods, in the case of exports, or considerably longer, for imports. This last point supports the fact that from a financial perspective, both contracts are akin to trade credit since both imply a late payment. Finally, it is worth noting that this proxy for trade credit period implies that on average transactions under CIA are paid 20 days before shipping, which is considerably lower than the number of days provided as trade credit.[28] Figure 8 shows the full distribution of maturities. By construction, the credit period for exporters is continuous, although spikes can be seen close to 30, 60, 90, 120 days, as it is standard in trade finance practice. For imports, since the number of days is directly reported, there are clear modes at 0 days (CIA), then 30, 60, 90, and 120 days.

Figure 8: Distribution of number of days



(a) Exports



(b) Imports

I complement this data set with data from the Chilean Tax Agency. This additional

[28]This difference comes from the fact that I do not have the actual date of production/invoicing of a given product. So this number of days should be considered a lower bound since the traded good was produced before the shipment date. As a matter of fact, for a subsample of the data set, I can obtain the actual date of the invoice, and for those cases, the average number of days of prepayment is between -1 and 0. Moreover, this sample has clear modes at 0, 30, 60 and 270 days. Appendix C1 shows the comparison for both the actual trade credit and the proxy measure I use throughout the paper.

firm-level data set includes measures of size (number of workers, equity, tax bracket based on total sales), age, and industry at the 6-digit level.

4.2.1 Quality

To test the main mechanism of the model and its implications, a key measure needed is product quality. For this, I will use two approaches. First, following Fan, Li, and Yeaple (2015) and Khandelwal, Schott, and Wei (2013), I will infer quality from prices and quantities. Alternatively, due to endogeneity and measurement error concerns in the quality estimation, I will focus on the wine industry and use wine ratings and other measures as proxies for product quality. To estimate quality using prices and quantities Khandelwal, Schott, and Wei (2013) assume a CES demand system that includes quality as a demand shifter, the demand for a product of a given quality   is defined as:

$$q = p \qquad A$$

where q is quantity, p reflects price,   is the demand elasticity, and A represents a combination of the price index and aggregate expenditure in country d. Taking logs and rearranging

$$\log \quad = \log q + \quad \log p + \log A$$

Then assuming a value for , log   can be estimated as the residual of

$$\log q_{fpdt} + \quad \log p_{fpdt} = \quad _{dt} + \quad _{p} + "_{fpdt}. \tag{20}$$

Where $_{dt}$ is a set of destination×year fixed effects that control for A and $_{p}$ are product fixed effects included since prices and quantities are not necessarily comparable across product categories. Thus quality can be proxied by $\widehat{\log \quad} \equiv$ ". The value of the demand elasticity   is key, and following the literature, I will use common values in the trade literature $= \{5; 10\}$, also I will use the values estimated at the product level by Broda and Weinstein (2006), thus $= \; _{p}$ in this case. Finally, when estimating quality with this methodology, I follow the literature[29] and restrict the sample to differentiated goods as defined by Rauch (1999) since these products by definition are the ones who might display quality differentiation. In contrast, homogeneous goods do not.

The previous measure of quality has several issues, particularly measurement error since it is based on estimation. Therefore I will use an alternative approach to test the robustness of my results. Specifically, I will take an objective measure of quality in a single industry, wine.

[29] See Khandelwal (2010), for example

The wine industry in Chile is not a large sector in Chile. It contributes 0.5% of the GDP and represents around 3% of total Chilean exports (7% of exports in manufacturing). However, it is a significant industry internationally. In 2018, Chile was the 5th largest wine exporter, representing 5.3% of world wine exports.[30] The key aspect of using the wine industry is the existence of several magazines and websites that publish objective and comparable ratings for wine. To use this information, I will exploit an additional feature of my data set, for each transaction, there is a variable that describes, in plain text, the product that is being traded. In the case of wine, from this variable, I will extract information that identifies the particular wine, for example, winery, brand if it exists, grape/blend[31], vintage and additional keywords e.g. *Reserve*, *Organic*. Using this information, I web-scrapped ratings, retail price, and awards for each wine. Additionally, from the description, I extract text that indicates if the wine is bulk wine, that obviously is not rated, but potentially may signal a low-quality wine.

Table 3: Summary stats

	Full Sample				Di erentiated goods				Wine			
	Mean	Median	1 decile	9 decile	Mean	Median	1 decile	9 decile	Mean	Median	1 decile	9 decile
FOB ($1000s)	62.3	5.8	0.2	58.4	20.4	3.2	0.1	50.3	9.2	3.9	0.8	22.8
Trade credit (days)	122.3	82	1	269	94.8	66	-8	260	104.8	80	38	254
Firms per year	7900.7	7707	7458	8403	5010.2	4917	4623	5553	377.0	361	340	427
Tot Exp per rm-year ($1000s)	8535.4	87.3	3.6	4481.4	1178.8	29	2.1	1071.9	4664.1	359.5	14.7	9739
Workers per rm-year	206.7	31	2	434	242.9	40	3	499	175.8	26	1	355
Dest. per rm-year	26.4	18	3	56	11.7	9	2	25	59.1	53	17	123
Trans. per rm-year	6408.6	2192	119	17147	4904.4	989	45	10165	10838.1	3586	461	39141
Prods. per rm-dest-year	11.1	4	1	27	13.9	5	1	37	-	-	-	-
Observations	9821302				2621197				1728119			

Given these approaches, I will focus my empirical analysis using only data for exports. Table 3 shows some summary statistics for the full sample and the restricted ones. As expected, the sample is very skewed in terms of value per transaction and exporter size (measured by total exports or by number of workers)

Table 4 describes additional statistics for the wine sample, particularly, statistics related to quality. In general, the exported wine is of high quality. This fact is shown by the high average price per bottle, high average rating, or the large share of the wine exports that have an award.

[30]For reference, France, Italy and Spain, the 1st, 2nd and 3rd largest wine exporters respectively, amount to almost 30, 20 and 10% of worldwide wine exports.

[31]Some examples of grape are Cabernet Sauvignon, Merlot, Pinot Noir, etc. With 'blend' I mean a mix of grapes.

It is worth to point out the fact that, according to Rauch (1999), wine is not a differentiated good. Thus both restricted samples are completely independent.[32]

Table 4: Additional statistics wine-quality

	Mean	Median	p1	p99
Price (FOB)	5.00	3.33	0.77	35.30
Final Price ($ per bottle)	25.71	10	4	141
Rating (0-100)	87.35	87	83	93
Award	0.43	0	0	1
Bulk	0.03	0	0	1

5 Empirical analysis

The primary purpose of this empirical section is to study the use of trade credit as a quality guarantee and to assess the validity of the proposed model. To do that, I will test the following hypotheses: (1) High-quality products are more likely to be traded under trade credit (Prediction 1). (2) Higher quality goods will be purchased with more extended trade credit periods (Prediction 1). (3) Trade credit period will be longer in countries with better legal institutions and markets with a high level of competition (Prediction 2); Trade credit will be shorter for products that quality is easier to verify (Prediction 3).

To capture the relationship between trade credit provision and quality described in Prediction 1, I will estimate the following equation:

$$I(CIA_{fpdt} = 1) = \quad \text{quality}_{fpdt} + \quad _{pdt} + {''}_{fpdt}; \tag{21}$$

where $I(CIA_{fpdt} = 1)$ is a dummy variable that is one if a transaction from firm f of product p to destination d at period t was paid under *cash-in-advance*, quality_{fpdt} is a measure of quality and $_{pdt}$ are product×destination×year fixed effects to control for unobserved heterogeneity potentially correlated with product quality, for example demand shocks. Similarly, for the second part of Prediction 1 that relates trade credit maturity and quality, I will estimate the following equation:

$$M_{fpdt} = \quad \text{quality}_{fpdt} + \quad _{pdt} + {''}_{fpdt}; \tag{22}$$

where M_{fpdt} is the maturity in days of the trade credit extended by firm f, when selling product p to destination d in period t.

[32] Several authors have indicated that one of the problems with Rauch (1999) is related to the classification of agricultural products, see Bernini, González, Hallak, and Vicondoa (2018) for a discussion.

To test Predictions 2 and 3 , I will estimate a general equation of the form

$$M_{fpdt} = \quad X + \quad 'Z + \quad + "_{fpdt}; \tag{23}$$

where X will be the relevant destination-specific measure for institutional quality, firm-destination-product specific measure of competition and product-specific measure of quality verifiability. Z represents a set of additional observables and are a set of fixed effects to control for unobservables.

5.1 Relationship between quality measures

Before moving to the main results, it is worthwhile to show that all the measures for product quality that I will use are correlated, as expected.

As previously stated, I will use two approaches to measure product quality. I start measuring quality from the data set as the residual of (20). Along these lines, for robustness, I will proxy product quality by firm size, as proposed by Kugler and Verhoogen (2011) and Manova and Zhang (2012).

Table 5 shows the cross-correlations between these measures of quality. All of these metrics are positively related, as has been well documented in the literature.

Table 5: Cross correlation over quality measures

	(= 5)	(= 10)	(= $_p$)	log N	log Equity	log tot Exp	Sales bracket	Age
(= 5)	1							
(= 10)	0.95	1						
(= $_p$)	0.46	0.40	1					
log N	0.17	0.10	0.15	1				
log Equity	0.24	0.16	0.17	0.75	1			
log tot Exp	0.31	0.17	0.21	0.65	0.66	1		
Sales bracket	0.18	0.08	0.13	0.71	0.80	0.67	1	
Age	0.11	0.05	0.08	0.38	0.41	0.34	0.42	1

Note: α is the estimated quality with the value of σ indicated. σ_p is the product-specific elasticity estimated by Broda and Weinstein (2006). $\log N$ is corresponds to the log of employment, log tot Exp is the log of the value of total of exports for a firm in a given year. Sales bracket is the classification of size based on total annual sales according to the Chilean tax agency. All correlations are significant at 1%.

Alternatively, for the case of wine, I will use additional measures for quality, such as wine rating, final price, awarded wine, and bulk wine. Table 6 shows the cross-correlation between these variables. As expected, high quality, measured as the residual of equation

(20), is positively correlated with size, high ratings, high final price, and the likelihood of having an award. Also, not surprisingly, high quality is negatively correlated with bulk wine. The rest of the correlations have the expected sign, except for the final price and the fact that the wine earned an award. This relationship has a negative correlation, although very low.

Table 6: Cross correlation over quality measures - Wine

	(= 5)	(= $_p$)	log *N*	log Equity	log tot Exp	Sales bracket	Age	Rating	log nal price	Award	Bulk
(= 5)	1										
(= $_p$)	0.64	1									
log *N*	0.44	0.42	1								
log Equity	0.44	0.39	0.86	1							
log tot Exp	0.46	0.49	0.83	0.81	1						
Sales bracket	0.42	0.41	0.80	0.73	0.87	1					
Age	0.25	0.22	0.48	0.48	0.49	0.52	1				
Rating	0.21	0.18	0.28	0.31	0.28	0.13	0.11	1			
log nal price	0.18	0.14	0.20	0.23	0.19	0.08	0.02	0.84	1		
Award	0.16	0.13	0.23	0.21	0.20	0.19	0.11	0.02	-0.02	1	
Bulk	-0.06	-0.03	-0.10	-0.08	-0.04	-0.02	-0.03	.	.	-0.16	1

Note: α is the estimated quality with the value of σ indicated. In the case of wine, Broda and Weinstein (2006) estimated $\sigma_p = 2.2$. $\log N$ is a measure of size and corresponds to the log of employment log tot Exp is the log of the value of total of exports for a firm in a given year. Sales bracket is the classification of size based on total annual sales according to the Chilean tax agency. Award and Bulk are dummy variables with value 1 if wine earned an award or if it is a bulk wine. All correlations are significant at 1%.

5.2 Results

Results are consistent with the predictions of the model. In particular, I find that high-quality goods more likely to be traded under trade credit, and high-quality goods have longer maturities. Additionally, trade credit will be longer in countries with better legal institutions, in markets where firms face more competition and for products for which quality is hard to verify.

5.2.1 Probability of extending trade credit

Table 7 shows one of the main empirical results of this paper, the estimation of equation (21), that relates quality and the likelihood of a transaction being paid in advance. The first column is the regression using size, measured by log employment, as a proxy for quality under the full sample, the following columns use the estimated quality under different elasticities, for those cases, I use the restricted sample of differentiated goods. To ease the comparison among results, row $\Delta I(CIA = 1)$ indicates the marginal change in the probability of *cash-in-advance* evaluating the independent variable from percentile 1 to percentile 99 (akin to going from low quality to high quality). Table 7 shows that higher quality products are, on average, 8 percent less likely to be traded under trade credit.

Table 7: Quality and Likelihood of Trade Credit

Dep. var	$I(CIA = 1)$			
	$\log N$	$= 5$	$= 10$	$= \ _p$
Quality	-0.008	-0.005	-0.002	-0.002
	(0.001)	(0.001)	(0.000)	(0.000)
Obs.	9181870	2576753	2576753	2285070
R^2	.439	.549	.548	.553
$\Delta I(CIA = 1)$	-0.072	-0.120	-0.094	-0.056

Note: All regressions include product×destination×year fixed effects. σ_p is the product-specific elasticity estimated by Broda and Weinstein (2006). $\log N$ is corresponds to the log of employment. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

Since the relationship between size and the probability of providing trade credit is well documented[33], perhaps the correlation between quality and trade credit is capturing the relationship of size and trade credit. To tackle this issue, I estimate equation (21) controlling by firm size. Table 8 indicates that the relationship between quality and provision of trade credit still exists, although its impact is cut by half.

Now I proceed to estimate equation (21) for the case of wine. Since, in this case, the sample is one product, I include a set of grape×destination×year fixed effects to control potential differences in types of wine. According to table 9, the results are similar, and they present the expected negative relationship between quality and the probability of pre-payment. Two important comments. First, the negative correlation measured by ratings and final prices exists but is very weak because the rated wines are already of high quality. Therefore there is not sufficient variance. Secondly and surprisingly, bulk wine seems to be traded through trade credit, which is counter-intuitive with the proposed mechanism, under the natural assumption that bulk wine is of lower quality compared to bottled wine. This result comes from the fact that bulk wine, although low quality, is traded in large volumes[34]. Thus each transaction of bulk wine becomes important for both exporter and importer. Table B1 in the Appendix shows that once controlling for the volume of each transaction, the

[33]See Justel (2019) for example

[34]Average volume of non-bulk wine is 4 tons, whereas average bulk wine is 52 tons

Table 8: Quality and Likelihood of Trade Credit and Firm Size

Dep. var	$I(CIA = 1)$		
	$= 5$	$= 10$	$= {}_p$
Quality	-0.002	-0.001	-0.001
	(0.001)	(0.000)	(0.000)
$\log N$	-0.019	-0.019	-0.020
	(0.003)	(0.003)	(0.004)
Obs.	2436580	2436580	2158721
R^2	.539	.538	.545
$\Delta I(CIA = 1)$	-0.059	-0.044	-0.026

Note: All regressions include product×destination×year fixed effects. σ_p is the product-specific elasticity estimated by Broda and Weinstein (2006). $\log N$ is corresponds to the log of employment. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

rest of coefficients remain the same, but the one for bulk wine becomes positive, significative and with a similar magnitude compared to the other ones.

Table 9: Quality and Likelihood of Trade Credit - Wine

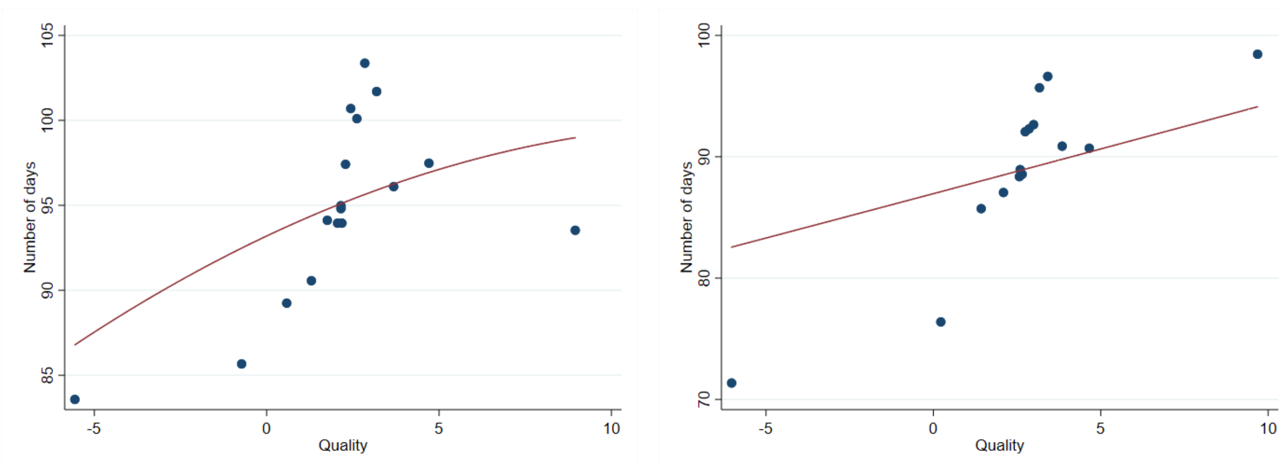
Dep. var	$I(CIA = 1)$								
	$\sigma = \sigma_p$	$\sigma = 5$	$\log N$	Rating	Avg Rating	log price	log Avg price	Award	Bulk
Quality	-0.010***	-0.004***	-0.008***	-0.001	-0.001*	-0.001	-0.001	-0.009***	-0.007**
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.002)	(0.003)
Obs	1661139	1663495	1540375	937489	950493	787027	1201204	1664188	1664188
R^2	.118	.112	.12	.129	.132	.153	.113	.111	.11
$\Delta I(CIA = 1)$	-0.089	-0.041	-0.063	-0.006	-0.009	-0.003	-0.003	-0.009	-0.007

Note: Broda and Weinstein (2006) estimated $\sigma_p = 2.2$ for wine. Rating and price correspond to the rating and final price of a particular wine-vintage. Avg Rating and Avg price are respective average ratings and final prices for a wine over vintages. Award and Bulk are dummy variables with value 1 if wine earned an award or if it is a bulk wine. All regressions include grape×destination×year fixed effects. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

5.2.2 Trade credit maturity

The previous section emphasized the relationship between the discrete choice of providing trade credit and product quality. One of the advantages of my data set is the fact that I can study the provision of trade credit as a continuum (how many days before/after arrival, the importer will pay). In this section, I show the second main result of this paper, namely the positive relationship between product quality and trade credit maturity. Figure C2 shows a graphic representation of equation (22). It shows the relationship between product quality and the number of days provided as trade credit.

Figure 9: Trade credit maturity and quality



(a) $\sigma = 5$ (b) $\sigma = \sigma_p$

Note: Both figures are binned scatter plots of number of days of trade credit vs. quality measured as the residual of (20) demeaned by product×destination×year. Left panel estimates quality using demand elasticity of 5 and right panel using the demand elasticity estimated by Broda and Weinstein (2006)

The results of estimating equation (22) are summarized in table 10. Once again, to ease comparison, row ΔM describes the difference in the number of days when evaluating the independent variable from the 1st percentile to the 99th. On average, high-quality goods have 20 days longer trade credit compared to low-quality products.

In the previous estimation, I used transactions conducted under trade credit and prepayment and without additional firm controls, which might be an important omitted variable. The results are robust when controlling for these potential issues. Table 11 summarizes several robustness checks. The first panel restricts the sample to exclude transactions conducted under *cash-in-advance*. The middle panel uses the full sample, trade credit, and CIA transactions, but controls for firm size. The final panel is a combination of a restricted sample and firm size. In general, results remain similar quantitatively.

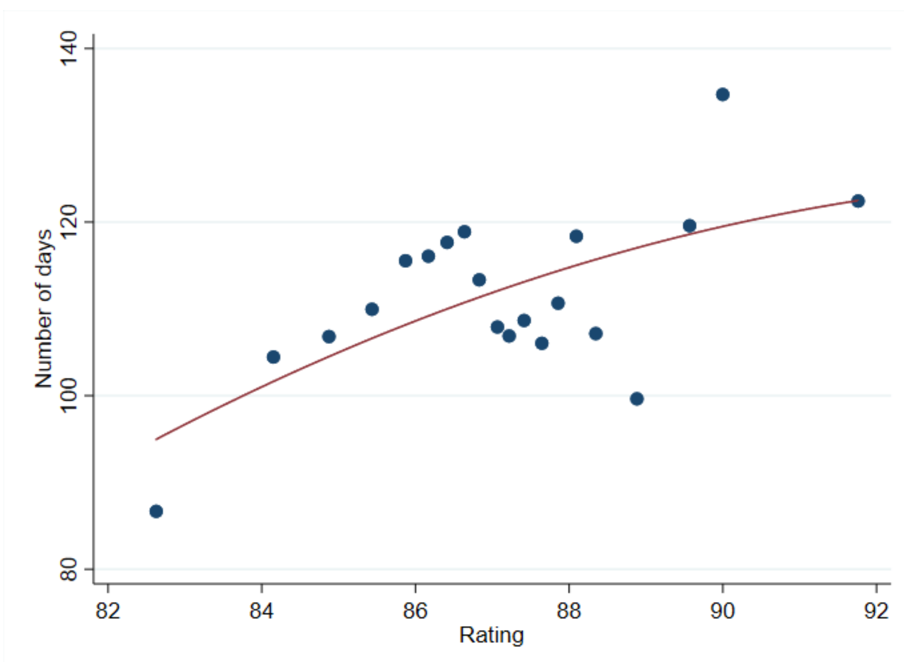
Table 10: Trade credit maturity and quality

Dep. var	M			
	$\log N$	$= 5$	$= 10$	$= \quad _p$
Quality	3.164	0.851	0.209	0.665
	(0.766)	(0.224)	(0.104)	(0.142)
Obs.	8849859	2401104	2401104	2125504
R^2	.553	.599	.598	.621
ΔM	26.972	21.046	10.740	21.283

Note: All regressions include product×destination×year fixed effects. σ_p is the product-specific elasticity estimated by Broda and Weinstein (2006). $\log N$ is corresponds to the log of employment. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

Now, I turn back the attention to the wine exports sample. As before, figure 10 shows graphically the relationship between trade credit maturity and wine quality, measured by its rating.

Figure 10: Trade credit maturity and wine rating



Note: Figure corresponds to binned scatter plot of number of days of trade credit vs. average Rating demeaned by grape×destination×year.

Table 11: Trade credit maturity and quality - Robustness checks

	$M > 0$				Size			$M > 0$ + Size		
	$\log N$	$= 5$	$= 10$	$= p$	$= 5$	$= 10$	$= p$	$= 5$	$= 10$	$= p$
Quality	2.698**	0.873**	0.291*	0.996**	0.515*	0.105	0.631**	0.736**	0.278*	0.999**
	(0.76)	(0.287)	(0.133)	(0.246)	(0.237)	(0.111)	(0.158)	(0.286)	(0.133)	(0.245)
$\log N$	-	-	-	-	5.717**	5.802**	4.069**	4.499**	4.579**	2.552*
					(1.025)	(1.032)	(1.013)	(1.091)	(1.098)	(1.086)
Obs.	8052086	2065979	2065979	1812642	2269693	2269693	2007557	1990042	1990042	1748159
R^2	0.565	0.611	0.611	0.64	0.604	0.604	0.626	0.618	0.618	0.646
ΔM	23.162	20.322	13.766	29.293	12.255	5.205	19.379	16.866	12.981	29.429

Note: All regressions include product×destination×year fixed effects. Panel 1 restricts the sample to transactions with positive trade credit ($M > 0$), panel 2 is the full sample, but includes log total employment, final panel restricts sample to transactions under trade credit and controlling for firm size. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

Table 12 reports the results from estimating equation (22) with the additional measures of quality. All the coefficients are significant. Moreover, these coefficients imply that high-quality goods have 30 more of trade credit. Tables B2-B4 in the Appendix show additional robustness checks with restricted sample and the inclusion of firm size as controls. The main result still holds.

Table 12: Trade credit maturity and quality - Wine

Dep var	M								
	$= {}_p$	$= 5$	$\log N$	Rating	Avg Rating	log price	log Avg price	Award	Bulk
Quality	6.772	4.024	6.292	2.266	3.013	5.721	7.783	15.759	-18.798
	(2.388)	(1.938)	(2.021)	(1.118)	(1.076)	(2.645)	(2.185)	(3.308)	(6.536)
Obs.	1652425	1654780	1531896	933345	946440	784245	1196461	1655466	1655466
R^2	.177	.167	.186	.184	.198	.261	.187	.168	.16
ΔM	57.495	36.556	48.911	22.658	30.129	20.381	25.709	15.759	-18.798

Note: Rating and price corresponds to the rating and final price of a particular wine-vintage. Avg Rating and Avg price are respective average ratings and final prices for a wine over vintages. Award and Bulk are dummy variables with value 1 if wine earned an award or if it is a bulk wine. All regressions include grape×destination×year fixed effects. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

5.2.3 Trade credit maturity, institutions, and competition

In this section, I test the additional predictions regarding trade credit maturity, quality of institutions, and competition. It has been shown in the literature the effect of some of these variables on the discrete decision of providing trade credit or not, so now I exploit the extensive margin, namely the number days of trade credit.

First, I start testing the first part of prediction 2: the positive relationship between trade credit maturity and better legal institutions. To verify that, I estimate the following regression.

$$M_{fpdt} = X_{dt} + {}'Z_{dt} + {}_{fpt} + {}''_{fpdt}; \qquad (24)$$

where X_{dt} will be a country-specific measure of institutional quality. Z_{dt} will be additional country-specific controls such as log GDP and log distance. Finally, I include firm×product×year fixed effects to capture supply shocks (e.g., productivity and learning). To measure institutional quality, I will use several measures; most of them already used in related literature.

First, I will use the most basic metric, GDP per capita; this measure has been extensively related to legal institutions.[35] Additionally, I will use the rule of law index constructed by the World Bank. This measure captures the perceptions of the extent to which agents have confidence in and abide by the rules of society, the quality of contract enforcement, property rights, the police, and the courts.[36] Finally, I will include measures used in Antras and Foley (2015) such as: Common Law dummy, a variable that captures if a given country has common law legal origin as opposed to other legal frameworks such as civil, German, socialist law; enforceability of contracts, a measured constructed by Knack and Keefer (1995) that captures the degree to which contracts are honored; law and order index that captures the integrity of legal system from the Country Risk Guide and it is obtained from Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2003).

Table 13 shows the results of estimating (25) for different measures of institutional quality. As can be seen, institutional quality is positively related to trade credit maturity. On average, for a given firm, selling a product, better institutions implies five days longer trade credit on average. This low number, compared to the quality-related estimations, favors the theory that contract enforcement seems to matter for the decision of providing trade credit more than the extension of the credit itself.

The first panel on table 13 corresponds to the full sample. The second panel excludes CIA contracts. It is worth to note that distance seems to play an important role as expected. This fact is indirectly captured in the theory since far destinations will receive their products later. Therefore these importers need more time to asses the quality of these products. This intuition is corroborated using an alternative specification where I additionally control by transportation mode. Table B7 in the Appendix describes that compared to waterborne transportation, arguably slower, air and ground transportation imply a shorter trade credit period.[37]

To test the competition effect on trade credit maturity, I will estimate the following equation.

$$M_{fpdt} = \quad X_{fpdt} + \quad {}'Z_{ft} + \quad {}_{pdt} + {}''_{fpdt}; \tag{25}$$

where X_{fpdt} will capture competition. Following the discussion of institutions, I will include product×destination×year fixed-effects to control for market and product characteristics. Z_{ft} will control for firm characteristics. As previously mentioned, I should expect that high levels of competition imply longer trade credit periods. Since measuring competition is hard, I will use two approaches. The first one uses the product complexity index (PCI),

[35] e.g. Acemoglu, Johnson, and Robinson (2001)

[36] More details in Kaufmann, Kraay, and Mastruzzi (2011)

[37] I additionally, control for the trade quantity since it might be the case that air and ground transportation have volume constraints. In general, results do not change.

Table 13: Quality and Institutions

	Full Sample					$M > 0$				
	$\log GDP_{PC}$	Rule of Law	Common Law	Enforce	Law&Order	$\log GDP_{PC}$	Rule of Law	Common Law	Enforce	Law&Order
Institution	3.123	3.064	4.263	1.536	0.524	1.777	1.978	4.203	1.042	0.536
	(0.912)	(0.866)	(2.318)	(0.645)	(0.330)	(0.857)	(0.813)	(2.249)	(0.600)	(0.296)
log GDP	1.533	1.573	1.639	0.575	1.444	1.649	1.639	1.524	0.882	1.391
	(0.477)	(0.491)	(0.503)	(0.840)	(0.552)	(0.406)	(0.420)	(0.449)	(0.828)	(0.490)
log dist	5.568	4.892	5.908	7.221	6.063	4.055	3.609	4.207	5.053	4.003
	(1.345)	(1.250)	(1.336)	(1.507)	(1.406)	(1.378)	(1.260)	(1.366)	(1.542)	(1.425)
Obs.	9127338	9148275	9122304	8007406	8788547	8263809	8280354	8259143	7247785	7951321
R^2	.807	.807	.808	.816	.808	.83	.83	.83	.837	.83
M	7.723	9.726	4.263	6.819	4.364	4.393	6.285	4.203	4.626	4.468

Note: Dependent variable is the trade credit maturity in days, M. First panel is the full sample. Second panel excludes prepaid transactions. All regressions include firm×product×year fixed effects. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

a product-year specific metric constructed by Hausmann, Hidalgo, Bustos, Coscia, Simoes, and Yildirim (2014) at HS 4-digit level. In a nutshell, this measure captures how complex a product is, where complexity is defined by the ubiquity of the product (how many countries produce the same thing) and the diversity of products that a given country produces.[38] Therefore, a highly complex product will be something that few countries produce and these countries have a very diversified production matrix. Based on this definition, it is natural to expect that highly complex product faces less competition, therefore using this specification, I expect < 0.

Table 14 describes the results of these estimations. For robustness, I included specifications with firm controls, firm FE and also a specification where I excluded CIA transactions. As expected, I find a negative relationship between product-complexity/competition and trade credit, where more complex products have between 18 to 50 days less of trade credit.

To complement this approach, I will use standard measures of competition. First, I will compute the Herfindahl-Hirschman Index (HHI) for each market, where a market will be defined as a product-destination-year combination. Through HHI, I measure the competition among Chilean exporters, not competition with the rest of the world. For a broader notion of competition, I will use the market share that a given firm has in a particular product-destination-year. This share will be computed over all the imports (not just of Chilean origin) of a country for a said product in a year obtained from UN COMTRADE. In other

[38] The actual measure is computed through, as it is known in network theory, the eigenvector centrality.

Table 14: Trade credit and competition - PCI

	Full Sample			$M > 0$		
	(1)	(2)	(3)	(4)	(5)	(6)
PCI	-12.566	-12.601	-1.424	-15.718	-16.105	-5.520
	(2.971)	(2.800)	(1.172)	(4.421)	(4.450)	(2.108)
Obs.	9167764	7661709	9156757	8304905	6983374	8299140
R^2	.423	.45	.794	.438	.466	.819
Prod-2d×Dest×Year FE	✓	✓	✓	✓	✓	✓
Firm Controls		✓			✓	
Firm×Year FE			✓			✓
ΔM	-42.7	-43.2	-4.83	-52.8	-54.6	-18.5

Note: Dependent variable is the trade credit maturity in days, M. Firm controls include log employment, log equity and log Age. First panel is the full sample. Second panel excludes prepaid transactions. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

words, market share is calculated as:

$$s_{fpdt} = \frac{\text{Sales}_{fpdt}}{\text{Imports}_{pdt}}$$

As before, large HHI and large market share imply that the firm faces less competition. Thus I expect < 0. Regarding this latter approach, other forces may explain this correlation. For example, a firm may use trade credit as a marketing strategy to increase its market share. This strategy implies that low market share firms will extend longer trade credit periods to increase their share, delivering the expected negative correlation. Alternatively, since large firms, with large market shares, produce high-quality goods, a positive correlation could also be found.[39] To address these issues, in a third specification, I will instrument the current market share by the previous year's market share of the same firm-product-destination. Table 15 shows the results of these estimations. The coefficient of interest is negative, as expected. Moreover, the magnitude of the competition seems important. On average, as we approach the monopoly case, firms provide 35 days less of trade credit. Notice that in both specifications, PCI and market share, when using the full sample, the results are dampened, compared to the restricted sample of only trade credit transactions. This effect speaks to

[39] Both arguments do not deliver a direct sign of the bias in the estimation.

the idea that competition drives the intensive margin of trade credit more than the extensive margin, at least in the context of international trade.[40]

Table 15: Trade credit and competition - Market Share

	Full Sample			$M > 0$		
	HHI	Market Share	Market Share$_{IV}$	HHI	Market Share	Market Share$_{IV}$
Competition	-26.394	-22.848	-37.770	-35.292	-32.559	-45.672
	(6.848)	(12.548)	(15.678)	(8.781)	(17.610)	(20.973)
Obs.	7886285	7008117	5717810	6381860	6381860	5259124
R^2	.453	.463	.477	.484	.482	.5
F-stat			14491.6			12847.8

Note: Dependent variable is the trade credit maturity in days, M. All regressions include firm controls: log employment, log equity and log age and Product-2d×Destination×Year fixed effects. First panel is the full sample. Second panel excludes prepaid transactions. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

Finally, prediction 3 states that products that, in principle, require more time to verify their quality (i.e., low) will have a longer trade credit period. To capture the notion of quality assessment, I will turn my attention to the Rauch (1999) classification of differentiated products used in the quality estimation. The hypothesis is that it is harder to verify quality for differentiated goods. Therefore, these products will have longer trade credit periods than the homogeneous/referenced priced goods. To test this prediction, I will estimate (25), where X_{fpdt} will be a dummy variable equal to one if the product is differentiated according to Rauch, zero if not. Table 16 shows the result of the estimation. For the sake of comparison, I estimate a version that only includes destination-year fixed effects. In this case, differentiated products have a shorter trade credit maturity, which is similar to the competition estimation.[41] Once I control for the type of product (HS 2-digit), the relationship flips and differentiated goods have 5 to 20 days longer trade credit periods.

[40] This result does not contradict what Demir and Javorcik (2018) found. In their case, exporters are choosing mainly between OA and DC, which fundamentally are two different forms of trade credit.

[41] The correlation between the differentiated product dummy and PCI (market share) is 0.25 (0.23)

Table 16: Trade credit and quality verifiability

	Full Sample			$M > 0$		
	(1)	(2)	(3)	(4)	(5)	(6)
Diff	-21.005	23.215	5.498	-19.220	22.010	5.638
	(6.241)	(7.206)	(2.550)	(7.643)	(6.552)	(2.457)
Dest×Year	✓			✓		
Firm Controls		✓			✓	
Prod-2d×Dest×Year		✓	✓		✓	✓
Firm×Year			✓			✓
Obs	9464609	7886285	9448375	8535148	7162498	8524639
R^2	.141	.454	.795	.128	.469	.82

Note: Dependent variable is the trade credit maturity in days, M. Firm controls include log employment, log equity and log Age. First panel is the full sample. Second panel excludes prepaid transactions. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

5.3 Additional results

5.3.1 Implied interest rate

Although not a direct implication of the model, using this data set, I can calculate the implied average interest rate for trade credit. To do this, I follow Schwartz (1974), where the price under trade credit corresponds to an original price (CIA) corrected for an interest rate. In other words:

$$P^{TC} = (1+r)^{M} P^{CIA} \tag{26}$$

For a more parsimonious estimation and to avoid issues like price seasonality and price variation due to exchange rate fluctuations, I will estimate the model at the annual level. This means that, for a given firm, I will define a transaction as the sum of all quantities exported of a product to a particular destination in a specific year, for a given payment method. Following this, I will compute the average annual price of said transaction. Finally, as for the trade credit maturity M, I will use the FOB-weighted trade credit maturity.

To compute the average interest rate relevant for trade credit, I will estimate the following equation, for exporters and importers.

$$\log p^{c}_{fpdt} = \quad X_{fpdt} + \quad _{fpdt} + {}''_{fpdt}; \text{ where } c \in \{CIA; TC\}; \tag{27}$$

where X will be either a dummy equal to 1 if the transaction is paid under some form of trade credit or directly the trade credit maturity M, and $_{fpdt}$ is a set of firm×product× destination×year fixed effects. The identification is given by the difference in price from a firm selling the same product to a particular destination in a year under two different modes (trade credit and *cash-in-advance*) with their different maturities.

Note that equation (27) can be obtained by taking logarithms on both sides of (26), in that case $= \log(1 + r) \approx r$ and $\log P^{CIA}$ will be captured by the set of fixed effects that will capture supply and demand factors that might affect the fundamental price.

Table 17: Prices and trade credit

	Exports				Imports			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$I(TC = 1)$	-0.033**	0.092**			-0.066**	0.042**		
	(0.009)	(0.011)			(0.004)	(0.004)		
M (in years)			-0.059**	0.223**			-0.306**	0.323**
			(0.021)	(0.024)			(0.018)	(0.016)
$\log q$		-0.148**		-0.146**		-0.231**		-0.235**
		(0.007)		(0.007)		(0.002)		(0.002)
Obs.	52818	52818	52818	52818	897984	897984	897984	897984
R^2	.961	.966	.961	.966	.937	.953	.937	.953

Note: Dependent variable is log price. All regressions include firm×product×country×year fixed effects. First panel is Exporters sample, second panel corresponds to the importers panel. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

Table 17 shows the estimation results. I divided M that was originally in days by 365. Thus will be a measure of the annual interest rate for trade credit. Columns (1) and (3) for exporters and (5) and (6) for importers show the results from estimating (27) directly. The results are counter-intuitive since they show that prices are lower under trade credit. One issue with this simple model is that it might omit quantity discounts that firms may offer[42] and because trade credit transactions are related to larger volumes, this can bias the estimations. Columns (2), (4), (6), and (8) control by the volume of a given transaction.

[42]This point has been stressed out by Meleshchuk (2018)

These results indicate that trade credit has an implied interest rate of 22% to 28% (25% to 32%) on average for exporters (importer).[43] This interest rate is quite large compared to the lending rate in US dollars obtained in the Chilean financial sector[44] but is comparable to other estimates related to trade credit, see Breza and Liberman (2017), Cuñat and Garcia-Appendini (2012), and Petersen and Rajan (1997) for similar calculations.

5.3.2 Trade Credit and Relationship

Another point stressed by the literature is the importance of the relationship between producer and retailer in the provision of trade credit. This issue has been discussed by Antras and Foley (2015), García-Marín, Justel, and Schmidt-Eisenlohr (2019), and Justel (2019). Using the exporters' data set, I can test the effect of repeated transactions on the likelihood of trade credit and the number of days of trade credit. One of the drawbacks of the data set is that it does not include information to identify the foreign buyer, in the case of exports, and the foreign seller for imports. Because of this, I will consider a transaction as a combination of firm-product-country.

To study this effect, I follow Piveteau (2019) in his identification strategy. I estimate the following equation.

$$Y_{fpdt} = \quad \log \text{Transactions}_{fpdt} + \quad {}_{pdt} + \quad {}_{fpt} + {}''_{fpdt}; \tag{28}$$

where Y will be trade credit maturity or a dummy variable equal to 1 if the transaction is *cash-in-advance*. ${}_{pdt}$ captures demand effects that can affect the dependent variable (quality of institutions, for example), and ${}_{fpt}$ will control for supply-side factors (product quality, size, financial shocks). Figure 11 shows a graphical representation of the estimation. As the figure shows, there is a positive relationship between the number of previous transactions and the number of days of credit. Antras and Foley (2015), García-Marín, Justel, and Schmidt-Eisenlohr (2019), and Justel (2019), also find this pattern in the data, for the provision of trade credit. They justify this mechanism through learning.

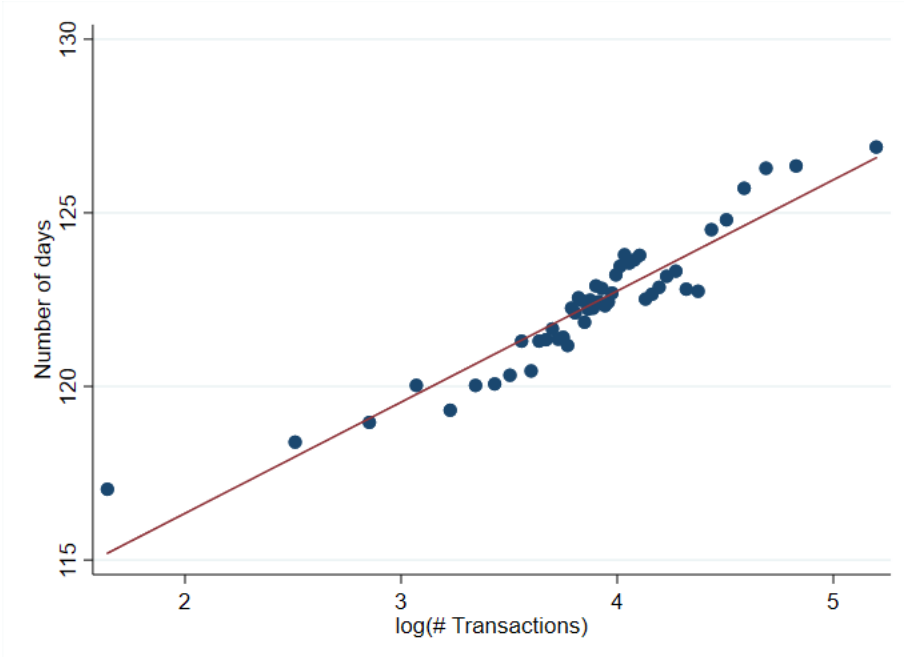
The positive relationship I find can be a mix of extensive and intensive margin effects. In order to disentangle these margins, table 18 shows the full estimation for different subsamples or trade credit measures.

This table concludes that the number of transactions affects the extensive margin, the provision of trade credit, as previously found in the literature, but not the intensive margin, the number of days. Column (1) shows the positive relationship shown in figure 11. Once

[43] In this sample, trade credit has effective maturity of 120 days in the case of exporters and 70 days in the case of importers.

[44] The lending rate in the 2009-2017 period for credits in US dollars and period greater than 3 months and less than 6 months was on average 2.4%, with a maximum of 6.1 and a minimum of 1.4%

Figure 11: Trade credit maturity and previous transactions



Note: Figure corresponds to binned scatter plot of number of days of trade credit vs. log Number of transactions. Both measures are demeaned at product×destination×year and firm×product×year level

Table 18: Trade credit maturity and relationship

Dep var	M	$M > 0$	$I(CIA = 1)$
log # Transactions	1.060	-0.338	-0.009
	(0.322)	(0.332)	(0.001)
Obs.	9329621	8435089	9653891
R^2	.844	.863	.734

Note: All regressions include product× destination×year and firm×product×year fixed effects. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

transactions under CIA are excluded, column (2) shows that there is no effect of transactions over the maturity of trade credit. To reinforce this idea, column (3) shows the same estimation but using an indicator for a *cash-in-advance* transactions. This column indicates that the number of transactions decreases the likelihood of CIA (alternatively, increases the probability of trade credit provision). It is worth noting that, due to the shape of the log function, the effect of the first number of transactions is very sharp, but it vanishes as the number of transactions increases.

6 Conclusion

In this paper, I developed a model in which trade credit has two objectives. It serves effectively as a product quality guarantee and, simultaneously, trade credit acts as a signal of the quality of the good.

In the model, similar to Long, Malitz, and Ravid (1993), product quality, known by the producer, is not observable by the buyer, but it can be verified over time before payment. So, the buyer can use the trade credit period to certify the quality of the product. In this theoretical framework, I show that firms producing low-quality goods will sell with payment in advance, whereas high-quality goods producers will extend trade credit. Additionally, I prove that higher quality goods have more extended trade credit periods.

In addition to the relationship between product quality and trade credit, the model delivers a set of testable predictions. Specifically, the theory suggests firms selling in countries with better legal institutions (e.g., the rule of law, contract enforcement) and in markets with the tougher competition will offer more extended trade credit periods. Also, the model predicts that firms producing goods that require a long time to verify quality will provide longer trade credit periods as well.

I empirically test the mechanism and predictions of the model using transaction-level data for exporters obtained from the Chilean Customs Agency. Trade credit is commonly used in international trade, and this detailed data set includes a variable that captures the in how many days a given transaction will be (was) paid. For quality measures, I use two strategies. Initially, I take and off-the-shelf methodology from Khandelwal, Schott, and Wei (2013) to estimate quality from the data set. Then, for robustness, I focus my attention on the wine industry in Chile. I use this industry because several widely accepted proxies for wine quality can be obtained from the internet (e.g., ratings, awards, retail price, among others).

I find evidence consistent with the proposed model. As for the main mechanism, I find that high-quality goods are 8% more likely to be traded under trade credit compared to low-quality goods. Moreover, high-quality products have, on average, 20 more days of trade credit.

The additional predictions are also corroborated. Countries with better legal institutions have five days longer trade credit periods, firms that face higher competition provide 20 to 50 days more of trade credit, and products for which quality is hard to asses have 5 to 20 days longer maturities.

I also find that the implied annual interest rate of trade credit is 25%, on average, quite high compared to the financial sector, but comparable to other estimations. Additionally, I find that repeated interactions affect the decision to provide trade credit, as previously seen in the literature. However, these interactions do not alter the maturity of the trade credit.

This model and its results imply that trade credit is not purely a financial tool for a firm to get funding, thus explaining the significant difference between the commercial interest rate and the trade credit implied interest rate. Firms use trade credit to certify the quality of the goods they are buying, similar to a standard money-back guarantee. Therefore trade credit might be favorable for firms since it allows trade.

This mechanism argues for a careful discussion from policymakers when planning for the regulations of trade credit. Countries like the U.S., France, and Chile have implemented policies that effectively cap the maturity of trade credit. Authors such as Barrot (2016) and Barrot and Nanda (2018) show that these policies have positive effects (more competition through entry increase and exit decrease, increase labor demand), but Breza and Liberman (2017) prove that these regulations could also have unintended consequences, namely trade reduction, in both intensive and extensive margin. An exciting avenue for future research is to embed these ideas into a general equilibrium model to study the welfare effects of regulation and how these effects are related to financial conditions, competition, and institutional framework.

References

Acemoglu, D., Johnson, S., Robinson, J. A. (2001). "The Colonial Origins of Comparative Development: An Empirical Investigation". *American Economic Review* 91.5, pp. 1369–1401.

Ahn, M. J. (2011). *A theory of domestic and international trade nance*. 11-262. International Monetary Fund.

Amiti, M., Weinstein, D. E. (2011). "Exports and financial shocks". *The Quarterly Journal of Economics* 126.4, pp. 1841–1877.

Antoniades, A. (2015). "Heterogeneous firms, quality, and trade". *Journal of International Economics* 95.2, pp. 263–273.

Antras, P., Foley, C. F. (2015). "Poultry in Motion: A Study of International Trade Finance Practices". *Journal of Political Economy* 123.4, pp. 853–901.

Bagwell, K. (1992). "Pricing to signal product line quality". *Journal of Economics & Management Strategy* 1.1, pp. 151–174.

Bagwell, K., Ramey, G. (1988). "Advertising and limit pricing". *The Rand Journal of Economics*, pp. 59–71.

Bagwell, K., Riordan, M. H. (1991). "High and declining prices signal product quality". *The American Economic Review*, pp. 224–239.

Balachander, S., Srinivasan, K. (1994). "Selection of product line qualities and prices to signal competitive advantage". *Management Science* 40.7, pp. 824–841.

Barrot, J.-N. (2016). "Trade credit and industry dynamics: Evidence from trucking firms". *The Journal of Finance* 71.5, pp. 1975–2016.

Barrot, J.-N., Nanda, R. (2018). "The employment effects of faster payment: evidence from the federal quickpay reform". *Harvard Business School Entrepreneurial Management Working Paper* 17-004.

Bernini, F., González, J., Hallak, J. C., Vicondoa, A. (2018). "The Micro-D classification: A new approach to identifying differentiated exports". *Econom a* 18.2, pp. 59–85.

Biais, B., Gollier, C. (1997). "Trade credit and credit rationing". *The Review of Financial Studies* 10.4, pp. 903–937.

Brennan, M. J., Maksimovics, V., Zechner, J. (1988). "Vendor financing". *The journal of nance* 43.5, pp. 1127–1141.

Breza, E., Liberman, A. (2017). "Financial contracting and organizational form: Evidence from the regulation of trade credit". *The Journal of Finance* 72.1, pp. 291–324.

Broda, C., Weinstein, D. E. (2006). "Globalization and the Gains from Variety". *The Quarterly journal of economics* 121.2, pp. 541–585.

Burkart, M., Ellingsen, T. (2004). "In-kind finance: A theory of trade credit". *American Economic Review* 94.3, pp. 569–590.

Chen, H., Frank, M. Z., Wu, O. Q. (2005). "What actually happened to the inventories of American companies between 1981 and 2000?" *Management science* 51.7, pp. 1015–1031.

— **(2007)**. "US retail and wholesale inventory performance from 1981 to 2004". *Manufacturing & Service Operations Management* 9.4, pp. 430–456.

Cho, I.-K., Kreps, D. M. (1987). "Signaling games and stable equilibria". *The Quarterly Journal of Economics* 102.2, pp. 179–221.

Chu, W., Chu, W. (1994). "Signaling quality by selling through a reputable retailer: An example of renting the reputation of another agent". *Marketing Science* 13.2, pp. 177–189.

Cuñat, V. (2006). "Trade credit: suppliers as debt collectors and insurance providers". *The Review of Financial Studies* 20.2, pp. 491–527.

Cuñat, V., Garcia-Appendini, E. (2012). "Trade credit and its role in entrepreneurial finance". *Oxford handbook of entrepreneurial nance*, pp. 526–557.

Daripa, A., Nilsen, J. (2011). "Ensuring sales: A theory of inter-firm credit". *American Economic Journal: Microeconomics* 3.1, pp. 245–79.

Demir, B., Javorcik, B. (2018). "Don't throw in the towel, throw in trade credit!" *Journal of International Economics* 111, pp. 177–189.

Demirguc-Kunt, A., Maksimovic, V. (2002). "Firms as financial intermediaries: Evidence from trade credit data. World Bank". *Policy Research working paper series* 2696.

Di Comite, F., Thisse, J.-F., Vandenbussche, H. (2014). "Verti-zontal differentiation in export markets". *Journal of International Economics* 93.1, pp. 50–66.

Djankov, S., La Porta, R., Lopez-de-Silanes, F., Shleifer, A. (2003). "Courts". *The Quarterly Journal of Economics* 118.2, pp. 453–517.

Dybvig, P. H., Lutz, N. A. (1993). "Warranties, durability, and maintenance: Two-sided moral hazard in a continuous-time model". *The Review of Economic Studies* 60.3, pp. 575–597.

Emery, G. W. (1987). "An optimal financial response to variable demand". *Journal of Financial and Quantitative Analysis* 22.2, pp. 209–225.

Fan, H., Li, Y. A., Yeaple, S. R. (2015). "Trade liberalization, quality, and export prices". *Review of Economics and Statistics* 97.5, pp. 1033–1051.

Ferris, J. S. (1981). "A transactions theory of trade credit use". *The Quarterly Journal of Economics* 96.2, pp. 243–270.

Fisman, R., Raturi, M. (2004). "Does competition encourage credit provision? Evidence from African trade credit relationships". *Review of Economics and Statistics* 86.1, pp. 345–352.

Foster, L., Haltiwanger, J., Syverson, C. (Mar. 2008). "Reallocation, Firm Turnover, and Efficiency: Selection on Productivity or Profitability?" *American Economic Review* 98.1, pp. 394–425.

García-Marín, Á., Justel, S., Schmidt-Eisenlohr, T. (2019). "Trade credit and markups". *CESifo Working Paper*.

Giannetti, M., Burkart, M., Ellingsen, T. (2011). "What you sell is what you lend? Explaining trade credit contracts". *The Review of Financial Studies* 24.4, pp. 1261–1298.

Hausmann, R., Hidalgo, C. A., Bustos, S., Coscia, M., Simoes, A., Yildirim, M. A. (2014). *The Atlas of Economic Complexity: Mapping Paths to Prosperity*. MIT Press.

Hoefele, A., Schmidt-Eisenlohr, T., Yu, Z. (2016). "Payment choice in international trade: Theory and evidence from cross-country firm-level data". *Canadian Journal of Economics/Revue canadienne d'economique* 49.1, pp. 296–319.

Hyndman, K., Serio, G. (2010). "Competition and inter-firm credit: Theory and evidence from firm-level data in Indonesia". *Journal of Development Economics* 93.1, pp. 88–108.

Justel, S. (2019). "Firm Heterogeneity and Trade Credit: Evidence from Chile". *mimeo*.

Kaufmann, D., Kraay, A., Mastruzzi, M. (June 2011). "The Worldwide Governance Indicators: Methodology and Analytical Issues". *Hague Journal on the Rule of Law* 3.2, pp. 220–246.

Khandelwal, A. (2010). "The long and short (of) quality ladders". *The Review of Economic Studies* 77.4, pp. 1450–1476.

Khandelwal, A., Schott, P., Wei, S.-J. (2013). "Trade liberalization and embedded institutional reform: Evidence from Chinese exporters". *American Economic Review* 103.6, pp. 2169–95.

Klapper, L., Laeven, L., Rajan, R. (Dec. 2011). "Trade Credit Contracts". *The Review of Financial Studies* 25.3, pp. 838–867.

Knack, S., Keefer, P. (1995). "Institutions and Economic Performance: Cross-country Tests Using Alternative Institutional Measures". *Economics & Politics* 7.3, pp. 207–227.

Kugler, M., Verhoogen, E. (2011). "Prices, plant size, and product quality". *The Review of Economic Studies* 79.1, pp. 307–339.

Lee, Y. W., Stowe, J. D. (1993). "Product risk, asymmetric information, and trade credit". *Journal of Financial and Quantitative analysis* 28.2, pp. 285–300.

Leibovici, F. (2018). "Financial development and international trade". *mimeo*.

Long, M. S., Malitz, I. B., Ravid, S. A. (1993). "Trade credit, quality guarantees, and product marketability". *Financial management*, pp. 117–127.

Lutz, N. A. (1989). "Warranties as signals under consumer moral hazard". *The Rand journal of economics*, pp. 239–255.

Maksimovic, V., Frank, M. Z. (2005). "Trade credit, collateral, and adverse selection". *Collateral, and Adverse Selection (October 26, 2005)*.

Manova, K. (2012). "Credit constraints, heterogeneous firms, and international trade". *Review of Economic Studies* 80.2, pp. 711–744.

Manova, K., Zhang, Z. (2012). "Export prices across firms and destinations". *The Quarterly Journal of Economics* 127.1, pp. 379–436.

Marotta, G. (2005). "When do trade credit discounts matter? Evidence from Italian firm-level data". *Applied Economics* 37.4, pp. 403–416.

McMillan, J., Woodruff, C. (1999). "Interfirm relationships and informal credit in Vietnam". *The Quarterly Journal of Economics* 114.4, pp. 1285–1320.

Meleshchuk, S. (2018). "Price Discrimination in International Trade: Empirical Evidence and Theory". *Mimeo*.

Mian, S. L., Smith Jr, C. W. (1992). "Accounts receivable management policy: theory and evidence". *The Journal of Finance* 47.1, pp. 169–200.

Milgrom, P., Roberts, J. (1986). "Price and advertising signals of product quality". *Journal of political economy* 94.4, pp. 796–821.

Moorthy, S., Srinivasan, K. (1995). "Signaling quality with a money-back guarantee: The role of transaction costs". *Marketing Science* 14.4, pp. 442–466.

Muûls, M. (2015). "Exporters, importers and credit constraints". *Journal of International Economics* 95.2, pp. 333–343.

Nelson, P. (1974). "Advertising as information". *Journal of political economy* 82.4, pp. 729–754.

Ng, C., Smith, J., Smith, R. (1999). "Evidence on the determinants of credit terms used in interfirm trade". *The journal of nance* 54.3, pp. 1109–1129.

Niepmann, F., Schmidt-Eisenlohr, T. (2017). "International trade, risk and the role of banks". *Journal of International Economics* 107, pp. 111–126.

Overgaard, P. B. (1993). "Price as a signal of quality: A discussion of equilibrium concepts in signalling games". *European Journal of Political Economy* 9.4, pp. 483–504.

Paravisini, D., Rappoport, V., Schnabl, P., Wolfenzon, D. (2014). "Dissecting the effect of credit supply on trade: Evidence from matched credit-export data". *The Review of Economic Studies* 82.1, pp. 333–359.

Parlhem, S. (2016). "Kartlaggning av betalningstider i naringslivet (Swedish)". *Memo, Swedish Ministry of Enterprise and Innovation*.

Petersen, M., Rajan, R. (1997). "Trade credit: theories and evidence". *The review of nancial studies* 10.3, pp. 661–691.

Pike, R., Cheng, N. S., Cravens, K., Lamminmaki, D. (2005). "Trade credit terms: asymmetric information and price discrimination evidence from three continents". *Journal of Business Finance & Accounting* 32.5-6, pp. 1197–1236.

Piveteau, P. (2019). "An Empirical Dynamic Model of Trade with Consumer Accumulation". *Mimeo*.

Rauch, J. E. (1999). "Networks Versus Markets in International Trade". *Journal of International Economics* 48.1, pp. 7–35.

Schmidt-Eisenlohr, T. (2013). "Towards a theory of trade finance". *Journal of International Economics* 91.1, pp. 96–112.

Schwartz, R. (1974). "An economic model of trade credit". *Journal of nancial and quantitative analysis* 9.4, pp. 643–657.

Schwartz, R., Whitcomb, D. (1979). "The Trade Credit Decision". *Handbook of Financial Economics*, pp. 257–273.

Singh, M. (2017). *Financial constraints and trade credit as a strategic tool: Evidence from small-scale reservation reforms in India*. Tech. rep. Working Paper.

Smith, J. K. (1987). "Trade credit and informational asymmetry". *The journal of nance* 42.4, pp. 863–872.

Spence, M. (1977). "Consumer misperceptions, product failure and producer liability". *The Review of Economic Studies* 44.3, pp. 561–572.

Tirole, J. (1988). *The theory of industrial organization*. MIT press.

Wernerfelt, B. (1988). "Umbrella branding as a signal of new product quality: An example of signalling by posting a bond". *The RAND Journal of Economics*, pp. 458–466.

Wolinsky, A. (1983). "Prices as signals of product quality". *The review of economic studies* 50.4, pp. 647–658.

A Proofs

A.1 Sketch of a proof of proposition 2

The solution of the maximization problem defined by (15) can be obtained by solving the Lagrangian defined as follows:

$$\mathcal{L} = \left(w\mathrm{e}^{(r+\ )M} - c^H\right)\frac{^H - \ Q - w\mathrm{e}^{\ r\ M}}{2} + \ M + \ \left[\Pi^L - \left(e^{\ \ M} w\mathrm{e}^{(r+\ )M} - c^L\right)\frac{^H - \ Q - w\mathrm{e}^{\ r\ M}}{2}\right]:$$

Where   is the Lagrange multiplier for the restriction $M \geq 0$ and   the multiplier related to the IC constraint. Taking first-order condition with respect to w and M and after some algebra, can be expressed as:[45]

$$\sigma = \frac{\alpha^H - \eta Q - we^{\ \ r^* M}}{2} \frac{(c^H - c^L e^{\ \ M})w}{2w - (\alpha^H - \eta Q)e^{r^* M} - c^L e^{(r+\ \ +\ \ )M}} \left[(r + \delta - r\ \ ) - \mu \frac{(2w - (\alpha^H - \eta Q)e^{r^* M} - c^H e^{(r+\ \ )M})}{(c^H - c^L e^{\ \ M})} e^{\ \ (r+\ \ )M} \right]$$

From this expression, two things are worth noting. First, the term outside the brackets is always positive regardless of the value of or M. Secondly, the sign of the expresion inside the brackets depends on . For small enough, the term $(r + \ \ - r\ \ )$ dominates, and because of the assumption $r + \ \ > r$ the whole expression will be positive, which implies that $\ \ > 0$, which means that the restriction $M \geq 0$ is binding. Similarly, for sufficiently large , the brackets might turn negative, but because of the nature of Lagrange multipliers, this cannot happen. Therefore, for large enough, the only option for that expression is to be equal to zero. Thus $\ \ = 0$, meaning the restriction $M \geq 0$ is slack. This result implies that the producer optimally chooses to provide trade credit as part of its signal of quality.

Finally, using this last result, imposing $\ \ = 0$, I can solve for w obtaining (16) □.

A.2 Existence of pooling equilibrium

Although the existence of the separating is guaranteed, the pooling equilibrium also may exist.

In a pooling equilibrium, low-quality and high-quality products will be sold under the same contract. To simplify the analysis, let me assume that in the pooling equilibrium, both goods are traded at $M = 0$.

Moreover, let me assume that the retailer knows there is a share of the population that sells high quality goods. Defining $\bar{\ } \equiv \ \ ^H + (1 - \ \ )\ ^L$, with this, the demand from the retailer for a given wholesale price w will be

$$q(w) = \frac{\bar{\ } - \ \ Q - w}{2}:$$

Focusing on the low-quality producer, for a given price of w, he has incentives to not deviate from the pooling equilibrium if

$$\Pi^L_{sep} \leq (w - c^L)q(w) \tag{29}$$

where Π^L_{sep} corresponds to the profits of the low quality producer in the separating equilibrium, given by (11). With this, a low-quality producer will not have incentives to deviate

[45] The steps are: take FOC with respect to w and recover an expression for λ, then take FOC with respect to M and substitute λ for the previous expression. Finally, collect terms and solve for σ

from the pooling equilibrium if

$$w \in \left[\frac{^{-} - \ \ Q + c^L}{2} - \frac{\sqrt{8 \ \ (\Pi_{pool}^{L;max} - \Pi_{sep}^{L})}}{2}; \frac{^{-} - \ \ Q + c^L}{2} + \frac{\sqrt{8 \ \ (\Pi_{pool}^{L;max} - \Pi_{sep}^{L})}}{2}\right] \tag{30}$$

where $\Pi_{pool}^{L;max} \equiv \frac{1}{8}(^{-} - \ \ Q - c^L)^2$ is the maximum profits a low quality producer can obtain under a pooling equilibrium.[46] Notice that since $^{-} > \ \ ^{L}$, the square root is well defined, therefore this interval is non-empty.

On the other hand, a high-quality producer faces a similar problem. This producer will not have incentives to deviate from the pooling equilibrium if

$$\Pi_{sep}^{H} \leq (w - c^H)q(w) \tag{31}$$

where Π_{sep}^{H} corresponds to the profits of the high quality producer obtained as the solution of (15)

By symmetry, a high-quality producer will not deviate from pooling if

$$w \in \left[\frac{^{-} - \ \ Q + c^H}{2} - \frac{\sqrt{8 \ \ (\Pi_{pool}^{H;max} - \Pi_{sep}^{H})}}{2}; \frac{^{-} - \ \ Q + c^H}{2} + \frac{\sqrt{8 \ \ (\Pi_{pool}^{H;max} - \Pi_{sep}^{H})}}{2}\right] \tag{32}$$

where $\Pi_{pool}^{H;max} \equiv \frac{1}{8}(^{-} - \ \ Q - c^H)^2$. In this case, the condition for a non-empty interval is not guaranteed. The following lemma summarizes these results.

Lemma 2. *If $\Pi_{pool}^{H;max} < \Pi_{sep}^{H}$ the pooling equilibrium does not exist.*

On the other hand, a pooling equilibrium exists for a given wholesale price w only if

- $\Pi_{pool}^{H;max} \geq \Pi_{sep}^{H}$,
- *$A \cap B \neq \ $, where A and B are the sets defined by (30) and (32) respectively and*
- *$w \in A \cap B$.*

Since firms may use prices and trade credit to deviate, the existence of the pooling equilibrium is not guaranteed. In the case that firms only use prices to separate, the pooling equilibrium will exist if   is sufficiently large. Intuitively, if the retailer believes that a large part of the firms is of high-quality, the low-quality firm has incentives to pool. Moreover, since   is big enough, the expected demand is close to the perfect information demand for the high-quality product and high-quality firm (that only uses prices as signal) will not pay the cost of signaling in the pooling equilibrium.[47]

[46] It corresponds to the profits as if low quality producer chooses his optimal price.

[47] Remember that when high-quality firms only use prices to signal quality then $\Pi_{sep}^{H} < \Pi_{sep}^{L}$, guaranteeing the non-empty intersection.

A.3 Trade credit, quality and competition

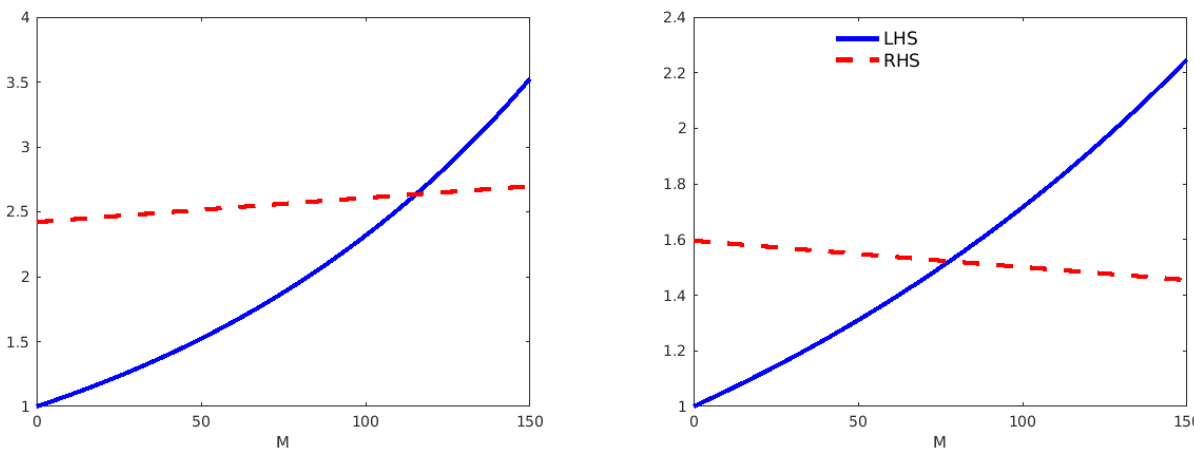
Assuming two levels of quality, combining (16) and (17) and assuming, for simplicity, $c^L = 0$, the IC constraint can be written as:

$$8 \ \Pi^L = (\ ^H - \ Q)^2 e^{\ (r+ \ \ + \ \ r \ )M} - c_H^2 \left(1 + \frac{r + \ \ - r}{\ }\right)^2 e^{(r+ \ \ \ \ r \ )M}$$

Using the fact that $8 \ \Pi^L = (\ ^L - \ Q)^2$, then M is defined as the solution of

$$e^{(r+ \ \ + \ \ r \ )M} = \frac{(\ ^H - \ Q)^2}{(\ ^L - \ Q)^2 + c_H^2 \left(1 + \frac{r+ \ \ \ r}{\ }\right)^2 e^{(r+ \ \ \ \ r \ )M}} \qquad (33)$$

Figure 12: Solution of the model



(a) $\mu > r + \delta + r$

(b) $\mu < r + \delta + r$

Note: Solid line corresponds to the left side of (33) and dashed line to the right hand side.

As figure 12 shows the LHS is upward sloping, whereas the RHS is upward (downward) sloping if $\ > (<) \ r + \ \ - r \ $. A couple of things worth noting. First, since the LHS is unbounded, whereas the RHS is bounded as $M \to \infty$[48], $M > 0$ only if $(\ ^H - \ Q)^2 \geq (\ ^L - \ Q)^2 + c_H^2 \left(1 + \frac{r+ \ \ \ r}{\ }\right)^2$. Secondly only the right-hand side depends explicitly on quality $(c_H; \ ^H)$ and competition $(\ Q)$. Therefore, provision of trade credit, the relationship between M and quality and the relationship between M and competition are completely defined by (33) and are described in the following lemmas.

Lemma 3. *If su ciently high then* $M > 0$

[48] Either this expression goes to 0 or $\left(\frac{\ ^H - \ Q}{\ ^L - \ Q}\right)^2 > 0$ depending on $\mu < (>) \ r + \delta - r^*$.

Lemma 4. *If quality increases then M increases.*

Lemma 5. *If $\ \geq r + \ - r$ and $\Delta \ > \frac{c_H^2}{L}\left(1 + \frac{r + \ \ r}{}\right)^2$ then M increases with Q for $Q \in [0; \ ]$, for some $\ < \ ^L$*

The proof of the lemma 3 comes from the fact that since $\Delta \ > \Delta c = c_H$, then for sufficiently high, $\Delta \ > c_H\left(1 + \frac{r + \ \ r}{}\right)$, adding $\ ^L - \ Q$ on both sides and squaring them, I find the condition for $M \ > 0$. Similarly, lemma 4 relies on $\Delta \ > \Delta c$. Meaning, as we increase quality, the cost does not increase as much, then the increase in the numerator will always be greater than the increase in the denominator. Then, the RHS of (33) shifts up, delivering a larger M $\square$.

The proof of the final lemma is less intuitive and I need to calculate the derivative of the RHS of (33) with respect to Q. Then, this expression will be increasing in Q if $\Delta \ > \frac{c_H^2}{L \ \ Q}\left(1 + \frac{r + \ \ r}{}\right)^2 e^{(r + \ \ \ \ r \ )M}$ and it will be decreasing otherwise.

The former condition will be satisfied for values of $Q \in [0; \ ]$ if $\ \geq r + \ - r$ and $\Delta \ > \frac{c_H^2}{L}\left(1 + \frac{r + \ \ r}{}\right)^2$ $\square$.

In other words, lemma 3 states the existence of the separating equilibrium for a sufficiently high . The next lemma describes the fact that trade credit maturity (and with more reason wholesale prices) are increasing as the traded good is of higher quality. This increasing signal deters the low-quality firm from mimicking the increasingly higher quality producer.

The final lemma says that if the difference in quality is sufficiently high or the rate of which information of bad quality arrives is high enough, firms that face tougher competition will provide more extended trade credit periods. Notice that this condition will fail for sufficiently high levels of competition (the term $\frac{c_H^2}{L \ \ Q}$ grows with Q), thus the non-monotonic relationship between competition and trade credit maturity.

B Additional Tables

Table B1: Quality and Likelihood of Trade Credit - Wine

	$\sigma = \sigma_p$	$\sigma = 5$	log N	Rating	Avg Rating	log price	log Avg price	Award	Bulk
Quality	-0.010***	-0.004***	-0.008***	-0.001	-0.001*	-0.001	-0.002	-0.010***	0.011***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.002)	(0.004)
log volume	-0.004***	-0.006***	-0.005***	-0.006***	-0.006***	-0.005***	-0.006***	-0.006***	-0.007***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Obs.	1647623	1649979	1527459	929343	941232	783158	1189972	1650215	1650215
R^2	.119	.114	.121	.132	.135	.155	.115	.113	.113
$\Delta I(CIA = 1)$	-0.083	-0.040	-0.060	-0.007	-0.010	-0.005	-0.005	-0.010	0.011

Note: Rating and price corresponds to the rating and final price of a particular wine-vintage. Avg Rating and Avg price are respective average ratings and final prices for a wine over vintages. Award and Bulk are dummy variables with value 1 if wine earned an award or if it is a bulk wine. All regressions include grape×destination×year fixed effects. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

Table B2: Trade credit maturity and quality - Excluding CIA transactions

	$= {}_p$	$= 5$	log N	Rating	Avg Rating	log price	log Avg price	Award	Bulk
Quality	5.545	3.551	5.471	2.216	2.955	5.654	7.719	14.961	-19.716
	(2.561)	(2.060)	(2.135)	(1.126)	(1.095)	(2.679)	(2.186)	(3.397)	(6.562)
Obs.	1582202	1584515	1468574	901661	915221	761570	1155687	1585142	1585142
R^2	.17	.163	.178	.186	.199	.264	.189	.166	.158
ΔM	46.491	31.746	40.956	22.161	29.549	20.143	25.496	14.961	-19.716

Note: Rating and price corresponds to the rating and final price of a particular wine-vintage. Avg Rating and Avg price are respective average ratings and final prices for a wine over vintages. Award and Bulk are dummy variables with value 1 if wine earned an award or if it is a bulk wine. All regressions include grape×destination×year fixed effects. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

Table B3: Trade credit maturity and quality - Firm size

	$= _p$	$= 5$	Rating	Avg Rating	log price	log Avg price	Award	Bulk
Quality	3.652	0.872	0.941	1.592	1.561	3.773	10.530	-13.403
	(1.829)	(1.415)	(0.874)	(0.852)	(1.813)	(1.691)	(2.178)	(5.520)
log N	4.210	5.876	7.464	8.057	10.662	8.569	5.668	6.179
	(1.400)	(1.728)	(2.520)	(2.568)	(2.367)	(2.412)	(1.950)	(1.999)
Obs.	1529460	1531287	894492	910119	752403	1120481	1531896	1531896
R^2	.189	.186	.208	.225	.314	.226	.19	.187
ΔM	30.562	7.780	9.406	15.918	5.561	12.463	10.530	-13.403

Note: Rating and price corresponds to the rating and final price of a particular wine-vintage. Avg Rating and Avg price are respective average ratings and final prices for a wine over vintages. Award and Bulk are dummy variables with value 1 if wine earned an award or if it is a bulk wine. All regressions include grape×destination×year fixed effects. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

Table B4: Trade credit maturity and quality - Excluding CIA transactions

	$= _p$	$= 5$	Rating	Avg Rating	log price	log Avg price	Award	Bulk
Quality	2.599	0.813	0.983	1.604	1.622	3.901	10.682	-15.167
	(1.965)	(1.531)	(0.912)	(0.895)	(1.866)	(1.757)	(2.246)	(5.513)
log N	3.978	5.082	6.795	7.454	10.146	7.949	4.837	5.336
	(1.483)	(1.821)	(2.623)	(2.667)	(2.455)	(2.509)	(2.058)	(2.112)
Obs	1466235	1468024	864234	880313	730753	1082685	1468574	1468574
R^2	.18	.179	.207	.224	.315	.224	.183	.18
ΔM	21.482	7.100	9.833	16.035	5.779	12.885	10.682	-15.167

Note: Rating and price corresponds to the rating and final price of a particular wine-vintage. Avg Rating and Avg price are respective average ratings and final prices for a wine over vintages. Award and Bulk are dummy variables with value 1 if wine earned an award or if it is a bulk wine. All regressions include grape×destination×year fixed effects. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

Table B5: Quality and Likelihood of Trade Credit - Month

	$\log N$	$= 5$	$= 10$	$=$ $_p$
Quality	-0.008	-0.008	-0.003	-0.003
	(0.001)	(0.002)	(0.001)	(0.001)
Obs.	8616460	2276519	2276519	2006583
R^2	.563	.702	.701	.707
$\Delta I(CIA = 1)$	-0.064	-0.180	-0.135	-0.096

Note: All regressions include product×destination×year×month fixed effects. σ_p is the product-specific elasticity estimated by Broda and Weinstein (2006). $\log N$ is corresponds to the log of employment. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

Table B6: Trade credit maturity and quality - Month

	$\log N$	$= 5$	$= 10$	$=$ $_p$
Quality	2.593	1.323	0.423	1.178
	(0.775)	(0.286)	(0.135)	(0.230)
Obs.	8616460	2276519	2276519	2006583
R^2	.655	.723	.723	.737
ΔM	22.109	31.509	20.583	37.973

Note: All regressions include product×destination×year×month fixed effects. σ_p is the product-specific elasticity estimated by Broda and Weinstein (2006). $\log N$ is corresponds to the log of employment. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

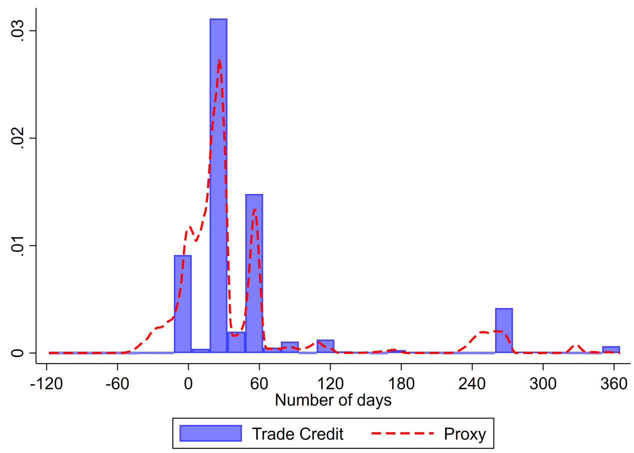
Table B7: Trade credit maturity and transportation mode

	Full Sample		$M > 0$	
	(1)	(2)	(3)	(4)
Air	-5.939	-5.117	-4.292	-3.951
	(1.952)	(1.929)	(1.944)	(1.921)
Ground	-12.646	-11.763	-9.673	-9.289
	(3.101)	(3.195)	(3.138)	(3.247)
Rest	-5.580	-7.600	-6.455	-1.135
	(6.306)	(8.147)	(6.884)	(9.032)
$\log q$		0.571		0.207
		(0.219)		(0.212)
Obs	9360070	9073179	8461144	8220031
R^2	.81	.807	.833	.83

Note: The benchmark transportation mode is waterborne. Air is a dummy variable that is equal to 1 if the product was transported by air. Ground will be 1 if the good was transported by land. Rest will be 1 if is the good is transported by alternatives like a pipeline or train. These products are minimal. All regressions include firm×product×year and destination×year fixed effects. Robust standard errors are clustered at firm × destination level. *, **, *** represent significance at 10, 5 and 1% respectively.

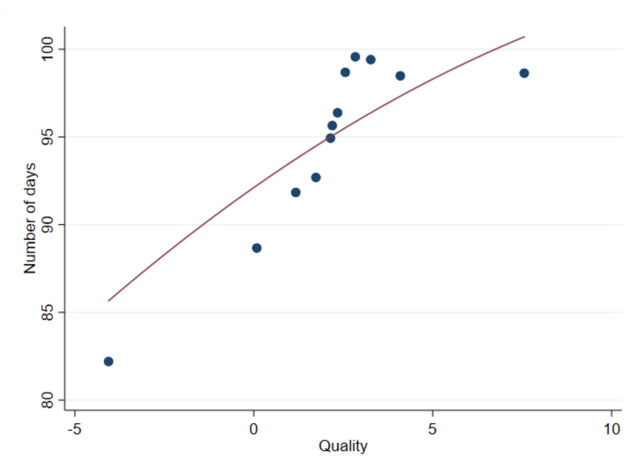
C Additional Figures

Figure C1: Trade credit maturity and proxy

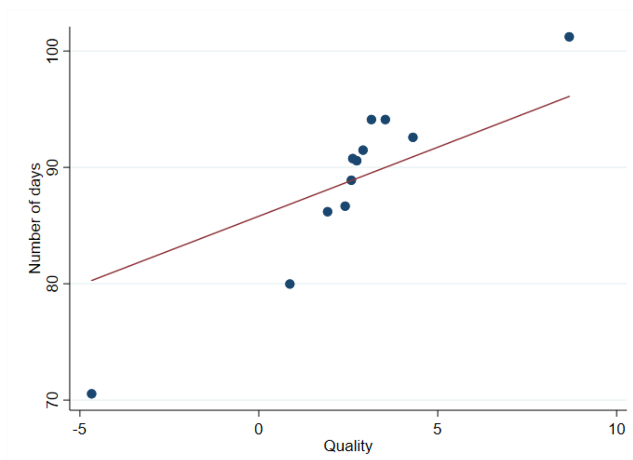


Note: The bars represent the exact trade credit period for a subsample and the dashed-line is the distribution of the measure of trade credit used throughout the paper.

Figure C2: Trade credit maturity and quality - Including months



(a) $\sigma = 5$



(b) $\sigma = \sigma_p$

Note: Both figures are binned scatter plots of number of days of trade credit vs. quality measured as the residual of (20) demeaned by product×destination×year×month. Left panel estimates quality using demand elasticity of 5 and right panel using the demand elasticity estimated by Broda and Weinstein (2006)