Trade Credit and Markups*

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Abstract

Trade credit is the most important form of short-term finance, with U.S. non-financial firms' trade credit equaling 24 percent of U.S. GDP. We show that with positive markups, trade credit reduces borrowing from banks and thereby lowers diversion risk and financing costs. In line with model predictions, Chilean export data show that a one standard deviation rise in upstream markups increases trade credit by 13 days. The extensive and intensive margins contribute about equally to this effect, which strengthens with the destination country's borrowing costs. Findings are robust to instrumenting markups with estimated physical productivity and including extensive fixed effects.

Keywords: Trade credit, markups, financial intermediation

JEL Classification: F12, F14, G21, G32

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1 Introduction

Trade credit is the most important form of short-term finance for U.S. firms.[1] In the first quarter of 2021, non-financial U.S. firms had about $5.2 trillion in trade credit outstanding equaling 24 percent of GDP. Trade credit affects key outcomes like corporate default (Jacobson and von Schedvin, 2015; Barrot, 2016; Amberg et al., 2021), the transmission of monetary policy (Nilsen, 2002; Adelino et al., 2020), and economic growth (Demirguc-Kunt and Maksimovic, 2001; Fisman and Love, 2003).

A central question in the literature is why trade credit coexists with bank lending and what factors make trade credit preferable over its alternatives. This paper speaks to this question by showing that trade credit reduces the need for bank borrowing and thereby limits diversion risk and financing costs. It develops a model where diversion risk gives rise to a wedge between the borrowing rate and the deposit rate, while positive markups imply that a buyer who pays cash in advance needs to borrow more than a seller who provides trade credit. Trade credit then has an advantage over cash in advance because it implies lower overall borrowing and financing costs. Importantly, this advantage is present even if firms' ability to divert is the same for goods and cash and when the seller and the buyer have the same financing costs.

In the model, an upstream firm (the seller) produces a good and sells it to a downstream firm (the buyer) at a markup, settling the transaction either through cash in advance or trade credit.[2] Under cash in advance, the buyer needs to pre-pay the full amount to the seller, which requires borrowing an amount equal to the full invoice. In contrast, extending trade credit requires less borrowing, as the seller only needs to cover her production costs in advance which may be substantially lower than the sales price if there is a markup. As the borrowing rate exceeds the deposit rate due to the risk of diversion by borrowers, the difference in borrowing needs between cash in advance and trade credit affects profits. The larger are the markup and the difference between the borrowing and the deposit rate, the more attractive is trade credit and the longer is the optimal trade credit maturity. All else equal, trade credit is preferred over cash in advance if there is a positive markup and a positive interest rate spread. As the

[1] Trade credit is defined as the implicit lending by a seller to a buyer when a buyer is given some time to pay for goods after receiving them.

[2] In model extensions, we also allow for partial pre-payments and letters of credit, a payment form used in international trade transactions. The letter of credit extension is particularly relevant, as we test the model using international trade data.

world typically features positive markups and positive interest rate spreads due to credit risk, the theory thus provides a strong rationale against using cash in advance and in favor of using trade credit in firm-to-firm transactions.

While the predictions of the model apply, in principle, to both domestic and international trade transactions, we test them using detailed data on international trade transactions from Chile. Specifically, for our analysis, we link two panel data sets. First, Chilean export data, which contain detailed information on the payment choice at the transaction level. Second, Chilean manufacturing survey data that we use to estimate firm-product markups following the method developed by De Loecker et al. (2016).

The data have two advantages that help identify the effect of markups on trade credit. They include detailed information on all inputs used and output produced by firms, which allows estimating quantity-based markups at the firm-product level and therefore avoids identification problems that arise when markups are estimated with revenue data (De Loecker et al., 2016; Syverson, 2019). And, as payment terms are available for buyers located in many different countries, differences in average borrowing costs across countries can be used, which are less likely to be endogenous to firms' payment choices than firm-level borrowing costs.

To strengthen identification, the empirical analysis does not only look at the direct effect of markups on trade credit but also at the effect of the interaction between markups and destination country borrowing costs. Studying this interaction term is crucial for two reasons. First, the prediction on markups and borrowing costs is, to our knowledge, unique to the financing cost mechanism presented here. While earlier work on competition, also predicts a positive relationship between upstream markups and trade credit use, we are not aware of any theory that explains the link between upstream markups and trade credit with borrowing costs. Second, the interaction term allows for the inclusion of a rich set of fixed effects, which directly address omitted variable concerns and make it more plausible that the exclusion restriction for the instrumental variable holds.

The main empirical findings are that trade credit use (extensive margin) and trade credit maturity (intensive margin) increase with markups. Importantly, as predicted by the model, the effect of the markup on trade credit increases with the buyer's borrowing rate. Effects are economically meaningful. A one standard deviation rise in upstream markups increases trade credit, on average, by 13 days. The extensive and intensive margins contribute about equally to this effect.

Results are robust to alternative measures of markups and the inclusions of a large set of fixed effect and control variables. Results continue to hold when instrumenting markups by plant-product level physical productivity. As the instrument is constructed from technological supply-side factors, the IV estimation also addresses concerns about competition and demand-side effects. U.S. firm-level data from Compustat, which capture both the extensive and intensive margin jointly, exhibit a similar relationship between markups and trade credit use that also strengthens with higher funding costs, as proxied by the real Effective Fed Funds Rate.

Our theory adds to the literature on the dominance of trade credit. In our model, trade credit is valuable because it reduces bank borrowing and thus limits diversion risk and financing costs. Burkart and Ellingsen (2004) study a complementary mechanism, where sellers extend trade credit because this type of credit is “in-kind” and is thus harder to divert than cash.[3] In our setup, diversion is symmetric across bank loans, advance payments, and goods, so that trade credit does not have an advantage because goods are more difficult to divert than cash.[4] The idea in our model that trade credit provides a way to save on financial costs is related to Emery (1984), where trade credit helps channel excess liquidity across firms. In contrast to this earlier work, our mechanism is operative even if the seller has no excess liquidity. Moreover, the financing cost advantage derived here works even if the buyer and seller face the same borrowing and deposit rates. For an early summary of the main theories on trade credit, see Petersen and Rajan (1997).

Our analysis extends work on payment choice in international trade by Schmidt-Eisenlohr (2013) and Antràs and Foley (2015) by looking at the interaction between markups and financing costs, deriving results for trade-credit maturity, and by introducing Nash-Bargaining and

[3] Amberg et al. (2020) extend this model with a labor-capital choice, showing that trade credit contributes to a capital bias for financially constrained firms.

[4] Another strand of research assumes asymmetric information between banks, suppliers, and buyers, as in Smith (1987) and Biais and Gollier (1997). Schwartz (1974) and Ferris (1981) suggest models where trade credit serves a transaction motive, separating the exchange of goods from the exchange of money. Schwartz and Whitcomb (1979), Brennan et al. (1988), and Mian and Smith (1992) rationalize trade credit use as a way to price discriminate. Wilner (2000), Cuñat (2007), Yang and Birge (2018), and Hardy et al. (2022) study the role of trade credit for risk-sharing within a supply chain.

variable markups.[5] The paper also contributes to the wider literature on financial frictions and trade (see e.g. Chor and Manova, 2012; Manova, 2013; Chaney, 2016; Leibovici, 2021).

The theoretical analysis of markups and trade credit complements earlier work, in particular on competition. In Demir and Javorcik (2018) and Giannetti et al. (2021), firms provide more trade credit if the downstream firm has more bargaining power. As a higher bargaining power of the downstream firm should imply smaller upstream markups, this should generate a negative correlation between the upstream firm's markups and trade credit provision. That is, this competition effect should go in the opposite direction from the financing cost channel derived in this paper.[6] Chod et al. (2019) study an externality when trade credit allows downstream firms to increase their cash purchases from the upstream firm's competitors, which generates a positive relationship between upstream markups and trade credit, similar to the one predicted by our model.[7] Importantly, none of these earlier papers predict that the relationship between trade credit and markups increases with the buyer's interest rate.

Finally, by showing in micro-data that trade credit use increases with markups, the paper expands on earlier empirical work by Petersen and Rajan (1997), who document a positive correlation between gross profit margins and accounts receivable in a survey data set of small firms. Instead of using gross profit margins at the firm level, this paper estimates markups at the firm-product level, applying the methodology in De Loecker et al. (2016). Furthermore, the detailed transaction-level data allow to separately estimate the effect of markups on the intensive and extensive margins of trade credit, which is not possible when using balance sheet data, as accounts receivable reflect the sum of both margins. Finally, by finding that the relationship between markups and trade credit increases in the borrowing rate of the destination country, the paper provides direct evidence for a mechanism that can explain the link between trade credit and markups.

The remainder of the paper is organized as follows. Section 2 presents the model of payment choice and derives the main testable predictions. Section 3 discusses the empirical specifications

[5] Additional theoretical work on the payment choice includes Ahn (2014), Olsen (2016), Niepmann and Schmidt-Eisenlohr (2017a), and Fischer (2020).

[6] Indeed, Demir and Javorcik (2018) provide evidence that an increase in upstream competition led to more trade credit provision and lower prices charged by upstream firms. Giannetti et al. (2021) study a policy reform that lowered the cost of trade credit provision for Italian firms. They find that the reform led to more trade credit provision and higher input costs for downstream firms.

[7] Another model that implies a positive relationship between upstream markups and trade credit is Daripa and Nilsen (2011), where suppliers subsidize buyers' inventory holdings through trade credit.

and presents the methodology for deriving rm-product markups. Section 4 describes our dataset. Section 5 presents the main empirical results with Chilean data. Section 6 presents results with U.S. data. Finally, section 7 discusses the implications of our study and routes for future research.

2 A Model of Trade Credit and Markups

This section presents our model of payment choice, featuring diversion of cash and goods and positive markups. It rst presents a parsimonious baseline model and derives the main results and testable predictions. It then introduces diversion of bank loans, goods, and advance payments by rms and a competitive banking sector where borrowing rates are endogenous. In a next step, the section derives results on trade credit maturity { the number of days granted to buyers until payment. Finally, the baseline model is further generalized in several ways, introducing variable markups, partial pre-payments, Nash-Bargaining, and letters of credit.

The model has two key elements. First, to pay for goods or production costs, rms need to borrow funds from the nancial sector, which is costly. Firms can also deposit surplus liquidity as deposits with the banking sector[8]. Importantly, banks charge a higher interest rate when lending funds to rms than the interest rates they pay to depositors, as borrowers may divert the borrowed funds. Second, sellers charge markups over marginal costs when selling their goods.

2.1 Baseline Model

One upstream rm (the seller) is matched with one downstream rm (the buyer). Both rms are risk-neutral. There are two periods. In period 0, the seller produces the goods and sends them to the buyer. In period 1, the buyer sells the goods to a nal consumer. Because of this time gap between production and nal sale, rms need to agree on payment terms. Firms have two options. First, buyers can pay in advance (cash in advance) before receiving the goods. Second, buyers can pay after delivery (on trade credit). A seller produces output for a total cost of C and sells it to the buyer. The buyer can then sell the goods to nal consumers and

[8] We assume that rms do not have excess liquidity ex-ante. However, a seller can have excess liquidity after getting paid by the buyer.

generate revenues R. To finance their transactions, the seller (buyer) can borrow from banks at an interest rate r_b (r_b), and deposit surplus funds at banks for a deposit rate of r_d.[9] For all endogenous variables (profits, payment) we use the sub-index "B" for the buyer and sub-index "S" for the seller.

To simplify the exposition, we make two working assumptions, that we later relax in sections 2.2 and 2.4. First, firms charge a constant markup to final consumers given by μ so that $R = \mu C$. Second, the seller makes a take-it-or-leave-it offer to the buyer, who can choose to accept or reject the offer. Throughout the analysis, we focus on the interesting case where the markup, μ, is sufficiently large such that both trade credit and cash in advance generate positive profits, $R > (1 + r_b)C$ and $R > (1 + r_b)C$, which implies $\mu > 1 + r_b$ and $\mu > 1 + r_b$. Let π_j^i denote the profit of the buyer or seller ($j \in \{B; S\}$) under trade credit or cash in advance ($i \in \{TC; CIA\}$).

Trade Credit. Under trade credit, the seller maximizes:

$$\pi_S^{TC} = P^{TC} - (1 + r_b)C;$$
$$\text{s.t.} \quad \pi_B^{TC} = R - P^{TC} \geq 0;$$

where P^{TC} is the total payment from the buyer to the seller. Under trade credit, the seller gets paid P^{TC}, while incurring the production costs C. Because production takes place in period 0 while sales only occur in period 1, the seller has to borrow the production costs C from a bank and pay the interest rate r_b. The maximization is subject to the participation constraint of the buyer. Solving for the optimal payment, P^{TC}, that respects the participation constraint implies $P^{TC} = R$, delivering profits of:

$$\pi_S^{TC} = R - (1 + r_b)C: \qquad (1)$$

Cash in Advance. Under cash in advance, the seller maximizes:

$$\pi_S^{CIA} = (1 + r_d)(P^{CIA} - C);$$
$$\text{s.t.} \quad \pi_B^{CIA} = R - (1 + r_b)P^{CIA} \geq 0:$$

[9] The assumption that the seller's outside option is the deposit rate could be relaxed, as the mechanism works as long as the seller's marginal return to capital is below the buyer's borrowing rate.

In period 0 the seller gets paid P^{CIA} and incurs production costs C. If the price charged to the buyer exceeds production costs, the seller deposits the surplus funds at a bank for interest rate r_d. The buyer pays P^{CIA} in period 0, borrowing from a bank at interest rate r_b. Solving for the optimal payment, P^{CIA}, that makes the buyer's participation constraint bind delivers $P^{CIA} = \frac{1}{1+r_b} R$. With seller pro ts of:

$$ {}^{CIA}_{S} = (1 + r_d) \quad \frac{1}{1 + r_b} R \quad C \quad : \tag{2} $$

Optimal Payment Choice. Combining equations (1) and (2) and rewriting shows that trade credit dominates if:

$$ {}^{TC}_{S} \quad {}^{CIA}_{S} = \quad (1 + r_b) \quad (1 + r_d) \quad \frac{1}{1 + r_b} \quad 1 \quad C > 0: \tag{3} $$

For the special case where borrowing rates are equal for both rms $r_s (= r_b)$, the condition simpli es to:

$$ (r_b \quad r_d)(\quad (1 + r_b)) > 0: \tag{4} $$

Equation (3) can be rewritten to nd that trade credit is preferred as long as:

$$ \frac{r_b \quad r_d}{1 + r_b} > r_b \quad r_d: \tag{5} $$

That is, with a su ciently large markup, rms always prefer trade credit, as long as the buyer's borrowing rate exceeds the seller's deposit rate. These ndings are summarized in the following Proposition.

Proposition 1 (Payment Choice)

Suppose the buyer's borrowing rate is above the seller's deposit rate, $r_b > r_d$, and $> 1 + r_b$. Then:

i) If the buyer and seller face equal borrowing costs $r_s (= r_b)$, the seller always prefers trade credit.

ii) There is always a markup, , that is large enough to make the seller choose trade credit over cash in advance.

Proof. Follows directly from equations (4) and (5). ∎

The financing friction combined with a positive markup provides a rationale for the dominance of trade credit in firm-to-firm transactions. Trade credit dominates cash in advance because it minimizes gross borrowing from financial institutions and thereby financial intermediation costs. Importantly, the preference for trade credit does not depend on any financial cost advantage of the seller over the buyer. In fact, as shown in equation (4), trade credit is preferred in the case where buyers and sellers face the same borrowing and deposit rates.

To build further intuition, figure 1 illustrates the financing cost advantage of trade credit for the symmetric case. Panels A and B show the financing costs for trade credit and cash in advance, respectively, which equals the net funds borrowed from the financial system in each case. Then, panel C computes the difference in financing cost between cash in advance and trade credit (green area). It is easy to see that $r_b > r_d$ and $> 1 + r_b$ imply a preference for trade credit in the symmetric case, as derived formally in result (i) in Proposition 1.

Testable Predictions. To derive testable predictions, take the derivative of equation (3) with respect to . Rearranging implies that profits with trade credit relative to cash in advance rise in the markup if:

$$r_b - r_d > 0. \tag{6}$$

That is, as long as the buyer's borrowing rate is above the seller's deposit rate, trade credit becomes more attractive relative to cash in advance when the markup goes up. When buyers and sellers are located in the same country, this condition is satisfied as long as financial intermediation is costly and a firm pays more to a bank for borrowing funds than it receives for depositing them. The next section shows that this is indeed the equilibrium outcome when borrowers can divert funds from banks. In the international context, when buyers are located overseas, the condition is more likely to hold if the destination country has a higher borrowing rate and less likely to hold if the source country has a higher deposit rate. Importantly, while in the baseline model we assume that the opportunity cost of cash is given by the deposit rate,

Figure 1. The Financing Cost Advantage of Trade Credit

A. Trade Credit

B. Cash in Advance

C. Financing Cost Advantage I

Notes: The figures illustrate the financing cost of trade credit (panel A), cash in advance (panel B), and the difference in financing cost between cash in advance and trade credit (panel C) for the case where the seller and the buyer face the same borrowing and deposit rates. As long as there is a positive spread between borrowing and deposit rate and markups are above $(1 + r_b)$, trade credit has a financing cost advantage over cash in advance.

we note that our mechanism holds as long as the buyer's borrowing rate exceeds the marginal return to capital of the seller, as this ensures that conditions (5) and (6) are satisfied.

The following Proposition summarizes our results on trade credit and markups:

Proposition 2 (Trade Credit and Markups)

Suppose $r_b > r_d$. Then:

i) The use of trade credit increases with the markup.

ii) This effect increases with r_b and decreases with r_d.

Proof. Follows from equation (6) ■

Part (ii) of Proposition 2 represents the key prediction for testing the mechanism proposed in this paper: The effect of the markup should be stronger when the destination country's borrowing rate is higher and when the source country's deposit rate is lower. These additional predictions are intuitive. The difference in borrowing needs between trade credit and cash in advance only matters if there is a positive difference between the borrowing rate and the deposit rate. Naturally, this effect is larger, the larger is the interest rate difference. Panel C of figure 1 illustrates this finding, as the financing cost advantage, the green area, is the product between the interest rate difference and the markup, as $P^{CIA} \quad C = (\frac{\quad}{1+r_b} \quad 1)C$.

2.2 Diversion Risk

We now extend the model and micro-found the spread between the borrowing and deposit rates by introducing the possibility that firms divert funds or goods. Importantly, we allow the same type of diversion to take place between firms that implicitly lend to each other. That is, buyers that receive trade credit can divert goods, and sellers that receive advance payments can divert cash.[10]

Assume that a fraction ( ) of sellers (buyers) is reliable; that is, these firms always fulfill their contracts. If a firm is unreliable, it does not fulfill its contract voluntarily but diverts goods or funds whenever it gets the opportunity to do so. Assume that an unreliable firm gets the opportunity to divert goods or funds with probability 1 .

Banking Sector There is a competitive banking sector, and banks can borrow at the risk-free interest rate r_d. Banks offer loans to sellers and buyers to finance trade-credit and cash-in-advance transactions, respectively. With probability , the borrower is reliable, and the loan gets repaid in full, and with probability 1 , the borrower is unreliable and diverts a share of 1 of the borrowed funds.[11] We focus on the case where it is optimal for unreliable firms to

[10] In contrast, to Burkart and Ellingsen (2004), we do not assume that goods are harder to divert than cash. Instead, we assume equal abilities to divert across bank loans, trade credit, and advance payments. While we focus on this symmetric case here, results can also be derived in a model where only bank loans can be diverted or where diversion differs between bank loans and firm-to-firm lending. These results are available upon request.

[11] For tractability, we model diversion in reduced-form similar to Antràs and Foley (2015). However, a generalization of the setting in Burkart and Ellingsen (2004) should yield similar results. In Burkart and Ellingsen

imitate reliable firms. In appendix A we show that perfect competition between banks ensures that the only equilibrium is where banks offer a contract that is accepted by both types. Under trade credit, the seller borrows production cost C from the bank at rate r_b. Zero bank profits imply that the banks funding costs equal the expected repayment amount:

$$(1 + r_d) = (1 + r_b)(\quad + (1 \quad) \ ) \tag{7}$$

Solving for the borrowing rate delivers:

$$1 + r_b(\tilde{}) = \frac{1 + r_d}{\tilde{}};$$

with $\tilde{} = \quad + (1 \quad)$. Solving the analog problem for the buyer who borrows $\frac{R}{1+r_b}$ under cash in advance delivers:

$$1 + r_b(\tilde{} \ ) = \frac{1 + r_d}{\tilde{}};$$

with $\tilde{} \ = \quad + (1 \quad)$. As long as there is some diversion, $\ ; \ < \ 1$, there is a spread between the borrowing rate and the deposit rate.

The Seller Problem We focus on the case where it is optimal for unreliable firms to imitate reliable firms. In appendix A we show that for a sufficiently high share of reliable firms, , this pooling case is consistent with optimal behavior by both types of firms. Then, it is sufficient to derive the optimal choice of a reliable firm.

Trade Credit The reliable seller's maximization problem reads:

$$E[\ ^{TC}_{RS}] = \tilde{} \ P^{TC} \quad (1 + r_b(\tilde{}))C$$
$$\text{s.t. } E[\ ^{TC}_{RB}] = R \quad P^{TC} \quad 0:$$

A reliable seller gets paid P^{TC} with probability $\tilde{}$, while still incurring the production costs C with certainty. The optimal payment does not change compared to the baseline model and

(2004) diversion does not happen in equilibrium because banks set optimal incentive compatible contracts to prevent this outcome.

remains $P^{TC} = R$, delivering expected pro ts of:

$$E[\ {}^{TC}_{RS}] = \sim R \quad (1 + r_b(\sim))C: \qquad (8)$$

Cash in Advance The reliable seller maximizes:

$$E[\ {}^{CIA}_{RS}] = (1 + r_d)(P^{CIA} \quad C);$$
$$\text{s.t. } E[\ {}^{CIA}_{B}] = \sim R \quad (1 + r_b(\sim\ ))P^{CIA} \quad 0:$$

Under cash in advance, there is now a risk that a buyer is matched with an unreliable seller who may not deliver the goods. Thus, the buyer generates revenues R only with probability $\sim$. Solving for the optimal payment delivers $P^{CIA} = \frac{\sim}{1+r_b(\sim\ )}R$. With expected seller pro ts of:

$$E[\ {}^{CIA}_{RS}] = (1 + r_d) \quad \frac{\sim}{1 + r_b(\sim\ )}R \quad C \quad : \qquad (9)$$

This represents the general solution for all sellers, as we assumed that conditions are such that an unreliable seller always imitates a reliable seller (see appendix A for details). Taking the di erence between expected pro ts from trade credit and cash in advance delivers:

$$E[\ {}^{TC}_{RS}] \quad E[\ {}^{CIA}_{RS}] = \sim \quad (1 + r_b(\sim)) \quad (1 + r_d) \quad \frac{\sim}{1 + r_b(\sim\ )} \quad 1 \quad C > 0: \qquad (10)$$

For the special case where enforcement is symmetric ($\sim = \sim$), the condition simpli es to:

$$(1 \quad \sim)\sim \quad \frac{1 + r_b(\sim)}{\sim} \quad C > 0; \qquad (11)$$

which holds as long as there is some diversion of borrowed funds (< 1) and trade is pro table ($\frac{1+r_b(\sim)}{\sim} > 0$). Taking the derivative of equation (10) with respect to and rearranging implies that trade credit gets more attractive in if:

$$\sim (1 \quad \sim) > 0: \qquad (12)$$

That is, if there is any diversion risk, then trade credit use increases in. The intuition is quite straightforward: diversion creates a wedge between the borrowing and the deposit rates, making gross borrowing from banks costly. As trade credit has lower gross borrowing than cash in advance when there is a positive markup, diversion makes trade credit more attractive. Importantly, the fact that rms can divert goods under trade credit or advance cash payments under cash in advance does not a ect this trade-o , as these additional diversion opportunities exactly o set each other. The results from the model with diversion are summarized in the following corollary:

Corollary 1 (Trade Credit, Markups, and Diversion)

Suppose > 1=~ and there is diversion of cash and goods (~ < 1 and ~ < 1). Then, all predictions in propositions 1 and 2 continue to hold in the model with diversion.

Proof. Proposition 1: i) follows from equation (12); ii) rewrite equation 10 to get > $\frac{(1+r_d)}{\sim\ \sim}$; Proposition 2: i) follows directly from equation (12); ii) follows from taking the cross-derivative of equation (10) with respect to and r_b. ■

We illustrate the intuition for our results on diversion risk in gure 2 and table 1. The nancing cost advantage of trade credit arises because there is a larger total exposure to diversion risk with trade credit than with cash in advance. As shown in the gure and in the rst row of the table, rm-to- rm diversion risk is exactly the same for trade credit and cash in advance, with both payment terms implying a value of funds or goods at risk of F. However, diversion risk arising from bank borrowing is larger with cash in advance, as it requires more gross borrowing (row 2). This leads to higher borrowing cost with cash in advance (row 3), that are only partially o set by the positive deposit returns with cash in advance (row 4), as long as the borrowing rate exceeds the deposit rate (bottom-right cell of the table). Importantly, our results hold even when diverting cash and goods is equally di cult. Making goods harder to divert than cash as in Burkart and Ellingsen (2004) would add an extra factor in favor of trade credit but is not necessary for any our ndings.

Figure 2. Funds and goods at risk

Notes: This gure shows the funds and goods at risk, represented by the solid red arrows. The left part shows diversion risk under trade credit: the buyer needs to pay R to the seller and the seller needs to pay $C(1+ r_b)$ to the bank. The right part shows diversion risk with cash in advance: the seller has to deliver goods of value R and the buyer has to pay R to the bank. The gure also shows the deposit of the seller with cash in advance, $\frac{R}{1+r_b} \quad C$. However, there is no diversion risk for the deposit, so the link is depicted by the green dashed arrow.

Table 1. Diversion Risk and its Costs

	Cash in Advance (1)	Trade Credit (2)	Di erence (1) (2)
Firm-to- rm diversion risk	R	R	0
Bank loan diversion risk	R	$C(1 + r_b)$	R $(1 + r_b)C$
Cost of borrowing	$r_b \quad \frac{R}{1+r_b}$	$r_b C$	$r_b \quad \frac{R}{1+r_b} \quad C$
Return on deposit	$r_d(\frac{R}{1+r_b} \quad C)$	0	$r_d \quad \frac{R}{1+r_b} \quad C$
Net Costs	$r_b \quad \frac{R}{1+r_b} \quad r_d \quad \frac{R}{1+r_b} \quad C$	$r_b C$	$(r_b \quad r_d) \quad \frac{R}{1+r_b} \quad C$

2.3 Trade Credit Maturity

When extending trade credit, sellers can decide on the number of days that a buyer has to pay for the goods. We now extend the model to study this intensive margin of trade credit. Let t be the trade credit maturity and let T be the number of days after which revenues are realized by the buyer from selling the goods to nal consumers. Assume that diversion risk is increasing continuously with maturity, t; a plausible assumption, as longer payment times give rise to more opportunities to divert goods. To capture this, let diversion risk, (t), be a decreasing function of t. The seller then maximizes:

$$E[\,{}^{TC;l}_{S}\,] = (1 + r_d(T \quad t))(\tilde{}\ (t)P^{TC;l} \quad C) \quad r_b tC$$

$$\text{s.t.: } E[\,{}^{TC;l}_{B}\,] = R \quad P^{TC;l}(1 + r_b(T \quad t))$$

With an optimal payment of $P^{TC;I} = \frac{R}{1+r_b(T \quad t)}$, this implies expected seller pro ts of:

$$E[\ {}^{TC;I}_{S}] = (1 + r_d(T \quad t)) \frac{\sim (t)}{1 + r_b(T \quad t)} \quad 1 \quad r_b t \quad C \tag{13}$$

Focusing on the symmetric case and taking the derivative with respect to maturity, we nd that:

$$\frac{@E[\ {}^{TC;I}_{S}]}{@t} = C = \underbrace{(r_b \quad r_d) \frac{\sim(t)}{(1 + r_b(T \quad t))^2} \quad 1}_{\text{Financing Cost E ect } > 0} + \underbrace{\frac{}{1 + r_b(T \quad t)} [(1 + r_d(T \quad t))(\sim(t)^0)]}_{\text{Diversion E ect } < 0} \tag{14}$$

There are two opposing forces in the model. First, if markups are high enough and the borrowing rate exceeds the deposit rate, then the nancing cost advantage of trade credit lets pro ts rise with maturity, t. Second, as long as the diversion risk increases with maturity, $(\sim(t)^0 < 0)$ the diversion e ect lets pro ts decline with maturity t. For an interior solution to exist, we assume that diversion risk is convex in maturity t and rises su ciently quickly to eventually dominate the nancing cost channel. That is, assume that $(t > 0)^{00} < 0$ and $\frac{\sim(t)^0}{\sim(t)} > \frac{r_b}{1+r_b(T \quad t)}$. For the diversion e ect to dominate the nancing cost e ect at T, it is necessary that $(T)^0 < \frac{r_b \quad r_d}{}(\sim \quad 1)$.[12] We can then derive the following proposition.

Proposition 3 (Trade Credit Maturity)

Suppose the buyer and the seller face equal borrowing costs and diversion risks $(r_b =$ and $\sim = \sim)$, $r_b > r_d$ and $> 1 = \sim$. Then,

i) there is an optimal level of t that lies between 0 and T

ii) the optimal maturity, t, increases in , an e ect that increases in r_b.

Proof. See appendix B.1. ■

[12]To map the model back to our baseline, we assume that there is no diversion risk with zero maturity, $\sim(0) = 1$, and that diversion risk is the same as in the baseline model with maximum maturity, $\sim(T) = \sim$.

Proposition 3 implies very similar testable predictions for trade credit maturity as for the payment terms choice. In particular, it predicts that the maturity of trade credit increases in the markup and that the e ect of the markup on the maturity increases in the borrowing cost. We illustrate these ndings in gure 3, which plots the optimal maturity, t, against the markup, , for di erent borrowing rates, r_b, setting $\sim(t) = 1 + (\sim \quad 1)\left(\frac{t}{T}\right)^n$.[13]

Figure 3. Trade Credit Maturity, Markups and Interest Rates

Notes: The gure illustrates the optimal maturity, t, against the markup for di erent borrowing rates, assuming $\sim \; (t) = 1 + (\sim \quad 1)\left(\frac{t}{T}\right)^n$, and setting $\sim = 0{:}98$, $r_d = 0{:}02$, $n = 2$, and $T = 180$.

2.4 Model Extensions

The following subsections discuss four additional model extensions: Variable markups, partial pre-payments, bargaining between buyers and sellers, and letters of credit.

2.4.1 Variable Markups

Variable markups are a key extension, as they micro-found the instrumental-variable approach employed later, where markups are instrumented with productivity estimates. Assume that rms face a linear demand.[14] Then, the following proposition can be derived, with details in appendix B.2:

[13] In the example, we set $\sim = 0{:}98$, $r_d = 0{:}02$, $n = 2$, and $T = 180$.

[14] A linear demand would follow, for example, from a demand system as in Melitz and Ottaviano (2008). However, the below results do not depend on this speci c modeling choice for variable markups.

Proposition 4 (Trade Credit and Variable Markups)

Suppose the buyer's and seller's borrowing rates are not too different, the seller's borrowing rate is above the seller's deposit rate, $r_b > r_d$, $> 1 + r_b$, and firms face a linear demand. Then:

1. The markup decreases with the marginal cost of production c.

2. By decreasing the markup, an increase in the marginal cost of production makes trade credit less attractive relative to cash in advance.

3. The marginal cost affects the payment choice only through its effect on the markup.

Proof. See appendix B.2. ∎

Proposition 4 states that a decline in marginal costs (increase in productivity) leads to an increase in the markup and thereby to more trade credit provision: First, the linear demand creates a link where lower costs cause higher markups. Second, the financial cost mechanism developed here then links the increase in markups to an increase in the provision of trade credit. Importantly, there is no direct effect of marginal costs on the payment choice, as marginal costs do not directly affect the sign of the profit difference between trade credit and cash in advance but only affect it indirectly through their effects on the markups.

2.4.2 Partial Pre-Payment

The seller can ask for a partial pre-payment; that is, the buyer pays a fraction of the overall price in advance and pays the remainder after delivery. Interestingly, partial pre-payments only represent a very small fraction of transactions in our data as well as in other data that we are aware of (e.g. Antràs and Foley, 2015). As appendix B.3 shows, the only partial pre-payment that can be optimal is a prepayment that equals production costs C. For that case, optimal profits of the seller can be derived as:

$$ {}^{PP}_{S} = R \quad (1 + r_b)C: \qquad (15) $$

Profits with a partial pre-payment are very similar to those with trade credit. The only difference is that now production costs are pre-paid by the buyer, and therefore the buyer's borrowing rate, r_b, replaces the seller's borrowing rate, r_b, in the profit expression. These profits imply the following proposition:

Proposition 5 (Trade Credit and Partial Pre-Payments)

Suppose > $1 + r_b$ and > $1 + r_b$. Then:

i) If $r_b > r_b$, the seller pays after delivery (trade credit).

ii) If $r_d < r_b < r_b$, the buyer pre-pays production costs (partial pre-payment).

iii) If $r_d > r_b$, the seller pays before delivery (cash in advance).

iv) If $r_b = r_b$, the seller is indi erent between trade credit and a partial pre-payment of C.

Proof. See appendix B.3. ■

The proposition is quite intuitive. Suppose borrowing costs for both rms exceed the deposit rate. Then, if the seller has lower borrowing costs, she provides full trade credit. If the buyer has a lower borrowing cost, a partial pre-payment becomes optimal to shift nancing to the buyer. However, this only happens up to a point. Speci cally, the buyer only pre-pays production cost. Paying more in advance would create unnecessary nancing costs as any surplus funds get deposited into the bank by the seller, which only generates return r_d. Importantly, under partial pre-payment the seller still extends some trade credit to the buyer. Thus, the possibility of partial prepayment does not eliminate the nancing cost advantage of trade credit. Full cash in advance only becomes optimal when the borrowing rate of the buyer is so low that it is below the deposit rate of the seller. If the borrowing rates are the same for the buyer and the seller, the seller is indi erent between trade credit and a partial pre-payment.

Why are partial pre-payments not more common? One possible explanation that is beyond the scope of this model are legal frictions. Speci cally, partial pre-payments can be problematic from a legal perspective, as at any point in time, the legal ownership has to be assigned to one of the two parties. A buyer may be reluctant to pre-pay a fraction of the price without obtaining legal ownership. Conversely, the seller may be hesitant to transfer ownership rights before receiving the full payment. Adding this friction would be a promising extension to our model.[15]

2.4.3 Bargaining between Buyers and Sellers

So far, we derived results assuming that the seller has all bargaining power. To generalize the results, we extend the model to allow for di erent bargaining weights for the buyer and the

[15] Another way to make partial pre-payments less desirable would be to build on Burkart and Ellingsen (2004) and assume that cash is more easily diverted than goods.

seller, assuming that firms Nash-bargain over the surplus[16]. We derive the following corollary, with details in appendix B.4:

Corollary 2 (Payment Choice and Bargaining Power)
Suppose the seller has some bargaining power $\in ((0;1])$. Then all predictions in Propositions 1 and 2 hold for the case where both firms have bargaining power.

Proof. See Appendix B.4. ■

The corollary states that introducing bargaining power for both sellers and buyers does not affect our main results on trade credit and markups. In particular, all predictions in proposition 1 and proposition 2 continue to hold, as long as the seller has some bargaining power. This is because the seller can still charge a positive markup over marginal costs to the buyer and the financing cost advantage of trade credit remains active.

2.4.4 Letters of Credit

Letters of credit are a payment form used exclusively in international trade transactions. With a letter of credit, banks serve as intermediaries in the transaction to resolve the two-sided commitment problem between the buyer and the seller. The buyer pays a fee to the bank and commits to paying the seller.[17] The seller only receives payment from the bank after providing proof of shipment or delivery. Under these assumptions on commitment and letters of credit, the following proposition can be derived, with details in appendix B.5:

Proposition 6 (Payment Choice: with Commitment Problem)
The choice between trade credit and letters of credit is independent of the markup,

Proof. See appendix B.5. ■

The markup does not affect this choice because both trade credit and a letter of credit require the seller to finance the production costs and with both options payment only occurs after delivery. Therefore, trade credit increases with markups only at the expense of cash in advance, which we confirm empirically in section 5.3.

[16] We also looked at bargaining in the case of asymmetric information with enforcement frictions, using the Neutral Bargaining Solution proposed by Myerson (1984). Results are available upon request.

[17] This commitment can either reflect a long-term relationship with the bank or may require a deposit in the bank up to the value of the letter of credit. For tractability, we assume that it is sufficient for the buyer to pay the letter of credit fee in advance.

3 Empirical Approach

This section presents the main empirical specifications for the Chilean data, discusses threats to identification, and introduces our instrumental variable approach. In addition, it lays out the methodology we use to compute markups at the firm-product level.

3.1 Empirical Strategy

The empirical analysis looks at two outcome variables that are each constructed as trade-weighted averages at the firm-product-destination year level: (i) the share of exports sold on trade credit (extensive margin); and (ii) the trade credit maturity (intensive margin).

The model predictions are tested in two steps. First, the outcome variables are regressed on firm-product markups. The coefficient on markups should be positive in this specification. Second, different versions of the following regression at the firm-product-destination-year level are estimated:

$$TC_{ijpt} = \beta_1 \ln(\mu_{ipt}) + \beta_2 \ln(\mu_{ipt}) \times r_{b;jt} + X_{ijpt} + \alpha_i + \alpha_{jt} + \alpha_p + \varepsilon_{ijpt}; \tag{16}$$

where i denotes a firm, p a product, j a foreign country, and t denotes a year. TC_{ijpt} stands for the two outcome variables discussed above. μ_{ipt} is the markup, which we compute at the firm-product level following the methodology presented below in section 3.4. $r_{b;jt}$ denotes the borrowing rate in the destination country. This interest rate is at the country-year level and does not fully capture the buyer-specific borrowing costs in the model, which would, however, likely be endogenous. At the same time, the country-level borrowing cost should be a good proxy for the average cost of borrowing across all buyers in a destination country.

The main coefficient of interest is β_2 on the interaction term between the markup, μ_{ipt}, and the foreign borrowing rate, r_b. Propositions 2 and 3 predict the effect of markups on the share of trade credit and trade credit maturity to increase in the destination's borrowing rate, r_b.[18]

[18] Propositions 2 and 3 also have predictions on the interaction between markups and the domestic deposit rate r_d. However, as we study data from only one exporting country, Chile, there is very limited variation in that variable. In appendix table E.2, we interact the markup with the difference between the foreign borrowing rate and the domestic deposit rate, and the results are basically unchanged from those in table 4. In fact, in columns 2, 4, 6, and 8, the firm-product-year FEs eliminate any effect of r_d and its interaction with the markup, and results are therefore identical for those columns.

That is, $_2 > 0$.

The baseline specification includes firm ($_i$), product ($_p$) and country-year ($_{jt}$) fixed effects. While we first present results with firm, product, and destination-year fixed effects, our preferred specification includes firm-product-year and destination-year fixed effects. We cluster standard errors at the country-by-firm level.

3.2 Identification

There are two main challenges to identification in our setup that we discuss in detail below.

Omitted Variables. Omitted variables could pose a threat for identification if they directly affect both markups and trade credit use. For instance, financially constrained firms tend to provide less trade credit than financially unconstrained firms (Biais and Gollier, 1997; Burkart and Ellingsen, 2004; Cuñat, 2007). At the same time, financial constraints could plausibly affect markups, for example, by forcing firms to liquidate their inventories at lower prices to obtain cash. Another omitted variable could be competition in the destination market. More competitive environments may cause lower markups and may also lead to less trade credit provision, as shown in a recent paper by Demir and Javorcik (2018). If the baseline OLS estimates also capture this competition channel, this will generate a downward bias in the OLS coefficients. The empirical strategy directly addresses the omitted variable concerns by including granular fixed effects at the firm-product-year and the destination-year level. In addition, as described in more detail below, the IV strategy only exploits supply-side information to construct productivity estimates, resolving concerns that results are driven by changes to competition in the destination market.

Endogenous Markups. The model predicts that prices charged to the buyer are endogenous to the payment choice. In particular, a seller should charge a higher price when providing trade credit to pass on her borrowing costs to the buyer.[19] This price effect implies a positive

[19] In addition, if there is a two-sided commitment problem and imperfect contract enforcement, the seller also requires compensation for bearing the risk that the buyer may not pay. Antràs and Foley (2015) provide suggestive evidence for the price effect of trade credit, looking at transaction-level data from a U.S.-based exporter of frozen and refrigerated food products. We also estimated the correlation between a trade credit dummy and the unit values in our export data, and found that trade credit transactions, on average, have 3 percent higher unit values. Note that this is a relatively small effect relative to the dispersion of log markups

correlation between trade credit choice and markups, biasing the OLS estimates upward. This concern is addressed by the fact that the instrument is constructed without any price or revenue information but only uses supply-side information, as we discuss in detail next.

3.3 Instrumental Variable Estimation

To address omitted variable and endogeneity concerns, we implement an IV strategy, using firm-product physical total factor productivity (TFPQ) as an instrument for markups. As the model with variable markups shows, an imperfect pass-through of higher efficiency to lower prices can generate a positive correlation between physical productivity and markups.

For the main specification (16), the IV strategy works as follows. In the first stage, we predict firm-product markups and the interaction between firm-product markups and country characteristics with estimated firm-product TFPQ and its interactions with country characteristics. Importantly, when estimating the production function and computing TFPQ, we specify output and intermediate inputs in terms of physical units to avoid the so-called output and input price biases.[20] As De Loecker and Goldberg (2014) explain these biases lead to confounding measured productivity with markups. By specifying the production function in physical units, the estimated TFPQ only reflects supply-side production factors and does not reflect any demand conditions, which is crucial for the validity of TFPQ as an instrument for markups.

In the second stage, we regress each outcome variable, TC_{ijpt}, on predicted log markups, $\widehat{\ln \mu_{ipt}}$, predicted interactions between markups and interest rates, $\ln(\widehat{\mu_{ipt}}) \cdot r_{b;jt}$, controls, and fixed effects:

$$TC_{ijpt} = \beta_1 [\ln(\widehat{\mu_{ipt}})] + \beta_2 [\ln(\widehat{\mu_{ipt}}) \cdot r_{b;jt}] + X_{ijpt}\gamma + \delta_i + \delta_{jt} + \delta_p + \varepsilon_{ijpt} \quad (17)$$

Exclusion Restriction and Identification The exclusion restriction for using TFPQ as an instrument for markups requires that conditional on the fixed effects, TFPQ (and its interaction with destination-country borrowing rates) only affects the payment choice indirectly through its effects on markups (and its interaction with destination-country borrowing rates).

(standard deviation of 0.37).

[20] Appendix C provides technical details on the estimation of the production function at the firm-product level.

Our framework is consistent with this restriction, as shown in proposition 4. Nevertheless, there may be factors outside the model that might link productivity directly to trade credit provision. For instance, higher e ciency may re ect better management practices (Bloom and Reenen, 2007) or may imply that rms are less nancially constrained (Aghion et al., 2019). An additional concern is that sellers may be particularly e cient in producing a certain product. The higher e ciency may lead to higher bargaining power over the buyer of the product, which may indirectly a ect trade credit provision. In all these cases, e ciency would be linked to an omitted variable that may a ect trade credit preference at the rm-year or rm-product-year level. The rm-product-year xed e ects in our preferred speci cation directly control for these alternative mechanisms.

To threaten the exclusion restriction, any alternative mechanism would need to operate within rm-product-year and destination-year, as the identi cation of the interaction term between markups and borrowing rate comes from variation at that level.

To summarize, instrumenting markups by physical productivity and including detailed xed e ects resolves the two main endogeneity concerns discussed above. First, our IV resolves concerns about changes in competition in destination markets, as we only exploit changes in markups that are due to di erences in physical productivity at the rm-product level. Second, the IV also addresses the concern that rms charge higher prices under trade credit, as the physical productivity estimate only re ects di erences in technology and e ciency at the rm-product level and does not rely on revenue or price data.

3.4 Markups Estimation

To test the model, we construct markups at the rm-product-year level following the production-based approach by De Loecker et al. (2016). This methodology requires minimal working assumptions, is exible with respect to the underlying demand system, and only requires production data. We brie y explain the main elements of this methodology and relegate a more detailed technical discussion to appendix C.

The main insight in De Loecker et al. (2016) is that price-cost markup of a rm-product can be computed as the ratio between two elements: (i) The output elasticity of product with respect to any exible input V ($^{V}_{ipt}$), and (ii) the expenditure share of the exible input

V (relative to the sales of product p; s^{V}_{ipt}). The former element requires the estimation of the production function at the firm-product level, while the latter component can be directly computed from our data. We briefly explain how we compute each of these elements next.

To estimate the production function coefficients, we specify a Cobb-Douglas production function, with labor, capital, and materials as production inputs for each product p.[21] We measure output in terms of physical units and deflate materials expenditure with a firm-specific input price index. In this way, we avoid the occurrence of input and output price biases (see De Loecker and Goldberg, 2014, for details, and the discussion at the end of this section). To identify the production function coefficients in multi-product firms, we follow De Loecker et al. (2016), and assume that products are produced with the same technology in single- and multi-product firms. Hence, we identify the production function coefficients for all firms-products using the subset of single-product firms.[22] We estimate the production function coefficients following the methodology proposed by Ackerberg et al. (2015) to control for the endogeneity of firms' inputs choice.[23]

The second component needed to compute markups is the expenditure share, which is observed at the firm level. To estimate this element for products within a firm, we follow Garcia-Marin and Voigtländer (2019) and proxy for product-specific input use, assuming that inputs are used approximately in proportion to overall variable cost shares. For this, we take advantage of the fact that ENIA provides information on total variable costs (labor cost and materials) for each product produced by the firms. Finally, we compute the expenditure share by dividing the value of material inputs by product-specific revenues, which are observed in the data.

While the simplicity of the production-based approach to recover markups is compelling, it is subject to some concerns raised by recent studies (Bond et al., 2021; Doraszelski and Jaumandreu, 2019; Syverson, 2019). When the production function is estimated with revenue

[21]We consider the widely used Cobb-Douglas production function for our analysis to keep comparability with the U.S. based results, where we use the production function estimates from De Loecker et al. (2020).

[22]The main limitation of this approach is that it restricts economies of scope on the production side, but as we discuss in the robustness checks section, our main results also hold when using average product margins (directly observed in our data) or when computing markups at the firm-level, which are not subject to this criticism.

[23]In addition, we implement the correction suggested by De Loecker (2013), to allow past exporting and investment decisions to affect firms' productivity, and include the probability of remaining single-product to correct for the bias that results from firm switching non-randomly from single to multi-product production (see De Loecker et al., 2016, for details).

data, the estimated coefficients are subject to the so-called price bias (De Loecker and Goldberg, 2014). As explained above, our data allow us to directly tackle this issue by using output and inputs in physical units when estimating the production function. Bond et al. (2021) raise additional concerns related to the identification of the output elasticity under different scenarios. We note that, while the level of log markups will be biased under these concerns, their variation across time and firms within product categories should be unaffected in our Cobb-Douglas specification.

4 Data

The main analysis uses information for the universe of Chilean manufacturing exporters over the period 2003-2007. In addition, we confirm our results with company-level Compustat data from the United States. A key advantage of the Chilean data is that it provides detailed information on physical inputs and outputs, allowing better identification of the main mechanism. This section reviews the main features of the Chilean data and describes the sample. We postpone the description of the U.S. Compustat dataset to section 6.

4.1 Details on the Chilean Data

The Chilean data combines information from two primary data sources. The first dataset is collected by the Chilean National Customs Service and provides information for the universe of Chilean exports. The data is available for the 90 main destinations of Chilean exports, accounting for over 99.7% of the value of overall national exports in our sample period. The dataset details the exporter's identity, the importing country, the 8-digit HS code, FOB value and volume of the merchandise, the payment due date, and the export transaction's financing mode. This last feature is key for our purpose, as it allows us to identify if each transaction was paid in advance (cash in advance – CIA), post-shipment (trade credit – TC), or with other modes (such as letters of credit or two-part contracts).

We complement the customs-level data with production-level data from the *Encuesta Nacional Industrial Anual* (Annual National Industrial Survey – ENIA). ENIA is collected by the Chilean National Statistical Agency (INE), and provides annual production information for the universe of Chilean manufacturing plants with 10 or more employees, according to the International Standard Industrial Classi cation (ISIC), revision 3. The ENIA survey data is generally considered of high quality and has been widely used in research.[24] It surveys approximately 4,900 manufacturing plants per year, out of which 20% are exporters. Approximately two third of the plants in ENIA are small (less than 50 workers); medium-sized (50-150 workers) and large (more than 150 workers) plants represent 20 and 12 percent, respectively. ENIA provides standard micro-level information (e.g., sales, inputs expenditures, employment, investment), and detailed information for each good produced (sales value, production cost, number of units produced and sold), and inputs purchased by the rm (value and volume for each input purchased by the plant). Output and input products are de ned according to the Central Product Classi cation (CPC) at the 8-digit level, identifying 1,190 products over 2003-2007.[25]

4.2 Sample Selection and Data Consistency

Our main analysis considers data for the sample of manufacturing exports for which the production data in ENIA is available. In the following, we explain the matching procedure between both datasets and the procedures we apply to ensure a consistent dataset. A detailed discussion of these issues is relegated to internet appendix D.

The matching procedure between the ENIA and customs datasets consists of two stages. First, we match rms using a common tax-identi er available in both datasets, allowing us to match all direct exporters in ENIA to customs. Next, we proceed to match products in ENIA and customs. For this, we rst use the United Nations' correspondence tables between CPC and HS product classi cations, leading to a unique match for about 60% of the exported products in ENIA. In cases where we nd multiple matches, we check the potential matches and manually assign products with concordance within 4-digit HS categories in both datasets. We drop rm-products where there is no clear connection between the product categories in both datasets and matches where the rms appear exporting non-manufacturing products. This procedure allows matching 86% of the exported rm-product observations in ENIA to customs.[26]

[24] Examples of studies using the ENIA dataset include Pavcnik (2002), Levinsohn and Petrin (2003), Ackerberg et al. (2015), Garcia-Marin and Voigtländer (2019), Gandhi et al. (2020), among others

[25] For example, CPC disaggregates the wine industry (ISIC 3132) into 4 di erent categories: \Sparkling wine", \Wine of fresh grapes", \Cider", and \Mosto".

[26] The imperfect match between ENIA and customs may be because rms in ENIA report that a product is

To ensure a consistent dataset, we follow several steps, including the deletion of observations that have missing, zero, or implausible variation in the values of any of the main variables. In the empirical analysis, we aggregate the transaction data at the annual frequency, the frequency at which we estimate markups. The final dataset consists of 88,546 firm-product-destinations-year observations. The resulting dataset represents 69.2% of the value of (non-copper) exports over the period 2003-2007.

4.3 Additional Data

To complement the manufacturing survey and customs data, we collect information for the importing countries' deposit and lending rate, as well as for domestic inflation from the International Monetary Fund's International Financial Statistics. We use this data to construct real (ex-post) interest rates as the difference between the nominal rates and the realized inflation in the respective year.

4.4 Descriptive Statistics

Table 2 reports descriptive statistics for the characteristics of the firms and the products they export over the period 2003-2007. The average firm in the sample has $22 million in total value of shipments ("exports"), employs approximately 275 workers, and export 7.5 different 8-digit HS products. Firms in the sample are larger than the average firm in the Chilean ENIA, which is expected because our sample only includes exporters.[27] Large firms (more than 150 employees) account for 44% of the firms, while small firms (less than 50 employees) only account for 23% of the firms in the sample.

The second panel in table 2 provides information disaggregated at the firm-product level. Firms export their products to an average of 3.4 different destinations. The average markup over marginal cost is 15.6%, which is slightly smaller than the average markup computed over all products in ENIA – that is, including also goods produced for the domestic market.[28]

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exported independently if the firms exported directly or through intermediaries. Only the former case has a match with the customs data, while the latter does not.

[27] A large literature documents that exporters are larger in terms of employment and sales, are more productive, and pay higher wages, among other characteristics. See for example Bernard and Jensen (1999) and Bernard and Wagner (1997).

[28] Table D.1 in the internet appendix provides summary statistics for markups in the full ENIA dataset,

Focusing on payment terms, the data shows a clear dominance of trade credit. Approximately 83% of the transactions are paid for this way (third panel in table 2). About 9 percent of the transactions are paid cash in advance, and another 6 percent use letters of credit. Other contracts { including two-part contracts where a fraction of the value is paid upfront and the rest once the good arrives at the destination { are relatively rare and account for less than 1.5% of all transactions. The average maturity of trade credit is 170 days, which is notably longer than what is typically documented for domestic transactions. This di erence is in large part due to the longer transport times in international trade, as the geographical distance from Chile is a strong predictor of trade credit maturity in our data (gure 4). We also report total trade credit days, which is the average days of trade credit granted independent of the payment form. Finally, the last panel in table 2 provides summary statistics on country-level variables that we use in the empirical analysis.

Table 2. Summary Statistics

	Mean	Std. Dev.	P25	P50	P75	Obs.
	(1)	(2)	(3)	(4)	(5)	(6)
Firm Characteristics						
Export Value (US$)	22,097.8	226,983.9	163.8	1,005.4	5,560.5	3,381
Employment	274.6	527.1	53	120	284	3,381
# Exported products (at the 8-digit HS level)	7.5	9.5	2	5	10	3,381
Firm-product Characteristics						
# Destinations by rm-product-year	3.4	5.1	1	1	4	25,444
Markups (in logs)	0.156	0.371	-0.119	0.111	0.383	25,444
Physical total factor productivity (in logs)	0.386	3.335	-2.567	1.305	2.991	25,444
Firm-product-destination Characteristics						
Trade-Credit Share	83.1	35.3	100	100	100	88,546
Cash-in-Advance Share	9.3	27.5	0	0	0	88,546
Letters-of-Credit Share	6.3	22.6	0	0	0	88,546
Trade Credit Maturity (days)	169.5	94.6	90	168	270	77,328
Total Trade Credit (days)	141.2	104.6	58.9	119.6	269	88,546
Country Characteristics						
Foreign borrowing rate	5.162	4.226	2.547	4.372	6.762	353
Chilean deposit rate	0.899	0.559	0.853	0.873	1.152	353

Notes: The table lists the summary statistics for the variables used in the paper's baseline analysis sample. It comprises customs-level data for the universe of Chilean manufacturing exporters that can be matched to the Chilean Annual Manufacturing Survey (ENIA), over the period 2003-2007.

aggregated at the 2-digit level. The average estimated markup is 1.3, while the median is 1.1.

Figure 4. Trade Credit Share and Distance

Notes: The gure shows a binscatter plot of trade credit maturity (in days) against distance to Chile (in logs). The gure controls for year xed e ects. The gure excludes Paraguay, Argentina, and Uruguay for whom geographic distance is a poor proxy for shipping time.

5 Results

Before turning to the econometric evidence, we illustrate our main results in gure 5. The gure shows four binscatter plots. Panel A shows charts for trade credit shares (extensive margin), while panel B shows charts for trade credit maturities (intensive margin). In all charts, the average value of the outcome variable in each bin is plotted against the average rm-product markup (in logarithm). For all variables, the plot is based on residuals after taking out country-year xed e ects. Charts on the left show data for countries with borrowing rates that are above the median rate across years and destinations, while charts on the right show data for countries where borrowing rates are below the median. As predicted by proposition 2, for high-interest-rate destinations, there is a clear positive relationship between the intensive and extensive margins of trade credit and markups. In contrast, for low-interest-rate destinations, the relationship is either weaker (right chart, Panel A) or at (right chart, Panel B).[29]

5.1 Main Results

We now turn to the main econometric analysis.

[29] Figure 6 replicates the extensive margin (panels A) of gure 5 for the share of transactions nanced through cash in advance and letters of credit contracts. These gures suggest that rms increase trade credit use with markups at the expense of cash in advance contracts. The use of letters of credit contracts, in contrast, appears unresponsive to markups.

Figure 5. Trade Credit Share, Markups and Interest Rates

A. Trade Credit Share (extensive margin)

High Interest Rate Destinations

Low Interest Rate Destinations

B. Trade Credit Maturity (in days, intensive margin)

High Interest Rate Destinations

Low Interest Rate Destinations

Notes: The gures show binscatter plots of the trade credit share (panel A) and trade credit maturity (panel B) against markups (in logs). Each panel splits the data for export destinations with borrowing rates above and below the median rate across destinations. Trade credit share and trade credit maturity are computed at the rm-product-destination level, and markups are computed at the rm-product level, following the methodology by De Loecker et al. (2016). All gures control for destination-year xed e ects.

Trade credit use increases in the markup Table 3 presents our baseline results on trade credit use and the level of markups. Columns 1 through 3 show results for the trade credit share, while columns 4 through 6 report results on trade credit maturities.

Columns 1 and 4 report OLS results. In line with propositions 2 and 3, and the evidence presented in gure 5, we nd a positive and highly signi cant coe cient for markups both for the extensive margin and the intensive margin. Columns 2 and 5 show the rst stage

Table 3. Trade Credit and Firm-Product Markup: Baseline Regressions

Dependent Variable:	Trade Credit Share			Trade Credit Maturity		
Speci cation:	OLS	FS	IV	OLS	FS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
ln(Markup)	2.208***	|	11.07***	5.347***	|	18.331**
	(0.491)		(2.971)	(1.940)		(7.276)
ln(TFPQ)	|	0.051***	|	|	0.055***	|
		(0.0038)			(0.0043)	
First Stage F-Statistic	|	183.5	|	|	154.7	|
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	88,546	88,546	88,546	77,328	77,328	77,328

Notes: All regressions are run at the rm-product-destination level (with products de ned at the HS8-level). Trade credit shares are computed as the ratio of the FOB value of trade credit transactions to the FOB value of all export transactions over a year. Trade credit maturity corresponds to the days from shipping to the agreed payment due date in the trade credit contract. Markups and TFPQ are computed at the rm-product level. Columns 1 and 4 report OLS estimates. The rst stage results of the IV regressions are reported in columns 2 and 5, together with the (cluster-robust) Kleibergen-Paap rKWald F-statistic. The corresponding Stock-Yogo value for 10% maximal IV bias is 16.4. IV results are reported in columns 3 and 6. Standard errors (in parentheses) are clustered at the rm-product level. Key: *** signi cant at 1%; ** 5%; * 10%.

regressions, where we instrument markups by TFPQ. The rst stages work well, with F-statistics substantially above the Stock-Yogo critical value of 16.4 for 10% maximal IV bias. Consistent with proposition 4, the coe cients on TFPQ are positive and highly signi cant, implying that rms charge higher markups in products they produce more e ciently. The magnitude of the rst-stage coe cient in column 2 implies that a ten percent increase in TFPQ is associated with an increase in markups of 0.5%. Columns 3 and 6 present the instrumental variable results. The estimated coe cients are positive and highly signi cant at the 1% level. The coe cients are also notably larger than the OLS coe cients in columns 1 and 4, indicating that results are biased towards zero without instrumenting for the endogenous markups.

E ects are economically meaningful. Based on the IV coe cients in columns 3 and 6, an increase of one standard deviation in the rm-product log markup (0.371 log points) increases the trade credit share by 4.1 percentage points and lengthens the average trade credit maturity by 6.8 days. Combining the two margins implies an increase in trade credit of 12.6 days, with each margin explaining about half of the e ect.[30]

[30] To compute the total e ect, rst note that the average total trade credit length across all transactions equals the product between the trade credit share and trade credit maturity. Then, the implied e ect of markups on

Markups effects increase in the borrowing rate abroad Next, we present results on the interactions between markups, trade credit, and interest rates, based on equation (16). Columns 1, 2, 5, and 6 of table 4 report OLS estimates and columns 3, 4, 7, and 8 report IV estimates. In all specifications, standard errors are clustered at the firm-destination level. All first stage regressions have F-statistics clearly above the 16.4 threshold (see table E.1 for the full first stage regressions).

Columns 1 and 5 estimate the baseline specification, including firm, product, and destination-year fixed effects. The coefficient on the interaction term between the markup and the buyer's borrowing rate, r_b, is positive and highly significant for trade credit shares. The coefficient also has the expected sign for trade credit maturities but is insignificant. Columns 2 and 6 add firm-product-year fixed effects with little effect on estimated coefficients.

IV coefficients for the interaction term presented in columns 3, 4, 7 and 8 are notably larger than the OLS estimates. Moreover, they are now highly significant both for trade credit shares and for trade credit maturities. As before, adding the more stringent firm-product-year fixed effects does not materially alter the estimates. However, these additional fixed effects tighten the identification of the interaction term between markups and destination country borrowing rate, as they address concerns about omitted variables that may directly link physical productivity to trade credit use at the firm-product level.

Estimated effects for the interaction terms are also economically relevant. Consider two firm-products at the 25th (markup of 0.89) and 75th percentile (markup of 1.47) of the markup distribution, respectively. Based on the coefficient in column 8, a one-standard-deviation higher borrowing rate (4.2 percentage points) in the destination country increases the share of trade credit by 3.1 percentage points and the average trade credit maturity by 10.7 days for a firm with a markup at the 75th percentile relative to a firm with a markup at the 25th percentile. This implies that total credit increases by 14.2 days more for a firm at the 75th percentile than for a firm at the 25th percentile, with the intensive margin accounting for 63 percent of this effect.

To summarize, both the baseline regressions and the interaction term regressions generate results fully in line with the model predictions in propositions 2 and 3. That is, trade credit

total trade credit equals the extensive margin effect (0.041) times the average trade credit maturity (169.5 days) plus the intensive margin effect (6.8 days) times the average trade credit share (0.832).

Table 4. Trade Credit and Firm-Product Markup: Heterogeneity

Dependent Variable:	Trade Credit Share				Trade Credit Maturity			
Speci cation:	OLS		IV		OLS		IV	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln(Markup)	0.654 (0.950)	—	4.068 (5.161)	—	3.949 (2.733)	—	0.1425 (11.825)	—
ln(Markup) r_b	0.282** (0.140)	.301** (0.148)	1.157** (0.588)	1.290** (0.590)	0.257 (0.301)	0.480 (0.403)	3.054** (1.537)	3.412** (1.675)
First Stage F-Statistic	—	—	172.5.0	49.5	—	—	145.3	44.7
Firm FE	Yes	No	Yes	No	Yes	No	Yes	No
Product FE	Yes	No	Yes	No	Yes	No	Yes	No
Destination-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-product-year FE	No	Yes	No	Yes	No	Yes	No	Yes
Observations	88,546	88,546	88,546	88,546	77,328	77,328	77,328	77,328

Notes: The table reports the coe cient estimates from equation (16). All regressions are run at the rm-product-destination level (with products de ned at the HS8-level). Trade credit share (columns 1 to 4) corresponds to the ratio of the FOB value of trade credit transactions to the FOB value of all export transactions over a year. Trade credit maturity (columns 5 to 8) corresponds to the days from shipping to the agreed payment due date in the trade credit contract. Markups are computed at the rm-product level (products are de ned at the 5-digit CPC level). Columns 1, 2, 5, and 6 report OLS, while columns 3, 4, 7, and 8 report IV results using TFPQ (and its interaction with the interest rate spread) as an instrument for markups (and its interaction with the interest rate spread). All IV regressions report the (cluster-robust) Kleibergen-Paap rK Wald F-statistic; the corresponding Stock-Yogo value for 10% maximal IV bias is 16.4. All regressions control for the logarithm of rm employment. Standard errors (in parentheses) are clustered at the rm-destination level. Key: *** signi cant at 1%; ** 5%; * 10%.

use both at the extensive and the intensive margin increases with markups. And this e ect of markups on trade credit increases with destination country borrowing rates.

5.2 Robustness Checks.

In this subsection, we discuss the most important robustness checks, with additional robustness checks reported in appendix E.

Average product margins. We begin by studying whether our results depend on the method used to estimate markups. Our baseline markup measure is derived following De Loecker et al. (2016). ENIA provides information for product-level price-cost margins, an alternative proxy for markups that does not depend on a particular methodology. In particular, ENIA reports the variable production cost per product, de ned as the sum of raw material and direct labor costs involved in the production of each product. Product margins can be derived by dividing prices (unit values) over this reported measure of average variable cost.[31] Columns 1-4 of table 5 estimate our IV regressions for the trade credit share and maturity, respectively, when using margins as a proxy for markups. The regressions deliver qualitatively similar results, with highly signi cant coe cient estimates.

Table 5. Robustness: Alternative Markup Proxies

Markup measure:	Average Price-Cost Margin				Firm-Level Markup			
Dep. Variable:	TC Share		TC Maturity		TC Share		TC Maturity	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln(Markup)	96.87*	—	227.4	—	17.02***	—	36.93***	—
	(53.56)		(165.2)		(4.683)		(11.38)	
log(Markup) r_b	—	2.309**	—	5.448**	—	1.242**	—	3.547**
		(.906)		(2.279)		(.606)		(1.716)
First Stage F-Statistic	4.7	23.4	3.0	21.3	201.7	50.7	165.1	44.2
Firm FE	Yes	No	Yes	No	Yes	No	Yes	No
Firm-Product-Year FE	No	Yes	No	Yes	No	Yes	No	Yes
Product FE	Yes	No	Yes	No	Yes	No	Yes	No
Destination-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	87,435	87,435	76,371	76,371	86,377	86,377	75,498	75,498

Notes: The table replicates the baseline speci cations in tables 3 and 4 when using the average price-cost margin (columns 1 to 4) and rm-level markups (columns 5 to 8). All regressions are run at the rm-product-destination level (with products de ned at the HS8-level). Trade credit shares (columns 1, 2, 5, and 6) are computed as the ratio of the FOB value of trade credit transactions to the FOB value of all export transactions over a year. Trade credit maturity (columns 3, 4, 7, and 8) corresponds to the days from shipping to the agreed payment due date in the trade credit contract. Standard errors (in parentheses) are clustered at the rm-product level. Key: *** signi cant at 1%; ** 5%; * 10%.

Firm-level markups. Our baseline markup measure uses reported average variable cost shares to allocate inputs to outputs. We do not need to assume this when computing markups at the rm level. Results in table 5 show similar point estimates when using the rm-level markups instead of rm-product-level markups.

Additional Fixed E ects. While our main analysis with interaction terms allows for a very rich set of xed e ects, we can also expand the set of xed e ects for the baseline estimation (table 3), as shown in table 6. In the table, all coe cients are highly signi cant except for that in column (6), which is, however, only marginally insigni cant and has a size that is broadly in

[31] Note that the average variable cost is self-reported by managers, making the application of rules of thumb likely. Nevertheless, as Figure E.1 in the appendix shows, there is a remarkable positive relationship between markups and reported margins, suggesting that our markup estimates yield sensible information about the pro tability of the products produced by the rm.

line with the previous estimates.[32]

To summarize, our baseline results are robust to using alternative markup measures, estimating markups at the firm level, and to the inclusion of more stringent fixed effects.

Table 6. Robustness: Varying the Set of Fixed Effects

Dependent Variable:	Trade Credit Share			Trade Credit Maturity		
	(1)	(2)	(3)	(4)	(5)	(6)
ln(Markup)	7.540***	6.656**	38.62**	23.12***	22.67**	41.70
	(2.678)	(3.203)	(15.41)	(7.292)	(9.941)	(30.02)
First Stage F-Statistic	136.7	65.65	49.54	116.1	54.77	40.86
Firm FE	Yes	Yes	No	Yes	Yes	No
Country-Year FE	Yes	No	Yes	Yes	No	Yes
Product-Country FE	Yes	No	Yes	Yes	No	Yes
Country-Product-Year FE	No	Yes	No	No	Yes	No
Firm-Year FE	No	No	Yes	No	No	Yes
Observations	88,546	88,546	88,546	77,328	77,328	77,328

Notes: The table replicates table 3 including different set of fixed effect variables. All regressions are run at the firm-product-destination level (with products defined at the HS8-level). Trade credit shares are computed as the ratio of the FOB value of trade credit transactions to the FOB value of all export transactions over a year. Trade credit maturity corresponds to the days from shipping to the agreed payment due date in the trade credit contract. Markups are computed at the firm-product level and use TFPQ as an instrument for markups. All regressions report the (cluster-robust) Kleibergen-Paap rKWald F-statistic; the corresponding Stock-Yogo value for 10% maximal IV bias is 16.4. Second stage results are reported in column 6. Standard errors (in parentheses) are clustered at the firm-product level. Key: *** significant at 1%; ** 5%; * 10%.

5.3 Trade Credit, Cash in Advance, and Letters of Credit

In our baseline model, we study the trade-off between trade credit and cash in advance. However, as discussed earlier, in international trade, there is a third payment form called letters of credit that is used quite frequently. In our data, it has a share of 6.3 percent compared to 83 percent for trade credit and 9.3 percent for cash-in-advance (see table 2). In this subsection, we provide evidence in support of our modeling assumption, showing empirically that markups affect the choice between trade credit and cash in advance, but not that between trade credit and letters of credit.

[32] Adding firm-year fixed effects weakens the exclusion restriction notably, as differences in access to finance, the quality of management or other factors that vary at the firm-year level and that may affect both markups and trade credit are now controlled for. When we include firm-year fixed effects, identification comes from variation in markups across products within the same firm. Thus, any violation of the exclusion restriction would need to operate at the firm-product-year level.

According to the model, buyer-seller pairs substitute cash in advance with trade credit as the markup increases, and this effect should be stronger in destinations with higher borrowing rates (proposition 2). In contrast, the choice between trade credit and letters of credit should be independent of the markup (proposition 6).

These predictions align with the binscatter plots in figure 6. Panel A show that the use of cash in advance declines in markups, with the effect being stronger for destinations with relatively high borrowing rates. The charts are almost the exact mirror image of panel A in figure 5, suggesting that firms with a higher markup increase their use of trade credit at the expense of cash in advance. Letters of credit, in contrast, appears relatively unresponsive to markups, both in high and low-interest rate destinations (panel B).

Figure 6. Markups, Cash in Advance, and Letters of Credit

A. Cash-in Advance Share and Markups

High Interest Rate Destinations   Low Interest Rate Destinations

B. Letters of Credit Share and Markups

High Interest Rate Destinations   Low Interest Rate Destinations

Notes: The figure shows binscatter plots of the cash in advance (panel A) and the letter of credit shares (panel B) against firm-product markups (in logs), computed as in De Loecker et al. (2016). In each panel, charts on the left show data for countries with borrowing rates that are above the median rate across years and destinations, while charts on the right show data for countries where borrowing rates are below the median, respectively. All figures control for destination-year fixed effects.

Table 7 con rms the results econometrically, focusing on the interaction-term speci cations from table 4. Column 1 repeats the baseline using trade credit share as the dependent variable for reference. Then, in columns 2 and 3, we change the dependent variables, using the share of FOB export value nanced through cash in advance or letters of credit. As predicted by the theory, the coe cients for the cash in advance share (column 2) closely mirror those for trade credit (column 1), suggesting that rms substitute cash in advance with trade credit in destinations with higher borrowing costs. In contrast, the letter of credit share appears unresponsive to the interaction terms between the markup and the borrowing rate.

Table 7. Trade Credit, Cash in Advance, Letters of Credit and Firm-Product Markup

Sample:	Full sample			TC vs. CIA	TC vs. LC
Dep. Variable:	TC share	CIA share	LC share	TC share	TC share
	(1)	(2)	(3)	(4)	(5)
log(markup) r_b	1.290**	-1.720***	0.207	1.609***	-0.378
	(0.590)	(0.494)	(0.301)	(0.481)	(0.415)
First stage F-Statistic	49.5	49.5	49.5	57.9	40.6
Firm-Product-year FE	X	X	X	X	X
Destination-year FE	X	X	X	X	X
Observations	88,546	88,546	88,546	79,425	76,057

Notes: This table replicates table 4 modifying the dependent variable (columns 1-3) and sample (columns 4-5). All regressions are run at the rm-product-destination level (with products de ned at the HS8-level). Trade credit (TC), cash in advance (CIA), and letters of credit (LC) shares correspond to the ratio of the FOB value of transactions nanced through each payment form to the FOB value of all export transactions over a year. Markups are computed at the rm-product level (products are de ned at the 5-digit CPC level). Columns 4-5 restrict the sample, dropping transactions nanced through letters of credit (column 4) and cash in advance (column 5). All regressions are estimated using the interaction between TFPQ and the foreign borrowing rate as an instrument for markups and its interaction with the foreign borrowing rate; the (cluster-robust) Kleibergen-Paap rK Wald F-statistic is reported for each of them (the corresponding Stock-Yogo value for 10% maximal IV bias is 16.4). Standard errors (in parentheses) are clustered at the rm-destination level. Key: *** signi cant at 1%; ** 5%; * 10%.

Finally, in columns 4 and 5, we study the source of variation driving the coe cient in column 1, dropping transactions nanced exclusively using letters of credit (column 4) or cash in advance (column 5). Results con rm the conclusions drawn from columns 2 and 3, suggesting that most of the variation that explains the nancing cost advantage of trade credit comes from rms substituting cash in advance and trade credit. When dropping the transactions nanced with letters of credit, we obtain a very similar coe cient to our baseline estimate in column 1. In contrast, when dropping cash in advance transactions, we obtain a non-signi cant coe cient for the interaction between markups and interest rates.

6 Evidence from the United States

In this section, we repeat the main empirical analysis using firm-level data from the United States for the period 1965-2016. For this analysis, we use information on all publicly traded companies included in Compustat. This dataset has been used extensively across different fields (more recently in De Loecker et al., 2020, who document the evolution of market power in the United States). Compustat samples relatively few U.S. companies each year. However, these companies tend to be large and account for a large share of private sector employment and sales.

In the Compustat data, we calculate trade credit use as the ratio of accounts receivables over sales. Account receivables are the total value of trade credit outstanding and therefore reflect both the extensive and the intensive margins of trade credit. As before, markups are estimated following the methodology in De Loecker et al. (2016). In the computation of markups, we consider the cost of goods sold (COGS) as the relevant flexible input.[33] We take the elasticity of COGS with respect to output directly from De Loecker et al. (2020), and calculate the share of COGS in sales from the data. As for the case of the Chilean data, we exclude companies with missing or zero NAICS code, sales, or COGS, and firm-years with trade credit share above 100 percent or with extreme values for markups (below the 2nd or above the 98th percentiles of the markups distribution).

One important limitation of Compustat relative to the Chilean export data is that it does not provide information for output in terms of physical units. This prevents us from estimating physical productivity and using the instrumental variable approach that we use in the main analysis.

We find very similar results in the U.S. data as in the Chilean data. As shown in figure 7, the U.S. data also exhibit a clear positive relationship between trade credit use and markups, that seems to be even stronger than the one we found for Chile. This is confirmed in columns 1 and 2 of table 8, that show a strong positive correlation between markups and trade credit, controlling for industry-year (at the 2-digit level) and firm fixed-effects. [34] In column 3, we present results

[33] COGS is a composite that includes all expenditure incurred by firms in the production of the goods. While its specific composition varies across sectors, it mostly reflects variation in intermediate inputs, labor cost, and energy.

[34] As the data varies at the firm-year level, we only control for firm and industry-year fixed effects, and cluster standard errors at the firm level.

on an interaction between the markup and the real (ex-post) effective Fed Funds Rate, our measure of borrowing costs in the U.S. data. Consistent with our theory and the evidence for Chile, the interaction term is positive and highly significant (again, with a similar magnitude as the OLS estimate for Chile). Altogether, the results for the United States suggest that our findings for Chile generalize to the case of large U.S. firms as measured in Compustat: Total trade credit use increases with markups, especially when borrowing is more expensive.

Figure 7. Trade Credit Increases with Markups: U.S. Evidence

Notes: The figure shows a binscatter diagram where the average trade credit share in each bin is plotted against markups. Markups are computed at the firm level as in De Loecker et al. (2020), using Compustat data for 1965-2016. Markups are in terms of natural logarithms. The figure controls for 2-digit industry-year fixed effects.

Table 8. Trade Credit Share and Markups in the United States

	(1)	(2)	(3)
log(markup)	.0457***	.0227***	.0166***
	(.0021)	(.0024)	(.0020)
log(markup) × Real Effective Fed Funds Rate	—	—	.373***
			(.0053)
Industry-year FE	X	X	X
Firm FE	—	X	X
Observations	138,680	136,789	129,125

Notes: The table estimates the main specifications using data for U.S. companies included in Compustat between 1965 and 2016. Trade credit share corresponds to the ratio of account receivables to sales. Markups are computed at the firm level using the cost of goods sold (COGS) as variable input, following De Loecker et al. (2020). All regressions control for the logarithm of firm employment. Standard errors (in parentheses) are clustered at the firm level. Key: *** significant at 1%; ** 5%; * 10%.

7 Concluding Remarks

Trade credit is the most important form of short-term nance for U.S. rms. This paper studies Chilean rm-product-destination level data and U.S. rm-level data, documenting that trade credit use and trade credit maturities increase in markups, e ects that increase with the buyers' borrowing costs. It proposes a model of trade credit choice with positive markups and interest rate spreads due to credit risk to rationalize these facts and the general dominance of trade credit for rm-to- rm transactions.

An important conceptional point of the model is that the choice that rms face is not between trade credit and bank nance, but rather whether the buyer or the seller borrows from a bank. If the seller borrows, the buyer gets trade credit. If the buyer borrows, the seller receives cash in advance, which Mateut (2014) pointedly referred to as \reverse trade credit." The key result of the theory is that when there are positive markups and diversion risk creates an interest rate spread, it is never optimal for the buyer to borrow and pre-pay the full invoice. Instead, the seller should either provide full trade credit to the buyer or the buyer should only pre-pay production costs, as this minimizes gross borrowing and hence total nancial intermediation costs. That is, trade credit has a nancing cost advantage because this payment form minimizes the total amount of bank loans that are exposed to diversion risk.

Our model implies that rms' payment choices a ect the aggregate level of borrowing, making the size of the nancial sector endogenous. This prediction is qualitatively consistent with recent developments in aggregate U.S. data that suggest rising markups (as estimated by De Loecker et al., 2020) and more use of trade credit over time. As higher markups make trade credit more attractive, rms may rely more on that nancing form and less on the formal nancial sector. Future work could shed more light on how heterogeneity in the adoption of trade credit may a ect the size and the development of the nancial sector. The last point may be particularly relevant in the context of developing and emerging economies where nancial frictions and diversion risks are larger and hence the potential savings from using trade credit more prominent.

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Internet Appendix

Trade Credit and Markups

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A Derivation of conditions for pooling

In the following, we derive two results. First, we show that banks always o er a pooling contract that is acceptable to both types of rms. Second, we show that for su ciently large shares of reliable rms, and , the only contracts that are used are those that are acceptable to both types of rms.

A.1 Pooling and separating cases for bank lending

When banks lend out funds, they have two choices. First, o er a rate that is only accepted by unreliable rms. Second, o er a rate that is accepted by both rms.

Lemma 1
The only equilibrium is where banks o er a contract that is accepted by both types.

Proof. There are three cases to consider. First, banks could o er a contract aimed at reliable rms only. However, unreliable rms would always accept this contract as well, as their expected payo is strictly higher as they may divert funds, making this contract infeasible. Second, there could be a pooling contract. In the pooling case, perfect competition in the banking sector drives the borrowing rate to $1+r_b(\tilde{}) = \frac{1+r_d}{\tilde{}}$. Finally, banks could o er a contract aimed at unreliable rms only. Then, perfect competition drives the borrowing rate to $1+r_b^{SB}(\ ) = \frac{1+r_d}{}$. As we assume that trade is pro table in the pooling case, that is $\frac{R}{C} = \ > \frac{1+r_b(\tilde{})}{\tilde{}} = \frac{1+r_d}{\tilde{}^2}$, there exists an interest rate $1+r_{\bar{b}} = 1+\ r_b(\tilde{}) + \ $ that is acceptable to both types of rms and generates strictly positive pro ts for banks. As $r_{\bar{b}} < r_b^{SB}(\ )$, both types of rms would prefer this contract, which eliminates the separating contract for bad types. Therefore, the only equilibrium contract is the pooling contract where $1+r_b = 1+\ r_b(\tilde{}) = \frac{1+r_d}{\tilde{}}$. ■

A.2 Pooling and separating for rm contract choice

This section derives conditions for the pooling case in the model with endogenous nancing costs and a two-sided commitment problem. Speci cally, it derives conditions under which it is optimal for unreliable rms to imitate reliable rms and for sellers to o er terms that both types of buyers accept. In particular, we need to derive conditions to exclude the following four cases:

1. The seller asks for a payment that is only accepted by unreliable buyers under trade credit.
2. The reliable seller chooses cash in advance, but the unreliable seller chooses trade credit.
3. The seller asks for a payment that is only accepted by unreliable buyers under cash in advance.
4. The reliable seller chooses trade credit, but the unreliable seller chooses cash in advance.

Trade Credit - pooling case   This is the baseline case discussed in the main text. The reliable seller maximizes:

$$
\begin{aligned}
E[\ {}^{TC;P}_{RS}] &= \sim\ P^{TC;P} \quad (1 + r_b(\sim))C; \\
\text{s.t. } E[\ {}^{TC;P}_{RB}] &= R \quad P^{TC;P} \quad 0;
\end{aligned}
$$

and chooses $P^{TC;P} = R$. This implies the following expected pro ts for reliable and unreliable sellers under pooling, respectively:

$$
\begin{aligned}
E[\ {}^{TC;P}_{RS}] &= \sim\ R \quad (1 + r_b(\sim))C \qquad \text{(A.1)} \\
E[\ {}^{TC;P}_{US}] &= \sim\ R \quad\quad (1 + r_b(\sim))C;
\end{aligned}
$$

where unreliable sellers have higher expected pro ts, as there is a chance that they can divert bank funds, so they only repay with probability .

Trade Credit, Separating Case 1   The seller asks for a payment that is only accepted by unreliable buyers under trade credit.

Then, the payment exceeds revenues, $P^{TC;S} > R$. Unreliable buyers still accept this contract, as they know that they can deviate with probability . Expected pro ts of an unreliable buyer under separation are:

$$
E[\ {}^{TC;S1}_{UB}] = R \quad P^{TC;S1}:
$$

In this case, the seller picks $P^{TC;S1} = \frac{R}{\ }$. Importantly, reliable buyers now reject the contract, so that the exporter only gets the initial contract accepted with probability 1 , the share of unreliable rms. Expected pro ts of a reliable and unreliable seller under a buyer-separating contract case 1 are hence:

$$
\begin{aligned}
E[\ {}^{TC;S1}_{RS}] &= (1 \quad)(R \quad (1 + r_b(\sim))C): \qquad \text{(A.2)} \\
E[\ {}^{TC;S1}_{US}] &= (1 \quad)(R \quad\quad (1 + r_b(\sim))C):
\end{aligned}
$$

Combining equations (A.1) and (A.2), and substituting in the pooling equilibrium borrowing rate, a reliable seller picks the pooling case as long as:

$$E[\ {}^{TC;P}_{RS}]\quad E[\ {}^{TC;S}_{RS}]\ ,\quad (\qquad (1 \qquad)(1 \qquad))\ R \qquad (1 + r_b(\sim))C:$$

Which can be rearranged to:

$$\frac{R}{C} \qquad \frac{(1 + r_b(\sim))}{(\qquad (1 \qquad)(1 \qquad))} \tag{A.3}$$

Note that for the unreliable seller the corresponding condition is always weaker and reads:

$$E[\ {}^{TC;P}_{US}]\quad E[\ {}^{TC;S}_{US}]\ ,\quad (\qquad (1 \qquad)(1 \qquad))\ R \qquad (1 + r_b(\sim))C:$$

That is, if a reliable seller prefers the pooling case, an unreliable seller will also prefer this contract.

Trade Credit, Separating Case 2 The reliable seller chooses cash in advance, but the unreliable seller chooses trade creditf a rm asks for a trade credit loan in this case, the bank knows it is matched with an unreliable rm, and it charges a rate to o set the risk of diversion, that is $1 + r_b^S(\ ) = \frac{1+r_d}{\ }$. Then, expected pro ts of an unreliable seller are:

$$^{TC;S2}_{US} = \sim\ R \quad (1 + r_d)C \tag{A.4}$$

In equilibrium, the bank can't make a loss, so net the seller can't steal anything, so they pay $1 + r_d = \ (1 + r_b^S(\ ))$ in expectation. To rule out case 2, we need to combine the following four pro t expressions. Pro ts of an unreliable seller under cash in advance:

$$^{CIA;P}_{US} \quad = \quad (1 + \ r_d)\ \ \frac{\sim R}{1 + r_b(\sim\ )} \qquad C$$

Pro ts of a reliable seller under cash in advance:

$$^{CIA;P}_{RS} \quad = \quad (1 + \ r_d)\ \ \frac{\sim R}{1 + r_b(\sim\ )} \qquad C$$

Pro ts of an unreliable seller under trade credit separating case 2:

$$^{TC;SC2}_{US} \quad = \quad \sim\ R \quad (1 + r_d)C$$

And pro ts of a reliable seller under trade credit with pooling:

$$^{TC;P}_{RS} \quad = \quad \sim\ R \quad (1 + r_b(\sim))C$$

A su cient condition for the separating case to be dominated is that:

$$^{CIA;P}_{US} \quad ^{TC;SC2}_{US} \quad ^{CIA;P}_{RS} \quad ^{TC;P}_{RS} :$$

If this condition holds, then the reliable seller choosing CIA implies the unreliable seller choosing CIA as well. Rearranging delivers:

$$^{CIA;P}_{US} \quad ^{CIA;P}_{RS} \quad ^{TC;SC2}_{US} \quad ^{TC;P}_{RS}$$

Plugging in from above and simplifying delivers:

$$\sim \quad \frac{1}{2}$$

We can rewrite to:

$$\frac{1}{2} \tag{A.5}$$

Cash in Advance, Separating Case 3 The seller asks for a payment that is only accepted by unreliable buyers under cash in advance. Then, the seller o ers $P^{CIA;S\,3} = \frac{\sim R}{(1+r_d)}$, which is only accepted by unreliable buyers. The seller expected pro ts is:

$$E[\ ^{CIA;S\,3}_{RS}] = (1 \quad)(1+r_d) \quad \frac{\sim R}{(1+r_d)} \quad C$$

The seller prefers the pooling equilibrium where she serves both reliable and unreliable buyers as long as:

$$R \sim (\sim \quad (1 \quad)) \quad C(1+r_d) \tag{A.6}$$

Note that a necessary condition to ensure a pooling equilibrium is that $\sim > (1 \quad)$. This can be rewritten to:

$$> \frac{1}{2}$$

Then, (A.6) can be rewritten as:

$$\frac{R}{C} \quad \frac{(1+r_d)}{\sim(\sim \quad (1 \quad))} \tag{A.7}$$

Cash in Advance, Separating Case 4 The reliable seller chooses trade credit, but the unreliable seller chooses cash in advance. Then, the buyer knows that she is dealing with an unreliable seller and the participation constraint becomes:

$$E[\ {}^{CIA;S\,4}_{RB}] = R \quad (1 + r_b(\tilde{\ }))P^{CIA;S\,4}:$$

The unreliable seller then picks the optimal payment $P^{CIA;S\,4} = \frac{}{1+r_b(\tilde{\ })}R$, delivering expected pro ts of:

$$E[\ {}^{CIA;S\,4}_{US}] = (1 + \ r_d) \quad \frac{R}{1 + r_b(\tilde{\ })} \quad C \quad :$$

A su cient condition for the pooling case to dominate is:

$$ {}^{TC;P}_{US} \quad {}^{CIA;SC\,4}_{US} \quad {}^{TC;P}_{RS} \quad {}^{CIA;P}_{RS}$$

Which can be rewritten to:

$$ {}^{TC;P}_{US} \quad {}^{TC;P}_{RS} \quad {}^{CIA;SC\,4}_{US} \quad {}^{CIA;P}_{RS}$$

Plugging in the pro ts and simplifying delivers:

$$\frac{R}{C} > \frac{(1 + r_b(\tilde{\ }))}{(1 \quad)} (1 \quad) \quad \frac{(1 \quad)}{\tilde{\ }}$$

Can cancel further to get:

$$\frac{R}{C} \quad \frac{(1 + r_b(\tilde{\ }))}{} \; 1 \quad \frac{1}{\tilde{\ }}$$

This condition holds if:

$$\tilde{\ } \quad 1 \tag{A.8}$$

Combining the conditions To summarize, pooling requires the following three conditions:

$$\frac{R}{C} \quad \frac{(1 + r_d)}{\tilde{\ }(\quad (1 \quad)(1 \quad))} \tag{A.9}$$

$$\frac{1}{2} \tag{A.10}$$

$$\frac{R}{C} \quad \frac{(1 + r_d)}{\tilde{\ }(\quad (1 \quad)(1 \quad))} \tag{A.11}$$

$$\tilde{\ } \quad 1: \tag{A.12}$$

Now, rewriting equation (A.9), focusing on the symmetric case:

$$\frac{}{\tilde{}(\tilde{} \quad (1 \quad))} \quad \tilde{X}$$

And taking the derivative with respect to delivers:

$$\frac{\tilde{}(\tilde{} \quad (1 \quad)) \quad ((1 \quad)(\tilde{} \quad (1 \quad)) + \tilde{}(2 \quad))}{(\tilde{}(\tilde{} \quad (1 \quad)))^2} < 0$$

This can be simpli ed to:

$$(1 \quad)[\ ^2(2 \quad) + \quad] < 0 \tag{A.13}$$

Thus, we now know that condition (A.9) gets weaker as increases. So there is always a level of for which the condition holds.

Finally, for ! 1, the above conditions converge to:

$$\frac{R}{C} > 1 + r_d \tag{A.14}$$

$$1 > 0 \tag{A.15}$$

$$\frac{R}{C} > 1 + r_d \tag{A.16}$$

We thus know, that there exists an ; > 0 for which all pooling conditions hold. Intuitively, as the fraction of unreliable rms converges to zero, it is always optimal to o er contracts that are also acceptable to reliable rms to maximize expected pro ts.

B Model Extensions

B.1 Trade Credit Maturity

Proof for proposition 3

Part (i) : At t=0, the FOC, given by equation (14), is strictly positive, as only the nancing cost channel is active:

$$\frac{@E[\ _S^{TC;I}]=C}{@t} j_{t=0} = (r_b \quad r_d) \quad \frac{}{(1 + r_b T)^2} \quad 1 \quad > 0:$$

At t =T, equation (14) simpli es to:

$$\frac{@E[\ _S^{TC;I}]=C}{@t} j_{t=T} = (r_b \quad r_d)(\tilde{} \quad 1) + \quad \tilde{}(T)^0:$$

This expression is negative if:

$$\phi(T)' < \frac{r_b - r_d}{}(\phi - 1)$$

Due to continuity, this implies that the first order condition is zero at least once between $t = 0$ and $t = T$. To ascertain that we have a unique solution that represents a maximum, we look at the second-order condition of the problem next. Taking derivatives of equation (14) with respect to t we find:

$$\begin{aligned}
\frac{\partial^2(\Pi^{TC;I}/C)}{\partial t^2} &= (r_b - r_d)\left[\frac{\phi(t)'}{(1 + r_b(T - t))^2} + \frac{2\phi(t) r_b}{(1 + r_b(T - t))^3}\right] \\
&+ \phi(t)'' \frac{(1 + r_d(T - t))}{(1 + r_b(T - t))} - \frac{\phi(t)' r_d}{(1 + r_b(T - t))} \\
&+ \phi(t)' r_b \frac{(1 + r_d(T - t))}{(1 + r_b(T - t))^2}
\end{aligned} \tag{B.1}$$

Gathering terms:

$$\frac{\partial^2(\Pi^{TC;I}/C)}{\partial t^2} = \frac{2(r_b - r_d)}{(1 + r_b(T - t))^2}\left[\phi(t)' + \frac{\phi(t) r_b}{(1 + r_b(T - t))}\right] + \underbrace{\phi(t)'' \frac{(1 + r_d(T - t))}{(1 + r_b(T - t))}}_{< 0 \text{ as } \phi(t)'' < 0}$$

A sufficient condition for $\frac{\partial^2(\Pi^{TC;I}/C)}{\partial t^2} < 0$ is that the term in the square brackets is negative:

$$\phi(t)' + \frac{\phi(t) r_b}{(1 + r_b(T - t))} < 0 \tag{B.2}$$

This can be rewritten to:

$$\frac{\phi(t)'}{\phi(t)} > \frac{r_b}{1 + r_b(T - t)}, \tag{B.3}$$

which is one of the conditions we required for the function $\phi(t)$. Intuitively, this condition requires that the diversion risk rises sufficiently quickly with maturity, t. When this condition holds, the SOC is always negative in the range $t \in [0, T]$ and there exists a unique interior solution for t that maximizes expected seller profits.

Part (ii): The cross-derivative of expected seller profits over C w.r.t. t and is given by:

$$\frac{\partial^2 \Pi^{TC;I}}{\partial t \partial}/C = (r_b - r_d)\left[\frac{\phi(t)}{(1 + r_b(T - t))^2}\right] + \frac{1}{1 + r_b(T - t)}[(1 + r_d(T - t))(\phi(t)')]$$

As long as the financing cost advantage effect weakly dominates the diversion effect, it is the case that:

$$\frac{1}{1+r_b(T \quad t)}[(1+r_d(T \quad t))(\tilde{\ }(t))^0] \qquad \frac{r_b \quad r_d}{} \quad \frac{\tilde{\ }(t)}{(1+r_b(T \quad t))^2} \quad 1 \quad :$$

Substitute this expression in to get:

$$\begin{aligned}\frac{@^2 \ ^{TC;I}}{@t@}=C &= (r_b \quad r_d) \quad \frac{\tilde{\ }(t)}{(1+r_b(T \quad t))^2} + \frac{1}{1+r_b(T \quad t)}[(1+r_d(T \quad t))(\tilde{\ }(t))^0] \\ & \quad (r_b \quad r_d) \quad \frac{\tilde{\ }(t)}{(1+r_b(T \quad t))^2} \qquad \frac{r_b \quad r_d}{} \quad \frac{\tilde{\ }(t)}{(1+r_b(T \quad t))^2} \quad 1 \\ &= \frac{r_b \quad r_d}{} > 0:\end{aligned}$$

That is, the e ect of the maturity on pro ts increases in the markup . In addition, this expression increases in the borrowing rate r_b, implying that the e ect of the markup on the optimal maturity increases in r_b.

B.2 Variable Markups

This subsection presents additional details and derivations for the variable markup extension presented in section 2.4.1. Let the linear demand take the form $Q(p) = 1 \quad p$. Pro ts can be represented by: $= pQ(p) \quad cQ(p) = (p \quad c)(1 \quad p)$. With: $^{TC} = 1$; $^{TC} = 1 + r_b$; $^{CIA} = \frac{1+r_d}{1+r_b}$; $^{CIA} = 1 + r_d$. Solving for the optimal price charged to nal consumers, we nd: $p = \frac{1}{2} + \frac{c}{2}$; $p^{TC} = \frac{1}{2} + \frac{(1+r_b)c}{2}$; $p^{CIA} = \frac{1}{2} + \frac{(1+r_b)c}{2}$. Then, calculate rm-to- rm markups, recalling that $P^{TC} = R$ and $P^{CIA} = \frac{R}{1+r_b}$ as $^{TC} = \frac{R}{Qc} = \frac{p}{c}$; $^{CIA} = \frac{1}{1+r_b}\frac{R}{Qc} = \frac{1}{1+r_b}\frac{p}{c}$.[1] Which delivers:

$$^{TC} = \frac{1}{2c} + \frac{1+r_b}{2}; \tag{B.4}$$

$$^{CIA} = \frac{1}{1+r_b} \quad \frac{1}{2c} + \frac{1+r_b}{2} \tag{B.5}$$

It is easy to see that markups decrease (increase) in the marginal cost (productivity). We can now derive pro ts as $= \quad \frac{1}{2} \quad \frac{c}{2} \quad ^2$; $^{TC} = \quad \frac{1}{2} \quad \frac{(1+r_b)c}{2} \quad ^2$; $^{CIA} = \frac{1+r_d}{1+r_b} \quad \frac{1}{2} \quad \frac{(1+r_b)c}{2} \quad ^2$. From this we can calculate the di erence in pro ts between trade credit and cash in advance

[1]Note that the markup of interest is the one charged to the buying rm (P/Qc) as opposed to the markup charged to the nal consumer $p=c$.

as:

$$= \left[\frac{1}{2} \left(\frac{(1+r_b)c}{2} \right)^2 \quad \frac{1+r_d}{1+r_b} \frac{1}{2} \left(\frac{(1+r_b)c}{2} \right)^2 \right]$$

$$= \left[{}^{TC}(c) \quad (1+r_b)^2 \quad (1+r_d)(1+r_b) \quad {}^{CIA}(c) \quad 1) ^2 \right] c^2 \tag{B.6}$$

Taking the derivative with respect to c delivers $\frac{\partial}{\partial c} = (1+r_b) \frac{1}{2} \frac{(1+r_b)c}{2} + (1+r_d) \frac{1}{2} \frac{(1+r_b)c}{2}$. It is easy to see that the derivative is negative as long as $r_b > r_d$ and r_b and r_b are not too different. To see this, redefine $\frac{1}{2} \frac{(1+r_b)c}{2} = \frac{1}{2} \frac{(1+r_b)c}{2} +$, with: $= \frac{c}{2}(r_b \quad r_b)$. Then the condition simplifies to:

$$\frac{\partial}{\partial c} = (r_b \quad r_d) \frac{1}{2} \frac{(1+r_b)c}{2} + (1+ r_d)$$

$$= (r_b \quad r_d) \quad {}^{TC}(c) \quad (1+r_b) \quad c + (1+ r_d) \tag{B.7}$$

So as long as $r_b > r_d$, ${}^{TC} > 1 + r_b$, and is not too large, this derivative will be negative. As shown above, is a function of the difference in borrowing rates abroad and at home and goes to zero in the case of symmetric borrowing costs.

B.3 Partial Pre-Payments

This section provides the details on the partial pre-payments extension and shows that the only partial payment that can be optimal is one that equals the production costs, C. There are two cases to consider.

Case 1 In the first case, the buyer pays at least the production cost C in advance ($P^{PP} \quad C$, where $\quad 1$ denotes the fraction of). Then, profits can be written as ${}^{PP}_S = (1+ r_d)(P^{PP} \quad C) + (1 \quad)P^{PP}$; ${}^{PP}_B = R \quad (1+r_b) P^{PP} \quad (1 \quad)P^{PP}$. Solving for the maximum payment that satisfies the participation constraint of the buyer implies $P^{PP} = \frac{R}{1+ r_b}$. Plugging P^{PP} back into seller profits gives ${}^{PP}_S = (1+ r_d) \quad \frac{R}{1+ r_b} \quad C + \frac{(1 \quad)R}{1+ r_b}$. Then, taking the derivative with respect to delivers:

$$\frac{\partial {}^{PP}_S}{\partial} = (r_b \quad r_d) \frac{R}{(1+ r_b)^2} \tag{B.8}$$

Equation (B.8) implies that profits fall in the pre-payment share if the foreign borrowing rate exceeds the deposit rate, $r_b > r_d$. Thus, if $r_b > r_d$, the optimal pre-payment is less or equal to production costs, C. If borrowing abroad is very cheap and $r_b < r_d$, equation (B.8) becomes positive and full pre-payment (cash in advance) is optimal.

Case 2 In the second case, the buyer pays less than C in advance ($P^{PP} < C$). The problem then reads $_S^{PP} = (1+ r_b)(P^{PP} \quad C) + (1 \quad)P^{PP}$; $\quad _B^{PP} = R \quad (1 + r_b) P^{PP} \quad (1 \quad)P^{PP}$. As the buyer pro ts do not change, the payment remains $P = \frac{R}{1+ r_b}$. Plugging into seller pro ts delivers $_S^{PP} = (1 + r_b) \left(\frac{R}{1+ r_b} \quad C \right) + \frac{(1 \quad)R}{1+ r_b}$. Taking the derivative with respect to delivers:

$$\frac{@ _S^{PP}}{@} = (r_b \quad r_b) \frac{R}{(1 + r_b)^2} \tag{B.9}$$

Equation (B.9) is driven by the di erence in borrowing rates, $r_b \quad r_b$. If the domestic borrowing rate exceeds the foreign borrowing rate, the optimal pre-payment is greater or equal to the production costs. If the foreign borrowing rate is higher than the domestic borrowing rate, the optimal pre-payment is zero.

The optimal pre-payment To summarize, there are three cases:

i) Suppose $r_b > r_b$. Then, $r_b > r_d$ because $r_b > r_d$. And equation (B.8) implies $P^{PP} \quad C$ and equation (B.9) implies $P^{PP} = 0 \;) \quad P^{PP} = 0$. The seller provides trade credit.

ii) Suppose $r_b > r_d$ and $r_b > r_b$. Then, equation (B.8) implies $P^{PP} \quad C$ and equation (B.9) implies $P^{PP} \quad C \;) \quad P^{PP} = C$. The seller asks for a pre-payment of C.

iii) Suppose $r_d > r_b$. Then, $r_b > r_b$ because $r_b > r_d$. And equation (B.8) implies that $= 1$ and equation (B.9) implies that $P^{PP} \quad C \;) \quad P^{PP} = 1$. The seller asks for cash in advance.

B.4 Nash Bargaining

This section provides details for the Nash-Bargaining extension. The bargaining model is solved in two steps. First, pro ts under the two payment options are derived. Then, rms pick the payment option that maximizes joint surplus. Let $(1 \quad)$ be the bargaining power of the seller (buyer).

Trade Credit With trade credit, the bargaining problem reads:

$$NP^{TC} = \quad {}_S^{TC} \quad {}_B^{TC\;1} = (\underbrace{P^{TC} \quad (1 + r_b)C}_{\text{Seller Pro t}})\;(\underbrace{R \quad P^{TC}}_{\text{Buyer Pro t}})^{1} \;:$$

Solving the problem delivers an optimal payment $P^{TC} = R + (1 \quad)(1 + r_b)C$ and a Nash Product with trade credit of:

$$NP^{TC} = \quad (1 \quad)^{1} \quad (R \quad (1 + r_b)C) : \tag{B.10}$$

Cash in Advance   With cash in advance, the bargaining problem reads:

$$NP^{CIA} = \quad {}^{CIA}_{S} \quad {}^{CIA}_{B}{}^{1} = \underbrace{(1 + r_d)(P^{CIA} \quad C)}_{\text{Seller Pro t}} \underbrace{(R \quad (1 + r_b)P^{CIA})}_{\text{Buyer Pro t}}{}^{1} \; :$$

Solving the problem delivers an optimal payment $P^{CIA} = \frac{R + (1 \quad)(1 + r_b)C}{1 + r_b}$ and Nash product under cash in advance:

$$NP^{CIA} = \quad (1 \quad)^{1} \quad (1 + r_d) \; (1 + r_b) \quad (R \quad (1 + r_b)C) \tag{B.11}$$

Combining equations (B.10) and (B.11), the two rms prefer trade credit if:

$$(\quad (1 + r_b))(1 + r_b) \quad (\quad (1 + r_b))(1 + r_d) \; > 0 \tag{B.12}$$

Proof for predictions from Proposition 1   Suppose the foreign borrowing rate is above the domestic deposit rate ($r_b > r_d$). and the seller charges a positive markup over e ective costs ($> 1 + r_b$). Then:

i) If the buyer and seller face equal borrowing costs ($r_b = r_b$), the seller always prefer trade credit.

ii) There is always a markup, , that is large enough to make the seller choose trade credit over cash in advance.

Proof. i) if $r_b = r_b$, then condition (B.12) simpli es to: ($\quad (1 + r_b))((1 + r_b) \quad (1 + r_d) \;) > 0$. Under the assumption stated in the proposition, trade credit is then always preferred over cash in advance, as long as > 0.
ii) let go to in nity. Then, condition (B.12) becomes: $(1 + r_b) \quad (1 + r_d) \; > 0$, which always holds, as long as > 0. ■

Proof for predictions from Proposition 2   Suppose $r_b > r_d$. Then:

i) The use of trade credit increases with the markup .

ii) This e ect increases with r_b and decreases with r_d.

Proof. i) Taking the derivative of condition (B.12) with respect to delivers: $\frac{@Equ(B.12)}{@} = (1 + r_b) \quad (1 + r_d)$. This derivative is positive if $r_b > r_d$ and > 0. ii) Taking the cross derivatives with respect to and $1 + r_b$ and $1 + r_d$, respectively, delivers: $\frac{@Equ(B.12)^2}{@ \; @(1 + r_b)} = \quad (1 + r_b) \quad {}^{1}$ and $\frac{@Equ(B.12)^2}{@ \; @(1 + r_d)} = \quad (1 + r_d) \quad {}^{1}$. These two cross-derivatives are positive and negative, respectively, as long as is larger than zero. ■

B.5 Letters of Credit

This section provides details for the extension with letters of credit that builds on the model with diversion risk in section 2.2.

Letter of Credit Letters of credit are a payment form that is used exclusively in international trade transactions. With a letter of credit, banks serve as intermediaries in the transaction to resolve diversion problems between buyers and sellers. Assume that a bank can incur monitoring costs to perfectly verify delivery of goods before paying out funds to the seller. For this service, the buyer pays a fee to the bank and commits to paying the seller.[2] Assume that this fee is proportional to the transaction size: $F^{LC} = f^{LC} P^{LC}$. The seller only receives payment from the bank after providing proof of shipment or delivery. Assuming that rms are still able to divert bank funds as before, pro ts are given by: $^{LC}_{S} = P^{LC} \quad (1 + r_b(\tilde{\ }))C$ and $^{LC}_{B} = R \quad P^{LC} \quad (1 + r_b(\tilde{\ }))(f^{LC} P^{LC})$. With a letter of credit, there is no risk and the seller receives P^{LC} with certainty and the buyer generates revenues R with certainty.[3] Solving for the optimal P^{LC} that makes the buyer indi erent delivers $P^{LC} = \frac{R}{1+f^{LC}(1+r_b(\tilde{\ }))}$ And plugging back into seller pro ts leads to:

$$^{LC}_{S} = \frac{R}{1 + f^{LC}(1 + r_b(\tilde{\ }))} \quad (1 + r_b(\tilde{\ }))C:$$

Optimal Payment Choice Comparing trade credit with a letter of credit delivers:

$$E[\ ^{TC}_{S}] \quad E[\ ^{LC}_{S}] = \ \tilde{\ } \quad \frac{1}{1 + f^{LC}(1 + r_b(\tilde{\ }))} \quad C > \ 0; \qquad \text{(B.13)}$$

As stated in proposition 6, the markup, , does not a ect the sign of this equation and therefore has no e ect on the choice between trade credit and a letter of credit.

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[2]This commitment can either re ect a long-term relationship with the bank or may require a deposit in the bank up to the value of the letter of credit. For tractability, we assume that it is su cient for the buyer to pay the letter of credit fee in advance.

[3]This is a simplifying assumption, as, in reality, letters of credit are not completely risk-free. Relaxing this assumption should not a ect any of our results. For a detailed analysis of letter of credit risk see Niepmann and Schmidt-Eisenlohr (2017b).

C Additional Details on Markups Estimation

To test the predictions of the theory, we compute markups at the seller-product level using the methodology proposed by De Loecker et al. (2016). The main advantage of this methodology is that it allows us to compute markups abstracting from market-level demand information. It only requires to assume that firms minimize cost for each product and that at least one input is fully flexible.

The starting point in De Loecker et al. (2016), is to consider the firm's cost minimization problem. After rearranging the first-order condition of the problem for any flexible input V, the markup of product p produced by firm i in year t (μ_{ipt}) can be computed as the ratio between the output elasticity of product p with respect to the flexible input V (θ^V_{ipt}) and expenditure share of the flexible input V (relative to the sales of product p; $s^V_{ipt} \equiv P^V_{ipt} V_{ipt} / P_{ipt} Q_{ipt}$):

$$\underbrace{\mu_{ipt}}_{\text{Markup}} \equiv \frac{P_{ipt}}{MC_{ipt}} = \frac{\theta^V_{ipt}}{s^V_{ipt}}; \tag{C.1}$$

where P (P^V) denotes the price of output Q (input V), and MC is marginal cost. While the numerator of equation (C.1) – the input-output elasticity of product p – needs to be estimated, the denominator is directly observable in our data. Next, we explain the procedure we follow for deriving each of these elements.

Input-output elasticity. To estimate the input-output elasticities, we specify production functions for each product p using labor (L), capital (K), and materials (M) as production inputs:

$$Q_{ipt} = \omega_{ipt} F(K_{ipt}; L_{ipt}; M_{ipt}) \tag{C.2}$$

where Q is physical output, and ω denotes productivity. There are two important assumptions on equation (C.2). First, the production function is product-specific, which implies that single and multi-product firms use the same technology to produce a given product. Second, as is standard in the estimation of production functions, we assume Hicks-Neutrality, so that ω is log-additive.

The estimation of (C.2) follows De Loecker et al. (2016) in using the subset of single-product firms to identify the coefficients of the production function. The reason for using only single-product firms is that, for this set of firms, there is no need of specifying how inputs are distributed across individual outputs. Different from De Loecker et al., we deflate inputs expenditure with firm-specific input price indexes to avoid that the so-called input price bias affect the estimated coefficients (see De Loecker and Goldberg, 2014[4]).

[4]In De Loecker et al. (2016), input prices are not available in their sample of Indian firms, so they implement

Our baseline specification assumes a Cobb-Douglas production function, and allows for the presence of a log-additive non-anticipated shock (ε). A shortcoming of the Cobb-Douglas specification is that it assumes that input-output elasticities are constant across firms and over time. On the other hand, the Cobb-Douglas specification is widely used, allowing for a more direct comparison of our results with other estimates in the literature. In the robustness checks section, we present results derived with a more flexible Translog production function, which allows for different types of complementarities among production inputs. Results are quantitatively similar, although coefficients are slightly less precisely estimated than with the Cobb-Douglas baseline. Taking logs to (C.2), we obtain (lower cases denote logarithm of the variables)

$$q_{ipt} = \beta_k^p k_{ipt} + \beta_l^p l_{ipt} + \beta_m^p m_{ipt} + \omega_{ipt} + \varepsilon_{ipt} \tag{C.3}$$

The estimation of (C.3) follows Ackerberg et al. (2015) (henceforth, ACF), who extend the methodology proposed by Olley and Pakes (1996) and Levinsohn and Petrin (2003) to control for the endogeneity of firms' inputs choice —which is based on the actual level of firms' productivity.[5] To identify the coefficients of the production function, we build moments based on the productivity innovation ξ. We specify the following process for the law of motion of productivity:

$$\omega_{ipt} = g(\omega_{ipt-1}, d^x_{ipt-1}, d^i_{ipt-1}, d^x_{ipt-1} \times d^i_{ipt-1}, \hat{s}_{ipt-1}) + \xi_{ipt} \tag{C.4}$$

where d^x is an export dummy, d^i is a categorical variable for periods with positive investment, and $\hat{s}$ is the probability that the firm remains single-product. The endogenous productivity process (C.4) follows the corrections suggested by De Loecker (2013), allowing firms' productivity path to be affected by past exporting and investment decisions. In addition, it follows De Loecker et al. (2016) in including the probability of remaining single-product to correct for the bias that results from firm switching non-randomly from single to multi-product.

The first step of the ACF procedure involves expressing productivity in terms of observables. To do so, we use inverse material demand $h_t(\cdot)$ as in Levinsohn and Petrin (2003) to proxy for unobserved productivity, and estimate expected output $\phi_t(k_{ipt}, l_{ipt}, m_{ipt}, x_{ipt})$ to remove the unanticipated shock component ε_{ipt} from (C.3).[6] Then, the ACF procedure exploits this representation to express productivity as a function of data and parameters: $\omega_{ipt}(\beta) = \hat{\phi}_t(\cdot) - \beta_k k_{ipt} - \beta_l l_{ipt} - \beta_m m_{ipt}$, and form the productivity innovation ξ_{ipt} from (C.4) as a function of

a correction to control for input price variation. We discuss below the construction of the input price index we use in our sample of Chilean firms.

[5]ACF show that the labor elasticity is in most cases unidentified by the two-stage method of Olley and Pakes (1996) and Levinsohn and Petrin (2003).

[6]The vector x_{ipt} includes other variables affecting material demand, such as time and product dummies. We approximate $\phi_t(\cdot)$ with a full second-degree polynomial in capital, labor, and materials.

the parameters . The second step of ACF routine forms moment conditions on $_{ipt}$ to identify all parameters through GMM:

$$E(\ _{ipt}(\ )\ Z_{ipt}) = 0 \tag{C.5}$$

where Z_{ipt} contains lagged materials, labor, and capital, and current capital. Once the parameters are estimated, the input-output elasticities are recovered for each product as $^{V}_{ipt}$ $@\ln Q_{ipt} = @\ln V_{ipt}$. For the Cobb-Douglas case, $^{V}_{ipt} = \ ^{p}_{V}$, so that the input-output elasticity is constant for all plants producing a given product p.[7]

Implementation. To derive markups, we use materials as the relevant exible input to compute the output elasticity. While in principle, labor could also be used to compute markups, the existence of long-term contracts and ring costs make rms less likely to adjust labor after the occurrence of shocks. The second component needed in (C.1) to compute markups is the expenditure share, which requires to identify the assignment of rms' inputs across outputs produced by the rm. To implement this, we follow Garcia-Marin and Voigtländer (2019) and exploit a unique feature of our data: ENIA provides information on total variable costs (labor cost and materials) for each product produced by the rms. We use this information to proxy for product-speci c input use assuming that inputs are used approximately in proportion to the variable cost shares, so that the value of materials' expenditure $M_{ipt} = P^{V}_{ipt} V_{ipt}$ is computed as

$$\tilde{M}_{ipt} = \ _{ipt}\ \tilde{M}_{it}; \quad \text{where} \quad _{ipt} = \frac{TVC_{ipt}}{P_{j}\ TVC_{ijt}}: \tag{C.6}$$

Finally, we compute the expenditure share by dividing the value of material inputs by product-speci c revenues, which are observed in the data.

Input Price Index. To avoid input price bias in the estimation of the production function parameters (see De Loecker and Goldberg, 2014, for details), we de ate materials' expenditure using rm-speci c price indexes. The construction of the input price de ator involves ve steps. First, we de ne the unit value of input p purchased by rm i in period t as $P_{ipt} = V_{ipt} = Q_{ipt}$, where V_{ipt} denotes input p value, and Q_{ipt} denotes the corresponding quantity purchased. Next, we calculate the (weighted) average unit value of input p across all rms purchasing the input in year t. Then, for each rm, we compute the (log) price deviation from the (weighted) average for all the inputs purchased by the rm in year t. The next step involves averaging the resulting price deviations at the rm level, using inputs' expenditure as weight. Finally, we anchor the

[7] In the Translog case, the input elasticities $^{V}_{ipt}$ depend on the rms' input use. For multi-product rms, we derive inputs' use by each output following the same procedure we apply for computing the expenditure share of the inputs s^{V}_{ipt} explained next.

resulting average firm-level input price deviation to aggregate (4-digit) input price deflators provided by the Chilean statistical agency. Therefore, the resulting input price index reflects both, changes in the aggregate input price inflation, as well as firm-level heterogeneity in the price paid by firms for their inputs.

D Data Appendix

In this appendix we provide additional details on the construction of the dataset we use in the main empirical analysis. In the following, we briefly discuss the procedure we follow to combine the production data in ENIA with the customs-level data at the firm-product level. We also explain the data cleaning procedure we apply to avoid inconsistencies.

The main issue in combining data from Customs and ENIA at the firm-product level is that products are classified using different nomenclatures in both datasets: ENIA classifies products according to the Central Product Classification (CPC), while the Chilean Customs Administration classifies products according to the Harmonized System (HS). To deal with this issue, we follow several steps. First, we use the United Nations' correspondence tables to determine the list of HS products that could potentially be matched to each CPC product in ENIA.[8] We then merge the resulting dataset with customs data at the firm-HS-year level. This procedure results in two cases: (i) All exported HS products in customs within a firm-year pair are merged to ENIA, and (ii) Only a fraction (or none) of the exported products are matched to ENIA within a firm-year pair. For the latter cases, whenever there is concordance within 4-digit HS categories, we manually merge observations based on HS and CPC product descriptions. Borderline cases (no clear connection between product descriptions), as well as cases with no concordance at the 4-digit HS level are dropped.

In addition, to ensure a consistent dataset, we follow several steps. In particular, we exclude: (i) firm-year observations that have zero values for raw materials expenditure or employment, (ii) firm-product-year observations with zero or missing sales, product quantities, or with extreme values for markups (above the 98th or below the 2nd percentiles, or with large unplausible variations in markups within firm-products), and (iii) destination-year pairs with extreme values of the real borrowing rates, to avoid the influence of extreme values resulting from inflationary or deflationary episodes.[9] The final dataset consists of [ADJUST] 91,341 firm-product-destinations-year observations. The sample represents [ADJUST] 80.5% of the value of Chilean (non-copper) exports over the period 2003-2007. Table D.1 presents the estimated markups at the level of 2-digit industries.

[8] The correspondence table establishes matches between 5-digit CPC and 6-digit HS products. This level of disaggregation corresponds to 783 5-digit CPC products.

[9] In practice, this correction drops country-years with real borrowing rates above 35%, and below -4%.

Table D.1. Estimated Markups

Product	Mean	Median	St. Deviation
Food and Beverages	1.267	1.132	0.509
Textiles	1.543	1.432	0.562
Apparel	1.278	1.254	0.469
Wood and Furniture	1.127	1.009	0.435
Paper	1.157	1.042	0.462
Basic Chemicals	1.364	1.162	0.685
Plastic and Rubber	1.218	1.080	0.505
Non-Metallic Manufactures	1.657	1.541	0.785
Metallic Manufactures	1.166	0.995	0.505
Machinery and Equipment	1.131	0.989	0.480
Total	1.255	1.110	0.538

Notes: This table reports the average markup by aggregate sector for the sample Chilean exporters over the period 2003-2007.

E Additional Details on Robustness Checks

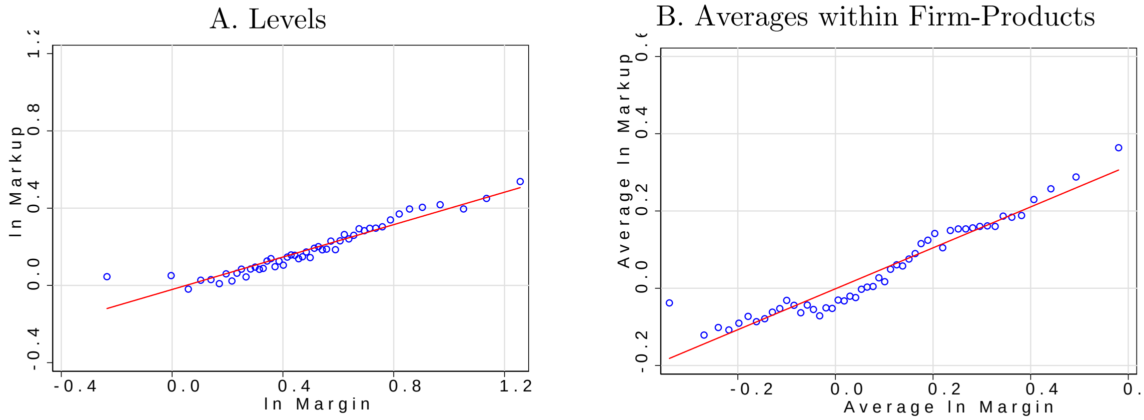
In this section, we provide details on the robustness checks mentioned in section 5.2:

Average product margin. An additional proxy for markups that we can compute in our sample is product-level price-cost margins. ENIA reports the variable production cost per product, de ned as the sum of raw material and direct labor costs involved in the production of each product. Product margins can be derived by dividing prices (unit values) over this reported measure of average variable cost. Note that the average variable cost is self-reported by managers, making the application of rules of thumb likely.

Figure E.1 shows binscatter plots for rm-product markups and sales-cost margins (with products de ned at the HS-8 level), for the raw data (left panel), and averaging across observations within rm-product pairs (right panel). Both gures control for country-year xed e ects (that is, the gure plots the within plant-product variation that we exploit empirically). There is a remarkable positive relationship between markups and reported margins, suggesting that our markup estimates yield sensible information about the pro tability of the products produced by the rm. This lends strong support to the markup-based methodology for backing out marginal costs by De Loecker et al. (2016). In addition, there seems to be a tighter relationship between markups and margins when both variables are averaged within rm-products.[10]

[10] One reason why both measures could be more correlated over longer periods of time is that the sales-cost margin measure relies on self-reported average variable cost. If managers measure product-level variable costs with error, then the sales-cost margin may be a poorer approximation of markups in the short run. However, if managers do not make systematic mistakes when reporting average variable costs, the measurement error cancels out when averaging over longer periods.

Figure E.1. Firm-Product level Markup and Sales-Cost Margin



Notes: The gure plots a binscatters diagram for rm-product markups and sales-cost margins.

First Stage Estimates Table 4. [REVISE TEXT] Table E.1 shows first stage estimates for the IV specifications in table 16 (columns 4-6), where we instrument firm-product markups (and its interaction with the deposit and borrowing rates) with firm-product physical productivity (TFPQ) (and its interaction with the deposit and borrowing rates). Across specifications, we obtain strong first stages, with stable coefficients for the first stage regression for the interaction between markups and borrowing rate, the only variable that is not absorbed by fixed effects in specifications 5 and 6 in table 4.

Accounting for the Domestic Deposit Rate. Table E.2 replicates table 4 when interacting the markup with the difference between the foreign borrowing rate and the domestic deposit rate. Estimated coefficients are very similar to the ones presented in table 4. In fact, in columns 2, 4, 6, and 8, the firm-product-year FEs eliminate any effect of rd and its interaction with the markup, and results are therefore identical for those columns.