Competition and Inter-Firm Credit: Theory and Evidence from Firm-level Data in Indonesia*

Giovanni Serio† Goldman Sachs International

Kyle Hyndman‡ Southern Methodist University

6 November 2006

Abstract

Using firm-level data we investigate the relationship between trade credit and suppliers' market structure and find a $\cap$-shaped relationship between competition and trade credit, with a discontinuous increase in credit provision between monopoly and duopoly. This "big jump" arises because monopolists are more likely to not offer *any* trade credit than firms in competitive environments. Our model exploits the fundamentally different nature between cash and trade credit sales, arguing that firms are unable to commit *ex ante* to a trade credit price. We show that monopolists will often sell only on cash, while credit is *always* provided in competitive environments.

JEL Classification: L1, O16

Keywords: Trade Credit, Competition, Development, Industrial Organization

1 Introduction

Trade credit is arguably one of the principal sources of credit for firms in both developing and developed countries (Petersen and Rajan, 1995; Rajan and Zingales, 1995). Trade

*We would like to thank Debraj Ray for his encouragement and advice. We have benefited from helpful comments from Luis Cabral, William Greene, Jonathan Morduch and Luca David Opromolla. All remaining errors are our own. A previous version of this paper circulated under the sole authorship of Giovanni Serio. Kyle Hyndman subsequently joined the project. The opinions presented in this paper reflect those of the authors and not necessarily those of Goldman Sachs.

†*Goldman Sachs International, Peterborough Court, 133 Fleet Street, London EC4A 2BB, United Kingdom. E-mail:* giovanni.serio@gs.com.

‡*Department of Economics, Southern Methodist University, 3300 Dyer Street, Suite 301R, Dallas, TX 75275. E-mail:* hyndman@smu.edu, *url:* http://faculty.smu.edu/hyndman/.

credit is the credit that is extended by suppliers of a good to buyers every time a delay of payment is granted. Typically suppliers can set distinct prices for up-front cash payments and for delayed payments. In countries with underdeveloped formal credit markets the significance of trade credit is particularly high: firms acting as financial intermediaries play a fundamental role as bank substitutes extending credit to other firms rationed in the formal credit sector (Demirgüç-Kunt and Maksimovic, 2002; Fisman and Love, 2003). Although a sizeable literature has paid attention to the determinants of trade credit, very few studies have addressed the particular question of how supplier competition affects inter-firm credit. This paper investigates the issue at both a theoretical and an empirical level.

In the empirical analysis we use a novel firm-level dataset from Indonesia, which combines two existing datasets, containing information on the trade credit policies of a sample of manufacturing firms. More importantly, however, we are able to recover the underlying competitive environment in which they operate. We uncover a left-skewed hump-shaped relationship between competition and trade credit provision. In monopolistic environments very little trade credit is provided; however, there is a dramatic increase in trade credit provision for duopolies, followed by a more gradual increase in trade credit provision before finally decreasing as the environment becomes more and more competitive. The most striking finding, and the part we will dwell on, is what we call the big jump in trade credit provision between monopoly and duopoly: monopolists are more likely to provide *no* trade credit at all to their clients than firms in more competitive environments.

While the traditional stories on loan enforcement can explain the decreasing portion of the relationship between competition and trade credit, the increasing segment — particularly the big jump — requires a different argument. In our theoretical discussion we show that monopolists sometimes prefer to give up their role as financial intermediaries by simply closing the trade credit window, while a duopolist never would. We construct a model in which suppliers initially post a cash price for up-front payments but are not able to commit *ex* *ante* to the terms of trade credit. Reminiscent of Coase's (1972) durable goods monopolist,[1] this lack of commitment can serve as a major handicap in setting cash prices. In particular, after a cash price is posted and the monopolist observes cash purchases, she may be tempted to loosen the terms of trade credit to attract those customers that could not afford to pay cash. Anticipating this, those that can afford to pay cash choose instead to wait and divert resources away from the monopolist's core business (cash sales). To avoid this outcome, the monopolist has two options: either distort the cash price or commit to only accepting cash payments. We show that often the firm is better off selling entirely on cash.

The conditions on the parameters that affect the shutdown zone are related to the parameters of the model in an interesting way: if formal banks can adequately screen clients then the shutdown zone widens and the monopolist is more likely to offer no trade credit. More striking, however, the same result is true *even* if the monopolist is relatively efficient at providing trade credit: we show that the monopolist's ability to efficiently provide trade credit causes a greater distortion of her cash market and smaller revenues from that source, leading to a greater probability of shutdown.

With competition, we show that commitment problems become irrelevant: Bertrand competition in the cash market pushes the cash price to marginal cost, leaving trade credit as the only source of profit for the supplier. This result follows from the fundamentally different nature between cash and trade credit. A buyer willing to pay cash for a homogenous product views suppliers as completely interchangeable and will choose the supplier with the lowest price. Moreover, since the buyer is paying cash, the supplier is willing to accept without knowledge of the buyer's characteristics. However, trade credit requires a closer relationship between buyer and seller. Therefore, the presence of supplier-client specific costs of credit provision prevent competition from driving trade credit margins to zero.

More generally, the model explains why trade credit may continue to grow with the number of competitors. This is driven by a more traditional competition effect: the entrance

[1] See also Stokey (1979, 1981), Bulow (1982) and Gul, Sonnenschein and Wilson (1986) for various formalisations of Coase's idea.

of a new competitor has no impact on the cash price, which is already at marginal cost, while it leads to a decrease in the equilibrium trade credit price. In the overall market, therefore, the number of cash buyers does not increase, *but* more buyers have access to trade credit. Therefore, there is an increase in the proportion of goods sold on credit, and so, keeping loan enforcement problems out of the model, we predict an increasing relationship between competition and trade credit. However, when the number of competitors increases loan enforcement constraints become increasingly serious. The possibility of deterring defaults by threatening to cut buyers out of future credit is less effective the higher is the number of alternative suppliers. Also the formation of *social norms* which prescribe that defaulters be boycotted by the entire market is less likely if the number of competitors gets higher. The estimation suggests that the enforcement constraints start biting with more than four or five competitors causing firms to reduce their trade credit thereafter.

The rest of the paper is organized as follows: Section 2 examines the related literature, Section 3 previews the empirical results as motivation for the theoretical model contained in Section 4. Section 5 describes the dataset, while Section 6 lays out the empirical approach. In Sections 7 and 8 we provide the main results and some robustness checks. Appendix A contains all proofs, while Appendix B contains relevant tables.

2 Related Literature

Three strands of related literature are relevant to our study: the literature on competition and formal credit provision, various studies of trade credit and the literature on durable goods in industrial organization, which was briefly discussed above.

The literature on bank credit provides conflicting conclusions about the relationship between creditors' market structure, access to credit and credit costs, with some studies conjecturing a negative correlation between competition and credit provision. Two sets of explanations are often proposed: those based on theories of the client-creditor relationship and those based on the loan enforcement argument. The literature on information asymmetries and agency problems has argued that competition is likely to reduce incentives to establish long-term relationships with the client which results in decreasing credit flows (Petersen and Rajan, 1995; Marquez, 2002). In competitive environments, creditors cannot expect to share the future surplus clients may generate. Similarly, studies on loan enforcement predict a negative relationship between competition and credit provisions pointing to the monopolist's ability to enforce payment by threatening to cut off future credit (Ghosh, Mookherjee and Ray, 2000). Conversely standard economic theory predicts a positive effect of competition on credit arguing that any deviation from perfect competition results in smaller loans to borrowers at a higher cost (see Guzman, 2000 and Heffernan, 1996).

There are many studies that have investigated both theoretically and empirically the determinants of trade credit, among others Cuñat (2006), Burkart and Ellingsen (2004), Mian and Smith (1992), Biais and Gollier (1997) and Petersen and Rajan (1997). The interest for trade credit in developing countries has grown in recent years (World Bank 2004), given its important role as bank credit substitute and thanks to increasingly reliable firm-level datasets (Fafchamps, 2000). Nevertheless very few studies address the issue of competition and interfirm credit provision. Two that have are McMillan and Woodruff (1999) and Fisman and Raturi (2004). Using firm level datasets in Vietnam and Sub-Saharan Africa respectively they derive opposite results regarding how market power affects suppliers' credit conditions. The former authors use a survey collected in Hanoi and Ho Chi Minh City and find a negative correlation between the number of competitors operating within one kilometer of the firm and trade credit provided. The latter authors use a dataset from buyers to show that clients of monopolists have a significantly lower probability of receiving credit than firms that deal with more competitive suppliers. Our results are consistent with both the papers and, in our opinion, provide a possible reconciliation of the two.

If we use a linear specification for the effect of competition on trade credit, we also find a significant negative correlation. However, we show that a non-linear specification fits better the data. Our analysis suggests that McMillan and Woodruff's estimates may differ because of the limited cross-section geographical variation of their data. Their survey covers only two urban and intensively industrialized districts with presumably highly competitive markets. Our survey, instead, covers all the major districts in Indonesia. Fisman and Raturi's dataset exploits remarkable cross-sectional variation with as many as five Sub-Saharan countries surveyed. Their results are in contrast with McMillan and Woodruff's but consistent with our finding of lower trade credit offered by monopolists. Our analysis, however, offers an important new insight on this issue. Using supplier data we can observe that the low probability of obtaining credit for monopolist's clients, found by Fisman and Raturi (2004), is due to the high number of monopolists that simply provide no credit to their clients. This requires, in our opinion, a radically new explanation from what has been so far conjectured by this literature. Our theoretical model sets out to reach this goal.

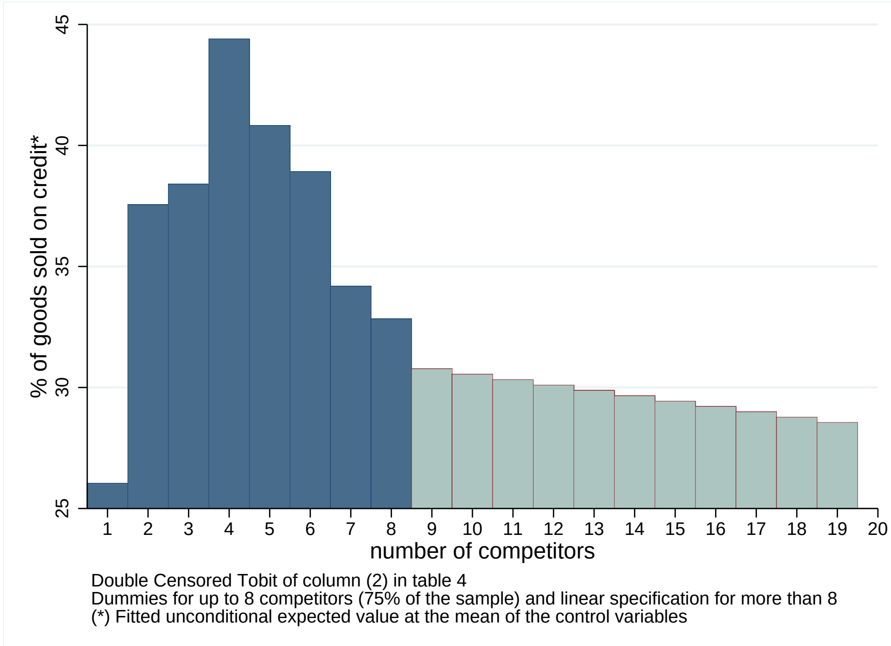
3 Summary of the Empirical Results

A thorough description of the dataset and details of the estimation and identification strategy are presented in Sections 5 and 6. Here we provide some evidence on the relationship between competition and the amount of trade credit provided by suppliers.

Figure 1 depicts the estimated proportion of goods sold on credit as a function of the number of competitors operating in a given area. At least three features of the estimation are striking. First, notice the sharp increase in trade credit provided to clients going from monopoly to duopoly. The average proportion of goods sold on credit when two firms compete is 42% higher than the same proportion when only one firm is active. Second, the trade credit granted increases gradually when a small number of firms compete reaching a peak at four competitors. Finally, the percentage of goods sold on credit decreases steadily when more than four competitors are active.

A closer investigation of the jump from monopoly to duopoly shows that, conditional on

FIGURE 1: The effect of competition on trade credit



providing some positive trade credit, monopolists do not extend less credit than duopolists. Instead, what explains the jump is the fact that *suppliers with no competitors are more likely to provide no trade credit to their clients*. We think that this finding is not adequately explained by the traditional argument provided by the literature that predicts a positive relationship between competition and credit provision. Instead of observing monopolists that provide a lower amount of credit at a higher price, we find that monopolists are more likely to offer no credit and sell all their products for cash only. This is despite the fact that their enforcement power is much stronger than firms operating in more competitive settings.

In contrast, the negative part of the relationship is consistent with those of McMillan and Woodruff (1999), as well as the predictions of the loan enforcement in developing countries literature which argues that in economies with weak creditor protection, default is deterred mainly by the threat withholding future access to credit. This threat is particularly strong if the creditor is a monopolist in a given market. Also with a small number of creditors social norms can give rise to positive levels of borrowing and lending (Ghosh, Mookherjee and Ray, 2000). As the number of lenders increases, however, the threat of reducing or cutting access to future credit is less effective since borrowers can more easily find alternative sources of financing and social norms are less likely to arise — hence the higher presence of credit rationing in more competitive credit markets. This literature provides a convincing interpretation of the negative relationship between competition and trade credit provision that arises in our data with more then four competitors.

4 The Model

In this section we explain the model and derive the main results. The model intentionally ignores enforcement constraints. We first provide conditions under which a monopolist would choose a cash-only policy. We then extend the analysis to the case of more than one supplier, showing that it is never optimal to adopt such a policy; this leads to a large increase in the proportion of goods sold on credit from monopoly to duopoly.

4.1 Monopoly

There is a single supplier of an intermediate good who produces the good at no cost. There is also a continuum of buyers with unit mass; each buyer i demands one unit of the intermediate good, transforms it into a final product at no cost and sells it at price P_i. Each buyer knows his/her selling price, while the supplier only knows that selling prices are drawn from some distribution $F(P)$. The supplier can either sell the intermediate good for cash or on credit. If the supplier provides the intermediate good on credit she will incur a monitoring cost $m > 0$. This monitoring cost can be thought of as the cost to ensure that the delayed payment is eventually made.

We assume that to finance a cash payment to the supplier, a buyer must apply for a bank loan, which she obtains with exogenous probability π. The supplier cannot distinguish buyers that actually applied for bank loans from those who did not, and must set the trade credit price based on her beliefs about the distribution of buyers who ask for trade credit.

The timing is as follows:

Stage 1: The supplier sets a cash price c;

Stage 2: The buyers decide whether to apply for a bank loan in order to pay cash or to wait and ask for trade credit;

Stage 3: Bank loan applications are accepted with probability π or rejected with probability $(1-\pi)$ by the bank. Cash payments are made. The remaining buyers are available to receive trade credit;

Stage 4: The supplier sets the trade credit price t;

Stage 5: Buyers decide whether or not to buy at this price;

Stage 6: Payoffs are realized.

The assumption that the trade credit price is set by the supplier only after buyers react to the cash price is critical to the model. In reality, it is more likely that a buyer sees both a cash and a trade credit price and then decides whether to pay cash or buy on credit. However, even in this situation it is likely that the final price for trade credit is not determined until final payment is actually made. For example, in the 1998 Survey of Small Business Finances, approximately 46% of buyers pay only after the agreed upon deadline. Moreover, many of these same firms indicate that there are no penalties for late payment. Therefore, this additional delay in payment can be thought of as a lower effective price than was initially agreed upon.[2] Indeed, the results of the World Bank's Investment Climate Core survey indicate that this is a general phenomenon: Entrepreneurs report that almost half of the clients who receive trade credit settle their payment after the initial deadline. In the 2003 survey, among Indonesian firms that reported overdue payments, it takes, on average, 5.3 weeks to resolve an overdue payment dispute with a standard deviation of 5.8 weeks.[3] To reiterate, by granting any delay in payment, a supplier opens the door to further

[2] See Cuñat (2006) for a reason why it may be optimal for a supplier to allow further delays in payment.
[3] These disputes are almost never resolved by courts.

(non-negotiated) delays, effectively lowering the price she obtains. The model we present should be viewed as a convenient shorthand for a more general model in which buyers have some ability to stretch the repayment timetable.

We do, however, introduce one commitment device for the supplier. In particular, we allow her to close the trade credit window and commit to a cash-only policy. Formally, this amounts to the addition of an initial stage to the game: Stage 0, the supplier chooses whether or not to shut down the trade credit window.

We are now ready to demonstrate the main result of this section:

PROPOSITION 1. *For any given monitoring cost, m, there exists a threshold probability of obtaining bank credit, $\hat{\pi}(m)$, such that for $\pi > \hat{\pi}(m)$, the supplier will optimally decide not to offer credit and pre-commit to a "cash-only" policy. Furthermore, the threshold value is increasing in the monitoring cost.*

A formal proof is provided in the appendix. Here we provide an example that illustrates the main intuition of the result and then we describe the key steps that lead to it. Consider first the case in which the supplier has full commitment power. It is easy to see that the supplier would never set the trade credit price, t, less than the cash price, c. If she did, all buyers would opt for trade credit, which is strictly less profitable for the supplier given the monitoring cost $m > 0$. Instead, by choosing $t > c$, all buyers with a selling price $P \geq c$ (henceforth "high price" types) will apply for bank credit. Among those rejected by the bank, those buyers with $P \geq t$ will ask for trade credit, while those buyers with $P < c$ (henceforth "low price" types) are left out of the market. In this full commitment scenario, the supplier is effectively able to separate the maximization problems for the cash and trade credit prices. Indeed, one can easily see that the optimal cash price, c^*, depends only on the distribution of buyer types, while the optimal trade credit price, t^*, depends on the distribution of buyer types and on the monitoring cost. Under standard regularity conditions on the profit function, both of these values are unique. Importantly, the probability of obtaining bank credit plays no role in the maximization problem of the supplier, and trade credit is only extended to those buyers rationed in the formal credit sector.

Suppose now that the supplier loses the ability to commit to a trade credit price. If $m > c^*$ it is obvious that $t > c^*$, since otherwise the monopolist would not even cover the monitoring cost. Thus she effectively has full commitment. Similarly, even if the monitoring cost were low, we could still have results identical to the full commitment case if the probability of obtaining bank credit were sufficiently low. In this case the distribution of buyers that apply for trade credit would have a large proportion of high price buyers rejected by the bank. The supplier would still find it optimal to set a trade credit price above the cash price and the full commitment scenario would be replicated.

The interesting range is then when m is low and π is relatively high. Indeed, consider the case in which $\pi \approx 1$. If all high price buyers applied to the bank very few of them would be rejected. Consequently, the distribution of buyers who apply for trade credit would be almost completely made of low price buyers. At this point, the monopolist would find it optimal to set a trade credit price below the cash price, thus selling the product to those buyers who could not afford to pay cash in the first place. Anticipating this lower trade credit price, buyers would bypass the bank and demand trade credit. However, this breaks the full commitment equilibrium.

Proposition 1, demonstrates that if the probability π is *high enough* and the monitoring cost in *low enough*, the supplier is better off denying credit to her clients and committing to a cash only policy. This, however, does not mean that when the full commitment equilibrium breaks the supplier immediately commits to a cash-only policy. Instead, she will first try to distort the cash price to convince some buyers to apply for a bank loan and pay cash. Only when the cash price distortion becomes too costly will she commit to no credit.

We now highlight the key aspects of the game at each stage and proceed via backward induction to derive the supplier's optimal strategy for various parameter values.

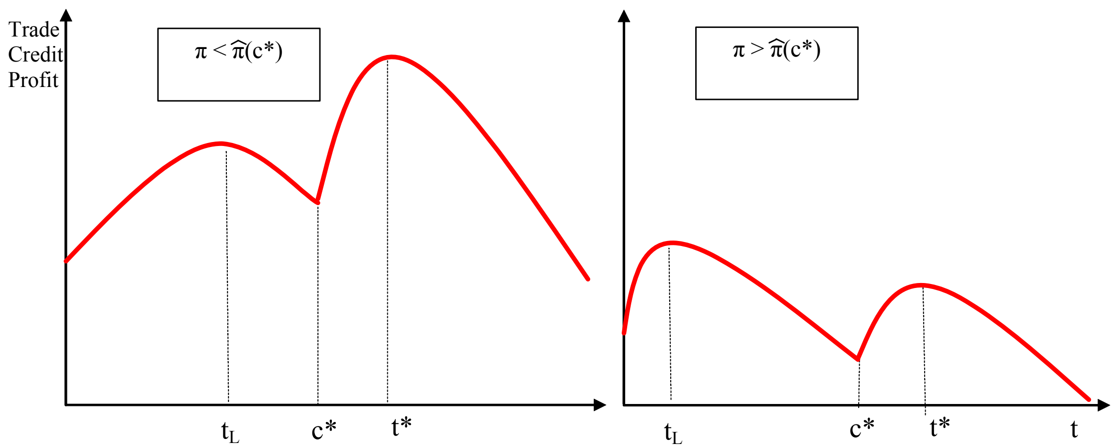
Stage 4: Determination of t. Since the supplier does not observe which buyers actually applied for a bank loan and which did not, her decision on t depends upon her beliefs about who applied for credit. We first examine the case in which the supplier believes that all high price buyers (*i.e.,* buyers for which $P > c$) applied for bank loan and low price buyers did not and show that there exists a threshold probability of obtaining bank credit $\hat{\pi}(m, c)$ such that for any π larger than $\hat{\pi}(c, m)$ the supplier will optimally set trade credit price below the cash price.

Observation 1. *Assume that the supplier's belief is that all high price types applied to the bank while low price types did not. Then there exists a threshold value $\hat{\pi}(c, m)$, such that for $\pi > \hat{\pi}(c, m)$, $t < c$, while for $\pi < \hat{\pi}(c, m)$, $t > c$. Furthermore, $\hat{\pi}(c, m)$ is strictly decreasing in c and strictly increasing m.*

The proof of this observation is in the appendix; however, the intuition can be seen in Figure 2 where we show the supplier's trade credit profit function for the case in which the cash price was set at the "full commitment" level c^* and all the high price buyers apply to the bank. Notice that for given values of π, the profit function has a double-hump shape. On the left side, we show a situation in which the probability of obtaining bank credit $\pi < \hat{\pi}(c, m)$. In this case, observe that the trade credit price would be set at the full commitment level t^*. On the right side, we show a case in which $\pi > \hat{\pi}(c, m)$ and the supplier will optimally set the trade credit price at t_L — below the cash price — and the full commitment equilibrium cannot be attained. Finally, note that, in the restricted domain $t > c$, profits are always maximised at $t = t^*$, and this value does not vary with π.

Observation 1 also asserts that the threshold value of the bank loan acceptance probability is increasing in c. This implies that there exists a critical value that we call $\hat{c}(m, \pi)$, such that for smaller cash prices the "left hump" is lower then the "right hump" and the supplier sets a trade credit price above the cash price. As we shall see in stage 2, this suggests that for any probability π larger than $\hat{\pi}(c^*)$, the supplier could set a cash price weakly less than the threshold $\hat{c}(m, \pi)$, thus inducing the Stage 4 incarnation of herself to set the trade

Figure 2: Typical Trade Credit Profit Functions



credit price above the cash price. How much smaller this threshold value is than the full commitment optimal cash price c^* depends on the parameters of the model, π and m. If the cash price is set, instead, greater than or equal to the optimal full commitment trade credit price t^*, the threshold probability is zero.

The fact that $\hat{\pi}(c, m)$ is decreasing in m shows that the lower is the monitoring cost the higher is the incentive for the supplier to set a trade credit price lower than the cash price. Interestingly, this result is different from what the literature on informal credit markets and on trade credit has traditionally argued. This literature has emphasized the fact that suppliers can rely on better knowledge of their clients or lower transaction costs in dealing with them than banks. Thanks to this advantageous position suppliers can bridge the gap between rationed borrowers and the formal credit sector. Our result, on the other hand, shows that if suppliers cannot commit to a trade credit price greater than the cash price, this very same advantage can turn against the supplier. The *closer* is the seller to the buyers, the greater is the temptation to lower the trade credit price below the cash price.

Before we proceed with our analysis of the previous step, we briefly look at the case in which no buyer applies to the bank. This would trivially lead to the same trade credit profit as the case of $\pi = 0$, which, under standard conditions on the distribution of buyers types, would have a unique maximum at t^*.

Stage 2: Buyers' Decision. Consider now a buyer who observes a cash price c. Her strategy can be defined as a probability of applying for bank loan and is a function of her type, P, the probability of obtaining bank credit, π, the monitoring cost, m, and the cash price, c. Clearly, low price types will ask for trade credit regardless of the values of the parameters. However, for high price types, the decision depends on the parameters since such buyers must anticipate the eventual trade credit price. If the cash price they observe is less than or equal to the threshold cash price $\hat{c}(m, \pi)$, they will apply for a bank loan and the supplier will set the trade credit price at t^*. If, instead, they observe $c \geq t^*$ they will ask for trade credit with probability one and the supplier will charge a trade credit price equal to t^*. The question remains open regarding the equilibrium of the continuation game $c \in (\hat{c}(\pi, m), t^*)$. We show in Lemma 2 in the appendix that if $c \in (\hat{c}(\pi, m), t^*)$, no pooling strategy for which all high price types take the same action can be part of any equilibrium.

This leaves open the possibility that a strategy that is different among high price buyers can be part of the equilibrium. More formally, say that buyers use type-contingent strategies if there exists types $P_i \neq P_j$, $P_i, P_j \geq c$, such that $\sigma(P_i, c, m, \pi) \neq \sigma(P_j, c, m, \pi)$, where $\sigma(P, c, m, \pi)$ is the probability that a buyer of type P applies for a bank loan given π, m and c. With non-degenerate type-contingent strategies it must be the case that all such buyers are indifferent between applying for a bank loan and asking for trade credit. Therefore, they must believe that the trade credit price will equal the cash price.[4] It can be shown that many equilibria with type-contingent strategies exist, but all are pay-off equivalent to the supplier. Thus we have the following:

Observation 2. *The following strategies are an equilibrium of the continuation game start-*

[4]This is proven in Lemma 3 in the appendix. In Lemma 4, also in the in the appendix, necessary and sufficient conditions are provided for type-contingent equilibrium strategies when $c \in (\hat{c}(\pi, m), t^*)$.

ing at stage 3:

$$\text{Buyers:} \begin{cases} \textit{Low price types never apply for bank loan} & \textit{for any } c \\ \textit{High price types apply for a bank loan} & \textit{if } c \leq \hat{c}(\pi, m) \\ \textit{High price types do not apply for a bank loan} & \textit{if } c \geq t^* \\ \textit{High price types adopt a strategy } \sigma_m(P) \in (0,1) & \textit{if } c \in (\hat{c}(\pi, m), t^*) \end{cases} \tag{1}$$

$$\textit{Supplier's trade credit price: } t = \begin{cases} t^* & \textit{if } c \geq t^* \textit{ or } c \leq \hat{c} \\ c & \textit{for } c \in (\hat{c}, t^*) \end{cases} \tag{2}$$

Stage 1: The determination of c. Naturally, if the value of $\pi < \hat{\pi}(c^*, m)$, the lack of commitment is not binding and we have the full commitment equilibrium. If, instead, $\pi > \hat{\pi}(c^*, m)$, the supplier will face three alternatives. First, she can set $c \leq \hat{c}(\pi, m)$ and commit to a trade credit price that is higher than the cash price, thereby ensuring that all high price buyers apply for the bank loan. Alternatively, she can set $c \geq t^*$, thus inducing all the buyers' types to ask for trade credit. Finally, she can set $c \in (\hat{c}, t^*)$, to which the high price buyers will respond with a type-contingent strategy $\sigma_m(P)$. It is shown in Lemma 5 that it is never optimal for the supplier to set a cash price $c \geq t^*$. However, whether $c = \hat{c}(\pi, m)$ or $c \in (\hat{c}(\pi, m), t^*)$ depends on the parameters and the distribution of buyer types. In any case we show that the equilibrium cash price will be different from the full commitment "unconstrained" optimal value c^*.

Stage 0: Opening or Closing the Credit Window. It is by now clear that if the probability of obtaining bank credit is high enough, the supplier must distort the cash price away from its unconstrained optimal value c^* in order to induce some of the buyers to pay cash. Nevertheless, if π were just above $\hat{\pi}(c^*, m)$ the distortion the supplier needed to make would not be very strong. She could lower the cash price to $\hat{c}(\pi, m)$ and still offer trade credit to her clients. Intuitively, the higher π, the more severe the cash price distortion will have to be and the lower the profits of the supplier. If π increases above a certain level and if a commitment device is available that allows the supplier to sell only on cash, she will use it. Hence the decision to shut down trade credit stated in Proposition 1.

4.2 Multiple Suppliers and the "Big Jump"

Now suppose there are N suppliers. If a supplier provides the intermediate good on credit to a buyer she will incur a buyer-specific monitoring cost which is distributed according to a distribution $I(\cdot)$.[5] Put differently, every buyer i draws N i.i.d. monitoring costs — one for each supplier from $I(\cdot)$. Every supplier now sets a cash price c and a trade credit price t which is buyer-specific. The rest of the model is identical to the monopoly case. The fact that the monitoring costs for the same buyer vary across suppliers reflects the presence of heterogeneous transaction costs in dealing with the client. For cash payments, instead, as in the monopoly case, there are no such costs. This captures the idea that a buyer willing to pay cash perceives suppliers of an identical product as perfect substitutes and is likely to trigger fierce competition among sellers. If, instead, trade credit is sought, transaction costs enter into play and the buyer is likely to face different terms from different suppliers.

In the appendix, we prove the following result:

Proposition 2. *With two suppliers, the cash price is* $c = 0$*, each supplier's trade credit window is open and the trade credit price set by supplier* $j = 1, 2$ *for buyer* i *is* $t_{ij} = \max\{m_{ij}, \min\{m_{i,-j}, t^*_{ij}\}\}$*, where* m_{ij} *is the monitoring cost for supplier* j *of buyer* i *and* $t^*_{ij} = argmax\{(t_{ij} - m_{ij})(1 - F(t_{ij}))\}$

Hence, with more than one supplier, the commitment problem disappears, because cannibalisation of the cash market has left trade credit as the only avenue for profit. Moreover, trade credit is only extended to those buyers rejected by the bank.

[5] With many suppliers, it is now necessary to allow for supplier-buyer specific monitoring costs. However, it is not difficult to see that the monopoly model could also be extended to incorporate heterogenous monitoring costs. In this case we would have different threshold values of π that would induce the monopolist to shut the trade credit window.

We now provide an intuitive argument for the equilibrium trade credit prices. We could think of the monitoring cost as a measure of how close the supplier is to the buyer. For each supplier we can distinguish three sets of buyers. For supplier 1, for example, the first set corresponds to buyers that are too far from her competitor and for which the supplier can charge the optimal price $t^*(m_{1i})$. The second group consists of those buyers closer to supplier 1 but that are within reach of supplier 2. More formally those with $m_{1i} < m_{2i} < t^*(m_{1i})$. For this group supplier 1 will optimally set the trade credit price equal to her competitor's monitoring cost. Finally, for those buyers closer to supplier 2, the price is set to m_1.

What about the proportion of goods sold on trade credit conditional on providing some trade credit? Will a monopolist who sells both on credit and for cash would increase or decrease the proportion of goods sold on credit in response to the entry? Unfortunately, the answer to this question is ambiguous. In the duopoly case, if we look at the set of buyers who are too far from the competitor, Proposition 2 shows that their trade credit price equal to the monopolist's price. The cash price, instead, declines considerably leading to an overall lower proportion of goods sold on credit. The results on the other buyers more exposed to competition is less clear. Whether the proportion of them buying on credit over those paying cash increases depends on how much the trade credit price declines relative to the cash price, which ultimately depends on the distribution of monitoring costs.

Our final proposition states that, with more than one supplier, the proportion of goods sold on credit by each supplier increases with the number of suppliers. Intuitively the entrance of a new competitor has no effect on cash sales but exerts downward pressure on trade credit prices since now buyers can purchase from an additional supplier. The decrease in the trade credit price allows more buyers rejected by the bank to access trade credit.

PROPOSITION 3. *With more than one supplier, an increase in the number of competitors leads to an increase in the proportion of good sold on credit by each of them.*

4.3 Discussion of the Model

The model that we have discussed makes sharp predictions and does a good job of explaining why a monopolist might be willing to pre-commit to cash-only sales and why such a pre-commitment is of no value when the level of competition increases. When our model is combined with the standard loan enforcement story, the hump-shaped relationship between competition and credit provision that we alluded to earlier and will presently show exists for a sample of Indonesian firms in our empirical analysis becomes clear. Before proceeding to the empirics, we discuss some extensions and alternative modeling choices.

Suppose that instead of a fixed probability of obtaining bank credit, banks have some ability to screen lenders, so that π is actually an increasing function of the buyer type, P. In this case, not only can it be shown that the same results go through, but one can easily see that the commitment problem of the supplier would become even more severe. Intuitively, with $\pi'(P) > 0$, the distribution of buyers demanding trade credit would be *even more* skewed in favour of low price buyers, making the supplier all the more tempted to set the trade credit price below the cash price. Therefore, the monopolist supplier would have greater incentive to close the trade credit window.

In the model, all buyers rejected by the bank and those who did not apply for bank credit ask for trade credit in stage 3, even though, in equilibrium, buyers can anticipate the trade credit price. Therefore, there is no reason for low price buyers to even apply for trade credit. One can imagine constructing a trembling hand perfect equilibrium (even if there is some small cost of asking for trade credit) in which buyers continue to ask for trade credit because they anticipate that with positive probability, the supplier will actually set a lower trade credit price. However, at a more fundamental level, whether or not low price buyers actually ask for trade credit or not does not actually affect the decision problem of the supplier, leaving the trade credit price, and indeed, the predictions of the model, unaffected.

We now move our discussion to some alternatives. The driving force behind our results is the assumption that the supplier cannot commit to a trade credit price before observing whether or not buyers pay cash. However, one may argue that the supplier can use reputation building as an alternative commitment device. For example, suppose that the buyer sets $(c,t) = (c^*, t^*)$ in every period; if she ever sets $t < c$, then the one-shot equilibrium we have derived ensues. The threshold value $\hat{\pi}$ may increase, but the essence of our result remains intact: In order for the the supplier to invest in reputation, it must be that the punishment for a one-shot deviation from (c^*, t^*), is higher than the one-shot gain. The former is no larger than $\delta(t^*(1 - F(t^*)(1 - \pi))$, while the latter is equal to $(1 - \delta)\left[(t_L - m)(1 - F(t_L) - \pi(1 - F(c))) - (t^* - m)(1 - F(t^*))(1 - \pi)\right]$. Observe that an increase in π lowers the punishment and increases the one-shot deviation gain. Therefore, if π is close enough to one, the supplier has the incentive to deviate and set $t < c$. Hence, the "cash-only" policy remains, for some parameter values, a more effective commitment device.

However, one may also consider models in which the supplier does not suffer from any commitment problems. For example, suppose that suppliers do not have a commitment problem but face a fixed cost of providing trade credit and that the extra profit generated from setting a trade credit price $t^* > c^*$ does not sufficiently compensate the monopolist supplier for the fixed cost of selling on credit. Moreover, as in our model, when the degree of competition increases, the cash price goes to zero and trade credit becomes the supplier's only source for profit. However, it can easily be shown that if the fixed cost induces the monopolist to sell only on a cash basis, then so too will oligopolists, *even though* the cash market has been cannibalised by Bertrand competition.

Maintain the assumption that the monopolist supplier can fully commit to a trade credit price higher than the cash price, but now assume that there is a single buyer selling in a final end market, facing its own demand curve, who buys many units of the intermediate good from the supplier. In this case, except for implausibly high monitoring costs, it is difficult to imagine that the monopolist would close the trade credit window. One can view the cash and trade credit prices charged by the monopolist as contributing to the marginal cost of production of the buyer; therefore, for plausible values of m, the buyer would demand positive amounts of trade credit if she were denied bank credit. Moreover, even if she gets a loan, the buyer may be rationed by the bank and so may purchase some units from the monopolist on cash and some on credit.

5 The Data

In the empirical analysis we combine a firm-level survey in Indonesia sponsored by the World Bank in 1998 and conducted by the *Budan Pusat Statistik* (BPS), the Central Bureau of Statistics, and annual data by the same BPS covering all manufacturing establishments in Indonesia with at least 20 employees. The fact that the two datasets have been collected by the same agency using the same geographical and industrial classification codes, make them easy to be combined. In particular, both datasets contain detailed firm location codes and industrial sector codes for the main good produced. For every firm included in the survey sample it is, therefore, possible to retrieve a large set of information on their competitors operating in the same geographical area and to use this information to build measures of competition. We will come back to this in the identification strategy section. However, we first briefly discuss the two datasets.

The World Bank survey is part of a larger survey conducted in four East Asian countries in order to assess the effect of the Asian financial crises on the manufacturing sector and is described in Hallward-Driemeier (2001). However, only in the Indonesian dataset is the detailed firm location information contained that is essential for our analysis.

The survey was conducted by the BPS with the help of the National Development Planning Agency (BAPPENAS) between November 1998 and February 1999. The original sample includes 955 manufacturing firms mainly from four manufacturing sectors (food processing, textiles, chemicals and processed rubber, electronics and others), selected based on their importance to the economy in terms of value added, export orientation and employment, as well as being representative of the manufacturing sector in Indonesia. Individual firms were selected to ensure that the sample was a representative mix of firms of different size, location, ownership structure, and production orientation.

In our main specification we use a restricted sample which excludes those firms who declare that their biggest competitor is abroad, as well as those which export all their products. Our sample size is reduced to approximately 600 firms; however, the number varies in some specifications due to missing observations. The sample distribution is as follows: food processing 35%, chemicals/rubber 25%, textiles 29%, electronics 8%, others 3%. Small and medium firms (*i.e.,* employing between 20 and 150 workers) account for approximately 65% of the sample, while large firms account for approximately 35% of the sample. The sample is predominantly composed of non-exporters and single-establishment firms: 80% of the firms do not export at all and 90% export less than 30% of their production; approximately 90% of the firms in our sample have only one establishment.

What makes the survey particularly suited for our purposes is the detailed section on trade credit, which includes questions on the percentage of goods sold on credit, the average number of days before payment is due — both before and after the Asian Financial Crisis.[6] The questions suffer from the usual memory recall and measurement error bias that characterize this kind of survey. The memory recall bias is likely to affect the change in the percentages and days reported for before and after the crisis, especially if the effect of the crisis on trade credit is not of great magnitude. Since we are focusing only on the period before the financial crisis, however, the cross-sectional variation exploited for the identification of the parameters is less likely to be significantly affected by this kind of error. A potentially more relevant issue is the possible survival bias coming from the fact the only those firms active in the aftermath of the Asian financial crisis are included; however, in Section 8 we use the information contained in the "census" dataset before and after the crisis and show that survival bias is not a significant problem.

[6] The questionnaire also asked for the average discount offered for early payments. However, the ambiguity of the question, which does not give room to identify the kind of discount offered, led only very few firms to answer, making the data uninformative.

The census data by the BPS contains a complete enumeration of all manufacturing establishments in Indonesia with more than 20 employees and includes precise location codes, 4 digit classification (ISIC 2^{nd} Rev.) of the main good produced and some detailed quantitative information such as short form income statements and balance sheets. No data on the firms' trade credit policies is contained in this survey. We use the BPS data to retrieve information on the competitive environment in which the firms in the World Bank Survey operate and derive a set of control variables. Table 1 reports summary statistics of the data included in our study.

6 Empirical Approach

Our main goal is to accurately capture the functional form of the relation between competition and trade credit provision while controlling for unobserved heterogeneity potentially correlated with the level of competition.

The equation we want to estimate is the following partially linear model:

$$TC_{ips} = f(C_{ps}) + \eta' X_{ips} + \alpha' Z_s + \varepsilon_{ips} \tag{3}$$

where TC_{ips} is the proportion of goods sold on credit by firm i, producing product p in geographical area s. C_{ps} is a measure of competition in the production of good p in area s. X_{ips} are firm level characteristics, while Z_s are area characteristics. In order to estimate (3), we will use different specifications of $f(\cdot)$ to capture the possible nonlinearity of the effect of competition on trade credit.

The dependent variable of our estimates is a proportion with many observations at 0 and 100%; therefore, we will use a two-limit Tobit estimation procedure. When estimating the full relationship between competition and trade credit provision, the non-linear nature of the double-censored Tobit estimation makes it difficult to deal with potential unobserved heterogeneity at the level of the industrial sector or sub-district. Therefore, we also present results of OLS fixed effects estimation. Since we are also interested in the "big jump", we will devote attention to the binary decision to provide trade credit. This has the advantage of making it easier to control for unobserved heterogeneity. We will discuss this more below, but now turn our attention to the measure of competition used in our estimates.

6.1 Measure of Competition

The first step in estimating the empirical relationship between competition and trade credit policies is to define a measure of competition in trade credit supply. We will use mainly the number of "competitors" in the sub-district where the firm operates. For the analysis we define competitors as those firms producing the same product, as classified at the four-digit ISIC level. The usual problems connected with the use of sector classification to measure competition apply here. The relevant market might include products classified in different sectors but perceived as substitutes by the buyers. Our assumption is that, on average, the sector classification adequately captures product classification.

A crucial condition underlying the use of our measure of competition is that markets for trade credit provision be predominantly local. That is, trade credit should be provided, at least with greater probability, to clients who operate in close proximity to the supplier. While predominantly local markets is a sufficient condition, it is not necessary, especially in contexts where information and enforcement problems are significant: geographical vicinity makes information flows between the borrower and lender easier and often turns out to be crucial in mitigating obstacles to credit provision.

We will see that the estimates show consistent evidence in favor of the local trade credit market hypothesis: only local competition and the local characteristics of the area help to significantly explain trade credit provision. Indeed, the characteristics of the Indonesian economy and of the firms in our sample provide further clues that local markets are actually prominent. First, the country's widespread island archipelago geography and generally poor transportation infrastructure is often quoted as a reason that makes local markets significant in Indonesia (Blalock-Gertler, 2003). Second, given the aforementioned restrictions on our dataset, those that remain are mainly small-to-medium, single-establishment firms selling domestically.

The extension of the geographical area that covers the relevant market for trade credit provision must take into account the characteristics of the data. The available data are organized in administrative units which include provinces (*propinsi*), districts (*kabupaten*) sub-districts (*kecamatan*) and villages (*desa*). The choice of sub-districts as the relevant area has been mainly driven by the empirical analysis on different geographical levels. In Section 8 we show that once we include the number of competitors in the sub-district, the number of competitors in the district, province or country have no explanatory power on the amount of trade credit granted to clients. This result suggests that trade credit markets *are* actually local. There are around 4,000 subdistricts in the country with an average of 20 villages each. In our sample we have 40 subdistricts, 25 districts and nine provinces.

To be sure, the number of competitors is not necessarily the best measure of competition but seems particularly well-suited to our problem. When we examine the robustness of our results we also use market share as an alternative measure of competition and show that the qualitative results do not change. This measure, however, is more likely to be affected by problems of endogeneity due to a reverse causality between trade credit and market shares: sales as well as market shares are affected by the trade credit policies.

6.2 Functional Form

We will use both a parametric and a semiparametric approach to estimate (3). The former approach allows us to deal more effectively with issues of endogeneity or unobserved heterogeneity, while the latter can more effectively capture the predicted non-monotonicity of $f(C_{ps})$ without making any assumptions on the precise nature of any non-monotonicity. For our parametric estimates, we use two specifications of $f(C_{ps})$. The first is a log quadratic specification:

$$TC_{ips} = \alpha + \beta_1 \log(C_{ps}) + \beta_2 \log(C_{ps})^2 + \eta' X_{ips} + \alpha' Z_s + \varepsilon_{ips} \tag{4}$$

where all the variables are as previously defined. We take the log quadratic because it is better-suited to capture an asymmetric non-linear relationship between competition and trade credit than is a quadratic specification.

We also estimate (3) with a linear spline specification with knots at $C_{ps} = C_{pc}^{j*}$, $j = 1, \ldots, K$:

$$TC_{ips} = \alpha + \beta_1 C_{ps} + \sum_{j=1}^{K} \beta_{j+1} I(C_{ps} \geq C_{ps}^{j*})(C_{ps} - C_{ps}^{j*}) + \eta' X_{ips} + \alpha' Z_s + \varepsilon_{ips} \tag{5}$$

where $I(C_{ps} \geq C_{ps}^{j*})$ is an indicator function that takes value 1 if C_{ps}^{j*} or more competitors are operating in the subdistrict and 0 otherwise. This is interacted with the number of competitors in excess of C_{ps}^{j*}. We choose the knots starting from the results of the log quadratic specification and test whether other knots increase our fit.

In our semiparametric approach we first approximate $f(C_{ps})$ with a step function. This leads to the following specification:

$$TC_{ips} = \alpha + \sum_{j=1}^{H} \beta_j I(C_{ps} = C_{ps}^{j*}) + \beta_{H+1} \log(C_{ps} I(C_{ps} > C_{ps}^{H*})) + \eta' X_{ips} + \alpha' Z_s + \varepsilon_{ips} \tag{6}$$

where $I(C_{ps} = C_{ps}^{j*})$ is a dummy for different numbers of competitors. When there are more than C_{ps}^{H*} competitors, we take the logarithm of the number of competitors, C_{ps}. The coefficients of the dummies β_j (plus the constant) can be interpreted as the mean trade credit provided in subdistricts with j competitors. We will report the results of some hypothesis tests on the coefficients to test the shape of $f(C_{ps})$.

6.3 Identification Strategy: Unobserved Heterogeneity

Our identification strategy relies on the ability of our cross-sectional estimates to control for potential sources of endogeneity, with two of the most relevant being subdistrict-level and firm-specific unobserved heterogeneity correlated with competition.[7] The possible correlation of those factors determining the location of the firm with variables correlated to trade credit provision can be a serious problem that we have to deal with in our identification.[8]

In particular, the decision of the firm to locate in a certain subdistrict might be influenced by some unobserved characteristics potentially correlated with credit supply. Urban or intensely populated areas, for example, may attract firms for the size of the market or the endowment of infrastructure but may also have more effective legal enforcement systems which could facilitate the provision of credit (Fisman-Raturi, 2004). This kind of heterogeneity might introduce a positive bias on the estimates of the coefficient of competition. Put differently, in areas with a high number of firms we should observe, all else equal, a higher amount of trade credit. Naturally other subdistrict specific characteristics might be at work which affect the coefficient in the opposite direction.

To deal with this, in all specifications we use district level dummies along with three-digit sector dummies. Unfortunately, this is not enough because the variation in firms' location within a district would still introduce a bias. When we study the binary decision to grant trade credit, we are able to estimate a logit subdistrict fixed-effects model, thereby conditioning out any unobserved heterogeneity at the subdistrict level. However, when analysing the full relationship between competition and trade credit, it is no longer possible to condition out subdistrict fixed effects due to the highly non-linear nature of the Tobit.

[7] Industrial sector heterogeneity is also relevant. It is well-documented that trade credit varies substantially across industrial sectors according to specific characteristics of the products or of the production process. We control for differences among products using three-digits ISIC sector dummies in all the specifications. In the robustness checks we also check possible interactions with the level of competition.

[8] A direct "reverse causality" argument seems less relevant for our estimates. Although trade credit provision might be a non-negligible source of revenue, we believe that a vast majority of manufacturing firms decide where to locate their activity based on other factors than direct trade credit opportunities in the specific geographical area.

Furthermore, any attempt to directly estimate ξ_s along with $f(C_{ps})$ might introduce an incidental parameter problem which could undermine the consistency of $f(C_{ps})$ (Greene, 2004). To cope with this, we estimate a random-effects Tobit model à la Chamberlain (1980) in which we allow for correlation between unobserved effects and competition. We also report the results of OLS estimates in which we include subdistrict fixed effects.

As for firm-level heterogeneity, we include a large set of firm-level control variables capturing the financial situation of the firm, its size, its productivity shocks as well as the propensity to export. The basic identification assumption is that, conditioning on our control variables at the firm and subdistrict level, the variation in the number of competitors operating in each subdistrict is exogenous to trade credit and is enough to identify the effect of competition on trade credit provision.

7 Results

7.1 The Full Relationship

Table 2 shows the results of the estimation of (4) estimated with a double censored Tobit. The marginal effects on the unconditional expected value of trade credit at the mean of the control variables are reported. In all the specifications, the coefficients for competition are individually and jointly significant at the one percent level. In the first specification, besides the log of the number of competitors and its square, we include three firm-level control variables: the percentage of goods exported, the log of sales and the log value of fixed assets. In the second, we include subdistrict level characteristics such as log total number of manufacturing firms and log total sales as well as the average percentage of goods exported in the subdistrict, which has the effect of reducing the coefficient of competition. We also included a measure of firm turnover in the subdistrict in 1996 — specifically, the proportion of firms which started operating in the subdistrict in 1996 plus the proportion of those which exited in the same year.[9] This variable has a negative and significant impact on the amount of trade credit provided, signalling that suppliers are more wary to provide trade credit in those districts where the turnover of new and old firms is higher.[10] In the last specification in column (3), we include a set of additional firm level control variables including age, interest expenses on sales, percentage of capacity usage and change in the capacity usage from the previous year. The inclusion of these control variables results in a marginal decrease in the coefficient of competition. Notice that the proportion of goods sold on trade credit reaches a maximum at approximately four active competitors in the subdistrict and starts declining as the number of competitors continues to increase. The standard error of the maximum is 0.6, which implies a 95% confidence interval of roughly $(3, 5)$.

In Table 3, we report the estimation results for (5) with a double censored Tobit and the same control variables as in column (3) of Table 2. We include a single knot at 4 competitors.[11] The coefficient of $I(C_{ps} \geq 4)(C_{ps} - 4)$ is negative and significant, which confirms the change in the sign of the slope at the knot. The estimates indicate that each additional nearby competitor results in a 3.5 percentage point increase in the proportion of goods sold on credit up to four competitors. With more than four competing firms, the proportion of goods sold on credit decreases smoothly with a 0.33 percentage point decrease per extra competitor. In column (2) we estimate a restricted model which includes only the number of competitors and restricts the coefficient of $I(C_{ps} \geq 4)(C_{ps} - 4)$ to 0. The coefficient on competition is negative and significant, and suggests that an additional supplier decreases the proportion of goods sold on credit by 0.3 percentage points. This last specification is analogous to the one run by McMillan-Woodruff (1999), who estimate a decrease of 0.7 percentage points for an additional competitor. The negative correlation between competition

[9]The number of entries and exits is computed looking at the firms operating in the subdistricts at the end of 1995 and comparing them with those operating at the end of 1996. The firms included in the survey are those with more than 20 workers. Consequently some of the entries and exits might reflect an increase or decrease in employment by a firm above or below the threshold for inclusion in the survey.

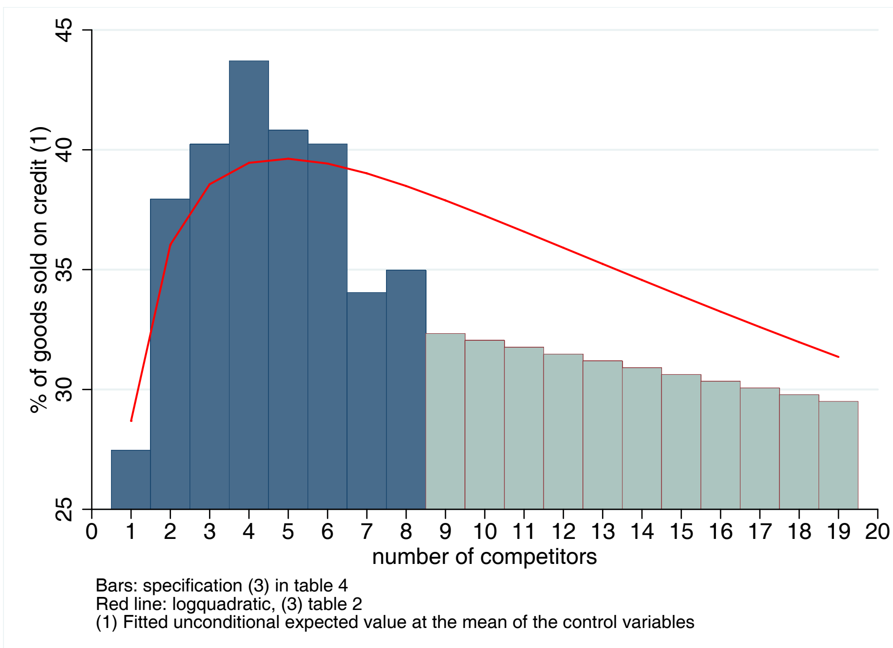
[10]If we break the turnover measure in its two components, proportions of new entries and exits, the coefficients of the two variables are both negative and significant.

[11]This is our best linear spline form. We also tested for the presence of additional and/or different knots, but the fit did not improve.

and trade credit estimated by McMillan-Woodruff (1999) can be driven by a prevalence of large numbers of competitors operating in the district. In particular, the fact that their dataset is limited to two largely populated and industrialized districts in Vietnam suggests that their sample includes few firms that operate as monopolists. Our sample, instead, is representative of the whole manufacturing sector in Indonesia. Nevertheless, should we base our conclusions on this last specification we would support the authors' results that competition is harmful for trade credit provision. However, a likelihood ratio test suggests that the unrestricted model with a change in the slope better fits the data.

We then estimated (6) by including one dummy variable for each number of competitors from 1 to 8 and taking the log number of competitors beyond 8. Results using a double censored Tobit and the same control variable as in column (3) in Table 2, are depicted in Figure 3 together with the log quadratic fitted values. To make the results more easily interpretable, the estimates are reported in Table 4 in a slightly different form. In place of the dummies for the number of competitors we report the coefficients of the dummies on whether the number of competitors is greater than or equal to 2, 3, . . . , 8. The coefficient on the first dummy, then, can be interpreted as the increase in the proportion of goods sold on credit going from monopoly to duopoly; the second dummy as the increase from two to three competitors, and so on up to eight. A t-test on the coefficient is then a test of the significance of each increase. A joint Wald test on the coefficients, instead, confirms that, on average, trade credit provision increases with up to four competitors and decreases thereafter. Interestingly, the most significant jump in the amount of credit provided is between monopoly and duopoly: the proportion of goods sold on credit by a duopolist is 42 percent higher than the same proportion for a duopolist while the increase for each competitor is smooth up to four before declining in even more competitive settings.

FIGURE 3: Effect of competition on credit provision, dummies and log quadratic specifications



7.2 The Big Jump

As the reader is by now well aware, the most dramatic change in trade credit provision is going from monopoly to duopoly. One might imagine that this is so for two reasons. It may be that monopolists provide less trade credit at a higher price than do duopolists, or rather that they simply do not provide *any* trade credit. We now show that it is the latter explanation. As a first pass, we break the analysis into two parts. First, we look at the binary decision to grant trade credit and second, we examine the relationship between competition and credit provision *conditional on providing some trade credit*.

In column (2) of Table 5, one can see that what explains the discontinuous increase in trade credit provided is the probability of offering some positive trade credit. The estimates indicate that a duopolist has a probability of granting trade credit that is 17 percentage points larger than for monopolists. Moreover, conditional on providing some trade credit, duopolists appear to sell a lower proportion of goods on trade credit, even if the difference not significant, perhaps due to the reduced sample size.

In the third column of Table 3 we estimate a logit model including only a dummy variable for monopoly as measure of competition. This specification is similar to the one used by Fisman and Raturi (2004) and the results are consistent with theirs. Nevertheless, the analogy cannot be pushed too far. Fisman and Raturi look at buyers' data and find that the probability of obtaining credit is lower if the supplier is a monopolist. Their result, therefore, does not rule out a scenario in which monopolists offer lower trade credit to their clients. However, looking at data from the suppliers' side, we find something profoundly different and yet consistent with their observations: suppliers with no competitors are more likely not to provide trade credit at all.

In order to control for unobserved heterogeneity at the subdistrict level, we estimate fixed- and random-effects logit models on the binary decision to grant some positive or no trade credit. The logit is among the very few non-linear models that allow to difference out the fixed effect. One can see from Table 10 that the random-effects estimates are very close to the fixed-effects estimates, suggesting that our subdistrict level control variables do a good job in controlling for unobserved heterogeneity. Moreover, we see that the identical relationship holds — monopolists are simply less likely to offer any trade credit than firms in competitive settings.

8 Robustness Checks

Alternative Measures of Competition. We estimated our empirical model using alternative geographical areas to assess the level of competition; specifically, we included the number of competitors in the country, province, and district. Importantly, once we control for the number of competitors in the subdistrict, the other variables do not have additional explanatory power — a result confirmed by a likelihood ratio test.[12] As a further check, in Table 7 we also show the same estimates as in Tables 2 and 4 using the number of competitors in the district in place of the subdistrict. The log quadratic specification still shows a hump shaped relationship between competition and trade credit but with a less sharp increase for low numbers of competitors. Not surprisingly, the specification with the dummies in (6) shows a similar pattern.

Second, we use market shares in the subdistrict as opposed to the number of competitors. This has the advantage of capturing possible differences in the relative size of competitors at the cost of increased problems of endogeneity. The estimates, reported in Table 8 confirm the non-linear hump-shaped relationship between competition and trade credit provision. As an additional check we include the market share in the country, province and district and, in specification (3), a dummy for market share equal one. The results are analogous to those obtained using the number of competitors.

Industry Analysis. One concern is that we may be biasing our results by pooling across different industries with a wide variety of products and different competitive features: n

[12] The table with these results is available upon request.

competitors in electronics may have a very different impact than n competitors in food processing. To explore this issue we ran the estimations by industry. The estimates are reported in Table 9. The qualitative results are the same as the pooled estimation, even if the reduced sample size makes the estimates less accurate and more noisy. We also report estimates excluding the metal tools and structure sector where the effect of competition on trade credit is particularly pronounced. The effect of competition is dampened, but remains significant.

Survival Bias. Another concern comes from the fact that the World Bank survey was conducted after the Asian financial crisis with only surviving firms sampled. If competition is correlated with the likelihood that a firm exits the market after the financial crisis our estimates might be biased. In particular, if monopolists and duopolists experienced different mortality rates we could confound the differences in trade credit for the remaining sample with the inherent differences in the population. We address this issue using the BPS census data for before and after the financial crisis. We estimate a logit model to determine the effect of the competition in the subdistrict before the financial crisis on the probability of firms' death. After conditioning on firm size and the same set of control variables used in our main estimation we find that monopolists are not more likely to survive than firms operating in more competitive settings. Therefore, we do not feel that survival bias is a concern.

Fixed-Effects Estimates. Finally, we address the issue of unobserved heterogeneity at subdistrict and product level, estimating fixed effect models. OLS estimates of (4) with subdistrict and four digit ISIC product fixed effects are reported in Table 10. Notice that the estimates are very close to those obtained with Tobit. Estimates of (6), not reported, are also very similar to the corresponding Tobit estimation results.

9 Conclusions

In this paper we explored the relationship between trade credit and competition. In the empirical analysis we combined a World Bank Survey conducted in Indonesia with a comprehensive dataset from the Indonesian Central Bureau of Statistics (BPS) which contains a complete enumeration all Indonesian manufacturing firms with more than 20 workers. The use of the two datasets allowed us to combine data on the trade credit policies of a sample of firms with detailed information on the competitive environment in which each of them operate. The estimates revealed a $\cap$-shaped relation between credit provision and competition. In our sample, the amount of trade credit provided by suppliers increases sharply going from monopoly to duopoly and more gradually up to four competitors, before declining steadily thereafter. We argued that the decreasing part of the relationship is consistent with previous studies and in line with the literature on loan enforcement in developing countries.

However, the increasing part and in particular the "big jump" from monopoly to duopoly is particularly striking. Indeed, it is not that monopolists offer less trade credit at a higher price, but that they are much more likely to offer no trade credit at all to their clients. Importantly, this empirical result survives a number of robustness checks — among them, controlling for unobserved heterogeneity at the level of the market where the firms operate. This result cannot be explained with traditional arguments provided from the literature, but instead requires a radically different explanation.

To this end, we provided a model in which suppliers are able to post cash prices but are unable to commit *ex ante* to the terms of trade credit. This lack of commitment is a natural consequence of the fundamentally different nature between trade credit and cash. Cash payment represents a completely impersonal relationship between buyer and seller, whereas trade credit is much more demanding in terms of the buyer-seller relationship. Indeed, since payment is delayed (often beyond what was originally agreed upon), the terms of trade credit are effectively determined only after the good is delivered.

By simply allowing for some lack of commitment in setting trade credit price we showed that monopolists may be tempted to use trade credit as a tool for price discrimination and this possibility can seriously jeopardize their core business. This happens because borrowers, in anticipation of favorable trade credit conditions, decide not to pay cash. In this case suppliers may prefer to protect their main activity by accepting only cash payment. In the theoretical model we also demonstrated that this is more likely to happen if the market for "informal credit" is thin because the banks do relatively little credit rationing or if the supplier is particularly efficient in providing credit. Interestingly, this latter point suggests that, in the presence of commitment problems, the very same advantage that make suppliers ideal informal creditors can turn out to be detrimental to them and cause them to shun this extra role.

This result makes a contribution to the literature on informal credit markets. This literature, in line with the studies in corporate finance, has pointed out that suppliers can leverage the relationship with their clients and act as informal creditors, extending credit to borrowers who are rationed in the formal sector. Most of the advantages of suppliers over banks, such as lower monitoring costs, easier liquidation of inventories in case of default or higher enforcement power given by lock-in effects, are strongest when the supplier is a monopolist. Here we document empirically that monopolists often decide to give up their role as informal creditors and focus only on their core business.

The theoretical explanation we provide can be extended to the many cases in developing countries where informal credit is interlinked to another activity. Our analysis suggests that with the growth of formal credit, many "interlinking" creditors, such as firms or rice traders, especially if not pressed by competition, may decide to abruptly give up their role as creditors and focus solely on their main activity. The access to credit by borrowers can in turn become even more difficult. This possibility may have serious implications for less developed countries or transition economies that are attempting to install formal credit markets or improve the existing ones. Consistent with what has been suggested by the literature on relational and formal contracts (Dixit, 2004), this result supports the idea that the process of gradual improvement of formal markets may inflict an interim cost to the economy, by worsening the outcomes of the currently used informal systems. Our results on small firms in Indonesia may be an example of what could happen in contexts where formal credit is starting to be increasingly more available.

References

[1] Beck T, A. Demirgüç-Kunt and V. Maksimovic *Bank Competition, Financing Obstacles and Access to Credit* World Bank Policy Research Working Paper 2996, March 2003.

[2] Biais, B. and C. Gollier, 1997. *Trade credit and credit rationing,* Review of Financial Studies 10, pp. 903–937.

[3] Blalock, G. and Paul Gertler 2004. *Learning from Exporting Revisited in a Less Developed Setting. Journal of Development Economics* 75(2): 397-416.

[4] Bulow J. 1982. *Durable Goods Monopolists,* Journal of Political Economy vol. 90 pp. 314-332.

[5] Burkart M. and T. Ellingsen, 2004. *In-Kind Finance: A Theory of Trade Credit* American Economic Review, vol. 94(3), 569-590.

[6] Chamberlain G., 1980. *Analysis of covariance with qualitative data,* Review of Economic Studies 47, pp. 225–238.

[7] Coase R., 1972. *Durability and Monopoly,* Journal of Law and Economics 15, pp. 143–149.

[8] Cuñat, V., 2006. *Trade Credit: Suppliers as Debt Collectors and Insurance Providers,* Review of Financial Studies, *forthcoming.*

[9] Demirgüç-Kunt A. and V. Maksimovic, 2002. *Funding growth in bank-based and market-based financial systems: evidence from firm-level data,* Journal of Financial Economics 65 pp. 337-363.

[10] Fisman, R. and M. Raturi, 2004. *Does Competition Encourage Credit Provision? Evidence from African Trade Credit Relationships*, Review of Economics and Statistics.

[11] Fisman, R. and I. Love, 2003. *Trade Credit, Financial Intermediary Development, and Industry Growth,* Journal of Finance 58(1) pp. 353–374.

[12] Fafchamps, Marcel, 2000. *Ethnicity and Credit in African Manufacturing* Journal of Development Economics, 61(1), 205-35.

[13] Ghosh P., D. Mookherjee and D. Ray *Credit Rationing in Developing Countries: An Overview of the Theory*, Chapter 11 in Readings in the Theory of Economic Development, edited by D. Mookherjee and D. Ray, London: Blackwell, 2000, pages 383–301.

[14] Greene W. H. *Fixed Effects and the Incidental Parameters Problem in the Tobit Model*, in Econometric Reviews, 2004.

[15] Gul F., H. Sonnenschein and R. Wilson, 1986. *Foundations of Dynamic Monopoly and the Coase Conjecture,* Journal of economic Theory vol 39 pp. 155-190.

[16] Hallward-Driemeier, M. *Firm-Level Survey Provides Data on Asia's Corporate Crisis and Recovery,* Policy Research Working Paper 2515, World Bank, January 2001.

[17] Heffernan, S., 1996. *Modern Banking in Theory and Practice*. Wiley, New York.

[18] Lee Y.W. and J.D. Stowe, 1993, *Product Risk, Asymmetric Information, and Trade Credit* in "Journal of Financial and Quantitative Analysis", vol. 28, n. 2, pp.285-300;

[19] Long M. S., I.B. Malitz and S. A. Ravid,1993. *Trade Credit, Quality Guarantees, and Product Marketability*, in "Financial Management", vol. 22, n. 4, pp. 117-127;

[20] Marquez, Robert, 2002. *Competition, Adverse Selection, and Information Dispersion in the Banking Industry*, The Review of Financial Studies, vol. 15, n. 3, pp. 901-926.

[21] McMillan, John, and Christopher Woodruff, 1999. *Interfirm Relationships and Informal Credit in Vietnam*, Quarterly Journal of Economics, 114(4), pp.1285-1320.

[22] Mian, S. L., and C., 1992. *Accounts receivable management policy: Theory and evidence,* Journal of Finance 47, pp. 169–200.

[23] Petersen, M. A., and R. G. Rajan, 1997. *Trade Credit: Theories and Evidence,* Review of Financial Studies, 10(3), Fall, 661-91.

[24] Petersen, M. A., and R. G. Rajan, 1995. *The Effect of Credit Market Competition on Lending Relationships,* The Quarterly Journal of Economics, Vol. 110, No. 2. (May, 1995), pp. 407-443.

[25] Rajan, R. G., and L. Zingales, 1995. *What Do We Know about Capital Structure? Some Evidence from International Data,* The Journal of Finance, Vol. 50, No. 5. (Dec., 1995), pp. 1421-1460.

[26] Stokey N., 1979. *Intertemporal Price Discrimination* Quarterly Journal of Economics vol. 93 pp. 355-371

[27] Stokey N., 1981. *Rational Expectations and Durable Goods Pricing.* Bell Journal of Economics vol.12 pp. 112-128

[28] World Bank. Global Development Finance (2004).

Appendix A: Omitted Proofs

Proof of Observation 1: Let us focus on the subgame in which the supplier fixes t. For given c and m the suppliers will choose a t which maximizes the following profit function:

$$H(t) = \begin{cases} (t-m)(1-F(t))(1-\pi), & \text{if } t \geq c \\ (t-m)(1-F(t)-\pi(1-F(c))), & \text{if } t \leq c \end{cases} \tag{7}$$

Let t_L denote the trade credit price which maximizes $H(t)$ on the domain $[0, c]$, t_H the trade credit price which maximizes $H(t)$ on the domain $[c, \infty)$ and $\hat{t}$ the trade credit price which maximizes $H(t)$ on $\mathbb{R}_+$. Also observe that $t_H = \max\{c, t^*\}$, where $t^* = \text{argmax}(t-m)(1-F(t))(1-\pi)$ and that t^* is independent of c and π, while t_L depends is a function of both. We aim to show that there is a threshold, $\hat{\pi}(c, m)$ such that for all $\pi \leq \hat{\pi}(c, m)$, $\hat{t} = t_H$ and for all $\pi < \hat{\pi}(c, m)$, $\hat{t} = t_L < c$. In order to do so, define

$$Z(\pi) = (t_H - m)(1 - F(t_H))(1-\pi) - (t_L - m)(1 - F(t_L) - \pi(1 - F(c)))$$

We will prove the existence of a unique point $\hat{\pi}(c, m)$ such that $Z(\hat{\pi}(c, m)) = 0$, and for π above this threshold, $Z(\pi) < 0$, while for π below this threshold $Z(\pi) > 0$.

First notice that $Z(0) > 0$ and $Z(1) > 0$. Therefore, since $Z(\pi)$ is continuous, the claim is proven if we can demonstrate that $Z'(\pi) < 0$.

$$Z'(\pi) = -\pi(t_H - m)(1 - F(t_H)) + \pi(t_L - m)(1 - F(c)) + \frac{\partial t_L}{\partial \pi}\frac{\partial Z}{\partial t_L}$$

We claim that the last term is zero and that the sum of the first two terms is negative. Consider the former claim. If we let x^* denote the unconstrained argmax of $(x - m)(1 - F(x) - \pi(1 - F(c))$, we see that one of two things may happen: either $x^* = t_L$, in which case $\frac{\partial Z}{\partial t_L} = 0$ or $x^* > t_L$, in which case $\frac{\partial t_L}{\partial \pi} = 0$. In either case, our claim is proven. Now consider the sum of the first two terms and notice that for all $\pi > 0$, $x^* < t^*$. Therefore, if $t_H = c$, $t_L < t_H$ and we are done. If $t_H > c$ and $t_L \leq c$, since $Z(0) > 0$, we are also done.

The next part of the proof requires us to show that $\hat{\pi}(c, m)$ is increasing in m and decreasing in c. Observe that $\frac{\partial Z(\hat{\pi}(c,m))}{\partial m} = (1 - F(t_H))(1 - \pi)) + \frac{\partial t_H}{\partial m}\frac{\partial Z}{\partial t_H} + (1 - F(t_L) - \pi(1 - F(c))) + \frac{\partial t_L}{\partial m}\frac{\partial Z}{\partial t_L}$. It can be easily shown that $\frac{\partial t_H}{\partial m}\frac{\partial Z}{\partial t_H} = 0$ and $\frac{\partial t_L}{\partial m}\frac{\partial Z}{\partial t_L} = 0$. Furthermore at $\pi = \hat{\pi}$ it must be that $(1 - F(t_H))(1 - \pi) < 1 - F(t_L) - \pi(1 - F(c))$. Hence, we have shown that $\frac{\partial Z(\hat{\pi}(c,m))}{\partial m} > 0$, which together with $\frac{\partial Z(\pi)}{\partial \pi} < 0$ implies that $\frac{\partial \hat{\pi}(c,m)}{\partial m} > 0$.

To show that $\hat{\pi}(c, m)$ is decreasing in c, notice that $\frac{\partial Z(\hat{\pi}(c,m))}{\partial c} < 0$. This together with $\frac{\partial Z}{\partial \pi} < 0$ shows the last part of the lemma.

Finally, if $c > t^*$ notice that for all $t < c$, $(t-m)(1-F(t)-\pi(1-F(c))) > (t-m)(1-F(t))(1-\pi)$. Therefore, when $t_H = c$, $Z(\pi) < 0$ for all π and it follows that $\hat{\pi} = 0$. □

We state, without proof, the following simple result:

Lemma 1. *Let c be the cash price fixed by the supplier. Suppose that the supplier holds the belief that all buyer types apply for trade credit. Then the optimal trade credit price is $t^* = \hat{t}$.*

Let the $\sigma_i(P, c, m)$ the probability that buyer i, with price P, facing a cash price of c and a monitoring cost of m applies for a bank loan. Define a *pooling* strategy to be one in which for buyers i and j with $P_i, P_j > c$ and $P_i \neq P_j$, $\sigma_i(P_i, c, m) = \sigma_j(P_j, c, m) = \sigma(P)$.

Lemma 2. *If $c \in (\hat{c}, t^*)$ no pooling strategy can be part of an equilibrium of the continuation game.*

Proof. Suppose that a buyer of type $P > c$ observes $c \in (\hat{c}, \hat{t})$ and $\sigma(P) = 1$. Given her strategy, she must believe that $t > c$. On the other hand, given the proposed strategy of all high price buyers, the supplier believes that such buyers actually apply for bank credit. Therefore, by Observation 1, she will choose a trade credit price $t^* = t_L < c$ — a contradiction. Alternatively assume that the buyer observes $c \in (\hat{c}, \hat{t})$ and $\sigma(P) = 0$. In this case, she must anticipate $t \leq c$. In this proposed equilibrium, the supplier should correctly believe that all buyer types ask for trade credit. Therefore, by Lemma 1, she will set a trade credit price $t^* = \hat{t} > c$, again contradicting the presumption that we had an equilibrium.

The final case is the one in which $\sigma(P) \in (0,1)$. In this case, high price buyers must anticipate that $t = c$. The supplier's trade credit profit function at $t = c$ is $H(c) = (c-m)(1-F(c))(1-\pi\sigma(P))$. Now it can be easily seen that $H(c) < H(\hat{t})$, where $\hat{t}$ is as defined in Observation 1 — the unique argmax of the trade credit profit function. □

Lemma 3. *In any equilibrium with type-contingent strategies $t = c$, unless $\pi = 0$.*

Proof. The result is trivial for strictly mixed strategies. Therefore, consider the case in which two high price buyers P_i and P_j adopt different pure strategies. Without loss of generality let $\sigma(P_i) = 0$ and $\sigma(P_j) = 1$. Define $\mathbb{E}[\Pi(\sigma(P_k)]$ to be the expected profit of buyer k conditional on his strategy, $\sigma(P_k)$. Suppose to the contrary that $t > c$. Clearly, this cannot be an equilibrium since $\mathbb{E}[\Pi(0)] = P_i - t < \pi(P_i - c) + (1-\pi)(P_i - t) = \mathbb{E}[\Pi(1)]$ unless $\pi = 0$. Next suppose that $t < c$. Analogously, we have $\mathbb{E}[\Pi(1)] = \pi(P_i - c) + (1-\pi)(P_i - t) < P_i - t = \mathbb{E}[\Pi(0)]$. □

Lemma 4. *A type-contingent strategy profile $\sigma(P)$, $P \in supp(F)$, is is part of a type-contingent equilibrium if and only if:*

$$\sigma(c) = 0 \tag{8}$$

$$\pi \int_c^\infty \sigma(P)f(P)dP = 1 - F(c) - f(c)(c-m) \tag{9}$$

Proof. From the previous lemma we know that a necessary condition for any type-contingent equilibrium strategy is that $t = c$. We now show that (9) and (9) are necessary and sufficient to induce the supplier to opticriptsizey set $t = c$.

Consider the supplier profit function from trade credit:

$$(t-m)[1 - F(t) - \pi \int_t^\infty \sigma(x)f(x)dx] \tag{10}$$

The demand for trade credit in square bracket can be seen as the mass of people with $P > t$ minus those who already obtained the bank loan. Recall that $\sigma(P) = 0$ for $\forall P < c$. The left derivative of (10) at $t = c$ is equal to

$$1 - F(c) - \pi \int_c^\infty \sigma(x)f(x)dx - f(c)(c-m) \tag{11}$$

while the right derivative is:

$$1 - F(c) - \pi \int_c^\infty \sigma(x)f(x)dx - f(c)(c-m) + \pi\sigma(c)f(c)(c-m) \tag{12}$$

Given that (10) is continuous and concave, the function obtains its maximal value at $t = c$ if and only if 11 ≥ 0 and 12 ≤ 0. The result easily follows from this. □

Given the continuation strategy profile by buyers given by (1) and the supplier's response given by (2), let $G(c)$ denote the profit function of the supplier as a function of the cash price. Furthermore, define $\tilde{c} = \text{argmax}_{c \in (\hat{c}, t^*]} G(c)$.[13]

Lemma 5. $G(\tilde{c}) > G(t^*)$.

Proof. With some effort, one can show that for all $c \in (\hat{c}, t^*)$, $G(c) = (c-m)(1-F(c)) + mf(c)(c-m)$. Therefore, it is obvious that $G(\tilde{c}) = \max_{c \in (\hat{c}, t^*]}(c-m)(1-F(c)) + mf(c)(c-m) > \max(t-m)(1-F(t)) = G(t^*)$. □

[13]Under standard conditions, $\tilde{c}$ is assured to exist.

Lemma 6. *The supplier's equilibrium strategy is:*

$$\begin{aligned}
(c,t) &= (c^*,t^*), && \text{if } \hat{c} \geq c^* \\
(c,t) &= (\tilde{c},t^*), && \text{if } \hat{c} < c^* \text{ and } G(\hat{c}) < G(\tilde{c}) \\
(c,t) &= (\hat{c},t^*), && \text{if } \hat{c} < c^* \text{ and } G(\hat{c}) \geq G(\tilde{c})
\end{aligned} \tag{13}$$

Proof. The supplier's total profit function is:

$$G(c,t) = c\pi \int_0^\infty \sigma(P)f(P)dP + (t-m)[1 - F(t) - \pi \int_0^\infty \sigma(P)f(P)dP]$$

which, upon plugging the strategies into (1) and (2), and simplifying, can be written as:

$$G(c) = \begin{cases} c\pi(1-F(c)) + (t^*-m)(1-F(t^*))(1-\pi) & \text{for } c \leq \hat{c} \\ (c-m)(1-F(c)) + m\pi \int_c^\infty \sigma(P)f(P)dP & \text{for } c \in (\hat{c}, t^*] \\ (t^*-m)(1-F(t^*)) & \text{for } c \geq t^* \end{cases} \tag{14}$$

To prove the optimality of the first equation in (13) suppose that $\hat{c} \geq c^*$. Then $\max G(c)$ for $c \leq \hat{c}$ is $G(c^*) = c^*(1-F(c^*))\pi + (t^*-m)(1-F(t^*))(1-\pi) \geq (t^*-m)(1-F(t^*))$ if and only if $c^*(1-F(c^*)) \geq (t^*-m)(1-F(t^*))$, which is easily seen to be the case. We must also show that $G(c^*) \geq G(\tilde{c})$. Rewrite $G(c)$ for $c \in (\hat{c}, t^*]$:

$$c(1-F(c)) - m\int_c^\infty (1-\pi\sigma(P))f(P)dP \tag{15}$$

which can be shown to be scriptsizeer than $c(1-F(c))\pi + (c-m)(1-F(c))(1-\pi)$.[14]

To prove the optimality of the second equation in (13) recall from Lemma 5 that $G(\tilde{c}) \geq (t^*-m)(1-F(t^*))$. It is easily verified that if standard concavity conditions apply to the cash and trade credit profit functions and $\hat{c} < c^*$, then $\hat{c} = \text{argmax}_{c\leq\hat{c}} G(c)$. Therefore, if $G(\tilde{c}) \geq G(\hat{c})$ then $G(\tilde{c}) = \max G(c)$. The optimality of the third equation in (13) for the case in which $G(\hat{c}) \geq G(\tilde{c})$ follows easily. Finally, note that for $c \geq t^*$, $G(c)$ is constant. □

PROOF OF PROPOSITION 1.

The proof of this result proceeds by showing the existence of two thresholds, π_1 and π_2, such that if $\pi > \pi_1$, the supplier would rather close the trade credit window rather than choose $c = \tilde{c}$, while if $\pi > \pi_2$, the supplier would rather close the trade credit window rather than choose $c = \hat{c}$. Then, the threshold as

[14] Observe that $-m\int_c^\infty (1-\pi\sigma(P))f(P)dP \leq -m(1-\pi)(1-F(c))$; upon rearranging terms, the inequality becomes clear.

claimed in the statement of the proposition is $\hat{\pi}(m) = \max\{\pi_1, \pi_2\}$.

First, observe that the profit obtained by closing the trade credit window and choosing the optimal cash price is: $G(c^*|\text{cash only}) = \pi c^*(1 - F(c^*))$. Furthermore, recall that:

$$G(\tilde{c}) = \tilde{c}(1 - F(\tilde{c})) - mf(\tilde{c})(\tilde{c} - m) \quad (16)$$

$$G(\hat{c}) = \hat{c}(1 - F(\hat{c}))\pi + (t^* - m)(1 - F(t^*))(1 - \pi) \quad (17)$$

That $G(c^*|\text{cash only}) \geq (16)$ for π large enough is obvious once one realises that $\tilde{c}$ does not depend upon π. Therefore, we have that $\pi_1 = \frac{\tilde{c}(1-F(\tilde{c}))-mf(\tilde{c})(\tilde{c}-m)}{c^*(1-F(c^*))} < 1$.

That $G(c^*|\text{cash only}) \geq (17)$ for π large enough is also a straightforward calculation. Define $V(\pi) = \pi c^*(1 - F(c^*)) - \pi\hat{c}(1 - F(\hat{c})) - (t^* - m)(1 - F(t^*))(1 - \pi)$, and notice that $V(\pi)$ is continuous, $V(1) > 0$ and $V(0) < 0$. It can further be seen that $V'(\pi) > 0$ — hence the existence of π_2.

Finally, that the threshold is increasing in m, can easily be seen by examining (16) and (17) and observing that since both $\tilde{c}$ and $hatc$ are less than c^*, they are increasing in m. □

Proof of Proposition 2

Proof. First, observe that in equilibrium $c = 0$. If not, it can easily be seen that one supplier will always undercut the other so as to capture the entire cash market. To see that $t_{ij} = \max\{m_{ij}, \min\{m_{i,-j}, t^*_{ij}\}\}$ consider, WLOG, the maximization problem of supplier 1 with respect to buyer i: $\max_{t_{i1}}(t_{i1} - m_{i1})(1 - F(t_{i1}))$ subject to s.t. $t_{i1} \leq \max\{m_{i2}, m_{i1}\}$. The constraint comes from the fact that if $t_{i1} > m_{i2}$, then supplier 2 would find it optimal to undercut supplier 1 in order to serve buyer i. Obviously, if $m_{i2} < m_{i1}$ supplier 1 will set t_{i1} no scriptsizeer than m_{i1}.

Finally, the fact that in equilibrium the trade credit window is open follows trivially from the observation that if the trade credit window were closed, supplier profit would be zero since $c = 0$. □

Appendix B: Omitted Tables

Table 1: Descriptive Statistics

Variable	obs	Mean	Std. Dev	Min	Max
% goods sold on credit	599	46	41	0	100
# days of payment delay granted to customers	595	28	31	0	180
Employment	599	321	582	17	1800
# of competitors in subdistrict	599	12	27	1	182
% goods exported	599	10	25	0	99
log(1 + sales96)	599	14	2	9	20
log(10 + book value of fixed assets 96)	599	10	6	0	21
firm age in 96 (years)	599	12	11	0	80
interest expense on sales 96	599	2	6	0	1
% capacity usage in 96	599	71	26	0	100
# of firms in subdistrict 96	599	92	111	1	398
log(sales in subdistrict 96)	599	19	2	10	23
Average % of goods exported in subdistrict	599	11	21	0	99
% production capacity usage in subdistrict 96	599	70	20	0	100
% firm turnover in subdistrict 96	599	11	14	0	100

Table 2: Tobit Percent of Goods Sold on Trade Credit in Early 1997

	(1)	(2)	(3)
log(# of competitors in subdistrict)	13.919 (3.62)***	12.400 (3.6)***	13.295 (3.26)***
log(# of competitors in subdistrict)^2	-3.732 (4.27)***	-3.710 (4.25)***	-4.128 (4.36)***
% goods exported	-0.153 (2.05)**	-0.240 (2.36)**	-0.217 (2.08)**
log(1 + sales)	0.822 (0.96)	0.809 (.86)	1.333 (1.35)
log(10 + book value of fixed assets)	0.566 (1.87)*	0.587 (1.94)*	0.612 (1.91)*
log(# of firms in subdistrict)		5.798 (1.95)*	8.063 (2.62)***
log(sales in subdistrict)		-2.426 (1.45)	-4.253 (2.42)**
Average % of goods exported in subdistrict		0.187 (1.48)	0.171 (1.32)
% firm turnover in subdistrict		-31.543 (2.33)**	-27.936 (2.02)**
firm age (years)			-0.434 (2.57)**
% production capacity usage			-0.069 (0.65)
interest expense on sales			76.888 (2.69)***
% production capacity usage in subdistrict			-0.078 (0.59)
constant	24.245 (0.93)	50.362 (1.63)	97.016 (2.92)***
Observations	598	598	568
Log Likelihood	-1710.83	-1705.11	-1640.15

Absolute value of z-statistics in parentheses.

Marginal effects on the unconditional expected value of the dependent variable.

3-digit ISIC sector dummies and district dummies included in all specifications

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3: Percent of Goods Sold on Trade Credit in Early 1997

	Tobit (1)	Tobit (2)	Logit (3)
# of competitors in subdistrict	3.512 (2.11)**	-0.308 (3.60)***	
(# of competitors in subdistrict - 4)$\mathbb{I}(\#comp < 4)$	-3.846 (2.29)**		
monopoly			-0.805 (2.68)***
% goods exported	-0.210 (2.00)**	-0.212 (2.02)**	-0.004 (0.57)
log(1 + sales)	1.299 (1.32)	1.148 (1.17)	0.008 (0.11)
log(10 + book value of fixed assets)	0.621 (1.94)	0.598 (1.87)*	0.047 (2.14)**
log(# of firms in subdistrict)	7.734 (2.52)**	9.141 (3.04)***	0.252 (1.26)
log(sales in subdistrict)	-3.586 (2.07)**	-3.699 (2.13)**	-0.109 (0.91)
Average % of goods exported in subdistrict	0.162 (1.25)	(0.188) (1.46)	0.002 (0.26)
firm age (years)	-0.415 (2.47)**	-0.425 (2.53)**	-0.025 (2.15)**
interest expense on sales	82.237 (2.82)***	82.901 (2.81)***	12.080 (2.90)***
% production capacity usage in subdistrict	-0.119 (1.66)*	-0.113 (1.57)	-0.004 (0.82)
constant	83.917 (2.56)**	95.925 (2.96)***	21.507 (·)
Observations	568	568	499
Log Likelihood	-1643.99	-1646.63	-256.85

Absolute value of z-statistics in parentheses.

(1) & (2) Marginal effects on the unconditional expected value of the dependent variable.

3-digit ISIC sector dummies and district dummies included in all specifications

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: Tobit Percent of Goods Sold on Trade Credit in Early 1997

	(1)	(2)	(3)
# comp in subdistrict ≥ 2	11.882 (2.37)**	11.612 (2.30)**	10.226 (1.97)**
# comp in subdistrict ≥ 3	1.455 (0.22)	0.856 (0.13)	1.904 (0.28)
# comp in subdistrict ≥ 4	4.824 (0.65)	4.215 (0.56)	3.325 (0.44)
# comp in subdistrict ≥ 5	-3.185 (0.34)	-5.113 (0.55)	-3.366 (0.35)
# comp in subdistrict ≥ 6	0.340 (0.003)	-0.873 (0.08)	-0.316 (0.03)
# comp in subdistrict ≥ 7	-4.375 (0.35)	-4.559 (0.37)	-6.266 (0.48)
# comp in subdistrict ≥ 8	-0.798 (0.08)	0.775 (0.08)	2.484 (0.23)
(# comp in subdistrict)$\cdot\mathbb{I}$(comp ≥ 9)	-0.192 (2.50)**	-0.221 (2.80)***	-0.272 (3.04)***
% goods exported	-0.143 (1.90)*	-0.229 (2.21)**	-0.204 (1.90)*
log(1 + sales)	0.938 (1.06)	0.925 (0.96)	1.384 (1.36)
log(10 + book value of fixed assets)	0.579 (1.89)*	0.613 (2.00)**	0.618 (1.91)*
log(# of firms in subdistrict)		6.183 (2.06)**	8.173 (2.63)***
log(sales in subdistrict)		-2.437 (1.44)	-4.276 (2.40)**
Average % of goods exported in subdistrict		0.196 (1.51)	0.163 (1.22)
% production capacity usage in subdistrict		-0.136 (1.56)	-0.089 (0.67)
% firm turnover in subdistrict		-30.098 (2.20)**	-28.107 (2.01)**
interest expense on sales			77.042 (2.69)***
% production capacity usage			-0.064 (0.59)
firm age in 96 (years)			-0.424 (2.49)**
constant	25.653 (0.97)	64.395 (2.00)**	98.991 (2.95)***
Observations	599	599	569
Log Likelihood	-1709.63	-1702.67	-1639.78

Absolute value of z-statistics in parentheses.

Marginal effects on the unconditional expected value of the dependent variable.

3-digit ISIC sector dummies and district dummies included in all specifications

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: Analysis of the "Big Jump"

	Tobit (1)	Probit (2)	Tobit (3)
# comp in subdistrict ≥ 2	10.696 (2.11)**	0.171 (2.12)**	-3.277 (0.81)
# comp in subdistrict ≥ 3	0.785 (0.1)	0.022 (0.21)	1.084 (0.22)
# comp in subdistrict ≥ 4	5.334 (0.72)	0.014 (0.12)	7.058 (1.22)
# comp in subdistrict ≥ 5	-3.146 (0.33)	-0.053 (0.38)	-2.441 (0.32)
# comp in subdistrict ≥ 6	-1.599 (0.14)	-0.091 (0.53)	3.502 (0.38)
# comp in subdistrict ≥ 7	-4.363 (0.35)	0.083 (0.45)	-1.175 (0.12)
# comp in subdistrict ≥ 8	-2.769 (0.29)	-0.041 (0.26)	-6.625 (0.87)
(# comp in subdistrict)$\cdot\mathbb{I}$(comp ≥ 9)	-0.228 (2.85)***	-0.003 (2.49)**	-0.051 (0.79)
log(# of firms in subdistrict)	3.637 (1.79)*	0.057 (1.99)**	-0.972 (0.70)
log(1 + sales)	0.672 (0.75)	-0.004 (0.29)	1.398 (1.91)*
log(10 + book value of fixed assets)	0.567 (1.86)*	0.011 (2.47)**	-0.203 (0.83)
% goods exported	-0.124 (1.64)	-0.001 (0.99)	-0.080 (1.22)
constant	22.029 (0.84)	5.933 (5.35)***	27.901 (2.64)***
Observations	599	528	372
Log Likelihood	-1707.92	-281.31	-1358.93

Absolute value of z-statistics in parentheses.

(1) dependent variable: % goods sold on credit; M.E. on the unconditional expected value.

(2) dependent variable: 1 if some goods are sold on trade credit; 0 o/w.

(3) dependent variable: % of goods sold on trade credit if positive; M.E..

3-digit ISIC sector dummies and district dummies included in all specifications

* significant at 10%; ** significant at 5%; *** significant at 1%

TABLE 6: Alternative Geographical Areas

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
log(# of competitors in country 96)	18.818 (1.13)	18.597 (1.12)	18.427 (1.11)	19.083 (1.15)	18.981 (1.14)	18.411 (1.24)	18.068 (1.22)	2.451 (1.06)	
log(# of competitors in country)^2	-1.437 (0.91)	-1.430 (0.91)	-1.421 (0.90)	-1.489 (0.95)	-1.474 (0.94)	-1.420 (1.02)	-1.484 (1.07)		
log(# of competitors in province)	-5.398 (0.67)	-5.141 (0.64)	-4.884 (0.60)	-3.093 (0.43)	-1.717 (0.24)	-1.228 (0.40)			
log(# of competitors in province)^2	0.291 (0.30)	0.286 (0.30)	0.256 (0.27)	0.036 (0.04)	0.65 (0.08)				
log(# of competitors in district)	5.703 (0.97)	5.576 (0.94)	5.460 (0.93)	2.961 (0.97)					
log(# of competitors in district)^2	-0.522 (0.55)	-0.507 (0.53)	-0.470 (0.50)						
log(# of competitors in village)	-3.787 (0.36)	2.739 (0.68)							
log(# of competitors in village)^2	1.725 (0.66)								
log(# of competitors in subdistrict)	11.285 (2.19)**	9.946 (2.10)**	10.435 (2.24)**	11.192 (2.53)**	12.970 (3.23)***	12.942 (3.23)***	12.711 (3.21)***	12.937 (3.27)***	13.919 (3.62)***
log(# of competitors in subdistrict)^2	-3.647 (3.21)***	-3.356 (3.22)***	-3.179 (3.15)***	-3.402 (3.76)***	-3.540 (3.95)***	-3.528 (4.00)***	-3.534 (4.00)***	-3.638 (4.15)***	-3.732 (4.27)***
% goods exported	-0.155 (2.06)**	-0.159 (2.11)**	-0.157 (2.09)**	-0.157 (2.09)**	-0.158 (2.11)**	-0.158 (2.12)**	-0.160 (2.15)**	0.156 (2.09)**	-0.153 (2.05)**
log(1 + sales)	0.826 (0.96)	0.862 (1.00)	0.837 (0.97)	0.837 (0.97)	0.870 (1.01)	0.867 (1.01)	0.858 (1.00)	0.874 (1.02)	0.822 (0.96)
log(10 + book value of fixed assets)	0.579 (1.91)*	0.589 (1.94)*	0.588 (1.94)*	0.588 (1.94)*	0.591 (1.94)*	0.591 (1.95)*	0.600 (1.98)**	0.578 (1.91)*	0.566 (1.87)*
Constant	-24.428 (0.51)	-28.791 (0.60)	-26.537 (0.56)	-28.701 (0.60)	-31.536 (0.66)	-31.225 (0.66)	-29.192 (0.62)	9.651 (0.33)	24.245 (0.93)
Observations	598	598	598	598	598	598	598	598	598
Log Likelihood	-1708.56	-1708.78	-1709.02	-1709.14	-1709.61	-1709.61	-1709.69	-1710.26	-1710.83

Absolute value of z-statistics in parentheses.

3-digit ISIC sector dummies and district dummies included in all spec.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 7: Estimates at District Level

	(1)	(2)
log(# of competitors in district)	10.287 (2.62)***	
log(# of competitors in district)^2	-1.543 (2.35)**	
# comp in district ≥ 2		6.588 (0.70)
# comp in district ≥ 3		11.392 (1.30)
# comp in district ≥ 4		-11.617 (1.11)
# comp in district ≥ 5		9.662 (0.86)
# comp in district ≥ 6		-5.345 (0.42)
# comp in district ≥ 7		-8.196 (0.60)
# comp in district ≥ 8		15.522 (1.57)
(# comp in district)$\cdot\mathbb{I}$(comp ≥ 9)		-0.020 (0.82)
% goods exported	-0.166 (2.11)**	-0.164 (2.06)**
log(1 + sales)	2.032 (2.26)**	1.991 (2.19)**
log(10 + book value of fixed assets)	0.596 (1.97)**	0.621 (2.03)**
Constant	-46.486 (3.15)***	-48.436 (3.14)***
Observations	599	599
Log Likelihood	-1789.54	-1787.68

Absolute value of z-statistics in parentheses.

3-digit ISIC sector dummies and province dummies included in all spec.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 8: Market Shares

	(1)	(2)
Market share in subdistrict	42.310 (2.00)**	41.919 (1.98)**
(Market share in subdistrict)^2	-50.874 (2.59)***	-45.492 (2.290**
Market share in district		-9.242 (1.06)
Market share in province		-5.932 (0.36)
Market share in country		-28.793 (0.57)
% goods exported	-0.232 (2.22)	-0.237 (2.26)**
log(1 + sales)	0.677 (0.64)	1.228 (1.12)
log(10 + book value of fixed assets)	0.745 (2.41)**	0.779 (2.51)**
log(# of firms in subdistrict)	2.765 (0.98)	3.321 (1.17)
log(sales in subdistrict)	-1.034 (0.61)	-1.035 (0.61)
Average % of goods exported in subdistrict	0.210 (1.61	0.212 (1.62)
Constant	49.438 (1.60)	41.346 (1.32)
Observations	595	595
Log Likelihood	-1705.36	-1703.73

Absolute value of z-statistics in parentheses.

* significant at 10%; ** significant at 5%; *** significant at 1%

TABLE 9: Industry Analysis

	All Sectors	w/o metal product & machines	Food	Textile	Chemical & plastic prods	Metal product & machines
	(1)	(2)	(3)	(4)	(5)	(6)
log(# of firms in subdistrict)	12.428	7.911	7.386	3.382	9.206	62.386
	(3.16)***	(2.02)**	(1.36)	(0.43)	(0.11)	(2.47)**
log(# of firms in subdistrict)^2	-3.726	-3.057	-2.973	-2.070	-2.783	-17.087
	(4.27)***	(3.55)***	(1.29)	(1.45)	(0.78)	(2.04)**
log(1 + sales)	0.577	0.198	-0.788	2.584	1.244	1.229
	(0.67)	(0.23)	(0.96)	(1.39)	(0.71)	(0.37)
log(10 + book value of fixed assets)	0.554	0.515	0.420	-0.651	-0.306	1.825
	(1.83)*	(1.70)*	(1.49)	(0.87)	(0.56)	(1.67)*
log(# of firms in subdistrict)	3.421	3.641	3.858	-1.441	11.651	6.466
	(1.71)*	(1.86)*	(2.16)**	(0.35)	(3.23)***	(0.67)
% goods exported	-0.135	-0.135	-0.102	-0.062	0.004	-0.148
	(1.79)*	(1.85)*	(1.50)	(0.51)	(0.02)	(0.18)
Constant	20.718	30.098	11.457	17.522	-3.821	-139.187
	(0.79)	(1.19)	(0.52)	(0.58)	(0.11)	(1.82)*
Observations	598	549	209	154	186	49
Log Likelihood	-1709.36	-1581.48	-609.28	-404.93	-540.19	-115.86

Absolute value of z-statistics in parentheses.

3-digit ISIC sector dummies and district dummies included in all spec, except (6) where province dummies were used.

Marginal effects on the unconditional expected value of the dependent variable.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 10: Fixed-Effects Estimates

	Sub-district Random Effects (Logit) (1)	Sub-district Fixed Effects (Logit) (2)	Sub-district Fixed Effects (OLS) (3)
log(# of competitors in subdistrict)	0.753 (3.00)***	0.821 (2.09)**	14.875 (2.41)**
log(# of competitors in subdistrict)^2	-0.219 (3.83)***	-0.247 (2.55)**	-4.218 (3.01)***
% goods exported	-0.003 (0.50)	0.000 (0.02)	0.046 (0.42)
log(1 + sales)	0.012 (0.18)	0.040 (0.50)	0.904 (0.73)
log(10 + book value of fixed assets)	0.047 (2.30)**	0.021 (0.76)	0.209 (0.49)
log(# of firms in subdistrict)	0.296 (1.48)		
log(sales in subdistrict)	-0.034 (0.30)		
Average % of goods exported in subdistrict	-0.007 (0.82)		
% production capacity usage	-0.008 (1.32)		
Constant	18.604 (0.00)		
Observations	599	276	598
Log Likelihood†	-292.66	-103.68	0.0577

Absolute value of z-statistics in parentheses.

(1) & (2) dependent variable: 1 if some goods are sold on trade credit; 0 o/w

(3) dependent variable: % goods sold on T.C.

* significant at 10%; ** significant at 5%; *** significant at 1%

† (3) actually reports the R^2.