

# FIRMS' TRADE-FINANCING DECISIONS DURING CRISES

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Firms procure funds not only from specialized financial intermediaries, but also from suppliers, generally by delaying payments. The empirical evidence on trade credit raises questions that are hard to reconcile with existing theories:

- What justifies the widespread use of trade credit by financially unconstrained firms that have access to seemingly cheaper alternative sources?
- Why is the reliance on trade credit not always increasing in the degree of credit rationing?
- Does input lending affect the borrower's choice of inputs?
- Does the degree of creditor protection affect financing and input choices?

This chapter addresses these questions in a unified framework.

A consensus exists that trade credit is most common among firms that face borrowing constraints. This follows from the assumption that trade credit is more expensive than bank loans. According to this view, reliance on trade credit should increase in credit rationing, but the empirical evidence is not generally consistent with this common belief. Large U.S. firms (presumably less likely to be credit-constrained) rely more heavily than small firms on trade credit, with accounts payable averaging 11.6 percent and 4.4 percent of sales for large and small firms, respectively (Petersen and Rajan 1997). Similarly, in the Italian manufacturing sector, trade credit finances, on average, 38.1 percent of the

input purchases of nonrationed firms and 37.5 percent of rationed ones (Marotta 2005).

A common feature in the use of trade credit, which is independent of the degree of credit rationing, is that the supplier's lending is tied closely to the value of the input. Given that not all inputs can be purchased on account, trade credit is likely to go together with some bias in the input combination. This relation seems to be confirmed by scattered evidence on financing and technological choices. Some papers find greater use of trade credit in countries with less creditor protection, such as developing countries (Rajan and Zingales 1995; La Porta et al. 1998; Demirgüç-Kunt and Maksimovic 2001; Fisman and Love 2003). Further evidence shows that firms in developing countries have a higher proportion of fixed assets and fewer intangibles than firms in developed countries (Demirgüç-Kunt and Maksimovic 1999). Although fragmented, these findings suggest a cross-country correlation between financing and input choices and identify the degree of creditor protection as a possible explanation.

To account for the foregoing stylized facts, we propose a model with collateralized bank and trade credit. Firms face uncertain demand and choose between two inputs with different degrees of observability and collateral value: tangibles and intangibles. Firms are opportunistic in that they can divert borrowed resources for private uses, but they get a lower return when diverting inputs instead of cash. Borrowers' opportunism might generate credit constraints.

Firms choose between two types of financier: banks and suppliers. Banks are specialized intermediaries and have a cost advantage in providing finance. Suppliers have both information and liquidation advantages in providing finance. The information advantage derives from suppliers' ability to observe costlessly that an input transaction has taken place. Coupled with the lower profitability of input diversion, this advantage mitigates borrowers' opportunism and relaxes firms' financial constraints. The liquidation advantage derives from the suppliers' ability to extract a greater liquidation value from the inputs collateralized in case of default. Uncertainty and multiple inputs in a model with moral hazard are the key notions used to address the open questions above.

An original feature of the model presented here is the explanation of why firms with unused lines of bank credit could demand trade credit: even they could benefit from the liquidation advantage of their suppliers. This advantage makes trade credit cheaper than bank loans, offsetting the banks' lower cost of funds.

The liquidation advantage is sufficient by itself to explain the demand for trade credit by financially unconstrained firms. The interaction between the liquidation and the information advantages helps show why reliance on trade credit does not always increase with the stringency of financing constraints. Financially constrained firms could take trade credit for both reasons. If it is for the incentive

(to relax financial constraints), credit-rationed firms finance a larger share of their inputs by trade credit than do nonrationed firms, as theoretical literature holds. Conversely, when the liquidation motive dominates, the share of inputs purchased on account remains constant across firms with different degrees of credit rationing.

Regardless of the motives underlying the use of trade credit, suppliers always finance the inputs they sell but they never lend cash. The absence of cash lending by suppliers implies that trade credit can be used to finance only specific inputs, which in this setting are tangibles. It follows that whenever trade credit is used to relax financial constraints, a credit-rationed business can benefit from it only by distorting its input combination. This introduces a link between financing and input decisions, which the authors explore here to derive new predictions. More intensive use of trade credit goes together with a technology biased toward tangible assets, and the bias increases as the legal protection of creditors weakens. These predictions reconcile the scattered international evidence.

The chapter is related to the literature on trade credit that has sought to explain why agents should want to borrow from firms rather than from financial intermediaries. The traditional explanation is that trade credit facilitates the transaction (Ferris 1981; Brennan, Maksimovic, and Zechner 1988; Long, Malitz, and Ravid 1993; Summers and Wilson 2002) and relaxes borrowing constraints (Biais and Gollier 1997; Burkart and Ellingsen 2004), thus playing both nonfinancial and financial roles. What these theories fail to explain is why trade credit is also used by financially unconstrained firms and why resorting to trade credit does not necessarily increase with the severity of financial constraints, as the empirical literature shows.

This chapter proposes a new rationale for trade credit use in the liquidation advantage that suppliers have over other creditors, and it claims that when that advantage exceeds the bank's intermediation advantage, trade credit is used by rationed and unrationed firms alike.

Finally, the literature has disregarded the relationship between financing and input decisions and offered no explanation of why firms lend only inputs. The use of a multi-input technology allows us to fill these gaps.

## The Model

A risk-neutral entrepreneur has an investment project that uses a tangible and an intangible input. The tangible input can be interpreted as raw material and physical capital, and intangibles as skilled labor. Inputs can be purchased  $q$  and then invested in the production process  $I$ . The amount of input purchased is observed only by the suppliers, while the amount invested is totally unobservable and is

converted into a verifiable output whose value depends on the demand conditions. At times of high demand, with probability  $p$ , invested inputs produce output according to an increasing and concave production function  $f(I_p, I_m)$ . At times of low demand, there is no output, and the firm's worth is only the scrap value of unused inputs.

The entrepreneur is a price taker in both the input and output markets. The output price is normalized to 1, and so are the prices of tangible and intangible inputs.

To carry out the project, the entrepreneur uses observable internal wealth  $A$  as well as external funding from competitive banks  $L_B$  or suppliers  $L_S$  or both. Banks lend cash. The supplier of intangibles provides the input, which is fully paid for in cash. The supplier of tangibles sells the input but can also act as a financier, lending both inputs and cash.

### *Moral Hazard*

Unobservability of investment to all parties, and of input purchases to parties other than the supplier, raise a problem of moral hazard. The entrepreneur might not invest the funds raised, either in cash or in-kind, in the venture but divert them to private uses. This problem limits the amount of credit the entrepreneur can obtain from financiers. However, the supplier can observe whether inputs have been purchased. This advantage, together with the lesser liquidity of inputs than cash, implies that moral hazard is less severe when funding comes from the supplier and not the bank.

In particular, one unit of cash gives the entrepreneur a return  $\phi < 1$  if diverted, where  $\phi$  can be interpreted as the degree of vulnerability of creditor rights; one unit of the tangible input  $q_t$  gives a return  $\phi\beta_t$  if diverted, where  $\beta_t < 1$  denotes the tangible input liquidity. When  $\beta_t$  is close to 1, the input can be resold at near the purchase price and converted into a monetary benefit. Last, diverting the intangible input gives a zero return.

### *Collateral Value*

Tangible inputs have value when repossessed in default, while intangibles have zero collateral value. Hence, the total value of pledgeable collateral is  $I_t$ . However, different financiers have different liquidation abilities. We define  $\beta_i I_t$  as the liquidation value extracted by a given financier in case of default, with  $i = B$ , and  $S$  referring to the bank or supplier. The supplier has a better knowledge of the resale market, so we assume  $\beta_S > \beta_B = 0$ , for simplicity. This makes it always efficient to pledge the collateral to the supplier in case of default.

Finally, the cost of raising one unit of funds on the market is assumed to be higher for the supplier than for the bank ( $r_B < r_S$ ). This is consistent with the special role of banks.

### **Contracts**

The entrepreneur-bank contract specifies the credit granted by the bank  $L_B$  and the entrepreneur's repayment obligation in case of high-demand  $R_B$ . The contract between the entrepreneur and the supplier of the tangible input specifies the credit granted by the supplier  $L_S$ , the input provision  $q_p$  and the entrepreneur's repayment obligation  $R_S$  in case of high demand. Unlike the bank, the supplier can condition the contract also on the input purchase  $q_t$ . Last, given that the intangible input is fully paid for when purchased, the contract between entrepreneur and supplier specifies the amount of the input purchased,  $q_m$ . All parties have limited liability protection.

The sequence of events is as follows:

1. Banks and suppliers make contract offers specifying the size of the loan, the repayment obligations, and the amount of inputs purchased,  $q_p, q_m$ .
2. The entrepreneur chooses among contract offers.
3. The investment or diversion decisions are taken,  $I_p, I_m$ ; uncertainty resolves.
4. Repayments are made.

### **The Optimization Problem**

Firms carry out production, which is financed with internal funds, with the cash provided by banks or with the cash or in-kind resources lent by suppliers of the tangible input. Because banks have a comparative advantage in raising funds ( $r_B < r_S$ ), entrepreneurs would prefer bank financing to trade credit. However, trade credit has two advantages relative to bank's financing: First, the supplier is better at liquidating the inputs if repossessed from a defaulting firm. Second, lending inputs rather than cash reduces the scope for diversion due to their lower liquidity and thus mitigates the entrepreneur's moral hazard problem.

So trade credit arises from two motives: a liquidation motive (to exploit the supplier liquidation technology) and an incentive motive (to relax financial constraints created by moral hazard problems). In this section, we discuss the conditions under which each of the two motives becomes relevant and the way they interact.

Firms maximize profits, which can be split into two components: the returns from production ( $EP$ ) and from diversion ( $D$ ). The expected return from production is

$$EP = p \{f(I_p I_{nt}) - R_B - R_S\}. \quad (2.1)$$

The return from diversion is

$$D = \phi \{ \beta_t (q_t - I_t) + (A + L_B + L_S - q_t) \}$$

where the term in round brackets denotes the return from tangible input diversion, net of the amount invested in production, and that in square brackets denotes the return from residual cash diversion (the amount of cash not spent on the input purchase).

Because intangibles have zero liquidity, an opportunistic entrepreneur purchases only tangibles ( $q_t \geq I_t \geq 0$ ) and never intangibles for diversion ( $q_{nt} = I_{nt} = 0$ ). Moreover, because the diversion technology is inefficient ( $\phi < 1$ ), partial diversion is never optimal. Thus, either all funds (and inputs) are used for investment ( $D = 0$ ) or they are diverted, in which case none of the purchased inputs is invested:  $I_t = 0$ .

To prevent the entrepreneur from diverting all resources in equilibrium, the return from investment must exceed the maximum return from cash and input diversion, that is

$$EP \geq \phi (A + L_B), \quad (2.2)$$

$$EP \geq \phi [\beta_t q_t + A + L_B - (q_t - L_S)], \quad (2.3)$$

where (2.2) is the incentive constraint in relation to the bank, which prevents the entrepreneur from diverting internal funds as well as the credit raised from the bank, while (2.3) is the incentive constraint in relation to the supplier, preventing the entrepreneur from diverting inputs, plus any spare cash left after the input purchase. If the above constraints hold, there is no diversion in equilibrium, so that  $D = 0$  and  $q_t = I_t$ .

Banks and suppliers participate in the venture if their expected returns cover at least the opportunity cost of funds:

$$pR_B = L_B r_B \quad (2.4)$$

$$pR_S + (1 - p)\beta_S C = L_S r_S. \quad (2.5)$$

To make the problem interesting, we assume that creditor protection is sufficiently poor ( $\phi$  high) to constrain the investment of a zero-wealth entrepreneur.

The rest of this section derives two types of demand for trade credit: (a) a demand for liquidation, arising from the supplier's liquidation advantage and

depending on the collateral value of the firm's assets, and (b) a demand for incentive, arising from the informational advantage and depending on the firm's borrowing constraints and input liquidity.

**The Liquidation Motive**

Assume that conditions (2.2) and (2.3) are slack; (2.4), (2.5), and (2.6) identify the liquidation motive *LM* for trade credit demand. Because  $\beta_S > \beta_B$ , pledging the collateral to the supplier relaxes its participation constraint more than the bank's. As a consequence, the total repayment due from the entrepreneur in the good state decreases, and total surplus increases. However,  $r_B < r_S$  implies that the entrepreneur prefers bank credit to trade credit, that is,  $L_S = 0$ . Having the supplier acting as a liquidator without taking trade credit implies, using equation (2.5), that  $R_S < 0$ . Because the interest is in the supplier's role as financier, such contracts are not allowed for and repayment is required to be nonnegative (equation [2.6] holds):

$$R_S = \beta_S C. \tag{2.6}$$

Solving equation (2.5) for  $R_S$ , condition (2.6) implies a lower bound on trade credit demand equal to the collateral value of the inputs pledged to the supplier:

$$L_S = (\beta_S / r_S) I_t. \tag{2.7}$$

Condition (2.7) sets the trade credit demand for liquidation motives  $L_{S,LM}$  equal to the discounted value of the collateral to the supplier.

**The Incentive Motive**

In addition to extracting more value from assets, trade credit can relax the entrepreneur's financial constraints. Because diverting inputs is less profitable than diverting cash, the supplier is less vulnerable than banks to borrowers' opportunism and could thus be willing to provide credit when the bank is not (condition [2.2] is binding). In this case, the demand for trade credit is above the level defined by condition (2.7), and trade credit is taken for incentive motives. However, suppliers are not willing to meet all possible requests because supplying too many inputs on credit could induce the entrepreneur to divert them all. The maximum trade credit extended for incentive motives *IM* is

$$L_{SIMmax} = (1 - \beta_t) I_b \tag{2.8}$$

which obtains when both incentive constraints (conditions [2.2] and [2.3]) are binding.  $(1 - \beta_t)$  measures the extent to which the supplier's informational advantage reduces moral hazard. If inputs are as liquid as cash ( $\beta_t = 1$ ), this advantage is ineffective. The supplier cannot offer any trade credit when banks ration cash. Conversely, if inputs are illiquid, the informational advantage becomes important. The maximum line of trade credit is positive, and the less liquid the inputs, the greater the line of credit.

From the foregoing, it follows that two regimes could arise, depending on whether the demand for liquidation motives  $LM$  (2.7) exceeds the maximum credit line extended for incentive motives  $IM$  (2.8). This condition can be redefined exclusively in terms of the parameters of the model as follows:

$$\beta_s/r_s - (1 - \beta_s) \begin{matrix} \leq \\ > \end{matrix} 0. \quad (2.9)$$

When inputs are illiquid ( $\beta_t$  low) or have low salvage value ( $\beta_s$  low), the incentive motive outweighs the liquidation motive ( $IM > LM$ ) and condition (2.9) is strictly negative. Vice versa, when inputs are liquid ( $\beta_t$  high) or have high collateral value ( $\beta_s$  high), the liquidation motive outweighs the incentive motive ( $LM \geq IM$ ) and condition (2.9) is weakly positive.

## Results

Our results are presented in three parts. The first subsection identifies two regimes and examines how trade credit varies with the entrepreneur's wealth between regimes. The second focuses on the trade credit demand of financially unconstrained firms. The third investigates the relation between financing, technology, and borrowing constraints.

### *Trade Credit and Two Alternative Regimes*

As shown in the previous section, trade credit could be taken for liquidation or for incentive reasons. The way these two motives interact across different levels of wealth depends on inequality (2.9). When strictly negative, wealthy entrepreneurs take trade credit for liquidation motives, and the less-wealthy take trade credit for incentive motives. The share of inputs purchased on credit is nonincreasing in wealth and larger for entrepreneurs that are credit-rationed. We define this regime as the *dominant incentive motive*. When inequality (2.9) is positive or zero, all entrepreneurs, regardless of wealth, take trade credit for liquidation reasons, and the share of inputs purchased on credit is



the same for rationed and nonrationed firms. We define this regime as the *dominant liquidation motive*.

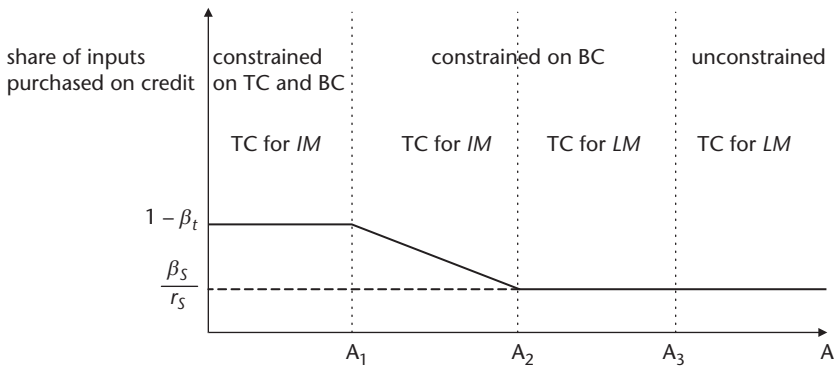
Our theoretical results reconcile an apparent conflict between the theoretical literature and the empirical evidence. On the one hand, in arguing that trade credit mitigates credit rationing by banks, the theoretical literature has highlighted a positive relationship between trade credit and borrowing constraints (Biais and Gollier 1997; Burkart and Ellingsen 2004). On the other hand, some empirical literature finds that reliance on trade credit is practically unaffected by the degree of credit rationing (Petersen and Rajan 1997; Marotta 2005). This section accounts for both these cases.

**Dominant incentive motive**

The dominant incentive motive regime is illustrated in figure 2.1. The population of entrepreneurs is distributed into four wealth areas with different degrees of credit rationing. For each area, the figure shows the motive for trade credit demand (liquidation or incentive) and the share of inputs purchased on account.

Sufficiently rich entrepreneurs ( $A \geq A_3$ ) finance the first-best investment by taking a constant amount of trade credit, equal to the discounted value of collateralized assets, and a variable amount of bank credit.<sup>1</sup> Each unit of trade credit below this amount costs less than bank credit because the supplier exploits the

**Figure 2.1** Regime where the Incentive Motive Dominates



Source: Authors.

Note: The figure shows the degree of credit rationing and the motive for trade credit demand for different levels of wealth ( $A$ ). Entrepreneurs can be constrained on trade credit (TC), or bank credit (BC), or be unconstrained. TC can be demanded for an incentive motive (IM) or a liquidation motive (LM). The solid line shows the share of inputs purchased on credit for different levels of wealth.  $1 - \beta_t$  is the proportion of inputs that cannot be diverted, and  $\beta_S/r_S$  is the scrap value of collateral inputs.

greater liquidation revenues accruing in the bad state to decrease the repayment required in the good state.

The price of one unit of trade credit and bank credit is given by  $r_S$  and  $r_B/p$ , respectively. An extra unit of trade credit above the level set in equation (2.7) costs more than bank credit because there is no more collateral to pledge. This is the amount of trade credit for liquidation motives. As wealth comes down toward  $A_3$ , trade credit stays constant while bank credit increases to compensate for the lack of internal wealth, as follows:

- For  $A < A_3$ , the loan needed to finance the first-best investment implies a large repayment obligation that leaves the entrepreneur with a return lower than the return from diversion. Banks must therefore ration the entrepreneur to prevent opportunistic behavior, hence credit rationing. Suppliers are still willing to sell inputs on credit because they face a less severe incentive problem.
- For  $A_2 \leq A < A_3$ , however, firms do not yet increase trade credit demand because the cost of an extra unit is still higher than the cost of bank credit. Thus, they are forced to reduce the investment below the first-best, and also trade credit and bank finance, but they keep the share of inputs purchased on account constant.
- For  $A < A_2$ , the shadow cost of bank credit exceeds the marginal cost of trade credit. Firms start demanding trade credit also for incentive motives, that is, to relax financial constraints. Thus, bank credit stays constant, but both trade credit and the share of tangible inputs purchased on account rise to their maximum. This is reached at  $A = A_1$ , when the incentive constraint in relation to the supplier also binds.
- For  $A < A_1$ , the entrepreneur is constrained on both credit lines and forced to reduce investment further. Both trade and bank credit decrease, but the share of inputs purchased on credit stays constant at its maximum  $(1 - \beta_t)$ .

In summary, across the wealth areas described in figure 2.1, the share of inputs purchased on account is nondecreasing in credit rationing.

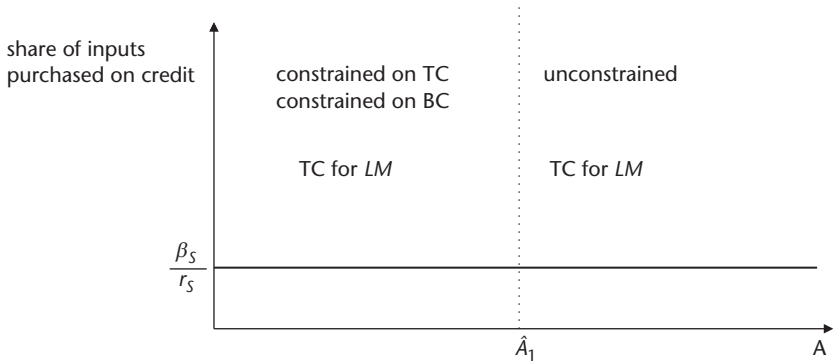
### Dominant liquidation motive

Figure 2.2 illustrates the dominant liquidation motive regime and has the same interpretation as figure 2.1.

In this regime, there are only two wealth areas:

- For  $A \geq \hat{A}_1$ , firms are wealthy enough to finance the first-best investment without exhausting their credit lines. They use a constant amount of trade

**Figure 2.2** Regime where the Liquidation Motive Dominates



Source: Authors.

Note: The figure shows the degree of credit rationing and the motive for trade credit demand for different levels of wealth ( $A$ ). Entrepreneurs can be constrained on trade credit (TC), or bank credit (BC), or be unconstrained. Trade credit is demanded for a liquidation motive ( $LM$ ). The solid line shows the share of inputs purchased on credit for different levels of wealth.  $\beta_S/r_S$  is the scrap value of collateral inputs.

credit, equal to the scrap value of collateral assets and, as wealth decreases, an increasing amount of bank credit. The funding from banks ceases when  $A = \hat{A}_1$ . Because the amount of inputs financed on credit is large, the total funding obtained is so great that an extra amount of it induces the entrepreneur to divert all resources.

- Thus, for  $A < \hat{A}_1$ , being financially constrained on both credit lines, entrepreneurs are forced to reduce both sources of external financing as well as the investment level. In contrast with the previous regime (the dominant incentive motive), they keep financing a constant share of input by trade credit equal to  $\beta_S/r_S$  for any level of wealth. They have no incentive to alter it because this would increase the total cost of financing. Each unit of trade credit above the scrap value is more expensive than bank loans. Similarly, each unit below this amount can be replaced only by more costly bank credit.

Thus, in contrast with earlier financial theories, trade credit use is independent of financial constraints: both rationed and nonrationed firms purchase the same share of inputs on account, as the empirical evidence to date indicates. In this second regime, trade credit is never demanded to mitigate borrowing constraints but only for liquidation motives.

*Trade Credit Demand of Financially Unconstrained Firms*

The right sides of figures 2.1 and 2.2 describe the use of trade credit by unconstrained firms and deliver a common prediction: financially unconstrained firms take trade credit to exploit their suppliers' liquidation advantage. The amount of trade credit used equals the collateral value of tangible inputs pledged to the supplier.

This result also posits that the use of trade credit is bound to the value of the inputs as collateral, in line with Mian and Smith (1992) and Petersen and Rajan (1997), because the supplier's liquidation advantage makes trade credit cheaper than bank loans only up to this collateral value. Therefore, this liquidation story requires that the input has a positive collateral value; it is worth sufficiently more to the supplier than to the bank in case of default, which implies the supplier's contractual seniority; and the bankruptcy law does not alter the contractually agreed-on claims held by creditors. It follows that whether the liquidation motive arises depends on traded goods characteristics—in that not all goods have a liquidation value in case of default—as well as the characteristics of the legal system.<sup>2</sup>

This result also implies that, even though the opportunity cost of funds is higher for input suppliers than for banks, trade credit can be cheaper than bank loans. This finding contrasts with the rather high interest rates implied by standard buyer-seller agreements generally cited in the related literature. In line with this prediction, several recent papers show that trade credit can be cheaper than bank loans (for example, Fabbri and Klapper 2009).

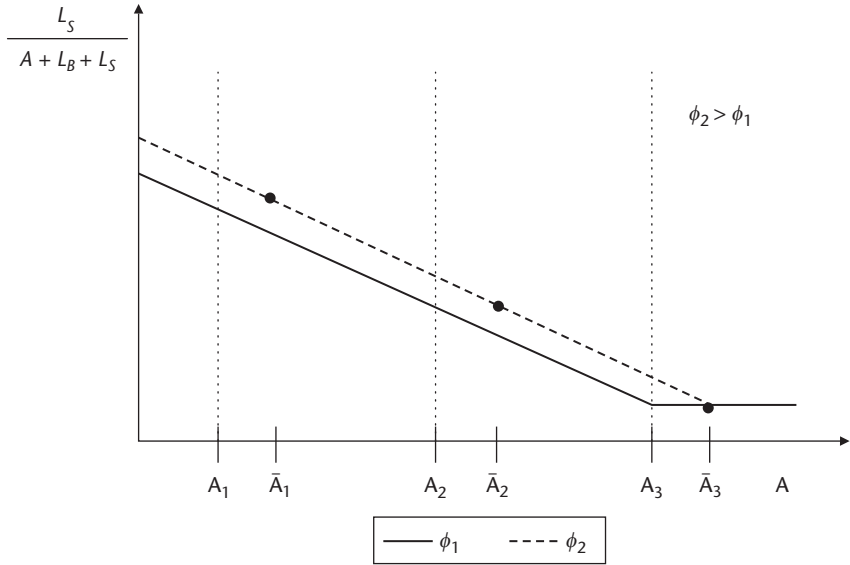
*Input Tangibility, Financial Decisions, and Creditor Protection*

Regardless of the motives underlying the use of trade credit, suppliers always finance the inputs they sell, but they never lend cash. It follows that when a constrained entrepreneur uses trade credit to relax a borrowing constraint, he also distorts the input mix toward tangibles. This implies a link between financing and input choices across different levels of wealth and borrowing constraints.

In particular, greater use of trade credit goes together with an input bias toward tangible assets, and the bias becomes stronger when creditor vulnerability increases. The intuition is that because bank credit is more sensitive than trade credit to moral hazard, weaker creditor protection raises the relative cost of bank financing. Rationed entrepreneurs consequently rely more on trade credit and tangible inputs.

Figures 2.3 and 2.4 display trade credit intensity and input tangibility, respectively, for different wealth levels.

**Figure 2.3** Trade Credit Intensity, Wealth, and Creditor Protection



Source: Authors.

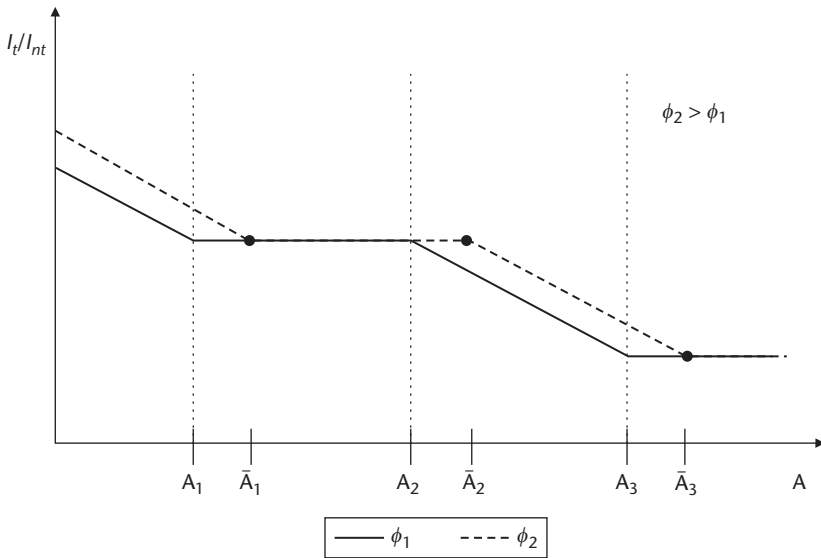
Note: The figure shows trade credit intensity  $[L_S / (A + L_B + L_S)]$  for different levels of wealth ( $A$ ) and for high and low degrees of creditor rights protection,  $\phi_1$  and  $\phi_2$ , respectively.

Firms with  $A \geq A_3$  are unconstrained on both credit lines, so both the price ratios between trade and bank credit and those between inputs are invariant in wealth. Both trade credit intensity and input tangibility hold constant for levels of wealth above  $A_3$ . For  $A < A_3$ , the moral hazard problem in relation to the bank becomes binding.

Reductions in wealth within the interval  $A_2 \leq A < A_3$  increase the shadow cost of bank credit and thus decrease the price ratio between the two sources of funding. Firms give up more bank credit than trade credit, increasing trade credit intensity (in figure 2.3, the solid line in the interval  $A_2 \leq A < A_3$ ). The higher price of bank credit also affects the input prices but by a different amount. It is translated fully into a higher price of intangibles because they are totally financed by bank credit and only partially into a higher price of tangibles, given that only a share  $(1 - \beta_S/r_S)$  is financed by bank credit. The input price ratio thus falls for decreasing levels of wealth, inducing entrepreneurs to increase input tangibility (in figure 2.4, the solid line in the interval  $A_2 \leq A < A_3$ ).

When wealth falls below  $A_2$ , the shadow cost of bank credit equals the cost of trade credit. For  $A_1 \leq A < A_2$ , firms are indifferent between financing sources.

**Figure 2.4** Input Tangibility, Wealth, and Creditor Protection



Source: Authors.

Note: The figure shows input tangibility, that is, the ratio between tangible and intangible assets ( $I_t/I_{nt}$ ), for different levels of wealth ( $A$ ) and for high and low degree of creditor rights protection,  $\phi_1$  and  $\phi_2$ , respectively.

Although constrained by banks, they are still unconstrained by suppliers and can take trade credit at a constant price to compensate for their lesser wealth. Thus, trade credit intensity increases (in figure 2.3, the solid line in the interval  $A_1 \leq A < A_2$ ). This extra credit is used to finance the purchase of tangibles, freeing resources to intangibles and leaving the input combination unchanged (in figure 2.4, the solid line in the interval  $A_1 \leq A < A_2$ ).

Finally, when  $A < A_1$ , entrepreneurs are financially constrained on both credit lines. The prices of both sources rise, but more for bank credit, given its greater exposure to moral hazard. Because the tangible input is financed partly by trade credit, while the intangible is financed entirely by bank credit, the input price ratio decreases, increasing input tangibility (in figure 2.4, the solid line in the area  $A < A_1$ ).

The dotted lines in figures 2.3 and 2.4 show how trade credit intensity and input tangibility, respectively, respond to an increase in creditor vulnerability. Any increase in  $\phi$  moves all the thresholds of wealth rightward, given that all incentive constraints bind at higher wealth. Firms with  $A \geq \bar{A}_3$  are unconstrained on both credit lines, and neither trade credit intensity nor asset tangibility varies. When

wealth decreases ( $\bar{A}_2 \leq A < \bar{A}_3$ ), the incentive constraint on the bank becomes stringent, and the shadow cost of bank credit rises. When  $\bar{A}_1 \leq A < \bar{A}_2$ , the two sources of finance cost the same, but firms are not constrained by suppliers and can use trade credit to keep investment and input combination constant (the dotted line does not shift upward in figure 2.4) and increase trade credit intensity (the dotted line shifts upward in figure 2.3). When  $A < \bar{A}_1$ , the change in  $\phi$  makes the entrepreneur's moral hazard more severe in relation to both bank and supplier. Thus, both trade credit intensity and asset tangibility increase, as shown by the upward shift of the dotted lines in both figures.

The preceding analysis allows the authors to obtain the following predictions:

- *Prediction 1.* Credit-constrained firms have higher trade credit intensity and use technologies more intensive in tangible assets than unconstrained ones. Moreover, assuming that countries differ only in the degree of creditor protection, that leads to prediction 2.
- *Prediction 2.* In countries with weaker creditor protection, credit-constrained firms have higher trade credit intensity and a technological bias toward tangibles. Unconstrained firms have the same trade credit intensity and input tangibility across countries with different degrees of creditor protection.

If one takes into account that credit-constrained firms are more widespread in countries with weaker creditor protection, prediction 2 is consistent with two distinct sets of empirical evidence. First, there is a greater use of trade credit in countries with less creditor protection, including developing countries (for example, Rajan and Zingales 1995). Second, firms in developing countries have a higher proportion of fixed to total assets and fewer intangible assets than those in developed countries (for example, Demirgüç-Kunt and Maksimovic 1999). This chapter thus offers a theory that reconciles these distinct findings.

## Conclusions

The chapter has investigated the determinants of trade credit and its interactions with borrowing constraints, input combination, and creditor protection. By interacting two motivations for trade credit use (liquidation and incentive motive), which the literature had so far dealt with separately, the paper has derived a set of new predictions, presented here as answers to the questions posed in the introduction.

1. *What justifies the widespread use of trade credit by financially unconstrained firms that have access to seemingly cheaper alternative sources?*

An important result presented in this chapter is that financially unconstrained firms (with unused bank credit lines) take trade credit to exploit the supplier's liquidation advantage.

2. *Why is the reliance on trade credit not always increasing in the degree of credit rationing?*

If inputs purchased on account are sufficiently liquid, the reliance on trade credit does not depend on credit rationing, but on the liquidation advantage.

3. *Does input lending have an impact on the borrower's choice of inputs?*

The second major contribution presented in this chapter is the analysis of the link between financing and input decisions. Specifically, more intensive use of trade credit goes together with a technology biased toward tangibles, and the bias increases as financial constraints tighten and creditor protection weakens. In short, greater reliance on trade credit is associated with more intensive use of tangible inputs.

4. *Does the degree of creditor protection affect financing and input choices?*

Better creditor protection decreases both the use of trade credit and the input tangibility.

## Notes

1. The model implicitly assumes the entrepreneur's wealth is never so high as to finance entirely the first-best investment.
2. For a discussion of this issue, see Fabbri and Menichini 2010.

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