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TRADE CREDIT AS COLLATERAL

by Massimo Omiccioli*

Abstract

A remarkable feature of short-term business finance is the widespread use of trade credit as collateral in bank borrowing, especially by small and medium-sized firms. The paper models the incentives for a firm to collateralize accounts receivable as a trade-off between the benefit from lower interest rates and the implicit cost arising from the disclosure of private information associated with this form of collateral. The model shows that the share of receivables pledged as collateral is larger: *i)* when the borrowing firm is riskier (and the difference in interest rates between secured and unsecured lending is larger); *ii)* when information disclosure costs for the firm are lower (e.g. when the information is dispersed among many banks and firm's assets are mostly made up of tangibles); *iii)* when the default correlation between sellers and buyers is lower; *iv)* when the legal protection of creditors is weaker (and suppliers have a greater advantage over banks in monitoring and enforcing loan contracts). These predictions are supported by empirical evidence from a sample of 7,250 Italian firms.

JEL Classification: G32, G33, L15.

Keywords: trade credit, collateral, information disclosure.

Contents

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1. Introduction[1]

A large body of literature, both theoretical and empirical, has analyzed the provision of collateral as a key feature in debt contracting.[2] In this context little attention has been given to a special type of secured debt contract, which involves pledging accounts receivable as collateral for bank borrowing. Yet this form of collateralization accounts for a large share of bank loans to non-financial firms. In the United States lines of credit secured by short-term assets, such as receivables or inventories, accounted for approximately 23 per cent of the total amount of commercial and industrial loans at commercial banks in 1998 (Klapper, 2001). In Italy loans secured by accounts receivable represented, at the end of 2002, 22 per cent of total bank loans to non-financial companies and 54 per cent of the amount extended under short-term lines of credit.

Despite its widespread use, the collateralization of accounts receivable is far from being homogeneous across firms. It usually plays a more important role for smaller and riskier firms, while larger and more creditworthy companies often choose different policies to manage and finance their accounts receivable.[3] Why does the extent of collateralization vary across firms? If firms can take advantage of lower interest rates on loans secured by accounts receivable, what are the costs that can counterbalance this benefit? This paper argues that the information disclosure arising from the use of trade credit as collateral may represent, from the firms' perspective, the other side of the financial advantage. Therefore the firm's choice is modelled as a trade-off between borrowing costs and disclosure costs. Riskier firms have a stronger incentive to pledge receivables as collateral because the difference in interest rates between secured and unsecured lending increases with the probability of default of the borrower. On the other hand, firms that are more exposed to the costs arising from the disclosure of information will have a stronger incentive to choose different policies to manage and finance their accounts receivable. Theoretical predictions are tested on a large sample of Italian firms.

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[2] For a recent survey, see Coco (2000).

[3] Mian and Smith (1992), for example, find that the larger, more creditworthy firms establish captive finance subsidiaries, while the smaller, riskier firms issue accounts-receivable secured debt.

While the existing literature has already recognized that a bank may learn valuable information about a borrowing firm and its customers from having accounts receivable as collateral,[4] the costs perceived by firms as a result of the disclosure of such information have generally been overlooked.[5] Two mechanisms can give rise to information disclosure costs for firms. First, if the information on the borrower leaks out to competitors, this can lower the expected returns from product market operations (Yosha, 1995; Bhattacharya and Chiesa, 1995; Ruckes and von Rheinbaben, 2004). Second, the borrower and his customers may find it convenient to retain some degree of flexibility in their debt contract and some degree of opacity towards the bank itself. When receivables are collateralized and the customer cannot pay the trade debt on time, the debt contract between the buyer and the supplier cannot be informally renegotiated and the information that the invoice has not been paid will damage the reputation of both. As a consequence, pledging receivables as collateral entails a loss of flexibility, which is one of the greatest advantages of trade credit.[6]

I formalize this interpretation by presenting a simple model that describes how much trade credit the firm is willing to pledge as collateral for bank borrowing as the outcome of two opposite forces: the lower interest rates on credit lines secured by accounts receivable and the information disclosure costs associated with this form of collateral. The buyer needs credit in order to buy inputs from the seller and can be financed either by the bank or by the seller. In the latter case, the seller refinances the credit through the bank, either using accounts receivable as collateral (secured lending) or not (unsecured lending). Both banks and suppliers observe customer default probabilities, are risk neutral and price loans at their expected payoff. The supplier has an advantage over the bank in investigating the creditworthiness of the buyer, as well as in monitoring and enforcing repayment of the credit. Moreover, since pledging receivables as collateral prevents buyers and sellers from renegotiating their debt contracts, this further reduces the buyer's *ex ante* probability of default on trade debt. Perfect competition in product and credit markets is assumed.

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[4] See, for example, Biais and Gollier (1997), Boot (2000), and especially Mester, Nakamura and Renault (2002).

[5] Information disclosure costs have been widely discussed in other fields of corporate finance: see, for example, Boot and Thakor (2001).

[6] This can be viewed as an application of the idea put forward by Boot and Thakor (2003) on the potential loss of flexibility associated with pledging an asset as collateral.

The model offers a rich set of predictions, which are supported by the empirical evidence on the use of trade credit as collateral in a sample of 7,250 Italian firms.[7] The share of accounts receivable pledged as collateral is larger: *i)* when borrowing firms are riskier; *ii)* when they are smaller and younger and do not belong to corporate groups; *iii)* when they are less exposed to the costs associated with information disclosure (i.e. when they have a larger number of bank relationships and their assets mostly consist of tangibles); *iv)* when their customers are more creditworthy; *v)* when risk correlation between sellers and customers is lower; *vi)* when there is less legal protection for creditors (and trade creditors have a larger advantage over bank lenders).

The rest of the paper is organized as follows. Section 2 examines the costs and benefits of using trade credit as collateral and reviews the related literature on the subject. Section 3 presents the formal model, while section 4 empirically tests its predictions. Section 5 concludes.

2. Costs and benefits of using trade credit as collateral

The standard literature on secured lending is mainly concerned with 'outside' collateral and cannot be easily applied to the analysis of the collateralization of accounts receivable, which represent the most typical form of 'inside' collateral.[8] Unlike fixed assets, whose liquidation value does not depend on the cash flow derived from a firm's normal business, the value of trade credit depends on the ability of the firm to collect its accounts receivable and on the capacity of its customers to repay their debts. Furthermore, as Berger and Udell (1995) point out, the decision to pledge accounts receivable 'may have different motivations than pledging other collateral'.[9] From the seller's perspective, the main purpose of trade credit is to provide a guarantee of product quality (Lee and Stowe, 1993; Long, Malitz and Ravid, 1993) or more generally to build customer relationships (Smith, 1987; Summers and Wilson,

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[7] Compared with the only two other empirical studies on the subject (Berger and Udell, 1995; Klapper, 2001), in this paper I can exploit: *a*) a much larger and more diversified sample of firms; *b*) a unique bank-firm matched dataset containing individual information on loans and interest rates by borrower and lending bank, as well as balance sheet information on borrowing firms (including a measure of firms' default risk).

[8] Assets which are used in the project to be financed represent 'inside' collateral, while assets which are not used in the project represent 'outside' collateral. A more general distinction between 'inside' and 'outside' collateral hinges on the correlation between the value of the collateralized assets and the cash flow derived from the firm's normal business (outside collateral having a low correlation and inside collateral a high correlation).

[9] For an overview of accounts receivable management policies, see Mian and Smith (1992).

2001).[10] As a result, being able to extend trade credit at competitive conditions is an essential tool for competition in the product market. The decision of a firm to post accounts receivable as collateral can be seen as a way to lower funding costs in order to be able to offer trade credit at competitive terms.

The lower borrowing cost on loans secured by accounts receivable stems essentially from the principle of risk diversification (Frank and Maksimovic, 1998; Klapper, 2001; Burkart and Ellingsen, 2004). The bank will not be repaid only if both the buyer and the supplier default on their obligations. As in standard portfolio analysis, when the probabilities of default are not perfectly correlated, diversification lowers total portfolio risk. Most of the earlier literature on the financial explanations for trade credit (Schwartz, 1974; Emery, 1984; Duca, 1986) disregards the use of trade credit as collateral in bank borrowing. As a result, in these models, where suppliers have an advantage over banks in screening their clients and in monitoring and enforcing loan contracts, trade credit only flows from larger or more creditworthy firms to those that are in some way riskier or credit-constrained. On the contrary, when accounts receivable can be collateralized, it is not necessarily true that trade credit can only be extended by firms with an easier access to capital markets.

As Boot and Thakor (2003) point out, it is somewhat puzzling that unsecured loans are observed despite the obvious benefit of a lower borrowing cost with a secured loan: 'what exactly is the cost the borrower perceives in pledging an asset as collateral?' The collection of accounts receivable provides the bank with exclusive access to a continuous stream of information about the borrowing firm and its customers (Mester, Nakamura and Renault, 2002). This gives the bank an information advantage, but it can represent a cost for the borrowing firm and for its customers. This is evident if we imagine that all sales are made on credit and all accounts receivable are pledged as collateral to only one bank. In this case the bank will know each and every customer of the borrowing firm, their relative shares in firm's total sales, the length of payment delays granted to each customer, whether the customer pays on time or not or is insolvent. As in Yosha (1995), Bhattacharya and Chiesa (1995), Ruckes and von Rheinbaben (2004), if such information is disseminated through voluntary or unintentional

[10] Price discrimination may represent another motive for trade credit (Brennan, Maksimovic and Zechner, 1988), but it seems to have limited empirical relevance (Ng, Smith and Smith, 1999; Summers and Wilson, 2002; Cannari, Chiri and Omiccioli, 2004).

leaks to third parties (such as competitors and suppliers), this can be highly detrimental to the borrower as well as to the customers.

The borrower can reduce information disclosure costs by limiting the total amount of information which is disclosed (the share of accounts receivable pledged as collateral), but this comes at the cost of higher interest rates. As an alternative, the borrower can achieve the same goal by dispersing a given amount of information among a plurality of banks. This represents a sharp difference between standard lending and lending secured by accounts receivable. In the first case, when the borrowing firm is required to release confidential information to the lenders in order to demonstrate its creditworthiness, increasing the number of creditors enhances the probability of an information leak because the same amount of information is revealed to a plurality of lenders. By contrast, in the second case each bank has access only to a limited amount of information and cannot exploit the complementary effect of the different pieces of information.[11]

There is an additional reason, closer in spirit to the analysis by Boot and Thakor (2003), why information disclosure can represent a cost for the borrowing firm and for its customers. Boot and Thakor (2003) suggest that pledging an asset as collateral entails a loss of flexibility, which may represent the other side of its financial advantage. Trade credit is usually a highly flexible form of credit, which relies mostly on informal mechanisms of enforcement, based on 'reputation' and long-term relationships and often without any written contract. For example, suppliers are often willing to accept late payments without charging interest, or to allow customers to take unearned cash discounts,[12] especially when they have a long-standing relationship (Ng, Smith and Smith, 1999; Summers and Wilson, 2002; Cannari, Chiri and Omiccioli, 2004). Besides being an obvious advantage for the buyer, this flexibility can also benefit the supplier, when he has an interest in relaxing *ex post* trade credit terms, for example in order to help customers overcome a temporary financial difficulty, thereby protecting his long-term investment. In this case suppliers can be seen as liquidity insurance providers (Cuñat, 2002). Pledging accounts receivable as collateral involves waiving this form of flexibility. Since it is the bank (and not the seller) which collects the receivables, sellers and buyers are prevented from informally renegotiating their contracts. Moreover, when

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[11] On the subject, see Mester, Nakamura and Renault (2002).

[12] The buyer takes the discount for prompt payment, but does not pay within the discount period.

the customer cannot pay his trade debts on time, this information will directly damage his reputation and indirectly also the reputation of his supplier. As an extreme case of relationship lending, trade credit can be particularly exposed to the soft-budget-constraint problem. In some cases the seller may find it convenient to relinquish the flexibility of trade credit and the possibilities of renegotiation, for example when he wants to make it more costly for the buyer to delay payment or to default. Pledging accounts receivable as collateral, in this case, can be seen as a tool to discipline the buyer's behaviour and should result in a lower probability of default or late payment.

3. The model

In this section I model the incentives for a firm to collateralize its accounts receivable as a trade-off between lower interest rates and information disclosure costs arising from the use of trade credit as collateral. I build mostly on the models of Frank and Maksimovic (1998), Klapper (2001) and Burkart and Ellingsen (2004). The main novelty consists in incorporating information disclosure costs in the model.

The model considers three types of agents: sellers, buyers and banks. The buyer needs credit in order to buy inputs from the seller and can be financed either by the bank or by the seller. In the latter case, the seller refinances the credit through the bank, either using his accounts receivable as collateral (secured lending) or not (unsecured lending). Perfect competition in product and credit markets is assumed.

The seller has an advantage over the bank in investigating the creditworthiness of the buyer, as well as in monitoring and enforcing repayment of the credit (Petersen and Rajan, 1997). One of the reasons may be the in-kind nature of trade credit, given that inputs are less easily diverted than cash and hence less subject to moral hazard (Burkart and Ellingsen, 2004). As a result, the buyer's probability of default is not independent from the subject that is granting the credit: it is lower in the case of trade credit than in that of bank credit.

The probability of default on bank debt is ρ_S for the seller and ρ_B for the buyer (with $0 < \rho_i < 1$. In the case of trade credit, on the other hand, the probability of default of the buyer is equal to $\rho_B(1-\tau)$, where τ measures the financing advantage of the seller over the bank (with $0 < \tau < 1$). Moreover, if the seller pledges his accounts receivable as collateral for bank borrowing, this further reduces the probability of default of the buyer, given that a double monitoring mechanism is in operation (directly by the trade creditor and indirectly by the bank). In this case the probability of the buyer defaulting on his trade debt is equal to $\rho_B(1-\tau-\gamma)$, where γ measures the advantage of the double monitoring (with $0 < \gamma < 1-\tau$).

The risk-free interest rate is R and all parties are risk neutral. As a result both the bank and the supplier price loans at their expected payoff. The borrower promises to repay $(1+R)$ at time t_1 and in return the bank lends L at time t_0. If the buyer or the seller is directly funded by the bank on an unsecured basis, L_i^u is equal to $(1-\rho_i)$ and the interest rate is

$$r_i^u = \frac{1+R}{1-\rho_i} - 1, \tag{1}$$

where $i = (B, S)$ and the superscript u indicates that the bank loan is unsecured.

When the buyer is financed by the seller, who in turn refinances the credit through secured bank lending, the bank will not be repaid only if both the seller and the buyer are insolvent. The amount of secured bank lending extended to the seller (L_S^s) is equal to $1 - \rho_S\rho_B(1-\tau-\gamma) - \sigma_{SB}$, where σ_{SB} is the covariance between the default of the buyer (on trade debt) and the default of the seller (on bank debt) and has the following upper limit:[13]

$$\sigma_{SB} \leq \min\left[\rho_S; \rho_B\left(1-\tau-\gamma\right)\right] - \rho_S\rho_B\left(1-\tau-\gamma\right). \tag{2}$$

The interest rate on bank lending secured by accounts receivable is:

$$r_S^s = \frac{1+R}{1-\rho_S\rho_B(1-\tau-\gamma)-\sigma_{SB}} - 1. \tag{3}$$

From (1), (2) and (3) it is possible to derive the following proposition:

PROPOSITION 1. *Interest rates on bank borrowing secured by accounts receivable are always lower than interest rates on unsecured lending as long as the covariance in insolvency between the buyer (on collateralized trade debt) and the seller (on unsecured bank debt) is not perfect.*[14] *The difference in interest rates between unsecured and secured lending increases as*

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[13] If the two events are D_S and D_B, we have: $\sigma_{SB} = \Pr(D_S \cap D_B) - \Pr(D_S)\Pr(D_B)$, where $\Pr(D_S \cap D_B) \leq \min\left[\Pr(D_S); \Pr(D_B)\right]$. It is worth noting that the importance of the default correlation between sellers and buyers stems from the very nature of trade credit as inside collateral.

[14] Suppose the supplier is insolvent every time the buyer does not pay his trade debt. In this case the joint probability of default will be equal to the lowest between the buyer's probability of default (on trade debt) and the

the probability of default of the borrower rises.[15]

If the seller funds his trade credit via unsecured borrowing, the interest rate he must charge in order to break even is:

$$r_{TC}^{u} = \frac{1+R}{(1-\rho_S)\left[1-\rho_B\left(1-\tau\right)\right]} - 1 \quad (4)$$

On the other hand, if the seller funds his trade credit via secured borrowing, the interest rate he must charge is:

$$r_{TC}^{s} = \frac{1+R}{\left[1-\rho_S\rho_B(1-\tau-\gamma)-\sigma_{SB}\right]\left[1-\rho_B\left(1-\tau-\gamma\right)\right]} - 1. \quad (5)$$

If the buyer is indifferent between using trade credit or bank credit, the interest rate on trade credit must be equal to or lower than the interest rate the buyer would pay on unsecured bank credit. From equations (1), (4) and (5) it is possible to derive the following proposition (see the Appendix for the proof):

PROPOSITION 2. *When unsecured bank borrowing is used to finance accounts receivable, for trade credit to be viable the seller must have a lower probability of default than the buyer.*[16] *On the contrary, by using receivables as collateral, even riskier firms may be able to offer trade credit, at competitive terms, to more creditworthy firms.*[17]

The interest rate on trade credit cannot be higher than the interest rate the buyer would pay on unsecured bank debt, but it must be higher than the cost of funding trade credit in order to compensate for the probability that the buyer could default. But when the seller and the buyer have the same probability of default, they both pay the same interest rate on unsecured bank debt. As a consequence, trade credit cannot be offered at competitive terms when it is

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seller's probability of default (on bank debt). When the buyer's probability is the lowest, the joint probability will be lower than the seller's probability of default. When the seller's probability is the lowest, the joint probability will be equal to the seller's probability of default.

[15] When the seller's probability of default (on bank debt) increases, the joint probability of default increases by a proportion equal to the buyer's probability of default (on trade credit), which is lower than unity by definition.

[16] This is the case described by Schwartz (1974), in which trade credit only flows from firms that pay low interest rates to firms that pay higher interest rates.

[17] This is the case described by Burkart and Ellingsen (2004), in which 'firms simultaneously give and take trade credit because receivables can be collateralized'.

funded by unsecured bank borrowing. This may be possible only when trade credit is financed by pledging accounts receivable as collateral because in this case the borrowing cost is lower than the interest rate both the seller and the buyer pay on unsecured bank debt.

The discussion above shows that interest rates on loans secured by accounts receivable are always lower than interest rates on unsecured loans, if we rule out the hypothesis of perfect correlation in insolvency between sellers and buyers. If this is the case, trade credit should always be financed by secured borrowing. Even if riskier firms have a stronger incentive to pledge trade credit as collateral, nevertheless this incentive should also work for more creditworthy firms. In the rest of this section I model how information disclosure costs can counterbalance the financial advantage of pledging trade credit as collateral.

When the seller extensively uses accounts receivable as collateral, the bank is given access to a continuous stream of information about the borrower's commercial and financial developments. This disclosure of information can impose a cost both on the seller and on his customers. It is reasonable to expect that both sellers and buyers will trade off these information disclosure costs against the advantage of lower interest rates.

As far as the seller is concerned, his commercial and financial conditions will be most transparent when he has an exclusive banking relationship with the lender and when he pledges all his accounts receivable as collateral. Disclosure costs will be lower when the share of trade credit pledged as collateral (α) is smaller and when the number of bank relations is larger. For simplicity, we can write disclosure costs for the seller as a linear relation: $dc_S = \vartheta\alpha$, where ϑ is an inverse function, *inter alia*, of the number of bank lenders. For the buyer, on the other hand, the existence of disclosure costs creates a wedge between the interest rates he is willing to pay: *i)* when the seller *uses* trade credit as collateral; *ii)* when the seller *does not use* trade credit as collateral. We can suppose that in the first case the buyer is not willing to pay more than the interest rate he would pay by borrowing directly from the bank (r_B^u), while in the latter case he may be willing to pay something more ($r_B^u + \kappa$) in order to avoid disclosing information to the bank and to retain the flexibility of trade credit.[18]

[18] In line with Cuñat (2002), it is possible to interpret κ as a liquidity insurance premium. Results do not change if we suppose $r_{TC}^u \leq r_B^u$ and $r_{TC}^s \leq (r_B^u - \kappa)$. In this case κ should be interpreted as strictly measuring information disclosure costs for the buyer.

For a profit maximizing firm, the problem can be stated as follows:

$$\max_{\alpha} \Pi^{TC} \text{ subject to } r_{TC} \leq \alpha r_B^u + (1-\alpha)\left(r_B^u + \kappa\right), \tag{6}$$

where

$$\Pi^{TC} = \frac{P\left(1 + r_{TC}\right)\left(1 - \rho_B\left(1 - \tau - \alpha\gamma\right)\right) - C\left(1 + \alpha\left(r_S^s + \vartheta\right) + (1-\alpha)\, r_S^u\right)}{1 + R} \tag{7}$$

By imposing $P = C = 1$ (perfect competition in the product market) and $r_{TC} = \alpha r_B^u + (1-\alpha)\left(r_B^u + \kappa\right)$ (perfect competition in the credit market), the solution is:

$$\alpha^* = \frac{r_S^u - r_S^s - \vartheta + \gamma\rho_B\left(1 + r_B^u\right) - \kappa\left(1 - \rho_B\left(1 - \tau + \gamma\right)\right)}{2\kappa\gamma\rho_B}, \tag{8}$$

or

$$\alpha^* = \frac{\frac{1+R}{1-\rho_S} - \frac{1+R}{1-\rho_S\rho_B(1-\tau-\gamma)-\sigma_{SB}} - \vartheta + \gamma\rho_B\left(\frac{1+R}{1-\rho_B}\right) - \kappa\left(1 - \rho_B\left(1 - \tau + \gamma\right)\right)}{2\kappa\gamma\rho_B}. \tag{9}$$

Formally we have:

$$\begin{cases} \alpha = 0 & \text{if } \alpha^* \leq 0 \\ \alpha = \alpha^* & \text{if } 0 < \alpha^* \leq 1 \end{cases} \tag{10}$$

with $\partial\alpha^*/\partial\rho_S > 0$, $\partial\alpha^*/\partial\vartheta < 0$, $\partial\alpha^*/\partial\kappa < 0$, $\partial\alpha^*/\partial\sigma_{SB} < 0$, $\partial\alpha^*/\partial\gamma > 0$ and $\partial\alpha^*/\partial R > 0$, while the sign of the derivatives with respect to τ and ρ_B is not defined and depends on the relative value of disclosure costs (see Appendix for details). However, $\partial\alpha^*/\partial\tau$ will tend to be higher (more positive) for riskier sellers, while the opposite is true for $\partial\alpha^*/\partial\rho_B$.

PROPOSITION 3. *(i) Riskier firms make more use of trade credit as collateral. (ii) When disclosure costs (for sellers and buyers) are higher, the share of trade credit pledged as collateral is smaller. (iii) When the correlation in insolvency between sellers and buyers is higher, the share of trade credit pledged as collateral is smaller. (iv) The greater the effect of using trade credit as collateral in reducing the probability of default of buyers, the larger the share of trade credit pledged as collateral. (v) When (risk-free) interest rates are higher, firms make more use of trade credit as collateral. (vi) The effect of the enforcement advantage* *of suppliers over banks on the share of trade credit pledged as collateral will tend to become (more) positive for riskier firms. (vii) The effect of a higher insolvency risk of customers on the share of trade credit pledged as collateral will tend to become (more) negative for riskier sellers.*

To capture the economic intuition behind these effects we should simply observe that the relative advantage of secured versus unsecured loans can be affected in two different ways: *i)* by reducing the costs of financing trade credit; *ii)* by increasing the expected return on sales made on credit. The results for ρ_S, ϑ, σ_{SB}, κ and γ are straightforward. Since the difference in interest rates between secured and unsecured loans increases with the probability of borrower default (ρ_S), riskier firms have a stronger incentive to pledge trade credit as collateral. On the other hand, ϑ and σ_{SB} lower the relative advantage of secured loans in financing trade credit, while κ reduces the relative return on sales. The influence of γ is twofold, but both effects go in the same way, since γ lowers the funding costs for trade credit and increases its expected return. On the contrary, τ and ρ_B have opposite effects on relative costs and returns and the sign of the aggregate effect is undetermined.[19]

The solution given in equations (9) and (10) is based on the existence of: *a)* positive disclosure costs for the buyer ($\kappa > 0$); *b)* an advantage for the seller in pledging trade credit as collateral in terms of reducing the probability of default by the buyer ($\gamma > 0$). When either of these conditions is not met, we obtain a corner solution: the share of trade credit pledged as collateral is either zero or one (Table 1). In this framework, as long as $r_B^u < r_{TC}^s$, no trade credit will be available and transactions will take place only on cash terms. When $r_B^u \geq r_{TC}^s$ and $\vartheta < (r_S^u - r_S^s)$, there will only be cash terms as long as $r_B^u < r_{TC}^s + \vartheta$; above this level, suppliers will offer both cash terms and trade credit (two-part terms) and will use only bank lending secured by accounts receivable ($\alpha = 1$). On the other hand, when $\vartheta > (r_S^u - r_S^s)$ trade credit will be available only when it can be funded through unsecured bank borrowing ($\alpha = 0$).

[19] While τ reduces both relative costs and returns on trade credit financed by secured loans, ρ_B increases them.

Table 1

SOLUTIONS FOR $\kappa = \gamma = 0$

Condition 1	Condition 2	Condition 3	Trade Credit	α
$r_B^u < r_{TC}^s$	-	-	no	-
$r_B^u \geq r_{TC}^s$	$\vartheta < (r_S^u - r_S^s)$	$r_B^u < r_{TC}^s + \vartheta$	no	-
$id.$	$id.$	$r_B^u \geq r_{TC}^s + \vartheta$	yes	1
$id.$	$\vartheta > (r_S^u - r_S^s)$	$r_B^u < r_{TC}^u$	no	-
$id.$	$id.$	$r_B^u \geq r_{TC}^u$	yes	0

4. Empirical evidence

In this section I empirically test the theoretical results described in the preceding section, by analyzing the use of trade credit as collateral in a large sample of Italian firms. The objective is to estimate the model described by equations (9) and (10), where the dependent variable is the share of accounts receivable pledged as collateral for bank borrowing.

I am aware of only two empirical studies on the use of trade credit as collateral: Berger and Udell (1995) and Klapper (2001).[20] Both studies use logit regressions to estimate the probability that a firm has an outstanding line of credit secured by accounts receivable and use samples of around 850 US firms.[21] The characteristics of the sample firms, however, differ sharply: while Klapper (2001) uses a sample of publicly traded companies, Berger and Udell (1995) use data on small firms. Both papers find evidence that lines of credit secured by accounts receivable are used by riskier borrowers. On the other hand, while Klapper (2001) shows that larger firms have a lower probability of pledging trade credit as collateral, the

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[20] Berger and Udell (1995) analyze various types of collateral separately, while other studies, such as Harhoff and Korting (1998) and Elsas and Krahnen (1998; 2000), do not distinguish between accounts receivable and other forms of collateral or guarantees. As we have seen, this distinction is crucial for two reasons: *i*) accounts receivable represent "inside" collateral; *ii*) the decision to pledge accounts receivable may be based on different motives than the decision to pledge other forms of collateral.

[21] In the study by Berger and Udell (1995) collateral also includes inventories.

opposite is true for Berger and Udell (1995). The latter study, moreover, finds evidence that lines of credit secured by accounts receivable are more often used by younger firms and by firms with shorter bank relationships.

Compared with the aforementioned empirical studies, in this paper I can exploit: *a*) a much larger and more diversified sample of firms; *b*) a unique bank-firm matched database containing individual information on loans and interest rates by borrower and lending bank, as well as balance-sheet information on borrowing firms (including a measure of firms' default risk).

4.1 *Description of the data and variables*

The data used in the empirical analysis are taken from two main sources: the Central Credit Register (*Centrale dei Rischi*) and the Company Accounts Data Service (*Centrale dei Bilanci*). The first source contains information on loans and interest rates by borrower and lending bank; credits are reported by all Italian banks when the amount is above a threshold of 75,000 euros; interest rates are reported by a sample of around 70 banks (which includes the main banks at national level). The second source contains balance sheet information on a large number of firms. I merged information from these two sources for the year 2000, restricting the field of analysis to manufacturing firms. After controlling for problems of data quality, I obtain a sample of almost 7,250 firms. Table 2 shows the distribution of sample firms by region, size and industry.

Data on 'matched loans' from the Central Credit Register are used to approximate the amount of firms' borrowing secured by accounts receivable. 'Matched loans' is the classification used by the Central Credit Register for credit transactions with a form of predetermined redemption, the majority of which are loans granted to make receivables from third parties immediately available to bank customers. Data on the total amount of firms' receivables are taken instead from balance-sheet information collected by the Company Accounts Data Service. As a consequence, for each firm the dependent variable ($alfa$) is defined as the ratio between the amount of credit actually used in the category 'matched loans' and the total amount of accounts receivable (definitions of variables are summarized in Table 3).

Figure 1 shows the frequency distribution of $alfa$ for sample firms. As can be seen, 18 percent of sample firms do not use trade credit as collateral at all or only to a very limited extent (less than 10 percent of their accounts receivable). About a third of sample firms, on the contrary, pledge at least 50 percent of their accounts receivable. There are 419 observations (5.8 per cent of the sample) in which the dependent variable is greater than unity. I chose to retain these observations in order to avoid problems of sample selection bias, although I checked whether the econometric results were influenced by their inclusion. Measurement errors can arise from using different sources of information (with different reporting requirements). Furthermore, banks often extend lines of credit that can be used either as 'matched loans' or as overdrafts ('revocable loans' in the classification of the Central Credit Register) and classify them according to their prevailing use.

The distribution of $alfa$ has an important bearing on the empirical relevance of the model described by equations (9) and (10). The model refers to the case in which κ and γ are strictly positive. On the contrary, when they are equal to zero we should observe a bimodal distribution around the values of zero and one. As can be seen from figure 1, the distribution of $alfa$ strongly rejects this hypothesis.

As shown in equation (9), the amount of trade credit the seller is willing to pledge as collateral depends on: *a)* his own probability of default; *b)* the probability of default of his customers; *c)* the covariance between these two probabilities; *d)* the advantage of the seller over the bank in investigating the buyer's creditworthiness, as well as in monitoring and enforcing repayment of the credit; *e*) the costs for the seller of information disclosure associated with pledging trade credit as collateral.

The credit risk of individual borrowers ($rhos$) is approximated by the difference between the interest rate on unsecured overdraft facilities ('revocable loans') and a risk-free reference interest rate.[22] By using equation (1), we obtain:

$$\rho_S = \frac{r_S^u - R}{1 + r_S^u}. \tag{11}$$

[22] In doing so, I follow the seminal study by Berger and Udell (1990), which empirically analyzes the risk-collateral relationship. As risk-free interest rate I used the average yield before tax for Italian Treasury Bills (BOTs), which was equal to 4.5 per cent in the year 2000.

Empirically, this can be seen as an imperfect measure of credit risk for three reasons.[23] First of all, interest rates can be influenced by factors other than borrower creditworthiness. Moreover, lending rates reported to the Central Credit Register also include commissions and fees. Finally, in the theoretical analysis, for the sake of simplicity, all agents are supposed to be risk-neutral. In case of risk aversion, of course, the interest rate would contain an additional factor such as risk premium and expression (11) would overestimate the probability of default by the borrower. These problems notwithstanding, I believe that this is the most direct and reasonable measure of credit risk as perceived by the banks. Anyway, to check the robustness of the results, as an alternative proxy for borrower quality I use credit scores provided by the Company Accounts Data Service, which serve as predictors of insolvency.[24]

In order to extract from interest rates information on the probability of default by customers ($rhob$) and on its covariance with the probability of default by the borrower ($sigma$), I proceed in the following way. From equations (1) and (2), we can obtain:

$$\frac{(r_S^s - R)(1 + r_S^u)}{(r_S^u - R)(1 + r_S^s)} = \rho_B (1 - \tau - \gamma) + \sigma_{SB} \frac{1}{\rho_S}. \tag{12}$$

Therefore I estimate the following model:

$$y_i = \sum_j \beta_{0j} D_{ij} + \sum_j \beta_{1j} D_{ij} x_i + u_i, \tag{13}$$

where y_i is the left-hand side of expression (12), D_{ij} are dummy variables, and x_i is the inverse of our measure of ρ_S, given by expression (11).[25] In this way I obtain estimates of $\rho_B^* = \rho_B(1 - \tau - \gamma)$ and σ_{SB} for 52 sub-groups of firms defined as the intersection of 4 regions and 13 industries. These, of course, are very rough estimates of the underlying variables. Problems arising in estimating the probability of default of borrowers from interest rates are obviously magnified in this case. Once again, however, these estimates can at least

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23 See Harhoff and Korting (1998) and Elsas and Krahnen (1998) for detailed criticism.

24 Credit scores are computed by the Company Account Data Service using discriminant analysis according to the methodology described in Altman (1968) and Altman, Marco and Varetto (1994). They measure firms' default risk and take values from 1 ('high security') to 9 ('very high risk'). I merge the upper two classes because of paucity of observations. Elsas and Krahnen (2000) use the bank's internal borrower ratings as a proxy for expected default risk.

25 Regression results are not shown. R^2 is equal to 0.5. As can be seen from Table 4, the average probability of default by customers (18.1 per cent) is much higher than for sellers (4.3 per cent). On average, the estimated default correlation is 6.5 per cent.

represent an ordinal approximation to the reference variables. Even if we express α^* in terms of $\rho_B^* = \rho_B(1 - \tau - \gamma)$, the sign of $\partial\alpha^*/\partial\rho_B^*$ is undefined and its value is lower (more negative) for riskier sellers; on the other hand, in this case $\partial\alpha^*/\partial\tau$ should always be positive and its value is decreasing with the seller's probability of default (see Appendix for details).

As a proxy for the financing advantage of the seller over the bank in terms of screening, monitoring and enforcement, I use a measure of local judicial inefficiency. As Burkart and Ellingsen (2004) state, '[w]ith perfect legal protection of creditors, trade credit loses its edge, because it becomes as difficult to divert cash as to divert inputs. More generally, the importance of trade credit compared to bank credit should be greater when creditor protection is weaker'. Compared with bank lending, trade credit is closer to a pure relationship-based system, where 'parties intent on maintaining their 'reputation' honour the spirit of the agreement (often in the absence of any written contract) in order to ensure a steady flow of future business within the same network of firms' (Rajan and Zingales, 2001). As a consequence, the relative advantage of trade credit over bank lending should be greater in environments where the legal enforcement of contracts is less efficient.[26] As a measure of local judicial inefficiency, I use the ratio of the average number of civil proceedings pending in the local court district to the number of proceedings settled in every year ($judinef$).[27]

In the preceding theoretical discussion, information disclosure costs play a crucial role in determining how much trade credit the firm is willing to pledge as collateral. Since the dispersion of information among a large number of banks can be seen as a means of reducing disclosure costs, the easiest way to test this hypothesis is by focusing on the characteristics of the relationship between banks and borrowers. Two alternative proxies are used: the number of banks that extend to the firm a line of credit secured by accounts receivable ($numban$), and the share of the main bank ($firstbank$). What we expect is a negative association between the intensity of bank-borrower relationships and the share of trade credit pledged as collateral. It is worth noting that, in general, theoretical models predict a positive correlation between the extent of collateralization and relationship intensity for inside collateral, and the opposite for

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[26] See Demirgüç-Kunt and Maksimovic (2001) for empirical evidence that firms are more likely to rely on trade credit in countries where legal institutions are less efficient.

[27] Data are averages over the period 1995-1998; local court districts are 164. I wish to thank Amanda Carmignani for kindly providing me with her data; for details, see Carmignani (2004).

outside collateral.[28] Since accounts receivable are a typical form of inside collateral, this test should be biased against the hypothesis maintained.

Another way to test the same hypothesis is by selecting firms which are less exposed to the costs associated with information disclosure. Following Bonaccorsi and Dell'Ariccia (2003), in this case I use the share of fixed physical assets on firm's total assets ($tangib$), which can be seen as a proxy of firm transparency. The intuition is that costs associated with the disclosure of information on commercial and financial relations with customers will be lower for firms whose assets are mostly made up of tangibles. The share of physical capital, however, can also influence our dependent variable in the opposite direction. A higher share of tangible assets reduces information asymmetries between the bank and the borrower, because it makes easier for the bank to observe the 'quality' of the prospective borrower, to monitor his actions and to enforce repayment. As a consequence, it should also reduce the need for the borrower to use accounts receivable as collateral. Once again, therefore, finding a positive effect of the share of tangibles on the fraction of accounts receivable pledged as collateral should be seen as a stronger test of the information disclosure hypothesis.

Additional variables are included in the econometric analysis to control for other factors of heterogeneity across firms: age, size, industry, region, and business group affiliation. In the literature on financial intermediation it is usually assumed that information asymmetries are less severe for larger and older firms, which as a result should be less financially constrained (Petersen and Rajan, 1994; Berger and Udell, 1995; Beck *et al.*, 2004). Larger and older firms should be less exposed to information asymmetry problems also regarding the quality of their products and therefore they should need to resort less to trade credit as an implicit guarantee (Lee and Stowe, 1993; Long Malitz and Ravid, 1993). In both cases, it should be easier for larger and older firms to avoid the information disclosure associated with the use of trade credit as collateral. The same should be true for firms that belong to corporate groups.

Finally, before turning to the econometric analysis, it may be useful to check empirically one of the core elements underlying the model described by equations (9) and (10): the prediction that the difference in interest rates between unsecured and secured lending increases

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[28] For the first case, see Longhofer and Santos (2000) and Welch (1997); for the latter case, see Boot and Thakor (1994).

as the probability of default by the borrower rises. This is clearly the case, as can be seen simply by plotting the two variables (Figure 2).[29]

4.2 *Econometric results*

To test the predictions put forward by Proposition 3, I estimate a Tobit model of the following form, which can be seen as a first-order linear approximation to the model described by equations (9) and (10):[30]

$$\begin{aligned} alfa &= \beta_0 + \beta_1 rhos + \beta_2 numban \left\{\beta_3 firstbank\right\} + \beta_4 tangib \\ &\quad + \beta_5 judinef + \beta_6 age + \beta_7 group + \textstyle\sum_i \beta_{8i} S_i \\ &\quad + \left(\textstyle\sum_j \beta_{9j} R_j + \sum_k \beta_{10k} I_k\right) \left\{\beta_{11} rhob + \beta_{12} sigma\right\} + \varepsilon, \end{aligned} \tag{14}$$

where S_i, R_j, I_k are dummy variables for size, region and industry. All independent variables (except dummies) are in log and have been standardized around the mean. The definition of variables is reported in Table 3, while Table 4 shows summary statistics.

Tobit regression results are reported in Table 5. Observations with the dependent variable equal to zero are obviously considered left-censored, while observations in which the line of credit is fully used are taken as right-censored.[31] Standard errors are adjusted for clustering of observations in order to control for the bias arising in the estimation of the effects of aggregate variables (such as $judinef, rhob$ and $sigma$) on individual outcome (Moulton, 1990).

Due to the fact that variables $rhob$ and $sigma$ are not estimated for individual observations but for groups of firms defined by region and industry, $rhob$ and $sigma$ cannot be included together with these dummy variables. Regression results obtained including region and industry dummies (and not including $rhob$ and $sigma$) are reported in the first two columns of Table 5, while in the other two columns dummy variables are dropped and $rhob$ and $sigma$ are included. In all these regressions the number of banks ($numban$) is used as a proxy for the

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[29] The ratio between the difference in interest rates and the probability of default by the borrower has an upper limit equal to $\frac{1+R}{1-\rho_S}$, for $\rho_B(1-\tau-\gamma)$ and σ_{SB} equal to zero, and becomes lower as $\rho_B(1-\tau-\gamma)$ and σ_{SB} increase. This explains the shape of the scatter diagram.

[30] Alternative specifications are shown in brackets.

[31] In this case the share of accounts receivable pledged as collateral is actually constrained by the amount of credit granted by the bank. As a consequence, we do not observe the actual share of trade credit the firm would be willing to use as collateral.

intensity of bank-borrower relationships. As shown before, the predicted effects of $judinef$ and $rhob$ are not determined, but we have testable predictions concerning how they should change with the insolvency risk of the seller. As a consequence, in column (2) I also introduce the interaction between $judinef$ and a dummy variable equal to 1 when the insolvency risk of the seller is below the median, while in column (4) I introduce the interactions of $rhob$ and $judinef$ with a dummy variable equal to 1 when the insolvency risk of the seller is above the median.

Empirical results are strongly in line with theoretical predictions. First of all, in all specifications the share of trade credit pledged as collateral is significantly higher for riskier firms. Moreover, larger and older firms make less use of trade credit as collateral, even after controlling for credit risk; the same is true for firms which belong to corporate groups. The share of receivables pledged as collateral is larger when the intensity of the relationship between the firm and the bank is lower and when firm's assets are mostly made up of tangibles. This gives support to the hypothesis that firms try to avoid disclosing information on their commercial and financial relations with customers, and that they do so the more this information is valuable. As predicted, when the legal protection of creditors is weaker (and the informal instruments of enforcement give suppliers a relatively greater advantage over banks), the share of accounts receivable used to obtain bank credit is larger. Also as predicted, this effect is weaker for low-risk suppliers (column 2). Finally, when measures of customers' riskiness and covariance of insolvency between buyers and sellers are included, both variables have a negative effect and are highly significant (column 3).[32] Furthermore, the interactions of $rhob$ and $judinef$ with the dummy variable for high-risk suppliers have a negative effect as predicted (column 4).

As a preliminary robustness check, the same regressions as in Table 5 are re-run by using the share of the first bank (instead of the number of banks) as a proxy for the intensity of bank-borrower relationships. Econometric results hardly change at all (see Table 6) .

Several other robustness checks are also performed, and their results are reported in Table 7. Firstly, since Tobit models are highly sensitive to the assumptions about the distribution of the error term and since the share of censored observations is relatively small in our sample (7

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[32] Standard errors in the table do not take into account that $rhob$ and $sigma$ are estimated. However the two variables would remain significant even if adjusted standard errors were twice as large as reported.

per cent of the total), the model is re-estimated by ordinary least squares in order to check that previous results were not overly influenced by the estimation method. OLS results reported in column (1) strongly reject this hypothesis. In column (2) we return to the Tobit regression, in this case treating as right-censored all the observations in which the ratio between facilities used and granted is over 0.80. The underlying hypothesis is that firms could be financially constrained even before exhausting the full amount of the line of credit. Econometric results do not change significantly. The same holds true for regression (3), in which observations with the dependent variable greater than unity are also dropped.

The last robustness checks concern the measure of borrowers' default risk. In this case I substitute the proxy extracted from interest rates with credit scores provided by the Company Accounts Data Service. Due to unavailability of data, the sample size falls by almost one third (distribution of firms by score are reported in Table 9). For comparison, in column (4) I report the results obtained by re-running my benchmark regression on this reduced sample. As can be seen, estimates do not change with sample selection. Table 8 shows the results obtained by using credit scores as a proxy for the probability of insolvency of the borrowers.[33] They are generally unaffected.[34] Above all, it is clearly confirmed that the share of trade credit used as collateral grows monotonically with the insolvency risk of the borrower.

5. Concluding remarks

In this paper I model the incentives for a firm to post accounts receivable as collateral as a trade-off between the benefits stemming from lower interest rates and the costs arising from the disclosure of information associated with this form of collateral. Since the difference in interest rates between unsecured and secured lending increases with the borrower's probability of default, riskier firms have a stronger incentive to pledge trade credit as collateral. On the other hand, firms which are more exposed to the costs associated with information disclosure (such as firms with few bank relationships and a high level of intangible assets) have stronger incentives to avoid this form of secured borrowing. These predictions are supported by empirical evidence on the collateralization of receivables in a large sample of Italian firms.

[33] In these regressions, as in column (3) of Table 7, I drop observations with the dependent variable greater than unity and consider right-censored observations in which the ratio between facilities used and granted is over 0.80.

[34] The only difference concerns the firm's age, which in this specification turns out to be insignificant (and positive).

Since setting up a finance subsidiary is a possible alternative to avoid disclosing information to third parties, the model can also shed some light on the decision by large firms to establish captive factors.[35] In their study of accounts receivable management policies, Mian and Smith (1992) shows that smaller and riskier firms issue accounts-receivable secured debt, while larger and more creditworthy firms establish captive finance subsidiaries.

The paper focuses on costs and benefits *for the firm* of using accounts receivable as collateral. In doing so, it obviously disregards other relevant aspects. In the model, for example, the bank is supposed to know the default risk of both the borrowing firm and its customer. Hence problems stemming from asymmetric information and moral hazard are ruled out. Possible extensions of the model should also consider: *a*) the informational advantage for the bank of having receivables as collateral (Mester, Nakamura and Renault, 2002);[36] *b*) the monitoring costs for the bank to exploit such information (Rajan and Winton, 1995; Klapper, 2001); *c*) moral hazard problems (Frank and Maksimovic, 1998; Burkart and Ellingsen, 2004).[37] The inclusion of these elements in a more complex model remains a topic for future research.

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[35] In Italy, the second largest market in the world for factoring turnover in 2003, captive industrial factors have a market share of about one third and are specialized in factoring both receivables and payables of parent companies (Benvenuti and Gallo, 2004). As far as accounts payable of parent companies are concerned, this is made easier by the legal right of the debtor to prevent the transfer of his debt to third parties without his agreement.

[36] This would imply, for example, that a larger number of bank relationships should lower both information disclosure costs for the borrower and the informational advantage for the lender.

[37] If the bank cannot directly observe the financial worthiness of the buyers that are being offered trade credit, concerns about the seller's credit policy could restrict the amount of secured lending the bank is willing to extend. In this case, long-term bank relationships could mitigate the problem, as in an infinitely repeated moral hazard game.

Tables and Figures

Table 2

DISTRIBUTION OF SAMPLE FIRMS BY REGION, SIZE AND INDUSTRY

Code	Item	No. of Firms	%
	Region		
NW	North-West	3,126	43.1
NE	North-East	2,516	34.7
CE	Centre	1,127	15.6
S&I	South & islands	479	6.6
	Size		
1	Less than 100 employees	4,861	67.1
2	100-199 employees	1,368	18.9
3	200-499 employees	755	10.4
4	Over 499 employees	264	3.6
	Industry		
DA	Food, beverages & tobacco	782	10.8
DB	Textiles & clothing	1,010	13.9
DC	Leather & footwear	348	4.8
DD	Wood products	158	2.2
DE	Paper & printing	386	5.3
DG	Chemical products	436	6.0
DH	Rubber & plastic materials	442	6.1
DI	Non-metallic mineral products	418	5.8
DJ	Metals & metal products	1,103	15.2
DK	Machinery & equipment	983	13.6
DL	Electrical & optical apparatus	553	7.6
DM	Trasport equipment	201	2.8
DN	Other manufacturing	428	5.9
	Total	**7,248**	100.0

Table 3

DEFINITION OF VARIABLES

Variable	Definition
Alfa	Ratio of firm's bank debt secured by accounts receivable (ARs) to firm's total ARs
Rhos	Ln (seller's probability of default)
Rhob	Ln (customers' probability of default)
Sigma	Ln (covariance in insolvency between sellers and customers)
Numban	Ln (number of banks with which the seller has a credit line secured by ARs)
Firstbank	Ln (share of the first bank with which the seller has a credit line secured by ARs)
Tangib	Ln (1 + ratio of tangible assets to total assets)
Judinef	Ln (ratio of pending trials to yearly trials defined in the local court districts)
Age	Ln (1 + firm's age in years)
Group	Dummy variable: 1 if the firm belongs to a corporate group, 0 otherwise

Table 4

SAMPLE STATISTICS

(original values)

Variable	Obs.	Mean	Std. Dev.	Min	Max
Alfa	7,248	0.4177	0.3432	0.0000	2.2033
Rhos	7,248	0.0432	0.0239	0.0006	0.1500
Rhob	7,248	0.1807	0.0494	0.0855	0.3870
Sigma	7,248	0.0051	0.0013	0.0012	0.0073
Numban	7,248	7.6500	4.0345	1.0000	42.0000
Firstbank	7,248	0.3288	0.1791	0.0669	1.0000
Tangib	7,248	0.2071	0.1397	0.0000	0.7966
Judinef	7,248	3.0439	1.1847	0.8071	21.0592
Age	7,248	24.0820	15.5374	0.0000	100.0000
Group	7,248	0.2986	0.4577	0.0000	1.0000

Table 5

DETERMINANTS OF THE SHARE OF TRADE CREDIT PLEDGED AS COLLATERAL

Independent Variable	(1) Tobit		(2) Tobit		(3) Tobit		(4) Tobit	
Constant	0.515 (0.023)	***	0.514 (0.023)	***	0.468 (0.012)	***	0.466 (0.012)	***
Rhos	0.062 (0.004)	***	0.050 (0.005)	***	0.065 (0.004)	***	0.047 (0.006)	***
Rhob					−0.055 (0.013)	***	−0.048 (0.013)	***
Rhob $(High\ Rhos)$							−0.043 (0.015)	***
Sigma					−0.054 (0.014)	***	−0.053 (0.014)	***
Numban	0.097 (0.004)	***	0.097 (0.004)	***	0.101 (0.006)	***	0.101 (0.006)	***
Tangib	0.049 (0.005)	***	0.049 (0.005)	***	0.043 (0.005)	***	0.043 (0.005)	***
Judinef	0.012 (0.005)	**	0.017 (0.005)	***	0.010 (0.007)		0.016 (0.007)	**
Judinef $(Low\ Rhos)$			−0.018 (0.005)	***				
Judinef $(High\ Rhos)$							−0.019 (0.015)	
Age	−0.009 (0.004)	**	−0.010 (0.004)	**	−0.009 (0.005)	*	−0.009 (0.005)	*
Group	−0.042 (0.009)	***	−0.041 (0.009)	***	−0.047 (0.010)	***	−0.045 (0.010)	***
Size 2	−0.071 (0.009)	***	−0.070 (0.009)	***	−0.070 (0.008)	***	−0.068 (0.008)	***
Size 3	−0.139 (0.011)	***	−0.137 (0.011)	***	−0.138 (0.013)	***	−0.133 (0.013)	***
Size 4	−0.187 (0.018)	***	−0.186 (0.017)	***	−0.187 (0.020)	***	−0.181 (0.020)	***
Regional dummies	*yes*		*yes*		*no*		*no*	
Industry dummies	*yes*	***	*yes*	***	*no*		*no*	
/lnsigma	−1.131 (0.015)	***	−1.132 (0.015)	***	−1.118 (0.017)	***	−1.119 (0.017)	***
Log likelihhod	−2,441		−2,435		−2,533		−2,521	
Wald χ^2	1,943	(24)	1,987	(25)	1,091	(11)	1,566	(13)
Prob$>\chi^2$	0.0000		0.0000		0.0000		0.0000	
Observations: 7,248 (6,739 uncensored; 240 left-censored; 269 right-censored)								

Robust standard errors are reported in brackets under the coefficient. In columns (1) and (2) standard errors are adjusted for clustering in local court districts, in columns (3) and (4) for clustering in region and industry groups. In addition to the variables reported, where indicated the regression also includes 3 regional dummies and 12 industry dummies. In these cases, stars indicate the results of joint significance tests.*** Significant at the 1 per cent level. ** 5 per cent. * 10 per cent.

Table 6

ROBUSTNESS CHECKS:

FIRSTBANK **USED INSTEAD OF** *NUMBAN*

Independent Variable	(1) Tobit		(2) Tobit		(3) Tobit		(4) Tobit	
Constant	0.503 (0.023)	***	0.503 (0.023)	***	0.460 (0.012)	***	0.458 (0.012)	***
Rhos	0.068 (0.005)	***	0.055 (0.005)	***	0.071 (0.005)	***	0.052 (0.006)	***
Rhob					−0.060 (0.013)	***	−0.053 (0.013)	***
Rhob $(High\ Rhos)$							−0.042 (0.015)	***
Sigma					−0.055 (0.014)	***	−0.053 (0.014)	***
Firstbank	−0.067 (0.004)	***	−0.067 (0.004)	***	−0.072 (0.004)	***	−0.071 (0.005)	***
Tangib	0.045 (0.005)	***	0.045 (0.005)	***	0.038 (0.005)	***	0.039 (0.005)	***
Judinef	0.014 (0.005)	***	0.020 (0.006)	***	0.013 (0.008)	*	0.018 (0.007)	***
Judinef $(Low\ Rhos)$			−0.020 (0.005)	***				
Judinef $(High\ Rhos)$							−0.017 (0.015)	
Age	−0.007 (0.004)	*	−0.007 (0.004)	**	−0.007 (0.005)		−0.007 (0.005)	
Group	−0.042 (0.010)	***	−0.041 (0.010)	***	−0.047 (0.010)	***	−0.045 (0.010)	***
Size 2	−0.053 (0.009)	***	−0.051 (0.009)	***	−0.052 (0.008)	***	−0.068 (0.008)	***
Size 3	−0.108 (0.012)	***	−0.105 (0.012)	***	−0.106 (0.013)	***	−0.101 (0.013)	***
Size 4	−0.147 (0.017)	***	−0.145 (0.016)	***	−0.147 (0.020)	***	−0.141 (0.020)	***
Regional dummies	*yes*		*yes*		*no*		*no*	
Industry dummies	*yes*	***	*yes*	***	*no*		*no*	
/lnsigma	−1.110 (0.014)	***	−1.111 (0.014)	***	−1.096 (0.017)	***	−1.098 (0.017)	***
Log likelihhod	−2,587		−2,580		−2,680		−2,667	
Wald χ^2	1,631	(24)	1,634	(25)	961	(11)	1,223	(13)
Prob$> \chi^2$	0.0000		0.0000		0.0000		0.0000	
Observations: 7,248 (6,739 uncensored; 240 left-censored; 269 right-censored)								

Robust standard errors are reported in brackets under the coefficient. In columns (1) and (2) standard errors are adjusted for clustering in local court districts, in columns (3) and (4) for clustering in region and industry groups. In addition to the variables reported, where indicated the regression also includes 3 regional dummies and 12 industry dummies. In these cases, stars indicate the results of joint significance tests.*** Significant at the 1 per cent level. ** 5 per cent. * 10 per cent.

Table 7

ROBUSTNESS CHECKS

Independent Variable	(1) OLS		(2) Tobit		(3) Tobit		(4) Tobit	
Constant	0.513 (0.021)	***	0.540 (0.026)	***	0.444 (0.024)	***	0.506 (0.028)	***
Rhos	0.046 (0.004)	***	0.060 (0.005)	***	0.048 (0.004)	***	0.043 (0.006)	***
Numban	0.095 (0.003)	***	0.094 (0.004)	***	0.078 (0.003)	***	0.100 (0.004)	***
Tangib	0.049 (0.005)	***	0.046 (0.005)	***	0.028 (0.004)	***	0.056 (0.005)	***
Judinef	0.019 (0.005)	***	0.020 (0.006)	***	0.015 (0.005)	***	0.023 (0.006)	***
Judinef $(Low\ Rhos)$	−0.017 (0.005)	***	−0.028 (0.006)	***	−0.015 (0.004)	***	−0.026 (0.007)	***
Age	−0.008 (0.004)	**	−0.013 (0.004)	***	−0.011 (0.003)	***	−0.009 (0.005)	**
Group	−0.037 (0.009)	***	−0.045 (0.010)	***	−0.043 (0.006)	***	−0.044 (0.011)	***
Size 2	−0.067 (0.009)	***	−0.070 (0.011)	***	−0.043 (0.008)	***	−0.076 (0.013)	***
Size 3	−0.132 (0.010)	***	−0.133 (0.013)	***	−0.095 (0.008)	***	−0.144 (0.015)	***
Size 4	−0.179 (0.017)	***	−0.185 (0.019)	***	−0.157 (0.020)	***	−0.199 (0.023)	***
Regional dummies	*yes*	*	*yes*		*yes*		*yes*	**
Industry dummies	*yes*	***	*yes*	***	*yes*	***	*yes*	***
/lnsigma	−		−1.041 (0.015)	***	−1.341 (0.010)	***	−1.134 (0.017)	***
R^2/Log likelihood	0.2019		−3,462		−1,598		−1,654	
F / Wald χ^2	92.8 (25,	149)	1,479	(25)	1,741	(25)	2,074	(25)
Prob$>$ F / χ^2	0.0000		0.0000		0.0000		0.0000	
Observations:	7,248		7,248		6,829		4,981	
uncensored	−		5,842		5,588		4,648	
left-censored	−		240		240		170	
right-censored	−		1,166		1,001		163	

Robust standard errors, adjusted for clustering of observations in local court districts, are reported in brackets under the coefficient. In addition to the variables reported, where indicated the regression also includes 3 regional dummies and 12 industry dummies. In these cases stars indicate the results of joint significance tests. *** Significant at the 1 per cent level. ** 5 per cent. * 10 per cent.

Table 8

ROBUSTNESS CHECKS:

CREDIT SCORES USED INSTEAD OF *RHOS*

Independent Variable	(1) Tobit	(2) Tobit	(3) Tobit	(4) Tobit
Constant	0.117 *** (0.032)	0.116 *** (0.032)	0.142 *** (0.035)	0.099 *** (0.023)
Score 2	0.094 *** (0.027)	0.094 *** (0.027)	0.095 *** (0.027)	0.092 *** (0.024)
Score 3	0.148 *** (0.027)	0.149 *** (0.027)	0.150 *** (0.027)	0.141 *** (0.026)
Score 4	0.244 *** (0.025)	0.243 *** (0.025)	0.246 *** (0.025)	0.238 *** (0.022)
Score 5	0.344 *** (0.025)	0.339 *** (0.025)	0.308 *** (0.032)	0.338 *** (0.023)
Score 6	0.439 *** (0.025)	0.431 *** (0.024)	0.402 *** (0.033)	0.433 *** (0.021)
Score 7	0.488 *** (0.027)	0.477 *** (0.027)	0.452 *** (0.035)	0.481 *** (0.022)
Score 8	0.496 *** (0.044)	0.482 *** (0.044)	0.461 *** (0.050)	0.490 *** (0.031)
Rhob				−0.057 *** (0.013)
Sigma				−0.061 *** (0.016)
Numban	0.058 *** (0.004)	0.057 *** (0.004)	0.058 *** (0.004)	0.063 *** (0.004)
Tangib	0.040 *** (0.004)	0.040 *** (0.004)	0.041 *** (0.004)	0.041 *** (0.004)
Judinef	0.012 *** (0.004)	0.021 *** (0.005)	0.017 *** (0.006)	0.014 ** (0.006)
Judinef $_{(Low\ Rhos)}$		−0.025 *** (0.004)		
Judinef $_{(Low\ Score)}$			−0.018 * (0.011)	
Age	0.004 (0.004)	0.004 (0.004)	0.004 (0.004)	0.004 (0.006)
Group	−0.048 *** (0.008)	−0.044 *** (0.008)	−0.045 *** (0.010)	−0.051 *** (0.009)
Size 2	−0.047 *** (0.013)	−0.040 *** (0.013)	−0.047 *** (0.008)	−0.044 *** (0.010)
Size 3	−0.089 *** (0.015)	−0.079 *** (0.014)	−0.089 *** (0.015)	−0.085 *** (0.013)
Size 4	−0.152 *** (0.020)	−0.138 *** (0.020)	−0.153 *** (0.020)	−0.149 *** (0.019)
Regional dummies	*yes*	*yes*	*yes*	*no*
Industry dummies	*yes* ***	*yes* ***	*yes* ***	*no*

(continues)

(Table 8 continued)

	(1)		(2)		(3)		(4)	
/lnsigma	-1.444 (0.014)	***	-1.448 (0.014)	***	-1.444 (0.014)	***	-1.425 (0.012)	***
Log likelihhod	-614		-593		-613		-688	
Wald χ^2	$4,783$	(30)	$4,897$	(31)	$4,670$	(31)	$2,807$	(17)
Prob> χ^2	0.0000		0.0000		0.0000		0.0000	
Observations: 4,679 (3,845 uncensored; 170 left-censored; 664 right-censored)								

Robust standard errors, adjusted for clustering of observations, are reported in brackets under the coefficient.

Where indicated the regression also includes 3 regional dummies and 12 industry dummies. In these cases stars indicate the results of joint significance tests. *** Significant at the 1 per cent level. ** 5 per cent level. * 10 per cent level.

Table 9

DISTRIBUTION OF SAMPLE FIRMS BY CREDIT SCORES

Code	Score	No. of Firms	%
1	High security	70	1.4
2	Security	208	4.2
3	High solvency	366	7.4
4	Solvency	1,355	27.2
5	Vulnerability	1,020	20.5
6	High vulnerability	853	17.1
7	Risk	1,027	20.6
8	High & very high risk	82	1.7
	Total	**4,981**	100.0

Figure 1

FREQUENCY DISTRIBUTION OF THE SHARE OF TRADE CREDIT PLEDGED AS COLLATERAL

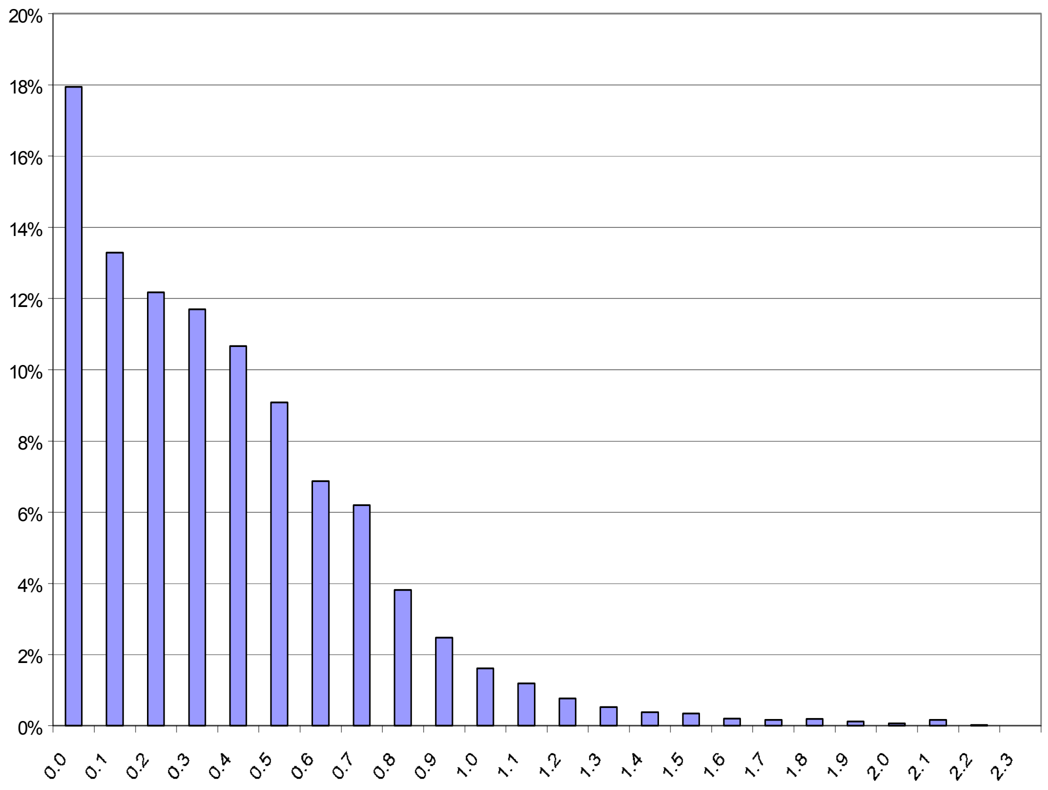
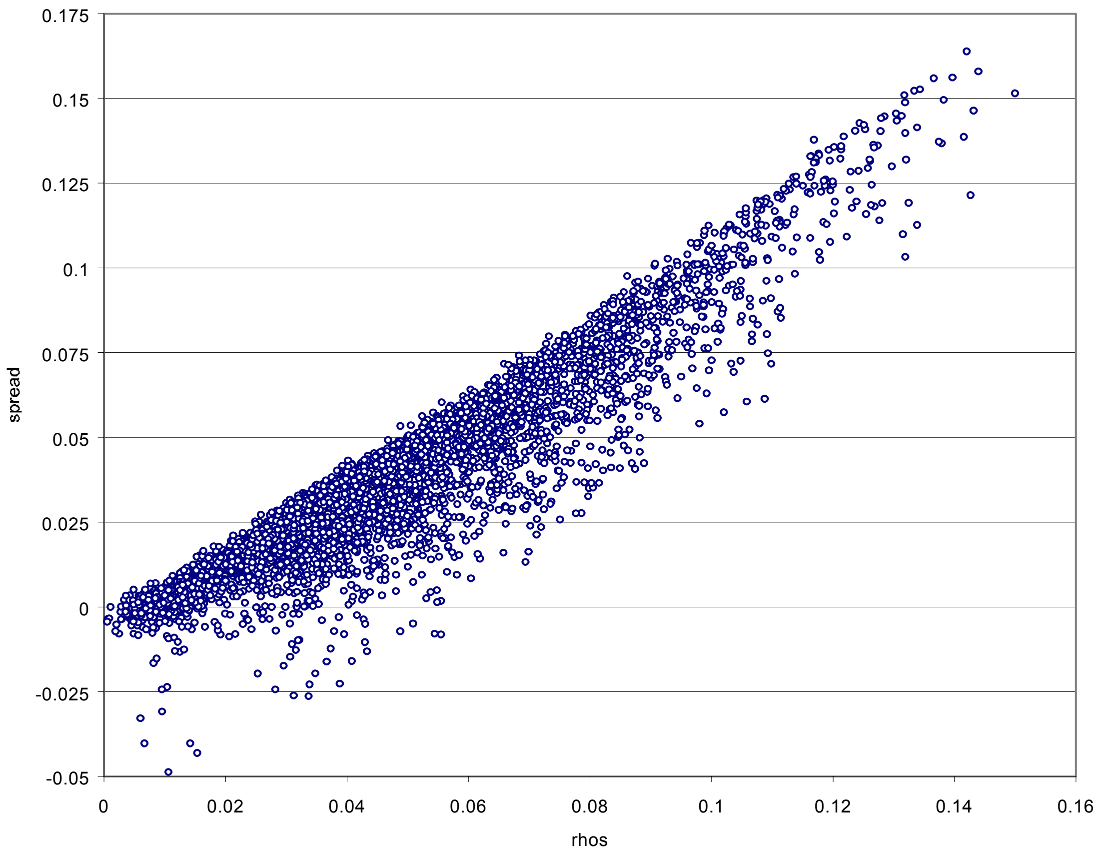


Figure 2

INTEREST RATE SPREAD

BETWEEN 'REVOCABLE' AND 'MATCHED' LOANS



Appendix

Proof of Proposition 2

When unsecured bank borrowing is used to finance accounts receivable, for trade credit to be at least as convenient as direct bank lending ($r_{TC}^{u} \leq r_{B}^{u}$), we must have:

$$\tau \geq \frac{\rho_S \left(1-\rho_B\right)}{\rho_B \left(1-\rho_S\right)}.$$

For $\rho_S = \rho_B$, τ should be ≥ 1, which is impossible by definition.

When accounts receivable are pledged as collateral for bank borrowing, for trade credit to be at least as convenient as direct bank lending ($r_{TC}^{s} \leq r_{B}^{u}$), we must have:

$$\sigma_{SB} \leq 1 - \rho_S \rho_B \left(1-\tau-\gamma\right) - \frac{\left(1-\rho_B\right)}{1-\rho_B \left(1-\tau-\gamma\right)}.$$

From the above equation we can easily derive the equilibrium condition between ρ_S and ρ_B for $r_{TC}^{s} = r_{B}^{u}$:

$$\rho_S = \frac{\rho_B \left(\tau+\gamma\right) - \sigma_{SB}\left(1-\rho_B\left(1-\tau-\gamma\right)\right)}{\rho_B \left(1-\tau-\gamma\right)\left(1-\rho_B\left(1-\tau-\gamma\right)\right)}.$$

In terms of the ratio of σ_{SB} to its upper bound (σ_{SB}^{*}), the condition for $\rho_S > \rho_B$ is:[38]

$$\frac{\sigma_{SB}}{\sigma_{SB}^{*}} < 1 - \frac{1}{\left(1-\rho_B\right)}\left[1 - \frac{\left(\tau+\gamma\right)}{\left(1-\tau-\gamma\right)\left[1-\rho_B\left(1-\tau-\gamma\right)\right]}\right].$$

Example Suppose $(\tau+\gamma) = 0.2$ and $\rho_B = 0.01$. In this case trade credit is viable for a seller who is riskier than the buyer if the covariance is less than 24.4 per cent of its upper bound.[39] When the covariance is 20 per cent of its maximum, a supplier with a probability of default of 6.5 per cent can offer trade credit to a client with a probability of default of 1 per cent at the same interest rate as the bank. With a risk-free interest rate equal to 4 per cent, this means that a firm that borrows from a bank at an interest rate of 11.2 per cent (on an unsecured basis) can make trade credit to a firm that pays an interest rate of 5.1 per cent.

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38 For $\rho_S > \rho_B$, $\sigma_{SB}^{*} = \rho_B \left(1-\tau-\gamma\right)\left(1-\rho_S\right)$.

39 This means that the seller will default in less than 24.4 per cent of the cases in which the buyer defaults.

Proof of Proposition 3

1) The derivative of α with respect to ρ_S is positive:

$$\frac{\partial \alpha}{\partial \rho_S} = \frac{\frac{1+R}{(1-\rho_S)^2} - \frac{(1+R)}{(1-\rho_S\rho_B(1-\tau-\gamma)-\sigma_{SB})^2}\rho_B(1-\tau-\gamma)}{2\kappa\gamma\rho_B} > 0$$

given that $(1-\rho_S) \leq (1-\rho_S\rho_B(1-\tau-\gamma)-\sigma_{SB})$ and $\rho_B(1-\tau-\gamma) < 1$.

2) The derivative with respect to ϑ is negative:

$$\frac{\partial \alpha}{\partial \vartheta} = -\frac{1}{2\kappa\gamma\rho_B} < 0.$$

3) The derivative with respect to κ is negative:

$$\frac{\partial \alpha}{\partial \kappa} = -\frac{1-\rho_B(1-\tau+\gamma)}{2\kappa\gamma\rho_B} - \frac{\alpha}{\kappa} < 0,$$

since α is always ≥ 0.

4) The derivative with respect to σ_{SB} is negative:

$$\frac{\partial \alpha}{\partial \sigma_{SB}} = -\frac{1}{2\kappa\gamma\rho_B}\frac{1+R}{(1-\rho_S\rho_B(1-\tau-\gamma)-\sigma_{SB})^2} < 0.$$

5) The sign of the derivative with respect to τ is not defined:

$$\frac{\partial \alpha}{\partial \tau} = \frac{\frac{\rho_S(1+R)}{(1-\rho_S\rho_B(1-\tau-\gamma)-\sigma_{SB})^2} - \kappa}{2\kappa\gamma}.$$

The sign will be positive for low levels of κ.

The derivative will tend to be (more) positive for riskier sellers:

$$\frac{\partial}{\partial \rho_S}\frac{\partial \alpha}{\partial \tau} = \frac{\frac{1+R}{(1-\rho_S\rho_B(1-\tau-\gamma)-\sigma_{SB})^2} + \frac{2\rho_S\rho_B(1-\tau-\gamma)(1+R)}{(1-\rho_S\rho_B(1-\tau-\gamma)-\sigma_{SB})^3}}{2\kappa\gamma} > 0.$$

If we express α in terms of $\rho_B^* = \rho_B(1-\tau-\gamma)$, the derivative with respect to τ

$$\frac{\partial \alpha}{\partial \tau} = \frac{(1+R)(1-\tau-\gamma)^2}{2\kappa(1-\tau-\gamma-\rho_B^*)^2} - 1 - \alpha$$

shall always be positive for $\kappa < 0.5$, since the first expression has a lower limit equal to $\left(1 + \frac{1}{2\kappa}\right)$ (for R and $\rho_B \to 0$).

Contrary to the previous case, the derivative will tend to be lower for riskier sellers:

$$\frac{\partial}{\partial \rho_S}\frac{\partial \alpha}{\partial \tau} = -\frac{1}{2}\frac{\frac{1+R}{(1-\rho_S)^2} - \frac{\rho_B^*(1+R)}{\left(1-\rho_S\rho_B^*-\sigma_{SB}\right)^2}}{\kappa\gamma\rho_B^*} < 0.$$

6) The derivative of α with respect to γ is positive:

$$\frac{\partial \alpha}{\partial \gamma} = \frac{1}{\gamma}\left(\frac{1}{2} - \alpha + \frac{\frac{\rho_S(1+R)}{(1-\rho_S\rho_B(1-\tau-\gamma)-\sigma_{SB})^2} + \frac{1+R}{1-\rho_B}}{2\kappa}\right).$$

Since $\alpha \leq 1$, the derivative will always be positive for

$$\kappa < \frac{\rho_S(1+R)}{(1-\rho_S\rho_B(1-\tau-\gamma)-\sigma_{SB})^2} + \frac{1+R}{1-\rho_B},$$

which is always true for $\kappa \leq 1$.

7) The sign of the derivative with respect to ρ_B is not defined:

$$\frac{\partial \alpha}{\partial \rho_B} = \frac{1}{\rho_B}\left(\frac{\kappa(1-\tau+\gamma) + \frac{\gamma(1+R)}{(1-\rho_B)^2} - \frac{\rho_S(1-\tau-\gamma)(1+R)}{(1-\rho_S\rho_B(1-\tau-\gamma)-\sigma_{SB})^2}}{2\kappa\gamma} - \alpha\right).$$

The sign will be negative for:

$$\begin{aligned}\kappa + \vartheta \quad &< \quad \left(\frac{1+R}{1-\rho_S} - \frac{1+R}{1-\rho_S\rho_B(1-\tau-\gamma)-\sigma_{SB}}\right) + \\ &\left(\frac{\rho_S(1-\tau-\gamma)(1+R)}{(1-\rho_S\rho_B(1-\tau-\gamma)-\sigma_{SB})^2} - \frac{\gamma\rho_B(1+R)}{(1-\rho_B)^2}\right)\rho_B.\end{aligned}$$

Furthermore, the derivative will tend to be (more) negative for riskier sellers:

$$\frac{\partial}{\partial \rho_S}\frac{\partial \alpha}{\partial \rho_B} = -\frac{\frac{(1-\tau-\gamma)(1+R)}{(1-\rho_S\rho_B(1-\tau-\gamma)-\sigma_{SB})^2} + \frac{2\rho_S\rho_B(1-\tau-\gamma)^2(1+R)}{(1-\rho_S\rho_B(1-\tau-\gamma)-\sigma_{SB})^3}}{2\kappa\gamma\rho_B} - \frac{1}{\rho_B}\frac{\partial \alpha}{\partial \rho_S} < 0$$

given that $\frac{\partial \alpha}{\partial \rho_S} > 0$.

If we express α in terms of $\rho_B^* = \rho_B(1-\tau-\gamma)$, the sign of $\frac{\partial \alpha}{\partial \rho_B^*}$ will be negative for:

$$\kappa + \vartheta \; < \; \left(\frac{1+R}{1-\rho_S} - \frac{1+R}{1-\rho_S\rho_B^* - \sigma_{SB}}\right) + \\ -\frac{(1+R)\,\rho_S\rho_B^*}{(1-\rho_S\rho_B^* - \sigma_{SB})^2} + \frac{\gamma\rho_B^{*2}\,(1+R)}{(1-\tau-\gamma-\rho_B^*)^2},$$

while its value will tend to be (more) negative for riskier sellers:

$$\frac{\partial}{\partial\rho_S}\frac{\partial\alpha}{\partial\rho_B^*} = -\,(1-\tau-\gamma)\,\frac{\frac{1+R}{(1-\rho_S)^2} + \frac{2(1+R)\rho_S\rho_B^{*2}}{\left(1-\rho_S\rho_B^*-\sigma_{SB}\right)^3}}{2\kappa\gamma\rho_B^{*2}} < 0.$$

8) The derivative with respect to R (the risk-free interest rate) is positive:

$$\frac{\partial\alpha}{\partial R} = \frac{\frac{1}{1-\rho_S} - \frac{1}{1-\rho_S\rho_B(1-\tau-\gamma)-\sigma_{SB}} + \gamma\frac{\rho_B}{1-\rho_B}}{2\kappa\gamma\rho_B} > 0.$$

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