# Trade Credit without Systemic Risk

A. Direer *†

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**Abstract**

An incentive to grant trade credit is shown in two simple frameworks in which the amount lent may be alternatively invested in a riskless asset. In the first one, productive risks of the buyer and the supplier are independent. A systemic risk emerges, as a risky account receivable increases the default risk of the supplier. This mechanism is however absent in the second framework in which the productions of the buyer and the seller are positively correlated. In this case, trade credit entails no systemic risk.

Key Words: asymmetric information, trade credit, corporate finance.
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## 1. Introduction

In France, the number of firms' defaults has sharply risen between 1970 and 1993 at an average annual rate of 10% (Longueville 1992). This trend is not specific to the French economy and is commonly observed among industrialized countries

*Ecole Normale Supérieure and Cepremap, URA 928. Correspondence to: ENS, Laboratoire de Sciences Sociales, 48 Bld Jourdan 75014 Paris. Email: direr@ens.fr.

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(Martel 1996). In Canada, Martel (1995) finds an annual average growth rate of defaults of 6,6% between 1980 and 1992.

It is often argued that trade credit is responsible of this tendency. Trade credit is indeed a form of financial intermediation operated by firms themselves. Each firm simultaneously holds accounts payable and accounts receivable in its balance sheet. Hence a deterioration of the creditworthiness of accounts receivable may hit the firm's net wealth and propagates to its own creditors. This mechanism is sometimes called a domino effect and has long been recognized. Marshall (1923) notes: "*When a speculator fails, his failure may cause that of others who have lent their credit to him; and their failure again that of others. Many of those who fail may be really 'sound': that is, their assets may exceed their debts.*"

A relevant measure of the scope of financial intermediation by firms is the ratio $\min(b,d)/\max(b,d)$ where $b$ denotes accounts receivable and $d$ accounts payable. This ratio gives the share of trade credit which is passed through the firm. By using a sample of 2760 firms in 1997, Direr (2000) finds an average ratio of 61%. Hence, the greatest share of trade credit serves as financial intermediation between creditors and debtors of firms.

This financial pattern is further supported by the large amount of interfirm credit observed in most developed countries. In France, accounts payable are twice the short term banking debt and are of the same size of internal funds (Biais-Hillion-Malècot (1995)). According to UFB-Locabail (a French leasing corporation), 20% of the defaults originate failures of customers (Longueville 1992).

This chain mechanism should be distinguished from an competiting source of trade propagation. A firm may default because financially constrained customers cancel orders. This demand channel has nothing to do with a credit channel and may exist even in the absence of trade credit. In the following, the financial propagation is isolated and is referred to as systemic risk.

The aim of the paper is first to explain why firms prefer to lend to other firms instead of holding cash balances and second, to analyze whether trade credit generates financial contagion between firms. The financial motive and the scope of contagion are studied in a two firm model (a buyer and a supplier) in which productions are stochastic. Two polar cases are distinguished. In the first one, production levels of firms are independent whereas in the second case they are perfectly positively correlated. The last assumption is designed to account for the trade link that exists between a producer and its customer.

In both variants it is found that the supplier has an incentive to hold an account receivable from its customer instead of holding other means of payment such as bank account. This incentive comes from the presence of debt contracted by the supplier which induces a bias towards holding risky assets. This motive is even clearer in the case of perfectly correlated shocks. In this case, the supplier always defaults when the buyer does, thereby passing through the loss to its own creditors.

Systemic risk is however very different in the two environments. The existence of trade credit increases the risk of default when productions are independent whereas it is neutral in the case of perfectly correlated risks. This surprising result is explained by the presence of two opposite effects on default risk. When the seller fails, the value of supplier's assets falls and and its credit-worthiness does as well. This is the classical domino effect. But the supplier is compensated for the default risk by a higher interest rate on trade and this defaut premium strengthens the ability of the supplier to pay back its own debt in non-default states of the buyer. When production levels are perfectly correlated, this opposite effect exactly offsets the domino effect.

Several theories have been proposed to explain the existence and use of trade credit. The supplier may have an advantage over traditional lenders in investigating the credit worthiness of its client. It may check the buyer's premises more often than financial institutions would. The size and timing of the buyer's orders also give him an idea of the condition of the buyer's business (Petersen and Rajan (1997)). Moreover, if the buyer defaults, the supplier can seize the goods that are supplied (Mian and Smith (1992)). Trade credit may also be used to price discriminate. Since credit terms are usually invariant to the credit quality of the buyer, trade credit reduces the effective price to low quality borrowers (Schwartz and Whitcomb (1979). Other papers have studied trade credit as a way to reduce transaction costs by separating the payment cycle from the delivery schedule (Ferris (1981)).

The present paper differs from the aforementioned articles by displaying a new and intuitive incentive to grant trade credit. Moreover no one of those papers aim at explicitly dealing with systemic risk, which is the main concern of this article.

The paper proceeds as follows. In section 2, a first model is analyzed in which the productive risks of a supplier and a buyer are independent. Thi setting is modified in Section 3 by assuming a positive correlation between the level of production of the two firms. Section 4 concludes.

## 2. Model with independent productive risks

### 2.1. Assumptions

A two-period model is considered in which two firms $i = 1, 2$ operate. Firm 2 sells to firm 1. An exogenous amount $b_2$ is assumed to be kept by firm 2 in liquid assets in order to face unpredictable spending.. The sole decision studied by the model is taken by firm 2 at date 0 and consists in choosing whether to hold amount $b_2$ in a safe financial asset (equivalently a check account) or to lend it to firm 1 as account receivable. Account receivable is indeed a close substitute for money and trade credit between firms also provides transactions services (Ferris (1981), Ramey (1992)).

Productions $\widetilde{y}_i$ necessitate real assets $k_i$ and are stochastic. Firm 1 production takes the value $y_1^r$ with probability $p$ and $y_1^f < y_1^r$ with probability $1-p$. Firm 2 production $y_2$ is distributed over $[0, \overline{y}]$ according to the density function $f(.)$ and the cumulative $F(.)$, twice continuously differentiable. Both firms have to repay an exogenous amount of debt respectively denoted $d_1$ and $d_2$. Let $R_1$ and $R_2$ define gross interest rates on debt and $X$ the gross safe interest rate[1]. The firms and all debtholders are risk neutral.

For simplicity, both firms hold the same amount of debt ($d_1 = d_2 = d$), financial short-term asset ($b_1 = b_2 = b$), real assets ($k_1 = k_2 = k$) and internal funds ($w_1 = w_2 = w$). The ex ante balance sheet identity imposes $k + b = w + d$. To focus on firm 2 financing decision between account receivable and safe asset, firm 1 is assumed to hold $b$ as a safe asset. Last, a financial friction is introduced by assuming that creditors cannot observe the choice of firm 2 between the two kinds of short-term assets, so they cannot contract upon..

Let $E[\pi_2(j)]$ be expected profit of firm 2 when it grants trade credit to firm 1 ($j = 1$) or when he holds a safe asset ($j = 0$). In last case, expected profit is:

$$E[\pi_2(0)] = \int_{y^0}^{\overline{y}} (y + Xb - R_2 d) f(y) dy \tag{2.1}$$

where $y^0$ is the threshold value below which firm 2 defaults:

$$y^0 = R_2 d - Xb$$

When it grants trade credit, its return depends on whether firm 1 fails, which

[1] All interest rates are taken to be *gross* interest rates in the sequel.

happens with probability $1 - p^2$. In this case, the supplier-creditor 2 is given the prorata $b/d$ of the total asset $y_1^f + Xb$. Expected profit of the supplier is then:

$$E[\pi_2(1)] = p \int_{\widehat{y}}^{\overline{y}} [y + R_1 b - R_2 d] f(y) dy + (1-p) \int_{\widetilde{y}}^{\overline{y}} [y + (b/d)(y_1^f + Xb) - R_2 d] f(y) dy \tag{2.2}$$

where $\widetilde{y}$ and $\widehat{y}$ are bankruptcy thresholds (the values of production under which the firm defaults) respectively in the default case and in the non-default case of firm 1:

$$\begin{cases} \widetilde{y} = R_2 d - (b/d)(y_1^f + Xb) \\ \widehat{y} = R_2 d - R_1 b \end{cases} \tag{2.3}$$

### 2.2. Equilibrium

Gross interest rates $R_1$ and $R_2$ on debt of both firms are given by standard non-arbitrage conditions. This condition is for debtholders of firm 1:

$$pR_1 + (1-p)(y_1^f + Xb)/d = X \tag{2.4}$$

For debtholders of firm 2, it depends on the equilibrium choice of the supplier between trade credit and safe asset. This choice is derived from a profit maximization condition. At equilibrium, firm 2 chooses the type $j^* \in \{0, 1\}$ which maximizes his expected profit ($E[\pi_2(j^*)] \geq E[\pi_2(j)]$). Let us consider the incentive of firm 2 in case of a fixed $R_2$ (whatever its equilibrium value):

**Proposition 1.** if $R_2$ is fixed, $E[\pi_2(1)] > E[\pi_2(0)]$.

**Proof.** The difference between expected profits (2.2) and (2.1) can be rewritten:

$$E[\pi_2(1)] - E[\pi_2(0)] = p \int_{\widehat{y}}^{\overline{y}} [y - \widehat{y}] dF(y) + (1-p) \int_{\widetilde{y}}^{\overline{y}} [y - \widetilde{y}] dF(y) - \int_{y^0}^{\overline{y}} [y - y^0] dF(y)$$

Take the function:

$$g(x) = \int_x^{\overline{y}} [y - x] dF(y)$$

[2] To make things interesting, it is assumed that the low production case for firm 2 leads to his defaut: $y_1^f + Xb < R_1 d$.

Then, by exploiting the non-arbitrage condition (2.4): $y^0 = p\widehat{y} + (1-p)\widetilde{y}$. The desired inequality $E[\pi_2(1)] > E[\pi_2(0)]$ is therefore expressed as:

$$pg(\widehat{y}) + (1-p)g(\widetilde{y}) > g[p\widehat{y} + (1-p)\widetilde{y}]$$

This inequality holds true if $g(.)$ is convex over $[\widehat{y}, \widetilde{y}]$. Convexity is met: $g''(x) = f(x) > 0$. □

Therefore the supplier's expected profit with trade credit is greater than with a safe financial asset. This is because, as in Jensen and Meckling (1976) and Stiglitz and Weiss (1981), the debt return is a concave function of the stochastic cash flow. In particular, this holds true for $R_2$ at the equilibrium value satisfying the non-arbitrage condition. Taking into account this incentive of the supplier, the non-arbitrage condition for the debt of the supplier (firm 2) can be now written:

$$\begin{array}{c} p\left\{\int_0^{\widehat{y}_e}[y + R_1 b](1/d)f(y)dy + [1 - F(\widehat{y}_e)]R_2^1\right\} \\ +(1-p)\left\{\int_0^{\widetilde{y}_e}[y + (b/d)(y_1^f + Xb)](1/d)f(y)dy + [1 - F(\widetilde{y}_e)]R_2^1\right\} = X \end{array}$$

This is the average return when the buyer fails with probability $1-p$ and when it pays back its debt in full with probability $p$. This gives the equilibrium interest rate $R_2^1$ on the supplier's debt (superscript 1 indicates that the supplier holds a trade credit). In order to isolate the impact of trade credit on risk of firm 2, the non-arbitrage condition when it holds a safe asset instead is also expressed:

$$\int_0^{y_e^0}(y + Xb)(1/d)f(y)dy + [1 - F(y_e^0)]R_2^0 = X$$

which determines $R_2^0$. The bankruptcy thresholds (2.3) are:

$$\begin{cases} y_e^0 = R_2^0 d - Xb \\ \widetilde{y}_e = R_2^1 d - (b/d)(y_1^f + Xb) \\ \widehat{y}_e = R_2^1 d - R_1 b \end{cases}$$

We have the result (see the Appendix for the proof):

**Proposition 2.**
*(i)* $R_2^1 > R_2^0$
*(ii)* $pF(\widehat{y}_e) + (1-p)F(\widetilde{y}_e) > F(y_e^0)$.

Trade credit raises the interest rate $R_2^1$ of the debt's supplier (result $(i)$). As a consequence, its default probability is pushed upward (result $(ii)$). Hence, when production risks between the supplier and its customer are perfectly independent, the supplier prefers to grant a credit to the buyer instead of holding the amount in a bank account although this raises at equilibrium its probability of default.

## 3. Model with correlated productive risks

The previous section has put in evidence an intuitive way by which trade credit helps propagate default risks. However, we may ask if this result depends upon the assumption that productive risks of firms are independent. In reality, firms' production are positively correlated, especially when they share commercial links. Indeed a fall in demand of the buyer may propagate to the supplier if the former is led to reduce or even cancel its orders. In the following, I study what happens to incentive to grant trade credit and to systemic risk when the levels of production of the two firms are positively correlated. To keep things simple, I restrict my attention to an economy in which the risks are perfectly correlated.

### 3.1. Assumptions

The framework is unchanged, except that the stochastic production $y_1$ of the buyer is now ex ante and ex post the same as the one of the supplier. That is: $y_1 = y_2 \equiv y$. The density function of $y$ remains described by $f(.)$ over $[0, \overline{y}]$, once continuously differentiable..

### 3.2. Equilibrium

As in the previous section, I begin by studying the choice of the supplier (firm 2) between trade credit and acquiring a safe asset. The expected profit of the supplier if it holds a safe asset is unchanged (see (2.1). Moreover, assuming a positive correlation of the two productions doe not change the incentive of firm 2 to grant trade credit:

**Proposition 3.** For $R_2$ given, $E[\pi_2(1)] > E[\pi_2(0)]$.

**Proof.** There exist three thresholds of bankruptcy for the supplier: when it holds trade credit and (i) the buyer is able to pay back the credit (that is $y > y^0$),

(ii) the buyer defaults on its debt ($y \leq y^0$) and (iii) when the supplier holds a safe asset. Respectively:

$$\begin{cases} \widehat{y} + R_1 b = R_2 d \\ \widetilde{y} + (b/d)(\widetilde{y} + Xb) = R_2 d \\ y^0 + Xb = R_2 d \end{cases}$$

Those thresholds can be ordered: $\widehat{y} < \widetilde{y} < y^0$. Indeed, after rearranging the terms:

$$\widetilde{y} - y^0 = -\frac{bd}{b+d}(R_2 - X) < 0$$

As for the first inequality, the following inequality $\widehat{y} < \widetilde{y}$ must hold because, by definition of a bankruptcy, the supplier-creditor receive less than its total stake if the buyer defaults.. Or formally: $(b/d)(\widetilde{y} + Xb) < R_1 b$. The desired inequality is then straightforward. This order implies that the supplier defaults if and only if $y < \widetilde{y}$ whatever the value of $\widehat{y}$. This is because $\widehat{y}$ is also by symmetry the threshold value of default of the buyer. The supplier's expected profit with trade credit is:

$$E[\pi_2(1)] = \int_{\widetilde{y}}^{y^0} [y + \frac{b}{d}(y + Xb) - R_2 d] dF(y) + \int_{y^0}^{\overline{y}} [y + R_1 b - R_2 d] dF(y)$$

The net gain to grant a credit to the buyer is then:

$$E[\pi_2(1)] - E[\pi_2(0)] = \int_{\widetilde{y}}^{y^0} [y + \frac{b}{d}(y + Xb) - R_2 d] dF(y) + [1 - F(y^0)](R_1 - X)b$$

The right hand side first term is positive. Moreover, because the debt on firm 1 is risky, $R_1 - X > 0$ holds true. $\square$

Hence the supplier has as before an incentive to accord trade credit whatever the value of $R_2$. In particular, this incentive remains if $R_2$ is set at its equilibrium value. The intuition behind proposition 3 is the following. Because productive risks are correlated, the supplier always defaults on its debt when the buyer does. Hence the loss originated from the buyer's default is automatically passed through to the own debtors of the supplier. Conversely, the fact that the buyer pays back its debt makes very likely the survival of the supplier. Hence, the chance of the supplier to earn the full return $R_1$ is much greater than for other types of creditors. This raises the expected return of trade credit.

Having proved the incentive of the supplier to lend to the buyer, I now analyze the issue of systemic risk. Let us define $R_2^1$ the interest rate which satisfies the non-arbitrage condition when the supplier holds trade credit:

$$\int_0^{\widetilde{y}_e} [y + \frac{b}{d}(y + Xb)]dF(y) + [1 - F(\widetilde{y}_e)]R_2^1 = X$$

with $\widetilde{y}_e = [d/(b+d)][R_2^1 d - (b/d)Xb]$ the threshold value of default and $R_2^0$ the interest rate when the firm 2 holds a safe asset:

$$\int_0^{y_e^0} [y + Xb]dF(y) + [1 - F(y_e^0)]R_2^0 = X$$

where $y_e^0 = R_2^0 d - Xb$. It is possible to show the following result (See Appendix for the proof):

**Proposition 4.** $\widetilde{y}_e = y_e^0$.

This proposition shows that the supplier's default risk is left unaffected by its choice between trade credit and a safe asset. Hence, when productive risks are perfectly correlated, trade credit does not entail any additional risk in the productive system. This result is explained by the presence of two opposite effects on default risk. When the seller fails, the value of its assets and its credit-worthiness fall. This raises the level of risk in the economy *ceteris paribus*. But the model controls for the fact that the supplier is compensated for the default risk by a higher interest rate on trade credit. This risk premium strengthens its ability to pay back its own debt in the non-default states of the buyer. When production levels are perfectly correlated, this opposite effect exactly offsets the first effect.

## 4. Conclusion

In this paper I study the decision of a supplier between holding a safe asset or lending to another firm. When risk are uncorrelated, the supplier prefers to lend to the firm because debt return is a concave function of the stochastic cash flow and lending to a risky firm enhances expected profit by increasing the volatility of the cash flow. In this case it is shown that trade credit raises the default risk of the buyer.

Then, a similar mechanism is studied in an economy in which productive risks are correlated. This is intended to capture the commercial link between the two firms. As before, the supplier prefers trade credit. Indeed, because productive risks are correlated, the supplier always defaults on his debt when the buyer does. Hence the loss from the buyer's default is automatically passed through to the supplier's own debtors. Conversely, the fact that the buyer pays back its debt makes more likely the survival of the supplier. Hence, the chance of the supplier to earn the full return is much greater than for other types of creditors. This raises the expected return of trade credit.

But contrary to the previous situation, trade credit entails no additional risk. This is because the risk premium earned by the supplier strengthens its ability to pay back its own debt in the non-default states of the buyer. Interestingly, this last result contradicts the common opinion about the effect of trade credit on systemic risk.

# Appendix

## Proof of proposition 2

By virtue of the no-arbitrage condition, debtors of both firms earn in average $Xd$. This must be true in equilibrium whatever the choice of firm 2 between trade credit and a safe financial asset. Expected income of firm 2 is: $E(y) + Xb$. This income is divided between shareholders and debtors so that debtors are paid $Xd$ in average:

$$E(y) + Xb = E[\pi_2(j)] + Xd$$

Hence, expected income of shareholders does not depend at equilibrium upon supplier financial policy, (where debtors anticipate correctly this policy):

$$E[\pi_2(1)] = E[\pi_2(0)] \tag{4.1}$$

where the default thresholds are such that debtors claim the average return $X$ on each unit lent: $\widehat{y}_e = R_2^1 d_2 - R_1 b$, $\widetilde{y}_e = R_2^1 d_2 - (b/d_1)(y_1^f + Xb)$ and $y_e^0 = R_2^0 d_2 - Xb$.

Besides, for $R_2 = R_2^1$, $R_2^0$ *given* we know that $E[\pi_2(1)] > E[\pi_2(0)]$ (proposition 1). Since total expected income $E(y) + Xb$ does not depend on the choice of financing, the profitability of debt on the firm 2-supplier is lower for $R_2$ *given* when the supplier holds an account receivable than a riskless asset. Hence, for the debtors to earn $Xd$ in average, they have to claim a greater interest rate in case of trade credit: $R_2^1 > R_2^0$.

Let us define the function $g(.)$:

$$g(x) = \int_x^{\overline{y}} [y - x] dF(y).$$

Equality (4.1) may be rewritten:

$$pg(R_2^1 d_2 - R_1 b) + (1-p) g(R_2^1 d_2 - (b/d_1)(y_1^f + Xb)) = g(R_2^0 d_2 - Xb)$$

take the derivative with respect to $d_2$:

$$pg'(\widehat{y}_e) R_2^1 + (1-p) g'(\widetilde{y}_e) R_2^1 = g'(y_e^0) R_2^0$$

Since: $g'(x) = -[1 - F(x)]$ we have:

$$[1 - F(y_e^0)] > (R_2^0/R_2^1)[1 - F(y_e^0)] = p[1 - F(\widehat{y}_e)] + (1-p)[1 - F(\widetilde{y}_e)]$$

because $R_2^1 > R_2^0$. The desired inequality is then straightforward: $F(y_e^0) < pF(\widehat{y}_e) + (1-p)F(\widetilde{y}_e)$. $\square$

## Proof of proposition 4

For the same reasons put in the proof of proposition 2, the interest rate on firm 2's debt must be lower at equilibrium with the holding of a safe asset than with trade credit: $R_2^0 < R_2^1$. Identically, the firm obtains the same expected profit in both cases when the debtors correctly anticipates its financial policy:

$$E[\pi_2(1)] = E[\pi_2(0)] \tag{4.2}$$

Let us conjecture the solution $\widetilde{y}_e = y_e^0$. In this case, (4.2) expresses as:

$$\int_{y_e^0}^{\overline{y}} [y - y_e^0] dF(y) = \int_{\widetilde{y}_e}^{\overline{y}} [y - \widetilde{y}_e] dF(y)$$

Equality $\widetilde{y}_e = y_e^0$ is then validated. In order to rule out multiple equilibria, suppose by mean of contradiction that $\widetilde{y}_e < y_e^0$. By symmetry when firm 2 holds a riskless asset, as firm 1, both firms share the default threshold in this case. Equality (4.2) can the be written:

$$\int_{y_e^0}^{\overline{y}}[y+Xb-R_2^0 d]dF(y) = \int_{\widetilde{y}_e}^{y_e^0}[y+(b/d)(y+Xb)-R_2^1 d]dF(y)+\int_{y_e^0}^{\overline{y}}[y+R_1 b-R_2^1 d]dF(y)$$

It is simple to show that the right hand side of this equality is in fact greater than the left hand side. By definition of the threshold values:

$$\int_{\widetilde{y}_e}^{y_e^0}[y + (b/d)(y + Xb) - R_2^1 d]dF(y) > 0,$$

Then what we have to show reduces to:

$$\int_{y_e^0}^{\overline{y}}[y + R_1 b - R_2^1 d]dF(y) > \int_{y_e^0}^{\overline{y}}[y + Xb - R_2^0 d]dF(y)$$

or:

$$(R_1 - X)b > (R_2^1 - R_2^0)d. \tag{4.3}$$

By definition of $y_e^0$ and $\widetilde{y}_e$ we have:

$$\widetilde{y}_e + (b/d)(\widetilde{y}_e + Xb) - R_2^1 d = 0$$
$$y_e^0 + Xb - R_2^0 d = 0$$

The first equality implies:

$$y_e^0 + (b/d)(y_e^0 + Xb) - R_2^1 d > 0$$

because of the initial conjecture $y_e^0 > \widetilde{y}_e$. Put with the second equality:

$$y_e^0 + (b/d)(y_e^0 + Xb) - R_2^1 d > y_e^0 + Xb - R_2^0 d$$

or $(b/d)(y_e^0 + Xb) - R_2^1 d > Xb - R_2^0 d$. By replacing the term $y_e^0 + Xb$ by $R_2^0 d$ and by exploiting the symmetry between the two firms: $R_1 = R_2^0$, the inequality (4.3) is true, which contradicts the initial conjecture.

Last, suppose $\widetilde{y}_e > y_e^0$. If $y = \widetilde{y}_e$, firm 1 is solvent by definition. The discrepancy between expected profits $E[\pi_2(1)] - E[\pi_2(0)]$ is the equal to:

$$\int_{\widetilde{y}_e}^{\overline{y}}[y - \widetilde{y}_e]dF(y) - \int_{y_e^0}^{\overline{y}}[y - y_e^0]dF(y)$$

which is necessarily negative because $\widetilde{y}_e > y_e^0$. This contradicts once again the equilibrium condition of equality of expected profits. □

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