THE JOURNAL OF FINANCE • VOL. LV, NO. 1 • FEBRUARY 2000

The Exploitation of Relationships in Financial Distress: The Case of Trade Credit

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ABSTRACT

This paper develops optimal pricing, lending, and renegotiation strategies for companies in relationships where one firm is highly dependent on the other. Long-term trade–creditor firm relationships induce dependent trade creditors to grant more concessions in debt renegotiations than nondependent creditors. Anticipating these larger renegotiation concessions, not only do less financially stable firms prefer trade credit, but all firms agree to pay a higher interest rate for trade credit. The model also explains the existence of "teaser" interest rates and convenience classes. Findings are consistent with those of the relationship-lending literature.

TRADE CREDIT IS THE LARGEST SOURCE of short-term financing for American corporations. In 1993, trade creditors extended almost $1.5 trillion in credit to their customers. In the same year, the Internal Revenue Service (1997) estimates that for every dollar in short-term financing provided by credit markets, $1.94 in trade credit was outstanding. Most firms extensively use trade credit despite its apparent greater cost, and trade credit interest rates commonly exceed 18 percent. Petersen and Rajan (1994, 1995) posit that firms take trade credit when cheaper sources of financing have been exhausted; however, this does not explain why firms with financial slack use trade credit.

This paper provides a rationale for trade credit use by analyzing the effect of bilateral relationships on debt renegotiation. In particular, optimal pricing, lending, and renegotiation strategies are determined for companies, their trade creditors, and other credit market lenders.

Petersen and Rajan (1994, 1995, 1997) describe how relationships can be beneficial. This paper demonstrates that relationships can be detrimental if one party is dependent on another. For example, a firm in financial distress

* LECG/Navigant Consulting, Evanston, Illinois. This article is taken from Chapter 2 of my dissertation completed at Northwestern University. I thank Susan Chaplinsky, Peter DeMarzo, Patrick W. Duthie, Michael Fishman, Thomas George, Mort Kamien, Mitchell Petersen, Oliver Richard, and Andy Winton as well as seminar participants at Concordia University, Dartmouth College, the Federal Reserve Bank of Chicago, the Federal Reserve Bank of Philadelphia, the Federal Reserve Board, the University of Iowa, the London Business School, the Norwegian School of Management, Northwestern University, and Notre Dame for valuable comments. I also thank René Stulz (the editor) and an anonymous referee for their thoughtful suggestions. All mistakes are due to the author.

can take advantage of a creditor if it generates a large percentage of the creditor's profits.[1] This logic is applied to trade credit. Consistent with the evidence of Evans (1998), trade creditors, desiring to maintain an enduring product market relationship, grant more concessions to a customer in financial distress than would be granted by lenders in a competitive credit market. Anticipating these larger renegotiation concessions, the debtor firm agrees to pay a higher interest rate to a trade creditor than to a credit market lender. This is not to say that trade credit is more expensive than credit market loans; instead, the higher trade credit interest rate is fair compensation for the firm's receiving larger concessions if financial distress occurs. Therefore, when contracting, a borrower should ask a previously unexplored question: Will she generate a large percentage of her partner's profits? If so, the borrower should be willing to accept what appears to be a less favorable contract, anticipating more power in renegotiations should financial distress occur.

This model makes additional predictions that are consistent with empirical observations. Consistent with the evidence of Petersen and Rajan (1994, 1995, 1997) and Wilner (1997), this paper shows that firms with larger probabilities of default are more willing to pay the higher trade credit interest rate because associated renegotiation concessions are more likely. Petersen and Rajan and Wilner also demonstrate that the intertemporal variability of the trade credit terms is less than the variability of credit market rates. This paper shows that renegotiation concessions are inversely related to macroeconomic interest rates, thus dampening trade credit interest rate fluctuations. All other theoretical papers prove the opposite result: If a firm takes trade credit, the corresponding terms are always more variable than the terms the credit market would have charged the firm.[2] This paper also accurately predicts that convenience classes, which consist of creditors who are less likely to be dependent on the bankrupt debtor, grant fewer renegotiation concessions in Chapter 11 bankruptcy.

Most of the modeling in this paper assumes that the trade creditor possesses market power and the credit market is perfectly competitive. Under these assumptions, the trade creditor earns positive expected profits, forcing a dependence on the debtor firm; in contrast, the credit market does not earn positive expected profits, nor possess a similar reliance. Bulow and Shoven (1978) and Petersen and Rajan (1994, 1995) argue that in certain instances the credit market may not be perfectly competitive because one participant, a bank, can generate profits and a resulting dependence on the debtor firm. The model in this paper is extended to allow for this case. This extension demonstrates that the interest rate charged by a creditor varies

[1] Klein, Crawford, and Alchian (1978), Bulow and Shoven (1978), Berkovitch, Israel, and Zender (1993), and Franks and Nyborg (1995) demonstrate that deviations from absolute priority exist if a creditor is dependent on a bankrupt debtor. The degree of dependence varies with how much business a creditor can afford to lose.

[2] See Schwartz (1974), Schwartz and Whitcomb (1979), Brick and Fung (1984), Emery (1984, 1987), Smith (1987), Brennan, Maksimovic, and Zechner (1988), Freixas (1993), and Frank and Maksimovic (1995).

cross sectionally with the degree of dependence. Moreover, the paper's intuition can be extended to show that, consistent with Petersen and Rajan (1995), if a debtor could be dependent on its creditor, the creditor offers "teaser rates" and/or relaxed terms in order to create the dependence relationship.

The paper proceeds as follows. The characteristics of trade credit are discussed in Section I. The baseline model is described in Section II. In Section III, optimal trade credit and credit market rates are derived; trade credit interest rates are shown to exceed credit market rates in the baseline model. Comparative statics are performed in Section IV, model extensions are provided in Section V, and Section VI concludes by using this paper's findings to summarize the relationship-lending literature.

I. Trade Credit Interest Rates

The interest rate charged on trade credit loans varies with the terms of sale and the degree to which they are violated. Wilner (1997) and Ng, Smith, and Smith (1999) show that trade creditors often do not directly charge interest on their trade credit sales; instead they offer a discount for early payment. Common terms of sale are 2–10 net 30. The net or full purchase price is due in 30 days; a two-percent discount is obtained if payment occurs within 10 days of the sale.[3] The discount for early payment can be considered an interest charge for late payment. With a $1.00 purchase 2–10 net 30, the firm receives a $0.98 loan for 20 days; the interest charge is $0.02. Therefore, 2–10 net 30 implies an annual interest rate of 44.6 percent. Although some trade creditors extend terms of 8–30 net 50, implying rates of 358 percent, others offer no discount for early payment, implying interest-free loans. However, terms of sale are often violated as, for example, when firms delay payment. Because terms of a sale usually do not include an explicit tardiness penalty,[4] Wilner (1997) shows that delayed payment reduces the aforementioned rates by two-fifths. Even with this reduction, the interest rate on most trade credit loans far exceeds the June 25, 1998 commercial paper rate of 5.48 percent.[5]

[3] In practice, if a firm needs credit for 30 days and borrows from the credit market, it is optimal for the firm to take 10 days of trade credit then repay the supplier by borrowing from the credit market for 20 days. With this strategy, the firm can take advantage of the 10 days of free credit since the supplier considers payment on day 10 the same as a cash payment.

[4] A 1996 Credit Research Foundation survey shows that a majority of companies do not implement a late payment penalty. Seven percent of the companies previously charged a late payment penalty, but did not at the time of the survey. On average, trade creditors start assessing late payment penalties after 18 days of delinquency. The survey also finds that less than half the amount of the assessed penalties are actually collected. However, paying late is not completely costless; a reduced credit rating could ensue and/or the supplier could withhold future product.

[5] Commercial paper and trade credit loans are both short-term unsecured corporate obligations. Part of this interest rate differential is driven by a clientele effect as the largest and most financially secure borrowers issue commercial paper while most firms take trade credit. Section V.A of this paper discusses the clientele effect. Wilner (1997) also demonstrates that the magnitude of the delay, and thus the interest rate, varies cross-sectionally.

Trade credit rates have also been shown to be intertemporally stable. The Credit Research Foundation (1965) notes the prevalence of 2–10 net 30. Wilner (1997) demonstrates that though violation-adjusted trade credit rates fluctuate, they vary less than other interest rates. That paper shows that commercial paper rates dropped about 30 percent from 1983 to 1993 but effective trade credit rates contemporaneously decreased by only seven percent.[6]

II. The Baseline Model

This paper describes a three-period, three-player sequential decision model. The three players are a supplier/trade creditor, a manager of a firm, and a competitive credit market. The trade creditor is a monopolistic producer of a perishable commodity. The manager is the sole owner of a firm that purchases from the trade creditor and sells to a product market. In order to isolate the trade creditor–firm relationship, it is assumed that the firm is either the trade creditor's only customer or the trade creditor can perfectly price discriminate between his customers. (This assumption is relaxed in Section V.A.) The firm has no costs of production other than the price charged by the trade creditor. The firm's manufacturing process is one-to-one, it is unable to store goods for more than one period, and the firm is assumed to be a price taker when selling its good.

While the trade creditor is not cash constrained, the firm requires a loan to purchase its inputs. The firm has two potential sources of funding: the trade creditor and the credit market. The manager is assumed to issue debt to purchase her firm's inputs. In order to prevent the firm from entirely insulating itself from uncertainty in the product market, it is assumed that a three-period loan contract cannot be written.

Figure 1 displays the sequence of events. In period 0, the trade creditor produces one unit of his product and assumes the cost of production v. He sets two prices: a cash price (d_1) and a credit price (p_1).[7] The interest rate he charges, tc_1, is implicit in the formula: $p_1 = d_1(1 + tc_1)$. Given these prices, the credit market competitively sets an interest rate, r_1. The firm then purchases one unit of product from the trade creditor either with cash or on credit. If credit is selected, the firm agrees to pay the trade creditor p_1 in period 1. To pay in cash, the firm borrows d_1 from the credit market, uses

[6] The decline in commercial paper rates might be less than that in other unsecured, short-term loans as Calomiris, Himmelberg, and Wachtel (1995) show that commercial paper issuance is countercyclical.

Barzman (1975) provides an example of comparable colonial trade credit rates. In 1660, John Hull sold eight bushels of wheat to John Winthrop, Jr., the governor of Connecticut, for four shillings and three pence on three months credit. (In the seventeenth century, there were 12 pence in a shilling.) The prevailing cash price was four shillings. This transaction therefore induced an implied interest rate of 25 percent, not dissimilar to present-day trade credit rates.

[7] Actually, the trade creditor would quote a price of p_1 and an early payment discount of $1 - (d_1/p_1)$.

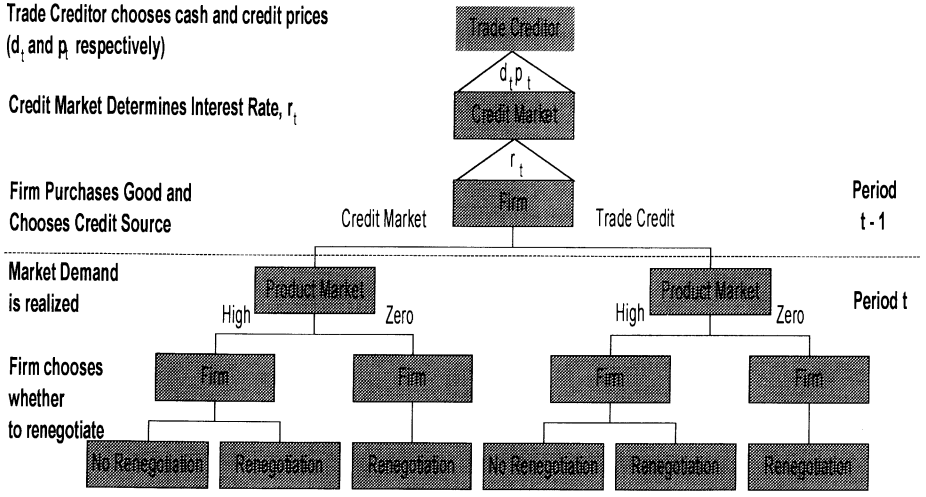

Figure 1. Sequence of events in sale, $t = 1$ and $t = 2$.

the borrowed funds to pay the trade creditor, and assumes a loan due in period 1 with face value of $d_1(1 + r_1)$. At the end of period 0, cash flows are discounted at the rate of $1/(1 + i)$, where i is the risk-free rate.

In period 1, the firm sells to a product market with stochastic demand. The market price, which is publicly observed and verifiable at this time, is either high, $a > 0$, or zero. The high price occurs with probability q. If the market price is zero, the firm is forced to renegotiate its debt as it has no revenues. If the high market price occurs, the firm has the choice to renegotiate or repay its creditor. The renegotiation game is discussed in Section III.A. After repayment or renegotiation, all profits are distributed as dividends and consumed.

Then a second sale occurs as long as the firm is not liquidated in period 1.[8] The events in the second sale are identical to those in the first sale except the prices and interest rates are denoted by p_2, d_2, tc_2, and r_2, respectively. After the second sale, the game ends.

Let π_t^{tc}, π_t^m, and π_t^{cm} be the expected profits, including and subsequent to sale t, of the trade creditor, the manager, and the credit market, respectively. These profits are given in time t dollars.

[8] The supplier and the firm are both economically viable in the second sale because the expected revenue the firm receives from selling to the market in the second sale exceeds the supplier's cost of production. If there is some probability that the firm is not economically viable in the second sale, the model can show that the supplier's expected sale 2 profits lessen along with the supplier's willingness to assist the firm in sale 1 renegotiation. The trade credit premium also decreases proportionately.

III. Solving the Baseline Model

This section shows that trade credit rates differ from credit market rates when the trade creditor earns positive expected profits from a continuing relationship. The model is solved by backward induction. Sale 2 results are determined first, then the solution to sale 1 is ascertained.

A. Renegotiation

Before determining optimal strategies, renegotiation must be discussed. It can occur either privately or in the bankruptcy courts. It is assumed to be immediate and costless. If the firm and its creditor(s) agree to reorganize the firm's debts, the firm continues to operate. If the firm and its creditor(s) cannot agree, the firm is liquidated and all parties receive nothing.[9]

Trade creditors and credit market lenders both provide unsecured short-term loans, which have equal priority under the Bankruptcy Reform Act of 1979. However, as stated more formally in Prediction 2 later, even though the law implies that both creditors should grant identical concessions, dependence on the financially distressed firm causes the trade creditor to grant greater concessions in sale 1 renegotiation than a similarly positioned credit market lender. In other words, the trade creditor receives a smaller fraction of cash and/or equity in the financially distressed firm in sale 1 renegotiation than does the credit market lender.

By using an unconventional methodology to calculate the amount received by the creditor(s) in renegotiation, this paper demonstrates the relationship between the trade creditor's dependence on the financially distressed firm and the renegotiation concessions. Instead of altering the fraction of the money at stake conceded by each creditor, the model assumes that both the trade creditor and credit market lender concede the same fraction but the amount of money at stake in renegotiation varies. To simulate equal priority, the creditors, irrespective of type, are assumed to receive the same fraction, $0 < s < 1$, while the debtor receives $1 - s$. Bebchuk and Chang (1992), Brown (1989), and Giammarino (1989) derive particular fractions in their theoretical models. The money at stake equals the financially distressed firm's current and expected future profits *plus* its creditors' expected future profits from trading with the firm. The creditors' expected future profits are included because they are a relationship-specific asset that affects renegotiation.[10] Therefore, in sale 1 renegotiation, the money at stake is larger if trade credit is being negotiated, as Theorem 2 (later) shows that

[9] Reorganization corresponds to a Nash Bargaining game with disagreement point zero. If disagreement occurs, all money is assumed to be spent on attorney's fees. If some fraction of the cash flows remain after disagreement, the paper's conclusions would hold with most reasonable disagreement points.

[10] See Klein et al. (1978). Additionally, Bulow and Shoven (1978) demonstrate how future profits affect a creditor's liquidation decision. Berkovitch et al. (1993) show that another relationship-specific asset, managerial salaries, affects bankruptcy bargaining.

the trade creditor earns positive expected profits in sale 2 but the credit market lender does not. The fact that the trade creditor's expected sale 2 profits are at stake only if trade credit is taken in sale 1 is explained in greater detail in Section V.D. Contrary to sale 1, in sale 2 renegotiation, irrespective of the creditor type, the money at stake equals the firm's current profits because there are no future profits since the game ends after sale 2.

The amount received by the creditor results from multiplying the money at stake by the fraction conceded. This distribution, which varies with the period, demand state, and creditor identity, is given out in cash and/or equity in the firm.[11] Let e^{tc} be the fraction of the firm's equity awarded to the trade creditor and let e^{cm} be the fraction of the firm's equity awarded to the credit market if renegotiation occurs after sale 1. Since the firm only has one creditor in sale 1, e^{tc} and e^{cm} are not simultaneously positive. If renegotiation occurs after sale 2, the creditor receives no equity because the game subsequently terminates. Creditors receive cash distributions only if renegotiation occurs when the market price is high, for no cash is generated when the zero demand state occurs and profits are assumed to be distributed at the end of each sale.

B. Sale 2

The amount of money at stake if renegotiation occurs after sale 2 equals either a or 0, depending on the sale 2 market price but not on the sale 2 credit source. If a trade credit loan is renegotiated in sale 2, renegotiation awards the trade creditor sa or 0, which equals a fraction s of the money at stake. The credit market receives the same amount if its loan is renegotiated in sale 2. Thus, the firm retains either $(1 - s)a$ or 0. Since the amount at stake is creditor independent, the renegotiation payoffs are creditor independent as well. Therefore, when there are no future profits from a continuing relationship, both creditor types receive the same amount in renegotiation as intended in the Bankruptcy Reform Act. Theorem 1 displays this sale 2 renegotiation result.

THEOREM 1: *If sale 2 renegotiation occurs when the market price equals zero, the creditor (credit market or trade creditor) and the debtor all receive nothing. If sale 2 renegotiation occurs when the market price is high, the creditor receives* sa *and the debtor receives* $(1 - s)a$.

Given the sale 2 renegotiation outcome, the manager's sale 2 strategy is explored. When the market price is zero, the firm is forced to renegotiate because it has no revenues. Therefore, the manager of the firm is left with

[11] For ease of exposition, the dependencies are suppressed in the sale 2 discussion. As there is no moral hazard, the same results would be obtained if the debtor distributed debt instead of equity. However, the equity case is mathematically easier to interpret.

decisions about (1) the source of credit and (2) whether or not to renegotiate when the market price is high. As renegotiation is a zero-sum game between the firm and its creditor(s) with no moral hazard, the manager optimally selects the strategy that minimizes the distribution to her creditor. Profits from this strategy are given in Lemma 1. All proofs of subsequent lemmas and theorems are displayed in the Appendix.

LEMMA 1: *Given* d_2, r_2, p_2, e^{tc}, *and* e^{cm}, *the manager's sale 2 profits equal:*

$$\pi_2^m(e^{tc},e^{cm}|d_2,p_2,r_2) = \frac{1}{1+i}(1-e^{tc}-e^{cm})q\{a-\min[sa,d_2(1+r_2),p_2]\}. \quad (1)$$

If $d_2(1+r_2)$ *is minimal, the manager's optimal strategy is to borrow from the credit market and not default in the high demand state. If* p_2 *is minimal, the manager's optimal strategy is to take trade credit and not default in the high demand state. If* sa *is minimal, the manager's optimal strategy is to borrow from either source and default in the high demand state.*

Anticipating the manager's credit and renegotiation choices, the credit market determines its interest rate, r_2. Because the credit market is competitive, Lemma 2 determines the r_2 that grants the credit market zero expected profits.

LEMMA 2: *In sale 2,* $r_2 = \infty$ *if* $[(1+i)d_2]/q > sa$ *and* $p_2 \geq sa$. *Otherwise,* $r_2 = [(1+i)/q] - 1$.

The sale 2 cash price, d_2, and credit price, p_2, are determined next. Because the credit market earns zero profits and there is no moral hazard, the trade creditor earns maximal profits when the manager's earnings are minimized. Theorem 2 derives optimal interest rates, managerial strategies, and the resulting profits.

THEOREM 2: *Given* $0 \leq e^{tc}, e^{cm} \leq 1$, *and* $[1/(1+i)]qsa - v > 0$, *in sale 2:*

1. *The trade credit and credit market interest rates are*

$$tc_2 = r_2 = \frac{1+i}{q} - 1. \quad (2)$$

2. *The firm only defaults when the zero market price occurs.*
3. *The firm is indifferent between both sources of credit.*

4. *The equilibrium expected profits for trade creditor, credit market, and manager are*

$$\pi_2^{tc}(e^{tc},e^{cm}) = \frac{1}{1+i}\,qsa - v + \frac{1}{1+i}\,e^{tc}(1-s)qa, \tag{3}$$

$$\pi_2^{cm}(e^{tc},e^{cm}) = \frac{1}{1+i}\,e^{cm}(1-s)qa, \tag{4}$$

$$\pi_2^{m}(e^{tc},e^{cm}) = \frac{1}{1+i}\,(1-e^{tc}-e^{cm})(1-s)qa. \tag{5}$$

The trade creditor's sale 2 profits can be decomposed into two parts: the money he earns from the sale of his product, $[1/(1 + i)]qsa - v$, and the money earned from holding e^{tc} of the firm's equity, $[1/(1 + i)][(1 - s)qa]$. The first term drives most of the later results and, as stated in the assumptions of Theorem 2, this term is assumed to be positive. The second term arises if trade credit is renegotiated in sale 1; this renegotiation awards the trade creditor e^{tc} of the firm's equity. The credit market's profits in sale 2 result from the equity it holds if renegotiation occurs on a credit market loan in sale 1. Lastly, the firm retains what it has not distributed to the creditors.

Theorem 2 indicates that the interest rates both creditors charge exactly compensate for the time value of money and the probability of default. The paper's first prediction immediately follows.

PREDICTION 1: *When the future profits of both creditors from a continuing relationship with the firm are zero, the trade credit and credit market interest rates are identical.*

Therefore, the standard Modigliani–Miller (1961) result arises in which, in the absence of frictions, the manager is indifferent between credit sources and all creditors charge the same interest rate. As is shown in Prediction 3, this result does not hold when there are future profits as in sale 1.

C. Sale 1

Like sale 2, the results of renegotiation are first determined. More money is at stake in sale 1 renegotiation if trade credit is taken than if the firm renegotiates with the credit market because the trade creditor's sale 2 profits are only at stake in the former case. Therefore, unlike sale 2, the equity and cash payments to the creditor are creditor-dependent as well as demand-dependent in sale 1. Let TC and CM represent the sale 1 creditor: the trade creditor or the credit market. R indicates that renegotiation occurs after sale 1. Let H and Z denote the sale 1 high and zero market price respec-

tively. Thus, e^{cm} (CM,R,Z) equals the equity received by the credit market if the firm renegotiates a credit market loan when the sale 1 market price is zero. Theorem 3 displays the sale 1 renegotiation results.

THEOREM 3: *When the sale 1 market price equals zero, no cash is distributed to the creditor. If a sale 1 credit market loan is renegotiated when the market price equals zero, the credit market receives* e^{cm} (CM,R,Z) = s. *If trade credit is renegotiated in sale 1 when the market price equals zero, the trade creditor receives*

$$e^{tc}(\text{TC,R,Z}) = s - \frac{\frac{1}{1+i}qsa - v}{\frac{1}{1+i}qa}. \tag{6}$$

The cash and equity payoffs for sale 1 renegotiation when the high market price occurs are displayed in the Appendix.

As the difference between the two equity payoffs is proportional to the trade creditor's expected sale 2 profits from selling the good, $1/(1+i)qsa - v$, Theorem 3 demonstrates that the financially distressed firm exploits the trade creditor's dependence by making him take less equity than the credit market in renegotiation.[12] Theorem 3 also shows that trade creditors grant fewer concessions as the risk free rate, i, increases. Intuitively, this relationship exists because, as macroeconomic rates rise, the trade creditor cares more about present profits than about protecting continuing relationships. Prediction 2 results directly.

PREDICTION 2: *Trade creditors assist their customers in financial distress more than the credit market by granting larger concessions in renegotiation. The amount of additional assistance varies with the dependence of the trade creditor on the financially distressed firm. As the risk free rate, i, increases, trade creditor concessions decrease.*

Evans (1998) provides evidence consistent with this prediction. She demonstrates that trade creditors grant more concessions in Chapter 11 bankruptcy than similarly positioned banks.

Since trade creditors receive a lower sale 1 renegotiation payoff, Prediction 2 implies that the manager's renegotiation payoff is higher if trade credit is renegotiated than if a credit market loan is renegotiated. Therefore, given that renegotiation occurs, the manager ex post prefers to possess trade credit

[12] The proof of Theorem 3 demonstrates that if default occurs when the market price is high, the default payoff to the trade creditor exceeds the default payoff to the credit market by an amount proportional to the trade creditor's expected sale 2 profits. Analysis of default in the high demand state is necessary for backward induction. Theorem 4 demonstrates that this strategy does not occur in equilibrium.

in sale 1 renegotiation. However, Theorem 4 demonstrates that prices are set to compensate for this preference, causing the manager to be ex ante indifferent between the two forms of credit.

Anticipating the sale 1 renegotiation results, sale 1 prices and strategies are determined using a methodology similar to the one used to find the sale 2 equilibrium. Due to the notational complexity of the terms, Lemmas 3 and 4 that determine the manager's and credit market's strategies are left to the Appendix. Equilibrium interest rates as well as the resulting managerial strategies are contained in the Theorem 4.

THEOREM 4: *In sale 1 equilibrium,*

1. *The trade credit interest rate is*

$$tc_1 = \frac{(1+i)(sa+(1-s)v)}{qsa+(1-s)v} - 1. \tag{7}$$

2. *The credit market interest rate is*

$$r_1 = \frac{1+i}{q} - \frac{1-q}{q}\frac{(1-s)qsa}{qsa+(1-s)v} - 1. \tag{8}$$

3. *The firm is indifferent between both forms of credit.*
4. *Renegotiation only occurs when the market price equals zero.*

Since there are no renegotiation costs and no moral hazard, the model achieves first best. Prediction 3 formally states the existence of the trade credit interest rate premium.

PREDICTION 3: *The trade credit interest rate exceeds the credit market rate.*

Proof: Combining equations (7) and (8), algebra leads to the following expression:

$$tc_1 - r_1 = \frac{1-q}{q}\frac{(1-s)(1+i)\left(\frac{1}{1+i}qsa - v\right)}{qsa+(1-s)v}. \tag{9}$$

Since $0 < q, s < 1$, $i > 0$, and $[1/(1+i)]qsa - v > 01$, $tc_1 - r_1 > 0$. Q.E.D.

This interest rate premium compensates the trade creditor for granting the larger concessions in sale 1 renegotiation described in Prediction 2. This premium also makes the manager indifferent between trade credit and a credit market loan. This indifference provides theoretical support to Petersen and Rajan's (1994, 1995, 1997) observation that firms take trade and other forms of credit simultaneously.

IV. Comparative Statics

In this section, comparative statics on the sale 1 trade credit interest rate, the sale 1 credit market interest rate, and the difference between the two are performed by differentiating equations (7), (8), or (9). Though the first two comparative static results are not surprising, the latter two results introduce two important insights of the model.

PREDICTION 4: *The trade credit and credit market interest rates,* tc_1 *and* r_1*, respectively, rise with the trade creditor's and credit market's cost of capital, i.*

As macroeconomic interest rates rise, the trade creditor and the credit market raise their interest rates to compensate for their increased cost of capital. This result is consistent with the findings of Long, Malitz, and Ravid (1995), Petersen and Rajan (1994, 1997), and Wilner (1997), who all find that trade creditors restrict credit terms when macroeconomic interest rates rise.

PREDICTION 5: *As the probability of the high demand state, q, increases, the trade credit interest rate,* tc_1*, falls since default is less likely.*

The paper now investigates the effect of parameter changes on the differential between trade credit and credit market interest rates.

PREDICTION 6: *The interest rate differential decreases as the cost of capital for the credit market and trade creditor, i, increase.*

An increase in real macroeconomic interest rates has two counteracting effects. Prediction 4 shows that the trade creditor and credit market lender raise their rates to compensate for the higher cost of capital. Conversely, Prediction 2 demonstrates that the trade creditor grants fewer renegotiation concessions, which diminishes the trade credit interest rate. In equilibrium, the first effect dominates: An increase (decrease) in the macroeconomic rate causes trade credit interest rates to rise (fall). However, the combination of the two effects causes the change in the trade credit interest rate to be less than the change in the credit market rate. This implies that trade creditors dampen the effects of macroeconomic interest rate fluctuations. Therefore, consistent with the evidence in Section I, trade credit rates are less responsive than credit market rates to changes in the risk-free rate. This result contrasts with that of Kiyotaki and Moore (1997) who theoretically show that trade creditors exacerbate credit shocks by demonstrating that credit rationing propagates in a small, closed economy. Propagation does not occur in this model as credit providers are assumed to be in a large economy and/or are not cash constrained.

PREDICTION 7: *The higher the trade creditor's sale 2 expected profits from sales,* $[1/(1+i)]qsa - v$*, the larger the difference between the trade credit and credit market interest rates.*

Prediction 7 results directly from combining Predictions 2 and 3. Prediction 2 demonstrates that greater sale 2 profitability increases the trade creditor's dependence on the firm as well as the amount conceded in renegotiation. Prediction 3 shows that the trade creditor charges a higher rate to compensate for granting larger renegotiation concessions. Although Petersen and Rajan (1994, 1995, 1997) mostly observe the opposite result—that larger profits imply less restrictive lending terms—they do show that Prediction 7 holds for the most profitable creditors in their sample.[13] In addition, they investigate borrowing by small businesses. Wilner (1997), who investigates larger COMPUSTAT firms, finds evidence consistent with Prediction 7. Sections V.C and V.D of this paper discuss why Prediction 7 might not hold for low profit creditors and young, small customers.

V. Model Extensions

A. Managerial Type

This section alters the model by assuming there are two different managerial types: good and bad. The manager privately observes her own type at the beginning of the game.[14] The probabilities of the high market price for the good and bad managers in sale 1 are $q_g > q_b$, respectively. Though managerial type affects sale 1, type is assumed not to affect sale 2; the high price probability equals q in sale 2 irrespective of type.

Results follow almost directly from the model in Section III. Since sale 2 is unaffected by this extension, Lemmas 1 and 2, as well as Theorems 1, 2, and 3, hold identically. Lemma 5, which presents optimal managerial strategies for sale 1, is similar to Lemma 3 with q_τ, $\tau = g$ or b, substituted in appropriately. Lemma 6 determines the credit market interest rate. Lemmas 5 and 6 appear in the Appendix. Theorem 5 presents the resulting equilibrium.

THEOREM 5: *In sale 1, there is a unique subgame, perfect-separating equilibrium where the good manager borrows from the credit market and the bad manager takes trade credit. Default only occurs when the market price equals zero.*

The intuition behind this equilibrium derives from Prediction 2, which notes that trade creditors grant more concessions in renegotiation than credit markets. Because the bad manager has a greater probability of defaulting,

[13] Petersen and Rajan (1994, 1995) refer to evidence consistent with Prediction 7 for larger and more mature firms when investigating lending by banks. They demonstrate that banks in concentrated credit markets charge higher rates to firms that are more than 10 years old.

[14] Even though the manager's type is private information, all parties observe the realization of demand. This assumption corresponds to the fact that sales figures are publicly disclosed while firm types are not. Freixas (1993) shows that one creditor might have better information about a manager's type. Pursuant to that logic, the assumption that the manager's type is private information can be relaxed. The supposition can be replaced by assuming that suppliers can only post one cash price and one credit price with no change in the forthcoming results.

she is more likely than the good manager to receive these renegotiation benefits. Therefore, the bad manager is willing to pay more than the good manager for trade credit. Since the trade creditor is unable to set different prices for different customers, a separating equilibrium where the bad manager takes trade credit and the good manager borrows from the credit market arises. Prediction 8 results.

PREDICTION 8: *Firms with a greater probability of default prefer trade credit to a credit market loan.*

Thus, trade credit can be used to discriminate between firms with different default risks. This prediction is consistent with most models of trade credit.[15] However, these models derive separating equilibria by assuming some form of credit rationing. This section demonstrates that separation can occur even without credit rationing. If rationing occurs, the discrimination result would be even stronger.

B. Systematic Shocks

This section assumes the firm is unable to insulate itself from the risk of the zero demand state. Credit rationing can induce this systematic risk. In this case, a relationship between the interest rate differential, creditor profitability, and the probability of the high demand state arises.

PREDICTION 9: *Although the effect of a change in the probability of the high demand state, q, on the difference between the trade credit rates and the credit market rates cannot be unambiguously determined, the effect diminishes as the trade creditor's expected sale 2 profits increase.*[16]

There are two counteracting effects of an increase in the probability of the high demand state. First, the trade creditor's expected sale 2 profits increase. Prediction 7 implies that the interest rate differential would subsequently increase. Second, the probability of period 1 default decreases, implying that renegotiation becomes less likely. Therefore, the trade creditor provides fewer renegotiation concessions and charges a lower interest rate.

Prediction 9 implies that as the trade creditor's expected sale 2 profits increase, the second effect becomes more dominant. If the profits are large enough, the second effect dominates, and Predictions 2 and 9 imply that trade creditors assist the customers in two ways. Prediction 2 shows that trade creditors help their customers in renegotiation. Prediction 9 demonstrates that trade creditors ease credit terms more rapidly than credit markets as the likelihood of customer default diminishes. Conversely, if the trade creditor's sale 2 profits are small enough, the difference between the trade

[15] See Schwartz (1974), Schwartz and Whitcomb (1979), Emery (1984, 1987), Smith (1987), Brennan et al. (1988), Freixas (1993), Frank and Maksimovic (1995), and Petersen and Rajan (1994, 1995).

[16] Mathematically this implies that although $\partial(tc_1 - r_1)/\partial q$ cannot be unambiguously signed, $[\partial^2(tc_1 - r_1)]/[\partial q \partial(1/(1+i)\, qsa - v)]$ is negative.

credit and credit market interest rates increases with the probability of the high demand state. This conclusion is consistent with Petersen and Rajan's (1995) observation that as a small firm ages, its borrowing costs fall faster in competitive lending markets.

C. Differing Competitive Assumptions

Similar results arise if the competitive assumptions are relaxed. In the baseline model, the trade creditor is monopolistic and the credit market is competitive. If the trade credit market becomes more competitive, the proportionality of the interest rate premium and trade creditor's expected future profits shown in Prediction 7 still exists. However, as the latter probably decreases with increased competition, so does the former. As was mentioned in the introduction, Bulow and Shoven (1978) and Petersen and Rajan (1994, 1995) show that one participant in the credit market, banks, could generate profits and a resulting dependence on a debtor firm. In this case, the interest rate differential is proportional to the relative dependence of the trade creditor and the bank on the debtor firm. This implies Prediction 10.

PREDICTION 10: *If the bank's future profits from a continuing relationship are larger than the trade creditor's, bank interest rates exceed the trade credit rate.*

Prediction 10 implies that trade creditors ease their terms relative to bank rates when banks possess relationships with their customers. Rajan and Zingales (1995) provide evidence consistent with this prediction in countries where banking relationships are important. The combination of Predictions 3 and 10 is consistent with the observation that trade credit rates are sometimes higher and sometimes lower than comparable credit market rates. Together these two predictions suggest that as an industry's competitiveness increases, a creditor's expected renegotiation concessions decrease, which causes credit terms to be eased.

This paper develops models where a creditor is dependent on a debtor. If the opposite dependence exists, according to the logic of this paper, a creditor should be able to extract rents from a dependent debtor. Therefore, creditors could offer "teaser rates" and/or relaxed terms in order to attract dependent debtors. Petersen and Rajan (1995) theoretically and empirically demonstrate that creditors initially aid small businesses by charging the low rates, expecting to earn profits by charging higher rates in the future.

D. Robustness of the Results and the Existence of Convenience Classes

The key insight of this paper is that in debt renegotiations trade creditors bargain to protect past loans as well as future profits. As discussed in Section III.A, this intuition is formalized by demonstrating that the trade creditor's future profits are a part of the money at stake in debt renegotiations only if trade credit is taken. Some might argue that a trade creditor's future profits should be included even if the firm borrows from the credit market.

According to this argument, the credit market would threaten to liquidate the firm if the trade creditor does not grant concessions. However, this argument is contradicted by backward induction as the credit market's threat to liquidate is not credible. Assume the trade creditor ignores the credit market's threat. Since this model describes a one-shot game, it is optimal for the credit market to accept the positive amount described in Theorems 1 and 3 as opposed to liquidating and receiving zero. Thus, the trade creditor can ignore the credit market's demand for concessions and the trade creditor's future profits would not be at stake if the firm borrows from the credit market. By a similar backward inductive argument, the trade creditor's threat of refusing to sell to a firm in the future unless he receives a certain amount in debt renegotiations is not credible.

The above rebuttal assumes that creditors fight for every dollar in debt renegotiations. However, if the financially distressed firm does not generate a large percentage of the creditor's profits, the creditor's threats described above become more credible. Consequently, those creditors who are less dependent on their financially distressed customers are also less apt to grant renegotiation concessions. In practice, this is observed as Chapter 11 allows the creation of a convenience class that consists of creditors owed less than a certain amount. As their threats are more credible, convenience classes usually grant fewer concessions than other unsecured classes. Fabozzi et al. (1993) discuss convenience classes.

Furthermore, the interest rate charged by a creditor should vary with the credibility of its threats. Wilner (1997) empirically demonstrates that the trade credit interest rate is parabolic in customer size. If the customer is very small, which implies that it does not generate a large percentage of the creditor's profits and is likely to depend on its creditor, the trade credit interest rate decreases. If the customer is very large, which means it is more able to extract renegotiation concessions from its creditors, the trade credit interest rate increases. This argument also provides a rationale for Petersen and Rajan's (1994, 1995, 1997) observations that creditors ease terms to young, small firms whose profitability increases and that young, small, and unprofitable trade creditors ease terms as their own profitability increases.

VI. Conclusion

This paper has concentrated on trade credit, but it also proves, more generally, that dependence in bilateral relationships explain many phenomena about lending. First, a dependent creditor grants more concessions in renegotiation than a creditor without such a dependence. To compensate for these concessions, the interest rate charged by the dependent creditor increases with the degree of dependence. These concessions also cause the dependent creditor's interest rate to fluctuate less than the nondependent creditor's rate in response to changes in the risk-free rate. Additionally, dependent creditors reduce the rates they charge more rapidly as their customer's likelihood of default decreases. When a dependent creditor can completely discriminate, its customers are indifferent between all loan types. If complete

discrimination cannot occur, a financially distressed firm, desiring the associated renegotiation benefits, borrows from the dependent creditor even if the nondependent creditor offers lower rates.

In summary, lending relationships can be understood by noting that dependence alters the pricing of financial contracts. If one party generates a large percentage of its partner's profits, it should be willing to enter into a seemingly unfavorable contract anticipating more power should problems arise. Petersen and Rajan (1994, 1995, 1997) provide evidence consistent with the above theory by investigating small businesses, which are likely to depend on their creditors. Specifically, their 1995 paper demonstrates that creditors offer "teaser rates" in order to attract dependent customers, then subsequently charge high rates. Alternatively, this paper demonstrates that firms receive two benefits from accepting a high interest rate loan from a dependent creditor. First, consistent with the evidence in Evans (1998), a dependent creditor grants more concessions when a customer is in financial distress. Second, a creditor reduces the rates it charges more rapidly as a customer's likelihood of default decreases. Finally, if dependence does not exist, as in the case of convenience classes in Chapter 11 bankruptcy, this paper accurately predicts that large renegotiation concessions are not granted.

Appendix

Proof of Lemma 1: Since the manager aims to maximize her profits, the proof enumerates the manager's strategy choices, determines the resulting profits, and selects the maximum.

If the market price equals zero, there are no revenues and the parties receive nothing irrespective of the manager's strategy choice.

When the market price is high, which occurs with probability q, the firm receives revenues of a. The amount it pays its creditor is strategy dependent. If trade credit and no renegotiation is chosen, the firm pays the trade creditor the cash price of p_2. If the credit market and no renegotiation is chosen, the firm pays the credit market $d_2(1 + r_2)$. If the firm renegotiates either form of credit when the market price is high, Theorem 1 states that the firm must pay its creditor sa.

Since the trade creditor and the bank possess e^{tc} and e^{cm} of the firm's equity, respectively, the manager receives only $1 - e^{tc} - e^{cm}$ of the firm's profits. By selecting the optimal strategy, the manager's sale 2 profits are

$$\begin{aligned}\frac{1}{1+i}(1-e^{tc}-e^{cm})\max\{q(a-sa),q[a-d_2(1+r_2)],q(a-p_2)\}\\ =\frac{1}{1+i}(1-e^{tc}-e^{cm})q\{a-\min[sa,d_2(1+r_2),p_2]\}.\end{aligned}\tag{A1}$$

Because the manager receives and transfers cash in period 3 and the manager's sale 2 profits are measured in period 2 dollars, discounting at the rate of $[1/(1 + i)]$ occurs. Q.E.D.

Proof of Lemma 2: If $d_2\,(1 + r_2) \leq \min(p_2, sa)$, the manager borrows from the credit market and does not default when the market price is high. Under this condition, the firm borrows d_2 in period 1. In period 2, with probability q, the firm repays the loan plus interest, $d_2\,(1 + r_2)$; with probability $1 - q$, the credit market receives nothing. The credit market's expected zero profit condition implies that

$$d_2 = \frac{1}{1+i}\,qd_2(1+r_2) \quad \text{or} \quad r_2 = \frac{1+i}{q} - 1.$$

Therefore, this interest rate is set if $d_2[(1 + i)/q] \leq \min(p_2, sa)$.

If $p_2 \leq \min\{sa, d_2[(1 + i)/q]\}$, the manager takes trade credit and does not default when the market price is high. Since trade credit is taken, the credit market's zero profit condition is trivially satisfied. Therefore, the credit market can set any interest rate, $r_2 \geq p_2/d_2 - 1$. One such rate that satisfies this condition is $r_2 = [(1 + i)/q] - 1$.

If $sa \leq \min\{p_2, d_2[(1 + i)/q]$, the manager defaults when the market price is high on either form of credit. In this case, if a loan is extended by the credit market, in period 1 the credit market loans d_2 and, in period 2 the firm defaults and credit market receives sa with probability q. The credit market's expected profits in this case are $\pi_2^{\text{cm}} = [1/(1 + i)]qsa - d_2$. If these expected profits are negative ($sa < [((1 + i)d_2)/q]$), the credit market charges an infinite rate. Q.E.D.

Proof of Theorem 2: Anticipating the firm's and the credit market's strategy choices, the trade creditor chooses a cash price and a credit price to maximize his profits. First I assume that prices are set so that the credit market offers a finite interest rate. Then I show that the trade creditor never prefers to set prices so that the credit market sets an infinite rate.

Assuming $[((1 + i)d_2)/q] \leq sa$ or $p_2 < sa$, by Lemma 2, the credit market interest rate, r_2, equals $[(1 + i)/q] - 1$. By Lemma 1, the trade creditor's revenues equal $[1/(1 + i)]q \min(p_2, d_2[(1 + i)/q], sa)$. The trade creditor always pays the cost of production, v. The trade creditor also receives a fraction e^{tc} of the firm's profits. Therefore, the trade creditor's profits are given by

$$\pi_2^{\text{tc}}(e^{\text{tc}}, e^{\text{cm}}) = \max_{p_2, d_2}\left\{\frac{1}{1+i}\,q\min\left(p_2, d_2\frac{1+i}{q}, sa\right) - v + \frac{1}{1+i}\,qe^{\text{tc}}\left[a - \min\left(p_2, d_2\frac{1+i}{q}, sa\right)\right]\right\}. \tag{A2}$$

Because $e^{\text{tc}} < 1$, the trade creditor's sale 2 profits are maximized when $p_2 = sa$ and $d_2 = [1(1 + i)]/qsa$. With these prices, the trade credit interest rate equals the credit market rate,

$$tc_2 = \frac{p_2 - d_2}{d_2} = \frac{1+i}{q} - 1 = r_2;$$

and the firm is indifferent between taking both forms of credit and between defaulting and not defaulting in the high demand state. Additionally, $[((1 + i)d_2)/q] \leq sa$ and $p_2 < sa$, as initially assumed. Substituting these prices into equation (A2), trade creditor profits become:

$$\pi_2^{tc}(e^{tc},e^{cm}) = \frac{1}{1+i} qsa - v + \frac{1}{1+i} e^{tc}qa(1-s). \tag{A3}$$

Conversely, if $p_2 \geq sa$ and $sa < [((1 + i)d_2)/q]$, Lemma 2 implies that $r_2 = \infty$ and the manager takes trade credit and defaults in the high demand state. In this case, the trade creditor's profits equal the profits in equation (A3). Therefore, this strategy is not strictly preferred. Q.E.D.

Proof of Theorem 3: The manager is owed a fraction $1 - s$ of the sum of the firm's current revenues and the period 2 profits of the debtor and creditor, which are listed in column 4 of Table AI. The manager receives her expected sale 2 profits. The manager also receives $1 - C$ of the cash at stake if the high market price occurs when trade credit is renegotiated. The manager receives $1 - B$ of the cash at stake if the high market price occurs when a credit market loan is renegotiated. The sum of what the manager receives is given in column 3 of Table AI. When the firm borrows from the credit market in sale 1, e^{tc} equals 0. When trade credit is taken, e^{cm} equals 0. The equity distributions, e^{tc} and e^{cm}, which are displayed in columns 5 and 6, respectively, are obtained by setting what the manager receives equal to what the manager is owed. The following two conditions must be satisfied for the fractions C and B to be between 0 and 1:

$$\max\left[0, s - \frac{1-s}{a}\left[\frac{1}{1+i} qa - v\right]\right] \leq C \leq s + \frac{v(1-s)}{a}, \tag{A4}$$

$$\max\left[0, s - \frac{q(1-s)^2}{1+i}\right] \leq B \leq s + \frac{(1-s)qs}{1+i}. \tag{A5}$$

Q.E.D.

LEMMA 3: *Given p_1, d_1, and r_1, the manager's cumulative profits equal*

$$\max\left\langle \begin{array}{c} \frac{1}{1+i}\left\{(1-s)\left[\left(1+\frac{1}{1+i}\right)qa - v\right]\right\}, \\ \frac{1}{1+i}\left\{q(a-p_1) + (1-s)\left[\frac{1}{1+i} qa - (1-q)v\right]\right\}, \\ \frac{1}{1+i}\left\{q[a - d_1(1+r_1)] + (1-s)(1-s+sq)\frac{1}{1+i} qa\right\}. \end{array} \right\rangle. \tag{A6}$$

Table AI

Default Payoffs in Sale 1

This table displays the equity payoffs to the trade creditor and the credit market, e^{tc}(CS,R,MP)and e^{cm}(CS,R,MP), respectively, which are functions of the sale 1 credit source (CS) and market price (MP). R stands for renegotiation. The fraction of the money at stake the creditor receives in renegotiation equals s. The risk-free rate is i. The probability of the high demand state equals q. The market price in the high demand state equals a. The trade creditor's cost of production equals v. Since only the loan originator receives an equity payoff: $e^{tc}(CM,R,\bullet) = e^{cm}(TC,R,\bullet) = 0$. The equity payoffs to the originator are endogenously determined by setting what the manager receives equal to what the manager is owed. The manager is owed $1 - s$ of the money at stake. The money at stake equals the sum of the manager's current revenues (a or 0, depending on the market price) and the creditor's and manager's sale 2 profits. $\pi_2^{bc}(e^{tc},e^{cm})$, $\pi_2^{cm}(e^{tc},e^{cm})$, and $\pi_2^{m}(e^{tc},e^{cm})$ denote the trade creditor's, credit market's, and manager's expected sale 2 profits, respectively, which are functions of the equity payoffs. These profits are given in equations (3), (4), and (5). The manager receives a fraction C (B) of the current revenues if the market price is high and trade credit (a credit market loan) is renegotiated. The manager also receives her expected sale 2 profits.

Credit Source	Market Price	Manager Receives	Manager Is Owed	e^{tc}(CS,R,MP)	e^{cm}(CS,R,MP)
Trade credit	High	$(1 - C)a + \pi_2^{m}(e^{tc}(TC,R,H),0)$	$(1-s)\left[\begin{matrix} a + \pi_2^{m}(e^{tc}(TC,R,H),0) \\ +\pi_2^{tc}(e^{tc}(TC,R,H),0) \end{matrix}\right]$	$s - \dfrac{\frac{1}{1+i}qsa - v}{\frac{1}{1+i}qa} + \dfrac{(1+i)(s-C)}{q(1-s)}$	0
Trade credit	Zero	$\pi_2^{m}(e^{tc}(TC,R,Z),0)$	$(1-s)\left[\begin{matrix} \pi_2^{m}(e^{tc}(TC,R,Z),0) \\ +\pi_2^{tc}(e^{tc}(TC,R,Z),0) \end{matrix}\right]$	$s - \dfrac{\frac{1}{1+i}qsa - v}{\frac{1}{1+i}qa}$	0
Credit market	High	$(1 - B)a + \pi_2^{m}(0,e^{cm}(CM,R,H))$	$(1-s)\left[\begin{matrix} a + \pi_2^{m}(0,e^{cm}(CM,R,H)) \\ \pi_2^{cm}(0,e^{cm}(CM,R,H)) \end{matrix}\right]$	0	$s + \dfrac{(1+i)(s-B)}{q(1-s)}$
Credit market	Zero	$\pi_2^{m}(0,e^{cm}(CM,R,Z))$	$(1-s)\left[\begin{matrix} \pi_2^{m}(0,e^{cm}(CM,R,H)) \\ +\pi_2^{cm}(0,e^{cm}(CM,R,H)) \end{matrix}\right]$	0	s

If the first term is maximal, the firm chooses trade credit and renegotiates when the high price occurs. If the second term is maximal, the firm takes trade credit and does not renegotiate if the high price occurs. If the last term is maximal, the firm borrows from the credit market and does not renegotiate if the high price occurs.

Proof of Lemma 3: The first step is to determine the manager's profits corresponding to the sale 1 strategy of defaulting on trade credit when the price is high. With probability q, the high demand state occurs and the manager receives 1 − C of the sale 1 cash flow, a, plus her sale 2 profits, which are obtained by substituting e^{tc}(TC,R,H) from Table AI into the manager's sale 2 profit function given in equation (5). With probability $1 - q$, the zero demand state occurs and the manager receives her sale 2 profits, which are obtained by substituting e^{tc}(TC,R,Z) from Table AI into the manager's sale 2 profit function. Therefore, the manager's combined sale 1 and sale 2 profits from this strategy equal

$$\frac{1}{1+i}\left\{(1-s)\left[\left(1+\frac{1}{1+i}\right)qa - v\right]\right\}.$$

The manager's profits for her other sale 1 strategies can be calculated in a similar manner. These calculations reveal a dominated strategy. Managerial profits from renegotiating trade credit in the high demand state exceeds the profits from renegotiating a credit market loan in the high demand state by

$$\frac{1}{1+i}(1-s)\left(\frac{1}{1+i}qsa - v\right) > 0.$$

Therefore, the manager never selects the latter strategy. Q.E.D.

LEMMA 4: *Given p_1 and d_1, the credit market sets its interest rate, r_1, to be*

$$r_1 = \frac{1+i}{q} - \frac{1-q}{q}\,\frac{\frac{1}{1+i}(1-s)qsa}{d_1} - 1. \tag{A7}$$

Proof of Lemma 4: The manager never defaults on a credit market loan when the price is high. If trade credit is taken, the credit market trivially earns zero profits.

If the firm borrows from the credit market and does not default when the price is high, the credit market sets its costs equal to its revenues, or

$$d_1 = \frac{1}{1+i}\left[qd_1(1+r_1) + \frac{1}{1+i}(1-q)(1-s)qsa\right]. \tag{A8}$$

The credit market loans d_1 at the beginning of sale 1. It receives $d_1(1 + r_1)$ with probability q. With probability $1 - q$, default occurs and the credit market receives equity that has a value of $[1/(1 + i)](1 - s)qsa$. The credit market interest rate, r_1, is implicit in equation (A8).

$$r_1 = \frac{1+i}{q} - \frac{1-q}{q}\,\frac{\frac{1}{1+i}(1-s)qsa}{d_1} - 1. \tag{A9}$$

Q.E.D.

Proof Theorem 4: Since this is a zero sum game between the trade creditor and the firm, the trade creditor maximizes his profits by setting prices, p_1 and d_1, to minimize the earnings of the firm. Therefore, the trade creditor's problem can be written as:

$$\min_{p_1,d_1}\left[\max\left\langle \begin{array}{c} \frac{1}{1+i}\left\{(1-s)\left[\left(1+\frac{1}{1+i}\right)qa - v\right]\right\}, \\ \frac{1}{1+i}\left\{q(a-p_1) + (1-s)\left[\frac{1}{1+i}qa - (1-q)v\right]\right\}, \\ \frac{1}{1+i}\left\{qa - (1+i)d_1 + \frac{1}{1+i}(1-s)qa\right\}. \end{array} \right\rangle\right]. \tag{A10}$$

The third term is obtained by substituting the credit market interest rate into the formula for the manager's profits gained by borrowing from the credit market and not defaulting in the high demand state. One set of equilibrium credit and cash prices are

$$p_1 = sa + (1-s)v, \tag{A11}$$

$$d_1 = \frac{1}{1+i}\{qsa + (1-s)v\}. \tag{A12}$$

Therefore, the trade credit interest rate equals

$$tc_1 = \frac{p_1 - d_1}{d_1} = \frac{(1+i)[sa + (1-s)v]}{qsa + (1-s)v} - 1. \tag{A13}$$

The credit market interest rate is

$$\begin{aligned} r_1 &= \frac{1+i}{q} - \frac{1-q}{q}\,\frac{\frac{1}{1+i}(1-s)qsa}{d_1} - 1 \\ &= \frac{1+i}{q} - \frac{1-q}{q}\,\frac{(1-s)qsa}{qsa + (1-s)v} - 1. \end{aligned} \tag{A14}$$

Q.E.D.

LEMMA 5: *Given p_1, d_1, and r_1, the manager of type τ's cumulative profits, $\tau \in \{g,b\}$ equal*

$$\max\left\langle \begin{array}{c} \frac{1}{1+i}\left\{(1-s)\left[\left(q_\tau + \frac{q}{1+i}\right)a - v\right]\right\}, \\ \frac{1}{1+i}\left\{q_\tau(a-p_1) + (1-s)\left[\frac{1}{1+i}qa - (1-q_\tau)v\right]\right\}, \\ \frac{1}{1+i}\left\{q_\tau[a - d_1(1+r_1)] + (1-s)(1-s+sq_\tau)\frac{1}{1+i}qa\right\}. \end{array}\right\rangle. \quad \text{(A15)}$$

If the first term is maximal, the manager chooses trade credit and renegotiates if the high price occurs. If the second term is maximal, the manager takes trade credit and does not renegotiate if the high price occurs. If the last term is maximal, the manager borrows from the credit market and does not renegotiate if the high price occurs.

Proof of Lemma 5: Apply the same steps as Lemma 3 with q_τ properly substituted for q. Q.E.D.

LEMMA 6: *Given p_1 and d_1, if the bad manager takes trade credit and the good manager borrows from the credit market, the credit market interest rate is*

$$r_1 = \frac{1+i}{q_g} - \frac{1-q_g}{q_g}\frac{\frac{1}{1+i}(1-s)qsa}{d_1} - 1. \quad \text{(A16)}$$

If the good manager takes trade credit and the bad manager borrows from the credit market, the credit market interest rate equals:

$$r_1 = \frac{1+i}{q_b} - \frac{1-q_b}{q_b}\frac{\frac{1}{1+i}(1-s)qsa}{d_1} - 1. \quad \text{(A17)}$$

Proof of Lemma 6: See the proof of Lemma 4.

Proof of Theorem 5: There are two potential separating equilibria.

Case 1: The good manager borrows from the credit market and the bad manager takes trade credit and both managers do not default in the high demand state.

As in Theorem 4, the trade creditor's profits are maximized by minimizing managerial earnings. Therefore, the prices, p_1 and d_1, are set to solve the following constrained minimization problem:

$$\text{Min}_{p_1,d_1}\left\{\begin{array}{l}\theta\left\langle\frac{1}{1+i}\left\{q_b(1-p_1)+(1-s)\left[\frac{1}{1+i}qa-(1-q_b)v\right]\right\}\right\rangle \\ +(1-\theta)\left\langle\frac{1}{1+i}\left\{q_g[a-d_1(1+r_1)]+(1-s)(1-s+sq_g)\frac{1}{1+i}qa\right\}\right\rangle\end{array}\right\} \tag{A18}$$

Subject to

$$\frac{1}{1+i}\left\{\begin{array}{l}q_b(a-p_1) \\ +(1-s)\frac{1}{1+i}qa \\ -(1-s)(1-q_b)_v\end{array}\right\} \geq \max\left\langle\begin{array}{l}\frac{1}{1+i}\left\{(1-s)\left[\left(q_b+\frac{q}{1+i}\right)a-v\right]\right\}, \\ \frac{1}{1+i}\left\{\begin{array}{l}q_b[a-d_1(1+r_1)] \\ +(1-s)(1-s+sq_b)\frac{1}{1+i}qa\end{array}\right\}.\end{array}\right\rangle, \tag{A19}$$

$$\frac{1}{1+i}\left\{\begin{array}{l}q_g[a-d_1(1+r_1)] \\ +(1-s)(1-s+sq_g)\frac{1}{1+i}qa\end{array}\right\} \geq \max\left\langle\begin{array}{l}\frac{1}{1+i}\left\{(1-s)\left[\left(q_g+\frac{q}{1+i}\right)a-v\right]\right\}, \\ \frac{1}{1+i}\left\{\begin{array}{c}q_g(a-p_1) \\ +(1-s)\left[\frac{1}{1+i}qa-(1-q_g)v\right]\end{array}\right\}.\end{array}\right\rangle, \tag{A20}$$

$$r_1=\frac{1+i}{q_g}-\frac{1-q_g}{q_g}\frac{\frac{1}{1+i}(1-s)qsa}{d_1}-1. \tag{A21}$$

The trade creditor sets prices to minimize managerial earnings in equation (A18). θ equals the probability that the manager is bad. Equations (A19) and (A20) are the incentive compatibility conditions for the bad and good manager, respectively. Equation (A21) is obtained from equation (A16).

The prices, $p_1 = sa + (1-s)v$ and $d_1 = [1/(1+i)]\{q_g sa + (1-s)v\}$, solve this minimization problem. Thus, Case 1 corresponds to a separating equilibrium.

Case 2: The bad manager borrows from the credit market and the good manager takes trade credit and both managers do not default in the high demand state.

The prices, p_1 and d_1, are set to solve a minimization problem which is identical to the one in equations (A18)–(A21) except θ and $1 - \theta$ as well as q_b and q_g are reversed in all the expressions. Algebra demonstrates that there are no prices that solve this minimization problem. Therefore, a separating equilibrium corresponding to Case 2 does not exist. Q.E.D.

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