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The Effects of Monetary Policy on Product Prices and Trade Credit Interest Rates

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We utilize a partial equilibrium model of third-degree price discrimination to analyze the effects of monetary policy on product prices and trade credit interest rates. We then calibrate the model with data from the 1993, 1998 and 2003 U.S. National Survey of Small Business Finances. The numerical results show that while the trade credit interest rate is higher and rises with the cost of capital, the interest rate differential decreases.

Field of Research: Working Capital Management, Monetary Policy

1. Introduction

Many theories have been proposed to explain the use of trade credit by vendors and the determination of credit terms. Credit terms specify when invoiced amounts are due and whether a cash discount could be taken for earlier payment. The *credit period* is the length of time allowable for payment of the invoice amount. The *cash discount* is the percentage amount that can be subtracted from the invoice if the customer pays within the *discount period*. Recognizing that the provision of a cash discount is equivalent to a reduction in price, Rashid and Mitra (1999) linked it to the price elasticity of demand. Here, we recognize the similarities between elasticities in economics and betas in finance[1], where the beta is used to capture the systematic risk of uncertain returns. Equally, if not more, important as the abovementioned theories of trade credit are those that integrate credit policy with other policy decisions. It has been recognized (Kim and Atkins, 1978; Kim and Chung, 1990) that suboptimal results will occur whenever interrelated policy variables are modeled independently. Therefore, it is desirable that credit management decisions be made jointly with other policy decisions. Perhaps the most important area of integration is the integration of a firm's credit policy with its product pricing as recognized by Kim and Atkin (1978, p.403) who state that "it is conceptually incorrect to analyze credit programs in isolation of pricing schemes." Their paper, along with Atkins and Kim (1977), use wealth-maximizing frameworks in their integrating efforts.

Recognizing that a cash discount for early repayment separates buyers with respect to their borrowing costs, Lim and Rashid (2002, 2008) introduce a partial equilibrium model of third-degree price discrimination where the firm sets two prices to maximize NPV: a product price, and a cash discount (which determines the effective price in the second market). Setting two prices then requires two elasticities: a cash discount elasticity of

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demand (which measures the sensitivity of sales to the cash discount or credit terms in general[2]), and the product price elasticity of demand (which measures the sensitivity of sales to the product price). The main conclusion of their paper is that *the effect of the cash discount elasticity is mainly on the optimal cash discount, while the effect of product price elasticity is mainly on the optimal product price*. Lim and Rashid's (2002, 2008) model has been empirically tested by Lim, Rashid and Mitra (2006) using a detailed database compiled by the United States National Survey of Small Business Finance (NSSBF). This dataset focuses on small firms, where trade credit is more likely to be a significant form of finance as such firms are more likely to face financial constraints. Lim, Rashid and Mitra (2006) find that proxies for the cash discount elasticity and the product price elasticity (SIC code) are statistically significant determinants of the cash discount *offered* to these firms, with *the proxies for the cash discount elasticity being more significant*, providing empirical evidence for Lim and Rashid's (2002, 2008) main conclusions.

There has been recent interest in how trade credit affects the credit channel of monetary policy transmission (as surveyed in Mateut, 2005). This interest in monetary policy effectiveness has increased in recent years. However, there has not been a satisfactory theoretical model to explain the empirical stylized fact that trade credit dampens the impact of monetary contractions as trade credit interest rates[3] fluctuate less than short-term bank interest rates. Our numerical computations are based on a rigorous theoretical model and suggest that while the trade credit interest rate is higher and rises with the short-term cost of capital, the interest rate differential decreases as the cost of capital rises. This finding is consistent with Ng, Smith and Smith's (1999) evidence that credit terms are stable over time. This may also explain the Meltzer (1960) hypothesis on credit channel transmission of monetary policy, i.e., trade credit fluctuates less than bank credit. In short, certain empirical phenomena related to the credit channel could be rationalized by assuming that firms set trade credit terms to maximize NPV[4].

The rest of the paper is organized as follows: Extant literature is reviewed in Section 2. Section 3 details the behavioral specifications of buyers, while Section 4 performs the theoretical analysis. In Section 5, we calibrate the model with data from the 1993, 1998 and 2003 U.S. National Survey of Small Business Finances and show that the Meltzer (1960) effect holds, i.e., while the trade credit interest rate is higher and rises with the cost of capital, the interest rate differential decreases. Section 6 concludes with a discussion of the similarities of our analysis with analyses of exchange rate pass-throughs.

2. Literature Review

Smith (1987) argues that a supplier provides trade credit in order to protect non-salvageable investment in the client's relationship. Ng, Smith and Smith (1999) show that credit terms involving a cash discount provide better screening and monitoring of a buyer's financial position to protect potential rents from non-salvageable investment in the buyer. Mian and Smith (1992) focus on the information advantage of trade credit over traditional financing. Emery (1984) proposes trade credit as a means of alleviating credit market imperfections, while Emery (1987) emphasizes that trade credit provides the means for the vendor to manage fluctuations in product demand. Brick and Fung (1984) consider the differential of tax rates between a supplier and its buyer as the reason for the provision of trade credit. Petersen and Rajan (1994) suggest credit rationing as a reason, while Schwartz and Whitcomb (1980), Brennan, Maksimovic and Zechner (1988) and Petersen and Rajan (1997, p.664) suggest price discrimination as a motive for the provision of trade credit.

The determination of an optimal cash discount from a theoretical perspective originated with Lieber and Orgler (1975) who developed expressions for the expected net present value or NPV of accounts receivable and implicit form solutions of the optimal discount. Later, Hill and Riener (1979) derived an explicit form solution of an optimal discount in a situation where the firm has no bad-debt exposure and the fraction of buyers discounting is known with certainty. Beranek (1991) provided analysis of behavioral factors determining the optimal cash discount. The significance of iintegrating trade credit with other factors can be appreciated in the context of integrating efforts of several papers. For example, there have been attempts to integrate corporate finance with macro-economics by Auerbach and King (1983) and Benninga and Talmor (1986). Froot and Stein (1998) developed an integrative framework for the capital allocation and capital structure decision. Schiff and Lieber (1974), Kim and Chung (1990) and Arcelus and Srinivasan (1993) presented models for the integration of accounts receivable and inventory management. Sartoris and Hill (1983) have shown how cash management, inventory management and credit policy are integrated, while Lim, Elahee and Rashid (2005) made capital budgeting decisions jointly with credit policy decisions. Lam and Chen (1986) model the stochastic part of product demand as exogenous. This subjects their model of uncertain product demand to their own critique of Kim and Atkins (1978) model of the bad-debt loss which they consider as exogenous. We therefore endogenize the uncertainty in product demand by making it dependent on changes in the cash discount and product price using demand elasticities.

3. Theoretical Model

In order to solve for the product price, P, and the cash discount, d, Lim and Rashid (2002, 2008) needed two separate elasticities of demand, Q: (a) the cash discount elasticity of demand, denoted by η_d, where:

$$\eta_d = \frac{\partial.Q}{\partial\, d}\frac{d}{Q} \qquad (1)$$

and (b) the product price elasticity of demand, denoted by η_p, where:

$$\eta_p = \frac{\partial.Q}{\partial\, \bar{p}}\frac{\bar{P}}{Q} \qquad (2)$$

Since this paper builds on the model of Lim and Rashid (2002, 2008), it is essential that the assumptions, notation and the model be presented briefly.

3.1 Assumptions and Notation

A single period framework is assumed. At the beginning of the period, both production and sale of Q quantity of output takes place, with the variable cost per unit, v, assumed to be constant. Given the length of credit period N_2 days, the firm considers providing a cash discount rate, d, for early repayment of invoices by customers. If a cash discount is provided, we denote the discount period as N_1 days. The sales are assumed to be uniformly distributed among customers. We assume that p fraction of customers take the cash discount, and of the (1-p) fraction that decline the cash discount, a λ fraction of these customers pay on day N_2. Thus, (1-p)(1-λ) fraction of customers are those who do not take the cash discount and do not pay on day N_2. This (1-p)(1-λ) fraction therefore default and become a bad debt loss.[5] The firm sets not only the value of d but also the level of $\bar{P}$. Assuming that the annual cost of short-term funds, k, is initially constant, the net present value of accounts receivable is given by:

$$V = p(1-d)PQ(1+k)^{-N_1/360} + (1-p)\lambda PQ(1+k)^{-N_2/360} - vQ \qquad (3)$$

The first term represents the present value of payments by customers who take the cash discount, while the second term represents the present value of payments by customers who do not take the cash discount and pay on day N_2. The last term gives the variable cost of production, Q. The firm's problem is to optimally choose the cash discount rate, d, and the product price, P. The optimal cash discount rate and product price will be denoted by d* and P* respectively. The separation of customers to those taking the cash discount and those not taking the cash discount makes the model one of third-degree price discrimination, similar to the model in Layson (1998). Layson denotes each market by 1 and 2, and denotes price and quantity by p and q. Equation (3) would then be a special case of Layson's (1998) profit function, $\pi(p_1,p_2)=p_1q_1+p_2q_2-C(Q)$, where $p_1=P(1-d)(1+k)^{-N_1/360}$, $p_2=P(1+k)^{N_2/360}$, $q_1=pQ$, $q_2=(1-p)\lambda Q$ and $C(Q)=vQ$. As our model is one of price discrimination, we would also require the three conditions for price discrimination to exist as postulated by Carroll and Coates (1999): (i) the firm must have some market power; (ii) there can be at best imperfect arbitrage opportunities; and (iii) customers must have different price elasticities of demand. The imperfect arbitrage opportunities result from imperfect financial markets, which Emery (1984) uses to explain the existence of trade credit.

3.2 Behavioral Specifications

3.2.1 The Specification of p

$$p = p(d, P), \quad \text{where} \quad \delta p/\delta d > 0 \quad \text{and} \quad \delta p/\delta P = 0 \qquad (4)$$

The excess of the opportunity cost of not taking the cash discount over individual borrowing rates of marginal customers after an increase in the cash discount explains why $\delta p/\delta d > 0$. It is this proportion, p, which reflects the demand interdependencies of the two markets. If a larger proportion of customers take the cash discount with an increase in d, demand in the other market (those not taking the cash discount) must fall. Next, with a reduction in the product price, the amount of borrowing needed declines, which may result in lower borrowing rates. If this happens, then the effect on p is positive. On the other hand, with a reduction in product price, quantity demanded rises, requiring more borrowing and perhaps higher borrowing rates. If this happens, then the effect on p is negative. It is difficult to know which of the two opposing effects is stronger. Therefore, we let δp/δP= 0 throughout.[6]

3.2.2 The Specification of λ

$$\lambda = \lambda (d,P), \text{ where } \quad \delta\lambda/\delta d \leq 0 \quad \text{and} \quad \delta\lambda/\delta P = 0. \qquad (5)$$

δλ/δd = 0 requires that among the customers who are not taking the cash discount, the percentage of those who would have paid on day N_2 and the percentage of those who would have defaulted is unchanged after an increase in the cash discount.[7] δλ/δd > 0 implies that, with an increase in the cash discount, customers who would have defaulted as a fraction of the customers who do not take the cash discount decrease. This effect is quite unlikely. Thus, we postulate that δλ/δd is either negative or has the highest value of zero. Initially we would let δλ/δd=0. With δp/δP=0, we may expect the bad-debt loss (1-p)(1-λ) to increase when the product price increases (i.e., δλ/δP<0). However, with a uniform distribution of a decrease in quantity demanded among customers, there is no reason why the bad-debt loss should increase. Therefore, we let δλ/δP= 0.

3.2.3 The Specification of Quantity Demanded, Q:

$$Q = Q (d,P) \text{ where } \delta Q/\delta d \geq 0 \text{ , and } \quad \delta Q/\delta P \leq 0 \qquad (6)$$

There are two notable points about equation (6). Firstly, δQ/δd≥0, as an increase in d signifies a reduction in the effective price, or increased generosity of credit terms. Secondly, δQ/δP≤0 reflects the law of demand which states that, ceteris paribus, a lower (higher) product price raises (lowers) quantity demanded of the product (unless the firm's demand curve is perfectly price inelastic in which case δQ/δP=0).

4. Theoretical Analysis

4.1 Determination of Optimal Cash Discount Rate and Product Price

Noting the above behavioral assumptions, the first order conditions for optimality are obtained by differentiating equation (3) with respect to the cash discount rate, d, and the product price, P (with δλ/δd = 0 initially) and equating the resulting expressions to zero:

$$\frac{\partial V}{\partial d} = \frac{\partial p}{\partial d}(1-d)\overline{P}Q(1+k)^{-N_1/360} - p\overline{P}Q(1+k)^{-N_1/360}$$
$$-\frac{\partial p}{\partial d}\lambda\overline{P}Q(1+k)^{-N_2/360} + \overline{P}(1-d)\frac{\partial Q}{\partial d}(1+k)^{-N_1/360} - v\frac{\partial Q}{\partial d} = 0 \qquad (7)$$

$$\frac{\partial V}{\partial \bar{P}} = p(1-d)\,Q\,(1+k)^{-N_1/360} + p(1-d)\,\bar{P}\frac{\partial Q}{\partial \bar{P}}(1+k)^{-N_1/360}$$

$$+ (1-p)\lambda Q(1+k)^{-N_2/360} + (1-p)\lambda \bar{P}\frac{\partial Q}{\partial \bar{P}}(1+k)^{-N_2/360} - v\frac{\partial Q}{\partial \bar{P}} = 0 \quad (8)$$

Note that for the present value of incremental sales due to the incremental cash discount (the fourth term in equation (7)), all incremental customers must take the cash discount. That is, the terms involving δQ/δd which measure the change in V from changing d must have p=1. Further discussion of these first-order conditions are found in Lim and Rashid (2002, 2008).[8]

4.2 Impact of the Cash Discount Elasticity of Demand, η_d, and the Product Price Elasticity of Demand, η_P, on Optimal d and P.

Using the definitions of η_d and $\eta_{\bar{P}}$ from Section 2, re-arrange equations (7) and (8) as follows:[9]

$$\frac{\partial Z}{\partial d} = \theta\left\{\frac{\partial p}{\partial d}(1-d) - p\right\}d - \frac{\partial p}{\partial d}\lambda d + \theta(1-d)\eta_d - \frac{\sigma\eta_d}{\bar{P}} = 0 \quad (9)$$

$$\frac{\partial Z}{\partial \bar{P}} = \theta p(1-d)(1+\eta_{\bar{P}}) + (1-p)\lambda(1+\eta_{\bar{P}}) - \frac{\sigma\eta_{\bar{P}}}{\bar{P}} = 0 \quad (10)$$

where $Z = V(1+k)^{N_2/360}$, $\theta = (1+k)^{(N_2-N_1)/360}$ and $\sigma = v(1+k)^{N_2/360}$

Equations (9) and (10) constitute a system of simultaneous equations in d* and P* where η_d and η_P play an important role. In equation (9), the effect of η_d is embodied in the last two terms as the first two terms simply represent a trade-off between the time value of money of early receipt of payment and the cash discount expense. In equation (10), if $\eta_P=-1$, the first order condition cannot be satisfied because the first two terms become zero while the last term is positive. For $0<|\eta_P|<1$, all three terms in equation (10) are positive, again making it impossible for this condition to be satisfied. This is a well-known result in microeconomics that a price setting firm must choose its output or price in the price elastic range of the demand curve (Tirole, 1988, p.66).

5. Numerical Results

For the solution of the simultaneous system in equations (9) and (10), a specific relationship between p and d has to be assumed. Following Rashid and Mitra (1999), we assume p=Bd where B is a positive constant. Instead of recursive substitution used by Rashid and Mitra (1999) and Lim and Rashid (2002, 2008), we use equation (11) and solve equations (9) and (10) using the “Solver” tool in MS Excel. We then calibrate the model using data from the National Survey of Small Business Finances. The NSSBF was conducted in 1988, 1993, 1998, 2003 and 2008 by the Board of Governors of the Federal Reserve System and the U.S. Small Business Administration. Financial data were collected only for the fiscal year in which the survey was conducted. For this study, we would use data collected in the 1993, 1998 and 2003 surveys, as the 2008 survey data were not publicly available at the time of writing this paper, and the 1988 survey data were missing some variables. Together with bad debt estimates found in Scherr (1989), the model is calibrated as follows: $\lambda = 0.99$; $k = 10\%$ per annum; $v = \$0.8$ per unit of output; $N_1 = 10$ days; $N_2 = 30$ days; $B = 10$. For a selected pairs of values of η_d and η_p, Table 1 presents optimal cash discount rates and optimal product prices.

As noted in Lim and Rashid (2002, 2008), higher (lower) is the product price elasticity of demand, lower (higher) is the optimal product price. Also, higher (lower) is the cash discount elasticity of demand, higher (lower) is d*. *As customers with higher cash discount elasticities have higher borrowing costs, this explains survey evidence that customers with higher borrowing costs are offered higher cash discounts*. As η_d rises, the rate of increase in d* slows down. We also find what Lim and Rashid (2002, 2008) term a “simultaneity effect”, that is, the cash discount is directly related to the contribution margin,[10] and results from the assumption of interdependent demands. The effect of the cash discount elasticity η_d on the optimal cash discount d* is much larger than the effect of the product price elasticity η_p on d*. This confirms Lim and Rashid’s (2002, 2008) main theoretical finding for a 60-day credit period and is consistent with Lim, Rashid and Mitra’s (2006) empirical evidence as described in Section 1. For most grids of η_d and η_p, the numerical values of d* are around 2%. Lim, Rashid and Mitra (2006) examine buyer firms from the 1993, 1998 and 2003 National Survey of Small Business Finances and find that the median and mode discount rates are 2%. Ng, Smith and Smith (1999) examine supplier firms and find the same 2% discount. Maness and Zietlow (2005) present an overview of cash discount practices consistent with competitive suppliers offering a 2% discount.[11]

Table 1: Optimal Cash Discount Rates and Optimal Product Price at Various Demand Elasticities

η_d \ η_P	d* (top of each cell), P* (bottom of each cell)			
	-1.5	**-2.0**	**-2.5**	**-3.0**
0.0	0.0076 $2.442	0.0076 $1.628	0.0076 $1.357	0.0076 $1.221
0.005	0.0172 $2.444	0.0155 $1.629	0.0144 $1.357	0.0137 $1.222
0.01	0.0222 $2.447	0.0199 $1.631	0.0183 $1.358	0.0171 $1.222
0.015	0.0262 $2.451	0.0233 $1.632	0.0213 $1.359	0.0199 $1.223
0.02	0.0295 $2.454	0.0261 $1.634	0.0238 $1.360	0.0222 $1.224

5.1 Effects of Monetary Policy Changes on Product Pricing and Trade Credit Interest Rates

For the three pairs of the two elasticities, Table 2 illustrates the effect of k on d*, P* and the trade credit interest rate or TCIR (for a 20-day net credit period in a 360-day year), where:

Trade Credit Interest Rate = TCIR = $[1/(1\text{-}d)]^{360/(N_2\text{-}N_1)} = [1/(1\text{-}d)]^{360/(30\text{-}10)} = [1/(1\text{-}d)]$

From Table 2, the following four observations can be noted:

(i) For any pair of the two elasticities, an increase in k raises d*. This is due to an increase in the time value gain of prompt payments.

(ii) While the effect of an increase in k on the product price is positive, this effect is small. This effect arises due to the simultaneity effect from interdependent demands.

Table 2: **Effect of Variations in k on d* and P* at three Selected Pairs of η_d and η_p**

d* (top of each cell), TCIR (middle of each cell), P* (bottom of each cell)

k (%) / η_d and η_p	0	5	10	15	20
0.005, -1.5	0.0155 32.56% $2.426	0.0164 34.55% $2.436	0.0172 36.54% $2.444	0.0179 38.54% $2.453	0.0187 40.53% $2.461
0.02, -1.5	0.0280 66.71% $2.437	0.0287 69.02% $2.446	0.0295 71.31% $2.454	0.0302 73.56% $2.462	0.0309 75.78% $2.470
0.005, -3	0.0119 24.04% $1.212	0.0128 26.04% $1.217	0.0137 28.07% $1.222	0.0145 30.11% $1.226	0.0154 32.15% $1.230

(iii) At a given η_P, an increase in η_d leads to an increase in d* at various levels of k. This is because k is basically a scale factor in the NPV framework and does not interact with η_d.[12]

(iv) At a given η_d, an increase in η_P lowers d* and this decline in d* is about uniform at different levels of k. This uniform decline is due to a lack of interaction of k with η_p.

The most important observation from Table 2, however, is that for any pair of the two elasticities, the increase in the trade credit interest rate (or TCIR) is *less* than the increase in k.[13] For example, when the short-term cost of capital of the firm, k, increases from 0% to 20%, the trade credit interest rate offered by the firm increases only from [32.56% to 40.53%], [66.71% to 75.78%] and [24.04% to 32.15%] for the three pairs of elasticities. That is, when k increases by 20% (in absolute percentage terms), the trade credit interest rate increases by *less than 10%* (in absolute percentage terms). This is consistent with Meltzer's (1960) argument that trade credit provides a buffer against changes in macroeconomic conditions reflected in changes in the short-term cost of capital k. It is also consistent with Wilner's (2000) model's predictions that the trade credit interest rate is higher and rises with the cost of capital, but the interest rate differential decreases as the cost of capital rises. Like our model, Wilner shows the change in the trade credit interest rate to be less than the change in the cost of capital. This implies that trade creditors dampen the effects of macroeconomic interest rate fluctuations. Unlike

Wilner's (2000) game-theoretic framework, we have made the same argument using only a simple NPV framework.[14] Nilsen (2002) tests the hypothesis of Meltzer (1960) and finds evidence that trade credit provides a buffer whereby the seller (firm) insures the buyer (firm) against the consequences of monetary contractions (i.e., higher short-term interest rates). In a survey paper, Mateut (2005, p.665) has concluded that "the trade-credit channel is likely to dampen the effects of contractionary monetary policies and more generally to make the recessions that generally follow these policies less severe". Using data from the 1993 and 1998 National Surveys of Small Business Finances, the median and mode cash discount rate offered to all firms is 2% (as discussed previously). The prime lending rate in 1993 (from the Fred2 database of the Federal Reserve Bank of St. Louis) was 6% while the prime lending rate for most of 1998 was 8.5%. This implies that while the prime lending rate rose by 2.5% (in absolute percentages), the cash discount rate (and thereby the trade credit interest rate) remained constant. Ng, Smith and Smith (1999) have also provided survey evidence that credit terms are stable over time.

6. Conclusion and Commonalities with the Exchange Rate Pass-Through Literature

In this paper, we argued that customers with higher borrowing costs should be *offered* higher cash discounts, consistent with Lim, Rashid and Mitra's (2006) survey evidence. We also showed that while the trade credit interest rate is higher and rises with the short-term cost of capital, the interest rate differential decreases as the cost of capital rises. That is, the change in the trade credit interest rate is less than the change in the short-term cost of capital. This finding led to our main conclusion that the empirical phenomena of credit terms being stable over time (in the United States in recent decades) and of the Meltzer (1960) effect could be rationalized by assuming that firms set credit terms to maximize NPV. The limitation of this result is that it does not consider menu costs, which we will consider in future work.

Our results on credit policy have some commonality with the literature on exchange rate pass-throughs. In the early years of floating exchange rates, economists expected to find a close association between movements in exchange rates and national price levels. Based on the presumption of approximate purchasing-power parity, it was felt that control of domestic inflation would become more problematic in an environment of exchange rate volatility. However, a substantial literature, covering many countries, has documented that exchange rate changes are, at best, weakly associated with changes in domestic prices at the consumer level. The low-degree of "exchange rate pass-through" both at the disaggregated level, for individual traded goods prices, and more generally, in aggregate price indexes, has been extensively documented. (Devereux and Yetman, 2002, p.347). In our model, firms will only adjust credit terms and product prices to maximize NPV. Still, the adjustment in the trade credit interest rate will be less than the change in the short-term interest rate as shown in Table 2. Devereux and Yetman (2002) find empirical evidence that for countries with very high inflation rates, the aggregate pass-through is very high, but there is a non-linear relationship between estimated pass-through coefficients and average inflation rates. As inflation rises, pass-through rises, but at a declining rate.

Many industrialized countries seemed to have experienced a decline in exchange rate pass-through to consumer prices in the 1990s, despite large exchange rate depreciations in many of them. Bailliu and Bouakez (2004) state the fact that this documented decline in exchange rate pass-throughs in recent years has coincided with the low-inflation period that most industrialized countries entered a decade or so ago, and has popularized the view that these two phenomena could be linked. Sekine (2006) also finds that pass-throughs have declined over time for all his sample countries. The decline in second-stage pass-through (from import prices to consumer prices) is associated with the emergence of the low and stable inflation environment as well as a rise in import penetration. In our paper, we have shown that credit terms remained remarkably stable in recent decades. The fact that firms have been reluctant to change credit terms recently has also been documented by Ng, Smith and Smith (1999) and Maness and Zietlow (2006, and references therein).

Finally, our results on the stability of credit terms were obtained in Lim and Rashid's (2002, 2008) model of third-degree price discrimination. As noted by Salinger (1995), third-degree price discrimination is a special case of a bundled good. Here, the firm bundles the product with credit. One extension would be to examine the effects of unbundling this good. This study could be relevant for several large manufacturers (e.g., General Motors) are in the process of spinning-off their credit divisions. Our conjecture is that financial markets are becoming more efficient and the "law of one price" would have greater application. Therefore, one condition for price discrimination to exist, postulated by Carroll and Coates (1999) as "imperfect arbitrage opportunities", no longer holds. Together with Emery's (1984) explanation of trade credit as a response to imperfect financial markets, we conjecture that more efficient financial markets might lead in future to decreased use of trade credit.

Endnotes

[1] We thank Yong Kim for suggesting that elasticity could be motivated by its similarities to the *beta* in finance.

[2] Lim, Rashid and Mitra (2006) find that credit terms are positively correlated with each other. Therefore, a higher cash discount implies more generous credit terms.

[3] A trade credit interest rate refers to the implicit interest rate when the customer forgoes the cash discount and pays the full price at the end of the credit period.

[4] The NPV framework is used extensively in textbooks like Maness and Zietlow (2005). In Graham and Harvey's (2001) survey, 75% of firms either always or almost always use both NPV and IRR to evaluate projects. Thus it should be as appropriate to study credit channel transmission of monetary policy in the NPV framework

[5] We recognize that these customers who do not pay on the due date of the credit period may not go bankrupt and may renegotiate the payments. But these customers may be dealt with on an individual basis, and it is cumbersome to model this behaviour. In our numerical computations, we will use magnitudes of p and λ that result in bad-debt loss ratios $(1-p)(1-\lambda)$ which are consistent with the empirical findings of Scherr (1989).

[6] Another justification goes as follows: Before a change in product price, customers' habits and borrowing rates determine a specific p. If the product price decreases, quantity demanded rises. However, there is no prior reason why the fraction of new customers who take the cash discount will be higher or lower than the existing fraction p.

[7] When $\delta\lambda/\delta d = 0$, $\delta(\text{bad debts})/\delta d = \delta/\delta d\ [(1-p)(1-\lambda)] = \delta/\delta d\ [1-p-\lambda+\lambda p] = -\delta p/\delta d + \lambda\delta p/\delta d = \delta p/\delta d\ (\lambda-1) < 0$. The bad-debt loss decreases when the cash discount increases as $\delta p/\delta d>0$ and $\lambda < 1$.

[8] In equation (7), the incremental customers are not divided into those who take cash discount and those who do not. The reason is simple: the incremental cash discount represents a price reduction only to those who take the cash discount. Otherwise there is no reduction in price. Thus, all incremental customers must take the cash discount.

[9] Each term in equation (7) is divided by PQ and multiplied by d. Each term in equation (8) is divided by Q. Terms in both equations are multiplied by $(1+k)^{N_2/360}$. Z is then the NPV of accounts receivable at the end of the credit period N_2.

[10] Sartoris and Hill (1988) find empirically that d* increases as the contribution margin, P*- v, increases. Beranek (1991) also find theoretically that "the optimal discount is lower the lower is the profit margin" (p.7).

[11] Scherr (1989) reports that the bad debt loss ratio never exceeds 1.8% and average only 0.5%. Therefore, we let $\lambda = 0.99$. This, together with B = 10 and d = 2%, produces a bad debt loss ratio of 0.8% of all sales. Sensitivity analysis is performed on this estimate of λ in the next section. Lim, Rashid and Mitra (2006) find the mode and median N_1=10 days and N_2=30 days. However, Lim and Rashid (2002) and Rashid and Mitra (1999) use N_2=60 days. In Lim and Rashid (2008), in order to compare our results with these earlier papers, it also reported numerical results for N_2=60 days. Finally, sensitivity analysis is performed on B in the next section and on k in the following section. When performing sensitivity analysis on v, only the product price changes. The contribution margin relative to v (i.e., [P*-v]/v) and optimal cash discount remain unchanged.

[12] Note that η_d reflects the borrowing costs of customers while k reflects the borrowing costs of the firm (seller). Although systematic factors make η_d and k not completely independent, there exist idiosyncratic factors like credit quality which cause η_d and k to be sufficiently independent that they do not interact.

[13] Chung and Lin (1998) prove that the objective functions of discounted infinite horizon present value of the revenue stream are concave. Arcelus and Srinivasan (1993) show, in Figure 1 of their paper, that the discounted present value of revenue stream changes only marginally when the cost of capital, k, changes, suggesting that the objective function is concave in k. Our results suggest that the NPV function is also concave in k.

[14] Maness and Zietlow (2005, p.173) find from the extant literature that the cash discount offered should be based on the offering company's cost of funds; when the opportunity cost of funds changes, so should the cash discount. This is related to Emery's (1984) financial explanation of trade credit where, due to imperfect financial markets, the borrowing rate is higher than the lending rate. Therefore, if the seller could negotiate with the buyer a trade credit interest rate between the borrowing rate and lending rate, the seller would earn a surplus of the difference between the trade credit interest rate and the lending rate, and the buyer would earn a surplus of the difference between the trade credit interest rate and the borrowing rate. This would imply that the trade credit interest rate would be affected by the costs of capital or monetary conditions. In this paper, we determine how the trade credit interest rate is affected by the cost of capital using only a simple NPV framework. If firms actually use this framework in practice (as suggested by Graham and Harvey (2001)), then it should be as appropriate to study the transmission of monetary policy in this framework as a game-theoretic or contract-theoretic framework where it is occasionally assumed (for analytical tractability) that the time value of money is zero.

References

Arcelus FJ, Srinivasan G. 1993. 'Integrating Working Capital Decisions'. *The Engineering Economist* 39: 1-15.

Atkins JC, Kim YH. 1977. 'Comment and Correction: Opportunity Cost in the Evaluation of Investment in Accounts Receivable'. *Financial Management* 6: 71-74.

Auerbach AJ, King MA. 1983. 'Taxation, Portfolio Choice and the Debt-Equity Ratios'. *The Quarterly Journal of Economics* 98: 587-609.

Bailliu J, Bouakez H. 2004. 'Exchange Rate Pass-Through in Industrialized Countries'. *Bank of Canada Review* Spring 2004:19-28.

Benninga S, Talmor E. 1986. 'The Interaction of Corporate and Government Financing in General Equilibrium'. *Working Paper 28-86*, Rodney L. White Center for Financial Research, University of Pennsylvania.

Beranek W. 1991. 'Behavioral Relations, Operating Factors and the Optimal Cash Discount'. *The 7th International Symposium on Cash, Treasury and Working Capital Management*, Kim, Y (ed). Chicago, October 1991.

Brennan M, Maksimovic V, Zechner J. 1988. 'Vendor Financing'. *Journal of Finance* 43: 1127-1141.

Brick IE, Fung WKH. 1984. 'Taxes and the Theory of Trade Debt'. *Journal of Finance* 39: 1169-1176.

Carroll K, Coates D. 1999. 'Teaching Price Discrimination: Some Clarification'. *Southern Economic Journal* 66(2): 466-480.

Chung KJ, Lin SD. 1998. 'Determination of the Optimal Procurement Policy under Integrating Working Capital'. *The Engineering Economist* 43: 269-277.

Devereux MB, Yetman J. 2002. 'Price-Setting and Exchange Rate Pass-Through: Theory and Evidence'. *Price Adjustment and Monetary Policy*, Proceedings of a Conference held at the Bank of Canada, November 2002, Bank of Canada, Ottawa, Ontario, Canada.

Emery GW. 1984. 'A Pure Financial Explanation for Trade Credit'. *Journal of Financial and Quantitative Analysis* 19: 271-285.

Emery GW. 1987. 'An Optimal Financial Response to Variable Demand'. *Journal of Financial and Quantitative Analysis* 22: 209-225.

Froot KA, Stein JC. 1998. 'Risk Management, Capital Budgeting, Capital Structure Policy for Financial Institutions: An Integrated Approach'. *Journal Financial Economics*, 47: 55-82.

Graham JR, Harvey CR. 2001. 'The Theory and Practice of Corporate Finance: Evidence from the Field'. *Journal of Financial Economics* 60: 187-243.

Hill NC, Riener KD. 1979. 'Determining the Cash Discount in the Firm's Credit Policy'. *Financial Management* 8: 68-73.

Kim YH, Atkins JC. 1978. 'Evaluating Investments in Accounts Receivable: A maximizing framework'. *Journal of Finance* 33: 403-412.

Kim YH, Chung KH. 1990. 'An Integrated Evaluation of Investment in Inventory and Credit: A Cash Flow Approach'. *Journal of Business Finance & Accounting* 17: 381-390.

Lam CH, Chen AH. 1986. 'A Note on Optimal Credit and Pricing Policy under Uncertainty: A Contingent-Claims Approach'. *Journal of Finance* 41: 1141-1148.

Layson SK. 1998. 'Third-Degree Price Discrimination with Interdependent Demands'. *Journal of Industrial Economics* 46:511-524.

Lieber Z, Orgler YE. 1975. 'An Integrated Model for Accounts Receivable Management'. *Management Science* 22: 212-219.

Lim W, Rashid M. 2002. 'An Operational Theory Integrating Cash Discount and Product Pricing Policies'. *Journal of American Academy of Business* 1: 282-288.

Lim, W, Rashid M. 2008. 'Variations on the Operational Theory Integrating Cash Discount and Product Pricing Policies'. *The Business Review, Cambridge*, 10: 1-7.

Lim W, Elahee MN, Rashid M. 2005. 'A Simple Model Integrating Capital Budgeting with Trade Credit'. *Corporate Finance Review* 9: 5-14.

Lim W, Rashid M, Mitra D. 2006. ‘Changes in Credit Terms and Clientele Effects on the Cash Discount Rate in Credit Policy’. *Review of Business Research* 6: 141-151.

Maness TS, Zietlow JT. 2005. *Short-Term Financial Management*, Third Edition. Thomson South-Western.

Mateut S. 2005. ‘Trade Credit and Monetary Policy Transmission’. *Journal of Economic Surveys* 19: 655-670.

Meltzer AH. 1960. ‘Mercantile Credit, Monetary Policy, and Size of Firms’. *Review of Economics and Statistics* 42: 429-437.

Mian SL, Smith Jr. CW. 1992. ‘Accounts Receivable Management Policy: Theory and Evidence’. *Journal of Finance* 47: 169-200.

Ng CK, Smith JK, Smith RL. 1999. ‘Evidence of the Determinants of Credit Terms Used in Interfirm Trade’. *Journal of Finance* 54: 1109-1129.

Nilsen JH. 2002. ‘Trade Credit and the Bank Lending Channel’. *Journal of Money, Credit and Banking* 34: 226-253.

Peterson MA, Rajan RG. 1997. ‘Trade Credit: Theories and Evidence’. *Review of Financial Studies* 10: 661-691.

Rashid M, Mitra D. 1999. ‘Price Elasticity of Demand and an Optimal Cash Discount Rate in Credit Policy’. *Financial Review* 34: 113-126.

Salinger MA. 1995. ‘A Graphical Analysis of Bundling’. *Journal of Business* 68(1): 85-98.

Sartoris WL, Hill NC. 1983. ‘A Generalized Cash Flow Approach to Short-Term Financial Decisions’. *Journal of Finance* 38: 349-360.

Sartoris WL, Hill NC. 1988. ‘The Relationship between credit policies and firm financial characteristics’. *Advances in Working Capital Management*, Kim YH, Srinivasan V (eds). JAI Press: Greenwich, CT.

Scherr F. 1989. *Modern Working Capital Management: Text and Cases*, Prentice Hall, Inc.: Eaglewood Cliffs, NJ.

Schiff M, Lieber Z. 1974. ‘A Model for the Integration of Credit and Inventory Management’. *Journal of Finance* 29:133-141.

Schwartz RA, Whitcomb D. 1980. ‘The Trade Credit Decision’. *Handbook of Financial Economics*, Bicksler J (ed). North-Holland: Amsterdam.

Sekine T. 2006. ‘Time-Varying Exchange Rate Pass-Through: Experiences of Some Industrial Countries’. *BIS Working Papers* No. 202, Bank of International Settlements, Basel Switzerland.

Smith J. 1987. ‘Trade Credit and Informational Asymmetry’. *Journal of Finance* 42: 863-869.

Tirole J. 1988. *The Theory of Industrial Organization*, MIT Press: Cambridge, MA.

Wilner BS. 2000. ‘The Exploitation of Relationships in Financial Distress: The Case of Trade Credit’. *Journal of Finance* 55: 153-178.