

# MUTUAL DEPENDENCIES IN FINANCIAL MARKETS: INTEREST RATES, PRICING, AND TRADE CREDIT RELATIONS

<sup>1</sup>Olivia Marie Leclerc and <sup>2</sup>Alexander James Wong

<sup>1</sup>Department of Economics, McGill University, Montreal, Quebec, Canada

<sup>2</sup>School of Business, University of British Columbia, Vancouver, British Columbia, Canada

**Abstract:** *This study investigates the impact of trade credit on the effectiveness of monetary policy transmission, addressing the empirical observation that trade credit tends to mitigate the effects of central bank actions. To elucidate this phenomenon, we develop a partial equilibrium model that incorporates third-degree price discrimination and menu costs. Our primary finding reveals that optimizing credit terms and product prices yields minimal net present value (NPV) gains compared to the minute menu costs associated with short-term interest rate adjustments during low-inflation periods. Consequently, credit terms and product prices remain relatively stable over time, in alignment with empirical evidence presented by Ng, Smith, Smith (1999), and Mateut (2005). Furthermore, our model provides insights into the Meltzer (1960) hypothesis, suggesting that trade credit experiences less volatility than bank credit in the context of monetary policy transmission. This implies that firms strategically set trade credit terms to maximize NPV while considering menu costs, thereby rationalizing certain credit channel-related empirical phenomena. The paper also explores parallels between trade credit dynamics and exchange rate pass-throughs, shedding light on the effectiveness of monetary easing during a pandemic. These findings contribute to a deeper understanding of the intricate relationship between trade credit and monetary policy, with potential implications for policy design and implementation.*

**Keywords:** Trade Credit, Monetary Policy Transmission, Menu Costs, Credit Channel, NPV Optimization

## 1. Introduction

How does trade credit affect the credit channel of monetary policy transmission? 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 central bank actions. In this paper, we present a partial equilibrium model of third-degree price discrimination with menu costs. The main result is that the increase in NPV from optimizing credit terms and product prices is less than even miniscule menu costs for short-term interest rate changes in low-inflation periods. Therefore, credit terms and product prices are stable over time. This finding is consistent with Ng, Smith and Smith's (1999) and Mateut's (2005) empirical evidence and 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 and take menu costs into account. Finally, similarities to exchange rate

pass-throughs and the effectiveness of monetary easing in a pandemic are discussed.

The rest of the paper is organized as follows: Extant literature is reviewed in Section 2, while Section 3 performs the analysis. In Section 4, numerical results show credit terms and product prices are stable even with large changes in interest rates. Menu costs are considered and the Meltzer (1960) effect is shown to hold in Section 5. Section 6 concludes with a discussion of exchange rate pass-throughs and the effectiveness of monetary easing in a pandemic.

## 2. Review of Factors affecting Trade Credit Terms

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*. Smith (1987) argues that a supplier provides trade credit in order to protect non-salvageable investment in the client's relationship. 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) and Petersen and Rajan (1997, p.664) suggest price discrimination as a motive for trade credit.

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.

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. 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. Further 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 demand (which measures the sensitivity of sales to the cash discount or credit terms in general), 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.*

## 3. Theoretical Analysis

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  $\eta_d$ , where:

$$\frac{Q}{Q} \frac{d}{d} \eta_d = \quad (1)$$

$\frac{dQ}{dP}$

and (b) the product price elasticity of demand, denoted by  $\eta_p$ , where:

$\frac{dQ}{dP}$

$\eta_p = \frac{P}{Q} \frac{dQ}{dP}$

$$\eta_p = \frac{P}{Q} \frac{dQ}{dP} \quad (2)$$

$\frac{dQ}{dP}$

$\frac{dQ}{dP}$

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.

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  $\lambda$  fraction of these customers pay on day  $N_2$ . Thus,  $(1-p)(1-\lambda)$  fraction of customers are those who do not take the cash discount and do not pay on day  $N_2$ . This  $(1-p)(1-\lambda)$  fraction therefore default and become a bad debt loss. The firm sets not only the value of  $d$  but also the level of  $P$ . Assuming that the annual cost of short-term funds,  $k$ , is initially constant, the net present value of accounts receivable is given by:

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

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) above would then be a special case of Layson's (1998) profit function,  $\pi(p_1, p_2) = p_1 q_1 + p_2 q_2 - C(Q)$ , 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 (Emery, 1984). Behavioral specifications of  $p$ ,  $\lambda$  and  $Q$  are given in Appendix 1. The theoretical derivation of the simultaneous equations determining the optimal cash discount rate and product price is shown in Appendix 2. The simultaneous equations are:

$$\begin{aligned} \frac{\partial V}{\partial d} &= pQ(1+k)^{-N_1/360} - pQ(1-d)(1+k)^{-N_1/360} - \lambda PQ(1+k)^{-N_2/360} = 0 \\ \frac{\partial V}{\partial P} &= pQ(1-d)(1+k)^{-N_1/360} + \lambda PQ(1+k)^{-N_2/360} - vQ = 0 \end{aligned} \quad (4)$$

$$\begin{aligned} \frac{\partial V}{\partial d} &= pQ(1+k)^{-N_1/360} - pQ(1-d)(1+k)^{-N_1/360} - \lambda PQ(1+k)^{-N_2/360} = 0 \\ \frac{\partial V}{\partial P} &= pQ(1-d)(1+k)^{-N_1/360} + \lambda PQ(1+k)^{-N_2/360} - vQ = 0 \end{aligned} \quad (5)$$

where  $Z = V(1+k)^{N_2/360}$ ,  $\theta = (1+k)^{(N_2-N_1)/360}$  and  $\sigma = v(1+k)^{N_2/360}$ .  $Z$  is then the NPV of accounts receivable at the end of the credit period  $N_2$ . Equations (4) and (5) constitute a system of simultaneous equations in  $d^*$  and  $P^*$  where  $\eta_d$  and  $\eta_p$  play an important role. In equation (4), the effect of  $\eta_d$  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 (5), 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 (5) are positive, again making it impossible for this condition to hold.

#### 4. Numerical Results

For the solution of the simultaneous system in equations (4) and (5), 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 solve equations (4) and (5) using the “Solver” tool in MS Excel. Using empirical estimates from the 1993, 1998 and 2003 National Survey of Small Business Finances as reported in Lim, Rashid and Mitra (2006) and 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  $\eta_d$  and  $\eta_p$ , Table 1 presents optimal cash discount rates and optimal product prices.

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

$\eta_d$	$\eta_p$	$d^*$ (top of each cell), $P^*$ (bottom of each cell)			
		-1.5	-2.0	-2.5	-3.0
	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

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  $\eta_d$  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, and results from the assumption of interdependent demands. The effect of the cash discount elasticity  $\eta_d$  on the optimal cash discount  $d^*$  is much larger than the effect of the product price elasticity  $\eta_p$  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  $\eta_d$  and  $\eta_p$ , 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. For the three pairs of the two elasticities, Table 2 illustrates the effect of  $k$  on  $d^*$  and  $P^*$ . Note that while  $k$  increases from 0% to 20%, with  $(\eta_d, \eta_p) = (0.005, -1.5)$ , the optimal cash discount only increases from 1.55% to only 1.87% while the optimal product price increases from \$2.43 to only \$2.46. Similar results are observed for other pairs of elasticities. Therefore, *credit terms and product prices are stable even with large changes in macroeconomic interest rates.*

**Table 2: Effect of Variations in  $k$  on  $d^*$  and  $P^*$  at three Selected Pairs of  $\eta_d$  and  $\eta_p$**

$d^*$  (top of each cell),  $P^*$  (bottom of each cell)

<b>k (%)</b> <b><math>\eta_d</math>, <math>\eta_p</math></b>	<b>0</b>	<b>5</b>	<b>10</b>	<b>15</b>	<b>20</b>
0.005,  -1.5	0.0155 \$2.42 6	0.016 4 \$2.43 6	0.017 2 \$2.44 4	0.017 9 \$2.45 3	0.018 7 \$2.46 1
0.02,  -1.5	0.028 0 \$2.43 7	0.028 7 \$2.44 6	0.029 5 \$2.45 4	0.030 2 \$2.46 2	0.0309 \$2.47 0
0.005,  -3	0.0119 \$1.212	0.012 8 \$1.217	0.013 7 \$1.22 2	0.014 5 \$1.22 6	0.015 4 \$1.23 0

## 5. Adding Menu Costs to the Model.

Menu costs refer to the direct costs of price adjustment (like changing a menu). Zbaracki *et al.* (2004) identify and measure three types of managerial costs (information gathering, decision-making, and communication costs) and two types of customer costs (communication and negotiation costs) related to price adjustment. They find that the managerial costs are more than six times, and customer costs more than twenty times, the menu costs, confirming McCallum’s (1988) notion that menu costs are of insignificant magnitude. In total, the price adjustment costs comprise 1.22% of the company’s revenue,



with menu costs comprising just 3.57% of the total price adjustment costs (or  $0.0435\% = 3.57\% \times 1.22\%$  of the company's revenue). Zbaracki *et al.* (2004, pp. 523 and 530) have excluded fixed costs from their calculations. Thus a company would incur menu costs of 0.0435% of revenues *each time a price change is made*. Also, the estimates of menu costs obtained from Zbaracki *et al.* (2004) are for a billion-dollar company. If there are economies of scale in menu costs, then a smaller company would incur menu costs larger than 0.0435% of revenues.

A profit-maximizing firm would only change its credit terms when the increase in the NPV of its accounts receivables exceeds the menu costs. With the NPV of accounts receivables,  $V$ , given by equation (3), the revenues are given by the first two terms. The increase in NPV as a percentage of revenues is calculated in Appendix 3. Suppose that  $k$  is initially at 5%. Also suppose  $(\eta_d, \eta_p) = (0.005, -1.5)$ . From Table 2,  $d^*$  is 1.64% and  $P^*$  is \$2.436. Now if the central bank raises short-term interest rates such that  $k$  is now 10%, the firm must decide whether to change  $d$  and  $P$  to their new optimal levels of 1.72% and \$2.444 respectively. Assuming that  $k$  stays at 10% for the next 30 days, in our model, the menu costs at the end of the credit period is  $0.0435\% \times 1.1^{(30/360)} = 0.0438\%$  of revenues. The firm will change  $d$  and  $P$  if  $\Delta Z$  is greater than 0.0438%. Now  $Z_d = 2.575\%$  and  $Z_p = 0.07\%$ . Both  $Z_d$  and  $Z_p$  are evaluated at the old optimum of  $d=1.64\%$  and  $P=\$2.436$ , but with  $k=10\%$  (i.e., at the new value of  $k$  which is exogenous). So  $\Delta d = 1.72\% - 1.64\% = 0.08\%$  or 0.0008 and  $\Delta P = \$2.4444 - \$2.4356 = \$0.0088$ . Thus  $Z_d \times \Delta d = 0.00207\%$  of revenues, which is the increase in NPV when the firm optimizes its cash discount, and  $Z_p \times \Delta P = 0.00063\%$  of revenues, which is the increase in NPV when the firm optimizes its product price. The total increase in NPV when the firm optimizes both  $d$  and  $P$  is  $\Delta Z = 0.0027\%$  of revenues, which is well below the menu costs of 0.0438% of revenues. Even though NPV increases when the firm optimizes  $d$  and  $P$ , the increase is much less than the menu costs. Therefore, the firm would optimally choose *not* to change  $d$  and  $P$ .

Table 3 shows the menu costs (as a percentage of revenues) at the end of the credit period for different levels of  $k$ . These menu costs will be compared to the estimates of the increase in NPV from optimizing  $d$  and  $P$ , as shown in Tables 4 to 8, where each table is for different pairs of elasticities. Tables 4 to 6 have the bad-debt loss falling proportionately as the cash discount,  $d$ , increases ( $\partial \lambda / \partial d = 0$ ), Table 7 has the bad-debt loss about constant ( $\partial \lambda / \partial d = 0.1$ ), and Table 8 has the bad-debt loss increasing as  $d$  increases ( $\partial \lambda / \partial d = -0.625$ ). We assume that  $k=5\%$  initially, and the central bank can increase  $k$  from 5% to the levels of  $k$  reported in the tables. For example,  $k=20\%$  refers to the central bank raising  $k$  from 5% to 20% and lists the optimal  $d^*$  and  $P^*$  for  $k=20\%$  and computations of the NPV increase. *The point is to find out how much  $k$  must increase from 5% in order for the increase in NPV from optimizing  $d$  and  $P$  to be larger than the menu costs.*

The second column in each table lists the optimal  $d^*$  and  $P^*$  for the respective  $k$ . The third column in each table lists the increase in NPV (as a percentage of revenues) when the firm optimizes  $d$ , which is  $Z_d \times \Delta d$ . In order to calculate  $Z_d$  with  $\partial \lambda / \partial d$  nonzero in Tables 7 and 8, we replace  $Z_d$  with  $Z_d'$ , with  $Z_d' = 100 \times [(\partial Z / \partial d) / d + (1-p) \times \partial \lambda / \partial d \times d] / A$  where  $\partial Z / \partial d$  is defined by equation (4). The fourth column in each table lists the increase in NPV (as a percentage of revenues) when the firm optimizes  $P$ , which is  $Z_p \times \Delta P$ . Note that  $Z_p$  is unaffected by  $\partial \lambda / \partial d$ . The fifth column in each table lists the total increase in NPV (as a percentage of revenues) when the firm optimizes both  $d$  and  $P$ , which is  $\Delta Z$ .

**Table 3: Menu Costs as a Percentage of Revenues at End of Credit Period (Day  $N_2$ )**

K	Menu Costs (% of Revenues)	k	Menu Costs (% of Revenues)
5%	0.0437%	28%	0.0444%
10%	0.0438%	29%	0.0444%
15%	0.0440%	30%	0.0445%
20%	0.0442%	31%	0.0445%

21%	0.0442%	32%	0.0445%
25%	0.0443%	36%	0.0446%
27%	0.0444%	47%	0.0449%

Table 4: Increase in NPV as a Percentage of Revenues at End of Credit Period (Day N<sub>2</sub>) $(\eta_d, \eta_p) = (0.005, -1.5)$ ;  $\partial\lambda/\partial d = 0$ 

k	d*, P*	Zd * Δd	Zp * ΔP	ΔZ
5%	0.0164, \$2.436	-	-	-
10%	0.0172, \$2.444	0.00207%	0.00063%	0.00270%
15%	0.0179, \$2.453	0.00805%	0.00239%	0.01044%
20%	0.0187, \$2.461	0.0176%	0.0051%	0.0227%
25%	0.0195, \$2.468	0.0304%	0.0088%	0.0392%
<b>27%</b>	0.0198, \$2.471	0.0364%	0.0104%	<b>0.0468%<sup>2</sup></b>
<b>30%</b>	0.0202, \$2.476	<b>0.0461%<sup>1</sup></b>	0.0132%	<b>0.0593%<sup>2</sup></b>

<sup>1</sup> NPV Increase from Change in Cash Discount Only Exceeds Menu Costs<sup>2</sup> NPV Increase from Change in Cash Discount and Product Price Exceeds Menu CostsTable 5: Increase in NPV as a Percentage of Revenues at End of Credit Period (Day N<sub>2</sub>) $(\eta_d, \eta_p) = (0.02, -1.5)$ ;  $\partial\lambda/\partial d = 0$ 

k	d*, P*	Zd * Δd	Zp * ΔP	ΔZ
5%	0.0287, \$2.446	-	-	-
10%	0.0295, \$2.454	0.00185%	0.00055%	0.00240%
15%	0.0302, \$2.462	0.00717%	0.00208%	0.00925%
20%	0.0309, \$2.470	0.0156%	0.0045%	0.0201%
25%	0.0310, \$2.477	0.0267%	0.0077%	0.0344%
<b>28%</b>	0.0319, \$2.481	0.0347%	0.0099%	<b>0.0446%<sup>2</sup></b>
<b>32%</b>	0.0324, \$2.487	<b>0.0466%<sup>1</sup></b>	0.0132%	<b>0.0598%<sup>2</sup></b>

<sup>1</sup> NPV Increase from Change in Cash Discount Only Exceeds Menu Costs<sup>2</sup> NPV Increase from Change in Cash Discount and Product Price Exceeds Menu CostsTable 6: Increase in NPV as a Percentage of Revenues at End of Credit Period (Day N<sub>2</sub>) $(\eta_d, \eta_p) = (0.005, -3)$ ;  $\partial\lambda/\partial d = 0$ 

k	d*, P*	Zd * Δd	Zp * ΔP	ΔZ
5%	0.0128, \$1.217	-	-	-
10%	0.0137, \$1.222	0.00223%	0.00260%	0.00483%
15%	0.0145, \$1.226	0.00869%	0.00992%	0.01861%
20%	0.0154, \$1.230	0.0190%	0.0214%	0.0404%
<b>21%</b>	0.0155, \$1.231	0.0215%	0.0241%	<b>0.0456%<sup>2</sup></b>
<b>25%</b>	0.0162, \$1,234	0.0329%	0.0364%	<b>0.0693%<sup>2</sup></b>
<b>29%</b>	0.0169, \$1.237	<b>0.0464%<sup>1</sup></b>	0.0507%	<b>0.0971%<sup>2</sup></b>

NPV Increase from Change in Cash Discount Only Exceeds Menu Costs

NPV Increase from Change in Cash Discount and Product Price Exceeds Menu Costs

**Table 7: Increase in NPV as a Percentage of Revenues at End of Credit Period (Day  $N_2$ )**

$(\eta_d, \eta_p) = (0.005, -1.5)$ ;  $\partial\lambda/\partial d = -0.1$

k	$d^*, P^*$	$Zd * \Delta d$	$Zp * \Delta P$	$\Delta Z$
5%	0.0139, \$2.435	-	-	-
10%	0.0146, \$2.443	0.0019%	0.0006%	0.0025%
15%	0.0153, \$2.452	0.0074%	0.0024%	0.0098%
20%	0.0161, \$2.460	0.0163%	0.0053%	0.0216%
25%	0.0168, \$2.467	0.0282%	0.0090%	0.0372%
27%	0.0171, \$2.470	0.0339%	0.0107%	<b>0.0446%<sup>2</sup></b>
31%	0.0176, \$2.476	<b>0.0464%<sup>1</sup></b>	0.0144%	<b>0.0608%<sup>2</sup></b>

<sup>1</sup> NPV Increase from Change in Cash Discount Only Exceeds Menu Costs

<sup>2</sup> NPV Increase from Change in Cash Discount and Product Price Exceeds Menu Costs

**Table 8: Increase in NPV as a Percentage of Revenues at End of Credit Period (Day  $N_2$ )**

$(\eta_d, \eta_p) = (0.005, -1.5)$ ;  $\partial\lambda/\partial d = -0.625$

k	$d^*, P^*$	$Zd * \Delta d$	$Zp * \Delta P$	$\Delta Z$
5%	0.0058, \$2.433	-	-	-
10%	0.0060, \$2.442	0.0007%	0.0007%	0.0014%
15%	0.0063, \$2.451	0.0027%	0.0027%	0.0054%
20%	0.0065, \$2.459	0.0060%	0.0057%	0.0117%
30%	0.0071, \$2.475	0.0164%	0.0147%	0.0311%
36%	0.0074, \$2.484	0.0250%	0.0217%	<b>0.0467%<sup>2</sup></b>
47%	0.0081, \$2.499	<b>0.0452%<sup>1</sup></b>	0.0367%	<b>0.0819%<sup>2</sup></b>

Although uncommon in the United States in recent decades with historically low inflation, absolute short-term rate changes over 15% could be recent phenomena in some countries, explaining World Bank survey evidence that trade credit fluctuates more in such countries. For example, the World Bank has survey evidence that trade credit fluctuated significantly after financial crises in developing countries when short-term interest rates fluctuated between 9 and 44 percentage points over a month.

## 5. Conclusion

In this paper, numerical computations showed that credit terms and product prices are stable even with large changes in macroeconomic interest rates. Using a menu cost estimate by Zbaracki *et al.* (2004) of just 0.0435% of revenues, it would require an increase in short-term interest rates from 5% to over 20% for the benefits of increasing trade credit interest rates and product prices to outweigh the menu costs. Although uncommon in the United States in recent decades with historically low inflation, absolute short-term rate changes over 15% could be recent phenomena in some countries, explaining World Bank survey evidence that trade credit fluctuates more in such countries (e.g., Indonesia, South Korea and Thailand in the Asian financial crisis of the late 1990s). This finding led to our main conclusion that the empirical phenomena of credit terms and product prices 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 and take menu costs into account.

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 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). This led Devereux and Yetman (2002) to develop a simple theoretical model of endogenous exchange rate pass-through that focuses exclusively on the role of price rigidities that come about because of the presence of “menu costs”. In their model calibration, they find that for annual rates of inflation higher than 25 percent, firms will adjust prices every period so price rigidity disappears completely. In that case, the pass-through from exchange rate changes to prices is complete. In short, in countries with very high inflation (or very high interest rates), prices become essentially flexible as the cost to firms of maintaining fixed prices fully offsets the menu costs. In our model, firms only adjust credit terms and product prices when short-term interest rates change more than 15 percent. Pass-throughs to credit terms and product prices are higher in periods with higher nominal interest rates (and thus higher absolute interest rate changes).

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 coincided with the low inflation period that most industrialized countries have entered and that these two phenomena are correlated. Sekine (2006) finds that pass-throughs have declined over time for all his sample countries. The decline in second-stage passthrough (from import prices to consumer prices) is associated with the emergence of a low inflation environment as well as a rise in import penetration. These results are consistent with our model, which predicts that credit terms and product prices would remain stable in recent decades due to low inflation.

Outside of the United States and other industrialized countries, however, credit terms have *not* been stable, especially in countries which suffered through financial crises. Devereux (2001) presents evidence that exchange rate passthrough is very rapid for emerging markets, but slow for advanced economies. He quotes the Governor of the Central Bank of Mexico, Guillermo Ortiz, who stated on 24 June 1999 that: “The pass-through of exchange rates to inflation was much higher in Mexico than in Canada, Australia or New Zealand. And this has to do a lot with history, with credibility of monetary policies, and this is one of the big challenges that we are facing today in Mexico in the conduct of monetary policy. And we have to really build sufficient credibility so that this pass-through from exchange rate movements to inflation ceases to be such an automatic reaction.”

Our model suggests that the stability of credit terms in the United States is due to the credibility established by the Federal Reserve in maintaining a low and stable inflation environment where short-term interest rate changes are gradual. The converse would, however, also be true. Monetary easing in times of recession (like during a pandemic) may not result in lower trade credit interest rates or more generous credit terms as the benefits of companies changing credit terms might be offset by menu costs. This explains the common observation that trade credit or credit card interest rates remain high even though the federal funds rate is near zero.

## References

- Atkins JC, Kim YH. 1977. Comment and Correction: Opportunity Cost in the Evaluation of Investment in Accounts Receivable. *Financial Management* 6: 71-74.
- Bailliu J, Bouakez H. 2004. Exchange Rate Pass-Through in Industrialized Countries. *Bank of Canada Review* Spring 2004:19-28.

- Beranek W. 1991. Behavioral Relations, Operating Factors and the Optimal Cash Discount. *The 7<sup>th</sup> International Symposium on Cash, Treasury and Working Capital Management*, Kim, Y (ed). Chicago, October 1991.
- 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.
- Devereux MB. 2001. Monetary Policy, Exchange Rate Flexibility, and Exchange Rate Pass-Through. *Revisiting the Case for Flexible Exchange Rates*, Proceedings of a Conference held at the Bank of Canada, November 2000, Bank of Canada, Ottawa, Ontario, Canada.
- 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.
- Dwor-Frecaut D, Colaco FX, Hallward-Driemeier M. 2000. Asian Corporate Recovery, Findings from Firm-Level Surveys in Five Countries. World Bank, Washington, D.C. Processed.
- 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.
- 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.
- 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, 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.

Love I, Zaidi R. 2003. Trade Credit and Financing Constraints: Evidence from the East Asian Crisis. World Bank, Washington, D.C. Processed.

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.

Journal of Finance and Bank Management, Volume 10, December 2022

McCallum BT. 1986. On “Real” and “Sticky-Price” Theories of the Business Cycle. *Journal of Money, Credit and Banking* **18**: 397-414.

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.

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

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

Schwartz RA, Whitcomb D. 1980. The Trade Credit Decision. *Handbook of Financial Economics*, Bicksler J (ed). NorthHolland: 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.

Zbaracki MJ, Ritson M, Levy D, Dutta S, Bergen M. 2004. Managerial and Customer Costs of Price Adjustment: Direct Evidence from Industrial Markets. *Review of Economics and Statistics* **86**: 514-533.