Option Value of Credit Lines as an Explanation of High Credit Card Rates

by

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Abstract

Credit lines offered by credit cards contain an option arising from changing default probabilities of cardholders. The option value can explain high credit card rates and high profits of cardissuers. The card rate yielding zero profit for cardissuers is higher than interest rates on most other loans because rational cardholders borrow more when they become riskier. Some cardholders facing high transaction costs of alternative financing borrow when the option is out of the money. Cardissuers can have above-normal profits when incomplete information about cardholders' risks makes it difficult to compete for those profitable customers.

1. Introduction

The competitive behavior in the credit card industry has been unusual. The structure of the market is competitive in that the industry consists of a large number of cardissuers independently setting card terms and is not subjected to significant regulatory barriers. Nevertheless, we observe that cardissuers maintain high credit card interest rates and make high profits. The credit card rate averaged about 16 percent in 1995 when the one-year Treasury rate was only about 6 percent (Federal Reserve Board (1)). Profits of cardissuers appear to be abnormal. According to Ausubel (1991), substantial premiums involved in credit card portfolio sales constitute a strong evidence of high expected profits.[1] In addition, Park (1993) reports extraordinarily high earnings on assets of banks specialized in the credit card business, and Ausubel (1995) shows high profits based on reverse-engineered Visa data. This paper proposes a theoretical reason for high interest rates and profits in the credit card industry.

In explaining high credit card interest rates, this paper focuses on the option value of credit card lines arising from changing default probabilities of cardholders. In effect, credit cards enable cardholders to borrow at fixed terms. Cardissuers, of course, have rights to change card rates. Unless cardissuers continuously evaluate cardholders' creditworthiness, however, cardholders with open access to credit can borrow before cardissuers raise card rates. Their default probabilities, however, change over time. Thus, no credit card rate is too high if cardholders borrow only when they become high risks, i.e., when the option is in the money. The option value is offset partly by cardholders' borrowing while they are low risks. Some low-risk

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[1]The premium stayed high in recent years. *American Banker* (1995) reports that the average premium was about 18 percent in 1994.

customers may choose credit card loans because of high transaction costs of alternative loans. Since the option value cannot be completely offset, however, credit card rates must be higher than those on most other loans. The literature on bank loan commitments also recognizes the option embedded in credit lines (e.g., Avery and Berger, 1991; Boot et al., 1987; and Thakor, 1982). In the case of commercial loans, the pricing of loan commitments is facilitated by up-front fees reflecting the option value. In the credit card market, where consumers show strong aversion to up-front fees and indifference about interest rates, competition has forced many cardissuers to waive annual fees. The option value, therefore, needs to be reflected in interest rates.

High profits of cardissuers can be explained by the difficulty of attracting profitable customers who borrow even when the option is out of the money. A lower card rate, which increases the option value of credit card lines, benefits both profitable customers and unprofitable customers who plan to borrow only in risky future periods. Profitable customers, however, may be underrepresented among new customers attracted by a lower rate when the default risk of cardholders is positively correlated with card balances and the information at the individual level is incomplete. In this situation, profitable customers are more likely to be denied for credit (Calem and Mester, 1995). If they find it difficult to attract profitable customers because of incomplete information, cardissuers will keep interest rates at high levels at which the marginal revenue equals the funding cost and make above-normal profits.

Another anomaly in the credit card industry is a weak correlation between the credit card rate and other market rates. Mester (1994) and Brito and Hartley (1995) offer plausible explanations for the stickiness of credit card rates. Mester shows that a lower market interest rate induces low-risk customers with collaterals to switch from credit card loans to collateralized loans. The credit card rate does not respond to a lower funding cost because a decreased proportion of low-risk customers lowers the expected return on credit card loans. In Brito and Hartley's model, the optimum amount of credit card loans depends on the ratio of the interest rate on competitive assets (opportunity cost of cash holdings) to the credit card rate. In this situation, lowering the credit card rate in line with the funding cost still results in a lower demand for credit card loans. When the funding cost drops, therefore, cardissuers extend loans to less creditworthy customers rather than lower card rates. Neither of these explanations is inconsistent with my model that does not explicitly address the stickiness of credit card rates. An additional explanation will be provided in a brief discussion. Credit card loans are open-ended in that borrowers can defer the full payment for a long time. The flexible payment schedule may be partly responsible for the stickiness of credit card rates.

This study is most closely related to Ausubel (1991) that explains extraordinary profits of card issuers based on an adverse selection problem. In his study, desirable customers are those who do not intend to borrow but end up borrowing (low-risk customers). High-risk customers, on the other hand, fully intend to borrow. Low-risk customers are less responsive to changes in card rates because they do not intend to borrow. In this situation, unilaterally lowering the credit card rate would disproportionately draw high-risk customers. This adverse selection problem enables cardissuers to keep card rates high and make high profits. A main similarity between the Ausubel's and this study is to recognize the difficulty of attracting desirable customers as a source of above-normal profits. The key distinction rests on the cause of problems faced by cardissuers. In addition to incomplete information about the creditworthiness of applicants, this study emphasizes the inability of cardissuers to promptly deal with changing default probabilities of cardholders. In my model, card rates can stay high even when cardissuers accurately evaluate the creditworthiness of applicants.

The rest of this paper is organized as follows. A model in the next section shows how credit card rates are determined. Section 3 discusses the consistency of the model with developments in the credit card industry. Lastly, the article's findings are summarized.

2. Profit-Maximizing Credit Card Rates

This section models an economy in which borrowers choose between closed-end loans and credit card loans, and cardissuers maximize expected profits taking the behavior of borrowers into account. This model explains high credit card rates and high profits of cardissuers based mainly on the option value of credit lines offered by credit cards.

2.1. *Borrowers*

In this two-period economy, goods to be consumed during a period must be obtained at the beginning of the period. Some consumers (borrowers), however, receive parts of their income at the end of the second period. At the beginning of the first period (t_1), borrowers are identical. Every borrower, whose utility function is concave, needs to borrow one unit of the good during the first period to smooth out consumption.

Some borrowers (proportion p_1) receive bad income and default on their debt (repay nothing) at the beginning of the second period (t_2). These borrowers are expected to have no income at the end of the second period (t_3) and hence are barred from the credit market. In addition, borrowers who repay the first-period debt are divided into two groups (type G and type B) at t_2 based on the prospect of income at t_3. Type G borrowers (proportion p_G) receive $(1+r_f)/(1-p_1)$ units at t_3 with certainty, where r_f is the risk-free rate of return per period. The rest

(p_B = 1- p_G) turns out to be type B borrowers whose income at t_3 is uncertain. They receive 0 unit with probability p_2 and $(1+r_f)/\{(1-p_1)(1-p_2)\}$ units with probability $(1-p_2)$. For simplicity, r_f is assumed to be zero. Then for an individual who repays the first-period borrowing, the second-period borrowing need is $1/(1-p_1)$, which is consistent with the budget constraint. At t_1, therefore, the expected amount of the second-period borrowing is one unit $\{(1-p_1)/(1-p_1)\}$ for everybody. To focus on the effect of differing default probabilities across individuals, it is also assumed that the economywide default probability remains the same in the second period ($p_1 = p_B p_2$). In other words, the increase in the default probability of type B borrows is exactly offset by the decrease in that of type G borrowers.

2.2. *Interest Rates without Market Friction*

Borrowers have access to two types of loans offered by a large number of risk-neutral financial intermediaries which borrow at the risk-free interest rate (0): closed-end loans and credit card loans. This basic case abstracts from transaction costs and asymmetric information about borrowers' income prospects. At t_1, borrowers and banks know only the probabilities of possible outcomes, which depend on the proportions of borrower types. In other words, borrowers themselves do not know their types. At t_2, both borrowers and financial intermediaries learn about the types of borrowers.

Closed-end loans must be repaid or renewed at new terms at t_2. The interest rate on closed-end loans is determined such that financial intermediaries earn zero profit. The contracted return on closed-end loans in the first period,

$$(1+r_{1a}) = \frac{1}{(1-p_1)} \tag{1}$$

Since individuals are identical at t_1, the default probability equals the proportion of borrowers who receive bad income at t_2. Thus, the lender makes zero profit when equation (1) holds. In the second period when the types of borrowers are known, interest rates on closed-end loans are based on the risk of each type.

$$(1 + r_{2Ga}) = 1 \quad and \quad (1 + r_{2Ba}) = \frac{1}{(1 - p_2)} \tag{2}$$

where r_{2ia} is the interest rate on closed-end loans charged to type i borrowers in the second period. The default probability is 0 for type G and p_2 for type B borrowers.

Knowing the borrowers' consumption-smoothing need and income potential, cardissuers allow individuals to borrow up to 1 unit in the first period and $1/(1-p_1)$ units in the second period. In expected value terms, the second-period credit limit is 1 unit because the probability that an individual will be allowed to borrow in the second period is $1-p_1$. Information about borrowers' types is available to cardissuers in the second period. Since the credit line is open, however, individuals can borrow before card issuers change the interest rate. Thus, for simplicity, credit card rates are assumed to be fixed at r_c. In reality, many cardissuers periodically adjust interest rates to the default risk of cardholders. The adjustment, however, is delayed and may be too late in some cases. An extreme example is maximum borrowing right before bankruptcy.[2] The assumption of a fixed card rate, therefore, is valid as long as cardissuers do not continuously

[2]*Forbes* (1997) reports, "Even some people who have never been late on their (credit card) payments are turning to bankruptcy court and walking away from their debts." This report suggests that cardholders can easily surprise cardissuers. Considering relatively small transaction volume per account, cardissuers may not find it profitable to evaluate cardholders' credit worthiness frequently and customize credit terms.

evaluate cardholders' risks.

Given that the default probability is higher for type B borrowers in the second period, the interest rate yielding zero profit for cardissuers depends on the expected amount of borrowing each period. The cardissuer's expected profit per cardholder, including those who default at t_2, for the two periods,

$$\begin{aligned} E(\pi) &= E(\pi_1) + E(\pi_2) \\ &= [(1-p_1)(1+r_c) - 1]E(L_{1c}) + p_G(1+r_c-1)E(L_{2Gc}) \\ &\quad + p_B[(1-p_2)(1+r_c) - 1]E(L_{2Bc}) \end{aligned} \tag{3}$$

where π_i is the per-cardholder profit in period i, L_{1c} is the amount of borrowing per cardholder in the first period, and L_{2ic} is the amount of borrowing by a cardholder who turns out to be type i at t_2.

Setting $E(\pi) = 0$ and solving for $1+r_c$,

$$1+r_c = \frac{E(L_{1c}) + p_G E(L_{2Gc}) + p_B E(L_{2Bc})}{(1-p_1)E(L_{1c}) + p_G E(L_{2Gc}) + p_B(1-p_2)E(L_{2Bc})} \equiv 1+r_{c0} \tag{4}$$

where $1+r_{c0}$ is the return on credit card loans satisfying the zero profit condition. The following proposition is obtained from this zero profit condition.

Proposition 1. *When $E(L_{2Bc}) > E(L_{2Gc})$, the per-period return on open-end loans satisfying the zero profit condition is greater than the first-period return on closed-end loans.*

Proof. When $E(L_{2Bc}) = E(L_{2Gc})$ and $p_1 = p_B p_2$ in equation (4),

$$1+r_{c0} = \frac{1}{1-p_1}$$

The first derivatives of $1+r_{c0}$ with respect to $E(L_{2Bc})$ and $E(L_{2Gc})$,

$$\frac{\partial(1+r_{c0})}{\partial E(L_{2Gc})} = \frac{-p_1 p_G [E(L_{1c}) + E(L_{2Bc})]}{[(1-p_1)E(L_{1c}) + p_G E(L_{2Gc}) + p_B(1-p_2)E(L_{2Bc})]^2} \leq 0$$

$$\frac{\partial(1+r_{c0})}{\partial E(L_{2Bc})} = \frac{p_1 p_G [E(L_{1c}) + E(L_{2Gc})]}{[(1-p_1)E(L_{1c}) + p_G E(L_{2Gc}) + p_B(1-p_2)E(L_{2Bc})]^2} \geq 0$$

$$therefore, \quad 1+r_{c0} > \frac{1}{1-p_1} \quad when \quad E(L_{2Bc}) > E(L_{2Gc}) \quad \blacksquare$$

In other words, the interest rate on credit card loans must be higher than that on closed-end loans in the first period if cardholders are expected to take advantage of the option to borrow at the same rate when they turn out to be risky borrowers.

When $r_{2Ba} > r_c > r_{1a}$, the option value of the credit line offered by credit cards at the beginning of the first period,

$$OV = p_B(r_{2Ba} - r_c) > 0 \tag{5}$$

Note that the maximum amount of borrowing in the second period is 1 in expected value terms. For a cardissuer to have zero profit, this option value must be compensated by cardholders' borrowing while they are less risky ($E(L_{1c})$ and $E(L_{2Gc})$).

If everybody is rational and faces no transaction cost, the only selection criterion is the interest rate. Given $r_c > r_{1a}$, cardholders use credit lines only if their riskiness increases in the second period and hence do not compensate for the option value. In this simple case, the equilibrium return on credit card loans,

$$1 + r_{c0} \; = \; 1 + r_{2Ba} \; \equiv \; 1 + r_{c01} \qquad (6)$$

This interest rate reflecting the risk in the worst case must be substantially higher than the average rate on closed-end loans. Furthermore, the equilibrium interest rate may not even exist in some cases.

Proposition 2. *There does not exist $r_{c0} < \infty$ under the following conditions: (1) Borrowers choose between closed-end and credit card loans based solely on interest rates; (2) p_2 differs across cardholders and is distributed between 0 and 1; and (3) p_2 at the individual level (p_{2i}) is unknown in the first period.*

Proof. $E(L_{1c}) = 0$ and $E(L_{2Gc}) = 0$ when borrowers choose loans based solely on interest rates. Since closed-end loans fairly price the risk of borrowers, the interest rate on closed-end loans for borrower i, $r_{2Bai} = 1/(1-p_{2i}) - 1$. Borrower i does not use credit card lines if $r_c > r_{2Bai}$ and borrows the maximum amount allowed if $r_c \leq r_{2Bai}$. In this case, the expected profit per cardholder,

$$E(\pi) \; = \; p_B \int_{p_2^*}^{1} [(1 - p_2)(1 + r_c) \; - \; 1] f(p_2)\, dp_2$$

$$= \; p_B [(1 + r_c)(1 \; - \; E(p_2 \,|\, p_2 \geq p_2^*)) \; - \; 1] \int_{p_2^*}^{1} f(p_2)\, dp_2$$

where $p_2^* = 1 - 1/(1+r_c)$, the critical level of p_2 at which the closed-end loan is equally attractive to the credit card loan offering r_c, and $f(\cdot)$ is the density function of p_2. $E(\pi) = 0$ when the expected default probability is p_2^*. However, the expected default probability when only those individuals with $p_2 \geq p_2^*$,

$$E(p_2 \mid p_2 \geq p_2^*) > p_2^* \quad for\ all \quad p_2^* < 1$$

Therefore, $E(\pi) < 0$ for all $r_c < \infty$. ■

In sum, Proposition 1 suggests a reason for high interest rates on credit card loans, and Proposition 2 shows the difficulty of pricing credit card loans. In particular, no interest rate is too high if cardissuers are unable to estimate the riskiness of cardholders in future periods, which is much more difficult to estimate than that in the current period.

2.3. *Transaction* costs

Closed-end loans such as personal and automobile loans are accompanied by transaction costs, both monetary and psychic, that are higher than those involved in credit card loans. Since transaction costs are weakly related to the amount of loans, I assume a fixed transaction cost per closed-end loan (x) and zero transaction cost for credit card loans. The following proposition summarizes the effect of the transaction cost of closed-end loans on the interest rate on credit card loans.

Proposition 3. *A large transaction cost of closed-end loans lowers the zero-profit interest rate on credit card loans by inducing low-risk cardholders to borrow more*.

While high-risk cardholders always prefer credit card loans, low-risk cardholders choose credit card loans only when high transaction costs make closed-end loans unattractive. Obviously, the zero-profit interest rate on credit card loans is lower when more low-risk borrowers use credit card loans.

In a simple case that the transaction cost is the same across borrowers, the credit card interest rate depends on the range of the transaction cost.

$$if \quad 1+r_{1a}+x < \frac{1 + p_B}{(1-p_1) + p_B(1-p_2)} = \frac{1 + p_B}{1 + p_B - 2p_1} \equiv 1+r_{c02}, \qquad (7)$$

$$then \quad 1+r_{c0} = 1+r_{c01}$$

Note that $r_{c0} = r_{c02}$ when $E(L_{1c}) =1$, $E(L_{2Bc}) = 1$, and $E(L_{2Gc}) = 0$ in equation (4). Thus, r_{c02} is the card rate yielding zero profit when cardholders borrow in the first period. When x is not large enough to induce cardholders to borrow in the first period, rate competition will result in negative profits. In this case, the transaction cost fails to lower r_c, and hence $r_{c0} = r_{c01}$.

$$if \quad 1+r_{1a}+x \geq 1+r_{c02} \quad and$$

$$1+r_{2Ga}+x < \frac{1 + p_G + p_B}{1 - p_1 + p_{1G} + p_B(1-p_2)} = \frac{1}{1-p_1} \equiv 1+r_{c03}, \qquad (8)$$

$$then \quad 1+r_{c0} = 1+r_{c02}$$

The card rate yielding zero profit, $r_{c0} = r_{c03}$ when $E(L_{1c}) = E(L_{2Gc}) = E(L_{2Bc}) = 1$. When $1+r_{1a}+x \geq 1+r_{c02}$, cardissuers can increase profits by lowering the interest rate. Since $E(L_{1c}) = 1$ for any $r_c \leq r_{1a}+x$, $E(\pi_p) > 0$ when $r_{c02} < r_c \leq r_{1a}+x$. Lowering r_c below r_{c02}, however, is not profitable because the transaction cost is not large enough to induce low-risk cardholders to borrow in the second period. In this case, therefore, competition will drive down r_c to r_{c02}.

$$if \quad 1+r_{2Ga}+x \geq 1+r_{c03}, \quad then \quad 1+r_{c0} = 1+r_{c03} \qquad (9)$$

In this case, cardissuers can make positive profits at some interest rates that are low enough to induce best-risk cardholders to choose credit card loans over closed-end loans. Competition will drive down r_c to r_{c03}.

2.4. *Varying transaction costs across borrowers*

Transaction costs of obtaining closed-end loans may vary across individuals due to differing availability of alternative borrowing tools and implicit costs. Some individuals may be able to borrow easily from friends and relatives. Credit unions at work places may also make closed-end loans to employees at low transaction costs. In addition, the opportunity cost of time and the psychic cost of dealing with lenders differ across individuals.

Thus, a more realistic assumption is that the transaction cost at the individual level is continuously distributed between x_m to x_M. Facing very high transaction costs, some borrowers with the lowest default probability choose credit card loans over closed-end loans ($1+r_{2Ga}+x_M \geq 1+r_{c01}$). Accordingly, $E(L_{1c})$ and $E(L_{2Gc})$ are positive when $r_c = r_{c01}$, and decrease with r_c. Assuming that the composition of cardholders with regard to the transaction cost is the same to all cardissuers, the expected amount of borrowing per cardholder in less risky states,

$$E(L_{1c}) = \int_{x_1^*}^{x_M} g(x)\,dx \quad and \quad E(L_{2Gc}) = \int_{x_2^*}^{x_M} g(x)\,dx \qquad (10)$$

where x_1^* and x_2^* are the critical levels of x at which credit card loans and closed-end loans are equally attractive ($x_1^* = r_c - r_{1a}$ and $x_2^* = r_c - r_{2Ga}$), and g(x) is the economywide density function of x. Since, $r_c > r_{1a} > r_{2Ga}$ by Proposition 1, the expected profit increases with $E(L_{1c})$ and $E(L_{2Gc})$. Thus, the profitability of cardissuers depends on the proportion of cardholders who borrow when the option is out of the money because of high transaction costs (HTC borrowers).

Holding the composition of cardholders constant,

$$\frac{\partial E(L_{1c})}{\partial r_c} = -g(x_1^*) \quad and \quad \frac{\partial E(L_{2Gc})}{\partial r_c} = -g(x_2^*) \tag{11}$$

Since $E(L_{1c})$ and $E(L_{2Gc})$ change gradually with r_c, the expected profit per cardholder can be maximized at a card rate yielding a positive profit.

Proposition 4. *The per-cardholder profit, $E(\pi)$, is maximized at $r_c^* \in (r_{1a}, r_{1a}+x_M)$ yielding a positive profit if (1) x is continuously distributed and (2) $x_M > r_{2Ba}-r_{1a}$.*

Proof. When $r_c \geq r_{1a}+x_M$, $E(\pi) = 0$ because no one borrows. When $r_c \leq r_{1a}$, $E(\pi) \leq 0$ because the maximum profit is zero even if all low-risk cardholders borrow. If x is continuously distributed, $E(\pi)$ is continuous in r_c because $E(L_{1c})$ and $E(L_{2Gc})$ are continuous in r_c. If $x_M > r_{2Ba}-r_{1a}$, $E(\pi) > 0$ at some $r_c \in (r_{1a}, r_{1a}+x_M)$. For example, $E(\pi) > 0$ when $r_c = r_{2Ba}$ because some HTC cardholders borrow. Under the two conditions, therefore, $E(\pi)$ is maximized at $r_c^* \in (r_{1a}, r_{1a}+x_M)$ yielding a positive profit. ■

This maximization of the per-cardholder profit is analogous to that of a monopolist facing a downward-sloping demand curve. Even when the per-cardholder profit is maximized at a card rate yielding a positive profit, however, competition will drive the profit down to zero if the demand for card loans is perfectly elastic. Thus, a positive profit of cardissuers requires low elasticity of the demand.

Empirically, Park (forthcoming) reports low elasticity of the demand for credit card loans; a decrease in the card rate by one percentage point is associated with about a two-percent increase in the card loan. Provided that the per-cardholder profit is maximized at a card rate yielding a positive profit, the total profit may also be maximized at a rate yielding a positive profit when the rate elasticity of the demand is low.

2.5. *Cardissuers' Profits with Imperfect Information*

When the composition of new customers drawn by lower r_c differs from that of existing customers, the total profit of a cardissuer can be expressed as:

$$E(\Pi) = n_e E_e(\pi) + n_n E_n(\pi) \tag{12}$$

where n_e and n_n are the numbers of existing and new customers, and $E_e(\pi)$ and $E_n(\pi)$ are per customer profits from existing and new customers.

Competition for new customers will completely eliminate above-normal profits of cardissuers if:

$$\frac{\partial E(\Pi)}{\partial r_c} = n_e \frac{\partial E_e(\pi)}{\partial r_c} + \frac{\partial n_n}{\partial r_c} E_n(\pi) + n_n \frac{\partial E_n(\pi)}{\partial r_c} < 0 \quad \textit{for all } r_c \in [r_{c04}, r_c^*) \tag{13}$$

where r_{c04} is the card rate at which the per-cardholder profit is zero when the transaction cost varies across cardholders, and r_c^* is the card rate at which the per-cardholder profit is maximized. Conversely, the maximum profit is positive if $\partial E(\Pi)/\partial r_c > 0$ for some $r_c \in [r_{c04}, r_c^*)$. This condition will hold either if the overall elasticity of the demand for credit cards is low (small magnitude of $\partial n_n/\partial r_c$) or if the composition of new cardholders is unfavorable ($E_n(\pi) \le 0$).

A possible explanation for the low elasticity of the card-loan demand is the cost of obtaining new cards (switching cost). The switching cost affects both the overall elasticity and the composition of cardholders. For cardissuers' profits to be positive, the switching cost should be either very high to most cardholders or higher for HTC cardholders. The first case is unlikely because many consumers receive preapproved credit card offers. Thus, a more plausible explanation is higher switching costs for HTC cardholders.

HTC borrowers benefit more from a lower card rate because they rely more on credit card loans. If the switching cost is the same across cardholders, therefore, a lower card rate will draw more HTC borrowers. Thus, to discourage competition through card rates, the higher switching cost needs to outweigh the larger benefit for HTC cardholders. Empirically, Calem and Mester (1995) support the higher switching cost for cardholders with larger balances by showing that they are more frequently denied for new cards.

In this model, HTC borrowers are more likely to be denied for new cards if cardissuers have incomplete information about cardholders' risks and observe a positive correlation between card balances and default risks. In a more realistic model with overlapping generations, cardissuers may turn down many profitable customers if it is uncertain for them whether applicants with large balances are HTC or high-risk customers. In this case, the proportion of HTC cardholders among newly approved ones can be lower than that among existing customers even if more HTC customers apply for new cards. In addition, the higher turn-down probability may discourage HTC cardholders from applying for new cards, worsening the problem. When the proportion of HTC borrowers is lower among new cardholders, cardissuers do not have the incentive to lower the card rate to the level yielding zero profit because $E_n(\pi) < 0$ for some $r_c \in [r_{c04}, r_c^*)$. With incomplete information about cardholders' risks, therefore, the abnormal profit of cardissuers can persist.

2.6. *Careless borrowers*

In this model, cardissuers can also benefit from borrowers' mistakes as in Ausubel (1991).

Although economic agents make rational decisions on average, some individuals are careless.[3] In most cases, mistakes are offset such that they do not affect the aggregate outcome. In this model, however, mistakes are likely to have asymmetric effects. Some borrowers may carelessly choose credit card loans over closed-end loans when the borrowing cost of closed-end loans is lower than that of credit card loans. Apparently, this type of mistakes will increase cardissuers' profits. Given that credit card loans are more readily available, however, it is highly unlikely that HTC borrowers mistakenly choose closed-end loans. Thus, on average, mistakes may be in favor of cardissuers.

The presence of careless borrowers may further discourage rate competition by adversely affecting the composition of new customers. Since they are not as rational as others, careless borrowers may be slow to respond to lower interest rates. Accordingly, the proportion of careless customers is likely to be lower among new customers.

2.7. *Stickiness of Credit Card Rates*

Although the model does not explicitly address this issue, the stickiness of credit card rates can be explained partly by the fact that credit card loans are open-ended. Cardholders can defer the full payment of credit card loans for a long time. Thus, the expected funding cost depends both on current and future interest rates. Changing interest rates on outstanding credit card balances, however, can be problematic. *Wall street Journal* (1995) reports that many state laws forbid lenders from applying higher interest rates on cardholders' balances after they cancel

[3] *Wall Street Journal* (1993) reports the results of a survey of 130 members of the British Parliament conducted by American Express. In the survey, almost 40 percent of those with credit cards did not know their credit card rates, and nearly half of respondents failed to define correctly the meaning of the annual percentage rate.

the cards. Thus, cardholders can cancel the cards and slowly repay the loans at the rates contracted initially. Even in the states that do not have such laws, applying higher interest rates on carried-over balances might cause legal problems.

A simple way to address this problem is to enter into a variable-rate contract. In fact, the number of cardissuers offering variable interest rates has been increasing rapidly in recent years. Among Visa or MasterCard issuers reporting credit card terms to the Federal Reserve Board, the percentage of cardissuers offering variable rates increased from 18 percent (26 out of 147) in January 1990 to 68 percent (97 out of 143) in January 1996 (Federal Reserve Board (2)). The prime rate was the most common benchmark rate.

3. Consistency of the Model with Competitive Behavior

Since the interest rate plays relatively a minor role in the credit card industry, cardissuers compete in various other forms. The model presented in the previous section can provide rationales for the competitive behavior in the credit card industry.

A common practice of cardissuers is to discriminate high- or unknown-risk applicants with a low credit limit instead of a high interest rate. This may be an optimum strategy when cardissuers are concerned mainly about an increased default probability in the future as in the model. Since a high interest rate discourages borrowing only when cardholders are less risky, a better way to manage risks may be to reduce the gap between borrowing in the high-risk state and that in the low-risk state by lowering the credit limit.

Some cardissuers charge lower interest rates on accounts with larger balances except for those with bad payment records. This practice also suggests an important role of the option value. If credit card rates largely reflect the default risk in the current period, interest rates should be higher on accounts with larger balances because those accounts tend to be riskier. Considering that the default probability can increase in the future, however, large balances in the current period compensate for potential losses in future periods. Thus, cardissuers can afford to offer low rates to customers with large balances.

A related phenomenon is to offer lower interest rates to customers transferring balances. With balance transfers, the possibility of increased default probabilities in the future is compensated by large balances of low-risk loans in the current period. In addition, cardissuers can overcome the difficulty of attracting profitable customers by specifically targeting customers with balances to transfer. As shown in the model, lowering the card rate across the board may fail to increase the profitability of cardholders if it attracts many customers who plan to use credit lines only when they become riskier.

In soliciting credit cards, many issuers offer low interest rates for the first year only. This may be interpreted as an attempt to mimic closed-end loans that price only the risk in the current period. With an introductory low rate, the option to borrow at the low rate in the high-risk state may expire before cardholders have a chance to exercise it. This attempt to mimic closed-end loans is a sensible strategy if cardissuers are able to evaluate the current period's creditworthiness of customers but are worried about the possibility of an increased default risk in the future.

Another notable development in the credit card industry is the prevalence of non-price competition. Instead of lowering interest rates, issuers enhance credit cards with various features such as rebates on purchases, travel related discounts, and automobile rental insurance. A motive of offering these enhancements may be product differentiation. Because of the option value embedded in credit lines, cardissuers cannot lower interest rates sufficiently to compete with closed-end loans. The value of an enhancement, however, may differ across individuals. Thus, enhancements can induce some low-risk borrowers to choose credit card loans over closed-end loans even though the cost of providing enhancements is much smaller than the interest rate differential.

In sum, the competitive behavior of cardissuers is consistent with the model that emphasizes the option value arising from changing default probabilities. Many practices in the credit card industry can be interpreted as an attempt to encourage borrowing while cardholders are less risky and discourage borrowing when they become riskier.

4. Conclusions

This paper has explained high credit card rates and high profits of cardissuers based on the option value of credit lines. High credit card rates reflect the value of the cardholders' option to borrow when they become riskier. The option value is partly offset by the presence of cardholders who choose credit card loans while they are less risky because of high transaction costs of alternative loans. It is difficult, however, to compete for these low-risk customers maintaining large balances when cardissuers have incomplete information about borrowers' risks. Lowering card rates may not increase cardissuers' profits if it disproportionately attracts undesirable customers who are risky or plan to borrow only when the borrowing option is in the money. Cardissuers, therefore, keep credit card rates at high levels that do not fully reflect the effect of borrowing at less risky times and make above-normal profits. This explanation is consistent with many pricing tactics in the credit card industry such as discriminating high-risk customers with low credit limits rather than high interest rates and offering lower rates for the first year only.

This study adds more dimensions to competition in the credit card industry. Previous studies imply that the pricing of credit card loans will become much more competitive if cardissuers are able to accurately evaluate the creditworthiness of applicants. Evaluating credit risks, of course, is difficult because some information is private. Pricing the option value recognized in this study, however, is much more complicated because cardissuers need to estimate the entire distribution of the default probability over time and the cardholders' tendency to borrow while they are less risky.

Given these difficulties, there does not seem to be apparent regulatory intervention or a pricing strategy that can comprehensively deal with many problems related to the option value. Providing information is a common solution to the lack of competition. Shaffer (1996), however, reports that the Fair Credit and Charge Card Disclosure Act of 1988 that intends to improve informational efficiency failed to increase competition in the credit card industry. A recent strategy of some cardissuers is to review the creditworthiness of cardholders more frequently and penalize high-risk customers (*Wall Street Journal*, 1995). Reviewing cardholders more frequently will reduce but not eliminate the option value. Cardissuers employ various competitive tactics as discussed in Section 3. Those tactics should increase competition. Nevertheless, it may be a slow process to reach the competitive equilibrium in which cardissuers make zero economic profit.

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Variable Definitions

HTC - high-transaction-cost cardholders who borrow when the option is out of the money
L_{1c} - amount of borrowing per cardholder in the first period
L_{2Bc} - the amount of borrowing by a bad-risk cardholder in the second period
L_{2Gc} - the amount of borrowing by a good-risk cardholder in the second period
n_e - number of existing customers
n_e - number of new customers
OV - option value of credit lines
p_1 - probability that a borrower defaults on loans in the first period
p_2 - probability that a bad-risk borrower defaults on loans in the second period
p_G - probability that a borrower turns out to be good risk in the second period
p_B - probability that a borrower turns out to be bad risk in the second period
r_{1a} - first-period interest rate on closed-end loans
r_{2Ba} - second-period interest rate on closed-end loans for bad-risk borrowers
r_{2Ga} - second-period interest rate on closed-end loans for good-risk borrowers
r_c - credit card rate
r_{c0} - credit card rate yielding zero profit
r_{c01} - zero-profit card rate when only high-risk borrowers borrow
r_{c02} - zero-profit card rate when low-risk borrowers borrow in the first period
r_{c03} - zero-profit card rate when low-risk borrowers borrow in both the first and second period
r_{c04} - zero-profit card rate when the transaction cost varies across borrowers
r_c^* - credit card rate at which per-cardholder profit is maximized with varying transaction costs
r_f - risk-free rate of return
t_1 - beginning of the first period
t_2 - beginning of the second period
t_3 - end of the second period
type B - bad risk borrowers in the second period
type G - good risk borrowers in the second period
x - transaction cost
x_m - lower limit of the transaction cost
x_M - upper limit of the transaction cost
g(x) - the probability density function of x
π - cardissuer's profit per-cardholder
π_1 - cardissuer's profit per-cardholder in the first period
π_2 - cardissuer's profit per-cardholder in the second period
$E_e(\pi)$ - expected per-customer profit from existing customers
$E_n(\pi)$ - expected per-customer profit from new customers
Π - total profit