MANAGERIAL AND DECISION ECONOMICS
Manage. Decis. Econ. **25:** 243–254 (2004)
Published online 16 June 2004 in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/mde.1146

Consumer Rationality and Credit Card Pricing: An Explanation Based on the Option Value of Credit Lines

Sangkyun Park*,†

Office of Management and Budget, USA

An option is embedded in credit cards. Since credit cards offer open credit lines, cardholders can borrow at the same terms when they become riskier. This option value raises the zero-profit card rate. Furthermore, adverse selection occurs if cardholders are better informed about the probability of becoming riskier in the future and borrow more when they become riskier. The adverse selection can limit rate competition and keep the card rate above the zero-profit card rate. An up-front fee is not a good alternative because it is also vulnerable to adverse selection. A low introductory card rate is an effective way to avoid the adverse selection problem when asymmetric information is mainly about the change in the borrower's risk profile in the future, as opposed to the riskiness in the present period. Copyright © 2004 John Wiley & Sons, Ltd.

INTRODUCTION

The credit card industry consists of a large number of cardissuers independently setting card terms and is not subjected to notable regulation that may impede competition. Nevertheless, competition through interest rates has been limited. Until the mid-1990s, cardissuers competed mainly through annual-fee waiver and other enhancement features, while charging interest rates on credit card loans (card rates) that were significantly higher than their funding costs. In recent years, many cardissuers offered low introductory rates ('teaser rates') but did not substantially lower regular card rates. In 2002, the card rate averaged 13.5 percent, while the 3-month Treasury rate was only 1.6 percent. (Board of Governors of the Federal Reserve System, 2003).

High card rates resulted in high accounting profits. The return on credit-card loans was substantially higher than those on other banking assets in the 1980s and the early 1990s (Nash and Sinkey, 1997; Park, 1993). The return gap narrowed recently but remained substantial (Smith, 2001).

Many studies suggest a possibility of market imperfection in the credit card industry. Ausubel (1991) argues that large premiums on credit card portfolios traded among cardissuers reflect high economic profits in the credit card business. Using a structural empirical test, Shaffer (1999) shows that cardissuers set the card rate above marginal cost, which also implies positive economic profits. Based on their empirical findings of differing search and 'switching costs' (costs of obtaining a new credit card) across borrowers, Calem and Mester (1995) conclude that competition in the credit card market is imperfect. According to Stango (2000), the presence of both fixed-rate and variable-rate cardissuers can attenuate competitive

*Correspondence to: 14903 Alpine Meadow Lane, Silver Spring, MD 20906, USA. E-mail: Sangkyun_Park@omb.eop.gov

†This paper was written while the author was an economist at the Federal Reserve Bank of New York. The views expressed are those of the author and do not reflect those of the Federal Reserve System or the Office of Management and Budget.

pressures by making card-rate movements volatile and asyhchronous. Park (1997) finds that cardholders sluggishly respond to changes in card rates.

Other studies explain high accounting profits and premiums on credit card portfolios within a competitive market framework. According to Nash and Sinkey (1997), the credit card business has been riskier (high volatility of return on assets) than other banking businesses, and the risk premium can account for the high accounting profit. The high volatility of return on assets, however, can be partly attributed to 'sticky' card rates that do not move closely with funding costs. Alternative explanations for premiums on credit card portfolios include rents of early entrants (Brito and Hartley, 1995) and a 'hidden asset' representing the opportunity to cross-sell other products (Nash and Sinkey, 1997). Given this controversy, the economic profits of cardissuers may have been smaller than the accounting profits. The notably high accounting profits until the mid-1990s, however, may be partly attributable to the difficulty of competing through card rates. The prevalence of teaser rates, a new pricing scheme, can explain reduced accounting profits in recent years.

This paper presents the option value of credit lines arising from changing default probabilities of cardholders as a possible explanation for high card rates and above-normal profits. In effect, credit cards enable cardholders who have become riskier to borrow at the initial terms. Although cardissuers have rights to change card rates, cardholders with open access to credit can borrow before cardissuers raise card rates. Raising interest rates later may not effectively prevent cardholders from taking advantage of credit lines.[1] The option value must be offset by either a high card rate or an upfront fee. Without an upfront fee, therefore, the zero-profit card rate is higher than the interest rate on other loans that do not offer open credit lines.

In this model, the most undesirable customers are the cardholders who are more likely to become riskier and borrow only when they become riskier. When the borrowers are better informed about the borrower-specific probability of becoming riskier, adverse selection can occur. For a borrower who plans to use more card loans when he/she becomes riskier, the expected gain from obtaining a credit card and the sensitivity of the expected gain to the card rate increase with the probability of becoming riskier in the future because the expected amount of card loans increases with the probability. Thus, if a large portion of cardholders plan to use more card loans when they become riskier, unilaterally lowering the card rate may disproportionately draw undesirable customers. This adverse selection problem can keep the card rate above the zero-profit card rate, which is already higher than the interest rate on many other loans.

The option embedded in credit lines has been analyzed by the literature on bank loan commitments to commercial borrowers (e.g. Avery and Berger, 1991; Boot *et al.*, 1987; Thakor, 1982; Thakor and Udell, 1987). In the case of commercial loans, an upfront fee usually compensates for the option value of credit lines. If cardissuers imposed a large enough up-front fee to offset the option value, high card rates would not be necessary. The model in this paper shows that undesirable customers are likely to prefer a card charging an upfront fee (fee card) to a card charging a high card rate (high-rate card). If a borrower becomes riskier and uses more card loans, he/she saves more from a fee card that offers a lower rate than from a high-rate card. Because of this vulnerability to adverse selection, the up-front fee may be an inferior pricing strategy in the credit card market.

When the main problem is asymmetric information about borrowers' risk in future periods, cardissuers can avoid adverse-selection by offering teaser rates. Since the low introductory rate does not apply in the future, it does not favor borrowers who are more likely to become riskier in the future. Thus, the option value arising from changing default probabilities can provide a rationale for the competition through teaser rates and explain the reduced profits of cardissuers in recent years.[2]

This paper adds to previous studies in several respects. Ausubel (1991) explains high card rates and high cardissuers' profits based on adverse selection. In his model, low-risk borrowers are irrational in that they underestimate the probability of borrowing and do not respond to lower card rates. Brito and Hartley (1995) and Mester (1994), who present credit-card pricing models in which borrowers are rational, focus mainly on the 'stickiness' of card rates (insensitiveness of card rates to funding costs). The model in this paper is capable of explaining high card rates and high cardissuers' profits without relying on consumer irrationality and is consistent with the prevalence of teaser rates and the reduced profits of cardissuers in recent years.

The rest of this paper is organized as follows. The next section models credit-card pricing under various assumptions. Then we discuss the consistency of the model with the prevalence of teaser rates. Lastly, the paper's findings are summarized.

PRICING THE OPTION VALUE OF CREDIT LINES

This section models an economy in which borrowers choose between closed-end loans and credit card loans, and cardissuers maximize the expected profit, taking the behavior of borrowers into account. The model shows how the option embedded in credit lines affects the borrowers' decision and the cardissuers' pricing strategy.

Economy

For simplicity, all agents in this two-period economy are assumed to be risk-neutral. A group of individuals (borrowers) need to borrow 1 unit at the beginning of each period. To focus on the changing risk profiles of borrowers, I assume that all borrowers receive enough income to repay the first-period debt at the end of the first period. This information is public. In the second period, borrowers are divided into two groups: type G and type B. While type G borrowers receive enough income at the end of the second period with certainty, type B borrowers receive enough income with probability $1-p$ and I_B ($I_B < 1$) with probability p. The average probability of becoming type B (α_A), which equals the economywide proportion of type B, is public information in the first period. For borrower i, the probability of becoming type B is $\alpha_i \in [\alpha_m, \alpha_M]$.

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 (r_f): closed-end loans and credit card loans. Lenders, who understand individuals' borrowing needs, set the borrowing limit at 1 unit.

The interest rate on closed-end loans is determined at the beginning of each period based on the riskiness of borrowers. In this economy, the closed-end loan market is frictionless. A large number of lenders, who compete without asymmetric information, make zero profit. Thus, when the default risk is zero, the lending rate equals the funding cost; the interest rate is r_f in the first period and also in the second period for type G borrowers. Setting the expected receipt from type B borrowers in the second period equal to the funding cost and solving for the interest rate, the second-period interest rate on closed-end loans for type B:

$$r_R = \frac{r_f + p(1 - I_B)}{1 - p}. \tag{1}$$

The default probability is p for type B borrowers in the second period, and a portion of principal (I_B) is recovered in the event of default.

Obtaining a closed-end loan also requires a transactions cost of x per period. Borrowers can prove their types to lenders in the second period, without incurring a larger transactions cost. In other words, x remains the same in the second period, for simplicity. The transactions cost, however, varies across borrowers (x_i for borrower i). In reality, borrowers may face 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 a low transactions cost. In addition, the opportunity cost of time and the psychic cost of dealing with lenders differ across individuals. For simplicity, it is assumed that x_i is not correlated with α_i. The transactions cost is likely to be positively correlated with the current-period riskiness of borrowers, but not with the future-period riskiness.

Credit cards, on the other hand, allow cardholders to borrow in the second period at the interest rate, r_c, ($r_f \leqslant r_c \leqslant r_R$) set at the beginning of the first period.[3] This assumption is a simplistic representation of the fact that cardholders can take advantage of open credit lines. Cardholders with open credit lines do not need to prove their type to cardissuers in the second period. Without the borrowers' proof, lenders find out the borrowers' types with delay. Thus, cardholders with open credit lines can borrow before cardissuers change the interest rate.[4] As a compensation for the open credit line, some cardissuers may charge a fixed upfront fee (F). The transactions cost of obtaining a credit card, however, is assumed to be zero, for simplicity, because it is generally lower (no application fee and little documentation) than that of obtaining closed-end loans, such as automobile loans and personal loans.

Borrowers' decisions

Individual i decides whether or not to obtain a credit card offered by a cardissuer based on the expected borrowing costs with and without the credit card. If the individual solely rely on the closed-end loan, the present value of the expected gross payment to the lender:

$$E(B_1) = x_i + \frac{1+r_f}{1+r_f} + \frac{x_i}{1+r_f} + \frac{(1-\alpha_i)(1+r_f)}{(1+r_f)^2} + \frac{\alpha_i(1-p)(1+r_R)}{(1+r_f)^2} + \frac{\alpha_i p I_B}{(1+r_f)^2}. \quad (2)$$

For the first period borrowing, the borrower pays the transactions cost (x_i) at the beginning of the period and repays the principal and interest ($1+r_f$) at the end of the period. For the second period borrowing, the borrower also pays x_i. The interest rate is r_f if type G (probability $1-\alpha_i$) and r_R if type B (probability α). A type B borrower pays $1+r_R$ only if he/she has enough income at the end of the second period (probability $1-p$). If income turns out to be bad (I_B), the borrower just pays I_B.

The expected payment with a credit card:

$$E(B_2) = F + \mathrm{Min}\left\{x_i + \frac{1+r_f}{1+r_f}, \frac{1+r_c}{1+r_f}\right\} + (1-\alpha_i)\,\mathrm{Min}\left\{\frac{x_i}{1+r_f} + \frac{1+r_f}{(1+r_f)^2}, \frac{1+r_c}{(1+r_f)^2}\right\} + \alpha_i\left\{\frac{(1-p)(1+r_c)+pI_B}{(1+r_f)^2}\right\}. \quad (3)$$

The borrower pays an upfront fee (if there is any) to obtain the credit card and uses the credit card loan only if it is cheaper than the closed-end loan. The credit card loan is cheaper for all type B borrowers.

Provided that the borrower has obtained the credit card, the transactions cost determines whether or not to use it in the first period and in the second period if the individual turns out to be type G. The decision criterion is

$$x_i > \frac{r_c - r_f}{1+r_f} \equiv x^*. \quad (4)$$

Even if $r_c > r_f$, the borrower chooses the credit card loan if x_i is high.

Then Equation (3) can be expressed as

$$E(B_2) = F + x_i + 1 + \frac{(1-\alpha_i)(x_i+1)}{1+r_f} + \alpha_i\left\{\frac{(1-p)(1+r_c)}{(1+r_f)^2} + \frac{pI_B}{(1+r_f)^2}\right\} \quad \text{for } x_i < x^*, \quad (5a)$$

$$E(B_2) = F + \frac{1+r_c}{1+r_f} + \frac{(1-\alpha_i)(1+r_c)}{(1+r_f)^2} + \alpha_i\left\{\frac{(1-p)(1+r_c)}{(1+r_f)^2} + \frac{pI_B}{(1+r_f)^2}\right\} \quad \text{for } x_i > x^*. \quad (5b)$$

For cardholders with $x_i < x^*$, card borrowing occurs only when the borrower becomes riskier. This contingent borrowing is driven entirely by the option value arising from the changing default probability. For borrowers with $x_i > x^*$, the amount of borrowing does not depend on the risk type. This borrowing is driven mainly by the transactions cost. For the remainder of this paper, the second-period card borrowing by type B is referred to as OV-driven borrowing, and the first-period card borrowing and the second-period card borrowing by type G are referred to as TC-driven borrowing. Similarly, cardholders with only OV-driven borrowing ($x_i < x^*$) are referred to as OV-driven cardholders, and cardholders whose TC-driven borrowing is the same as the OV-driven borrowing ($x_i > x^*$) are referred to as TC-driven borrowers.

The expected gain from obtaining a credit card is the saving on the borrowing cost [(2)-(5a) and (2)-(5b)]. Algebraically,

$$E(G) = -F + \frac{\alpha_i x_i}{1+r_f} + \frac{\alpha_i(1-p)(r_R - r_c)}{(1+r_f)^2} \quad \text{for } x_i < x^*, \quad (6a)$$

$$E(G) = -F + x_i + \frac{r_f - r_c}{1+r_f} + \frac{x_i}{1+r_f} + \frac{(1-\alpha_i)(r_f - r_c)}{(1+r_f)^2} + \frac{\alpha_i(1-p)(r_R - r_c)}{(1+r_f)^2} \quad \text{for } x_i > x^*. \quad (6b)$$

The borrower obtains the credit card if $E(G) > 0$.

The option value of open credit lines is defined as the expected interest saving from the OV-driven borrowing:

$$\mathrm{OV} = \frac{\alpha_i(1-p)(r_R - r_c)}{(1+r_f)^2} \equiv \alpha_i Z. \quad (7)$$

When $r_f < r_c < r_R$, TC-driven cardholders compensate cardissuers for this option value with an overpayment of interest while they are good risk. Provided that $r_c < r_R$, however, the option value represents a strict gain for OV-driven cardholders, in terms of interest payment.

Profit maximization by cardissuers

Cardissuers maximize profit with respect to F and r_c. The present value of the expected profit for a cardissuer:

$$E(\Pi) = FN + \frac{(r_c - r_f)\beta N}{1+r_f} + \frac{(1-\alpha_a)(r_c - r_f)\beta N + \alpha_a(1-p)(r_c - r_R)N}{(1+r_f)^2}, \quad (8)$$

where N is the number of cardholders, β is the proportion of TC-driven cardholders, and α_a is the average α specific to the cardissuer. All cardholders (N) pay the upfront fee ($F \geqslant 0$) at the beginning of the first period. Provided that $r_f < r_c < r_R$, the cardissuer derives positive net interest income $(r_c - r_f)$ from TC-driven borrowers at the end of the first period (βN) and from type G TC-driven borrowers $[(1-\alpha)\beta N]$ at the end of the second period. From type B borrowers ($\alpha_a N$), net interest income is negative $[(1-p)(r_c - r_R)]$ at the end of the second period. Clearly, the average profit per customer ($E(\Pi)/N \equiv E(\pi)$) increases with β and decreases with α_a.

The variables α_a, N, and β depend on the borrowers' responses to card terms F and r_c and hence are functions of F and r_c. Differentiating, $E(\Pi)$ with respect to F,

$$\frac{\partial E(\Pi)}{\partial F} = E(\pi)\frac{\partial N}{\partial F} + N\frac{\partial E(\pi)}{\partial F}, \quad (9)$$

where

$$\frac{\partial E(\pi)}{\partial F} = 1 + \frac{(2 + r_f - \alpha_a)(r_c - r_f)}{(1+r_f)^2}\frac{\partial \beta}{\partial F} - \frac{(r_c - r_f)\beta + (1-p)(r_R - r_c)}{(1+r_f)^2}\frac{\partial \alpha_a}{\partial F}. \quad (10)$$

Differentiating, $E(\Pi)$ with respect to r_c,

$$\frac{\partial E(\Pi)}{\partial r_c} = E(\pi)\frac{\partial N}{\partial r_c} + N\frac{\partial E(\pi)}{\partial r_c}, \quad (11)$$

where

$$\frac{\partial E(\pi)}{\partial r_c} = \frac{(1+r_f)\beta + (1-p)\alpha_a + (1-\alpha_a)\beta}{(1+r_f)^2} + \frac{(2 + r_f - \alpha_a)(r_c - r_f)}{(1+r_f)^2}\frac{\partial \beta}{\partial r_c} - \frac{(r_c - r_f)\beta + (1-p)(r_R - r_c)}{(1+r_f)^2}\frac{\partial \alpha_a}{\partial r_c}. \quad (12)$$

Adverse selection can prevent competition if cardissuers face a downward sloping demand curve in the short-run ($\partial N/\partial F < -\infty$ and $\partial N/\partial r_c < -\infty$ in the short run) and lowering F or r_c disproportionately draws borrowers who are more likely to become riskier ($\partial \alpha_a/\partial F < 0$ and $\partial \alpha_a/\partial r_c < 0$).[5]

Previous studies suggest that the short-run demand for credit cards is not so elastic. Park (1997) finds that cardholders sluggishly respond to changes in card terms. Smith (2001) reports that the response rate on credit card solicitations was only 0.6 percent in 2000. According to Durkin (2002), who analyzes a consumer survey, only 25 percent of consumers who have recently acquired a credit card carefully compared credit card terms.

Provided that cardholders slowly respond to card terms, asymmetric information can cause a failure of competition. If $\partial \alpha_a/\partial F < 0$ and $\partial \alpha_a/\partial r_c < 0$, lowering F or r_c can decrease the profit. Suppose, for example, that cardissuers offer similar card terms at which profits are positive and that $\alpha_a = \alpha_A$ (economywide average α) for all cardissuers. If a cardissuer lowers the card rate, α_n will be higher than α_A, where α_n is the average α for new customers. Then $E(\pi)$ for new customers will become negative at a card rate that is higher than the industry-wide zero-profit card rate (the zero-profit card rate at $\alpha_a = \alpha_A$), preventing further competition.

Pricing the option value with an upfront fee

One feasible pricing scheme is to charge an upfront fee reflecting the option value and set the card rate based on the current-period riskiness of borrowers ($r_c = r_f$). Without asymmetric information, competition will force cardissuers to lower the upfront fee until the profit drops to zero, and the pricing is straightforward. Suppose that neither lenders nor borrowers know in the first period the borrower-specific probability of becoming type B in the second period. In this case, both borrowers and lenders estimate that the probability of becoming type B is α_A. Then from Equation (7), the up-front fee consistent with zero profit when $\alpha_a = \alpha_A$:

$$F_0(a_A) = \alpha_A Z. \quad (13)$$

When there is asymmetric information about the probability of becoming riskier, however, the upfront fee is vulnerable to adverse selection. Suppose, for a moment, that the transactions cost is zero. When the cardissuer's estimate of the average α (α_{ae}) and the actual average (α_{aa}) differ from α_A, the expected profit of the cardissuer pricing the option value with an upfront fee,

$$E(\Pi_F) = NE(\pi_F) = N(\alpha_{ae}Z - \alpha_{aa}Z). \quad (14)$$

Proposition 1:
The up-front fee reflecting an option value less than that for the upper bound of α_i is not sustainable when (1) the transactions cost is zero; (2) the probability of becoming type B varies across cardholders; and (3) cardholders are better informed about the probability.

Proof:
When there is no transactions cost, the cost of the credit card is the upfront fee, and the benefit is the option to borrow at a low interest rate. Thus, Borrower i obtains the credit card if:

$$F_0(\alpha_{ae}) = \alpha_{ae}Z \leqslant \alpha_i Z \quad \text{or} \quad \alpha_i \geqslant \alpha_{ae}.$$

Given this decision rule, $\alpha_{aa} > \alpha_{ae}$ for all $\alpha_{ae} \in [\alpha_m, \alpha_M)$. From Equation (14), $E(\Pi) < 0$ when $\alpha_{aa} > \alpha_{ae}$. Thus, the only sustainable solution is to set $F = \alpha_M Z$.

Few borrowers will obtain the credit card if cardissuers set $F = \alpha_M Z$ and α_i widely varies across borrowers.

High transactions costs of obtaining closed-end loans alleviate this adverse selection problem. When $x_i > 0$ for most borrowers, some low-risk borrowers may obtain credit cards even if the upfront fee is not actuarially fair.[6]

By obtaining a credit card charging $r_c = r_f$ and $F > 0$, borrowers save the transactions cost and the interest cost. The expected gain from obtaining a credit card charging an upfront fee for borrower i,

$$E(G_F) = x_i + \frac{x_i}{1+r_f} + \alpha_i(1-p)\frac{r_R - r_c}{(1+r_f)^2} - F. \quad (15)$$

The borrower obtains a credit card if the expected gain is positive.

The following proposition summarizes the effects of the transactions cost.

Proposition 2:
With a positive transactions cost of obtaining closed-end loans, $E(\Pi_F)$ is zero at $\alpha_{ae} \in (\alpha_A, \alpha_M)$ under the following conditions: (1) for a positive number of borrowers with $\alpha_i \in [\alpha_m, \alpha_M), x_i$ is large enough to induce them to obtain a credit card offering $F_0(\alpha_M)$ and (2) for a positive number of borrowers with $\alpha_i \in [\alpha_m, \alpha_A), x_i$ is not large enough to induce them to obtain a credit cards offering $F_0(\alpha_A)$.

Proof:
If some borrowers with $\alpha_i \in [\alpha_m, \alpha_M)$ obtain credit cards, $\alpha_{aa} < \alpha_M$. Thus, from Equation (14), the expected profit is positive for cardissuers charging $F(\alpha_M)$. From Equations (6b) and (7), a borrower obtains the credit card if

$$x_i > \frac{(F - \alpha_i Z)(1+r_f)}{2+r_f}.$$

Thus, all borrowers with $\alpha_i \in (\alpha_A, \alpha_M]$ will obtain the credit card charging $F = F_0(\alpha_A) = \alpha_A Z$, regardless of x_i. Borrowers with $\alpha_i \in [\alpha_m, \alpha_A)$, however, do not obtain the credit card charging $\alpha_A Z$ unless x_i is large enough. If some of those borrowers do not obtain the credit card, $\alpha_{aa} > \alpha_A$ and $E(\Pi) < 0$ when $F = \alpha_A Z$. Thus, given that $E(\Pi_F)$ is continuous in α_{ae}, $E(\Pi_F) = 0$ at $F = \alpha_{a0} Z$, where $\alpha_{a0} \in (\alpha_A, \alpha_M)$.

The decision criterion in the above proof also suggests that many borrowers with low transactions costs may not obtain a credit card charging $F > \alpha_A Z$. In this model, however, the lack of the credit card does not necessarily lower consumer welfare or aggregate lending because borrowers can always obtain a closed-end loan at competitive rates.

Competition may fail to reduce the cardissuer's profit to zero if lowering the upfront fee disproportionately draws unprofitable borrowers (borrowers with high α). This adverse selection does not occur in this case because the benefit from a lower upfront fee is unrelated to $\alpha_i(\partial E(G_F)/\partial F = -1)$.

In sum, when borrowers are better informed about the probability of becoming type B, likely consequences of competing only through the upfront fee are the following. The zero-profit upfront fee that is sustainable is higher than the one reflecting the economywide average probability of becoming type B. At the high upfront fee, many borrowers with low transactions costs do not obtain the credit card.

Pricing the option value with a high card rate

Without an upfront fee, the option value of credit lines must be offset by a high card rate ($r_c > r_f$). From Equation (8), the card rate consistent with zero profit when $F = 0$,

$$r_{c0} = \frac{\beta(2 + r_f - \alpha_a)r_f + \alpha_a(1-p)r_R}{\beta(2 + r_f - \alpha_a) + \alpha_a(1-p)}. \qquad (16)$$

This equation shows key characteristics of the card rate. The zero-profit card rate is the same as the second-period interest rate on closed-end loans for type B borrowers ($r_{c0} = r_R$) when $\beta = 0$ and $\alpha_a > 0$. Cardissuers must charge r_R if cardholders borrow only when they become riskier. The zero-profit card rate decreases with β, which compensates for high-risk loans driven by the option value (OV-driven card loans), and increases with α_a, which increases the expected amount of OV-driven card loans.

$$\frac{\partial r_{c0}}{\partial \beta} = \frac{(1-p)(2 + r_f - \alpha_a)\alpha_a(r_f - r_R)}{\{\beta(2 + r_f - \alpha_a) + \alpha_a(1-p)\}^2} < 0, \qquad (17)$$

$$\frac{\partial r_{c0}}{\partial \alpha} = \frac{(1-p)(2 + r_f - \alpha_a)\beta(r_R - r_f)}{\{\beta(2 + r_f - \alpha_a) + \alpha_a(1-p)\}^2} > 0. \qquad (18)$$

In this model, β critically depends on the transactions cost of obtaining closed-end loans. A low-risk borrower chooses credit card loans over closed-end loans if the transactions cost is larger than the difference in the interest cost. Thus, high transactions costs lower the zero-profit card rate by inducing low-risk cardholders to choose credit card loans.

The gain from obtaining a credit card charging a high card rate instead of an upfront fee:

$$E(G_H) = \frac{\alpha_i x_i}{1 + r_f} + \frac{\alpha_i(1-p)(r_R - r_c)}{(1 + r_f)^2} \quad \text{for } x_i < x^*,$$

$$E(G_H) = x_i + \frac{r_f - r_c}{1 + r_f} + \frac{x_i}{1 + r_f} + \frac{(1-\alpha_i)(r_f - r_c)}{(1 + r_f)^2} + \frac{\alpha_i(1-p)(r_R - r_c)}{(1 + r_f)^2} \quad \text{for } x_i > x^*. \qquad (19)$$

The following two propositions are obtained from this equation.

Proposition 3:
For $r_c \in [r_f, r_R]$, the expected gain from obtaining a credit card charging no upfront fee is strictly positive for all borrowers with $x_i > 0$ and $\alpha_i > 0$.

Even when $r_c = r_R$, borrowers with a positive transactions cost can reduce the borrowing cost if they turn out to be type B. Thus, without an upfront fee, it is optimal for borrowers with a positive transactions cost to obtain a credit card charging r_R.

Proposition 4:
The responsiveness of the expected gain to the change in r_c increases with α for OV-driven cardholders and decreases with α for TC-driven cardholders.

Proof:
Differentiating $E(G_H)$ with respect to r_c and α,

$$\frac{\partial E(G)}{\partial r_c \partial \alpha} = \frac{-(1-p)}{(1 + r_f)^2} < 0 \quad \text{for } x_i < x^*,$$

$$\frac{\partial E(G)}{\partial r_c \partial \alpha} = \frac{p}{(1 + r_f)^2} > 0 \quad \text{for } x_i > x^*.$$

Thus, the magnitude of $\partial E(G)/\partial r_c$ (responsiveness) increases with α for OV-drive cardholders ($x_i < x^*$) and decreases with α for TC-drive cardholders ($x_i > x^*$).

OV-driven cardholders with higher α are more responsive to the card-rate change because the probability of taking advantage of the option to borrow at a low rate increases with α. An interesting result is that among TC-driven cardholders, those with lower α are more responsive to the card-rate change. The intuition is the following. TC-driven cardholders borrow the same amount, regardless of the outcome of the type. In this case, the expected borrowing cost is less affected by a change in the card rate for those with higher α because type B borrowers pays the interest only if they happen to have enough income at the end of the second period (probability $1-p$). Suppose, for example, that a borrower knew he/she would go bankrupt soon. Then the borrower would not care much about the borrowing rate because he/she would not pay.

These results lead to the following proposition.

Proposition 5:
The likelihood of adverse selection increases with the proportion of OV-driven cardholders to TC-driven cardholders.

This proposition can be more broadly interpreted. In this model, there are only two extreme types of cardholders (those with only OV-driven borrowing and others with the equal amount of TC-driven and OV-driven borrowing), and the type depends only on the transactions cost. Many other factors, such as liquidity constraints, inter-temporal income profiles, and risk preferences, can influence the amounts of TC-driven and OV-driven loans. In reality, therefore, many cardholders may be in-between; they use some card loans while they are creditworthy and use more when they become riskier. For a cardholder whose TC-driven borrowing is $Y(0 \leqslant Y \leqslant 1)$ and OV-driven borrowing is 1, it can be shown:

$$\frac{\partial E(G_H)}{\partial r_c \partial \alpha} = \frac{Y-(1-p)}{(1+r_f)^2}. \tag{20}$$

Thus, for those borrowers with $Y < 1-p$, the responsiveness $E(G)$ to r_c increases with α. Then adverse selection (disproportionately drawing borrowers with high α) can make the per-cardholder profit negative at $r_c > r_{c0}$ if the ratio of TC-driven borrowing to OV-driven borrowing is lower than $1-p$ for a large portion of cardholders. The adverse selection would limit competition through card rates.

Although it is difficult to prove rigorously, there are many plausible reasons that many cardholders use substantially more card loans when they become riskier. Theoretically, holding the interest rate constant, the expected borrowing cost is lower for riskier borrowers because the probability of repaying the loan is lower. In addition, cardholders who have become riskier (unemployed, for example) may have a larger liquidity need. In fact, many unemployed individuals live off their credit cards, while they look for new jobs (Novack, 1997; Slight, 2003). Bankruptcy lawyers observe that their clients are generally loaded up on credit card loans (Daly, 2003; Slight, 2003). Of course, the causality can be either way; large debt causes bankruptcy, or the prospect of bankruptcy causes large debt. However, the fact that card debt is particularly large for borrowers seeking bankruptcy indicates that many cardholders deliberately take advantage of the open credit lines. Novack (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.' Many borrowers have room to borrow more when they become riskier. Based on the Survey of Consumer Finances, 56 percent of households with credit cards borrow (and pay interest) on credit cards (Gross and Souleles, 2002). That is, 44 percent of households with credit cards do not use card loans at all. Considering that many households have multiple credit cards, the percentage of those cards with no loan may be much higher. Based on the analysis of a large data set of credit card accounts, Gross and Souleles (2002) also report that only about 14 percent of cardholders utilize 90 percent or more of the credit limit. The 14 percent of cardholders probably include those who have become riskier (OV-driven borrowers), as well as those who have large card borrowing for other reasons (TC-driven cardholders). Thus, it appears that only a small portion of cardholders have large TC-driven borrowing.

In sum, when cardissuers compete through the card rate, likely consequences are the following. The zero-profit card rate is higher than the one reflecting the current risk of borrowers. It is optimal for most borrowers to obtain credit cards even at a high card rate. By preventing rate competition, adverse selection can result in a card rate higher than the zero-profit card rate and an above-normal profit.

Upfront fees versus high card rates

The previous two sections assume that cardissuers compete through either the upfront fee or the card rate. This section considers competition between fee cardissuers and high-rate cardissuers and analyzes the relative vulnerability of the two pricing strategies to adverse selection.

Proposition 6:
The vulnerability of the fee card to adverse selection relative to that of the high-rate card increases with the proportion of OV-driven cardholders.

Proof:
While all borrowers with a positive transactions cost obtain a high-rate card (Proposition 3), a borrowers obtains a fee card only if $E(G_F)-E(G_H)>0$ when both types of cards are available.

$$E(G_F)-E(G_H) = x_i + \frac{x_i}{1+r_f} + \frac{\alpha_i(1-p)(r_c-r_f)}{(1+r_f)^2} - F \equiv E(G_{FH}) \quad \text{for } x_i < x^*,$$

$$E(G_F)-E(G_H) = \frac{r_c-r_f}{1+r_f} + \frac{(1-\alpha_i)(r_c-r_f)}{(1+r_f)^2} + \frac{\alpha_i(1-p)(r_c-r_f)}{(1+r_f)^2} - F \equiv E(G_{FH}) \quad \text{for } x_i > x^*,$$

$$\frac{\partial E(G_{FH})}{\partial \alpha_i} = \frac{(1-p)(r_c-r_f)}{(1+r_f)^2} > 0 \quad \text{for } x_i < x^*,$$

$$\frac{\partial E(G_{FH})}{\partial \alpha_i} = \frac{-p(r_c-r_f)}{(1+r_f)^2} < 0 \quad \text{for } x_i > x^*.$$

Thus, the likelihood of obtaining a fee card increases with α_i among OV-driven cardholders, and decreases with α_i among TC-driven cardholders. Accordingly, fee cardissuers are more likely to face adverse selection when the proportion of OV-driven cardholders is high.

Intuitively, for OV-driven cardholders who use card loans only when they become riskier, the interest saving is larger from a fee card $(r_R - r_f)$ than from a high-rate card $(r_R - r_c)$. The difference in the interest saving matters more for cardholders with higher α because the probability of realizing the interest saving is higher for those with higher α. As in the case of lowering the card rate, 'favorable' selection for the fee card is likely to occur among TC-driven cardholders because the interest rate does not matter if the cardholder defaults. Thus, the fee card is more vulnerable to adverse selection if many cardissuers use more card loans when they become riskier.

Even without competition from high-rate cardissuers, many borrowers do not obtain a fee card, and the average α is higher for fee cardholders as shown above; holding x_i constant, α_i must be high enough to compensate for the card fee. The high average α raises the zero-profit fee. If competition from high-rate cardissuers worsens the composition of fee cardholders, an even higher fee is necessary. Then the potential customer base will be further reduced. A smaller customer base reduces cross-selling opportunities, limits economies of scale in payment processing, and is inconsistent with the managers' desire to expand. Thus, if OV-driven borrowing is large relative to TC-driven borrowing, the upfront fee may not be viable in the credit card market.

In practice, cardissuers have never seriously relied on the upfront fee. In the early days of credit cards, cardissuers commonly charged an annual fee, but it was a nominal amount, which might have been to cover processing costs and cardholder benefits rather than price the option value. Simmons (1995) suggests that cardissuers needed the annual fee to cover their operating costs in the early days. Cardissuers also rely on the merchant discount to cover their operating costs. On average, however, both the annual fee and the merchant discount on credit cards have been substantially lower than those on charge cards (American Express), which are intended to cover processing costs and cardholder benefits. Thus, it is unlikely that the annual fee was intended to price the option value. Nowadays, most cardissuers waive the annual fee to broaden the customer base. Durkin (2002), who analyzes a consumer survey, reports that cardholders are the most sensitive about the annual fee; 95 percent of respondents said that the annual fee was important, while 91 percent responded that the card rate was important. Based on this finding, a large upfront fee to cover the option value would significantly reduce the customer base.

CONSISTENCY OF THE MODEL WITH PREVALENT PRICING STRATEGIES

Cardissuers need to structure the card rate such that they are adequately compensated for the option value, while avoiding adverse selection. Since the mid-1990s, cardissuers have been competing for customers by offering teaser rates. The card rate is low at the beginning and increases to the regular rate after the introductory period. This pricing scheme is sensible when the option value plays a major role; cardissuers observe the current-period riskiness but not the future-period riskiness of borrowers, and cardholders borrow more when they become riskier.

For borrower i, the expected gain from obtaining the credit card offering a teaser rate in the first period and the regular rate in the second period,

$$E(G_T) = x_i + \frac{r_f - r_T}{1+r_f} + \frac{x_i}{1+r_f} + \frac{(1-\alpha_i)(r_f - r_c)}{(1+r_f)^2} + \frac{\alpha_i(1-p)(r_R - r_c)}{(1+r_f)^2} \quad \text{for } x_i > x^*,$$

$$E(G_T) = x_i + \frac{r_f - r_T}{1+r_f} + \frac{\alpha_i x_i}{1+r_f} + \frac{\alpha_i(1-p)(r_R - r_c)}{(1+r_f)^2} \quad \text{for } x_T < x_i < x^*, \tag{21}$$

$$E(G_T) = \frac{\alpha_i x_i}{1+r_f} + \frac{\alpha_i(1-p)(r_R - r_c)}{(1+r_f)^2} \quad \text{for } x_i < x_T.$$

where r_T is the teaser rate, and x_T is the critical level of x at which the cardholder is indifferent between the card loan offering the teaser rate and the closed-end loan in the first period $\{(r_T - r_f)/(1+r_f)\}$.

Differentiating $E(G_T)$ with respect to r_T,

$$\frac{\partial E(G_T)}{\partial r_T} = \frac{-1}{1+r_f} \quad \text{for } x_i > x_T,$$

$$\frac{\partial E(G_T)}{\partial r_T} = 0 \quad \text{for } x_i < x_T. \tag{22}$$

The expected gain decreases with the teaser rate for TC-driven cardholders, while it is unaffected by the teaser rate for OV-driven cardholders. Thus, TC-driven cardholders are more likely to respond to a lower teaser rate. For both groups, the responsiveness of the expected gain to the teaser rate is unrelated to α_i. Thus, adverse selection does not occur. Based on these results, cardissuers can substantially increase TC-driven card loans by offering a low introductory rate, without causing adverse selection. Given that competition is not impeded by adverse selection, the introductory rate must drop until the profit from new customers becomes zero.

The cardissuer's profit from new customers attracted by a teaser rate,

$$E(\Pi_T) = N_T\left[\frac{\beta_{T1}(r_T - r_f)}{1+r_f} + \frac{\beta_{T2}(1-\alpha_A)(r_c - r_f)}{(1+r_f)^2} - \frac{\alpha_A(1-p)(r_R - r_c)}{(1+r_f)^2}\right], \tag{23}$$

where N_T is the number of new customers attracted by the teaser rate, and β_{T1} and β_{T2} are the proportion of TC-driven cardholders among the new customers in the first and the second period ($\beta_{T1} \geqslant \beta_{T2}$ because the card rate increases in the second period). Note that $\alpha_a = \alpha_A$ in this case because no adverse selection occurs.

Setting the per-customer profit equal to zero and solving for r_T, the zero-profit r_T,

$$r_{T0} = r_f + \frac{\alpha_A(1-p)(r_R - r_c) - \beta_{T2}(1-\alpha_A)(r_c - r_f)}{\beta_{T1}(1+r_f)}. \tag{24}$$

Clearly, r_{T0} decreases with r_c because the second-period profit increases with r_c. It is also clear from this equation that r_{T0} decreases with β_{T2}.

Thus, when r_c and β_{T2} are high, r_{T0} is very low, and it can be even lower than r_f. Suppose that $\beta_{T2} > 0$ and $r_c = r_R$. Then:

$$r_{T0} = r_f - \frac{\beta_{T2}(1-\alpha_0)(r_R - r_f)}{\beta_{T1}(1+r_f)} < r_f.$$

Since r_{T0} is continuous in r_c, there exist $r_c = r_R - \varepsilon$, at which $r_{T0} < r_f$, where ε stands for a very small number. Therefore, $r_{T0} < r_f$ at some $r_c \in (r_f, r_R)$. Intuitively, the first-period profit can be negative if a large second-period profit compensates for the first-period loss.

The critical variable in this analysis is β_{T2}. If β_{T2} is high, the second-period profit is high, and the gap between r_c and r_T can be large. The critical role of β_{T2} is consistent with cardissuers' competition for balance transfers. Many cardissuers often offer an even lower introductory rate for balance transfers. Cardholders who borrow a large amount at a high card rate in the first period are likely to borrow at a high card rate in the second period even if they turn out to be type G. Balance-transfer offers may be targeting those card holders who currently borrow at a high card rate from other cardissuers and would continue to use card loans after the low rate expires. For those cardholders, β_{T2} is high, and the introductory rate can be very low.

The success of this strategy requires a substantial switching cost. If the switching cost were zero, low-risk cardholders would move around cardissuers offering a low introductory rate. Then the teaser rate and the balance transfer would backfire the cardissuers using those strategies. Thus, the prevalence of those strategies is also consistent with the finding of Calem and Mester (1995) that the switching cost is substantial, especially for cardholders with a large card balance.

The transactions cost is also a critical element in this model because the cardissuers' profit derives largely from TC-driven card loans. In this model, the transactions cost is assumed to be zero for the card loan. A lower transactions cost of obtaining closed-end loans, therefore, would undermine the cardissuers' profit. The assumption, however, is a simple representation of the fact that the transactions cost is generally lower for the card loan. What matters is the difference in the transactions cost between the closed-end loan and the card loan. The transactions cost of obtaining loans in general may have been decreasing due to improved information and communication technology (e.g. credit scoring). However, it is not clear if the gap has narrowed. The transactions cost includes many non-pecuniary factors such as psychic costs and processing time, which are difficult to measure. A substantially narrowed gap in the transactions cost would lower the profitability of the credit card business.

CONCLUSIONS

Credit cards allow cardholders who have become riskier to borrow at the initial terms. Because of this option embedded in credit lines, the zero-profit card rate is higher than the interest rate on closed-end loans. Furthermore, an adverse-selection problem can keep the card rate even above the zero-profit rate and enable cardissuers to make above-normal profits. When cardholders are better informed about the borrower-specific probability of becoming riskier in the future and many cardholders are OV-driven (use more card loans when they become riskier), it is difficult for cardissuers to compete through the card rate or price the option with the upfront fee. A lower card rate may disproportionately attract those customers who are more likely to become riskier. The upfront fee is also vulnerable to adverse selection. For OV-driven cardholders, the expected benefit is greater from a fee card than from a high-rate card. Thus, borrowers with a high probability of becoming riskier in the future prefer a fee card to a high-rate card.

Teaser rates, which do not apply in future periods, do not favor borrowers who are more likely to become riskier in the future. Thus, when cardissuers are well informed about the current-period risk but not the future-period risk of cardholders, they can avoid the adverse selection problem by offering a teaser rate. Competition through the teaser rate should reduce above-normal profits of cardissuers. Thus, the explanation based on the option value of open credit lines is consistent with the prevalence of teaser rates and the reduced profits of cardissuers in recent years.

NOTES

1. For example, raising interest rates would be meaningless if the borrower planned to declare bankruptcy. In addition, cardissuers may face various legal barriers. Many states forbid lenders from applying higher interest rates on cardholders' balances after they cancel the cards. It will also be difficult to raise interest rates on accounts in good standing.
2. In an article reporting the slow profit growth of Bank One Corp., one of the largest cardissuers, Wall Street Journal (1999) attributes the reduced profits largely to competition through teaser rates.
3. When many cardissuers compete for customers, r_c cannot exceed r_R. When $r_c > r_R$, every borrower (even the one with the highest α) is profitable for cardissuers. Then there is no adverse selection problem that can prevent cardissuers from bidding down the card rate.
4. Continuous monitoring would prevent this behavior. In fact, cardissuers attempt to practice continuous monitoring to a certain extent by keeping the credit limit at a relatively low level and authorizing an increase upon request. A broader-based continuous monitoring, however, is not practical, although further improvement in information and communication technology would enable cardissuers to move closer to continuous monitoring.

5. If $\partial N/\partial F = -\infty$ and $\partial N/\partial r_c = -\infty$ in the short run, adverse selection would not hinder competition. In this case, lowering F or r_c would draw all borrowers, and hence $\alpha_a = \alpha_A$, where α_A is the economywide average of α. Then cardissuers that initially had an unfavorable ($\alpha_a > \alpha_A$) or average ($\alpha_a = \alpha_A$) customer composition would lower either F or r_c until the profit drops to zero.
6. Risk aversion of borrowers can have similar effects. Credit cards offering the same interest rate in the second period have an insurance feature (the same borrowing cost regardless of the outcome of the borrower type). Thus, risk aversion may also induce some low-risk borrowers to obtain credit cards.

REFERENCES

Ausubel LM. 1991. The failure of competition in the credit card market. *American Economic Review* **81**(1): 50–81.
Avery RB, Berger AN. 1991. Loan commitments and bank risk exposure. *Journal of Banking and Finance* **15**: 173–192.
Board of Governors of the Federal Reserve System, 2003. *Federal Reserve Statistical Release* G19.
Boot A, Thakor AV, Udell GF. 1987. Competition, risk neutrality, and loan commitments. *Journal of Banking and Finance* **11**: 449–471.
Brito DL, Hartley PR. 1995. Consumer rationality and credit cards. *Journal of Political Economy* **103**(2): 400–433.
Calem PS, Mester LJ. 1995. Consumer behavior and the stickiness of credit card interest rates. *American Economic Review* **85**(5): 1327–1336.
Daly D. 2003. (February 28) South Dakota Seems to Buck Bankruptcy Trend. *Rapid City Journal.*
Durkin TA. 2002. Consumers and credit disclosures: credit cards and credit insurance. *Federal Reserve Bulletin* **88**: 201–213.
Gross DB, Souleles NS. 2002. Do liquidity constraints and interest rates matter for consumer behavior? Evidence from Credit Card Data. *Quarterly Journal of Economics* **117**(1): 149–185.
Mester L. 1994. Why are credit card rates sticky? *Economic Theory* **4**: 505–530.
Nash RC, Sinkey Jr. JF. 1997. On competition, risk, and hidden assets in the market for bank credit cards. *Journal of Banking and Finance* **21**: 89–112.
Novack J. 1997. (June 2) Debtors' Vision, *Forbes.*
Park S. 1993. The credit card industry: profitability and efficiency. In *Studies on Excess Capacity in the Financial Sector*. Federal Reserve Bank of New York, 121–153.
Park S. 1997. Effects of price competition in the credit card industry. *Economics Letters* **57**: 79–85.
Shaffer S. 1999. The competitive impact of disclosure requirements in the credit card industry. *Journal of Regulatory Economics* **15**: 183–198.
Simmons M. 1995. *The Credit Card Catastrophe: The 20th Century Phenomenon That Changed the World.* Barricade Books: Fort Lee, NJ.
Slight R. 2003 (March 2). Bankruptcies double in decade. *News-Leader*.
Smith DS. 2001. How is the credit card industry treating its customers? testimony before the Subcommittee on Financial Institutions and Consumer Credit, U.S. House of Representatives.
Stango V. 2000. Competition and pricing in the credit card market. *Review of Economics and Statistics* **82**: 499–508.
Thakor AV. 1982. Toward a theory of bank loan commitments. *Journal of Banking and Finance* **6**: 55–83.
Thakor AV, Udell GF. 1987. An economic rationale for the pricing structure of bank loan commitments. *Journal of Banking and Finance* **11**: 271–289.
Wall Street Journal. 1999 (August 4). Bank One Shares Drop 23% on Forecast.