# A Theory of Credit Cards

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**Abstract**

A two-period model is constructed to study the interactions among consumers, merchants, and a card issuer. The model yields the following results. First, if the issuer's cost of funds is not too high and the merchant's profit margin is sufficiently high, in every equilibrium of our model the issuer extends credit to qualified consumers, merchants accept credit cards and consumers face a positive probability of default. Second, the issuer's ability to charge higher merchant discount fees depends on the number of customers gained when credit cards are accepted. Thus, credit cards exhibit characteristics of network goods. Third, each merchant faces a prisoner's dilemma where each independently chooses to accept credit cards, however all merchants' two-period profits are reduced because of intertemporal business stealing across industries.

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Key Words: Payment Cards, Merchant Discount, Payment Systems, Network Effect

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Today, credit cards serve as an indispensable credit and payment instrument in the United States. In 2003, there were 18.3 billion credit card transactions accounting for \$1.71 trillion (Committee on Payment and Settlement Systems, 2005). The popularity of credit cards continues to grow as evidenced by a greater proportion of merchants that accept them and of consumers that carry them. Using a dynamic model, we explore the costs and benefits of credit cards to consumers, merchants and the credit card network. In this article, we provide answers to the following questions. Why do merchants accept credit cards even though credit cards are the most costly payment instrument to process? What conditions are necessary for a credit card equilibrium to exist? Does the market for credit cards exhibit network effects? Does the decision of a merchant to accept credit cards affect profits of other merchants?

Consumers find credit cards convenient for making purchases by accessing lines of credit that they may choose to pay off at the end of the billing cycle or pay over a longer period of time. Around thirty to forty percent of consumers pay off their balances in full every month, such consumers are known as convenience users. In the United States, issuers seldom impose per-transaction fees and often waive annual membership fees.[1] Furthermore, issuers may provide incentives such as frequent-use awards, dispute resolution services, extended warranties and low-price guarantees to promote usage. While revolvers usually receive the same benefits as convenience users, they are usually charged for these card enhancements as part of finance charges on their borrowings.

Merchants also benefit from accepting credit cards. Merchants benefit from sales to illiquid consumers who would otherwise not be able to make purchases. By participating in a credit card network, merchants generally receive funds within 48 hours. Credit cards provide relatively secure transactions for non-face-to-face transactions as evidenced by the overwhelming use of credit cards for online transactions. Furthermore, merchants not accepting credit cards may lose business to other merchants that do.

However, credit cards are the most expensive payment instrument to accept. According to the Food Marketing Institute (2000), credit cards on average cost supermarkets 72¢ per transaction compared to 34¢ for PIN-based debit cards and 36¢ for checks.[2] A significant portion of the cost

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[1] According to a recent Federal Reserve Survey, 63 percent of issuers did not charge an annual fee (Board of Governors of the Federal Reserve System, 2000). Issuers are more likely to impose annual fees if their cards are loaded with additional enhancements.

[2] PIN-based debit cards use PINs to authorize transactions whereas signature-based debit cards use signatures.

is due to the merchant discount, the fee that each merchant pays to its financial institution for each transaction. In the United States, merchant discounts generally range from 1.25 percent to 3 percent of each transaction amount and are bilaterally negotiated between merchants and their financial institutions.

We construct a two-period, three-agent model to investigate these questions. Unlike the previous literature, we focus on the costs and benefits of purchases made with credit to both consumers and merchants. Much of the literature to date focuses on the determination of the interchange fee, the fee that the merchant's financial institution pays the consumer's financial institution, in a one-period model and ignores the intertemporal aspects of credit cards.[3] With the exception of Chakravorti and Emmons (2003), we present the only model that studies the costs and benefits of extending credit to consumers. First, rather than taking a reduced form approach where the costs and benefits of credit cards are exogenously assigned functional forms, we specify a model which endogenously yields costs and benefits to the involved parties. Second, we use a dynamic setting in which there are intertemporal tradeoffs for all of the parties involved. Surprisingly, this aspect of credit cards is largely ignored by theoretical models to date. Using this approach, we identify an intertemporal externality that merchants impose on one another because their credit acceptance decision has no (or little) impact on their own future earnings.

Our model yields the following results. First, if merchants earn a sufficiently high profit margin and the cost of funds is sufficiently low, a credit card equilibrium exists. In other words, the issuer finds it profitable to provide credit card services, merchants accept credit cards, and consumers use them. Second, the discount fee that merchants are willing to pay their financial insitutions increases as the number of illiquid credit card consumers increases. Third, a prisoner's dilemma situation arises, where each merchant chooses to accept credit cards but by doing so each merchant's discounted two-period profit is lower. In other words, there exists intertemporal business stealing among merchants across different industries. The remainder of the article is organized as follows. In the next section, we present our model. We solve for the credit card equilibrium in Section 2, discuss policy implications in Section 3, and conclude in Section 4.

[3] For theoretical models that consider the effects of regulating interchange fees, see Gans and King (2003a), Rochet and Tirole (2002), Schmalensee (2002), and Wright (2004).

## 1 The Model

In our model, the five main credit card participants—the consumer, the consumer's financial institution or the issuer, the merchant, the merchant's financial institution or the acquirer, and the credit card network—have been condensed to three participants. The issuer, the acquirer, and the network operator are assumed to be a single agent and referred to as the issuer.

Assume that there is a continuum, say $[0, 1]$, of indivisible goods exogenously priced at $p$. Each good is sold by a monopolistic merchant for whom unit cost is $c < p$.[4] Monopoly rents are maintained because each good within this continuum is distinct from one another (e.g., car repairs, new refrigerator, etc). By having a continuum of merchants, we focus our attention on a world where merchants are small and have no bargaining power to set the merchant discount rate.[5] Since merchants earn rents, credit cards can be of value if they increase sales.

Each consumer's demand for these goods is randomly determined in order to capture the notion that consumer spending may be stochastic and that some expenditures may be unanticipated. In particular, we assume that with probability $\gamma$ a consumer does not need to consume one of these goods and with probability $1 - \gamma$ she does. If she needs to consume then she is randomly and uniformly matched to one of these goods and must consume or else face a utility loss of $u$. In either case, consumers start at a base utility level which, for notational convenience, we normalize to 0. These goods can be thought of as a critical part or service required for an unanticipated breakdown of an appliance or a car, where the consumer has to purchase the part or service from a specific merchant. Other formulations where consumers gain utility from consumption are possible and yield identical results.

As is typically true in actual practice, we assume that merchants do not charge different prices to their credit card and cash purchasers. Differentiated prices at the point of sale has a long legislative and legal history in the United States (see Barron et al., 1992; Board of Governors of the Fed-

[4] Rochet and Tirole (2002), Schwartz and Vincent (2006) and Wright (2000) also assume noncompetitive goods markets in their credit card models. Chakravorti and Emmons (2003), Gans and King (2003b), and Wright (2000) consider competitive goods markets.

[5] We do not allow merchants to issue their own credit cards. Some merchants do issue their own credit cards but the market share of such cards is small compared to the share of third-party general-purpose credit cards. Committee on Payment and Settlement Systems (2005) reported U.S. general-purpose credit and charge card transactions in 2003 at 18.3 billion valued at $1.71 trillion of which retailer credit card transactions accounted for 1.92 billion valued at $133 billion.

eral Reserve System, 1983; Chakravorti and Shah, 2003; Kitch, 1990; Lobell and Gelb, 1981).[6] However, evidence from other countries where merchants are allowed to impose surcharges find that merchants do not usually impose them (Vis and Toth, 2000; IMA Market Development AB, 2000) confirming Frankel (1998), who suggested that merchants generally adhere to price cohesion.

Why merchants do not differentiate between credit and cash purchases is a difficult question to answer. It may simply be the case that faced with a higher price for credit purchases, consumers may choose to purchase elsewhere rather than pay a higher price. Anecdotal evidence from jurisdictions where merchants are allowed to set different prices suggests that price differences exist when competition is fierce such as discount travel agency or where competition is extremely weak. In any case, most merchants prefer to charge one price regardless of the payment instrument used.

The fact that merchants cannot increase prices to recover the additional costs associated with credit card transactions actually strengthens any result in which they are willing to accept credit cards. That is, because exogenously fixing prices removes a degree of freedom from the merchants, if credit card equilibria exist under fixed prices, they would also exist if merchants were free to adjust prices.

Assume there is a continuum of consumers. Each consumer has income $\omega_t$ in periods $t = 1, 2$. For each consumer, $\omega_t$ is independently distributed via continuous cumulative distribution function $F$ and associated probability density function $f$ and has support $\Omega = [\underline{\omega}, \bar{\omega}]$. Consumers have discount factor $\beta$. Consumers may choose from two payment instruments; they can pay with cash or with a credit card if they have sufficient credit available. Any money not spent in the first period earns return $R > 1$. $R$ will also be the issuer's cost of funds and the interest rate earned on merchants' first period profits.

Assume that a monopolistic issuer offers a credit card to all consumers with credit limit $L(\omega)$. That is, if a consumer has a first period income of $\omega_1$, the amount of credit issued to her by the financial institution is $L(\omega_1)$. Since the economy only lasts for two periods, credit is only offered in the first period. The issuer then collects debts owed (or however much is collectable) at the beginning of the second period.[7] It is important to

[6] The Netherlands, Sweden, and the United Kingdom prohibit credit card associations from imposing no-surcharge rules. The Australian authorities have imposed a similar ban.

[7] While there is uncertainty at the consumer level, there is no aggregate uncertainty given the large number of consumers. The results would not qualitatively change if aggregate uncertainty were introduced.

note consumers pay no interest on credit card purchases. This assumption is based on the observation that credit card purchases have a "grace period" during which no interest accumulates. There would be interest due only if part of the consumer's debt were carried over into a third period. The agreements between the issuer and consumers and between the issuer and the merchants is assumed to be costlessly enforceable.

For reasons of tractability, revolving credit is excluded and the economy lasts for only 2 periods. However, such an abstraction may not be unrealistic given the use of charge cards, such as the traditional American Express card, and industry estimates that as much as forty percent of credit card consumers pay off their balances in full every month.[8] Indeed, some issuers have specifically targeted pricing policies and incentives towards this group of consumers (see Chakravorti and Shah, 2003). The qualitative results of the model would not change if an additional period of credit were added. If credit was granted for another period, merchants would be able to sell goods to more consumers and may be willing to pay higher fees in return.[9]

Since the price of each good is identical, without loss of generality, the issuer can choose credit limits among functions of the following form: $L(\omega) = 0$ if $\omega_1 \notin \hat{\Omega}$ and $L(\omega) = p$ if $\omega_1 \in \hat{\Omega}$ where $\hat{\Omega} \subset \Omega$. That is, we can limit $L$ to take only the values of 0 and $p$ since a credit card is useful only if it allows one to consume the good—credit limits below $p$ or beyond $p$ are of no use. Since lower-income consumers will have a higher risk of default, it must be the case that the optimal $L(\omega)$ will have $\hat{\Omega} = [\hat{\omega}, \bar{\omega}]$ for some $\hat{\omega} \in \Omega$. Thus, the issuer can simply choose $\hat{\omega}$ to maximize revenues while minimizing defaults. Given that we examine credit limit functions which take values of 0 on $[\underline{\omega}, \hat{\omega})$ and $p$ on $[\hat{\omega}, \bar{\omega}]$, we will call $\hat{\omega}$ the *income requirement*, below which consumers are not offered credit cards.

Merchants must decide whether or not to accept credit cards as payment for first period purchases. The issuer imposes a per-sale transaction fee, $\rho \geq 0$, for each credit card purchase. The issuer pays the merchant the difference between the sales receipts and the amount corresponding to the merchant discount. Since the mix of customers matched to each merchant is the same, each merchant faces an identical profit maximization problem. As

[8]The short-term interest free loan is valuable to consumers who may not have cash on hand at the time of the purchase. For example, credit cards are often used by employees to pay for business expense to allow for their employers to reimburse them before they settle their credit card bill.

[9]In reality, some merchants, e.g., furniture and electronic stores, extend consumers credit without finance charges for a given period such as a year suggesting that merchants benefit when consumers purchase on credit and may even subsidize it.

| Date | Agent | Actions |
|---|---|---|
| $t = 0$ | Issuer | Choose $\hat{\omega}$ and $\rho$ |
| | Merchants | Accept/Not-Accept Credit Cards |
| $t = 1$ | Nature | Determine $\omega_1$ and demand for each consumer |
| | Consumers | Buy/Not-Buy<br>If Buy, Use/Not-Use Credit |
| $t = 2$ | Nature | Determine $\omega_2$ and demand for each consumer |
| | Issuer | Collect Debts |
| | Consumers | Make Cash Purchases |

Figure 1: Sequence of actions

will later be verified, in equilibrium all merchants will either accept credit cards or none will accept them.

The structure of the model is illustrated in Figure 1. At time 0, the issuer chooses the transaction fee, $\rho$, and the income requirement, $\hat{\omega}$, for consumers to qualify for a credit card. The merchants then decide whether or not to accept credit cards. At the beginning of periods 1 and 2, consumer incomes and desired consumptions are randomly determined. In period 1, each consumer decides whether to purchase her desired consumption good and then if she has access to credit, how she should pay for it. Any outstanding debts are collected after the realization of second period income. If she has sufficient funds in period 2, she may choose to consume but can only pay with cash, because the issuer extends no credit in period 2.

# 2 Equilibrium

## 2.1 Consumers

Starting with the second period, a consumer will always purchase the good she desires if she can afford it. If she had consumed with credit in the first period then she can afford to consume in the second period if $R\omega_1 + \omega_2 \geq 2p$. That is, she earns a return $R$ on her first period endowment, $\omega_1$. Her total cash balances in the second period must be used to pay off her debt from the first period, namely $p$. If $R\omega_1 + \omega_2 < p$ then she defaults and the sum $R\omega_1 + \omega_2$ is seized by the issuer. Before the realization of her second period income, the probability that she can afford to consume is

$\Pr(\omega_2 \geq 2p - R\omega_1)$. Similarly, given that she consumed with cash in the first period, the probability that she can afford to consume in the second period is $\Pr(\omega_2 \geq p - R(\omega_1 - p))$. Finally, if she did not buy at all in the first period, the probability that she can afford to consume in the second period is $\Pr(\omega_2 \geq p - R\omega_1)$. Given some target second period wealth level, $x$, the probability that $\omega_2$ is at least $x$ can be written in terms of the cumulative distribution function as $\Pr(\omega_2 \geq x) = 1 - F(x)$.

We can now calculate a consumer's first period discounted expected utility from purchasing with her credit card and from purchasing with cash. With probability $1 - \gamma$, a consumer needs to consume. If she has access to and buys on credit, she receives discounted expected utility of:

$$U^c(\omega_1) = -\beta(1-\gamma)\Pr[\omega_2 < 2p - R\omega_1]u. \tag{1}$$

By purchasing, she prevents a utility loss of $u$ in the first period and, if necessary (with probability $1 - \gamma$), if she can afford to, will consume in the second period. Second period consumption is discounted by $\beta$. If a consumer consumes with cash, she receives discounted expected utility of:

$$U^m(\omega_1) = -\beta(1-\gamma)\Pr[\omega_2 < p - R(\omega_1 - p)]u. \tag{2}$$

If a consumer does not consume in the first period, she gets utility of:

$$U^0(\omega_1) = -u - \beta(1-\gamma)\Pr[\omega_2 < p - R\omega_1]u. \tag{3}$$

Finally, with probability $\gamma$, the consumer simply does not need to consume at all and receives utility of:

$$U^{\emptyset}(\omega_1) = -\beta(1-\gamma)\Pr[\omega_2 < p - R\omega_1]u. \tag{4}$$

It follows that all consumers, given the opportunity, will consume and that if they have credit available will prefer to purchase on credit rather than pay cash. Because consumers are not explicitly charged for using their credit cards and earn interest on their funds for one period, credit card payments dominate cash payments.

If merchants were to set different prices based on the payment instrument used, liquid consumers would choose to use cash over credit cards given a sufficient price difference. However, there are different views in the academic literature about the welfare effects of setting different prices based on the payment instrument used (see Chakravorti, 2003). Chakravorti and Emmons (2003) suggest such a pricing strategy improves welfare given competitive markets when issuers offer incentives to convenience users who do not share in the cost of providing payment services. Schwartz and Vincent (2006) suggest that consumer surplus may be lower if merchants charge the same price for credit card and cash purchases. Rochet and Tirole (2002) and Wright (2000) suggest that allowing merchants to set different prices may not be welfare enhancing.

### 2.2 Merchants

We will derive conditions for the existence of equilibria in which merchants accept credit cards. Since prices and costs are exogenously specified, and accepting credit cards is costly, merchants will be willing to accept credit cards only if they increase sales volume. In a credit card equilibrium, it must be that $\hat{\omega} < p$ since otherwise merchants who accepted credit cards would not increase their sales and would also be required to pay fee $\rho$ on all credit card sales.

In order to make their decision, merchants forecast the current and future demand for their product. First period demand is based on the distribution of first period income, $F(\omega_1)$, and the credit limit offered by the issuer, $L(\omega_1)$. Second period demand depends on the distribution of total wealth, net of cash purchases or credit repayments, at the beginning of the second period. This in turn depends on the equilibrium and as a result, the credit limit function $L$. Let the distribution of second period net total income be given by the cumulative distribution function, $H(x; \hat{\omega})$.

Provided that $p \geq \hat{\omega}$, each merchant's discounted expected profits from accepting credit cards will be proportional to:

$$\pi^c = [1 - F(\hat{\omega})](p - c - \rho) + \frac{1}{R}[1 - H(p; \hat{\omega})](p - c). \tag{5}$$

The same merchant's discounted expected profits from not accepting credit cards will be proportional to:

$$\pi^{nc} = [1 - F(p)](p - c) + \frac{1}{R}[1 - H(p; \hat{\omega})](p - c). \tag{6}$$

Notice that since individual merchants are massless, a single merchant's decision of whether or not to accept credit has no effect on second period sales and as a result, a merchant will accept credit cards when:

$$[1 - F(\hat{\omega})](p - c - \rho) \geq [1 - F(p)](p - c).$$

and will not when the opposite is true. As long as $\rho$ is sufficiently small, if $\hat{\omega} < p$, the merchant will choose to accept credit cards. By accepting credit, a merchant sells an additional $F(\hat{\omega}) - F(p)$ units—all credit sales come at the additional unit cost of $\rho$. Finally, as we will see, the fact that the merchant's problem does not depend on $H(p;\hat{\omega})$ (and thus its credit acceptance decision) will have important implications for merchant welfare.

### 2.3 The Issuer

The issuer maximizes profits through choice of $\rho$ and $\hat{\omega}$. The question then is, under what conditions will the issuer choose $\rho$ and $\hat{\omega}$ such that merchants are willing to accept credit as a form of payment. To solve the issuer's problem, it needs to be able to forecast the gross income, $x = R\omega_1 + \omega_2$, of consumers to whom they extend credit, $\omega_1 \geq \hat{\omega}$. The distribution of $x$ conditional on the realization of $\omega_1$ is $G(x \mid \omega_1) = \Pr[R\omega_1 + \omega_2 \leq x] = F(x - R\omega_1)$. Conditional on $\omega_1 \geq \tilde{\omega}$ for some $\tilde{\omega} < \bar{\omega}$, the distribution of $x$ is:

$$G(x \mid \omega_1 \geq \tilde{\omega}) = \int_{\tilde{\omega}}^{\bar{\omega}} F(x - R\omega_1) \frac{f(\omega_1)}{1 - F(\tilde{\omega})} d\omega_1. \tag{7}$$

When all merchants accept credit, the issuer's profits can be written as:

$$\Pi = (1-\gamma)[1 - F(\hat{\omega})]\Bigg\{ -(p-\rho) + \frac{1}{R}\left[ p(1 - G(p \mid \omega_1 \geq \hat{\omega})) + \int_{\min\{R\hat{\omega}+\underline{\omega},p\}}^{p} x g(x \mid \omega_1 \geq \hat{\omega}) dx \right]\Bigg\}, \tag{8}$$

where $G(\cdot \mid \omega_1 \geq \hat{\omega})$ is given by (7) and $g(\cdot \mid \omega_1 \geq \hat{\omega})$ is the associated conditional probability density function. The first term is the amount lent to consumers for first period credit purchases, less the sales fee charged to merchants. The terms within the brackets are repayments from the consumers who do not default and those from consumers who do. Notice that as long as $F$ is continuous, $\Pi$ is continuous. Since $(\rho, \hat{\omega})$ must belong to the compact set $[0, p-c] \times [\underline{\omega}, \bar{\omega}]$, $\Pi$ has a global maximum so that there exists at least one equilibrium. We now investigate some of the properties of these equilibria.

Notice that $\rho$'s purpose is to extract rents from the merchants and has no effect on the gross rents available. It is therefore straightforward to derive the optimal $\rho$ by setting $\pi^c = \pi^{nc}$ and solving. When $\hat{\omega} > p$, no additional sales are generated by the acceptance of credit cards and $\rho = 0$. When

$\hat{\omega} \leq p$, this is given by:

$$\rho(\hat{\omega}) = \frac{F(p) - F(\hat{\omega})}{1 - F(\hat{\omega})}(p - c). \tag{9}$$

In other words, $\rho$ is a fraction of the additional first period revenues generated by the acceptance of credit cards. Differentiating $\rho(\hat{\omega})$ with respect to $\hat{\omega}$ yields:

$$\frac{\partial \rho}{\partial \hat{\omega}} = -\frac{f(\hat{\omega})(1 - F(p))}{(1 - F(\hat{\omega}))}(p - c). \tag{10}$$

and the following proposition:

**Proposition 1** *The fee that the issuer can charge merchants falls as credit becomes more restrictive.*

In a broader sense, the ability to increase merchant fees is directly related to the number of consumers that have access to credit cards. Credit cards in our model display characteristics of a network good because as the number of illiquid cardholders increases the value of accepting them also increases (e.g., Economides, 1996; Katz and Shapiro, 1985). In other words, our model derives a network effect based on the number of illiquid consumers that have access to credit.

The variable $\hat{\omega}$ determines the magnitude of available rents. Note first that if $(1 + R)\underline{\omega} \geq p$ then even the poorest consumers can afford to repay $p$ and there would be no defaults. As a result, if the bank issues any credit, it issues it to everyone (i.e., $\hat{\omega} = \underline{\omega}$). On the other hand, if $(1 + R)\underline{\omega} < p$ and $\hat{\omega} < p$ then depending on $\hat{\omega}$, some consumers may default. We investigate this more interesting, case. In particular, if $\hat{\omega}$ is such that $R\hat{\omega} + \underline{\omega} < p$, a positive measure of consumers default with certainty.

We will now derive conditions under which a credit card equilibrium exists. To determine whether or not banks are willing to extend credit to consumers, take the first order condition for the issuer's profit maximization problem with respect to $\hat{\omega}$. Since optimal $\rho$ is given by (9) for any $\hat{\omega}$, we can first substitute (9) into (8) before taking the first order condition. The first derivative is given by:

$$\frac{\partial \Pi}{\partial \hat{\omega}} = (1-\gamma) f(\hat{\omega}) \left\{ c + \frac{1}{R} \left[ p(F(p - R\hat{\omega}) - 1) - \int_{\min\{R\hat{\omega} + \underline{\omega}, p\}}^{p} x f(x - R\hat{\omega}) dx \right] \right\}, \tag{11}$$

where $\hat{\omega}$ must lie in $[\underline{\omega}, \bar{\omega}]$.

**Proposition 2** *If $R$ and $c$ are not too large then in every equilibrium, the issuer extends credit (i.e., the $\hat{\omega} \in [\underline{\omega}, p)$), almost all merchants accept credit and some consumers default.*

**Proof:** To evaluate the first order condition we need to evaluate it for $\hat{\omega}$ where 1) $R\hat{\omega} + \underline{\omega} \geq p$ and 2) $R\hat{\omega} + \underline{\omega} < p$.

Consider $\hat{\omega}$ such that $R\hat{\omega}+\underline{\omega} \geq p$. In this case there will be no defaults—the minimum income required to qualify for a credit card, including the return it earns, and the minimum income in the second period is sufficient to fully repay $p$. In this case,

$$F(p - R\hat{\omega}) = \int_{\min\{R\hat{\omega}+\underline{\omega}, p\}}^{p} xf(x - R\hat{\omega})dx = 0,$$

so that (11) simplifies to:

$$\frac{\partial \Pi}{\partial \hat{\omega}} = (1 - \gamma)f(\hat{\omega}) \left\{ c - \frac{p}{R} \right\}. \tag{12}$$

If $R = 1$ or $c = 0$, this is strictly negative so that as long as $R$ and $c$ are not too large, an equilibrium must have $\hat{\omega} < p$ so that there is credit.

Now, notice that at $R\hat{\omega}+\underline{\omega} = p-\varepsilon$, for $\varepsilon$ sufficiently small this derivative is still negative. Since (11) is strictly negative for $\hat{\omega} \in [(p-\underline{\omega}-\varepsilon)/R, \bar{\omega}]$, any maximum must satisfy $R\hat{\omega} + \underline{\omega} < p$. Thus, in every equilibrium, a positive measure of the consumers who purchased on credit, $F(p) - F(R\hat{\omega} + \underline{\omega})$, default.

Finally, the analysis so far has assumed that all merchants accept credit cards. Suppose that this were not the case and that in equilibrium some proportion $\zeta$ accept credit cards while some proportion $1 - \zeta$ do not accept credit cards. In this case, the issuer's profits would be given by $\zeta\Pi$ where $\Pi$ is as given in (8) and optimal $\hat{\omega}$ is still characterized by (11). However, if the issuer lowered $\rho$ by $\varepsilon$, then all merchants would strictly prefer to accept credit. Since we can take $\varepsilon$ to be small, the issuer can discontinuously increase her profits by lowering $\rho$ and in equilibrium the set of merchants who do not accept credit is of measure zero. As a result, in equilibrium almost all merchants accept credit. ■

That is, as long as there are sufficient rents available and the cost of funds is not too large, in every equilibrium of this model the issuer offers credit, merchants accept credit cards, and consumers use credit cards to make purchases when possible. The issuer chooses the income requirement,

$\hat{\omega}$, above which consumers can purchase on credit, such that a non-zero mass of consumers will be unable to pay off their first period debt and default. If the objective function is concave, then the equilibrium is unique.

Combined with the fact that merchants are massless, the set of any individual merchant's repeat purchasers will be of measure zero. This implies that merchants will not consider the effect of current decisions on future revenues. Since merchants' second period revenues are not directly impacted by their decision over whether or not to accept credit and since all of the additional first period rents are extracted, they must be worse off because as long as the consumers' rate of return is sufficiently low, the aggregate second period distribution of wealth and therefore sales are lower.

**Proposition 3** *So long as the consumers' rate of return of funds is sufficiently low, in any credit card equilibrium, merchants' discounted expected profits are strictly less than when credit cards are not available.*

This effect comes about because merchants face an externality much like that in the Prisoner's Dilemma. As a group, merchants realize group acceptance of credit cards reduces second period profits and that first period rents generated by the acceptance of credit cards will be fully extracted—they therefore recognize that, as a group, they would be better off not accepting credit. Individually, however, a merchant's decision of whether or not to accept credit cards has no effect on net total consumer incomes and the issuer can choose $\rho$ such that all merchants find it in their best interest to accept credit cards. Thus, merchants accept credit despite the fact that they are made worse off.

One can also think of this externality as an intertemporal business stealing effect.[10] Since merchants are unlikely to face the same customer in the future, the acceptance of credit cards allows individual merchants to capture sales which might otherwise be made by another merchant in the second period. Business stealing in our model occurs across industries and across time unlike any other model of payment card networks. With no repeat purchasers for any individual merchant, an individual merchant's current decision has no impact on its future sales so that its decision is based only on the additional revenues generated today, leading to the externality described.

Note that this externality is not a feature of our assumed finite horizon. In each period, each merchant faces a decision over whether or not to accept

[10]Hayashi (2006), Rochet and Tirole (2002), and Wright (2004) model business stealing in a single period.

credit. If those that accept credit have positive mass, the wealth distribution in all future periods will be permanently shifted downwards. Moreover, in each future period the merchant faces the same optimization problem and in a credit equilibrium will choose to accept cards, again paying out additional rents due to the acceptance of credit. Thus, with a longer time horizon, merchants are actually hit twice; in the current period, additional rents are extracted and the income distribution gets shifted downwards; in subsequent periods, not only has income been shifted downwards but additional rents due to credit in these periods are also extracted. The key factor driving this result is the assumption that each merchant has very few (measure zero) repeat purchasers so that each individual credit acceptance decision has no affect on future profitability. We will consider the effect of relaxing this assumption below.

Furthermore, the exogeneity of prices is not an issue. At first glance, one might suppose that an ability to set prices would allow the merchant to retain a share of any additional rents. However, since the issuer can rationally anticipate any price increase, it can still choose $\rho$ to completely extract any additional rents. In other words, given full extraction, if the merchant can raise its price in response to the merchant discount, it would still be unable to retain any of the additional first period rents from sales to illiquid consumers. Therefore allowing merchants to set prices based on the underlying cost of the payment instrument used would not qualitatively change our results.

## 3 Policy Implications

Our model provides a benchmark for policymakers to consider when setting policies regarding credit card networks. We consider a credit card market where consumers are given rebates in the form of an interest-free short-term loan and merchants do not impose surcharges on credit card purchases. We also consider a monopolistic issuer and merchants that are monopolists but no single merchant has any bargaining power with the issuer. Under these conditions, we find under what conditions a credit card equilibrium exists and which participants benefit.

Like Rochet and Tirole (2002), we can also model both the merchant discount and the interchange fee by assuming that the market for acquirers is competitive. Given such market structures, interchange fees serve as a lower bound for the merchant discount. Industry estimates indicate that the market for acquirers is fairly competitive in the United States given that certain classes of merchants are basically charged a merchant discount close to the interchange fee. Our results suggests that given the market structures we consider, if there is significant market power to set these fees, both consumers and the issuer must be better off—if it were not the case then either consumers would refuse to use credit cards or the issuer would refuse to issue them.

However, whether merchants gain in a credit card equilibrium *vis-à-vis* a no credit card equilibrium depends on several factors. In our model, there is a single monopolistic issuer/network, merchants have no bargaining power and an individual merchant's current sales have no effect on future sales. To see the effect of relaxing these assumptions, first consider the extreme case where there is instead a single merchant who still has no bargaining power. This single merchant will face all future consumers so that any change in next period's distribution of consumer wealth will directly impact its future sales. As a result, the merchant will fully internalize the impact of its current credit acceptance decision. However, since the card issuer still holds all of the bargaining power, all rents will still be extracted and therefore the merchant must be indifferent between accepting credit and not. Now suppose that the single merchant does have some bargaining power. In this case, the merchant must garner a share of the rents and must therefore be better off. In general, we can think of a model in which both the number of merchants and their bargaining power can vary with the equilibria ranging from the merchants being worse off (infinite number of merchants and zero bargaining power) to the merchants being better off (one merchant with positive bargaining power). To summarize, the merchants' welfare depends on:

1. The degree of concentration in the market for credit cards.

2. The amount of bargaining power held by merchants.

3. The impact of a single merchant's decision on its volume of future sales.

In other words, there are conditions under which credit cards are Pareto improving. But when the issuer is noncompetitive, merchants have little bargaining power and if repeat sales are infrequent then merchants may be worse off.

Our model raises several policy questions regarding the regulation of credit card networks. First, to what degree are the credit card networks able to collude? Second, what is the impact of a single merchant's decision to accept credit cards on the future distribution of consumer wealth and therefore own future sales? Third, how much bargaining power do merchants have in the determination of the merchant discount? It seems reasonable to believe that for most merchants, the decision to accept credit cards or not will have little impact on future income distribution and consequently will have little impact on future sales. Moreover, bargaining power appears to differ between merchants ranging from almost no bargaining power to large chains with strong bargaining power. Merchants with strong bargaining power is evidenced by merchant discounts being extremely close to the appropriate interchange fee. Thus, under our framework, whether or not some merchants are worse off depends on the degree to which the credit card network is monopolistic.

Recently, Chakravorti and Roson (2006), Guthrie and Wright (2006), and Rochet and Tirole (2003) investigated the impact of network competition on optimal consumer and merchant fees. None of these studies is able to conclude that competition results in the optimal price ratio between consumers and merchants. However, Chakravorti and Roson are able to show that the overall price level unambiguously decreases with network competition.

# 4 Conclusion

We constructed a model where we consider the various bilateral relationships in a credit card network. With the exception of Chakravorti and Emmons (2003), the literature on credit card networks ignores the cost and benefits of the extension of credit to network participants. We explain why merchants accept credit cards using the most restrictive possible environment—a single issuer, massless merchants, and no cost sharing by consumers either directly in the form of fees or finance charges or indirectly in the form of higher prices. Credit increases sales because both purchases and incomes vary over time and with credit cards 'credit worthy,' liquidity-constrained consumers are able to purchase—all else equal, merchants prefer to make a sale today rather than tomorrow. We demonstrate that a credit card equilibrium can exist if the cost of funds is relatively low and the merchant's profit margin is sufficiently high. We also show that using the merchant discount, the issuer will be able to fully extract rents from merchants resulting from sales to illiquid consumers.

Furthermore, the equilibrium interaction between the merchant discount and the accessibility of credit has network effects. If the card issuer makes credit more widely available, the merchant increases its sales to illiquid customers. This in turn allows the card issuer to increase the discount the merchant is charged. In other words, merchants are willing to pay higher merchant discounts if credit cards generate greater sales. That is, credit card services exhibit network effects.

Finally, we show that there is an externality where merchants find themselves in a prisoner's dilemma situation. In equilibrium, each merchant chooses to accept credit cards. However, when all merchants accept credit cards, they are all worse off. This result is dependent on the degree of market power held by the issuer, the amount of bargaining power held by merchants, and the ability of merchants to internalize the effect of their current credit acceptance decision on their own future sales. This result is unique to our model.

To summarize, we constructed a dynamic model of credit cards where the benefits to various participants are endogenously determined. Furthermore, in addition to explaining why merchants are willing to accept credit cards, the explicit dynamic nature of the model allows us to identify an important, intertemporal externality which exists in the market for credit cards. The existence of this externality may have important antitrust implications—what conclusion one draws depends on the degree to which the credit card network is monopolistic.

## References


Barron, J. M., M. E. Staten and J. Umbeck, "Discounts for Cash in Retail Gasoline Marketing," *Contemporary Policy Issues*, 10:89–102, 1992.

Baxter, W. F., "Bank Interchange of Transactional Paper: Legal and Economic Perspectives," *Journal of Law and Economics*, 26:541–48, 1983.

Board of Governors of the Federal Reserve System, *Credit Cards in the U.S. Economy*, Washington, DC: Board of Governors of the Federal Reserve System, 1983.

Board of Governors of the Federal Reserve System, *Semiannual Survey of Credit Card Plans*, Washington, DC: Board of Governors of the Federal Reserve System, 2000.

Chakravorti, S., "Theory of Credit Card Networks: A Survey of the Literature," *Review of Network Economics*, 2(2):50–68, 2003.

Chakravorti, S. and W. R. Emmons, "Who Pays for Credit Cards?" *Journal of Consumer Affairs*, 37(2):208–230, 2003.

Chakravorti, S. and R. Roson, "Platform Competition in Two-Sided Markets: The Case of Payment Networks," *Review of Economics*, 5(1):72–102, 2006.

Chakravorti, S. and A. Shah, "Underlying Incentives in Credit Card Networks," *The Antitrust Bulletin*, 68(1):53–75, 2003.

Committee on Payment and Settlement Systems, *Statistics on Payment and Settlement Systems in Selected Countries*, Basel, Switzerland: Bank for International Settlements, 2005.

Economides, N., "The Economics of Networks," *International Journal of Industrial Organization*, 14(2):673–99, 1996.

Food Marketing Institute, *It All Adds Up: An Activity Based Cost Study of Retail Payments*, Washington, DC: Food Marketing Institute, 2000.

Frankel, A. S., "Monopoly and Competition in the Supply and Exchange of Money," *Antitrust Law Journal*, 66:331–361, 1998.

Gans, J. S. and S. P. King, "Approaches to Regulating Interchange Fees in Payment Systems," *Review of Network Economics*, 2(2):125–145, 2003a.

Gans, J. S. and S. P. King, "The Neutrality of the Interchange Fees in Payment Systems," *Topics in Economic Analysis and Politics*, 3(1), 2003b.

Gans, J. S. and S. P. King, "A Theoretical Analysis of Credit Card Reform in Australia," *Economic Record*, 79(247):462–472, 2003c.

Guthrie, G. and J. Wright, "Competing Payment Schemes," *Journal of Industrial Economics*, forthcoming, 2006.

Hayashi, F., "A Puzzle of Card Payment Pricing: Why Are Merchants Still Accepting Card Payments?" *Review of Economics*, 5(1):144–174, 2006.

IMA Market Development AB, *Study Regarding the Effects of the Abolition of the Non-Discrimination Rule in Sweden*, European Commission: Competition Directorarte General, 2000.

Katz, M. L. and C. Shapiro, "Network Externalities, Competition, and Compatibility," *American Economic Review*, 75(3):424–40, 1985.

Kitch, E. W., "The Framing Hypothesis: Is It Supported by Credit Card Issuer Opposition to a Surcharge on a Cash Price," *Journal of Law, Economics, and Organization*, 6(1):217–33, 1990.

Lobell, C. D. and J. W. Gelb, "The Cash Discount Act," *New York Law Journal*, pp. 1–4, 1981.

Rochet, J.-C. and J. Tirole, "Cooperation Among Competitors: The Economics of Payment Card Associations," *Rand Journal of Economics*, 33(4):549–570, 2002.

Rochet, J.-C. and J. Tirole, "Platform Competition in Two-Sided Markets," *Journal of European Economic Association*, 1:990–1029, 2003.

Schmalensee, R., "Payment Systems and Interchange Fees," *Journal of Industrial Economics*, 50:103–122, 2002.

Schwartz, M. and D. R. Vincent, "The No Surcharge Rule and Card User Rebates: Vertical Control by a Payment Network," *Review of Economics*, 5(1):72–102, 2006.

Vis, E. and J. Toth, *The Abolition of the No-Discrimination Rule*, Amsterdam: The Netherlands: ITM Research for Competition DG, 2000.

Wright, J., "An Economic Analysis of a Card Payment Network," 2000, NECG and University of Aukland working paper.

Wright, J., "The Determinants of Optimal Interchange Fees in Payment Systems," *Journal of Industrial Economics*, 52(1):1–26, 2004.