A Theory of Credit Cards

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Abstract

Recent U.S. antitrust litigation and regulatory concerns over fees in Australia have questioned the nature of the various bilateral relationships and associated fees underlying credit card transactions. 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, a credit card equilibrium exists. 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 are worse off as a result.

JEL Classifications: G2, D4, L2
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Today, credit cards serve as an indispensable credit and payment instrument in the United States. In 1999, there were 14.2 billion credit card transactions accounting for $1.096 trillion (Credit Card News, 2000). The popularity of credit cards continues to grow as evidenced by the greater proportion of merchants that accept them and of consumers that carry them. In this article, we explore the costs and benefits of credit cards to consumers, merchants and the card issuer using a dynamic model.

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. Ernst and Young (1996) found that 83 percent of merchants thought that their sales would increase and 56 percent thought that their profits would increase by accepting credit cards. Merchants benefit from sales to illiquid consumers who would otherwise not be able to make the purchase. By participating in a credit card network, merchants are guaranteed funds usually 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.[2] Furthermore, in today's competitive marketplace, 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 (1998), credit cards on average cost supermarkets $1.07 per transaction compared to 8¢ for cash, 22¢ for online debit cards and 58¢ for checks.[3] A significant portion

[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] Based on our discussions with online merchants, there are few alternatives to credit cards today.

[3] Online debit cards use automated teller networks to process transactions as opposed to offline cards that use credit card networks

of the cost is due to the merchant discount, the level of discount that each merchant receives when converting its credit card receipts into good funds. In the United States, merchant discounts generally range from 1.25 percent to 3 percent and are bilaterally negotiated between merchants and their financial institutions.

Merchants seldom charge more to credit card customers. Price discrimination at the point of sale has a long legislative and legal history (see Barron et al., 1992; Board of Governors of the Federal Reserve System, 1983; Chakravorti and Shah, 2001; Kitch, 1990; Lobell and Gelb, 1981). While credit card surcharges are relatively rare, some merchants in California do impose surcharges on purchases made with online debit cards suggesting that merchants may face barriers to imposing credit-card surcharges at the point of sale.

Some credit-card pricing issues have been recently challenged in the U.S. courts. One antitrust case questions various credit card association rules such as duality, the ability of member institutions to issue both MasterCard and Visa products, and exclusivity, the inability of members of the associations to issue credit and charge cards from competitor networks. The other case questions the universal acceptance clause requiring merchants to accept all payment products offered by the card association's members carrying its logo. In this article, we explore some of these issues in the context of the model we develop.

Our paper provides answers to the following questions. Why do merchants accept credit cards even though credit cards are the most expensive payment instrument to process? What conditions are necessary for a credit card equilibrium to exist? Does the market for credit cards exhibit network externalities? Does the decision of a merchant to accept credit cards affect profits of other merchants?

We construct a two-period, three-agent, dynamic model to investigate these questions. 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 bank increases as the number of illiquid credit card consumers increases. This result indicates network externalities in the credit card market. Third, a prisoner's dilemma situation arises, where each merchant chooses to accept credit cards but by doing so they are all worse off as a group. 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.

1 The Model

In our model, the five major 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.[4] The issuer, the acquirer, and the network operator are assumed to be a single agent and referred to as the issuer. This may not be unrealistic given the history of the credit-card industry—when Bank of America started operating a credit-card system in 1958 it served as issuer, acquirer, and network operator.[5]

Assume that there is a continuum, say $[0, 1]$, of indivisible goods exogenously priced at p. Each good is sold by monopolistic merchant for whom unit cost is $c < p$.[6] 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.[7] 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 γ a consumer does not need to consume one of these

[4] American Express and Discover operate in this manner. Although American Express is primarily known for its charge cards, it also issues credit cards such as Optima and the new Blue card.

[5] In the 1960s, Bank of America licensed its BankAmericard product to other banks in large part because interstate branching restrictions at the time hindered expansion. Today, the BankAmericard is known as Visa, the most recognized and largest worldwide credit card network. For more details, see Chakravorti (2000), Evans and Schmalensee (1999), Mandell (1990) and Nocera (1994).

[6] Rochet and Tirole (2000) and Schmalensee (1999) also assume noncompetitive goods markets in their credit card models.

[7] We do not allow merchants to issue their own credit cards. We assume that the issuer has special skills in approving and extending credit and access to liquidity. 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. Nilson Report (1999) reported U.S. general-purpose credit and charge card transactions in 1998 at 10.04 billion valued at $986 billion whereas proprietary credit card transactions at 3.38 billion valued at $145 billion.

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 price discriminate between credit card and cash purchasers. Why merchants do not price discriminate 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. For example, in the eighties, some gasoline retailers gave discounts for cash payments but eventually returned to a policy of uniform pricing (Barron et al., 1992). In addition, national and state laws have also restricted pricing policies in the past and some states continue to do so. In 1999, California, Colorado, Connecticut, Florida, Kansas, Maine, Massachusetts, New York, Oklahoma, and Texas prohibited merchants from imposing credit card surcharges. However, Federal Reserve Regulation Z allows all merchants to offer discounts for non-credit-card purchases. Given that there is no economic difference between imposing surcharges for credit-card purchases or offering discounts for non-credit-card purchases, it seems puzzling that both types of statutes coexist.

The assumption that prices are exogenously set is not entirely unrealistic as we can take the magnitude of the markup to be dependent on the structure of the product market (i.e., the elasticity of demand, the availability of close substitutes, etc).[8] Furthermore, franchises often make "suggestions" to franchisees regarding many of their operating conditions, such as price. Moreover, 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

[8] Chakravorti and Emmons (2001) construct a model where they consider price changes resulting from costs associated with credit cards in a competitive goods market.

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 ω_t in periods $t = 1, 2$. For each consumer, ω_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 β. Consumers may choose from two payment instruments. They can pay with cash or with a credit card if they have sufficient credit available.[9] 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 ω_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.[10] It is important to 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 and industry estimates that over forty percent of credit-card consumers pay off their balances in full every month. Some issuers have specifically targeted pricing policies and incentives towards this group of consumers (see Chakravorti and Shah, 2001). Furthermore, the qualitative results of the model would not change if an additional period of credit were added, however a monopolist issuer should be able to earn rents from consumers in addition to rents that it earns from merchants.

Since the price of each good is identical, without loss of generality, the issuer can choose credit

[9] Cash transactions are assumed to have zero cost to consumers and merchants. An interesting extension of this model would be to consider payment instruments that withdraw funds from the consumer's transaction account electronically in real time such as debit cards.

[10] While there is uncertainty at the consumer level, there is no aggregate uncertainty given the large number of consumers. Hence, the issuer's credit risk is zero. The results would not qualitatively change if aggregate uncertainty were introduced.

Date	Agent	Actions
$t = 0$	Issuer	Choose $\hat{\omega}$ and ρ
	Merchants	Accept/Not-Accept Credit Cards
$t = 1$	Nature	Determine ω_1 and demand for each consumer
	Consumers	Buy/Not-Buy If Buy, Use/Not-Use Credit
$t = 2$	Nature	Determine ω_2 and demand for each consumer
	Issuer	Collect Debts
	Consumers	Make Cash Purchases

Table 1: Sequence of actions

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 sum of the sales receipts minus 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. Thus, in equilibrium all merchants will either accept credit cards or none will accept them.[11]

The structure of the model is illustrated in Table 1. At time 0, the issuer chooses the transaction fee, ρ, and the minimum income, $\hat{\omega}$, for consumers to qualify for a credit card. Merchants then decide whether or not to accept credit. At the beginning of periods 1 and 2, consumer incomes and desired consumptions are randomly determined. In period 1, each consumer decides whether to

[11] We later verify this in the proof of Proposition 2.

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 in period 2. 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 the consumer 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, ω_1. Her total money 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 ω_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 money. 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 β. 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 γ, 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 price discriminate, liquid consumers would choose to use cash over credit cards given the appropriate price difference. However, there is no consensus in the academic literature about the welfare effects of price discrimination. Chakravorti and Emmons (2001) suggest price discrimination improves welfare given competitive markets. Schwartz and Vincent (2000) suggest that consumer surplus is reduced in the absence of price discrimination. Rochet and Tirole (2000) and Wright (2000) suggest that in most cases allowing for price discrimination is not welfare enhancing. We will discuss the effect of price discrimination on other participants in the context of our model below.

2.2 Merchants

We are primarily interested in and 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 ρ 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 ρ is sufficiently small, if $\hat{\omega} < p$ then it is to the advantage of the merchant 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 ρ. 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 ρ and $\hat{\omega}$. The question then is, under what conditions will the issuer choose ρ 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 ω_1 is $G(x \mid \omega_1) = \Pr[R\omega_1 + \omega_2 \leq x] = F(x - R\omega_1)$. Conditional on $\omega_1 \geq \hat{\omega}$ for some $\hat{\omega} < \bar{\omega}$, 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, Π is continuous. Since $(\rho, \hat{\omega})$ must belong to the compact set $[0, p - c] \times [\underline{\omega}, \bar{\omega}]$, Π has a global maximum so that there exists at least one equilibrium. We now investigate some of the properties of these equilibria.

Notice that ρ'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 ρ 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, ρ 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).

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.

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 ρ 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^2 are not too large then in every equilibrium, the issuer extends credit (i.e., the $\hat{\omega} \in [\underline{\omega}, p^2)$), 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 ε 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 ζ 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 Π is as given in (8) and optimal $\hat{\omega}$ is still characterized by (11). However, if the issuer lowered ρ by ε, then all merchants would strictly prefer to accept credit. Since we can take ε to be small, the issuer can discontinuously increase her profits by lowering ρ 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 the aggregate second period distribution of wealth and therefore sales are lower.

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 ρ 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.[12] 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 in the future with another merchant. Note that this externality is not a feature of our assumed finite horizon. In any given period, the merchant faces a decision over whether to accept credit. With almost no repeat purchasers, their current decision has no impact on future sales so that their decision is based only on the additional revenues generated today, leading to the externality described.

Furthermore, the exogeneity of prices is not an issue when the issuer is a monopolist. 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

[12] Usually business stealing occurs in the same period. For example a merchant's decision to accept credit cards is influenced by its competitors. If no merchant accepts credit cards, the first one that does may be able to steal customers.

still choose ρ 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 first period rents from illiquid consumers. Allowing merchants to price discriminate (offer cash discounts or impose credit surcharges) would not qualitatively change our results since the issuer would still fully extract the rents merchants gain from illiquid consumers. In a credit card equilibrium, the result that merchants are worse off relative to the no credit card equilibrium still holds. First period sales expand as a result of the availability of credit but the merchants reap none of these additional rents. However, the additional first period sales reduce the second period wealth distribution, reducing second period sales and therefore the merchants are still worse off.

Finally, we would like to discuss introducing revolving credit. One way to introduce revolvers is to add a third period during which consumers receive further income but do not consume. Consumers who are unable to pay their remaining balances in the second period must pay interest on the remaining balances in the third period. Allowing for revolvers in this manner involves some additional difficulties; it complicates the consumer's problem and the rate of interest charged to the consumer should ideally be endogenously determined by the issuer. However, as far as the choice over the availability of credit goes, the problem remains essentially unchanged. Given some interest rate on consumer debt, one can easily calculate the future distribution of income. As long as this distribution is reasonably well behaved, maximizing issuer profits will yield qualitatively identical results.

3 Policy Implications

There are two antitrust cases pending against the two largest credit card networks—MasterCard and Visa—that claim over 75 percent of the general-purpose credit card market. In the first case, the U.S. Department of Justice charges the two associations with colluding. The Justice Department claims that these anticompetitive practices result in higher merchant discounts than those that would exist in competitive markets. The lower bound of the merchant discount is determined by the interchange fee. An interchange fee is paid by the merchant's financial institution to the consumer's institution.[13] Because interchange fees are set at the network level, insufficient competition at the network level may lead to higher interchange fees resulting in higher merchant discounts. The other case filed by a group of retailers led by Wal-Mart charges the two credit-card associations with imposing illegal tying arrangements that force merchants accepting one of the credit-card association's payment products to accept all of their products at the same price.

A key issue in the Department of Justice antitrust case is the nature of the cooperative arrangement in setting certain fees such as the interchange fee—the fee collected by the issuer from the acquirer. Rochet and Tirole (2000) and Schmalensee (1999) examine the setting of the interchange fee. Rochet and Tirole conclude that there are conditions under which the equilibrium interchange fee is second best optimal and that lifting the no-surcharge rule in these cases reduces welfare. When the equilibrium interchange fee is sub-optimal, lifting the no-surcharge rule may either increase or reduce welfare. Schmalensee does not model the product market and as a result cannot conduct welfare analysis. Instead, he looks at interchange fees which maximize the weighted sum of issuer and acquirer profits under various competitive regimes. Both Rochet and Tirole, and Schmalensee conclude that interchange fees need not, as argued by some, be zero.

Our model differs in two respects. 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. 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 future earnings.

Although we did not design our model with the antitrust issues raised in the two lawsuits in mind, the model provides some insight. The conclusions one can draw about antitrust issues depends on the actual market structure in place—this is an empirical and legal question beyond the scope of the current exercise—and its potential benefit or harm to the economy. Furthermore, we admittedly do not capture all aspects of the credit card market. With these caveats in mind,

[13] Interchange fees also exist in ATM networks. In ATM networks, the consumer's financial institution pays the operator of the ATM used. For a discussion of credit card interchange fees see Evans and Schmalensee (1999) and Balto (2000).

we offer some cautious observations.

Like Rochet and Tirole (2000) and Schmalensee (1999), we can also discuss equilibrium interchange fees. Suppose that an acquirer and a card issuer are necessary to complete a credit card transaction. As in Rochet and Tirole, assume that the acquiring banks have a transaction cost of η and are competitive so that the merchant discount is simply the sum of the interchange fee and η. That is, in our model, the interchange fee is chosen by the card issuer and is given by $\rho - \eta$. If we take η to be sufficiently small, then the equilibrium will be the same as in our prior analysis.

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:

i) The degree of concentration in the market for credit cards.

ii) The amount of bargaining power held by merchants.

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

This raises several questions regarding the Department of Justice antitrust case. First, to what degree are the credit card networks able to collude? Second, what is the impact of a single merchant's credit decision 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 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. This is evidenced by the fact that merchants bilaterally negotiate merchant discounts with their acquirers. Thus, under our framework, whether or not some merchants are worse off depends on the degree to which the credit card network is monopolistic. Together MasterCard and Visa hold 75 percent of the credit card market and whether or not they have been able to successfully collude in setting merchant discounts is an empirical and legal question.

4 Conclusion

In this article, we constructed a model along the lines of Baxter (1983) where we consider the various bilateral relationships in a credit card network. Our model explains why merchants accept credit cards in the most restrictive possible environment—one 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 predict that the issuer is able to fully extract rents from merchants resulting from sales to illiquid consumers.

The equilibrium interaction between the merchant discount and the accessibility of credit has properties similar to network externalities. 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. Such a result demonstrates that credit card services exhibit network good characteristics. To our knowledge our model is the only one that generates such a network effect in the context of credit card services.

We also derive 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.

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 market is monopolistic.

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