POLICY STUDIES

# Who Pays for Credit Cards?

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# WHO PAYS FOR CREDIT CARDS?


## ABSTRACT

We model side payments in a competitive credit-card market. If competitive retailers charge a single (higher) price to cover the cost of accepting cards, banks must subsidize convenience users to prevent them from defecting to merchants who do not accept cards. The side payment will be financed by card users who roll over balances at interest if their subjective discount rates are high enough. Despite the feasibility of cross subsidies among cardholders, price discrimination without side payments is Pareto preferred because of the costliness of the card network—unless banks have other motives, such as purchasing options on future borrowing by current convenience users.



Key words: credit cards, payments systems, consumer credit

JEL Classification: D11, D23, G21

# WHO PAYS FOR CREDIT CARDS?

> I view credit cards, bank originated or other, as a temporary but probably unavoidable retreat in the campaign to develop an efficient domestic payments mechanism.
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> Donald D. Hester, "Monetary Policy in the 'Checkless' Economy," *Journal of Finance* 27 (1972), May, p. 285.

Most payments researchers today would agree that the question of whether credit cards are "overused" is not a simple one. Wells (1996), for example, argues that checks may not be overused in the United States— even though they are very expensive to process— because consumers value some of their features very highly. Credit cards appear to be an even more expensive retail payment instrument than checks (Humphrey and Berger, 1990), yet they too have passed a market test of acceptance in the United States and, increasingly, abroad. Thus, we need to understand why and how credit-card usage has turned out to be not a "temporary retreat" but a full-scale assault on the retail payment practices that existed previously.

Credit cards serve not only as a source of revolving credit but also as a popular payment instrument among those who routinely pay off their balances in full each month. This is somewhat surprising because credit cards require an expensive supporting infrastructure. Do those who pay off their balances regularly pay for the services they receive? If they don't, who does?

This paper develops a model of the interrelated markets for credit-card issuance by banks and card-acceptance by merchants to explore the relationship between the pricing of goods and services in retail stores and the pricing of credit-card services. Credit-card fees include finance charges on borrowings, fixed fees, and usage fees (or subsidies). We assume that banks and retailers provide goods and services in competitive markets. Thus, consumers as a group or certain types of consumers ultimately pay for credit card services.[1] We derive four main results. First, a card-accepting merchant can serve the entire market by price-discriminating among consumers on the basis of payment method, but only liquidity-constrained customers will use credit cards.

Second, if merchants charge a single price regardless of how consumers pay and there are no side payments made by banks to "convenience users"— those who can purchase goods with cash if they so choose—, then card-accepting merchants who charge a uniform price for all purchases will attract only liquidity-constrained consumers.[2] In a competitive goods market, a card-accepting merchant must raise the goods price to cover the cost of accepting credit cards, but the higher price drives customers who can pay cash to other merchants who do not accept credit cards and hence can charge a lower price.

Third, we show that a merchant can, under certain conditions, attract all types of consumers— liquid and illiquid— where a uniform price is charged. However, card issuers must compensate convenience users for the higher goods prices that universal card usage necessitates.[3] In our model, a credit card equilibrium where liquid consumers use credit cards can only be supported if liquidity-constrained consumers subsidize their credit-card usage.

Finally, our model shows when credit-card usage can be welfare-enhancing. The key assumption in this regard is that at least a certain number of consumers face binding liquidity

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[1] Chakravorti and To (1999), Rochet and Tirole (2000), and Schmalensee (1998) consider non-competitive markets for goods and credit card services.

[2] Pricing policies such as one-price may be set at the network-level. In the past, this policy was mandated by the government. We assume the one-price policy as an exogenous constraint and search for conditions under which this arrangement is feasible. Currently, Federal Reserve Regulation Z prohibits the banning of discounts to consumers using other payment instruments. However, there are state laws and card association rules that prohibit imposing surcharges for credit-card purchases. For a discussion of cash discounts and credit card surcharges, see Barron, Staten, and Umbeck (1992), Kitch (1990), and Lobell and Gelb (1981).

[3] Given our assumption that markets are competitive, the costs of credit cards falls on consumers either in the form of higher prices or fees and finance charges imposed by card issuers. However, if markets are not competitive

constraints. Intuitively, the value of consumer credit may outweigh the costliness of the payment instrument with which it is bundled.

The paper is organized as follows. Section I provides an overview of credit-card costs and usage. Section II discusses previous contributions to the literature on credit-card usage. In Section III, we develop a model of the interrelated downstream markets in a credit-card network. We consider three pricing and subsidy schemes, including differentiated pricing and a single goods price with and without cross-subsidization within the credit-card network. Section IV compares the three schemes in terms of allocative efficiency and a simple utility-based measure of social welfare. Section V concludes.

## I. Credit-Card Costs and Usage

Table 1 shows that credit cards are relatively expensive retail payment instruments for merchants to accept. Compared to cash, which costs supermarkets only about 22 cents per $100 of purchases, credit cards appear to be extravagantly expensive, costing $2.41, nearly 11 times as much (Food Marketing Institute, 1998). A large component of merchants' cost of accepting credit cards is the merchant discount, the fraction of the face value of sales receipts that the merchant's bank retains as its fee. From the standpoint of the economy as a whole, this is simply a transfer payment, not a real resource cost. Taking these transfer payments into account and netting them out, however, Humphrey and Berger (1990) concluded that credit cards are indeed one of the most resource-intensive retail payment instruments. They calculate the total cost of credit cards to be 88 cents compared to 4 cents for cash and 79 cents for checks (in 1988 dollars).

Despite relatively high costs, credit-card usage is growing rapidly in the United States. The market share of credit cards increased from 14.5 percent to 21.4 percent in terms of the total

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merchants and card issuers could also share in the costs. See Chakravorti and To (1999), Rochet and Tirole (2000), and Schmalensee (1998) for models where markets are not assumed to be competitive.

dollar volume of consumer payments in the United States between 1990 and 1998, while market share in terms of consumer transactions increased from 13.9 percent to 17.4 percent (Nilson Report, 1997 and 1999).[4] A prominent trade publication predicts that, by 2005, the market shares of credit and charge cards will rise further to 25.6 percent in terms of dollar volume, and slightly decrease to 16.1 percent in terms of transactions (Nilson Report, 1999).[5]

## II. Previous Literature

Several good sources of detailed historical and institutional background on the credit-card market exist (Mandell, 1990; Evans and Schmalensee, 1993 and 1999; Nocera, 1994; Chakravorti, 2000). In Figure 1, we diagram the set of bilateral interactions that comprise a credit-card transaction. Prior to making credit-card purchases, consumers establish credit lines with their banks that they access at the point of sale with their credit cards. If a credit card is used, the merchant seeks authorization via the credit-card network. If a credit card is accepted for payment, the merchant submits its receipts to its bank. The merchant's bank presents the credit-card receipts to the consumer's bank. Then, the consumer's bank sends funds to the merchant's bank, which credits the merchant's account. At some later date, the consumer's bank bills the consumer for the credit-card purchases.

In Figure 2, we diagram the underlying fee structure of the transactions described above. In today's marketplace, consumers are not usually charged explicitly by merchants at the point of sale for using their credit cards. However, merchants pay their banks a fee for each credit-card transaction. The merchant's bank is charged an interchange fee by the consumer's bank. If consumers pay for their credit-card purchases when billed, they receive benefits, most notably an

[4] These figures include both credit and charge cards; only the former allow consumers to revolve balances.

interest-free short-term loan, and often incur no usage costs. If consumers pay in installments they pay an interest rate of which a part may be used to cover the costs associated with credit-card processing.

We divide the analytical literature on credit cards into three main groups, corresponding to the three sets of agents we study: consumers, merchants, the banks and the network associations. As this classification scheme and our discussion should make clear, much of the research to date on credit cards has focused on specific parts of the network, rather than attempting to integrate the pieces into a coherent whole.

**A. Consumer choice and credit cards.**

Many consumers value uncollateralized credit lines for making purchases when they are illiquid (i.e., before their incomes arrive) at relatively high interest rates. Because few alternatives to short-term uncollateralized credit exist, the demand for such credit may be fairly inelastic with respect to price (Brito and Hartley 1995).[6] Ausubel (1991) suggests that consumers may not even consider the interest rate when making purchases because they do not intend to borrow for an extended period when they make purchases; however, they change their minds when the bill arrives.

Stavins (1996) argues that consumers are somewhat sensitive not only to changes in the interest rate but also to the value of other credit-card enhancements such as frequent-use awards, expedited dispute resolution, extended warranties, and automobile rental insurance. However, she agrees with Ausubel (1991) and Calem and Mester (1995) that lowering interest rates may attract less creditworthy consumers, therefore dissuading some credit-card issuers from lowering their interest rates.

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[5] Nilson (1999) predicts that debit cards will play a larger role in retail payments in the United States and slightly affect credit card use.

What is surprising is that even liquidity-unconstrained consumers use credit cards. Industry sources estimate that convenience users comprise between thirty percent to forty percent of credit-card users. Whitesell (1992) argues that the opportunity cost of holding cash and of using checks in terms of lost float (especially for large transactions) exceeds that of credit cards. In addition to float, there may be other advantages to credit cards such as dispute resolution and limited consumer liability if the card is fraudulently used. Chakravorti (1997) argues that in today's marketplace, consumers have strong incentives to use credit cards for all purchases and pay of their balances each month.

The consumer credit-card use literature suggests that liquidity-constrained consumers are willing to pay relatively high interest rates partly because they have few alternatives and their demand for these services is fairly inelastic. Their demand inelasticity may be partly due to their relatively high discounting of future consumption. Card issuers could capture the difference between the willingness to pay higher interest rates and the cost of providing such loans, and distribute it to other agents as an incentive to increase their participation.[7]

**B. Merchants and credit cards.**

Less research has focused on merchants' acceptance of credit cards. This omission is perhaps surprising in light of the fact that the decision to accept credit cards appears to reduce merchant revenues by one to three percent— the amount of the discount merchants face in converting credit-card receipts into bank funds.

However, merchants may derive some offsetting benefits from accepting credit cards. Murphy and Ott (1977) suggest that merchants absorb some of the costs of credit-card use in order to price-discriminate among customers. According to Ernst and Young (1996), 83 percent

[6] Some financial institutions may allow overdrafts on checking accounts at interest rates comparable to credit cards.
[7] We will discuss possible motivations for banks to entice convenience users below.

of merchants surveyed thought that accepting credit cards would increase sales and 58 percent thought accepting credit cards would increase profits.  Note that according to the survey, an increase in sales is not necessarily associated with an increase in profits. Another advantage of accepting credit cards for merchants is that a third-party guarantees payment and the credit card receipts are converted to good funds relatively quickly.

**C.  Credit-card banks and networks.**

Banks influence the behavior of both consumers and merchants.[8]  Why banks encourage credit-card convenience use has two potential answers.  Extending credit cards to convenience users could be interpreted as banks buying options on future borrowing by consumers. Alternatively, banks might be subsidizing convenience users simply to make their overall portfolio performance look better in terms of lower chargeoffs and larger credit card volumes. We do not model the bank’s motivation to cross-subsidize convenience users in our one-shot static model; instead we explore market conditions where such cross-subsidization is possible.

Evidence on the subsidy to convenience users is difficult to quantify.  However, the existence of such a subsidy can be inferred from the following two observations.  First, the proportions of revenues and costs of card issuers, shown in Figure 3, indicate that the interchange fee and annual fees are relatively small portions of a credit issuer’s revenue at 10.7 percent.  Meanwhile, the cost of funds and operations is over two-thirds of the total.  Second, the interchange fee charged by American Express, primarily a charge-card issuer, is higher than those of Visa, MasterCard, and Discover, which are primarily credit card issuers.

Any model that seeks to accurately depict credit-card pricing policies must study the set of interrelated transactions as a whole.  However, only a few researchers, such as Baxter (1983), Chakravorti and To (1999), Rochet and Tirole (2000), and Schmalensee (1998) have investigated the broad array of interlinking relationships among the participants in a typical credit-card transaction. The key insight of Baxter's analysis is that the demand for and supply of *consumer* payment services need not generate the same level of output as generated by the demand for and supply of *merchant* payment services. In order to equilibrate these two distinct, yet fundamentally interdependent, markets, Baxter suggests a system of side payments might be necessary.

## III. A Model of Downstream Credit-Card Markets

Our model follows Baxter (1983) by analyzing incentives and constraints facing credit-card network participants interacting in distinct yet related markets. In contrast to Baxter, we emphasize downstream credit-card markets (card issuance and card acceptance) instead of upstream markets (general-purpose cards and interbank services).[9]

This section of the paper is composed of four parts. First, we present the basic model. The next subsection discusses a network in which merchants charge different prices to consumers according to their means of payment, either credit cards or cash. In the third subsection, we discuss the feasibility of a single-price retail environment. This discussion is inspired by the stylized fact that we very seldom observe merchants explicitly charging different prices according to the payment instrument used. Finally, we introduce the possibility of cardholder benefits paid by card-issuing banks to convenience users of credit cards in a single-price retail environment.

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[8] Although the consumer's bank and the merchant's bank may be different, many policies are agreed upon at the network level. Certain networks such as American Express and Discover do not have two distinct institutions serving consumers and merchants.

## A. The Model.

The economy has three dates, $t = 0$, $1$, and $2$, and many risk-neutral agents of four types: consumers, merchants, consumers' banks, and merchants' banks. Consumers receive a random income and wish to purchase goods from merchants. Consumers may use their credit cards to borrow from their banks in order to consume before their income arrives. If consumers use credit cards to purchase the good, merchants must clear sales receipts through their own banks back to consumers' banks.

All consumers are identical at $t = 0$, but differ at $t = 1$ according to the realization of the first of two random income shocks. Consumers are Type 1 if they receive no income at $t = 1$; type-2 consumers receive one dollar in cash at $t = 1$ and nothing in period 2. Type-1 consumers constitute the fraction $\alpha$ of the unit mass of all consumers and type-2 consumers have measure $1-\alpha$. Given that they receive nothing at $t = 1$, type-1 consumers face another income risk at $t = 2$: they receive one dollar of income with probability $1-\beta$, and they receive nothing with probability $\beta$. Thus, the ex ante probability of any consumer receiving one dollar of income at $t = 1$ is $1-\alpha$ (i.e., the probability of being a type-2 consumer). The probability of receiving one dollar at $t = 2$ is $\alpha(1-\beta)$; and the probability of receiving no income in any period is $\alpha\beta$. We refer to the latter two groups of consumers as "illiquid but solvent" Type 1s and "insolvent" Type 1s, respectively. All agents in the economy know the population values $\alpha$ and $\beta$, but a consumer's type is revealed after banks set their credit card policies and merchants have chosen whether to accept credit cards or not.

All consumers prefer to consume at $t = 1$ rather than $t = 2$. In particular, every consumer is willing to pay $1+m$ times as much for the good at $t = 1$ compared to $t = 2$. The parameter $m$

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[9] For precise definitions of upstream and downstream markets within credit-card networks, see United States Department of Justice (1998, pp. 6-8).

thus measures the impatience of consumers; if this subjective discount rate is higher than the consumer's borrowing rate, *i*, then borrowing to consume at $t = 1$ raises the welfare of type-1 consumers.

Only consumers' banks can lend to consumers. One could justify this assumption by defining banks as entities that specialize in credit-screening and loan collection, so merchants could conceivably own banks. This assumption is not critical for our analysis, which focuses on pricing and subsidization in downstream credit-card markets.

We assume that interbank clearing and settlement of credit-card receipts occurs instantly. Merchants' banks purchase these receivables from merchants and sell them to the consumers' banks that issued them. As before, our assumption that consumers' and merchants' banks are distinct entities is not critical for our story because interbank-clearing arrangements are part of the upstream credit-card market.

Payment clearing proceeds as follows. Consumers' banks incur a proportional cost *k* per dollar of credit-card receipts sent through the network; in other words, consumers' banks own the infrastructure. The cost *k* stands for telecommunications, computing, and other unit costs. These are the real incremental resource costs of operating the network compared to an all-cash economy (which we assume has zero transaction costs). We assume for ease of exposition that there are no fixed network costs.[10]

Merchants' banks implicitly charge merchants a discount, *d*, when purchasing credit-card receivables, so merchants' net proceeds from one unit of sales using a credit card are $p(1-d)$, where *p* is the purchase price per unit paid by consumers and is endogenous. Receivables are then sold by merchants' banks to consumers' banks for the face value of the receivables less a proportional interchange fee, $n$. Thus, merchants' banks earn a margin of $(d - n)$ on each dollar of receivables transacted, while consumers' banks earn revenue of $n$ on each dollar of their liabilities that clear back to them.

All credit-card arrangements are made at $t = 0$. The consumers' banks extend each consumer a line of credit of $pc_1$ where $c_1$ is the consumption of Type 1s. Note that Type 1s can only purchase with credit in period 1. Because banks are unable to discriminate between creditworthy and uncreditworthy consumers, they extend the same level of credit to all consumers. We assume that impatience, $m$, is very large, so all type-1 consumers want to borrow in order to consume early. Enforcement of credit-card loan agreements is costless at $t = 2$ if consumers have the income to pay.[11]

In what follows, we consider two pricing features of credit cards that are universally observed in practice and endogenous in our model: an interest rate on borrowing, $i$, and some level of cardholder benefits in the form of float, cash rebates, airline miles, loyalty points, record-keeping convenience, status enhancement, use as a form of identification, peer-group affinity value, etc. We summarize all of these benefits in the variable $b$, a rate of benefits that every card-issuing bank "pays" the type-2 consumers on each dollar of purchases made with the credit card.[12] These benefits are fungible with cash and are paid at $t = 1$.[13] Cardholders who pay

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[10] This is obviously unrealistic, but fixed costs raise issues related to network economics including the optimal number of general-purpose credit-card networks. While these are clearly important issues, our focus is on pricing and subsidization within a single competitive network.

[11] An interesting extension of our model would be to endogenize consumer repayment incentives (i.e., let consumers choose $\beta$), subject to penalties for non-payment.

[12] The results would not change if all cardholders received benefits. Note that some benefits such as float may be only available to consumers who pay their bills in full each month.

[13] In reality, all benefits may not be fungible with cash; however, there are examples of cash rebates offered by some card-issuers. The qualitative results would not change if benefits were not fungible with cash as long as consumers' utility is increasing in the level of benefits.

off their balances at $t = 1$ are "convenience" users of credit cards, while borrowers between $t = 1$ and $t = 2$ are "revolvers."[14]

Merchants buy an initial inventory of consumption goods, $g$, at a price of one dollar per unit of the good. That is, the consumption good serves as the numeraire in our model. A merchant, like a consumer, is impatient. Unlike a consumer, a merchant values only money (including his own bank's liabilities), not goods. The good depreciates completely after $t = 2$. In what follows, we assume that merchants operate in a competitive market so their sales revenue cannot exceed their cost of doing business.

Consumers' banks' cost of funds is zero (for expositional ease) and they lend at a rate $i$, determined by competition in the credit-card market. Consumers' banks bear consumer default costs, so they must earn enough on solvent borrowers to cover loan losses and network costs.

Since consumers are very numerous with total measure one, exactly $\beta$ of the type-1 consumers will receive no income (i.e., a proportion $\alpha\beta$ of all consumers). Therefore, total expected income for the economy is $1-\alpha\beta$ (disregarding the timing of the income); this first-best level of consumption could be achieved only if all consumers received cash incomes at $t=1$ (i.e., if $\alpha=0$) or if the cost of processing credit-card transactions were zero ($k=0$).

In what follows, we study credit arrangements that come as close as possible to the first-best level of consumption given liquidity, incentive, and information constraints, as well as the riskiness of extending consumer credit and the cost of clearing the resultant claims back to the issuer. We consider three different schemes for pricing goods and credit-card use. In the first scheme, merchants charge different prices to consumers depending on how they pay— by cash or credit card. Card-issuing banks charge an interest rate $i$ on loans but deliver no net cardholder

[14] Industry parlance characterizes convenience users as "deadbeats," an ironic reminder of the major source of card-issuing bank revenues and the fact that providing payment services to convenience users is costly.

benefits. In the second, merchants charge a uniform price to all consumers, regardless of how they pay. Banks assess interest charges but provide no cardholder benefits ($b = 0$). In the third scheme we consider, merchants charge a single price to all consumers but banks pay benefits to convenience users to compensate them for the higher retail prices necessary to cover the cost of the credit-card network. Table 2 summarizes these schemes.

**B. Differentiated goods prices with no cardholder benefits**

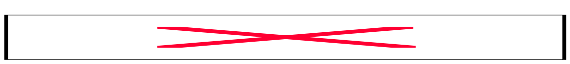
First, we consider the case in which the two types of consumers are served at potentially different prices, $p_c$ and $p_x$ (for credit and cash purchases, respectively) by a single merchant. Intuitively, this should be allocatively efficient because a merchant's effective costs of selling to the two types of consumers can be met exactly.

The merchant who price-discriminates solves the problem P1 below, where the price $p_c$ is charged on credit-card purchases and $p_x$ is charged on cash purchases. We assume competitive markets for merchants (M), merchants' banks (MB), and consumers' banks (CB), so none of these firms expect to make a positive profit in equilibrium:

P1: Max $E[\pi_M] = p_c[\alpha c_1 + (1-\alpha)c_2](1-d) + p_x(1-\alpha)x_2 - g$

$\{p_c, p_x\}$

s.t.

 Income-output identity

$E[\pi_M] \geq 0$ Voluntary-Participation constraint of merchant

$E[\pi_{MB}] = (d-n)p_c[\alpha c_1 + (1-\alpha)c_2] \geq 0$ V.P. of merchant bank

$$E[\pi_{PB}] = \alpha[(1-\beta)i - \beta + n - k]p_c c_1 + (1-\alpha)(n-k)p_c c_2 \geq 0$$ V.P. of consumer bank

$E[u_1] = (1-\beta)[1-(1+i-m)p_c c_1] + \beta(1+m)p_c c_1 \geq 0$ V.P. of type-1 consumer

$E[u_2] = 1 - (1-m)[p_c c_2 + p_x x_2] \geq 0$ V.P. of type-2 consumer

$1 - (1+i)p_c c_1 \geq 0$ Budget constraint, Type 1

$1 - p_c c_2 - p_x x_2 \geq 0$ Budget constraint, Type 2

$p_c c_1 = p_c c_2$ Identical credit limits

where $c_1$ and $c_2$ are the amounts of the good purchased with a credit card by type-1 and type-2 consumers, respectively, and $x_2$ is the amount of the good purchased by a type-2 consumer with cash. Type-1 consumers do not receive their incomes until $t=2$, so they cannot purchase goods with cash at $t=1$ (i.e., $x_1 = 0$). Because we assume that merchants' banks face a competitive environment, we have $d = n$: the merchant discount is equal to the network interchange fee. Note that type-1 consumers must borrow in order to consume anything at all at $t=1$.

The strategy for solving program P1 is based on our assumption of competitive markets: All firms in this economy operate with zero expected profit (that is, $E[\pi_M] = E[\pi_{MB}] = E[\pi_{PB}] = 0$), so the costs incurred to operate the interbank payment network must be borne by consumers. Furthermore, type-2 consumers would pay for the good at $t=1$ in cash rather than pay for a credit-card infrastructure that does not benefit them.

We now determine retail prices. When consumers use cash, merchants' cost of serving them is just the cost of acquiring the good, which is one dollar per unit. Therefore, $p_x$ (the cash price of the good) will be exactly one and we will have $c_2 = 0$ and $x_2 = 1$ (Type 2s pay cash). The extra cost of serving credit-card customers is exactly $k$ per dollar of sales revenue, where $k$ is the cost of using the payment-clearing network. Therefore, it must be the case that $k = n = d$ in a competitive economy, and $p_c = 1/(1 - k)$. Only liquidity-constrained consumers use cards and they pay a higher retail goods price for the privilege (finance charges are discussed below).

Replacing the income-output identity for $g$ in the merchants' objective function, we can rewrite problem P1 as problem P1.1:

P1.1: Max $E[\pi_M] = \alpha[p_c c_1 - (1-\beta)]$

{$p_c$}

s.t.

$E[\pi_M] = 0$

$E[\pi_{PB}] = \alpha p_c c_1[(1-\beta)i - \beta] = 0$

$1-(1+i)p_c c_1 = 0$

It is now easy to see that $i = \beta/(1-\beta)$, because the bank's required interest rate on credit-card borrowing reflects the risk of default by type-1 consumers. Because $p_c = 1/(1 - k)$, it then follows that $c_1 = (1 - \beta)(1 - k)$. Thus, the type-1 consumer pays an interest rate, $i$, that reflects the default risk of his type; he pays a retail goods price that reflects the extra cost of providing interbank clearing services, $k$; and his consumption is reduced below the level enjoyed by type-2 consumers (one unit) both because his expected income is lower and because his purchasing power is reduced in the face of a higher retail goods price. All consumption of goods in this economy occurs in period one and totals $1- \alpha\beta - \alpha(1-\beta)k$, reflecting the income risks of type-1 consumers (the term $\alpha\beta$) as well as the resource costs of providing credit and payment-clearing services to Type 1s of $\alpha(1-\beta)k$.

Comparative statics are straightforward. The higher is $\alpha$ or $k$ (the fraction of liquidity-constrained consumers and the variable cost of the payment system, respectively), the lower is consumption and hence social welfare. The higher is $m$ (the degree of consumers' impatience), the greater is the increase in social welfare when liquidity constraints can be relaxed. Finally, the higher is $\beta$ (the default risk of a liquidity-constrained consumer), the lower is expected welfare.[15]

**C. A single goods price with no cardholder benefits**

Now we restrict merchants to charge only one price, *p*. We observe this practice in many retail settings, which could be due to consumer resistance to differentiated pricing; to menu or calculation costs for the merchant; to a desire by the merchant to effectively price-discriminate by choosing not to pass through the costs of serving some customers; or perhaps to contractual arrangements between merchants and their banks preventing surcharges on credit card purchases. Implicit in the latter two explanations— price discrimination and some kind of tying arrangement— is some amount of market power and non-competitive rents possessed by merchants and/or banks.

The simple message of this section is that a merchant cannot serve both consumer types at $t = 1$ with a single goods price when no subsidies are paid and all markets are competitive. The argument is straightforward. In order to break even on type-1 consumers who buy on credit, the retail price must be $1/(1 - d)$. Merchants' banks earn a spread of $d - n$ on each dollar of credit-card receipts, but their market is also competitive, so $d = n$. Consumers' banks face a competitive lending market, so the interest rate they charge on loans, $i$, must equal the risk-adjusted expected return on lending, $\beta/(1-\beta)$. The resource costs of operating the credit-card network are $k > 0$ per dollar of receipts, and the assumed competitive nature of interbank clearing implies that $k = n$. But then $k = n = d$, and the retail price, $p > 1$, is higher at a merchant who accepts credit cards. This drives away consumers who do not need to borrow, since they

[15] To see this, note that $dC/d\beta = -\alpha + \alpha k$. This expression is negative for any $0 < k < 1$, that is, whenever the resource cost of the credit-card network is positive but does not eat up all of the economy's resources.

can purchase the good at a price of one from a merchant who does not accept credit cards. Thus, only type-1 consumers use credit cards.

### D. A single goods price plus cardholder benefits

Finally, we consider bank-provided cardholder benefits, which can be thought of as side payments contingent on credit-card use. Intuitively, side payments from banks may allow merchants to cover the costs of credit cards while ensuring that type-2 consumers use cards. However, increasing the use of credit cards means there is an unambiguous increase in the real resource costs of the payments system. This raises the questions of who pays to "bribe" type-2 consumers to use the credit card, and why? Several (not mutually exclusive) explanations are plausible:

a) *Type-1 consumers* pay for credit-card use by Type 2s in the form of higher interest rates on borrowing resulting in reduced consumption. The decision to cross-subsidize is dependent on the consumers' bank's ability to charge a higher than risk-adjusted interest rate to Type 1s. This is the explanation we adopt in this paper.

b) *Merchants* subsidize Type 2s' use of credit cards to raise overall profits. Merchants may believe that absorbing type-2 consumers' credit-card costs is a worthwhile marketing expense. For example, merchants may be able to sell goods with higher profit margins to type-2 credit-card users. However, if markets are competitive, this is not a feasible long-run strategy.

c) *Banks* may subsidize use of credit cards by type-2 consumers. Consumers' banks might believe they are purchasing an "option" on future borrowing by Type 2s— i.e., Type 2s who later become Type 1s— at which time banks would recoup losses made earlier. A one-shot model is unable to capture this phenomenon.

In this section, we assume interest revenue from type-1 consumers subsidizes all costs associated with type-2 credit card purchases; neither merchants nor banks earn positive profits that could be given to type-2 consumers. Alternative assumptions about the source of subsidy (or empirical investigation) are clearly interesting topics for future research.

We assume that merchants and/or banks prefer a single goods price for some reason(s) so all consumers will shop in the same stores. Benefits are paid in goods in period one only to type-2 consumers who use a credit card. These benefits are a proxy for a wide range of actual cardholder benefits.

To conserve space, we relegate detailed analysis of the model to the Appendix. One key point arising from the analysis is that, in order to provide a cross-subsidy to type-2 consumers to use credit cards, type-1 consumers must be "taxed" in some way— by our assumption of zero profits, there is no other surplus to transfer. The "tax revenue" could be raised through higher interest rates on borrowing.

The minimum transfer from type-1 to type-2 consumers is simply the level of benefits, *b*, required to bring Type 2s into the credit card network. That is, their consumption is the same whether they participate in the credit-card network or not. In the previous case, we found that single-price merchants could serve either Type 1s or Type 2s but not both. In the appendix, we show that, for Type 2s to use credit cards, *b* must equal:

$$b = 1 - \frac{1}{p^*},$$

where $p^*$ is the equilibrium price determined below.

To calculate the interest rate charged on consumer loans, as before, we set the consumers' banks' voluntary participation constraint to zero. The equilibrium interest rate is:

$$i = \frac{\beta}{1-\beta} + \frac{(1-\alpha)}{\alpha(1-\beta)}(1 - \frac{1}{p^*}) ,$$

which exceeds the interest rate charged under the two other schemes. The first term on the right-hand side of this expression is the familiar risk-adjusted required return for the bank. The second term reflects the additional cost to Type 1s of participating in a credit-card network in which Type 2s are rewarded for credit-card use. Banks must recover from type-1 consumers the amount of the subsidy paid to type-2 consumers, which is $(1 - \alpha)b$. The subsidy is collected from a fraction $\alpha$ of the population, only $1 - \beta$ of whom is solvent. Hence, the interest rate reflects both type-1 default risk and the per-capita subsidy provided to Type 2s.

Type-1 consumption, calculated by plugging $i$ into the budget constraint, is:

$$c_1 = \frac{1-\alpha\beta}{p^*\alpha} - \frac{(1-\alpha)}{\alpha} .$$

Type-1 consumption has decreased from the previous cases. Although $p^*$ is less than $1/(1-k)$, Type 1s must pay for $b$ resulting in an overall decrease in consumption. Under such a pricing scheme, goods are not being purchased by Type 2s with the least expensive payment instrument available to them, cash, but instead with credit cards resulting in reduced consumption for Type 1s. Type 2s face higher prices but remain at the same level of consumption as before. The equilibrium price is solved for in the appendix. Feasible values of $p^*$ range from *1* to $1/(1-k)$. Thus, only certain parameter values will result in such a pricing scheme being feasible.

This pricing scheme demonstrates that convenience users may be indifferent between using credit cards or cash in competitive goods and credit markets. In other words, we present the minimum level of benefits required to entice Type 2s to participate. We further demonstrate that if Type 1s sufficiently discount future consumption, they are willing to participate in such a pricing scheme.

## IV. Social-Welfare Comparisons

Consumer credit allows liquidity-constrained households to consume before their income arrives, but a credit-card infrastructure is costly to operate. How do the various pricing and cross-subsidy schemes compare in terms of a simple measure of social welfare that incorporates both the utility gains from borrowing and the resource use of a credit-card network? This section evaluates each of the schemes discussed above by comparing them to an economy with no credit cards as a benchmark.

If credit cards were not available, Type 2s could consume $1-\forall$ in period 1, while Type 1s could consume $\forall(1-\exists)$, but only in period 2 after their incomes had arrived. A simple measure of social welfare is the weighted sum of consumption by all agents, where period-two consumption is discounted at a rate of $(1+m)$ to reflect impatience. Table 3 shows that the benchmark level of social welfare in this economy, which we will call $SW_0$, is $\forall(1-\exists)/(1+m) + (1-\alpha)$.

We showed above that uniform pricing and price discrimination according to the payment instrument used are equivalent schemes when there are no cardholder benefits. Notice from Table 3 that, with credit cards, Type-1 consumption is lower in amount but is not discounted relative to the no-credit case. Thus, credit cards make Type 1s better off if and only if $(SW_1 - SW_0) = [m - k/(1-k)] > 0$— i.e., if impatience is sufficiently large relative to the resource costs of operating the credit-card network. Ballpark estimates of $m$ and $k$ imply that this condition is likely to be satisfied: if $m$, the consumer discount rate, is around 25 percent, and $k$, credit-card resource costs, are in the range of two percent of sales, then the condition becomes 0.25 - (0.02)/(0.98) = 0.2296, far above zero.[16]

Finally, if merchants set a uniform goods price and cardholder benefits are paid to Type 2s, then the amount of Type 1s' consumption decreases relative to the benchmark case and relative to the uniform pricing/price discrimination case, as well. This is because the Type 1s pay for Type 2s to participate at unchanged consumption levels. Our measure of social welfare in this case, $SW_2$, is unambiguously *lower* relative to the previous case because the credit-card network eats up more resources. However, such a scheme could be welfare-enhancing to an economy without credit cards if Type 1s sufficiently discount future consumption. As noted in the discussion above, however, such a credit-card pricing and cross-subsidization scheme may operate if competition from other networks can be resisted (or they are co-opted).

## V. Conclusion

Credit cards are a rapidly growing part of the retail payments and consumer-finance system in the United States. Yet credit-card pricing and apparent cross-subsidization among users defy easy explanation. We develop a model of interrelated downstream markets in a credit-card network— for card issuance and card acceptance— that explores the question of who pays for credit cards.

We show that, if no cardholder benefits are paid, uniform pricing by merchants and price discrimination are equivalent: consumer types separate themselves. Liquidity-constrained consumers are the only ones who use (and pay for) credit cards. If liquid consumers are compensated for decreased consumption resulting from higher goods prices and card-issuers are

[16] The consumer discount rate assumed for the household sector in the Federal Reserve Board's model of the U.S. economy is 25 percent per annum (Brayton, et. al., 1997, p. 236). See the Food Marketing Institute (1998) for

able to charge sufficiently high interest rates to a sufficiently large pool of creditworthy borrowers, it may be possible to charge a single price and serve all consumers with a credit card. Card-issuers pay a direct benefit to liquidity-unconstrained consumers, which they collect from liquidity-constrained consumers via higher interest rates.

Thus, our model shows how credit-card borrowers could be induced to pay for the entire credit-card network. Our results are critically dependent on our assumption of competitive markets. If merchants and card issuers earned rents, other explanations of who pays for credit cards would exist. Future research should seek to identify and quantify why card-accepting merchants and card-issuing banks perceive some cross-marketing benefits arising from convenience users of credit cards.

estimates of the costs of accepting credit cards.

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## APPENDIX: A Single Goods Price with Cardholder Benefits

Merchants solve program P2 (below), in which a merchant charges a single goods price, *p*. Card-issuing banks also pay a proportional (transaction-related) benefit, *b*, to type-2 card users. The benefit, *b*, must offset any loss in consumption of type 2s when they use credit cards to make purchases. The loss in consumption occurs because there is an increase in *p* to offset the cost of accepting credit cards. Note that type-1 consumers use credit cards for all purchases, while type-2 consumers will use a combination of cash and credit cards. Because card-issuers cannot distinguish the different types of consumers, they grant each consumer the same level of credit. Each Type 1 receives less than a $1 credit line because of default risk and the subsidy to Type 2s. Therefore, Type 2s are left with $1-pc_1$ to spend in cash. Type 2s' expenditure in cash lowers the equilibrium price because of the zero profit constraint on merchants. The equilibrium price will be in between *1* and *1/(1-k)* depending on the proportion of the various types of consumers.

P2: Max $E[\pi_M] = p[\alpha c_1 + (1-\alpha)c_2](1-d) + (1-\alpha)px_2 + (1-\alpha)pb - g$

{p}

s.t.

| | |
|---|---|
| $g = \alpha(1-\beta) + (1-\alpha)(1) - p[\alpha c_1 + (1-\alpha)c_2 + (1-\alpha)b]k$ | Income-output identity |
| $E[\pi_M] \geq 0$ | V.P. merchant |
| $E[\pi_{MB}] = (d-n)p\{\alpha c_1 + (1-\alpha)c_2 - (1-\alpha)b\} \geq 0$ | V.P. merchant bank |
| $E[\pi_{PB}] = \alpha pc_1\{(1-\beta)i - \beta + n - k\} + (1-\alpha)(n-k)pc_2 - (1-\alpha)pb \geq 0$ | V.P. purchaser bank |
| $E[u_1] = (1-\beta)[1-(1+i-m)pc_1] + \beta(1+m)pc_1 \geq 0$ | V.P. Type 1 |
| $E[u_2] = 1-(1-b-m)pc_2 - (1-m)px_2 \geq 0$ | V.P. Type 2 |

| | |
|---|---|
| $1-(1+i)pc_1 \geq 0$ | B.C. Type 1 |
| $1-pc_2-px_2 \geq 0$ | B.C. Type 2 |
| $b \geq 1 - c_2 - x_2$ | V.P. 2 Type 2 |
| $pc_1 = pc_2$ | Identical credit limits |

Most of program P2 is familiar from the previous discussion. The additional elements here are cardholder benefits and an additional voluntary participation constraint of Type 2s using credit cards for part or all of their purchases. Type 2s will purchase goods with cash and credit, and also receive a benefit *b*.

Type 2s will only participate in the credit card scheme if their total consumption with credit cards is no less than their total consumption without cards. In other words, their voluntary participation constraint(s) must be satisfied. Substituting a Type 2's budget constraint into his second voluntary participation constraint yields:

$$b = 1 - \frac{1}{p}.$$

As *p* rises, credit-card issuers must pay a higher *b* to Type 2s to compensate them for a loss in consumption resulting from higher goods prices.

In our model, card-issuing banks collect the cost of *b* from type-1 consumers. As before, we consider the case where $n=k=d$. Setting the purchaser banks' profit constraint to zero yields:

$$i = \frac{\beta}{1-\beta} + \frac{(1-\alpha)}{\alpha(1-\beta)}(1-\frac{1}{p}).$$

The first term is the risk associated with lending as before. The second term captures the additional cost of enticing Type 2s to use their credit cards.

To calculate $c_1$, plug in $i$ from above into the type-1 budget constraint. This substitution yields:

$$c_1 = \frac{1-\alpha\beta}{p\alpha} - \frac{(1-\alpha)}{\alpha} .$$

Type 1s consume less under such an arrangement because they pay for the additional cost of processing credit card transactions for type-2 consumers, even though they benefit from lower prices. Comparative statics are relatively straightforward, with type-1 consumption decreasing in $p$ and in $\beta$, the default risk of type-1 consumers.

To determine the equilibrium $p$, we need to solve the merchants' problem. Because merchants operate in a competitive market, their profits are zero which means total revenue equals total cost. Total revenue and total cost can be expressed as:

$$TR = pc_1(1-k) + p(1-\alpha)(1-c_1)$$

and

$$TC = \alpha c_1 + (1-\alpha) .$$

Equating these two expressions and solving for $p$ yields:

$$p = \frac{\alpha c_1 + (1-\alpha)}{\alpha c_1 + (1-\alpha) - c_1 k} .$$

To solve for $p$ in terms of the model's parameters, we substitute $c_1$ into the above equation, which leads to the following quadratic expression:

$$\frac{k(1-\alpha)}{\alpha} p^2 + (1-\alpha\beta - \frac{k(1-\alpha\beta)}{\alpha}) p - (1-\alpha\beta) = 0 .$$

Note that if $k$ is equal to *0*, $p$ equals *1*. In other words if there is no cost to use the system, the price would be $1 for both types of consumers. If ∀ is equal to *1* (all consumers are liquidity-constrained), $p$ equals *1/(1-k)*. Therefore, $p$ has a lower bound of *1*—otherwise merchants would earn negative profits—and $p$ has an upper bound of *1/(1-k)*. The equilibrium value of $p$ is:

$$p^* = \frac{-(\alpha - k)(1-\alpha\beta) + \Delta^{\frac{1}{2}}}{2k(1-\alpha)},$$

where:

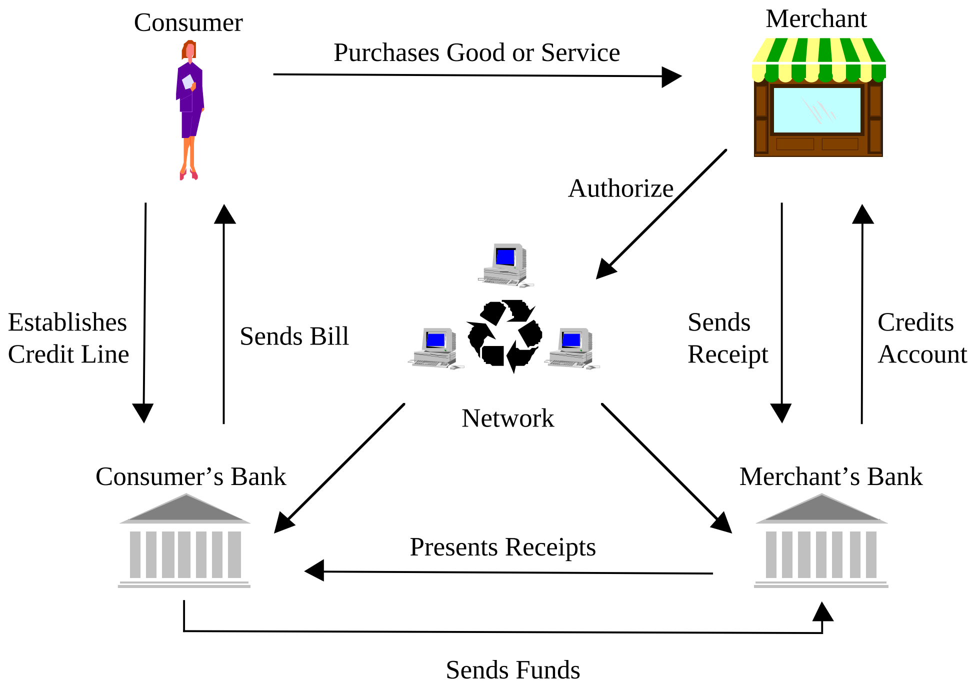
$$\Delta^{\frac{1}{2}} = (k^2 + \alpha^2 - 2k^2\alpha\beta + 2k\alpha + k^2\alpha^2\beta^2 - 2k\alpha^3\beta^2 - 2\alpha^3\beta + \alpha^4\beta^2 - 4k\alpha^2 + 4k\alpha^3\beta)^{\frac{1}{2}}.$$

Note that only certain parameter values will support a credit card equilibrium for this specific pricing scheme. The following relationship must hold:

$$\Delta^{\frac{1}{2}} \geq 2k(1-\alpha) + (\alpha - k)(1-\alpha\beta).$$

Plugging $p^*$ into the equations that determine the values for $b$, $i$, $c_1$ , and $x_2$ will yield the equilibrium values for these variables.

**Figure 1: A Credit Card Transaction**




Adapted from Evans and Schmalensee, 1993.

**Figure 2: Transaction Costs**

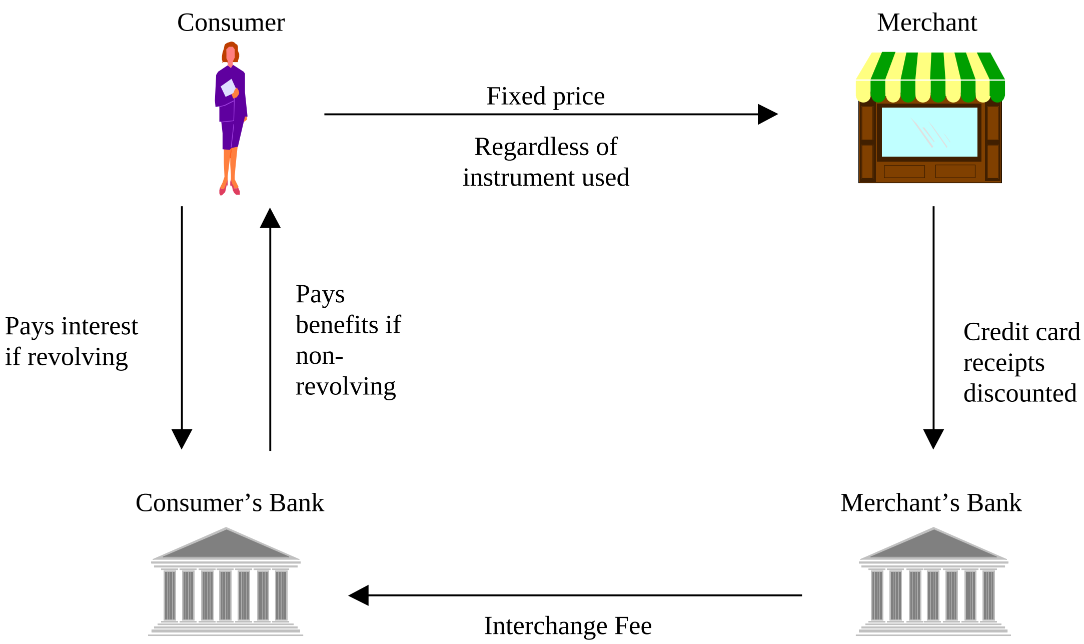
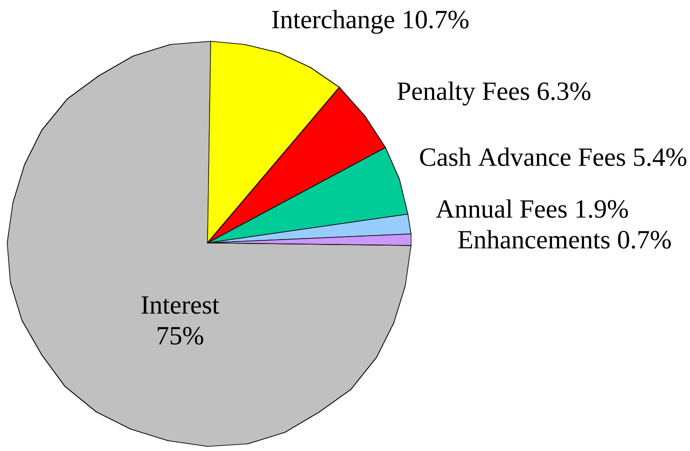
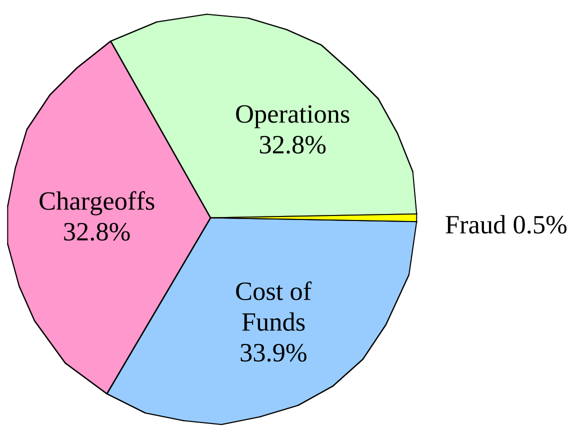


**Figure 3: Card Issuers' Revenues and Costs**




**Revenues**




**Costs**

Source: Credit Card News, April 15, 1999.

## TABLE 1

## AVERAGE COST TO SUPERMARKETS OF ACCEPTING SELECTED PAYMENT INSTRUMENTS, 1997

| | **Cash** | **Check (verified)** | **Credit card** | **On-line debit** | **Off-line debit** |
|---|---|---|---|---|---|
| Cost per transaction* | $0.08 | $0.45 | $1.07 | $0.29 | $0.80 |
| Cost per $100 of purchases | $0.22 | $0.82 | $2.41 | $0.70 | $2.43 |

*The average purchase amount varies by payment instrument.

Source: Food Marketing Institute, 1998, p. 3.

## TABLE 2

## GOODS PRICES AND NETWORK SUBSIDIES

| **Pricing and Subsidy Scheme** | **Goods prices** | **Subsidies** |
|---|---|---|
| Uniform pricing with no subsidies | Single price for all purchasers, p | None |
| Price discrimination with no subsidies | Different for cash and credit users, $p_x$ and $p_c$ | None |
| Uniform pricing with subsidies | Single price for all purchasers, p | Paid by banks to type-2 consumers |

## TABLE 3

## COMPARISON OF SOCIAL WELFARE

| | **Consumption by Type 1s** | **Consumption by Type 2s** | **Social Welfare**[1] |
|---|---|---|---|
| Benchmark case: No credit cards | $\alpha(1-\beta)$ (in period two) | $1-\alpha$ (in period one) | $SW_0 = \frac{\alpha(1-\beta)}{1+m} + (1-\alpha)$ |
| Uniform pricing or price discrimination with no cardholder subsidy | $\alpha(1-\beta)(1-k)$ (in period one) | $1-\alpha$ (in period one) | $SW_1 = 1-\alpha\beta - k\alpha(1-\beta)$ |
| Uniform pricing with cardholder subsidy | $\frac{1-\alpha\beta}{p^*} - (1-\alpha)$ (in period one) | $1-\alpha$ (in period one) | $SW_2 = \frac{1-\alpha\beta}{p^*}$ |

[1]Social welfare is defined as period two consumption divided by (1+m) plus one times period-one consumption, reflecting impatience.