Who Gains and Who Loses from Credit Card Payments? Theory and Calibrations*

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Abstract

We analyze buyers' welfare associated with the use of credit cards. Buyers are heterogeneous with respect to their payment choice, income, and benefits from paying with a card. The paper shows that merchant fees and card reward programs serve as a partial transfer from non-card users to card users. Using actual data, our calibrations show that three-quarters of banks' revenue from credit cards is indirectly generated from cash payers. Then we show how this subsidy translates to transfers from low to high income buyers. Finally, we compute the effects of merchant fees and card rewards on buyers' welfare and derive some policy implications.

Keywords: Credit and Debit Card Fees; Income Distribution; Merchant Fees; Rewards; Cash-back; No Surcharge Rule.

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1. Introduction

The typical consumer is largely unaware of the full ramifications of choosing to pay for goods and services with a credit card. Faced with a choice of cash, check, debit card, credit card, or an electronic deduction from a bank account, the consumer (naturally) thinks about her own costs and benefits of each payment instrument and chooses accordingly. For credit cards, consumers likely think most about their benefits: a delay in payment–"buy now, pay later" –and the rewards earned-cash back, frequent flyer miles, or other enticements. What many consumers do not know is that their decision to pay by credit card involves merchant fees, retail price increases, and a nontrivial transfer of income from cash to card payers as well as from low income to high income consumers.[1]

In contrast, the typical merchant is acutely aware of the ramifications of their customers' decisions to pay with credit cards. In exchange for the privilege of accepting credit cards, U.S. merchants pay their banks a merchant fee that is proportional to the dollar value of the sale. The merchant's bank, in turn, pays an interchange fee to the consumer's credit card bank that is also proportional to the sale.[2] Naturally, merchants seek to pass on this fee to their customers. Merchants may want to recoup the merchant fee only from consumers who pay by credit card. In practice, however, credit card associations impose a "no surcharge rule" (NSR) that prevents merchants in the United States from doing so.[3] Instead, merchants must mark up the retail price of goods and services for all consumers to recoup the cost the merchant fee.[4]

Together, the merchant fee, NSR, and final goods price markup for all consumers produce the well-known result that cash-paying consumers subsidize card-paying consumers,

[1]Most of the ideas in this paper now apply to debit cards as well, but to a lesser extent, so we focus only on credit cards. This is the first of many ways in which our analysis understates the main results of the paper.

[2]For an explanation of why interchange fees are proportional rather than fixed, as might be expected in a network, see Shy and Wang (Forthcoming).

[3]See Appendix C for additional discussions on the implications of the NSR.

[4]Of course, merchants also must recoup the cost of handling cash as well, but this cost is less than the merchant fee. Garcia-Swartz et al. (2006) estimate that the per-transaction processing cost for a cash transaction is \$0.27, compared to \$1.14 for a credit card transaction.

see Carlton and Frankel (1995), Frankel (1997), Katz (2001), Gans and King (2003), and Schwartz and Vincent (2006). By "subsidize" we mean that merchant fees are passed on to all buyers in the form of higher retail price regardless of the means of payments buyers use to pay for the goods and services they buy. Thus, buyers who do not pay with cards, end up paying higher retail prices to cover merchants' costs associated with merchant card fees. Because merchant fees eventually subsidize the rewards given to card users, and since cash users are not rewarded, non-card payers end up financing part of the rewards given to card users. For brevity and simplicity, we refer to non-card payers as cash payers, where "cash" represents all payment instruments other than credit cards: cash equivalents (money orders and travelers checks), checks, debit cards, prepaid cards, and electronic deductions from bank accounts.

If the cross subsidy of card payers by cash payers results from heterogeneity across consumers in the utility of cash and card payments, the cross subsidy would be innocuous in terms of consumer and social welfare. However, we show that credit card usage and the rewards paid for credit card usage (also proportional to the dollar value of sales) are both strongly positively correlated with consumer income. Consequently, the cross subsidy of credit card payers by cash payers also involves a regressive transfer of income from low income to high income consumers. This regressive transfer is then further amplified substantially by the practice of paying rewards to credit card users because rewards also are strongly positively correlated with income.[5] To our knowledge, documentation of these effects of credit card costs and benefits and the income transfer is new to the literature.[6]

This paper presents a static, partial equilibrium model that has cash and credit cards plus heterogeneity in consumer income. The model is designed to be used to quantify the magnitude of the gains and losses to consumers from the usage of credit cards for payment, but abstracts from the revolving credit and debt service features of the credit card market, see for example Gross and Souleles (2002). The model also abstracts from the details of the

[5]See Hayashi (2009) and her references for a comprehensive overview of card reward programs.

[6]However, these points were made recently in the New York Times "Rich and Poor Should Pay Same Price," October 1, 2009.

supply side of the payments market, both in terms of the provision of card and cash services. In particular, the model takes as given the well-established and seminal result of Rochet and Tirole (2006), about the role of the interchange fee between acquiring and issuing banks in the two-sided credit card market but notes that the optimal value of that fee is an empirical issue.[7] Instead, our model also abstracts from supply-side details of the market comprised of banks and credit card associations, which together we refer to broadly as "banks" and merely takes as given the existence of a merchant fee. Thus, our modeling exercise focuses on consumer heterogeneity and can quantify the consumer welfare effects of income transfers.

We calibrate the model using micro data on consumer credit card usage and related variables. Parameters derived from the model are notably sensible given the simplicity and limitations of the model and data. They imply that high-income consumers have an inherent utility benefit from credit card use that is twice as high as low-income consumers. These results suggest that the model can provide reasonable "order-of-magnitude" estimates of the income transfer from low-income to high-income consumers and consumer welfare. We conduct welfare and policy analyses assuming a NSR is in effect and benchmark estimates of the average merchant fee (2 percent) and average reward rate (1 percent), to approximately match U.S. credit card market conditions. An appendix provides sensitivity analysis of the calibrated model.

According to the calibrated model, merchants collect about $20.8 billion in fees annually from consumers, which they pay in full to the banks (merchants are assumed to be competitive and earn zero profits). Banks essentially split this income equally with consumers who use credit cards, a direct result of the 2 percent merchant fee and 1 percent reward rate. Cash users pay about 81% of all merchant fees. Low-income cash-paying consumers pay about half of the $20.8 billion merchant fees ($123 per household) whereas high-income cash-paying consumers pay about one-third of the merchant fees ($426 per household). The

[7] A complete list of contributions to two-sided markets is too long to be included here. The interested reader can consult Chakravorti and Shah (2003), Gans and King (2003), Rochet (2003), Wright (2003), Roson (2005), Armstrong (2006), Schwartz and Vincent (2006), Bolt and Chakravorti (2008), Hayashi (2008), Rysman (2009), and Verdier (Forthcoming). For a comprehensive study of interchange fees see Prager et al. (2009).

remaining portion is paid by card users. After taking into account rewards, high-income consumers receive $8.9 billion ($413 per household), whereas low-income consumers receive $1.4 billion ($15 per household) annually. Consumer welfare in the calibrated model depends on the merchant fee, the reward rate, and the NSR. As a result, the retail price (including cash handling costs) increases by about 0.79 percent over marginal cost.[8]

A key result of the model is that consumer welfare can be increased by reductions in the merchant fee or increases in the reward rate, but the rate of change is roughly similar. A one percentage point decrease in the merchant fee leads to a 0.093% increase in consumer welfare, while a one percentage point increase in the reward rate results in a 0.075% increase in consumer welfare. Thus, consumer welfare can be increased by about 0.018% by reducing the merchant fee and reward rate one percentage each. By keeping the difference between them roughly the same, consumer welfare can be increased without reducing banks' net income. Eliminating both merchant fees and rewards increases consumer welfare by 0.105%.

According to the calibrated model, consumer welfare also depends heavily on the degree of concavity in consumer utility. Because the model takes as given the level of the merchant fee, consumer welfare is always maximized where the reward rate equals the merchant fee because rewards are pure transfers to consumer regardless whether they go to low- or high-income consumers. However, the consumer-welfare maximizing level of the merchant fee and reward rate is strongly negatively correlated with concavity of utility because the more concave is utility the more consumer welfare is improved by reducing the income transfer from low-income to high-income consumers. If consumer utility is essentially linear, the optimal merchant fee and reward are both 2 percent but they decline quickly with increases in concavity; if concavity of the model's utility function increases by about 25 percent, the optimal merchant fee and reward rate drops to zero percent.

Our model and calibrations are consistent with the literature on two-sided markets in the sense we incorporate the benefits to consumers and merchants from using credit cards. As a result, we are able to calculate merchant fee and reward rate that maximize consumer

[8]Our model reveals that consumer welfare is not sensitive to the cost of handling cash.

welfare, although we cannot compute the interchange fee that maximizes social welfare. In addition, our analysis does not include the consumer welfare associated with households' ownership of banks and their claims on bank profits.

We want to be clear that we do not allege or imply that banks or credit card associations intentionally designed or operate the credit card market to produce a regressive transfer from low-income to high-income consumers. We are not aware of any evidence to support this allegation or any reason to believe it. However, the very existence of a non-trivial regressive transfer in the U.S. credit card market may be a concern that public policy makers wish to address. If so, our analysis suggests several policy interventions worth further study and consideration. We discuss direct options pertaining to elimination of the NSR, joint regulation of the merchant fee and reward rate, and tax-based redistribution of rewards, as well as the indirect option of increased competition.

Section 2 provides some data connecting income with card usage. Section 3 constructs a model of buyers who are heterogeneous with respect to (i) their income and, (ii) the benefits they derive from paying with a card relative to other means of payments. Section 4 explains the data and calibration methods. Section 5 computes the amount of subsidy from cash to card users, and the corresponding subsidy from low to high income groups. Section 6 calibrates for welfare maximizing rewards to card users and merchant fees, and for changes in welfare associated with a total elimination of card reward programs as well as merchant fees. Policy implications are explored in Section 7. Section 8 concludes.

2. Basic Facts about Credit Cards

2.1 The credit card market

Most card transactions take the following form. After a merchant charges a buyer's credit card, the merchant must submit a request for payment to their bank (card "acquirer"). The card acquirer then submits the request for payment to the buyer's credit card bank (card "issuer"). The card issuer then withdraws the amount from the buyer's bank account (debit

transaction), or lends money to the buyer (credit transaction). The issuer transfers the money to the acquirer who then pays the merchant.

There are several fees involved in this chain of payments. Issuers charge an interchange fee to acquirers, who then roll over these fees to merchants. Merchants that accept credit (or debit) cards for payment embed part or all these fees into their retail prices which buyers must pay. Figure 1 illustrates the above described chain of monetary transfers. The

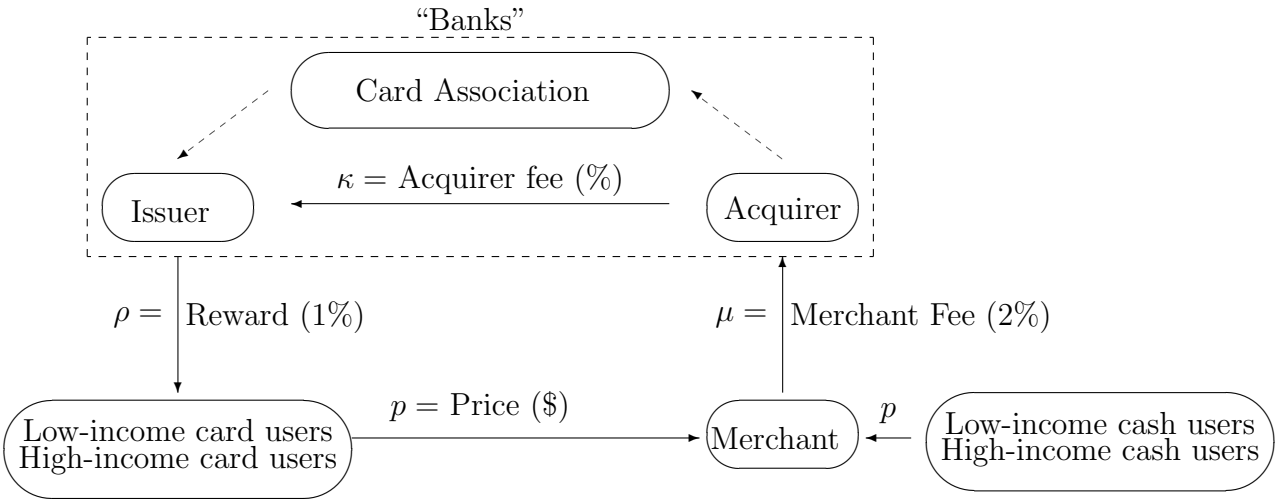

Figure 1: Fees and payments in a simple card network.

preceding description omits some other parties who may be involved in the transaction, such as the card organization (Visa or MasterCard as examples) through which the transaction obtains an authorization before it is allowed to proceed. Unlike card issuers and acquirers that charge proportional fees, card organizations charge fixed small per-transaction fees, say around 5¢, and therefore will be ignored in our analysis.[9] Also, merchants and acquirers may be connected via third-party payment processors who provide connection lines and card reading equipment to merchants.

[9]Until recently, Visa and MasterCard were owned by banks. Visa became public in early 2008, and MasterCard in 2006.

2.2 Credit Cards in the Economy

Over the last two decades, payment cards have enjoyed increased popularity in all sectors of the economy. Our research focuses on credit cards that are issued by banks and used by consumers. Figure 2 shows that the fraction of households who have a credit card (adopters) has been steady at about 70–75% during the past 2 decades, reflecting the maturity of the market. However, the percentage of total consumption expenditure paid for by credit card essentially doubled from about 6% to 12% during the same period.[10] Consumer credit card spending accounts for approximately half of all credit card spending in 2007.[11]

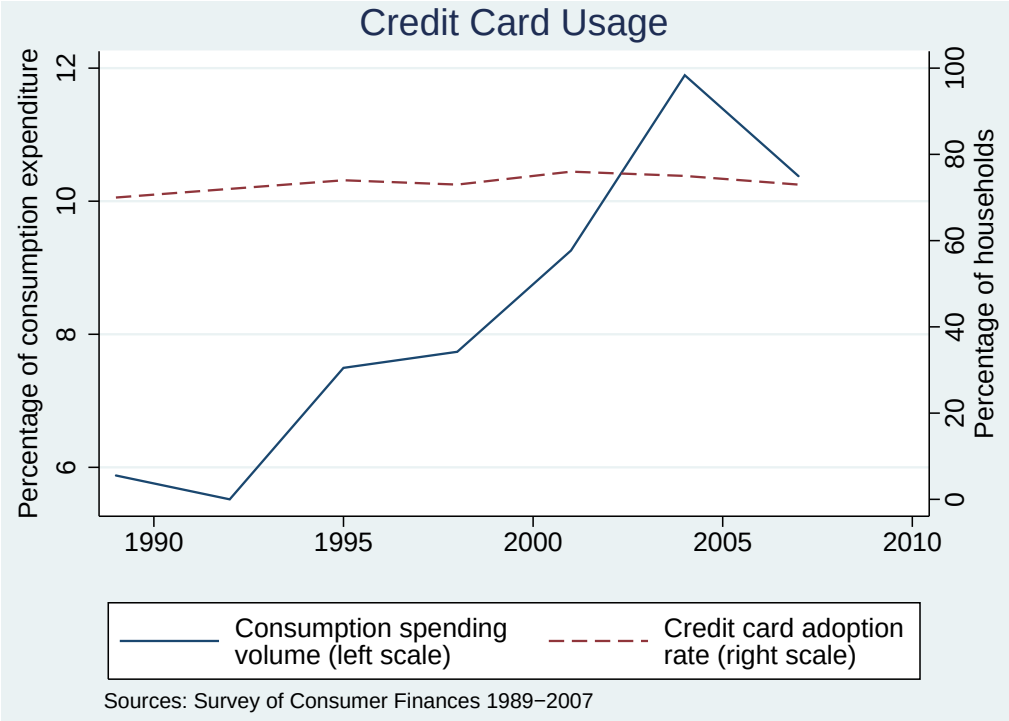

Figure 2: Credit cards.

[10]Both series were taken from the the Survey of Consumer Finances (SCF), which asked consumers about the amount of credit card charges they had in the previous month (variable *x412*) since 1989 ("Consumption spending volume") and on credit card adoption (variable *x410*) since 1989 ("Credit card adoption rate").

[11]Total credit card spending, which includes business and government, is from the Federal Deposit Insurance Corporation's Call Report data (series *rcfdc223* and *rcdfc224*).

2.3 Card usage and income

This section presents updated evidence showing that credit card adoption, use, and rewards increase with household income. Although previous literature found a positive relationship between income and credit card adoption [Stavins (2001), Mester (2003), Bertaut and Haliassos (2006), Klee (2006), Zinman (2009)], there has been less focus on the relationship between income and credit card use. Publicly-available data sources typically provide only the amounts charged on credit cards, which we define here as use. However, data on the number of transactions consumers make with credit cards from the 2008 Survey of Consumer Payment Choice also shows a positive correlation with income.

Based on data from the 2007 Survey of Consumer Finances, Table 1 shows that the fraction of households who hold at least one credit card increases monotonically with income. High-income households are not only more likely to hold a credit card, but also use it more than lower-income households do. Among the households with at least one credit card, high-income households use their credit cards more intensively–credit card use among adopters, measured as the total amount of new charges on all credit cards held by a household, increases with income.[12]

	Percentage of consumers (%)			$ 2007 (Avg.)	
Annual income	Have CC	$< \$100$	$> \$1000$	All	Adopters
Under $\$25,000$	41	8	4	163	394
$\$25,000$–$49,999$	66	10	7	271	410
$\$50,000$–$74,999$	85	9	17	535	633
$\$75,000$–$99,999$	89	5	25	724	810
$\$100,000$–$124,999$	93	3	36	1,093	1,176
Over $\$125,000$	95	2	57	3,138	3,309
Under $\$100,000$	65	8	11	348	537
Over $\$100,000$	94	3	50	2,386	2,536
Whole sample	70	7	18	730	1,040

Table 1: Households' credit card adoption rates and monthly charges by annual household income. *Source*: 2007 Survey of Consumer Finances.

[12]The charge numbers are based on the following question from the 2007 SCF: "On your last bill, roughly how much were the new charges made to these [Visa, Mastercard, Discover, or American Express] accounts?" The percentages are based on all consumers, not just credit card adopters.

The fraction of households with the smallest charges (below $100) is lowest among the high-income households, and, even more strikingly, the fraction of households with the highest charges, that is new charges over $1,000 in a single month, increases with income. Average new monthly charges on all credit cards held by a household increase with income, whether measured for all consumers or among the credit card adopters only. The average monthly charges for the highest income group (households earning over $125,000 a year) was 18 times higher than the average monthly charges for the lowest income group–those earning less than $25,000. Because merchant fees are proportional to the amount charged on credit cards, regardless of whether the cardholder pays his monthly balance or carries it over to the next month, total new credit card charges for each household are the relevant measure of credit card use in our analysis.

Table 2 shows that credit card rewards are also disproportionately more common among higher income consumers. As Table 2 shows, the fraction of cardholders with rewards increases monotonically with income. The pattern is visible for various types of rewards: cash back, frequent flyer miles, discounts, or others.

Income	Any Reward	Cash Back	Airlines Miles	Discounts	Other Rewards
Under $25,000	42	24	13	10	7
$25,000–49,999	52	30	17	11	10
$50,000–74,999	57	32	23	14	11
$75,000–99,999	66	36	33	14	11
$100,000–124,999	71	40	34	17	13
Over $125,000	78	38	44	16	16
Under $100,000	55	31	21	12	10
Over $100,000	75	39	40	16	15
Whole sample	59	33	25	13	11

Table 2: Percentage (%) of credit card adopters receiving credit card rewards. *Source*: 2007-2008 Consumer Finance Monthly survey conducted by the Ohio State University.

In our calibrations, we split the population into two groups: households earning less than a $100,000 and households who make more than that. This decision is motivated by the need for parsimony and the differences between these broad income groups shown in ables 1

and 2. The last two columns in Table 1, show that credit card spending by high-income consumers is nearly five times higher than credit card spending by low-income consumers. Also, the first column of Table 2 shows that high-income consumers are 20 percentage points more likely to receive credit card rewards. The difference between high and low income consumers' credit card spending and rewards is markedly greater for finer disaggregation of low income consumers.

2.4 Non-income factors affecting credit card use

Income is not the only factor positively correlated with credit card use. Schuh and Stavins (Forthcoming) estimated the use of credit cards as a function of various characteristics of credit cards, employing a 2006 survey of U.S. consumers. They found that when controlling for income, several characteristics influence the use of credit cards. In particular, the convenience, cost, and timing of payment of credit cards were found to have a statistically significant effect on consumers' use of credit cards for payment, holding income constant.

Using the more extensive 2008 Survey of Consumer Payment Choice, we estimated the effects of credit card characteristics on consumer adoption and use of credit cards controlling for income and other demographic variables. In their decision whether or not to adopt (acquire) credit cards, consumers are influenced by their assessments of credit card characteristics in terms of ease of use, record keeping, control over payment timing, and setup. When deciding whether or not to use credit cards for transactions, the significant characteristics are: ease of use, cost, and record keeping.[13] The results were qualitatively similar when we estimated the credit card use regressions separately for households earning below $100,000 a year and those with income above $100,000 a year. Pooling households with income below $100,000 a year and households with income above $100,000 a year could not be rejected. For households with annual income above $100,000, cost and record keeping had stronger effects on their use of credit cards than for lower-income households, but those characteristics were significant for both income groups.

[13]Cost is defined to include the benefit of rewards.

One implication of these results on characteristics is that there are non-pecuniary (that is, excluding cost) determinants of consumer choice of credit cards and other payment instruments. Presumably, the affect occurs because the characteristic of the payment instrument provides a utility benefit to consumers beyond the price (cost) or income effect. For example, ease of use or record keeping features of credit cards appear to yield a benefit to consumers that affect consumers' decisions to adopt and use credit cards. In our model, we label these non-pecuniary benefits from using credit cards as b.

2.5 The effects of card reward programs on merchant fees

Card reward programs increase the cost borne by card issuers. A fundamental question to be asked at this point, which is crucial to our investigation, is how rewards affect merchant fees. That is, how do reward programs get funded? Clearly, if we were to confine our analysis to debit cards only, merchant fees would constitute perhaps the only means of financing issuers' rewards on card purchases. However, in the case of credit cards, high interest and penalties paid by borrowers may also directly or indirectly contribute to fund some of issuers' expenses on rewarding card users. In fact, Chakravorti and Emmons (2003) demonstrate an equilibrium in the market for credit cards (as opposed to debit and charge cards) in which the "convenience use" of credit cards (that is, the use of credit cards for payment only and not for credit) by non-borrowing consumers is subsidized by liquidity-constrained consumers who borrow on their credit cards and pay high interest. Their results explain that borrowers pay high interest rates on credit because this interest is used to reward all credit card users including those who avoid interest charges by pay their full balance on time.

A rather "naive" approach to answering the question how rewards get funded would be to follow the "convention" that interchange fees (and hence merchant fees) are determined by card associations whereas rewards are determined by the bank that issues the specific card. If this were indeed the case, then there should not be any connection between rewards and merchant fees, which means that rewards cannot affect retail prices. This approach would also imply that all rewards (including those paid to debit and convenience users of

credit cards) must be financed solely by interest and penalties imposed on revolving credit card users. However, the evidence suggests that rewards are indeed funded by merchant fees. Levitin (2007) reports that 44% of interchange fees goes to fund reward programs. Hayashi (2009) also investigates the degree to which card reward programs are financed by merchant fees, but she does not draw definite conclusions.

An alternative approach would be to suggest that large banks, large stores, and brokerage firms should be able to influence interchange fees (and hence merchant fees and retail prices) by bargaining with card issuers on having higher interchange fees for cards that pay higher rewards. Large financial institutions and retailers can always switch to a competing brand-name card (say, from issuing cards under the Visa brand to MasterCard and American Express, or to any subset of these major brand-name cards) and therefore should be able to influence interchange fees.

It seems that rewards were initially used (in the 1980s) to attract more customers that would revolve. But this has been changed and now most high-end reward cards have higher consumer fees and more recently higher merchant fees.[14] Clearly, the answers to many of these questions are known to the card issuers but are difficult for us to find out for obvious reasons. Identifying cost allocation to specific revenue sources is difficult. This has been a huge issue in countries that have started to implement cost-based interchange fees. Although interest payments and penalties may be used to partly finance card reward programs, this paper abstracts from the credit aspect of payment cards and focuses more on cases where rewards are financed by merchant fees.

3. A Model of Cash and Card Users

Endogenously-determined variables will be denoted by lower case letters. Exogenous parameters will be denoted by Roman CAPITAL and Greek letters.

[14] "The Damage of Card Rewards," New York Times, January 8, 2010.

3.1 The card system

We analyze a simple card network as illustrated in Figure 1. A buyer purchases a good for an endogenously-determined price p. Under the no-surcharge rule which is discussed in the introduction, merchants charge the same price p regardless of whether buyers pay cash or pay with a credit card. Figure 1 illustrates some of the fees involved in card transactions. The merchant pays a percentage fee μ to the acquirer. The card acquirer pays a percentage fee κ to the card issuer.[15] The card issuer pays a percentage reward ρ to the buyer for paying with the issuer's card.

Typically, the card issuer and the card acquirer make some profit by setting $\rho < \kappa < \mu$. We assume that acquirers don't make above normal profit so that $\kappa = \mu$. Then, card issuers earn a profit if the reward rate is lower than the merchant fee rate ($\rho < \mu$). Otherwise, card issuers break even if $\rho = \mu$. Clearly we don't analyze the case $\rho > \mu$ which corresponds to losses of card issuers.

3.2 Buyers and income distribution

The consumer population is composed of two income groups who use credit cards or "cash" (representing all other payments besides credit cards) to buy a single good. There are N_L low-income buyers and N_H high-income buyers. Income levels are denoted by I_L and I_H respectively, where $0 < I_L < I_H$. Type i buyers ($i = L, H$) are uniformly indexed by b_i on the unit interval $[\beta_i - 1, \beta_i]$ (where $0 \leq \beta_i \leq 1$) according to the benefit they derive from paying with a card relative to paying with cash, as illustrated in Figure 3.

Thus, b_i measures the non-pecuniary benefit from paying with a card by an income group i buyer who is indexed by b_i. $b_i = \beta_i$ denotes buyers of income group i who benefit the most from using a card. $b_i = \beta_i - 1$ are income group i buyers who most prefer paying

[15] When the card issuer and the acquirer are owned by different financial institutions, the fee κ is referred to as an interchange fee. Because interchange fees involve fixing fees by competing card issuers, these fees have triggered many debates and court cases brought against card organizations by antitrust authorities and merchant associations.

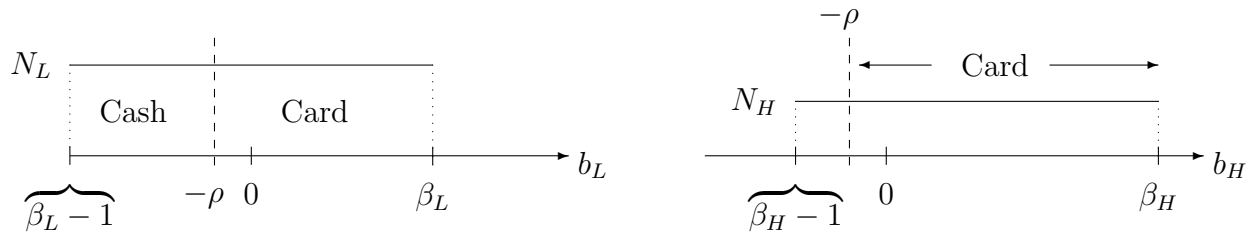

Figure 3: Distribution of buyers according to increased benefits from paying with cards. *Note*: Based on results presented later, the figure assumes $N_L > N_H$ (most buyers are low income) and $\beta_L < \beta_H$ (more high-income buyers prefer paying with a card relative to low-income buyers).

with cash over card.

Buyers have an endogenous choice of paying with cash or paying with a card. Banks (card issuers) reward card users by paying $\rho \cdot p$ as "cash back," where $0 < \rho < 1$ is the fraction of the price p that is paid back to the buyer. Therefore, the effective price paid by buyers is

$$p^b = \begin{cases} p(1-\rho) & \text{paying with a card} \\ p & \text{paying cash.} \end{cases} \tag{1}$$

Thus, assuming that buyers spend their entire budget, low-income buyers perform I_L/p^b transactions whereas high-income buyers perform I_H/p^b transactions. Therefore, we define the utility function of an income group i buyer who is indexed by b_i by

$$U_{b_i} = \begin{cases} \left[(1+b_i)\dfrac{I_i}{p(1-\rho)}\right]^{\alpha} & \text{paying with a card} \\ \left(\dfrac{I_i}{p}\right)^{\alpha} & \text{paying cash,} \end{cases} \qquad \text{for } 0 < \alpha \leq 1. \tag{2}$$

Equation (2) implies that a buyer's utility is increasing with the number of transactions (income divided by price). In addition, if the buyer pays with a card, the buyer gains an additional per-transaction benefit b_i (loss for buyers indexed by $b_i < 0$).

For each income group $i = L, H$, buyers who are indifferent between paying cash and paying with a card are found by solving

$$\left[(1+\hat{b}_i)\frac{I_i}{p(1-\rho)}\right]^{\alpha} = \left(\frac{I_i}{p}\right)^{\alpha} \quad \text{hence} \quad \hat{b}_i = -\rho. \tag{3}$$

Thus, buyers indexed by $b_i > \hat{b}_i$ pay with cards and buyers $b_i < \hat{b}_i$ pay cash, see Figure 3. In the special case where $\rho = 0$, buyers indexed by $\hat{b}_i = 0$ separate those who pay with cards $b_i > 0$ from those who pay cash $b_i < 0$. This means that card rewards induce some buyers who otherwise prefer to pay cash to use their cards in order to collect rewards.

The remainder of this section computes the number of card and cash payers as well as the number of transactions made with each payment instrument. Superscripts "h" (for cas**h**) denote cash payers whereas superscripts "d" (for car**d**) denote card payers. In view of the "indifferent" buyers described in (3) and Figure 3, the number of buyers from group i who pay cash is

$$n_i^h = [-\rho - (\beta_i - 1)]\, N_i, \quad \text{hence}$$
$$n^h = n_L^h + n_H^h = N_L[(1-\beta_L) - \rho] + N_H[(1-\beta_H) - \rho], \quad (4)$$

which is the total number of buyers (both income groups combined) who pay cash.

Next, the number of buyers from income group i who pay with cards is

$$n_i^d = (\beta_i + \rho)\, N_i, \quad \text{hence} \quad n^d = n_L^d + n_H^d = N_L(\beta_L + \rho) + N_H(\beta_H + \rho), \quad (5)$$

which is the total number of buyers (both income groups combined) who pay with cards.

The total number of *cash transactions* made by each income group (number of cash buyers times the number of transactions per cash buyer) is

$$t_i^h = n_i^h \frac{I_i}{p} = \frac{N_i I_i[(1-\beta_i) - \rho]}{p} \quad \text{hence}$$
$$t^h = t_L^h + t_H^h = \frac{N_L I_L[(1-\beta_L) - \rho] + N_H I_H[(1-\beta_H) - \rho]}{p}, \quad (6)$$

which is the total number of cash transactions in the economy for a given price p and reward level ρ.

Similarly, the total number of *card transactions* made by each income group is

$$t_i^d = n_i^d \frac{I_i}{p(1-\rho)} = \frac{N_i I_i(\beta_i + \rho)}{p(1-\rho)} \quad \text{hence}$$
$$t^d = t_L^d + t_H^d = \frac{N_L I_L(\beta_L + \rho) + N_H I_H(\beta_H + \rho)}{p(1-\rho)}. \quad (7)$$

3.3 Merchants

Merchants supply one "good" which could be either a product or a service. Free entry results in normal (zero) profits. Similar to Wang (2010), we model a "mature" card market in the sense that we assume that all merchants accept payment cards and cash. Thus, we assume for simplicity that consumers do not have to search for a merchant who accepts their preferred payment instrument. Let σ denote the unit production cost borne by merchants, and let $0 \leq \epsilon < 1$ denote the effort (disutility) of the merchant from a cash transaction relative to card transaction. Thus, the merchant's disutility from handling cash is $\epsilon \cdot p$. Under free entry, profits are reduced to zero so

$$0 = t^h[p(1-\epsilon) - \sigma] + t^d[p(1-\mu) - \sigma] \quad \text{hence} \quad p = \frac{(t^h + t^d)\sigma}{t^h(1-\epsilon) + t^d(1-\mu)}, \tag{8}$$

which is the equilibrium price in a competitive merchant industry. In the above, $t^h[p(1-\epsilon)-\sigma]$ is the profit made from t^h cash transactions, and $t^d[p(1-\mu)-\sigma]$ from t^d card transactions, where $p(1-\mu)$ is the net price a merchant receives after paying the fee to the card acquirer.

4. Data and Calibrations

We use several consumer-level micro data sets to calibrate the model. Income and card expenditure data at the household level are from the Survey of Consumer Finances 2007 (SCF), the Consumption Expenditure Survey (CEX) family level extract by Harris and Sabelhaus (2000), and the Statistics of Income 2006 survey (SOI). Transactions data are taken from the Survey of Consumer Payment Choice 2008 (SCPC) and population data are from Haver.

To utilize the model we must find the values of N_i, I_i, β_i, σ, ϵ, ρ, and μ. The following procedures were used to match the model with the data:

Observed values: The per-dollar merchant effort of handling cash was set to $\epsilon = 0.5\%$.[16]

[16]Garcia-Swartz et al. (2006) report that the marginal cost of processing a \$54.24 transaction (the average

The merchant fee is set to $\mu = 2\%$, a common assumption in the payments industry.[17] The reward rate is set at $\rho = 1\%$, which corresponds to the average value of the most U.S. credit card reward programs.[18] We refer to the settings of the cash handling cost, merchant fee, and reward rate as the "benchmark" settings but we also experiment with different values of μ and ρ and even attempt to calibrate for their optimal levels.

The number of households in each group (N_L and N_H) also is obtained from data. We divided them into two income groups: Households that make less than $\$100,000$ a year and those who make more than that.[19]

Calibrated and derived values: Income levels (I_L and I_H), maximum benefits from card usage by groups (β_L and β_H), and marginal cost of the composite good, σ.

The I_i and β_i, $i = L, H$, are adjusted so that the model matches the "total consumption expenditure" and the "total expenditure made with bank-issued credit cards" figures in the data. See Appendix A for a detailed description of the data construction. Total credit card expenditure by each income group in the model is

$$n_i^d \frac{I_i}{1-\rho} = (\beta_i + \rho) N_i \frac{I_i}{1-\rho}, \quad i = L, H,$$

where n_i^d was substituted from (5). Note that we divide income by $1-\rho$ to incorporate

check transaction) is \$0.43 (or 0.8%) if it is a cash transaction and \$1.22 (or 2.25%) if it is paid by a credit/charge card. Our calibrations find that the average transaction of cash and credit card payments is about \$44.44. The study by Bergman et al. (2007) for Sweden found that the total private costs incurred by the retail sector from handling 235 billion Swedish Crown (SEK) worth of transactions was 3.68 billion SEK in 2002, which would put our measure of cash handling costs to $\epsilon = 1.6\%$. They also note that unit social costs (per transaction costs incurred by everybody not just retailers) of credit card payments and unit social costs of cash payments are roughly the same. For the Norwegian payment system Gresvik and Haare (2009) estimates that private costs of handling 62.1 billion Norwegian Crown (NOK) worth of cash transactions incurred by the retailers was 0.322 billion NOK in 2007, which would imply $\epsilon = 0.5\%$. In that study the unit social cost of cash payments is two to three times higher than that of card payments made with internationally branded payment cards (i.e., VISA, MasterCard).

[17] Merchant fees in the U.S. were in the range of \$40–\$50 billion in 2008 see for example "Card Fees Pit Retailers Against Banks," *New York Times*, July 15, 2009. This approximately equals 2% of the U.S. credit cards sales for that same year published in the Call Report data for depository institutions.

[18] One percent cash back is widely observed. Most airline mileage and other points systems also have an approximate cash value of about $\rho = 1\%$. However, we do not have any data on the rate at which consumers actually claim their rewards, so the actual reward rate could be lower.

[19] According to Haver, in 2007 there were $116,011,000$ households in the U.S. Using the weights in the SCF we extract the number of households in each income group, N_L and N_H.

the reward into card expenditures. From (4), (5), and $N_i = n_i^d + n_i^h$, total consumption expenditures by income group $i = L, H$ in the model are given by

$$n_i^h I_i + n_i^d \frac{I_i}{1-\rho} = (1-\beta_i-\rho)I_i + (\beta_i+\rho)\frac{I_i}{1-\rho}, \quad i = L, H.$$

From data on total expenditure and card expenditures by each income group $i = L, H$, we use the above two equations to extract the income level I_i as well as the maximal benefit from card usage β_i. The marginal cost parameter σ is extracted from equation (7), by substituting the equilibrium price (8) into (7), and then matching with the card transaction figure in the SCPC.

Table 3 summarizes the model's parameter values obtained under the above computations.

Parameter	Notation	Value	Procedure
Cash effort	ϵ	0.5%	Assumed
Merchant fee	μ	2.0%	Assumed
Card Reward	ρ	1.0%	Assumed
Low income households (millions)	N_L	94.4	Data
High income households (millions)	N_H	21.6	Data
Low income level	I_L	$\$31,059$	Calibration
High income level	I_H	$\$107,946$	Calibration
Highest card benefit	β_L	0.123	Calibration
Highest card benefit	β_H	0.252	Calibration
Marginal cost	σ	\$44.18	Calibration
Total consumption expenditure	n/a	\$5.3bn	Appendix A
Total credit card expenditure	n/a	\$1bn	Appendix A

Table 3: Computed values of model paramters and variables.

One important qualification is warranted regarding the I_L and I_H entries in Table 3. While we refer to them in our model as income they are better interpreted as consumption spending. In this simple static model there is no difference between disposable income and consumption, since there are no savings by construction. In the data, however, we had to account for savings (Appendix A describes how we obtained the consumption figures). According the SCF 2007, households in our low-income group had on average about $\$41,500$

gross income, whereas high-income households had a $\$260,000$ average gross income. Using the Statistics of Income (SOI) 2006 tables we accounted for the different tax rates faced by these households, and using the CEX data we computed their average propensity to consume. The median low-income household spent 72% of gross income (81% of disposable income) on consumption, while the median high-income household spent only 37% of gross income (44% of disposable income).

5. Results

The buyer population is divided into four groups: High-income card users, high-income cash users, low-income card users, and low-income cash users. The no-surcharge-rule implies that all buyers pay the same equilibrium price (8) independently of which means of payment they use (and the income they earn). Table 4 shows the distribution of households and transaction

	Distribution of Households		
	Low-income	High-income	Total
Cash buyers	70	14	84
Card buyers	11	5	16
Total	81	19	100
	Distribution of Transactions		
	Low-income	High-income	Total
Cash buyers	48	32	80
Card buyers	8	12	20
Total	56	44	100

Table 4: Distribution of households and transactions (percentage of total).

volumes among these four groups of buyers.

Given the $\$100,000$ cut-off value between the income groups, 81% of the households belong to the low-income group. Using actual data on credit card expenditure we conclude that most of these households ($70/81 \approx 85\%$) use only cash, about 15% ($\approx 11/81$) use cards.[20] In the high-income group, card users make up about a quarter ($\approx 5/19$) of the

[20]Note that for the purpose of this paper we identify a household with a single payment instrument, but we still maintain correct share of payment instruments among the two income groups.

group. As far as transactions are concerned, despite their low share in the population (19%) high-income households generate 44% of all transactions. The main driving force behind our results will be the disproportionately large share of the high-income group in credit card transactions ($12/20 = 60\%$) compared to their share in total transactions (44%).[21]

5.1 Equilibrium price and markup

Substituting the calibrated parameters from Table 3 into (4)–(8), the equilibrium price (8) becomes

$$p\big|_{\substack{\mu=2\% \\ \rho=1\%}} = \$44.44, \quad \sigma = 44.09, \quad \text{and} \quad L(p,\sigma;\mu,\rho) = \left(\frac{p-\sigma}{p}\right) 100 = 0.79\%, \tag{9}$$

which is the Lerner's index commonly used for measuring markup over marginal cost. Thus, our calibrations suggest that

Result 1. *A merchant's cash effort $\epsilon = 0.5\%$, $\mu = 2\%$ merchant fee, and $\rho = 1\%$ reward, generate a 0.79% (or 35¢) price increase over marginal cost.*

The additional consumer expediture associated with the markup over marginal cost funds the merchants' fee ($20.8 billion[22] in aggregate) as well as the cash handling costs ($21.2 billion in aggregate).

Next, if we deviate from the observed benchmark merchant fee and card reward rate, we can simulate how these parameters affect the price markup borne by all consumers. Figure 4 depicts the markup as a function of μ and ρ. Note that we exclude from the graph all points in which $\rho > \mu$ (the shaded triangle on the floor of the three-dimensional graph),

[21] The information supplied in Table 4 is consistent with Tables 1 and 3 because the model credit card spending shares in the two income groups were calibrated from the groups' overall spending data. Table 1 shows that low-income households spend $\$4,176$ ($= \$348 \times 12$) annually while high-income households spend $\$28,632$ ($= \$2,386 \times 12$) each year. Table 3 shows that total annual household spendings $I_L = \$31,059$ and $I_H = \$107,946$, implying that low-income households use credit cards to pay for 13% of their total consumption expenditure, whereas the same number for high-income households is 27%. Since each transaction in the model has a value of p, the Table 4 can be used to replicate the same numbers (except for rounding errors): $8/56 \approx 14\%$ and $12/44 \approx 27\%$.

[22] This amounts to about half of the $42 billion estimated from Call Report data for whole economy, which also includes business and government card payments)

because banks make negative profits when rewards exceed merchant fees. Figure 4 shows that both relationships appear to be approximately linear, and the markup is more sensitive (steeper slope) to the merchant fee than to the reward rate. The reason for this follows from equation (8), which shows that the merchant fee affects price directly because it is a cost for the merchant, whereas the reward rate has only an indirect effect by making credit cards more attractive thereby increasing the number of card users, see equation (5). As

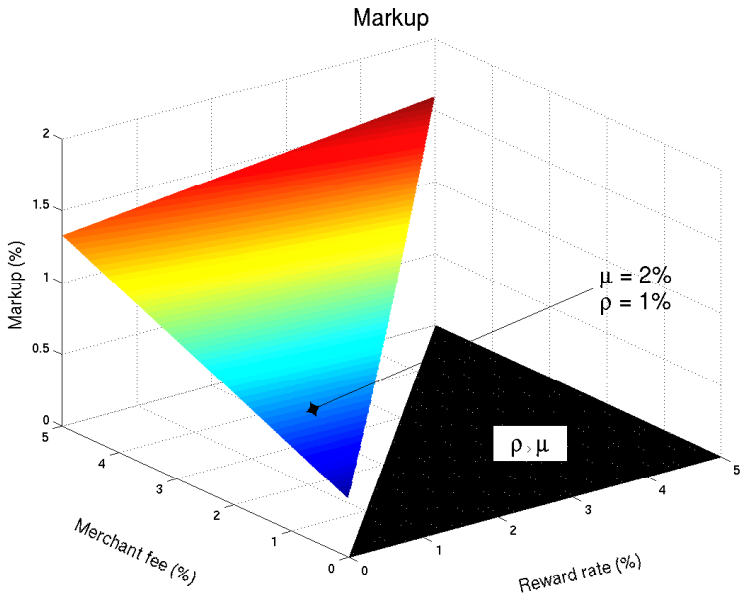

Figure 4: Consumer price markup as a function of the merchant fee and the reward rate

far as magnitudes are concerned, the elasticity of the markup with respect to the merchant fee (evaluated at $\mu = 2\%, \rho = 1\%$, and $\epsilon = 0.5\%$) is 0.49. In other words, eliminating merchant fees (a change of -100%) would result in halving the markup (from 0.79% to around 0.4%). On the other hand, rewards have a much smaller effect on the markup; the corresponing elasticity of the markup (measured at the same point) is only 0.022, meaning that abolishing rewards (-100% change) would only yield a 2.2% reduction in the markup to approximately 0.77%. These numbers are illustrated in Figure 4 by the point corresponding to no merchant fee and no rewards, which shows that in this case the markup would be 0.4% to cover the costs of cash-handling ($\epsilon = 0.5\%$) imposed by 80% of the population who pay

cash.

5.2 Income transfers between cash and card users

Transfers paid by households consist of two parts. First, under the no surcharge rule (NSR), price exceeds marginal cost σ at the point of sale because it incorporates at least part of the merchant fee μ and the cost of handling cash ϵ. In addition, card payers receive rewards from the issuing bank in the form of an aggregate transfer equal to $\rho \cdot p \cdot t_i^d$.

We define total transfers by each income group $i = L, H$ (and per household) as:

$$X_i^h = t_i^h(p - \sigma - \epsilon p) \quad \text{and} \quad x_i^h = \frac{X_i^h}{n_i^h}, \tag{10}$$

$$X_i^d = t_i^d(p - \sigma - \mu p) - \rho p t_i^d \quad \text{and} \quad x_i^d = \frac{X_i^d}{n_i^d}, \tag{11}$$

$$X^h = X_L^h + X_H^h, \quad \text{and} \quad x^h = \frac{X^h}{n^h} \tag{12}$$

$$X^d = X_L^d + X_H^d, \quad \text{and} \quad x^d = \frac{X^d}{n^d}. \tag{13}$$

Thus, the transfer by each cash user, defined by (10), is the price actually paid less the cost associated with a cash transaction (marginal and cash-handling costs). In other words our benchmark for a price of a *cash* transaction is $\sigma + \epsilon p$ which equals the cost that the buyer inflicts on the merchant. Similarly, the transfer by each card payer, defined by (11), is the price less the cost associated with a card transaction (marginal cost and merchant fee) minus the card rewards they receive. In other words, our benchmark for a price of a *card* transaction is the cost $\sigma + \mu p$ that the buyer inflicts on the merchant.[23]

Observe that the above transfers sum to zero ($X^h + X^d = 0$) *provided that* total rewards $\rho p t_i^d$ are not taken into account in (11). Otherwise, $X^h + X^d = -\rho p t_i^d$. This implies that card rewards are financed by banks. Figure 5 illustrates the two types of transfers defined

[23]Note that the above definitions compute the transfers *paid* by households belonging to a certain group, so a negative number indicates transfers received by the group (we may refer to it as a "subsidy"). For example, the transfer (10) is likely to be positive because under the NSR the price p paid by cash users embeds card merchant fees, whereas we expect (11) to be negative because card users do not bear the full cost they impose on the merchants.

	Total			Per household		
	I_L	I_H	Total	I_L	I_H	Avg.
Cash buyers	7.5	5.0	12.5	91	317	128
Cash buyers	−8.9	-13.9	−22.8	−692	−2,406	−1,225
Total/Average	−1.4	−8.9	−10.3	−15	−413	−89

Table 5: Transfers by income group and payment instrument. Totals are $ billions.

in (10) and (11). Table 5 displays the transfers defined by (10)–(13), which are summarized

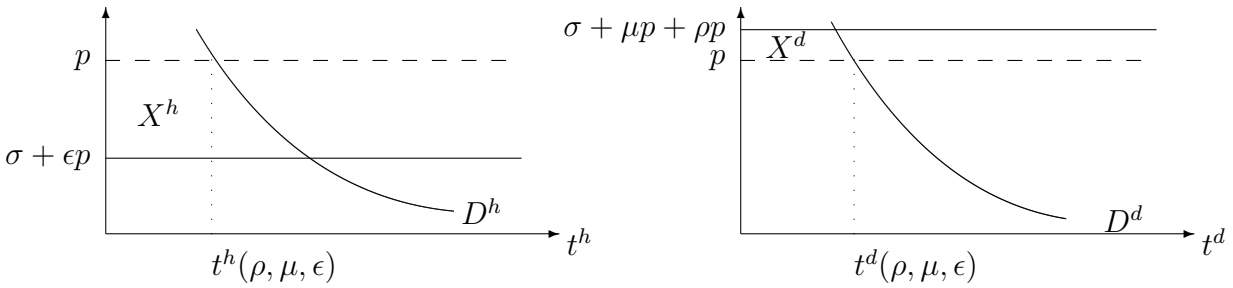

Figure 5: Illustration of transfers from cash (left) to card (right) users.

in Result 2.

Result 2. *Using definitions (10)–(13), each cash payer transfers* \$128 *($x^h = 128$) annually to card users, and each card user is subsidized on average by* $\$1,225$ *($x^d = -1,225$) annually.*

To our knowledge, this result is the first quantitative estimate of the theoretical results showing a transfer from cash payers to card payers. For the average low-income cash payer, the difference in Result 2 ($\$1,353$) represents 4.4% of their income ($\$31,059$ from Table 3).

5.3 Income transfers between low and high income buyers

The previous section computed the transfer from cash to card buyers resulting from merchant fees and rewards given only to card users. Section 2.3 has already established the correlation between card usage and income. We now demonstrate a method to compute how

the transfer from cash to card users translates into income redistribution. Similar to the transfer definitions given by (12) and (13), the transfer paid by each income group is

$$X_L = X_L^h + X_L^d \quad \text{and} \quad X_H = X_H^h + X_H^d. \tag{14}$$

Result 3. *With a* $\epsilon = 0.5\%$ *merchant cash effort ,* $\mu = 2\%$ *merchant fee, and* $\rho = 1\%$ *reward, total transfer of rents received by low-income buyers equals* \$1.4 *billion (*$X_L = -\$1.4$ *billion). Total transfer of rents received by high-income buyers equals* \$8.9 *billion (*$X_H = -\$8.9$ *billion). In per buyer terms,* $x_L = -\$15$ *and* $x_H = -\$413$.

On a first glance, it may seem odd to find out that *both* income groups *receive* transfers (both transfers are negative). This happens because the \$10.3 billion ($= 1.4 + 8.9$) rewards given back to card users are actually financed by the banks.

In other words, at the point of sale the NSR introduces a transfer from cash payers to card payers which sums to zero across the income groups. However, the total transfer to each income group must also include rewards paid for by the card issuing banks. High-income consumers receive 86% ($= 8.9/10.3$) of the income transfer even though they are only 19 percent of the households and account for 44 percent of the transactions. For the average low-income consumer, the difference in Result 3 (\$406) represents 1.3% of their income.

Figure 6 shows how the subsidy paid by low-income households varies with the merchant fee and the reward rate. In an economy without merchant fees (and hence with no rewards) the low-income group receives a transfer, because high-income card users "overpay" at the point of sale to cover merchants' cost of handling cash. As the merchant fee increases, however, the price markup also increases and the transfer will reverse sign, so it will be the low-income (cash payers) who cover parts of the merchant fees imposed by the card payers.

Formally, the elasticity of the transfers with respect to the merchant fee (evaluated at $\mu = 2\%$ and $\rho = 1\%$) is 2.44, so an increase in the merchant fee would increase transfers paid by low-income households (actually decrease the transfer received by the group). Note that X_L is slightly negative when $\mu = 2\%$ and $\rho = 1\%$, so low-income households receive a transfer. Also, the elasticity with respect to rewards is -3.10.

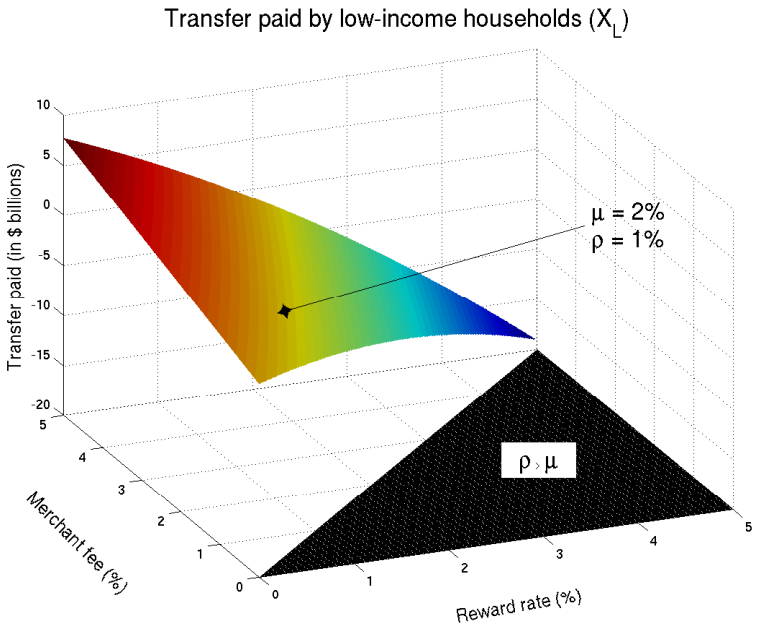

Figure 6: Transfer paid by low-income households as a function of the merchant fee and the reward rate

Rewards have a direct and an indirect effect on the amount of transfers. The direct effect is apparent from the second term in equation (11), if card users get higher rewards than the transfers paid by card users will decrease. The indirect effect comes from equation (5) which shows that card rewards attract more buyers to pay with a card within each income group.

We interpret the above transfers as *income redistribution* because the transfer elasticities for the low-income group have opposite signs (positive for μ and negative for ρ), whereas the same elasticities of the high-income group are both negative (-0.39 with respect to μ and -0.74 with respect to ρ), although smaller in magnitude. This implies that an increase in the merchant fee results in a larger transfer received by high-income households compared with the transfer received (at some point actually transfer paid) by low-income households.

5.4 Banks' income from consumer credit cards

Banks' net income from buyers in this paper is given by $p \cdot t^d(\mu - \rho)$. Just like the transfers analyzed in previous sections, banks' net income is non-linear with respect to the merchant fee

and the reward rate. Our calibration reveals that in 2007 banks' net income from consumer credit card payments was $10.3 billion. Figure 7 displays banks' net income as a function of the merchant fee μ and the reward ρ. One interesting feature of this graph is that the

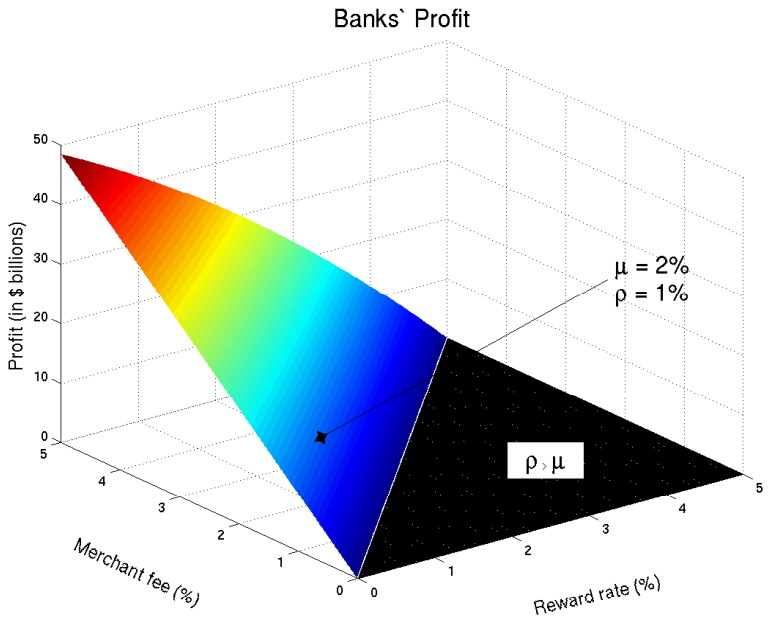

Figure 7: Banks' net income as a function of the merchant fee and the reward rate

iso-profit lines are nearly linear with respect to μ and ρ which implies that banks can keep the same net income using different combinations of merchant fee and reward rates, while keeping $(\mu - \rho)$ constant. This result is drawn in Figure 8.[24]

We conclude this section with an attempt to compute banks' source of revenue according to the four buyer groups. That is, we compute the burden imposed by merchant fee on each group of buyers. To do this we compare the price that would prevail in the absence of merchant fees to the equilibrium price in the model according to the first-order approximation given by

$$\Delta p = \frac{\partial p}{\partial \mu}\Delta\mu = \frac{t^d(t^h + t^d)\sigma}{[t^h(1-\epsilon) + t^d(1-\mu)]^2}\Delta\mu. \tag{15}$$

[24]Figure 6 shows that the amount of transfer paid by low-income households differs vastly along the $(\mu - \rho) = 1\%$ line, as it ranges anywhere between $X_L = -\$12.3$ billion $(\mu = 5\%, \rho = 4\%)$ and $X_L = \$0.9$ billion $(\mu = 1\%, \rho = 0\%)$, suggesting that consumer welfare might also change substantially along the banks' iso-profit line.

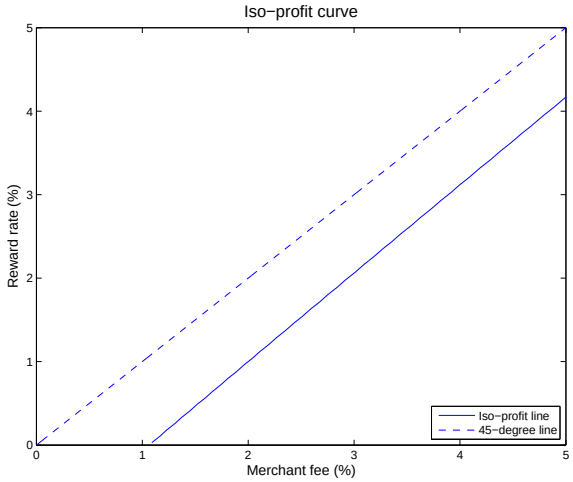

Figure 8: Banks' iso-profit line as a function of the merchant fee and the reward rate

Evaluating the above expression at the equilibrium values of t^h and t^d, using the benchmark parameter values and $\Delta\mu = -0.02$ $(= -2\%)$ yields the values for $t_i^h \Delta p$ and $t_i^d \Delta p$, $i = L, H$, which are displayed in the upper section of Table 6.[25] Table 6 implies the following result.

	Revenue from Merchant Fees					
	Total			Per household		
	I_L	I_H	Total	I_L	I_H	Total
Cash payers	10	6.7	16.7	123	426	172
Card payers	1.6	2.5	4.1	124	430	219
Total	11.6	9.2	20.8	123	428	180
	Rewards to Consumers					
Cash payers	0	0	0	0	0	0
Card payers	4	6.3	10.3	314	1,090	555
Total	4	6.3	10.3	43	292	89

Table 6: Banks' gross income sources and expenditure (totals are $ billions).

Result 4. *Cash users pay for about three-quarters* ($\approx 16.7/20.8$) *of banks' revenue from merchant fees. Moreover, low-income cash-users pay for almost half* ($\approx 10/20.8$) *of banks' gross income.*

Taking rewards into account, that is subtracting rewards received by each group from

[25] These computations are not accurate because we hold the reward rate constant at the 1% level, thereby entering the range in which $\mu < \rho$ (the black regions of the three-dimension graphs).

each entry in Table 6, we can identify the sources of banks' net income. Table 7 reveals

	Total			Per household		
	I_L	I_H	Total	I_L	I_H	Total
Cash payers	10	6.7	16.7	123	426	172
Card payers	−2.4	−3.8	−6.2	−190	−660	−336
Total	7.6	2.9	10.5	80	135	89

Table 7: Sources of banks' net income (totals are $ billions).

that banks actually lose money from their operations with card users ($ -6.25 billion), but they more than offset this loss with the merchant fee that they earn from cash payers. It is important to re-emphasize at this point, that in our model all card users are convenience users and thus pay no interest rates on outstanding balances, which would be another source of revenue for the card networks.

Finally, Table 7 also shows that three-quarters ($\approx 7.6/10.5$) of banks' net income is generated by low-income households, despite the fact that the high-income group uses credit cards more than the low-income group ($12/20 \approx 60\%$, see Table 4).

6. Consumer Welfare Calibrations

The analytical framework developed in this paper enables us to calibrate the consequences of merchant fees and card rewards on consumer welfare stemming from the redistribution of income between the two income groups.[26] In view of buyers' utility function (2) and Figure 3, aggregate consumer welfare of income group i buyers is given by

$$cw_i(\rho,\mu) = N_i \left\{ \left(\frac{I_i}{p}\right)^{\alpha} [-\rho - (\beta_i - 1)] + \left[\frac{I_i}{p(1-\rho)}\right]^{\alpha} \int_{-\rho}^{\beta_i} (1+b_i) db_i \right\}, \quad i = L, H, \quad (16)$$

where the equilibrium price p is given in (8). The above expression consists of the sum of utilities gained by cash users and card users (whose utilities must be integrated over b_i

[26]This partial equilibrium model does not take into consideration how changes in banks' profits affect consumption demand. For this reason, we do not extend this analysis to include social welfare. However, if household ownership of banks is increasing in income too, then taking bank profits into consideration could magnify our central result.

because buyers derive different benefits from card usage). Total buyer welfare as a function of the reward rate ρ and merchant fee μ is therefore given by $cw(\rho, \mu) = cw_L(\rho, \mu) + cw_H(\rho, \mu)$, and is plotted in Figure 9.

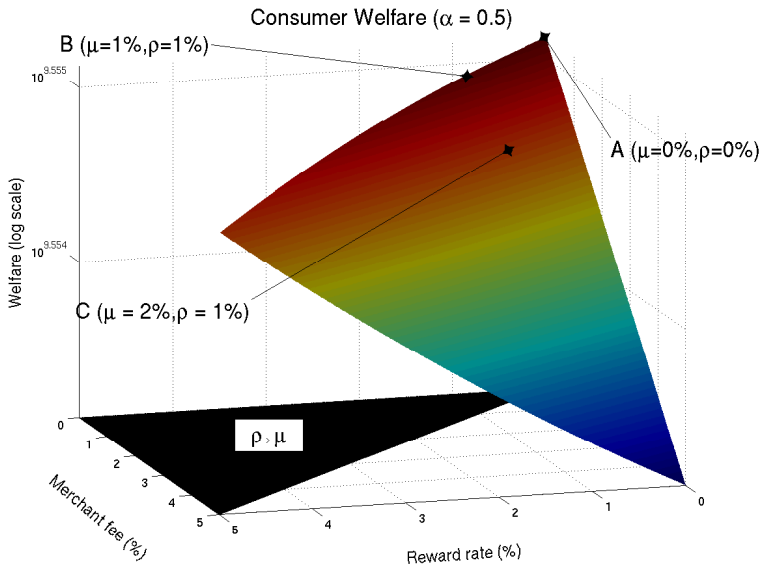

Figure 9: Consumer welfare as a function of the merchant fee and the reward rate

Figure 9 shows that consumer welfare increases monotonically with the reward rate (keeping μ constant). The reason for this is that in our partial equilibrium setup the rewards are pure windfalls received by the households from the banks. On the other hand consumer welfare falls very fast with an increase in the merchant fee. More precisely, the elasticity of the welfare function with respect to the merchant fee (evaluated at point C on the graph where $\mu = 2\%, \rho = 1\%$) is -0.002, meaning that eliminating the merchant fee (while leaving rewards unchanged) would increase aggregate consumer welfare by 0.2%. However, note that this change is infeasible without reducing ρ as well. The elasticity with respect to the reward rate (at point C) is 0.0008. Hence, eliminating rewards (while leaving merchant fee unchanged) would lead to a 0.08% decline in aggregate consumer welfare.

Using these elasticities we can infer the welfare implications of certain changes in the payment fee structure. If, for example, the merchant fee is cut in half to one percent, the economy would move to point B ($\mu = 1\%, \rho = 1\%$) and based on the aforementioned

elasticities, this move would entail a 0.1% ($= -0.002 \cdot (-50\%)$) increase in consumer welfare. Figure 9, however, reveals that this is not the maximum attainable level of welfare. A move from point B to point A ($\mu = 0\%, \rho = 0\%$) would further increase consumer welfare, although (as can be seen from the graph) this move would raise welfare by a smaller amount than the move from point C to point B. The elasticities calculated above confirm this, the welfare improvement would only amount to a further 0.02%, which is the difference between the welfare gain from another one percent reduction in the merchant fee and the welfare loss from the elimination of rewards ($0.0008 \cdot (-100\%) = -0.08\%$).[27] So eliminating merchant fees (and hence rewards) would result about in a $0.1\% + 0.02\% = 0.12\%$ increase in consumer welfare, compared to the $\mu = 2\%, \rho = 1\%$ starting point.

Also along the diagonal ($\rho = \mu$) in Figure 9 the concavity of the social welfare function is apparent (based on $\alpha = 0.5$ in our simulations). The parameter α affects the shape of the utility function and hence the optimal transfer levels. In particular, as α rises, the redistribution between the two income groups becomes more desirable. But, as the individual utility functions become closer to linear, redistribution becomes less desirable. Figure 10

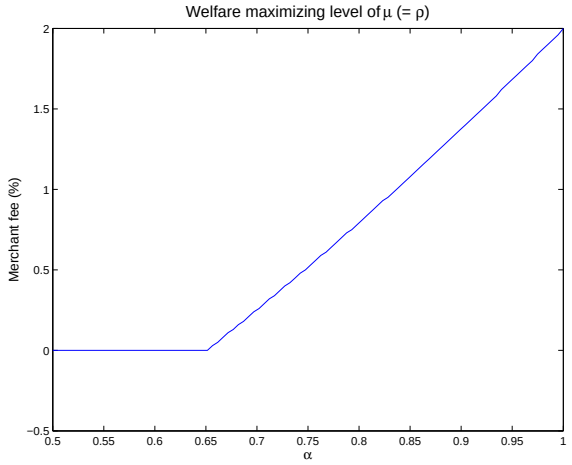

Figure 10: Consumer welfare maximizing merchant fee as a function of α

portrays the following result.

[27] This computation is slightly imprecise because we assume that the elasticity at point C is the same as in point B. The exact calculation is given in Table 9 below.

Result 5. *The merchant fee and card reward that maximize total consumer welfare decline with an increase in the degree of concavity of buyers' utility function (2) with respect to the number of transactions (a decrease in α).*

Result 5 highlights the distortion with the income distributions caused by the merchant fee and card usage programs. When buyers' utility becomes more concave (α decreases), any transfer from low- to high-income buyers has a greater impact on low-income buyers. For low values of α, eliminating merchant fees and card rewards is optimal. In the opposite-extreme case of a linear utility, the loss to low-income buyers is smaller than the gain to high-income buyers, so positive merchant fees and rewards become optimal.

However, even for high levels of α such as linear utility ($\alpha = 1$), the move from point C to point A in Figure 9 would still be welfare improving. In fact, with a linear utility function, welfare would increase by 0.18% (relative to the case in which $\alpha = 0.5$). Whereas the consumer optimum in this case would be at $\mu = \rho = 2\%$, a move to $\mu = 0\%$ and $\rho = 0\%$ would still raise welfare because such a move eliminates banks' profit, so all households would be paying lower prices.[28]

Our calculations may understate the welfare effects of reward programs because we assume that every credit card user benefits from some kind of reward program. SCF data actually shows that this is not true, even in the high-income group only about 80% of card users have reward cards. Even among card users who receive rewards, it is questionable whether they actually redeem all of their rewards (for example, frequent-flyer miles).

Finally, Figure 11 illustrates that there exists combinations of merchant fees and card reward rates such that it is possible to reduce the merchant fee from $\mu = 2\%$ to $\mu = 1.07\%$ and card reward from $\rho = 1\%$ to $\rho = 0$ while keeping banks' profit constant and also improving total consumer welfare.

[28]The reason why this improvement is bigger than the one in our benchmark model follows from the different shape of the utility functions. In particular, a higher α results in higher marginal utilities so the welfare effects of no bank profits are magnified.

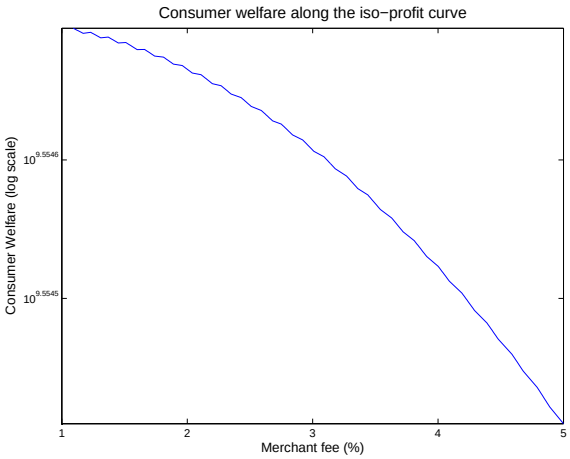

Figure 11: Welfare improving fee and reward reductions along banks' iso-profit line

Result 6. *Improving consumer welfare by lowering merchant fees and card rewards need not reduce banks' profit.*

This result suggests that public policy makers may be able to craft policy initiatives that would partially address the regressive transfer in the credit card market, thus making consumers better off without reducing banks' profit.

7. Policy Implications

Our model and analysis suggest there is likely an opportunity to increase consumer welfare through public policies that reduce the transfer of income from low-income to high-income consumers in the credit card market. Of course, we cannot say whether or not these policy interventions would also increase social welfare without modeling the supply side of the credit card market as well. Nevertheless, we briefly draw out the policy implications pertaining to consumer welfare as motivation for further research and policy analysis of social welfare. We see at least three options for direct policy changes, as well as an indirect option.

The first direct policy option is to eliminate the "no surcharge rule" NSR that is imposed by U.S. credit card associations. Eliminating the NSR would give merchants the right to

recoup the merchant fees they pay on credit card sales by imposing a surcharge on their customers (consumers) who pay by credit card, leaving cash-paying customers with a lower price (and implicit discount). If adopted, this differential pricing scheme by payment instrument might lead consumers to reduce their usage of credit cards, which would in turn reduce the income transfer. However, eliminating the NSR would not necessarily lead to surcharging of credit card payments or a reduction in the income transfer. Merchants may decide for other reasons not to surcharge, perhaps for fear of losing their valuable, high-income customers, see Bolt and van Renselaar (2009).

A second direct policy option is to regulate the merchant fee, reward rate, or both. Alternatively, the government could regulate the interchange fee among banks, which is the primary determinant of the merchant fee. This action has been taken recently by a number of countries, such as Australia and Spain. Regulation of the interchange and merchant fees, or rewards rate, is very controversial and generally less popular with economists. However, if policy makers consider this option, then our model and analysis offers a crucial new insight for them to bear in mind. We have shown that consumer welfare depends not only on the merchant fee (which depends on the interchange fee) but also on the reward rate. More generally, it is the gap between the fees and reward rate, as well as the levels of the fees and rate, which matters for consumer welfare. Thus, regulation of merchant or interchange fees should not be imposed independent of consideration of the reward rate.

Table 8 summarizes the elasticities with respect to the merchant fee and the reward rate that we have discussed thus far. Recall from Section 5.1 that regulating the merchant

Variable	Merchant Fee	Reward rate
Markup	0.49	0.02
Transfer (L)	2.44	−3.10
Transfer (H)	−0.39	−0.74
Consumer Welfare	−0.0020	0.0008

Table 8: Key elasticities (at $\mu = 2\%, \rho = 1\%$) with respect to μ and ρ in the model

fee without changing the reward rate would have a much larger effect on the price markup

than regulating the reward rate without changing the merchant fee (first line in Table 8). Furthermore, Section 6 showed that regulating the merchant fee without changing the reward rate would affect consumer welfare much more than regulating the reward rate without changing the merchant fee (fourth line in Table 8). However, it is important to remember that optimal policy would require simultaneous regulation of the merchant fee and the reward rate.

Table 9 provides a guide to the effects of policy changes by showing the percentage changes in consumer welfare associated with reductions in merchant fee and reward rates below their benchmark values ($\mu = 2\%$ and $\rho = 1\%$). A positive number indicates an

	Reward rate (ρ)				
μ	0	0.25	0.50	0.75	1.0
0.00	**0.105**	.	.	.	.
0.25	0.082	**0.104**	.	.	.
0.50	0.059	0.081	**0.103**	.	.
0.75	0.036	0.057	0.079	**0.101**	.
1.00	**0.013**	0.034	0.055	0.077	**0.099**
1.25	−0.011	**0.010**	0.031	0.052	0.074
1.50	−0.034	−0.014	**0.007**	0.028	0.049
1.75	−0.057	−0.037	−0.017	**0.004**	0.025
2.00	−0.08	−0.061	−0.041	−0.021	**0**

Table 9: Percentage changes in consumer welfare associated with reductions in merchant fee and reward rates below their benchmark values ($\mu = 2\%$ and $\rho = 1\%$).

increase in consumer welfare. The maximum possible increases in consumer welfare are found on the upper boldface diagonal where $\mu = \rho$. The iso-profit combinations associated with $(\mu - \rho) = 1.0$ are on the lower boldface diagonal.

A third direct policy option is to follow standard public finance theory to address a regressive transfer. The government could use taxes and government spending to redistribute income from high-income to low-income consumers. In principle, it is possible to tax credit card rewards and use those tax revenues to subsidize cash payers according to their incomes. However, developing an optimal public finance redistribution scheme may be difficult and complex given the interactions between payment instrument choice and income, and given

the lack of complete understanding about the inherent utility benefits from credit card use.

The feasibility of any of these potential policy options is in question as of the writing of this paper. The ability to eliminate the NSR, regulate interchange fees, merchant fees, or reward rates appears to be outside the existing U.S. regulatory structure.[29] Taxing and redistributing income associated with card rewards would require new Congressional legislation. Changes in the regulatory structure for oversight of financial institutions is on the agenda for Congress. However, the kinds of institutional changes that would give some regulator purview over credit card associations are not, nor is any proposal for fiscal policies that would redistribute income to address the regressive transfer stemming from credit card payments.

Consequently, the most feasible and effective public policies to address the regressive income transfer in the credit card market may be those that influence credit card costs and usage indirectly. Perhaps the simplest and most effective option would be for the government (including the Federal Reserve) to increase competition by expanding and improving access to alternative payment networks and services. The Automatic Clearing House (ACH), for instance, could be expanded improved to provide a more attractive alternative for public or private payments service providers to credit card networks. However, these and other policy options require considerable more research and policy analysis before they can be adopted.

8. Conclusion

TO BE WRITTEN.

Appendix A. Data

Total consumption expenditure was computed using the consumption over disposable income shares from the CEX extract by Harris and Sabelhaus (2000) and a household income variable

[29] However, elimination of the NSR may result from antitrust cases currently pending against credit card associations.

from the SCF. Variables for the consumption over disposable income ratio come from the Annual 109 Category Income (VAR(109)) block: Income is the sum of the first 14 variables; taxes are the sum of the following eight variables (15 through 22); consumption is the sum of the next 47 consumption variables (from 23 through 69). We used data from 1998–2002. The SCF does not have a disposable income measure. To construct it we used the Adjusted Gross Income variable ($x5751$) in the SCF and Table 1.4 from the SOI 2006 (All Returns: Sources of Income, Adjustments, and Tax Items, by Size of Adjusted Gross Income, Tax Year 2006) to figure out how much federal tax households payed. Then household income was computed as the sum of the following variables: $x5702$, $x5704$, $x5706$, $x5708$, $x5710$, $x5712$, $x5714$, $x5716$, $x5718$, $x5720$, $x5722$, and $x5724$. Using these measures of income and taxes with the CEX consumption ratio we obtained the estimate for annual consumption spending by household.

Total annual credit card spending was computed as the product of the (weighted) average of series $x7973$ and $x412$ (if $x412 > 0$) multiplied by 12. Total annual bank credit card transactions was taken from Table 19 (monthly credit card usage multiplied by 12) in SCPC 2008 (Foster et al. (2009)).

Appendix B. Sensitivity Analysis

The following sections contain the sensitivity analysis to changes in β_H, ϵ and α. Since we are not aware of any other study that has directly estimated β_H, we would like to see how our assumption that richer people intrinsically derive higher utility from using credit cards affects our results. Also, as noted above, the empirical studies find rather different values for the costs of handling cash and these differences could have important implications for our results.

When thinking about the welfare implications of different parameter values one has to look carefully at the utility of all four groups in the model: (i) low-income cash users, (ii) low-income card users, (iii) high-income cash users and (iv) high-income card users. The

different parameter values considered below will lead to different transfers between these groups. In general, since our social welfare function is utilitarian a redistribution to groups with higher marginal utility will be desirable. With our concave individual utility functions low-income households will have higher marginal utilities, but the $(1+b_i)$ (with $b_i > 0$) term in card users utility will raise their marginal utility above cash users' within their respective income group.

Appendix B.1 Sensitivity analysis with respect to β_H

We will now analyze what would happen if β_H would decrease all the way to the level of β_L. Having $\beta_H > \beta_L$ means two things in the model: (i) higher share of card users in the high-income group (see equation (5) and (ii) higher average marginal utility of card users in that income category. The former change means that for $\beta_H > \beta_L$ the cash payer to card payer transfer will cause a redistribution of income between the income groups as well. Intuitively, there will be more card payer who underpay in the high-income group so the cash payers (in both income categories) will have to overpay by more, but with the number of card payers in the low income category fixed (for a given β_L) this overpaying will result in a cross-subsidy from low-income households to their high-income counterparts. For concave utility functions this redistribution will lower total consumer welfare. At the same time a higher β_H also results in a higher utility gain from redistributing money from cash users to card users within the same income group. Remember that in both income groups card payers derive higher marginal utilities from an additional transaction, so a redistribution from cash to card payers *within* each income group is welfare increasing, until the marginal utilities of cash and card users within the income groups are equalized. As β_H increases, this utility gain is traded off against the utility loss from a simultaneous redistribution of money from poor to rich.

The top panel of Figure 12 helps to gage the effect of a change in β_H on the aggregate consumer welfare function. The mean change in the consumer welfare function has the exact same shape as the maximum change (not shown) or the change at the point of ($\mu = 2\%, \rho =$

1%). This finding indicates, that changes in β_H will not affect the shape of the consumer welfare function drastically, so we expect our results to be robust to changes in β_H.

The second graph shows how the "transfer payment by the low-income group" hyperplane in Figure 6 changes with β_H. In particular, we plot the minimum (dashed line) and maximum (solid line) points of the hyperplane and the transfer payment by the low-income group at a 2% merchant fee and 1% reward rate (dotted line). The increase in β_H leads to more high-income card users and with that to higher prices so the transfer hyperplane in Figure 6 shifts up.

Figure 14 plots the welfare maximizing level of μ as a function of β_H and ϵ, illustrating the story about the within- and across-income-group redistribution outlined above. Higher β_H leads to relatively more card payers among the rich, thus more of the cash to card payer redistribution becomes also low-income to high-income redistribution. Since this latter is detrimental to aggregate welfare, the optimal level of μ decreases to curtail the amount of cash to card payer redistribution.

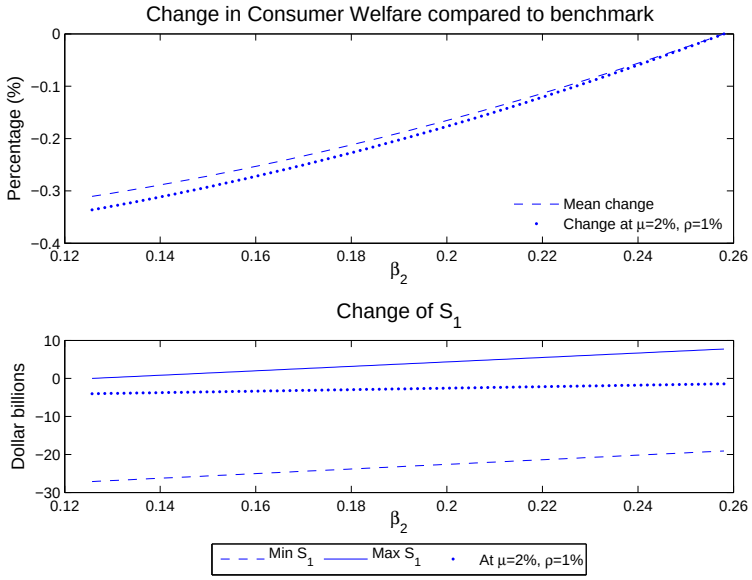

Figure 12: Welfare and transfers as a function of β_H

Appendix B.2 Sensitivity analysis with respect to ϵ

Changes in ϵ leads to changes in the consumer welfare function that are of similar magnitude as the changes inflicted by different values of β_H. Surprisingly, the redistribution stays also fairly constant as ϵ changes. Higher levels of ϵ tend to shift the subsidy hyperplane (Figure 6) down a bit.

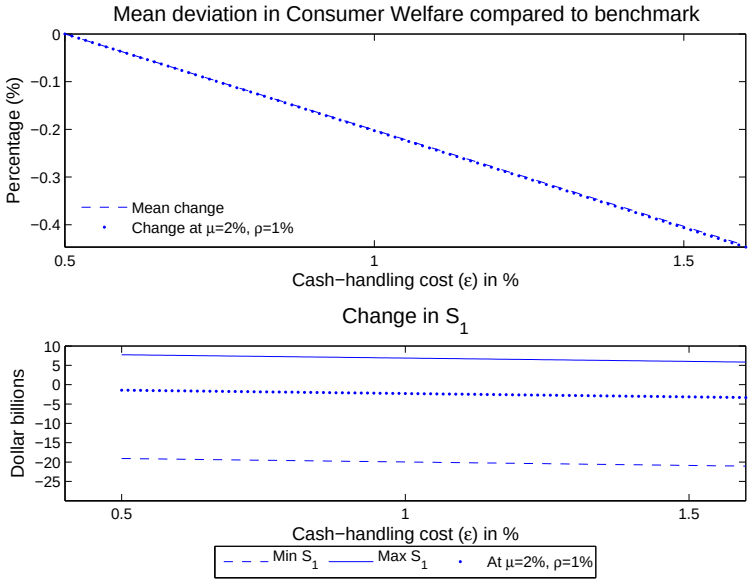

Figure 13: Welfare and transfers as a function of ϵ

A rise in the costs of cash handling leads to a redistribution from card to cash payers, just like the increase in the merchant fee lead to a transfer from cash payers to card payers. Again, the no surcharge rule forces merchants to recover the higher costs imposed by cash payers by charging higher prices to all customers, so as ϵ increases the price paid by card users will increase even though their purchases did not impose any additional costs to the merchants. Since this transfer means a redistribution from high- to low-income households (with $\beta_H > \beta_L$) it can increase social welfare as long as it helps to equalize marginal utilities between the income groups. As can be seen from Figure 14, however, this redistribution can become inefficiently high for high values of ϵ, which would then validate a non-zero merchant fee to redirect some of the transfer to low-income households back to high-income

households. In our benchmark model with a high β_H, for example, a 1.6% cash handling cost would require a 0.3% merchant fee to maximize consumer welfare. As can be seen on Figure 14, the optimal merchant fee changes markedly with different values for β_H. The intuition behind the figure is the same as above, the difference between β_L and β_H (difference between the fraction of card users in the income groups) increases the between income group redistribution. If there were no redistribution between income groups, the transfer resulting from cash handling costs would decrease welfare since it would channel money from (high marginal utility) card payers to (lower marginal utility) cash payers. This is why in the case of equal βs and high ϵ, a high merchant fee (1.8%) would be optimal to offset the transfer from card payers to cash payers. As β_H increases, however, the redistribution towards cash payers becomes more desirable, as it becomes subsidy from high-income to low-income households, while the redistribution caused by the merchant fee becomes less desirable since it works the other way around.

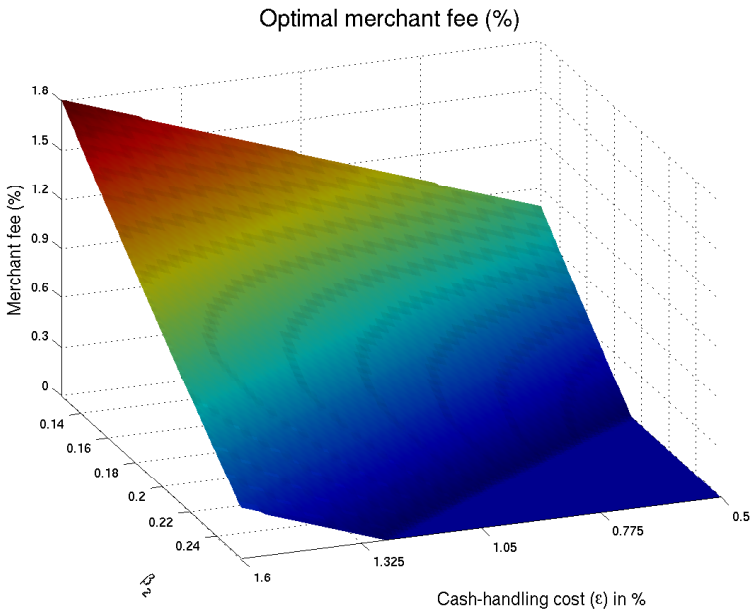

Figure 14: Optimal merchant fee as a function of β_H and ϵ

Cash handling costs play an important role in determining the markup. Due to the high fraction of cash payers (ca. 85% in low- and 75% in high-income group), the markup moves

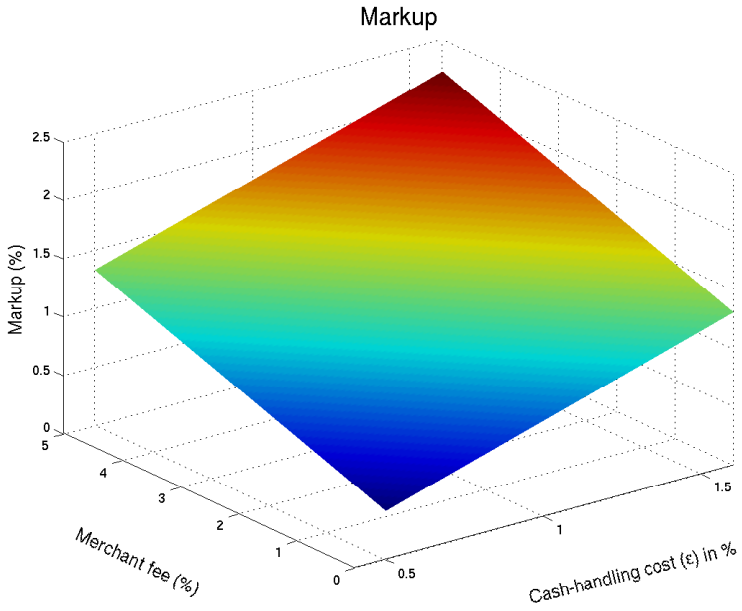

Figure 15: Markup as a function of μ and ϵ

almost one-for-one with ϵ. Figure 15 plots the markup as a function of cash handling costs and the merchant fee. Note that while the merchant fee goes from 0 to 5 percent cash handling costs only vary between 0.5 and 1.6%, keeping this in miind, Figure 15 shows that the markup is almost five times more responsive to changes in ϵ than to changes in μ.

Appendix C. Discussions of the NSR

Our analysis is conducted under the assumption that merchants obey the *no-surcharge-rule* (NSR in what follows). Under the NSR, merchants sign an agreement under which they cannot charge consumers an additional fee for using a card. Over the years, formal NSR agreements have been declared illegal by several antitrust authorities but not in the United States. Most merchants in the United States still don't impose a surcharge on card payments and many don't give discounts for cash payments. Bolt and van Renselaar (2009) provide an empirical analysis of the effect of surcharging card payments on actual payment behavior in the Netherlands where surcharging is currently allowed.

The following list provides some explanations for why merchants don't surcharge buyers for card payments despite having to pay a high fee for each card transaction.

Buyers' perception: Most buyers are not aware of the high fees imposed on merchants. Buyers may suspect that the sole purpose of a card surcharge is to enhance merchants' profit with no cost justification. Clearly, educating consumers may solve this problem.

Proper marking: Most states require shops to mark prices on all items they sell. Imposing a surcharge on cards may require placing two labels. By itself, this should not be a big problem, however, when a sale is declared merchants will have difficulties with marking down different prices associated with the different means of payments.

Competition: Card acceptance under high merchant fees may reflect a "bad" equilibrium on the part of merchants in which no merchant can profitably deviate by refusing to accept card payments. See Hayashi (2006) for a theoretical study.[30]

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[30]Borzekowski and Kiser (2008) present evidence showing that merchants can substantially reduce their cost by not accepting credit cards. In fact, Ausubel (1991) has already suggested that the use of plastic cards by buyers cannot always be explained in a rational matter. Merchants may also manifest similar behavior.

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