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

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Abstract:

Merchant fees and reward programs generate an implicit monetary transfer to credit card users from non-card (or "cash") users because merchants generally do not set differential prices for card users to recoup the costs of fees and rewards. On average, each cash-using household pays $149 to card-using households and each card-using household receives $1,133 from cash users every year. Because credit card spending and rewards are positively correlated with household income, the payment instrument transfer also induces a regressive transfer from low-income to high-income households in general. On average, and after accounting for rewards paid to households by banks, the lowest-income household ($20,000 or less annually) pays $21 and the highest-income household ($150,000 or more annually) receives $750 every year. We build and calibrate a model of consumer payment choice to compute the effects of merchant fees and card rewards on consumer welfare. Reducing merchant fees and card rewards would likely increase consumer welfare.

Keywords: credit cards, cash, merchant fees, rewards, regressive transfers, no-surcharge rule

JEL Classifications: E42, D14, G29

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CPRC CONSUMER PAYMENTS Research Center

1. Introduction

The typical consumer is largely unaware of the full ramifications of paying for goods and services by credit card. Faced with many choices—cash, check, debit or credit card, etc.—consumers naturally consider the costs and benefits of each payment instrument and choose accordingly. For credit cards, consumers likely think most about their benefits: delayed payment—"buy now, pay later"—and the rewards earned—cash back, frequent flier miles, or other enticements. What most consumers do not know is that their decision to pay by credit card involves merchant fees, retail price increases, a nontrivial transfer of income from cash to card payers, and consequently a transfer from low-income to high-income consumers.

In contrast, the typical merchant is acutely aware of the ramifications of his customers' decisions to pay with credit cards. For the privilege of accepting credit cards, U.S. merchants pay banks a fee that is proportional to the dollar value of the sale. The merchant's bank then pays a proportional interchange fee to the consumer's credit card bank.[1] Naturally, merchants seek to pass the merchant 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 companies impose a "no-surcharge rule" (NSR) that prohibits U.S. merchants from doing so, and most merchants are reluctant to give cash discounts.[2] Instead, merchants mark up their retail prices for all consumers by enough to recoup the merchant fees from credit card sales.

This retail price markup for all consumers results in credit-card-paying consumers being subsidized by consumers who do not pay with credit cards, a result that was first discussed in Carlton and Frankel (1995), and later in Frankel (1998), Katz (2001), Gans and King

[1] Shy and Wang (Forthcoming) show that card networks extract higher surplus from merchants using proportional merchant fees (rather than fixed, per-transaction fees). The amount of surplus that card networks can extract increases with the degree of merchants' market power.

[2] See Appendix D for additional discussion on the implications of the NSR. Card associations allow U.S. merchants to give cash discounts under certain restrictions. However, cash discounts are not widely observed. Frankel (1998) argues that a prohibition on credit card surcharges can have effects different from those resulting from a prohibition on cash discounts, because card surcharges allow merchants to vary their charges according to the different merchant fees they pay on different cards, whereas a cash discount is taken from a single card price.

(2003), and Schwartz and Vincent (2006). For simplicity, we refer to consumers who do not pay by credit card as cash payers, where "cash" represents all payment instruments other than credit cards: cash, checks, debit and prepaid cards, etc.[3] "Subsidize" means that merchant fees are passed on to all buyers in the form of higher retail prices regardless of the means of payments buyers use to pay. Thus, cash buyers must pay higher retail prices to cover merchants' costs associated with the credit cards' merchant fees. Because these fees are used to pay for rewards given to credit card users, and since cash users do not receive rewards, cash users also finance part of the rewards given to credit card users.

If the subsidy of card payers by cash payers results from heterogeneity in consumer preferences and utility between cash and card payments, the subsidy may be innocuous in terms of consumer and social welfare. However, U.S. data show that credit card use is very positively correlated with consumer income. Consequently, the 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 amplified by the disproportionate distribution of rewards, which are proportional to credit card sales, to high-income credit card users.[4] Frankel (1998, Footnote 85) was the first to connect the wealth transfers to average income of groups of consumers (that is, poorer non-cardholders subsidizing wealthier cardholders). This idea was later discussed in Carlton and Frankel (2005, pp. 640–641) and Frankel and Shampine (2006, Footnote 19).[5]

Our contribution to this line of research is that we are the first to compute who gains and loses from credit card payments in the aggregate economy. We compute dollar-value estimates of the actual transfers from cash payers to card users and from low-income to

[3]McAndrews and Wang (2008) demonstrates the possibility of a subsidy in the opposite direction (from card to cash users) in cases where merchants' cost of handling cash exceeds merchants' card fees. McAndrews and Wang's definition of cards includes debit cards, which are less costly than credit cards, whereas in our paper debit cards are considered part of "cash." Humphrey et al. (1996) and Humphrey et al. (2006) also provide evidence that electronic payment instruments, such as debit cards, are less costly than paper instruments, such as cash or check. Again, however, we focus only on credit cards, which have high merchant fees and are more costly than other payment instruments, paper or electronic.

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

[5]Similar points were made recently in *New York Times* articles by Floyd Norris, "Rich and Poor Should Pay Same Price," October 1, 2009; and by Ron Lieber, "The Damage of Card Rewards," January 8, 2010.

high-income households. A related paper by Berkovich (2009) estimates the total amount transferred from non-rewards consumers to rewards consumers in the United States resulting from gasoline and grocery purchases only.[6]

We propose a simple, model-free accounting methodology to compute the two transfers by comparing the costs imposed by individual consumer payment choices with actual prices paid by each buyer. On average, each cash buyer pays $149 to card users and each card buyer receives $1,133 from cash users every year, a total transfer of $1,282 from the average cash payer to the average card payer. On average, and after accounting for rewards paid to households by banks, when all households are divided into two income groups, each low-income household pays $8 to high-income households and each high-income household receives $430 from low-income households every year. The magnitude of this transfer is even greater when household income is divided into seven categories: on average, the lowest-income household ($20,000 or less annually) pays a transfer of $21 and the highest-income household ($150,000 or more annually) receives a subsidy of $750 every year. The transfers among income groups are smaller than those between cash and card users because some low-income households use credit cards and many high-income households use cash. Finally, about 79 percent of banks' revenue from credit card merchant fees is obtained from cash payers, and disproportionately from low-income cash payers.

To conduct welfare and policy analysis of these transfers, we construct a structural model of a simplified representation of the U.S. payments market and calibrate it with U.S. micro data on consumer credit card use and related variables. Parameters derived from the model are notably reasonable given the simplicity and limitations of the model and data. High-income households appear to receive an inherent utility benefit from credit card use that is more than twice as high as that received by low-income households. Eliminating the merchant fee and credit card rewards (together) would increase consumer welfare by 0.15 to

[6]This estimated transfer is about $1.4b to $1.9b, and rewards are found to have a disproportionate impact on low-income minorities and to resemble a regressive tax on consumption. These estimates focus exclusively on rewards transfers and do not account for the full range of transfers from low- to high-income consumers resulting from merchant fees.

0.26 percent, depending on the degree of concavity of utility, which also can be interpreted in an aggregate model as the degree of aversion to income inequality in society.

Our analysis is consistent with, but abstracts from, three features of the U.S. payments market. First, we focus on the convenience use of credit cards (payments only) and do not incorporate a role for revolving credit, which is an important feature of the total consumer welfare associated with credit cards.[7] U.S. data indicate that household propensity to revolve credit card spending is surprisingly similar across income groups, so it is unlikely that interest income plays a major role in the transfers. This fact supports working with a static model that is more tractable for data analysis. Second, we abstract from the supply-side details of the payments market for both cash and cards. We take as given the well-established, seminal result of Rochet and Tirole (2006) concerning the critical role of an interchange fee between acquiring and issuing banks in the two-sided credit card market, a result that notes that the optimal level of the interchange fee is an empirical issue.[8] By incorporating both merchant fees and card rewards rates, we can assume that the interchange fee lies between these rates and is set internally in the banking sector to the optimal level conditional on fees and rewards. Finally, we do not incorporate a role for the distribution of bank profits from credit card payments to households that own banks, because of a lack of sufficient micro data. Given these three simplifications, we can assess only the consumer welfare implications of the payment instrument transfers but not the full social welfare implications.

We want to be clear that we do not allege or imply that banks or credit card companies have designed or operated the credit card market intentionally to produce a regressive transfer from low-income to high-income households. We are not aware of any evidence to

[7]For example, the work of Carroll (1997) provides motivation for credit cards to help consumers smooth income in the face of income and wealth shocks and achieve optimal consumption plans. However, the actual impact of credit card borrowing on consumer and social welfare is complicated, as can be seen from literature, including Brito and Hartley (1995), Gross and Souleles (2002), Chatterjee et al. (2007), and Cohen-Cole (Forthcoming).

[8]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), Evans and Schmalensee (2005), Armstrong (2006), Schwartz and Vincent (2006), Bolt and Chakravorti (2008), Hayashi (2008), Rysman (2009), and Verdier (Forthcoming). For a comprehensive empirical study of interchange fees, see Prager et al. (2009).

support this allegation or any *a priori* reason to believe it. However, the existence of a non-trivial regressive transfer in the credit card market may be a concern that U.S. individuals, businesses, or public policy makers wish to address. If so, our analysis suggests several principles and approaches worth further study and consideration, which we discuss briefly at the end of the paper. Recent U.S. financial reform legislation, motivated by concerns about competition in payment card pricing, gives the Federal Reserve responsibility for regulating interchange fees associated with debit (but not credit) cards. Our analysis provides a different but complementary motivation—income inequality—for policy intervention in the credit card market.

Section 2 documents three basic facts about card card use. Section 3 demonstrates a simple "accounting" of transfers from cash to card users and from low-to high-income buyers. Section 4 presents an analytical model, which is then used in Section 5 to calibrate the welfare-maximizing merchant fees and rewards to card users, and to compute changes in welfare associated with a total elimination of card reward programs and merchant fees. Policy implications are explored in Section 6. Section 7 subjects our computations of income transfers to a wide variety of tests associated with additional modifications of the data. Section 8 concludes. An appendix provides data details and sensitivity analysis of the calibrated model.

2. Basic Facts about Credit Cards

This section establishes three basic facts about credit cards: 1) consumer credit card use has been increasing; 2) consumer credit card use and rewards are positively correlated with household income; and 3) credit card use varies across consumers due to heterogeneity in nonpecuniary benefits from cards, even within income groups. These facts motivate our analysis and modeling of transfers among consumers, associated with convenience use of cards.

2.1 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 and charge cards issued by banks, stores, and gas stations and used by consumers only. Figure 1 shows that the fraction of households who have a credit card (adopters) has been steady at about 70–75 percent during the past two decades, reflecting the maturity of the market. However, the percentage of total consumption expenditure paid for by credit card increased from about 9 percent to 15 percent during the same period.[9] As a result, revenue from merchant fees, which are proportional to credit card spending, also increased. Consumer credit card spending accounts for approximately half of all credit card spending in 2007.[10]

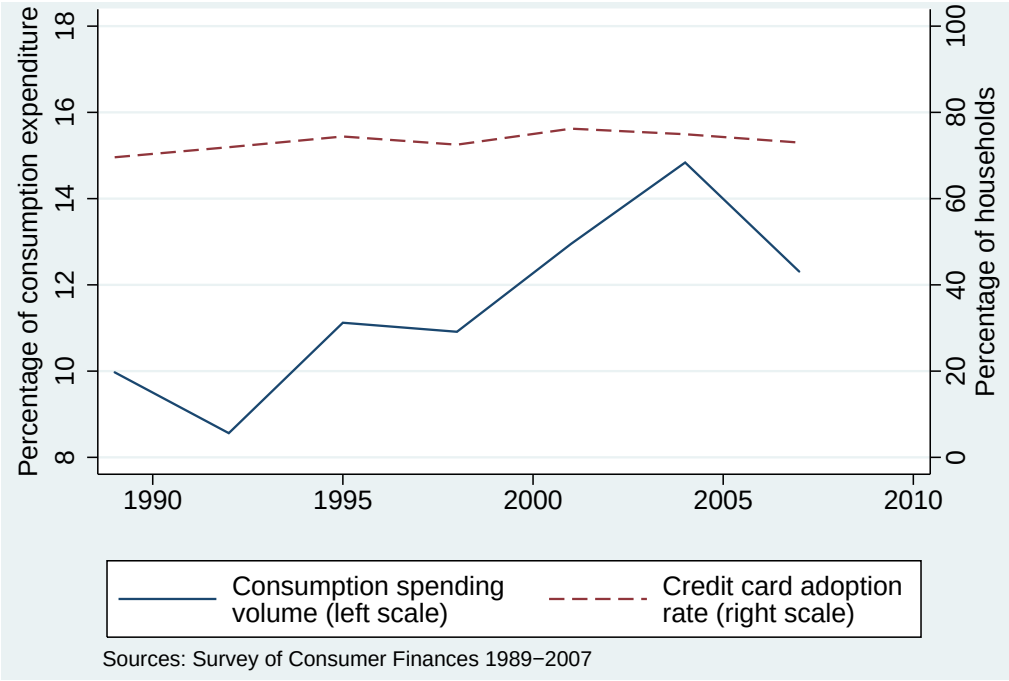

Figure 1: Credit card adoption and spending rates.

[9]Both series were taken from 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 about credit card adoption (variable *x410*) since 1989 ("Credit card adoption rate").

[10]Total credit card spending, which includes business and government expenditures, was about $42 billion in 2007, according to the Federal Deposit Insurance Corporation's Call Report data (series *rcfdc223* and *rcdfc224*).

2.2 Card use and 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 (2009a), Schuh and Stavins (2010)), there has been less focus on the relationship between income and credit card use. Publicly available data sources, such as the 2007 Survey of Consumer Finances, typically provide only the dollar amounts charged on credit cards, which we define here as use. However, data on the number of transactions consumers make with credit cards are available from the new 2008 Survey of Consumer Payment Choice (SCPC).

The data reveal a strong positive correlation between consumer credit card use and household income, as shown in Table 1. (The unequally sized income categories are as reported in published aggregate data from the Consumer Expenditure Survey.) The proportion of households who hold (have adopted) at least one credit card increases monotonically with income (first column). Average new monthly charges on all credit cards held by a household also increases monotonically with income among households who have adopted credit cards (second column).[11] And the share of credit card spending in total household consumption also increases monotonically with income (third column).[12]

The data also reveal a strong positive correlation between consumer credit card rewards and household income, as shown in Table 2. The share of credit card holders earning any type of rewards increases monotonically with income. A similar pattern is visible for each of the major types of rewards as well: cash back, frequent flyer miles, discounts, and others.

In most of our analysis, we split the consumer population into two income groups: households earning less than $\$100,000$ and households earning more than that.[13] This decision

[11]The new 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?" 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 is the relevant measure of credit card use.

[12]The share of credit card spending in household income actually decreases with household income, however, because the marginal propensity to consume falls with household income.

[13]Table 7 generalizes our results to multiple income groups.

Annual income	Have cc	Average monthly cc charge by adopters	Share of cc spending in consumption
Under $\$20,000$	42%	\$447	8.4%
$\$20,000$–$49,999$	67%	\$478	9.3%
$\$50,000$–$79,999$	87%	\$714	12.8%
$\$80,000$–$99,999$	92%	$\$1,026$	15.7%
$\$100,000$–$119,999$	93%	$\$1,293$	17.9%
$\$120,000$–$149,999$	97%	$\$1,642$	20.9%
Over $\$150,000$	97%	$\$4,696$	27.6%
Under $\$100,000$	68%	\$616	11.3%
Over $\$100,000$	96%	$\$2,966$	24.8%
Whole sample	73%	$\$1,190$	16.9%

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

is motivated by the need for parsimony in modeling, by the significant differences in credit card behavior between these two broad income groups shown in Tables 1 and 2, and by our desire to put the focus more on the transfer to higher-income households (and less on the transfer from lower-income households). Table 1 shows that credit card spending by high-income consumers is nearly five times higher than credit card spending by low-income consumers, and Table 2 shows that high-income consumers are 20 percentage points more likely to receive credit card rewards. The difference between the lowest-income (less than $20,000 per year) and the highest-income ($150,000 per year or more) households' credit card spending and rewards is markedly greater.

2.3 Non-income factors affecting credit card use

Income is not the only factor that is positively correlated with credit card use. Schuh and Stavins (2010) estimated the use of payment instruments as a function of various characteristics of these instruments, employing a 2006 survey of U.S. consumers. They found that, after controlling for income, the characteristics of convenience, cost, and timing of payment have a statistically significant effect on credit card use. Using the more extensive 2008 SCPC, we re-estimated the effects of payment instrument characteristics on consumer adoption and

Income	Any Reward	Cash Back	Airlines Miles	Discounts	Other Rewards
Under $20,000	48	27	17	13	8
$20,000–49,999	50	28	17	11	10
$50,000–79,999	62	35	26	13	12
$80,000–99,999	68	38	36	15	11
$100,000–119,999	71	37	33	16	15
$120,000–149,999	82	44	39	19	25
Over $150,000	75	33	48	15	19
Under $100,000	57	32	23	12	10
Over $100,000	77	37	40	16	19
Whole sample	61	33	27	13	12

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

use of credit cards, using the following specification:

$$\frac{CC_i}{TOTPAY_i} = f\left(CHAR_i, DEM_i, Y_i, NUM_i\right), \tag{1}$$

where $CC_i/TOTPAY_i$ is consumer i's share of the number of credit card payments in total payments; $CHAR_i$ is a vector of characteristics of credit cards relative to all other payments adopted by consumer i, DEM_i is a vector of demographic variables for consumer i, including age, race, gender, education, and marital status; Y_i is a set of income and financial variables; NUM_i is the set of dummy variables indicating the number of other payment instruments adopted by consumer i.

Table 3 shows the distribution of credit card use, calculated as a share of credit card payments in all payments for each consumer. The share of credit card transactions is higher for the over $100K income group than for the under $100K income group across the whole distribution. However, there is substantial variation within each income group. For example, among the high-income consumers, the 10th percentile of credit card users pay for 4 percent of their transactions with credit cards, compared with 70 percent of transactions for the 90th percentile of users. Therefore, there is variance in credit card use within income groups that needs to be explained.

Several relative payment-instrument characteristics have a significant effect on credit card

Percentile	Under $100K	Over $100K	Whole Sample
10^{th}	0	4	1
25^{th}	5	13	5
50^{th}	15	30	18
75^{th}	34	55	39
90^{th}	63	70	66

Table 3: Distribution (%) of credit card use within income groups for credit card adopters. *Note*: Based on the 2008 Survey of Consumer Payment Choice, and weighted using the population weights from the 2008 SCPC.

use. Table 4 shows the estimated coefficients on payment-instrument characteristics from estimating equation (1) for three different samples. While the cost of credit cards (which includes rewards as well as interest rates and fees) is significant in all specifications and for both income groups, other attributes of credit cards also are important determinants of credit card use, conditional on cost. Controlling for income categories (column 1 of Table 4), ease of use and record keeping have a strong and statistically significant effect on credit card use. In separate regressions by household income category, record keeping and cost have much stronger effects on higher-income consumers (column 3) than on lower-income consumers (column 2), while ease of use was not statistically significant for the higher-income group.

The preceding results indicate that payment-instrument characteristics are valued differently by consumers both within and between income groups. The model in Section 4 captures consumers' nonpecuniary benefits from using credit cards relative to cash, such as record keeping, in a utility parameter labeled as b_i, specific to income group i. This parameter turns out to be an important factor determining the choice of cash versus credit card for payments.

3. Transfer Accounting

This section demonstrates a simple, model-free approach to computing two implicit monetary transfers between U.S. consumers that result when some buyers pay with credit cards and others do not. One transfer is from cash buyers to credit card buyers; the other is from

	(1)		(2)		(3)	
Explanatory Variables	Whole Sample		Under $100K		Over $100K	
Cost	0.10	***	0.10	***	0.13	***
Speed	0.00		−0.05		0.11	
Security	0.01		0.02		−0.02	
Control	0.01		0.01		−0.00	
Records	0.11	***	0.08	**	0.17	**
Acceptance	0.06		0.06		0.08	
Ease	0.11	***	0.12	**	0.11	
Income categories included?	Yes		No		No	

Table 4: Three credit card use regressions. *Note*: Authors' estimation using the 2008 Survey of Consumer Payment Choice. *** significant at the 1% level, ** significant at the 5% level.

low-income buyers to high-income buyers. Our methodology decomposes national income account data on consumption into consumer groups defined by payment choice and income level, using micro data on consumption, credit card spending, and related variables (along with the benchmark estimates of payment costs). Humphrey, Kaloudis, and Øwre (2004) use an analogous methodology to estimate cash use in Norway.

3.1 The payments market

Figure 2 illustrates a simplified version of the U.S. payments market that frames the computation of aggregate transfers. There are three types of agents: buyers (consumers), merchants, and "banks." Buyers can have high or low incomes and pay by credit card or cash (all other non-credit card payments). A representative merchant sells a representative good to all consumers. This assumption is not strictly true for all markets, so we explore the implications of relaxing it in Section 7. However, it is a good approximation for most transactions and it is necessary to compute the transfers, given the lack of micro data on payment choice at the level of individual transactions.[14] Finally, "banks" represents the financial market that provides credit card payment services. It includes banks that issue cards to consumers

[14]It also greatly simplifies the modeling task by avoiding the need to have search and matching of individual consumers, merchants, and goods—a level of detail for which proper data are not currently available anyway—in addition to payment choice.

("issuers"), banks that receive card payments from merchants ("acquirers"), and card companies (Visa or MasterCard are examples) that facilitate interactions among banks and between banks and their customers.[15] The literature on two-sided markets analyzes the details of the "banks" and merchant markets but tends to abstract from consumer heterogeneity, restricting analysis of transfers among consumers. Our analysis takes the opposite approach.

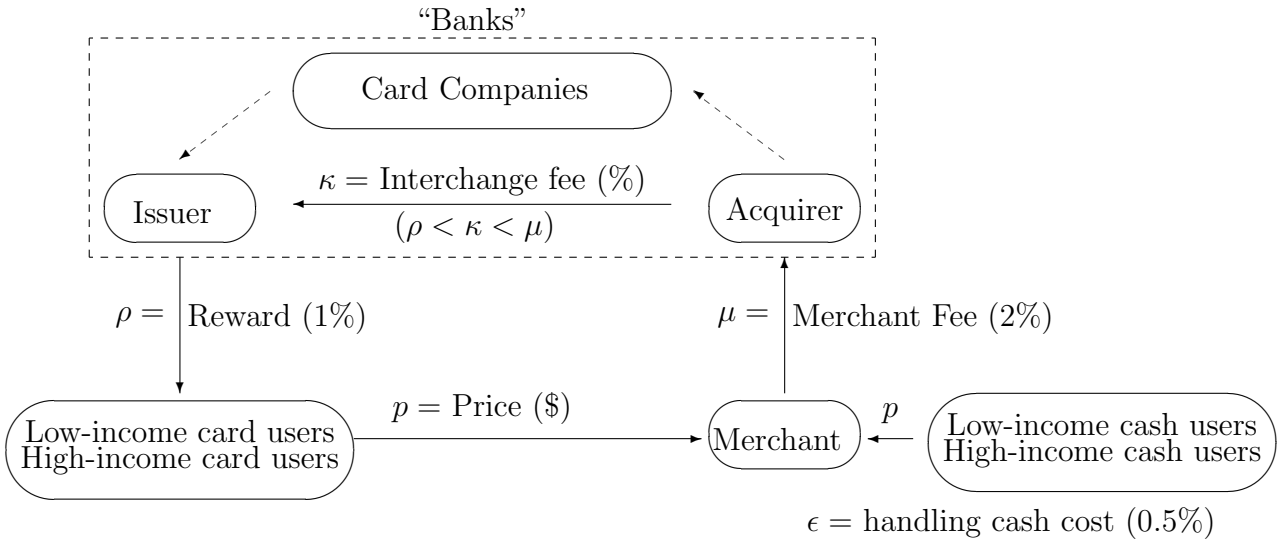

Figure 2: Fees and payments in a simple market with a card network.

Payments occur as follows. Buyers purchase a good for an endogenously determined price, p, using cash or credit card according to buyers' preferences for the payment instruments. The merchant incurs a cost with either payment choice. For cash, the merchant bears a cost, denoted $0 \leq \epsilon < 1$, associated with handling cash transactions. Thus, the merchant's cost of accepting a cash transaction is $\epsilon \cdot p$.[16] For credit cards, the merchant pays a fee, μ, to banks (acquirers) that is proportional to card sales. Thus, the merchant's cost of accepting a credit card transaction is $\mu \cdot p$. Card buyers receive a partial rebate of the merchant fee from banks (issuers) in the form of card rewards, ρ, that are proportional to card sales and

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

[16] As drawn, the cash-handling cost ϵ is a marginal cost. However, the actual cost of handling cash may include a fixed cost as well. Footnote 22 presents estimates of the cost of handling cash where ϵ could be interpreted as average cost that includes possible fixed costs because the data do not distinguish well between fixed and marginal costs.

are given to encourage use.[17] Thus, card buyers receive reward income of $\rho \cdot p$.

The merchant fee and reward rate are closely related to pricing decisions internal to banks. Acquirers pay a proportional fee, κ, to issuers. When the card issuer and card acquirer are owned by different financial institutions, κ is called an interchange fee. Because interchange fees involve the fixing of fees by competing card issuers, they have triggered many debates and court cases against card organizations by antitrust authorities and merchant associations.[18] Typically, banks make profits by setting $\rho < \kappa < \mu$, which we assume holds. Our analysis of the transfers among consumers requires only the merchant fee and reward rate and not the inclusion of the interchange fee.

Regardless of whether buyers choose cash or credit card, U.S. merchants tend to charge the same price, p, despite incurring different costs from the two payment instruments. Under the no-surcharge rule, merchants cannot charge credit card buyers a higher price than the price they charge cash buyers to recoup the extra cost ($\mu - \epsilon \approx 1.5$ percent in our calculations). However, under certain conditions card companies do allow the merchant to offer a discount to cash buyers, which is conceptually the same as surcharging cards.[19] Nevertheless, while some U.S. merchants have offered cash discounts from time to time, they generally do not do so widely or consistently. One reason may be the cost of offering two prices. Another reason may be concerns about adverse customer reactions to differential pricing and especially to penalizing card buyers, who tend to be higher-income households and to buy more goods.

The simplified payments market in Figure 2 covers only convenience use of credit cards and not the revolving credit feature of cards. In reality, banks also receive revenue from consumers through interest payments on revolving debt and from credit card fees (annual, over-the-limit, etc.), so it is possible that card rewards may be funded from sources of

[17] To fund rewards, banks use revenue from merchant fees and possibly other sources, such as annual fees or interest from revolving credit card debt. Funding of rewards is discussed more later.

[18] Some court cases in the United States and worldwide are discussed in Bradford and Hayashi (2008).

[19] For example, Section 5.2.D.2 of Visa U.S.A. April 2008 operating regulations states that "A Merchant may offer a discount as an inducement for a Cardholder to use a means of payment that the Merchant prefers, provided that the discount is clearly disclosed as a discount from the standard price and, non-discriminatory as between a Cardholder who pays with a Visa Card and a cardholder who pays with a 'comparable card'." See also Footnote 2.

credit card revenue other than merchant fees.[20] However, our data and analysis presented below suggest that these alternative sources of credit card revenue are unlikely to alter our qualitative conclusions about transfers. Furthermore, the welfare effects of credit card borrowing and lending are extremely difficult to identify in economic theory and practice—revolving debt may be welfare improving, even at very high interest rates—whereas the welfare effects of transfers among consumers associated with convenience use of credit cards are less so.

3.2 Data and assumptions

The payments market discussed in Section 3.1 generates implicit monetary transfers between consumers, regardless of whether revolving credit is extended for card purchases. Calculation of these transfers does not require a formal economic model, only data and arithmetic—hence the terminology "transfer accounting."[21] However, the transfer calculations are based on three key economic assumptions described below.

The quantitative fees and costs portrayed in Figure 2 represent "benchmark" estimates of recent conditions in the U.S. payments market. The limited available data suggest that a reasonable, but very rough, estimate of the per-dollar merchant effort of handling cash is $\epsilon = 0.5$ percent.[22] Available data suggest that a reasonable estimate of the merchant fee across all types of cards, weighted by card use, is $\mu = 2$ percent.[23] And available data

[20] Section 7.2 discusses the funding of card rewards and the relevant literature.

[21] See Appendix A for more details about the data.

[22] Garcia-Swartz, Hahn, and Layne-Farrar (2006) report that the marginal cost of processing a $54.24 transaction (the average check transaction) is $0.43 (or 0.8 percent) if it is a cash transaction and $1.22 (or 2.25 percent) if it is paid by a credit/charge card. The study by Bergman, Guibourg, and Segendorf (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 at $\epsilon = 1.6$ percent. 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 $\epsilon = 0.5$ percent.

[23] Merchant fees in the United States 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 range approximately equals 2 percent of the U.S. credit card sales for that same year in the Call Report data for depository institutions. Actual merchant fees are complex and heterogeneous, varying over cards and merchants. We estimate merchant fees across cards as follows: general purpose (Visa, MasterCard, and Discover) 2 percent; American

suggest that a reasonable estimate of the reward rate is $\rho = 1$ percent.[24] However, according to Table 2, only 55 percent of low-income credit card holders receive rewards, compared with 75 percent of high-income card holders. For this reason, the average card user in either income group will not receive the full reward, ρ, but only ρ multiplied by the fraction of credit cards with rewards among all credit cards carried by this income group. Thus $\rho_L = 0.57$ and $\rho_H = 0.79$ denote the *effective* reward rates received by an average household belonging to income groups L (low) and H (high), respectively.[25]

In addition to the benchmark specifications, the only data needed to calculate the transfers are sales revenues (credit card and total) and the number of buyers. Let t denote the quantity of transactions and $S = t \cdot p$ denote sales revenue. Sales are measured by consumption from the National Income and Product Accounts (NIPA) and Consumer Expenditure Survey (CEX), which were $S = \$9.83$ trillion in 2007.[26] About 42 percent of this consumption does not involve a payment choice for consumers, for example, imputed rental of owner-occupied housing, employer-provided health insurance, and fees paid for financial services, and thus this portion is excluded from the calculations[27]. Let $N = N_L + N_H$ be the total number of buyers and the sum of buyers with low and high incomes (subscripts L and H, respectively). Buyers are measured by the number of households, as reported by the Census Bureau, which was $N = 116.0$ million in 2007. The proportions of high- and low-income households and credit card spending data are obtained from the Survey of Consumer Finances (SCF) and applied to N.[28] For reasons described earlier, we set $\$100,000$ as the

Express 2.2 percent; and specific purpose (branded) 1 percent, see Hayashi (2009) for some numbers.

[24]One-percent cash back is widely observed. Most airline mileage and other points systems also have an approximate cash value of about $\rho = 1$ percent.

[25]Parameters ρ_L and ρ_H are set to be equal to the credit-card-spending-weighted average of the adoption numbers in the top half of Table 2, which explains the slight difference from 0.55 and 0.75. In practice, the actual reward rate could be even lower, because holders of reward credit cards may not claim all of their rewards or the rewards may expire, but we do not have data on the rate at which consumers actually claim their rewards.

[26]For more details about the CEX data source, see Harris and Sabelhaus (2000).

[27]We would like to thank Tim Chen (`Nerdwallet.com`), Leon Majors (Phoenix Marketing International), and Jay Zagorsky (Boston University) for helping us clarify whether credit cards can be used for mortgage payments.

[28]Zinman (2009b) compares the SCF with industry data and finds that the two sources match up well on credit card charges and fairly well on account balance totals.

cutoff level of household income (denoted I).

It is well known that consumption and income are distributed unevenly across households, and this situation is evident in Table 5. Low-income buyers account for 81 percent of all households but only 58 percent of transactions. Low-income buyers also tend to favor cash payments: 70 percent of all households are low-income cash buyers, and 50 percent of all transactions are conducted by low-income cash buyers. In addition, high-income households have a disproportionately higher share of credit card transactions (about $13/42 \approx 31$ percent) than their population share (19 percent). All this shows that high-income households make higher use of credit cards.[29]

	Distribution of Households			Distribution of Transactions		
	I_L	I_H	Total	I_L	I_H	Average
Cash buyers	70	13	83	50	29	79
Card buyers	12	6	17	8	13	21
Total	81	19	100	58	42	100

Table 5: Distribution of households and transactions (percentage of total).

Three assumptions are needed to define the implicit transfers among households.

A-1 All households pay the same price, p, for the representative product (good or service); that is, the merchant does not charge different prices to cash buyers and card buyers.

A-2 The merchant passes through the full merchant fee to its customers via the retail price.

A-3 Rewards to card users are not funded by banks' revenue generated by borrowing activities.

The validity of these assumptions is an empirical matter and the data needed to verify them are not available. One needs data on individual transactions that identify not only the payment instrument but also the consumer who uses it and the merchant who receives it.

[29]The household units in Table 5 are representative agents created across heterogeneous households to obtain a parsimonious aggregate representation of the data for modeling purposes. Households without credit cards are literally cash-only households (where cash means non-credit-card). However, there are no households that strictly use credit cards only, and most households use both cash and credit cards. Our aggregate transfer calculations cannot account for this within-household heterogeneity, a refinement we leave for future research.

Such matched consumer-merchant data are extremely rare, and may not even be sufficient. If consumers of different income groups buy different products within merchants, and if merchants price those products not only according to their price elasticities of demand but also by their probabilities of being paid for by cash versus credit, then consumer-merchant data are needed at the level of detailed individual products (goods and services) as well. Future research based on such rich and finely graded data would provide valuable refinements of our calculations. However, Section 7 considers some alternative calculations that explore the effects of relaxing these assumptions on the transfers.

3.3 Transfer definitions

Our goal is to measure the actual transfers in the U.S. payments market and their effects on consumer welfare. Thus, we define each transfer as the difference between the actual money paid by a household toward merchant payment costs, on one hand, and the reference value (amount of money) the household would pay if it faced the full cost of its payment choice in the current payment environment, on the other. The actual money paid is the household's share of the merchant's total cost of payments ($\mu S^d + \epsilon S^h$). The reference value of the payment depends on the marginal cost of the good for the household. As shown in Section 4, the marginal cost of producing the good (denoted σ) is the same for all households but the marginal cost of payment varies across households according to the household's payment choice. Households paying by cash impose a marginal cost of $\epsilon \cdot p$ for their transactions, and households paying by credit card impose a marginal cost of $\mu \cdot p$ for their transactions.

With this transfer definition in mind, consider first the transfer between cash and credit card users. Let X denote the transfer made (or subsidy received, if the transfer is negative). Then the transfer made by cas**h** users (superscript h) is

$$X^h \stackrel{\text{def}}{=} \left\{ \frac{S^h}{S} \left(\mu S^d + \epsilon S^h \right) \right\} - \epsilon S^h \quad \text{and} \quad x^h \stackrel{\text{def}}{=} \frac{X^h}{N_L^h + N_H^h}, \tag{2}$$

where x^h denotes the transfer per household, our preferred metric. The term of X^h in braces is what cash users actually pay toward total merchant payment costs: the cash share of total

spending, $(S^h/S) = 0.79$, times the total merchant cost of transactions, $(\mu S^d + \epsilon S^h) = \$47$ billion. Cash users indirectly pay a portion of the cost of credit card payments, $(\mu S^d) = \$24$ billion, because cash and credit card buyers pay the same equilibrium price, p, which will be calibrated later using the model in Section 4. The last term of X^h (outside the braces) is the total cost of cash transactions: that is, cash-handling costs, $(\epsilon S^h) = \$22$ billion.

Similar to (2), the transfer (or subsidy received, if the transfer is negative) made by credit car**d** users (superscript d) is

$$X^d \stackrel{\text{def}}{=} \left\{ \frac{S^d}{S} \left(\mu S^d + \epsilon S^h \right) - (\rho_L S_L^d + \rho_H S_H^d) \right\} - \mu S^d \quad \text{and} \quad x^d \stackrel{\text{def}}{=} \frac{X^d}{N_L^d + N_H^d}. \tag{3}$$

The term of X^d in braces is what credit card users actually pay toward total merchant payment costs net of the rewards they receive. The first term inside the braces is their contribution to merchants' transaction costs: the card share of total spending, $(S^d/S) = .21$, times the total merchant cost of transactions. The second term inside the braces adjusts for credit card rewards, $(\rho_L S_L^d + \rho_H S_H^d) = \$8.5$ billion. The last term of X^d (outside the braces) is the total merchant cost of credit card transactions, which equals banks' fee revenue from all credit card transactions.

The credit card transfer, equation (3), contains two components. One is the point-of-sale (POS) transfer, which occurs at the merchant:

$$\widetilde{X}^d \stackrel{\text{def}}{=} \left\{ \frac{S^d}{S} \left(\mu S^d + \epsilon S^h \right) \right\} - \mu S^d \quad \text{and} \quad \widetilde{x}^d \stackrel{\text{def}}{=} \frac{\widetilde{X}^d}{N_L^d + N_H^d}. \tag{4}$$

The second component is an adjustment for rewards, $-(\rho_L S_L^d + \rho_H S_H^d)$, which are subtracted from the POS transfer because rewards are rebated to credit card users by banks and reduce the contribution of card users to total merchant payment costs. The rewards adjustment to the POS transfer captures the portion of the overall transfer that occurs because credit card users do not pay the full value of the rewards they receive. Instead, cash users pay for part of the rewards, and this rewards-related transfer varies across income groups. Thus, the POS transfer, which excludes rewards, understates the actual transfer occurring as a

result of credit card payments.[30] Nevertheless, the POS transfer provides an informative, lower-bound estimate of the transfer, so we report both estimates. Furthermore, the POS transfer would be the appropriate measure if credit card users paid the full value of their own rewards.[31]

Section 2.2 established a positive correlation between card use and income, which motivates calculation of the transfer between low-income and high-income households. Similar to the transfer definitions given by (2) and (3), the transfers paid by each household income group are

$$X_L \stackrel{\text{def}}{=} \left\{ \frac{S_L}{S} \left(\mu S^d + \epsilon S^h \right) - \rho_L S_L^d \right\} - (\mu S_L^d + \epsilon S_L^h), \tag{5}$$

$$X_H \stackrel{\text{def}}{=} \left\{ \frac{S_H}{S} \left(\mu S^d + \epsilon S^h \right) - \rho_H S_H^d \right\} - (\mu S_H^d + \epsilon S_H^h). \tag{6}$$

The first terms in braces are what households actually pay toward total merchant payment costs: the amounts of merchant payment costs borne by income groups L and H, respectively, $((S_L/S) = .58$ and $(S_H/S) = .42)$, less their credit card rewards, $(\rho_L S_L^d) = \$2.7$ billion and $(\rho_H S_H^d) = \$5.8$ billion, respectively. The second terms are the total merchant costs of each household's own payment choice: $(\mu S_L^d + \epsilon S_L^h) = \$24$ billion and $(\mu S_H^d + \epsilon S_H^h) = \$23$ billion. Note that the total (aggregate) transfer among households by income level is the same as between cash-using and card-using households:

$$X = X_L + X_H = -(\rho_L S_L^d + \rho_H S_H^d). \tag{7}$$

Similar to equation (4), the POS transfers between low-income and high-income house-

[30] See Appendix B for more details on this point. We especially thank Fumiko Hayashi, Bob Triest, and Paul Willen for helping us to clarify our thinking about the transfer definitions, especially the central and crucial definition in equation (3).

[31] A simple way to see this point is think of an alternative payment market in which merchants surcharge credit card users for their rewards at the POS and then rebate the full rewards instantly to households using credit cards. In this case, merchants would pay a fee to banks net of rewards, $(\mu - \rho)$, rather than paying the full merchant fee and having banks pay rewards to households later.

holds are

$$\widetilde{X}_L \stackrel{\text{def}}{=} \left\{ \frac{S_L}{S} \left(\mu S^d + \epsilon S^h \right) \right\} - \left(\mu S_L^d + \epsilon S_L^h \right) \tag{8}$$

$$\widetilde{X}_H \stackrel{\text{def}}{=} \left\{ \frac{S_H}{S} \left(\mu S^d + \epsilon S^h \right) \right\} - \left(\mu S_H^d + \epsilon S_H^h \right) \tag{9}$$

and they omit the adjustment for rewards, which varies by income group. At the household level, the relative magnitudes of the income group transfers are determined primarily by two facts that favor high-income households: $S_H^d > S_L^d$ and $\rho_H > \rho_L$.

3.4 Transfer estimates

Applying the benchmark specification and data described in Section 3.2 to the transfer equations defined in Section 3.3 yields the central results of this paper. Table 6 displays the transfer estimates in billions of 2007 dollars and on a per household basis. These two types of estimates are qualitatively equivalent but we focus on the latter. Recall that positive (negative) numbers indicate that households using a payment instrument paid a transfer (received a subsidy).

	Total ($ Billions)			Per household, total ($)		
	I_L	I_H	Total	I_L	I_H	Average
Cash buyers	9.0	5.3	14.3	111	352	149
Card buyers	−8.3	−14.5	−22.8	−613	−2,188	−1,133
Total/Average	0.8	−9.3	−8.5	8	−430	−73
	POS only ($ Billions)			Per household, POS ($)		
Cash buyers	9.0	5.3	14.3	111	352	149
Card buyers	−5.6	−8.7	−14.3	−414	−1,311	−710
Total/Average	3.4	−3.4	0	37	−160	0

Table 6: Transfers in the payment market by household income and payment instrument.

To our knowledge, the results in Table 6 are the first quantitative estimates for the aggregate economy of theoretical measures of transfers between buyers stemming from the choice of payment instrument. Two main conclusions can be drawn from the results.

Result 1. *Cash payers subsidize credit card payers. The average cash-paying household transfers* \$149 *($x^h = 149$) annually to card users, and the average credit-card-paying household receives a subsidy of* $\$1,133$ *($x^d = -1,133$) annually from cash users.*

The annual transfer gap (difference) between the average cash and card users is $\$1,282$ ($x^h - x^d = \$1,282$), which represents 1.8 percent of median income across all households in 2007.

Result 2. *Low-income households subsidize high-income households. The average low-income household transfers* \$8 *($x_L = 8$) annually to high-income households, and the average high-income household receives a subsidy of* \$430 *($x_H = -430$) annually from cash users.*

The annual transfer gap (difference) between the average low-income household and the average high-income household is \$438 ($x_L - x_H = \$438$), which represents 0.6 percent of median income across low-income households in 2007. By far, the bulk of the transfer gap is enjoyed by high-income credit card buyers, who receive a $\$2,188$ subsidy every year. Although low-income credit card buyers also receive a subsidy (\$613) and high-income cash buyers pay a larger transfer (\$352) than low-income cash buyers, the greater use of credit cards and receipt of rewards gives high-income households a non-trivial subsidy each year.

These transfer estimates, based on only two income categories (defined by a cutoff of $\$100,000$), significantly understate the magnitude of the transfer between the lowest- and highest-income households. Dividing households into seven income categories instead, as in Table 7, reveals that the transfer gap between the lowest-income households (less than $\$20,000$) and the highest-income households ($\geq \$150,000$) increases to \$771 per household each year. The average lowest-income household pays \$21 each year, and the average highest-income household receives \$750 each year, from the convenience use of credit cards. In between, the transfer gap is nonlinear across groups—relatively flat until household income rises above $\$100,000$ annually, then sharply increasing in the highest categories. Thus, each of a large number of lower-income households pays a relatively small dollar amount of transfer,

while each household of a small number of higher-income groups receives a relatively large dollar amount of subsidy.[32]

	Transfers paid	
Income range	POS	Total
Under $\$20,000$	\$32	\$21
$\$20,000$–$49,999$	\$45	\$26
$\$50,000$–$79,999$	\$35	−\$11
$\$80,000$–$99,999$	\$16	−\$61
$\$100,000$–$119,999$	−\$11	−\$113
$\$120,000$–$149,999$	−\$50	−\$207
Over $\$150,000$	−\$313	−\$750

Table 7: Transfers in the payment market by disaggregated income categories.

Section 4 develops a model to quantify the potential loss to consumer welfare resulting from these transfers. Before doing so, let us put the payment transfer estimates into perspective by viewing them in the context of another public policy issue. The literature on inflation finds that the potential welfare gain of reducing steady-state inflation from 10 percent to 0 percent ranges between 0.2 and 1.0 percent of the GDP (see Ireland (2009) and Lucas (2000)). These estimates translate into an annual per household cost of \$243 to $\$1,213$ (using 2007 GDP data). Thus, the magnitude of the payments transfers would seem to merit attention from policy makers similar to that devoted to controlling inflation.

3.5 Sources of banks' income

This subsection decomposes banks' gross and net income from merchant fees, μS^d, into sources of revenue from each of the four buyer groups. We multiply gross income (revenue) by the share of total spending of each group of buyers: S_L^h/S, S_L^d/S, S_H^h/S, and S_H^d/S. The results appear in the first panel of Table 8. We then compute rewards paid to credit card

[32]Table 7 implies that the transfers computed with only two income groups may be sensitive to the cutoff income level. We chose a cutoff of $\$100,000$ because the transfer paid increases nonlinearly with income, so a higher cutoff level is more representative of the transfer paid by the highest income groups. If the cutoff household income is $\$50,000$, then the low-income household pays \$37 instead of \$8, whereas the high-income household receives \$200 instead of \$430.

users in the second panel of the table. The third panel reports the net income of banks from merchant fees, that is, gross income (first panel) minus rewards (second panel).

	Revenue from Merchant Fees					
	Total ($ billions)			Per household ($)		
	I_L	I_H	Total	I_L	I_H	Total
Cash buyers	12.0	7.0	19.9	149	469	199
Card buyers	2.0	3.1	5.2	149	473	256
Total	14.0	10.1	24.2	149	470	209
	Rewards to Consumers (expenditure)					
Cash payers	0	0	0	0	0	0
Card payers	2.7	5.8	8.5	199	877	423
Total	2.7	5.8	8.5	28	270	73
	Net ($ billions)			Net Per household ($)		
Cash payers	12.0	7.0	19.0	149	469	199
Card payers	−0.7	−2.7	−3.3	−49	−404	−166
Total	11.4	4.3	15.7	120	200	135

Table 8: Banks' gross income sources and expenditure.

From Table 8 we can derive the following results about sources of banks' income from merchant fees:

Result 3. *Low-income households bear a disproportionately large burden of merchants' cost of credit cards because they tend to use cash more often than high-income households. Cash users pay* 82 *percent* ($\approx$ 19.9/24.2*) of banks' gross income from merchant fees, and low-income cash users pay* 50 *percent* ($\approx$ 12.0/24.2*) of banks' gross income.*

Result 4. *Cash payers receive no rewards (naturally) and high-income households receive the lion's share of credit card rewards. The average high-income card payers receive* $877 *in rewards annually, while the average low-income card payers receive only* $199*, less than one-fourth as much.*

Result 5. *Banks earn negative net income from credit card users, as rewards paid exceed revenues received from these households (net revenue of* −$3.3 *billion), but banks more than*

offset this loss with net income from cash-paying households (\$19.0 *billion). Almost three-quarters (*$\approx 11.4/15.7$*) of banks' net income is generated from low-income households, despite the fact that the high-income group uses credit cards more than the low-income group (*$13/21 \approx 60$ *percent in Table 5).*

Overall, the picture painted by these data and results is one in which low-income cash payers account for the bulk of the costs (merchant fee revenue) imposed by the payment choices (credit card purchases) of mostly high-income households.

4. A Model of Cash and Card Users

To investigate the welfare consequences associated with the redistribution of income among households, we construct an analytical model and then calibrate it. Endogenously determined variables will be denoted by lower case letters. Exogenous parameters will be denoted by roman capital and Greek letters.

4.1 Buyers

There are N_L low-income buyers and N_H high-income buyers. Income levels are denoted by I_L and I_H, respectively. Income group 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 and described in Section 2.3. Thus, b_i measures the nonpecuniary 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 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 belonging to income group $i = H, L$ is

$$p^b = \begin{cases} p(1-\rho_i) & \text{paying with a card} \\ p & \text{paying cash.} \end{cases} \tag{10}$$

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

$$U_{b_i} = \begin{cases} \left[(1+b_i)\dfrac{I_i}{p(1-\rho_i)}\right]^{\alpha} & \text{paying with a card} \\ \left(\dfrac{I_i}{p}\right)^{\alpha} & \text{paying cash,} \end{cases} \qquad \text{for } 0 < \alpha \leq 1. \tag{11}$$

Equation (11) 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 $b_i < 0$).

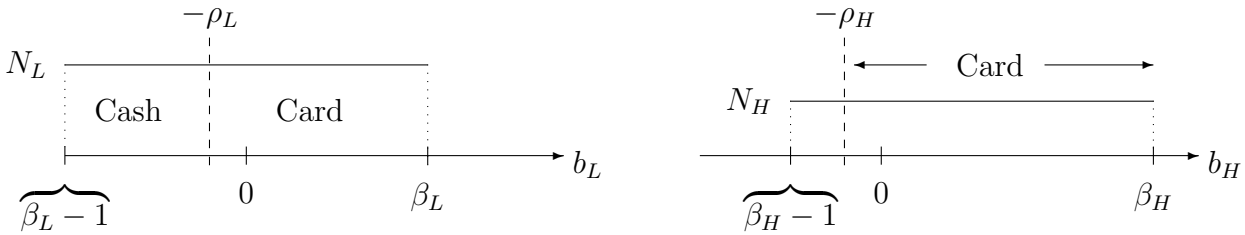

Figure 3: Distribution of buyers according to increased benefits from paying with cards. *Note*: Based on results presented later, the figure assumes $N_L > N_H$ (most buyers are low income) and $\beta_L < \beta_H$ (more high-income buyers prefer paying with a card relative to low-income buyers).

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

$$\left[(1+\hat{b}_i)\frac{I_i}{p(1-\rho_i)}\right]^{\alpha} = \left(\frac{I_i}{p}\right)^{\alpha} \quad \text{hence} \quad \hat{b}_i = -\rho_i. \tag{12}$$

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 $\rho_i = 0$, 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. Recall that 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 (12) and Figure 3, the number of buyers from group i who pay cash is

$$n_i^h = [-\rho_i - (\beta_i - 1)]\, N_i, \quad \text{hence}$$
$$n^h = n_L^h + n_H^h = N_L[(1-\beta_L) - \rho_L] + N_H[(1-\beta_H) - \rho_H], \quad (13)$$

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

$$n_i^d = (\beta_i + \rho_i)\, N_i, \quad \text{hence} \quad n^d = n_L^d + n_H^d = N_L(\beta_L + \rho_L) + N_H(\beta_H + \rho_H), \quad (14)$$

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

The total number of cash and card transactions made by each income group $i = L, H$, denoted by , t_i^h, and t_i^d in the model, multiplied by the price p, equals spending. Thus,

$$S_i^h = pt_i^h = n_i^h I_i \quad \text{and} \quad S_i^d = pt_i^d = n_i^d \frac{I_i}{1-\rho_i}. \quad (15)$$

4.2 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 (marginal) cost borne by merchants, and recall that $0 \leq \epsilon < 1$ denotes the effort (disutility) of the merchant from a cash transaction relative to a card transaction. Thus, the merchant's disutility from handling cash is $\epsilon \cdot p$. Under free entry, merchant profits are reduced to zero, so

$$0 = t^h[p(1-\epsilon) - \sigma] + t^d[p(1-\mu) - \sigma] \quad \text{hence} \quad p = \left[\frac{1}{\frac{t^h}{t^h+t^d}(1-\epsilon) + \frac{t^d}{(t^h+t^d)}(1-\mu)}\right]\sigma, \quad (16)$$

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

4.3 Calibrations

We first use the model to calibrate the number of cash and card users within each group, n_L^h, n_L^d, n_H^h, and n_H^d. These can be solved from (15) as functions of I_L and I_H. Because the numbers of low- and high-income households are known, solving $n_L^h + n_L^d = N_L$ and $n_H^h + n_H^d = N_H$ yields the calibrated values of I_L and I_H, which should be interpreted as consumption expenditures because savings are not modeled.

Next, in view of Figure 3, the key parameters to be calibrated are the maximal benefits from using cards relative to cash, β_L and β_H. These two parameters are solved directly from equations (13) and (14), assuming the card reward rates reported in Section 3.1. Transactions data from the Survey of Consumer Payment Choice (SCPC) show that credit cards accounted for 21.3 percent of consumer payments in 2008. Table 9 summarizes the model's parameter values obtained under the above computations.

4.4 Equilibrium price and markup

Substituting the calibrated parameters from Table 9 into (13)–(16), the equilibrium price (16) becomes

$$p\big|_{\substack{\mu=2\% \\ \rho=1\%}} = \$27.56, \quad \sigma = 27.34, \quad \text{and} \quad L(p,\sigma;\mu,\rho) = \left(\frac{p-\sigma}{p}\right)100 = 0.82 \text{ percent}, \quad (17)$$

which is the Lerner's index commonly used for measuring markup over marginal cost. Thus, our calibrations imply the following result:

Result 6. *Convenience use of credit cards induces a retail price markup of* 0.82 *percent over marginal cost (or* 22¢ *over* \$27.34*).*

Parameter	Notation	Value	Procedure
Cash effort	ϵ	0.5%	Assumed
Merchant fee	μ	2.0%	Assumed
Card reward	ρ	1.0%	Assumed
Rewards to low-income (cc-spend. weighted avg.)	ρ_L	0.57%	OSU 2007
Rewards to high-income (cc-spend. weighted avg.)	ρ_H	0.79%	OSU 2007
Number of credit card transactions	t_d	$43.9bn$	SCPC 2008
Total Spending Low-income	$N_L \cdot p \cdot t_L$	$\$3.33tr$	NIPA 2007
Total Spending High-income	$N_H \cdot p \cdot t_H$	$\$2.35tr$	NIPA 2007
Total Credit Card Spending Low-income	$N_L \cdot p \cdot t_L^d$	$\$0.47tr$	SCF 2007
Total Credit Card Spending High-income	$N_H \cdot p \cdot t_H^d$	$\$0.74tr$	SCF 2007
Low income level (excluding saving)	I_L	$\$34,879$	Calibration
High income level (excluding saving)	I_H	$\$110,153$	Calibration
Maximum card benefit (low income)	β_L	0.137	Calibration
Maximum card benefit (high income)	β_H	0.300	Calibration
Price	p	\$27.56	Calibration
Marginal cost	σ	\$27.34	Calibration

Table 9: Computed values of model parameters and variables.

To assess the sensitivity of this result, Figure 4 plots the retail price markup as a function of μ and ρ. The graph excludes all points in which banks make negative profit, which is depicted by the shaded triangle on the floor of the three-dimensional graph. Each relationship between the markup and the two parameters is each approximately linear, but the markup is more sensitive (steeper slope) to the merchant fee than to the reward rate. The reason for this result follows from equation (16), 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 (14).

The elasticity of the markup with respect to the merchant fee (evaluated at $\mu = 2$ percent, $\rho = 1$ percent, and $\epsilon = 0.5$ percent) is 0.52. In other words, eliminating the merchant fee (a change of -100 percent) would about halve the markup (from 0.82 percent to around 0.40 percent). These numbers are illustrated in Figure 4 by the point corresponding to no

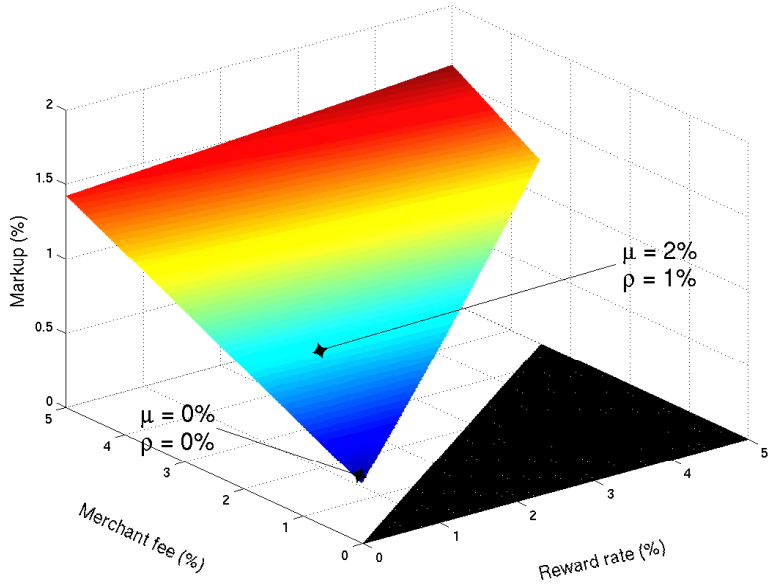

Figure 4: Consumer price markup as a function of the merchant fee and the reward rate.
Note: The color gradations facilitate distinguishing among levels (dark red, the highest, through dark blue, the lowest).

merchant fee and no rewards,[33] in which case the markup would be 0.40 percent to cover the costs of cash-handling ($\epsilon = 0.5$ percent) imposed by the 79 percent of the population who pay cash. On the other hand, rewards have a much smaller effect on the markup; the corresponding elasticity of the markup (measured at the same point) is only 0.014, meaning that abolishing rewards (-100 percent change) would yield only a 1.4 percent reduction in the markup to 0.79 percent.

4.5 Banks' income from consumer credit cards

Banks' net income from income group i buyers is given by $p \cdot t_i^d(\mu - \rho_i)$, $i = L, H$. Like the transfers analyzed in previous sections, banks' net income is nonlinear with respect to the merchant fee and reward rate. Banks' income from consumer credit card payments, net of rewards, was \$15.7 billion in 2007 (see Table 8). Thus, banks keep 65 percent of the revenues from merchant fees, while consumers receive 35 percent in rewards.

[33] Since the markup responds very little to a change in the reward rate, the vast majority of the reduction in the markup comes directly from the change in the merchant fee.

Figure 5 displays banks' net income from credit card spending as a function of the merchant fee, μ, and the reward, ρ. One interesting feature of the net income function

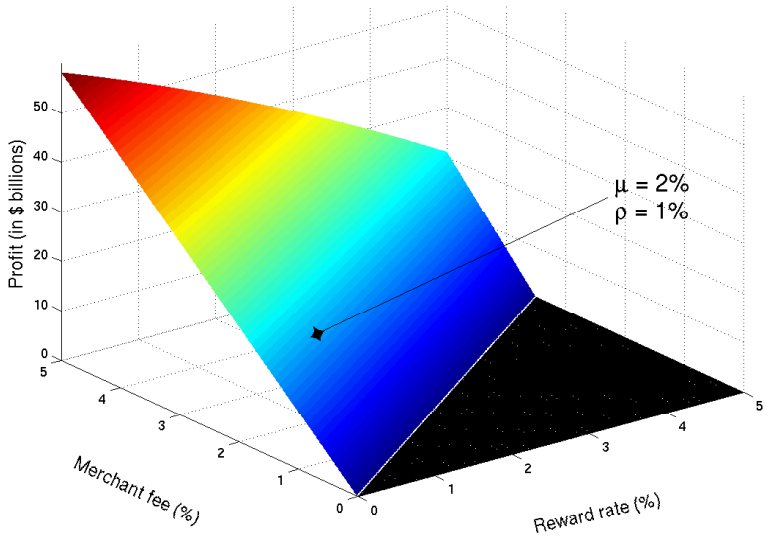

Figure 5: Banks' net income as a function of the merchant fee and the reward rate.

evident in the graph is that the iso-profit lines are nearly linear with respect to μ and ρ. Thus, banks can keep the same net income using different combinations of merchant fee and reward rates, while keeping $(\mu - \rho)$ approximately constant. This result is shown in Figure 6. The dashed line shows the combinations of parameters for which bank profits are

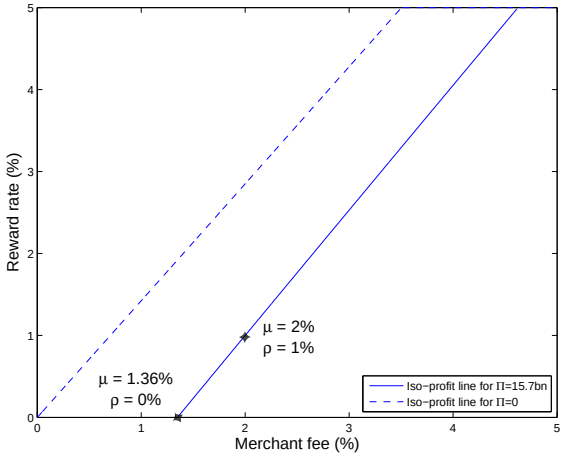

Figure 6: Banks' iso-profit lines as functions of the merchant fee and the reward rate

zero—combinations of reward rates and merchant fees to the left of this line would result

in losses to the banks. Since the rates at which households *actually* receive rewards (ρ_i) are both less than one, the slope of the iso-profit curves is greater than one, meaning that banks could offer a higher reward rate than the merchant fee, since they earn merchant fees on every credit card payment while they have to give rewards for only a fraction of these transactions. The solid line, which runs through the benchmark point, shows the combinations of parameters for which bank profits are constant at $15.7 billion. Reducing the merchant fee and reward rate to the point ($\mu = 1.36$ percent, $\rho = 0$ percent) would not alter bank profits, but would result in a lower retail price markup, as explained in the previous subsection.

5. 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 implicit monetary transfers between the two income groups.[34] In view of the buyers' utility function (11) and Figure 3, aggregate consumer welfare of income group i buyers is given by

$$cw_i(\rho_i, \mu) = N_i \left\{ \left(\frac{I_i}{p}\right)^{\alpha} [-\rho_i - (\beta_i - 1)] + \left[\frac{I_i}{p(1-\rho_i)}\right]^{\alpha} \int_{-\rho_i}^{\beta_i} (1 + b_i) db_i \right\}, \quad i = L, H, \quad (18)$$

where the equilibrium price p is given in (16). The above expression consists of the sum of utilities gained by cash users and card users (whose utilities must be integrated over b_i because buyers derive different benefits from card use). Therefore, total buyer welfare as a function of the reward rate, ρ, and merchant fee, μ, is given by $cw(\rho_L, \rho_H, \mu) = cw_L(\rho_L, \mu) + cw_H(\rho_H, \mu)$, and is plotted in Figure 7.[35]

[34] This partial equilibrium model does not take into consideration how changes in banks' profits affect consumption demand, because we do not have micro data on bank ownership (stocks). 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 would likely magnify our central results. Section 7.3 and Appendix B discuss the implications of income changes due to redistribution of banks' profits.

[35] A more general formulation of aggregate consumer welfare could take the form of $cw(cw_L, cw_H) = (cw_L)^{\gamma}(cw_H)^{1-\gamma}$. For our limited calibration purposes, the additive function is sufficient.

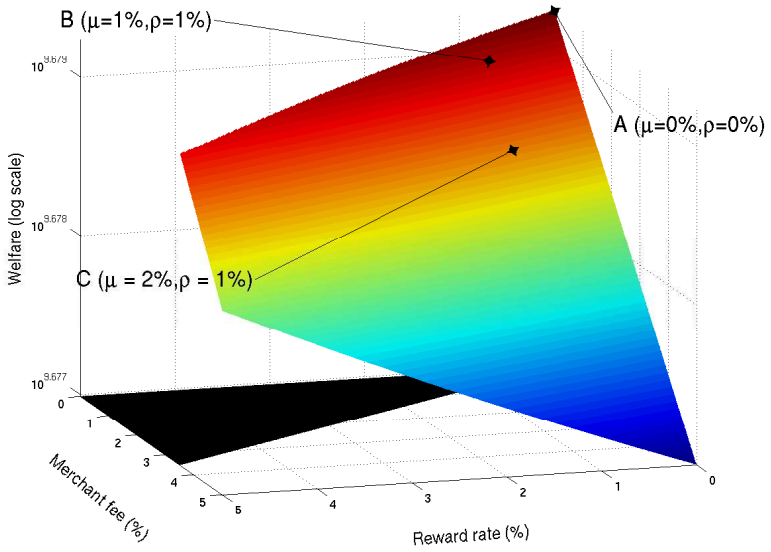

Figure 7: Consumer welfare as a function of the merchant fee and the reward rate (assuming $\alpha = 0.5$)

Consumer welfare increases monotonically with the reward rate, keeping μ constant. The reason for this result is that rewards are pure windfalls received by the households from the banks in this partial equilibrium setup. 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 the benchmark (point C on the graph, where $\mu = 2$ percent, $\rho = 1$ percent) is -0.0021, meaning that eliminating the merchant fee (while leaving rewards unchanged) would increase aggregate consumer welfare by $-0.0021(-100 \text{ percent}) = 0.21$ percent. However, this change is infeasible without reducing ρ as well. The elasticity with respect to the reward rate at point C is 0.0006. Hence, eliminating rewards, while leaving the merchant fee unchanged would lead to a 0.06 percent 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 1 percent, the economy would move to point B ($\mu = 1$ percent, $\rho = 1$ percent). Based on the aforementioned elasticities, this move would entail a 0.105 percent ($= -0.0021(-50 \text{ percent})$) increase in consumer welfare. However, Figure 7 reveals that this is not the maximum attainable level of welfare.

A move from point B to point A ($\mu = 0$ percent, $\rho = 0$ percent) would further increase consumer welfare, although this move would raise welfare by a smaller amount than the move from point C to B. The elasticities calculated above confirm this. The welfare improvement would amount to only a further 0.045 percent, which is the difference between the welfare gain from another 1-percent reduction in the merchant fee and the welfare loss from the elimination of rewards ($0.0006(-100 \text{ percent}) = -0.06$ percent).[36] So, eliminating the merchant fee, and hence rewards, would result about in a 0.105 percent + 0.045 percent = 0.15 percent increase in consumer welfare compared with the benchmark starting point.

The parameter α affects the shape of the utility function and hence the optimal transfer levels. As α declines, the transfer between household income groups becomes less desirable because the marginal utility loss from the low-income transfer becomes larger, while the marginal utility gain from the high-income subsidy gets smaller. When applied to aggregate data, as we do here, the parameter α can be interpreted equivalently as a measure of the economy's aversion to income inequality (lower α means greater inequality aversion).

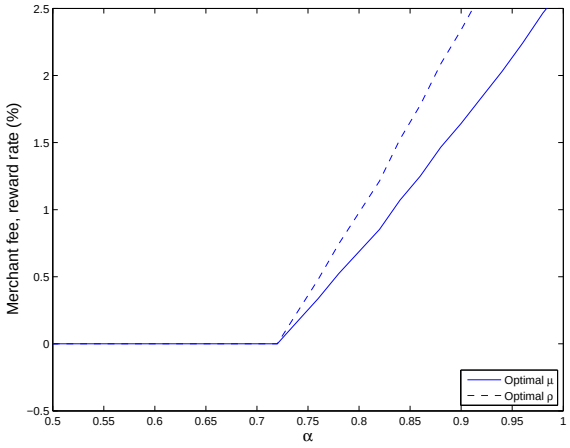

Figure 8: Consumer welfare-maximizing merchant fee and reward rate as functions of α (assuming zero bank profits)

Figure 8 plots the welfare-maximizing values of the merchant fee and reward rate for different values of α and portrays the following result:

[36]This computation is slightly imprecise because we assume that the elasticity at point C is the same as at point B. The exact calculation is given in Table 11 below.

Result 7. *The merchant fee and card reward that maximize total consumer welfare decline with an increase in the degree of concavity of buyers' utility function (11) with respect to the number of transactions (a decrease in α).*

Result 7 highlights the distortion in the income distributions caused by the merchant fee and card use 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 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 7 would still be welfare improving. In fact, with a linear utility function, welfare would increase by 0.26 percent (relative to the case in which $\alpha = 0.5$). Whereas the consumer optimum in this case would be at $\mu = 2.66$ percent and $\rho = 3.79$ percent, a move to $\mu = 0$ percent and $\rho = 0$ percent would still raise welfare, because such a move eliminates banks' net income, so all households would be paying lower prices.[37]

Finally, Figure 9 illustrates the combinations of merchant fee and card rewards such that it is possible to reduce the merchant fee from $\mu = 2$ percent to $\mu = 1.36$ percent, and card reward from $\rho = 1$ percent to $\rho = 0$, while keeping banks' net income constant and also improving total consumer welfare. The consumer welfare maximum is at $\mu = 1.36$ percent and $\rho = 0$ percent, the same point as depicted in the banks iso-profit function in Figure 6.

6. Policy Implications

Our model and analysis suggest that aggregate consumer welfare likely can be increased by reducing transfers between consumers, especially between low-income and high-income

[37]The reason why this improvement is bigger than the one in our benchmark model follows from the different shapes of the utility functions. In particular, a higher α results in higher marginal utilities, so the welfare effects of zero banks' net income are magnified.

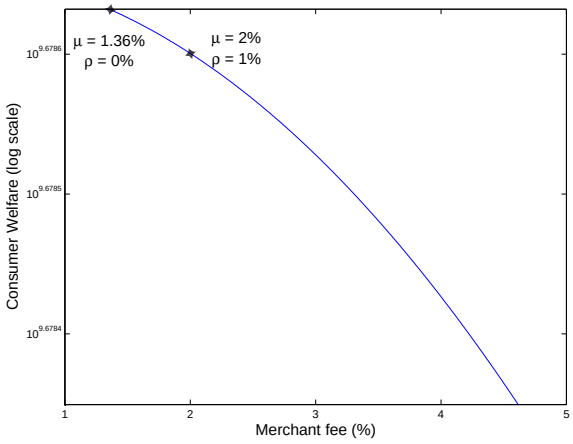

Figure 9: Welfare-improving fee and reward reductions along banks' iso-profit line

consumers. While it is natural to consider public policy initiatives in this endeavor, our research and discussions suggest preemptive actions that private sector agents (households, merchants, and banks) could take that would reduce the transfers. However, if private agents are not willing or able to take these actions to reduce the transfers, then public policy makers may wish to enact policies that would do so. Given the limitations of our model and analysis, we cannot provide precise policy recommendations that would necessarily optimize social welfare. Nevertheless, our research suggests some general principles and implications pertaining to consumer welfare that may be useful for policy deliberations:

- *Cost-based pricing*—One condition supporting the transfers is uniform pricing across payment instruments. Policies that would allow and encourage merchants to charge differential prices according to the costs imposed by payment instruments could help to reduce the transfers by reducing payment cross subsidies. Eliminating the NSR would seem to be an obvious option, but it may not be a sufficient incentive to induce differential pricing (for example, see Bolt and van Renselaar (2009)).

- *Full information*—Another condition supporting the transfers is the lack of full information about about merchant fees and other aspects of payment costs that have an impact on retail prices and consumer welfare. Policies that would require merchants, banks, or credit card companies to fully disclose fees, costs, and price markups to

consumers could help to reduce transfers by giving consumers the incentive to make optimal payment choices.

- *Redistribution*—The transfers can be reduced by compensating low-income households, using tax policies to redistribute money from high-income households according to credit card use and receipt of rewards. Direct methods may be complicated and costly, but tax deductions for reward contributions may be feasible.

- *Competition*—If there is inadequate competition in the credit card market, then government efforts to promote alternative payment instruments could help to reduce the transfers. Expanding access to low-cost existing networks, such as the Automatic Clearing House (ACH), is one possibility.

- *Regulation of fees and rewards*—The transfers likely can be reduced by regulating the merchant fee, but two important caveats apply. First, economists would caution as usual that regulators may have difficulty determining the optimal fee, so regulation of the merchant fee could actually reduce consumer welfare if the wrong level of the fee were selected. Second, and unique to our analysis, regulators should consider the merchant fee and reward rate simultaneously.

Of course, these policy implications and ideas would require more research and formulation before they could be considered and adopted.

Finally, these policies to reduce transfers are closely related to recent policies enacted to regulate payment card interchange fees worldwide. Policy makers in Australia and Spain, as well as the European Commission, have already taken actions to limit the interchange fees associated with credit cards. Actions taken by various countries are discussed in Bradford and Hayashi (2008). The recent U.S. financial reform bill (officially, the "Dodd-Frank Wall Street Reform and Consumer Protection Act" of 2010), signed into law on July 21, 2010, includes the Durbin Amendment, giving the Federal Reserve responsibility for regulating interchange fees associated with debit cards. In each of these cases, regulation of interchange fees was

motivated in part by concerns over an alleged lack of competition in payment card markets. Our analysis provides a different but complementary motivation—income inequality—for policy intervention.

Given that policy makers have been and will be focusing on regulating interchange fees, we can provide some potentially helpful information about the properties of merchant fees and rewards for policy makers who wish to take these parameters into consideration. Table 10 summarizes the key elasticities with respect to the merchant fee and the reward rate in the model. Recall from Section 4.4 that regulating the merchant fee without changing the

Variable	Merchant Fee	Reward rate
Markup	0.52	0.014
Transfer paid by low income (X_L)	5.99	-3.560
Transfer received by high income ($-X_H$)	0.50	0.658
Consumer Welfare	-0.0021	0.0006

Table 10: Key elasticities (at $\mu = 2\%, \rho = 1\%$) with respect to μ and ρ in the model

reward rate would have a much larger effect on the price markup and consumer welfare than regulating the reward rate without changing the merchant fee (first and last lines of Table 10). However, it is important to remember that optimal policy would require simultaneous regulation of the merchant fee and the reward rate. It would also require an analysis and treatment of household claims to banks' profits, which we have not considered here.

Table 11 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 ($\mu = 2$ percent and $\rho = 1$ percent). A positive number indicates an increase in consumer welfare. The maximum possible increases in consumer welfare are found at the top of each column where banks' net income is the smallest for the column.

	Reward rate (ρ)				
μ	0	0.25	0.50	0.75	1.0
0.00	0.147	·	·	·	·
0.25	0.121	0.137	·	·	·
0.50	0.095	0.111	0.128	·	·
0.75	0.069	0.085	0.101	0.118	0.134
1.00	0.043	0.059	0.075	0.091	0.107
1.25	0.018	0.033	0.049	0.065	0.081
1.50	−0.008	0.007	0.022	0.038	0.054
1.75	−0.034	−0.019	−0.004	0.011	0.027
2.00	−0.060	−0.045	−0.030	−0.015	0.000

Table 11: Percentage changes in consumer welfare associated with reductions in merchant fee and reward rates below their benchmark values ($\mu = 2\%$ and $\rho = 1\%$).

7. Qualifications and Extensions

Our analysis relies on several assumptions and simplifications imposed due to lack of data or for tractability. Relaxing these restrictions could alter the magnitudes of the transfer estimates. This section explores the potential impact of these restrictions, and provides some qualifications and extensions to the central results.

7.1 Transfer accounting assumptions

Section 3.2 lists three key assumptions underlying the estimates of the transfers between cash and card payers and between low-income and high-income households. In reality, each assumption may not hold exactly. So we designed some alternative transfer calculations to approximate more realistic conditions in the payments market that would occur if we relaxed the assumptions. Table 12 reports the results of our alternative transfer calculations and their deviations from the benchmark estimates based on two household income categories. To simplify the analysis, columns three and four report only the transfer gap, which we defined earlier as the difference between the average transfer per low-income household and the average transfer per high-income household. The remaining two columns report the percentage change for the alternative transfer estimate relative to the benchmark estimate.

Assumption	Alternative	Transfer Gap ($) Card	Income	Change (%) Card	Income
–	Benchmark (two income categories)	1,282	438	–	–
A-1	Partial price differentiation	1,234	365	−3.7	−16.7
A-2	Imperfect competition (merchants)	1,004	421	−21.7	−3.9
A-2a	Price markup (10%)	1,292	494	0.8	12.8
A-2b	Bargaining power over μ	995	372	−22.4	−15.1
A-3	Interest funding of rewards	1,148	314	−10.4	−28.4

Table 12: Changes in the transfer gap estimates due to relaxing the underlying assumptions.

First, we relaxed assumption A-1, one price for all buyers, and instead allowed for partial price differentiation between cash and credit card buyers. Price differentiation could arise for many reasons, including the following: the representative merchant could surcharge credit cards or discount cash purchases; there may exist heterogeneous merchants and/or products for which only cash or only credit cards are accepted; or low-income and high-income households may shop at different merchants so that cash and credit card purchases are segregated. Each of these reasons can be simulated in observationally equivalent fashion by excluding a portion of cash or card spending (or both) from the transfer calculations. We excluded 4.2 percent of consumption from broad NIPA categories that are likely paid for by cards only or cash only.[38] With partial price differentiation in the economy, the card transfer gap falls by 3.7 percent and the income transfer gap falls by 16.7 percent.

Next, we relaxed assumption A-2, complete (100 percent) pass-through of the merchant fee to consumers, and instead allowed for the pass-through to be more or less than complete by introducing two forms of imperfect competition. One form is classic market power for the merchant, which results in a traditional price markup over marginal costs and the cost of the payment instrument. The transfer formula for this price markup is:

$$X_i \stackrel{\text{def}}{=} \frac{\eta}{\eta+1}\frac{S_i}{S}(\mu S^d + \epsilon S^h) - (\mu S_i^d + \epsilon S_i^h) - \rho_i S_i^d \qquad i = L, H. \tag{19}$$

We simulate the effects of a 10-percent markup based on an elasticity of $\eta = 10$. The

[38] We subtracted from aggregate consumption the spending on "household furnishings and equipment," "air transportation," and "accommodations," which are likely paid mostly with credit cards.

other form is market power held by a very large merchant (for example, Walmart) over banks, giving the merchant leverage in bargaining over the merchant fee. We simulated this possibility by reducing the aggregate merchant fee 0.5 percentage points to 1.5 percent. The price markup of 10 percent increases the income transfer gap by 12.8 percent because the pass-through of payment costs in the retail price is more than 100 percent; the card transfer gap is only slightly higher. In contrast, bargaining power over the merchant fee reduces the card transfer gap by 22.4 percent and the income transfer gap by 15.1 percent. Combining these two different effects of market power, we see that imperfect competition tends to affect primarily the card transfer gap (21.7 percent lower) but leaves the income transfer gap largely the same (3.9 percent lower).

Finally, we relaxed assumption A-3, no funding of credit card rewards from revolving debt activity, and instead assumed that interest revenue from revolving debt held by high-income households is used to fund rewards paid to low-income households. As we show in more detail below, this alternative transfer calculation is not supported well by the data, even though it is often alleged in the literature. In any case, this alternative does not affect the card transfer gap, but it reduces the income transfer gap by 28.4 percent because of the direct transfer of interest payments from high-income to low-income household rewards.

One clear overall conclusion emerges from these alternative transfer calculations: both transfers remain economically significant even after adjusting for alternative conditions in the payments market. Although relaxing some assumptions leads to reductions in some of the estimates, the adjusted transfers are still about three-quarters (or more) as large as their benchmark values. Furthermore, we have omitted from the benchmark transfer calculations two very important features of credit card markets—redistribution of bank profits (discussed in Appendix B) and business credit card use (discussed below)—that likely would *increase* the transfer estimates. We believe that these increases to the transfer estimates are most likely greater (in absolute value) than the reductions reported in Table 12.

7.2 Revolving credit

It is important to emphasize once more that our model and analysis focus on the convenience use of credit cards and do not incorporate a role for revolving credit. Revolving credit is an important part of the value of credit cards to the economy, and we support future research that expands our analysis in this direction. We also recognize that debt activity could be another source of revenue for banks and credit card companies. This subsection explores the evidence on this issue further to reassure the reader that we have not grossly mischaracterized the transfers.

High interest and penalties paid by credit card borrowers on revolving debt may directly or indirectly fund some of the bank issuers' expenses on card rewards. 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 by nonborrowing consumers is subsidized by liquidity-constrained consumers who borrow on their credit cards and pay high interest. Chakravorti and Emmons's results explain that borrowers pay high interest rates on credit card debt because this interest is used to reward all credit card users, including those who avoid interest charges by paying their full balances on time. However, the evidence suggests that rewards are funded at least partly by merchant fees. Levitin (2007) reports that 44 percent 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 does not draw definite conclusions. In our calculations, rewards make up about 35 percent ($\approx 8.5/24.2$) of merchant fees. If we look at interchange fees instead of merchant fees, subtracting 0.5 percent (acquiring banks' profit) from 2 percent we compute 35 percent times $4/3 \approx 47$ percent, which is fairly close to the result in Levitin (2007).

The SCF provides data on credit card revolving debt, reported in Table 13, that help one to evaluate the idea of Chakravorti and Emmons (2003). The survey poses two questions related to revolving credit, and both show surprisingly little difference between low-income and high-income households. First, the SCF asks whether respondents usually pay off their

balances. For high-income households, 30.7 percent answer "sometimes" or "hardly ever," while for the low-income group, 32.9 percent provide the same answer. The second question is about the outstanding balance after the last payment, showing that 43.2 percent of low-income and 47.5 percent of high-income households carried debt. The similarity in revolving credit between income groups belies the conventional notion that credit card debt is predominantly a problem for low-income households.

	Low-income	High-income
Revolving debt (reported incidence)	32.9%	30.7%
Revolving debt (actual incidence)	43.2%	47.5%
Revolving debt (revolvers)	$6,243	$11,709
Interest rate (card holders/revolvers)	12.90%/12.20%	12.85%/11.15%
Annual interest payment (debt × rate)	$788	$1316
Aggregate interest payment (payment × households)	$30.9 billion	$13.4 billion
Aggregate annual rewards (from Table 8)	$2.7 billion	$5.8 billion

Table 13: Revolving credit activity by household income group

The remainder of Table 13 shows the implications of revolving credit for interest revenues to banks. Among revolvers, high-income households carry about twice as much revolving debt as low-income households, but their credit cards have interest rates about 1 percentage point lower.[39] The last two rows of Table 13 reveal that both income groups pay more than enough interest to cover the credit card rewards earned by the group. Thus, it seems unlikely that interest from either group cross-subsidizes the rewards of the other, so we conclude that the transfer calculations based only on convenience use of credit cards are likely accurate.

7.3 Other extensions

We close this section with a brief discussion of some extensions to our model and some analysis that we leave for future research.

[39]The interest rates in Table 13 are for all credit card holders (the first rate shown) and the debt-weighted average for all revolvers (the second rate shown). The other figures in the table, except for those shown in the last two rows, are averages over the entire income group.

Bank profits: We have not incorporated household ownership of banks (including card companies). In our analysis, banks make $15.7 billion of undistributed profits on consumer credit card services, which would be distributed to households in reality. Because the wealthiest 20 percent of the U.S. population holds the majority of all stocks, bank profits from merchant fees likely would be distributed disproportionately to high-income households. Thus, incorporating household ownership of banks is likely to increase the transfers from low-income to high-income households.

Business credit cards: We use data on credit card use by consumers only. The Call Report data on total U.S. credit card transactions indicate that total credit card spending by business (and including government) is about equal to consumer credit card spending. If businesses used credit cards at the same establishments as consumers, they would impose further costs on the merchants and raise retail prices even more. If businesses (and their profits) are more likely to be owned by high-income households, then incorporating business use of credit cards into the analysis is likely increase the transfers from low-income to high-income households.

Congestion (externality) effects: Murphy and Ott (1977) suggests that cash buyers impose more costs on merchants' sales staffs than on card users. If cash transactions take significantly longer to handle than credit card transactions, cash users may impose an externality on card users by slowing them down at the point of payment. This externality would offset, at least partly, the transfer from cash users to card users. However, the available data on the time it takes to handle a transaction by payment method do not provide strong support for this view.[40] It is possible that cash congestion effects may be relevant for highway toll booths, as discussed in Amromin, Jankowski, and Porter (2007). But electronic

[40] According to a 2000 study by the Food Marketing Institute, titled "It All Adds Up: An Activity Based Cost Study of Retail Payments," a credit card transaction takes longer to handle than a cash transaction: 49 seconds compared to 29 seconds. However, a 2006 study by MasterCard International titled "MasterCard PayPass: The Simpler Way to Pay," finds that the average cash transaction is slower than the average credit card transaction if no signature is required: 34 seconds compared to 27 seconds.

toll transponders that serve as a faster alternative to cash are not credit cards, and the proportion of toll payments is relatively small.

Credit card annual fees: Card fees are another potential source of revenue to fund card rewards that could affect the transfer estimates. If credit card holders pay for their rewards with high annual fees, then our transfer calculations would overstate the transfers. However, this possibility is unlikely to be a major factor. According to the 2003 Synergistics Credit Card Market survey, low-income households paid an average annual fee of $5.7, while high-income households paid $7.7. These data imply trivial changes in the transfer estimates.[41]

The preceding list of extensions suggests that the magnitudes of our estimates and results for transfers from low-income to high-income consumers may be altered quantitatively by future research. However, if anything, the qualitative nature of the regressive transfer is almost surely robust and the quantitative estimates are likely to increase relative to our benchmark.

8. Conclusion

We proposed an accounting methodology to calculate two types of implicit monetary transfers occurring in a simplified representation of the U.S. payments market: 1) the transfer between cash buyers and credit card buyers; and 2) the transfer between low-income and high-income households. Both of these transfers are estimated to be economically significant and robust to potential changes in the assumptions underlying the accounting methodology.

We also built an empirically tractable theoretical model of payment for consumption that includes all of the salient and economically important features of U.S. credit card payments. We calibrated this model with the best, most detailed data available to us and derived estimates of the average payment, retail price markup over marginal cost, and nonpecuniary

[41] Including credit card annual fees would reduce the card transfer gap by 0.6 percent to $1274, and reduce the income transfer gap by 0.5 percent to $436.

utility benefit of card use over cash use. The results are remarkably plausible given the relative simplicity of our data and model.

Extending our model and analysis with better data and more realistic features of the credit card market surely would provide more refined quantitative estimates of the two transfers. However, we are confident that the qualitative existence of these two transfers is robust to changes in the model and data. On balance, our estimates of the transfers likely understate the true values of the transfers, especially between income classes. Taking into account the quantitative impact of all potential improvements and extensions to the data and model, it is most likely that including in future research the factors we omitted from this analysis will yield higher estimates of the transfers.

Appendix A Data

To get total consumption expenditure, we looked at the National Income and Product Accounts (NIPA) for 2007. From the Personal Consumption Expenditure figure, we subtracted a number of subcategories, where we believe that the transfers analyzed in the paper did not take place, because assumption A-1 was not satisfied. Table 14 below details these calculations for our benchmark model and for the alternative simulation with partial price differentiation (the second row in Table 12): This adjustment resulted in dropping $4.13 trillion of personal consumption expenditures from the headline figure of $9.83 trillion. The drawback of using NIPA data is that we cannot break down consumption expenditure by income categories. To do that, we used the 2008 edition of the Consumer Expenditure Survey (CEX). Tables 2 and 2301 of the 2008 CEX contain the most detailed breakdown available of consumption by income. To make our calculations consistent with our NIPA consumption spending figure we had to take the same spending categories out of the CEX consumption figure as we took out of the NIPA. Unfortunately, the subcategories in the CEX and the NIPA do not map into each other one-for-one. So, from the CEX "Average annual expenditure" figure, we took out the entire "Healthcare" category as well as "Mortgage and

Line	Category name	Amount ($ Billions)
1	Personal consumption expenditures	$9,826.4
	Benchmark model	
29	Food produced and consumed on farms	$0.4
46	Net expenditures abroad by U.S. residents	$6.1
50	Housing	$1,472.9
60	Health care	$1,465.4
84	Food furnished to employees (including military)	$14.1
87	Financial services	$507.9
93	Net health insurance	$158.3
106	Social services and religious activities	$134.3
109	Foreign travel by U.S. residents	$113.9
111	NPISHs	$254.2
Total adjustments made		$4,127.5
	Partial price differentiation	
8	Furnishings and durable household equipment	$277.7
74	Air transportation	$51.6
85	Accommodations	$80.8
Additional adjustments made		$410.1

Table 14: Adjustments to PCE figure using NIPA Table 2.4.5, revised, August 5, 2010.

interest charges," "Property taxes," "Rented dwellings," "Cash contributions," and "Pensions and Social Security." (Expenditures on financial services are not measured in the CEX at all.) Once we had the relevant consumption and income figures from the CEX (readily available in Tables 2 and 2301 of the CEX publication), we could construct the average propensity to consume by each income category (except for the bottom income group). For the lowest income group, where consumers' average income was negative, the average total consumption expenditure per weighted respondent was matched so that it was equal to that of the second-lowest group. These average propensities could then be multiplied by the income figure in the Survey of Consumer Finances (SCF) 2007 to yield an estimate of total consumption expenditure by income group. We measured household income as the sum of variables $x5702$, $x5704$, $x5706$, $x5708$, $x5710$, $x5712$, $x5714$, $x5716$, $x5718$, $x5720$, $x5722$, and $x5724$. To make the resulting consumption number consistent with the NIPA data, we also multiplied the resulting number by a scalar so that it matched our adjusted total Personal

Consumption Expenditures figure.

Total annual credit card spending was computed as the sum of the values data gathered in response to questions in the SCF asking about consumers' total use of credit cards in the past month, $x412$, $x426$, $x420$, and $x423$, all multiplied by 12. For the partial price discrimination scenario we subtracted "Other lodging" and "Household furnishings and equipment" spending by income group from their respective total credit card spending. The figures for total annual credit card transactions were taken from Table 19 (monthly credit card use multiplied by 12) in SCPC 2008 (Foster et al. (2009)).

Appendix B Transfer Accounting Details

To understand better why it is appropriate to adjust the POS transfer for rewards, consider the aggregate accounting of the complete flow of funds among households, merchants, and banks. The revenue from merchant fees is paid to banks, which then distribute rewards to households that use credit cards. Thus, banks' profits (Π) are:[42]

$$\Pi = \mu S^d - (\rho_L S_L^d + \rho_H S_H^d). \tag{20}$$

Viewed this way, credit card rewards act as a claim on banks' profits that is paid to credit card users only, rather than to all owners of banks, and the distribution of rewards precedes the distribution of profits to owners of banks.[43] Because households own banks (either publicly or privately), banks' profits ultimately are income for households. Thus, rewards represent a transfer of profits and dividend income from owners of banks to credit card users who may or may not be owners of banks. Let D^i denote the dividends received by household type i. After rewards are paid to credit card holders, the distribution of profits to the owners of banks is

$$\Pi = D^h + D^d. \tag{21}$$

[42] In this equation, we omit the costs of providing credit card services for simplicity and clarity. If banks are perfectly competitive, then these profits would be zero.

[43] In a sense, owners of banks have subordinated claims to profits and credit card users have primary claims. However, this would be irrelevant if credit card users were the sole owners of banks.

Because our computations omit the distribution of banks' profits given in (21), the sum of transfers equals the negative amount of rewards,

$$X = X^h + X^d = -(\rho_L S_L^d + \rho_H S_H^d) < 0, \tag{22}$$

rather than zero. Therefore, estimates of the full aggregate transfer between cash-paying and card-paying households depends crucially on the structure of ownership of banks by households. In contrast, the sum of transfers at the point of sale,

$$\widetilde{X} = X^h + \widetilde{X}^d = 0, \tag{23}$$

does equal zero and does not depend on the ownership of banks.

Data on household ownership of banks by household payment choice and household income are not available, so we cannot estimate the full aggregate transfer. However, unless cash-paying households own a large portion of the banks, the full aggregate transfer likely is greater than the POS transfer for two reasons: (1) the dividend income of cash-paying households is reduced by the payment of rewards to credit card users; and (2) the post-rewards distribution of dividend income to households may not be proportional to the payment costs imposed on merchants by household payment choices. The credit card transfer, equation (3), includes rewards as an estimate of (1), but it does not include an estimate of (2). However, if the ownership of banks is positively correlated with income, the net effects of bank ownership on total (pre-reward) profits is likely to make the full aggregate transfer at least as large as the rewards-adjusted transfer. The rewards-adjusted transfer also allows evaluation of the independent effects of changes in the merchant fees versus changes in rewards. Clearly, more data and additional research in this area would produce more complete and refined estimates of the full aggregate transfer.

Transfer equations (2) and (3) can be rewritten using the definitions above to clarify the role of rewards in the transfers. Let $w^h = (S^h/S)$ and $w^d = (S^d/S)$ denote the spending shares of cash and card users, respectively, so that $w^h + w^d = 1$, and recall that $S^d = S_L^d + S_H^d$. Merchant fee revenue is divided between credit card users (in the form of rewards) and owners

of banks (in the form of profits), so that $\mu = (\pi + \rho)$, where π is profit expressed as a rate. Substituting this identity into the transfer equations, and then collecting and rearranging terms, yields

$$X^h \stackrel{\text{def}}{=} \left\{w^h \left[\pi S^d + \epsilon S^h\right] + w^h \rho (S_L^d + S_H^d)\right\} - \epsilon S^h \quad (24)$$

$$X^d \stackrel{\text{def}}{=} \left\{w^d \left[\pi S^d + \epsilon S^h\right] + (w^d \rho - \rho_L) S_L^d + (w^d \rho - \rho_H) S_H^d\right\} - \left[\pi S^d + \rho S^d\right]. \quad (25)$$

The structure of the rewritten transfer equations mirrors the original equations. In both equations, the first term in braces represents what payment users actually pay toward total merchant payment costs, and the second term (outside braces) represents the merchant cost of the household's payment choice. With regard to rewards, it is now clear from equation (25) that the credit card transfer represents the amount of imbalance between the rewards portion of credit card costs borne by the merchant ($-\rho S^d$), on the one hand, and the portion of that cost paid by credit card users ($(w^d \rho - \rho_L) S_L^d + (w^d \rho - \rho_H) S_H^d$), on the other. The portion paid by credit card users clearly shows that card users do not pay the full value of their rewards: $(w^d \rho - \rho_L) = (0.21 - 0.55) = -0.34$ and $(w^d \rho - \rho_H) = (0.21 - 0.75) = -0.54$.

Appendix C Sensitivity Analysis

The following sections present the sensitivity analysis to changes in β_H and ϵ. Since we are not aware of any study that has directly estimated β_H, we would like to see how our assumption that richer people derive higher utility from using credit cards affects our results. Also, as noted above, some empirical studies find values that differ from our estimates for the costs of handling the payment instruments that we labeled as "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 lead to different estimates of the 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 groups.

C.1 Sensitivity analysis with respect to β_H

We will now analyze what would happen if β_H decreased all the way to the level of β_L. Having $\beta_H > \beta_L$ means two things in the model: (i) a higher share of card users in the high-income group (see equation (14)) and (ii) a higher average marginal utility of card users in that income category. The former means that for $\beta_H > \beta_L$, the cash-payer-to-card-payer transfer will amplify the redistribution of income between the income groups as well. Intuitively, there will be more card payers 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 high-income group. Remember that in both income groups card payers derive higher marginal utilities from an additional transaction (for a given t), 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 income from low- to high-income groups.

The top panel of Figure 10 helps to gauge 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 ($\mu = 2$ percent, $\rho = 1$ percent). 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 remain robust to changes in β_H. The bottom panel of the same figure shows that the shape of the transfers paid by the low-income group changes with the value of β_H, as we would expect based on the discussion above, but the magnitude of the transfer at $\mu = 2$ percent and $\rho = 1$ percent stays fairly constant.

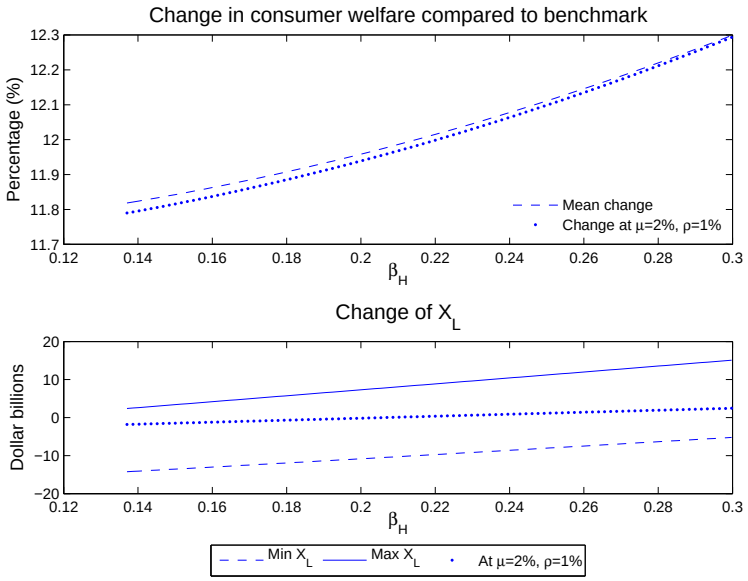

Figure 10: Welfare and transfers as a function of β_H

Figure 11 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. A higher β_H leads to a relatively higher number of card payers among the rich, and 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 with β_H to curtail the amount of cash-to-card-payer redistribution.

C.2 Sensitivity analysis with respect to ϵ

According to Figure 12, changes in ϵ lead to changes in the consumer welfare function that are of similar magnitude to the changes produced by different values of β_H. Again the upper

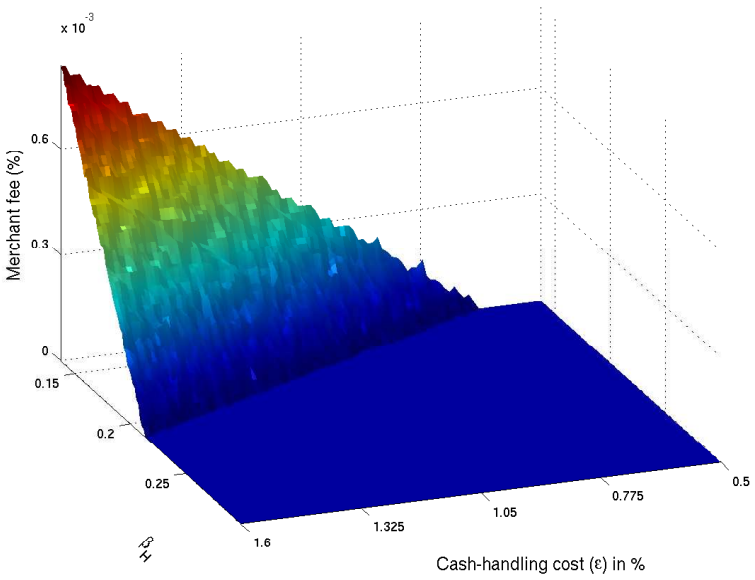

Figure 11: Optimal merchant fee as a function of β_H and ϵ

panel of Figure 12 suggests that the shape of the consumer welfare function does not change by much as ϵ takes on different values. Surprisingly, the redistribution also stays fairly constant as ϵ changes. From Equation 5 one can see that

$$\frac{\partial X_L}{\partial \epsilon} = \frac{S_L}{S} S^h - S_L^h = \frac{S_L}{S} S^h - \frac{S_L^h}{S^h} S^h = -0.05 \cdot S^h,$$

where the last line makes use of the figures in Table 5. In words, a change in ϵ changes low-income households' contribution to the costs imposed and to the costs paid by roughly the same amount. A rise in the cost of handling cash leads to a redistribution from card to cash payers, just as the increase in the merchant fee leads 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 do 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 11, however, this redistribution can become inefficiently high for high values of ϵ, which would then validate a nonzero merchant fee to redirect some of the transfer to low-income households back to high-income households.

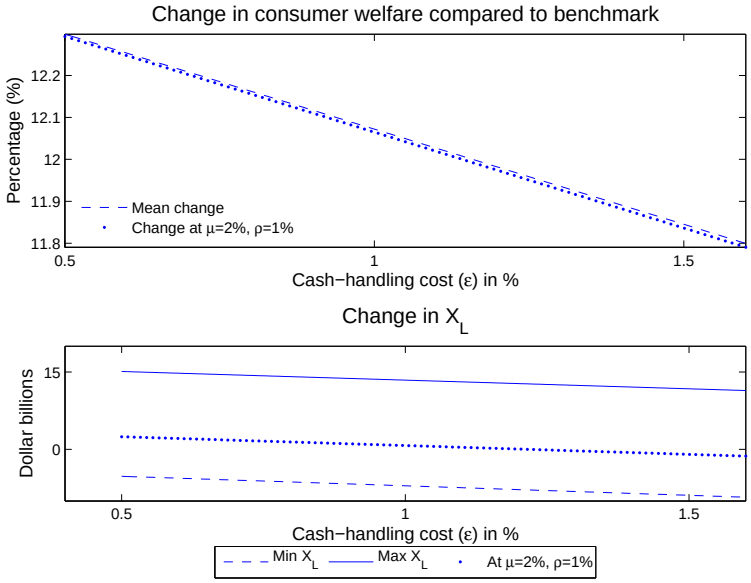

Figure 12: Welfare and transfers as a function of ϵ

However, in our benchmark model with a high β_H, a 1.6 percent cash-handling cost would still not warrant a positive merchant fee to maximize consumer welfare. Also, as noted above, for high cash-handling costs the optimal merchant fee changes markedly with different values of β_H, as the difference between β_L and β_H (difference between the fraction of card users in the two 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 income 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 (0.9 percent) 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 a subsidy from high-income to low-income households, while the redistribution caused by the merchant fee becomes less desirable, since it works in the opposite direction. Note that in Figure 11, a high merchant fee is optimal only for low β_H and high ϵ.

Cash-handling costs play an important role in determining the markup. Because of the high fraction of cash payers (approximately 86 percent in the low- and 69 percent in the high-

income group), the markup moves almost one-for-one with ϵ. Figure 13 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 vary only between 0.5 and 1.6 percent. Keeping this in mind, Figure 13 shows that the markup is almost five times more responsive to changes in ϵ than to changes in μ.

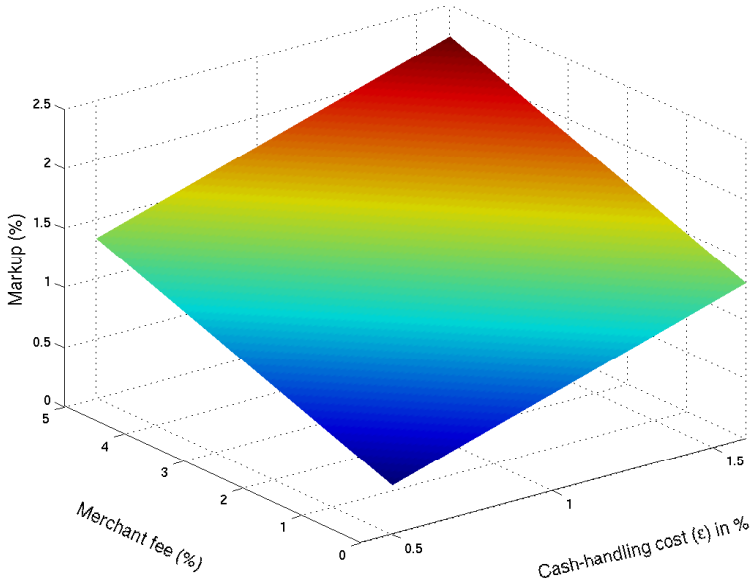

Figure 13: Markup as a function of μ and ϵ

Appendix D Discussions of the NSR

Our analysis is conducted under the assumption that merchants obey the *no-surcharge rule* (NSR). 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 do not impose a surcharge on card payments and many do not 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.

There are a number of explanations for why merchants do not surcharge buyers for card payments, despite having to pay a high fee for each card transaction.

Buyers' perceptions: 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 payment.

Competition: Card acceptance under high merchant fees may reflect a "bad" equilibrium for merchants, in which no merchant can profitably deviate by refusing to accept card payments. See Hayashi (2006) for a theoretical study.[44]

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[44]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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