



Payment card rewards programs and consumer payment choice

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ABSTRACT

By using a unique data set that contains detailed information about consumer payment choice and consumers' attitudes toward each payment method, we estimate the effects of payment card rewards on consumer choice of payment methods. Our approach allows us to control for consumer heterogeneity. We find the effects of rewards to be statistically significant across five retail types. Our policy experiments suggest that for the sub-population who hold both credit and debit cards, removing rewards would increase their share of paper-based payment methods (i.e., cash and checks), measured in terms of in-store transactions, by no more than 4 percentage points.

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1. Introduction

Credit and debit card payments have been growing rapidly. To continue the growth, payment card networks keep adding new merchants to their networks. But adding new cardholders is becoming more difficult because most consumers in the United States already have both credit and debit cards.¹ To increase their market shares and card usage by existing customers, US card issuers have been offering attractive rewards programs. Since launching the new rewards programs, many issuers have seen increases in spending on both credit and debit cards.² However, we know little about the sources of these increases. It is unlikely that rewards card users simply increase their spending on their credit and debit cards without changing their spending habits involving other payment methods. Which payment methods are mainly replaced by rewards credit and debit cards? To what extent do rewards card transactions replace other forms of payment transactions, such as cash and check transactions?

The answers to these questions are important for the debate about the welfare consequences of payment card rewards. On the one hand, the proponents argue that rewards can reduce total costs to the economy by inducing consumers to switch from a more costly payment method, such as checks, to a less costly payment method, such as credit and debit cards.³ Rewards may also increase the gross benefits of merchants and card issuers by increasing the total number/value of transactions. The proponents also believe that consumers would benefit from rewards. On the other hand, the opponents argue that rewards may not reduce the costs of the payment system if most consumers simply substitute rewards credit (debit) card transactions for non-rewards credit (debit) card transactions. In addition, the society would need to incur additional costs to maintain rewards programs. Rewards may also lead to distorted price signals to consumers, and cause some consumers to choose socially less efficient payment methods (Simon, 2005). Merchants may not benefit from rewards if they hardly increase the number/value of transactions. Moreover, rewards may lead to higher card transaction fees to merchants, which may cause higher prices for their goods and services. As a result, consumers, especially those who do not use rewards cards, could be hurt by the higher retail prices.

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¹ According to the 2004 Survey of Consumer Finances conducted by the Federal Reserve, 75% of US households hold at least one credit card and 74% hold an ATM/debit card.

² See, for example, *ATM&Debit News*, August 25, 2005 and December 22, 2005.

³ The Reserve Bank of Australia (2007) found that check is the most expensive payment method in Australia. In the United States, resource costs of checks are generally higher than those of cards (Garcia-Swartz et al., 2006).

The above debate has important public policy implications on the current fee structure of payment cards. A typical fee structure for a credit or debit card transaction requires a merchant to pay a merchant discount fee to its acquirer, who processes card transactions for the merchant. The major part of the merchant discount fee is transferred from acquirers to card issuers (the fee is called interchange fee in some card networks, such as MasterCard and Visa). The fees received by card issuers from the merchants can be used to provide rewards in some countries, including the United States, while regulations in other countries require the merchant discount fee (or the interchange fee) to be set based on the cost-based benchmark that excludes the cost of providing rewards.⁴ Consequently, rewards values have become significantly lower in some of these countries (e.g., Australia). Nevertheless, with scant empirical evidence on the effects of rewards, it is not clear whether these fee regulations are appropriate for them, and whether other countries should follow suit.⁵ Understanding the effects of rewards on payment choice could also help evaluate another possible policy that allows merchants to set surcharges that differ across any particular credit or debit cards. It is conceivable that surcharges set by merchants could neutralize the incentive generated by rewards on payment choice.

The welfare consequences of rewards programs and their implications on these public policies crucially depend on both the social costs of various payment methods and how rewards programs affect consumers' choice of payment methods.⁶ Our paper will focus on the latter—providing empirical evidence on how rewards programs influence consumer payment choice. To the best of our knowledge, this is the first study that empirically examines this research question.⁷ We exploit a unique consumer survey data set and estimate a series of multinomial logit models that explain how the following consumer characteristics are related to the payment choice across retail types: demographics, income, technology adoption, and most importantly, whether the consumer receives rewards on credit/debit cards. By using the parameter estimates, we conduct policy experiments to quantify the effects of removing reward features from payment cards on consumer payment choice. As discussed above, our policy experiments would allow us to shed light on the current policy debates, such as whether to regulate the payment card fee structure and whether to allow merchants to set surcharges.

Our unique data set allows us to alleviate two problems when estimating the *direct* effects of rewards programs.⁸ The first problem is that deciding whether to obtain rewards payment cards could be endogenous. It is likely that a typical consumer who chooses to obtain a rewards credit/debit card would use this payment method relatively more often, regardless of whether it offers rewards. To handle this problem, we adopt the approach proposed by Harris and Keane (1999), who used attitudinal data to control for unobserved consumer heterogeneity. Our data set provides detailed mea-

asures of individual perceptions toward each payment method. We use these measures to control for unobserved consumer heterogeneity in preferences for various payment methods.

The second problem is that some consumers may perceive that only a subset of payment methods is available to them at a given retail store, and thus, the choice set of payment methods may vary across consumers. Ignoring the variation of choice sets could lead to biased estimates of the parameters (e.g., Goeree, 2008; Ching et al., 2009). Previous literature has used panel data and made strong assumptions about the process of choice set formation in order to take choice set heterogeneity into account (e.g., Bronnenberg and Vanhonacker, 1996; Mehta et al., 2003). In contrast, our data set, which provides information on each consumer's perceived payment methods accepted by retail type, allows us to control choice set variation without taking this path.

Our results indicate that including attitudinal data (i.e., consumer perceived payment method attributes) produces a substantial improvement in model fit and interpretation of estimated parameters, particularly the effects of rewards programs. We find that the estimated coefficients are very similar whether we allow consumer choice set to vary by individual or not—this indicates the robustness of our results. The results from the policy experiments of removing rewards suggest that the majority of consumers who currently receive rewards on credit and/or debit cards would continue to use those payment methods even if rewards were no longer offered. For consumers who hold both credit and debit cards, we find that the share of paper-based payment methods for this sub-population would increase by no more than 4 percentage points, while the share of credit (debit) cards would decrease (increase).

The rest of the paper is organized as follows. Section 2 provides some background on the US payment card rewards programs and literature review. Section 3 describes the data set. Section 4 discusses the empirical model. Section 5 presents the results and discusses their implications. Section 6 concludes the paper.

2. Background

2.1. Rewards programs in the United States

In the United States, credit card rewards have more than 25 years of history, while debit card rewards are relatively new. All top 10 credit card issuers (whose aggregate market share is more than 80%) provide rewards, according to their websites; while about one-third of depository institutions provide debit card rewards, according to a report by Dove Consulting (2007). Consumers are more likely to receive debit card rewards when they make a signature-debit transaction rather than a PIN-debit transaction.⁹ Today, various types of rewards are offered: airline miles, cash-back, discounts, gifts, etc. Because of the variety of rewards programs and complexity of reward structure, it is difficult to obtain the average reward rates for credit and debit cards. But casual observation suggests that credit card rewards are usually more generous. According to Tony Hayes, an industry expert, the average value of the rewards for rewards credit cards is about 1% of the purchase value and that for rewards debit cards is about a quarter percent (Carten et al., 2007).¹⁰

⁹ A typical US debit card can carry out both PIN- and signature-debit transactions. To make a PIN-debit transaction consumers type personal identification number at the point of sale to authorize the transaction, while to make a signature-debit transaction they sign the receipt.

¹⁰ These average values are likely the gross value. Some reward credit cards, such as air mile cards, charge an annual fees but the majority of reward credit cards do not charge an annual fee. The net reward values (after subtracting an annual fee) could be lower, but are likely still positive.

⁴ Regulations that require cost-based interchange fees have been implemented in several countries, such as Australia, Mexico, Spain and Switzerland (Bradford and Hayashi, 2008).

⁵ Rochet and Wright (2010) analyze the welfare implications of imposing interchange fee caps from a theoretical viewpoint.

⁶ A complete welfare analysis also depends on other factors, such as implicit and explicit transfers among consumers, merchants, and card issuers. We leave this topic for future research.

⁷ After circulating a working paper version of this paper in 2006, several studies that examine this topic have appeared recently (e.g., Carbó-Valverde and Liñares-Zegarra, 2009; Simon et al., 2010).

⁸ A consumer's holding a rewards credit (debit) card would *directly* affect his utility of using the card, because he can receive, for example, 1% cash-back on his purchase with the card. It could also *indirectly* affect his utility by changing his attitudes toward credit (debit) cards. We refer the former "direct" effect and the latter "indirect" effect. Section 4 will give more details.

Payment card rewards are partly financed by the fees charged to merchants.¹¹ The merchant fees usually consist of several parts, and one of them is interchange fees, which are received by the card issuers.¹² The total annual interchange fee revenue of MasterCard and Visa card issuers was estimated at around \$30 billion in 2006, and it is reported that rewards account for 44% of the interchange fees (Dawson and Hugener, 2006). MasterCard and Visa credit card interchange fee rates vary by product category. Their non-rewards credit card products have the lowest interchange fee rates (1.43–1.58% for retail stores), while their high-end rewards credit card products have the highest rates (1.53–2.2% for retail stores). In contrast, the interchange fee rates for debit card transactions do not vary by whether the issuer of the card offers rewards or not. The interchange fee rates for a signature-debit transaction is generally higher (ranging between 0.62% and 0.75%) than those for a PIN-debit transaction (ranging between 0.3% and 0.75% with a cap around 65 cents). The differences in the interchange fee rates may reflect the rewards levels: Signature-debit card rewards are less generous than credit card rewards but more generous than PIN-debit card rewards.

2.2. Previous literature

The previous studies highlighted three important sets of factors that affect consumer payment choice: consumer characteristics, transaction characteristics, and payment method attributes.¹³ Some studies found that demographic and financial characteristics of consumers are correlated with the use of payment methods (e.g., Kennickell and Kwast, 1997; Stavins, 2001). Hayashi and Klee (2003) found that adoption of new technologies, such as online purchases and direct deposits, influences consumer's new payment method adoption decision of debit cards and online bill payments. They also found that transaction characteristics, such as value of transaction and physical environment, likely influence consumer payment choice. Hirschman (1982), Mantel (2000), Jonker (2005), and Klee (2006) found that payment method attributes or those perceived by consumers are strongly correlated with consumer payment choice. When estimating the effects of rewards on consumer payment choice, our study will control for these three sets of factors.

Another important factor that could affect payment choice is the price of payment methods. Most previous studies did not include this factor because very few data sets contain price information in conjunction with consumer payment choice. There are a few exceptions: Humphrey et al. (2001) estimated price elasticity for various payment methods by using Norwegian aggregate level data; Amromin et al. (2005) examined how consumers respond to differentiated pricing of cash and electronic toll payment on the Illinois tollway; Borzekowski et al. (2008) examined how fees assessed by banks on debit card transactions affect consumer payment choice; and Zinman (2009) investigated the choice between debit and credit cards for revolvers, who face interest charges associated with credit card transactions because they did not pay their credit balance in full. All of them find that consumers are price sensitive. Our paper investigates the impact of rewards programs on consumer payment choice. Although

whether a consumer receives rewards is not price information per se, it can be viewed as a proxy for negative per-transaction fees of credit and/or debit cards. Thus, to some extent, our study estimates how sensitive consumers are with respect to the price of using a payment method.

Merchant acceptance of payment methods is also an important factor that could affect consumer payment choice, but due to data limitations, previous studies did not consider this factor. Rysman (2007) is an exception. He found that a consumer's favorite card network is positively correlated with the number of local merchants who accept that network's cards. Our paper considers this factor in a different way. Since our data includes information on consumer perceived acceptance of payment methods by retail type, we control for heterogeneity in consumer choice set of payment methods by using this information.

3. Data

Our data set is the 2005/2006 Study of Consumer Payment Preferences conducted by the American Bankers Association and Dove Consulting. Data were collected using paper and Web-based surveys sent to US consumers in 2005 and a total of 3008 completed surveys were received. Although the survey sample is not nationally representative, the survey contains rich information about consumer payments, which is usually not available in the nationally representative data sources. Key features of our data are as follows.

First, our data set includes information on whether a consumer received rewards for using a credit card and a debit card, respectively.¹⁴ This allows us to examine whether credit/debit rewards receivers' payment choice is different from non-rewards receivers'.

Second, in addition to individual demographic characteristics, the survey asked each respondent to provide his/her perceptions toward each in-store payment method. Typically, a consumer's perceptions are not easily observed, or they are rarely incorporated for econometric analyses. We will argue that this type of data allows us to control for the unobserved consumer heterogeneity that could lead to severe bias in estimates of the effect of rewards programs.

Third, the survey asked about the most frequently used payment method by retail type, such as grocery stores, department stores, and fast food restaurants. A respondent chooses one out of five payment methods—cash, check, credit card, PIN-debit card, and signature-debit card.¹⁵ We interpret the most frequently used payment method as the payment method chosen by the consumer when estimating an individual level discrete choice model. Although our data set does not contain information on transaction characteristics, the variation of transaction characteristics may be limited conditioning on the retail type. For example, transaction values made in fast food restaurants are typically quite small. To some extent, this type of data allows us to control for the transaction characteristics.

Lastly, the survey asked about what payment methods the respondent believes are accepted by merchants in each retail type. We assume that a payment method belongs to a consumer's choice set in a particular retail type if the consumer believes it is accepted by merchants of that retail type. This allows us to control for

¹¹ The other sources would be annual fees, penalty fees, and interest rates paid by cardholders. To our knowledge, what proportion of rewards is financed by fees paid by merchants is unknown, although some industry experts believe the majority of rewards are paid for by interchange fees (e.g., Bruno-Britz, 2006).

¹² American Express and Discover, whose aggregate share in the US credit card market is less than 30%, do not have explicit interchange fee, but they also charge merchant for card transactions.

¹³ The review here only covers papers that are closely related to our study. Scholnick et al. (2008) provide a comprehensive survey of the recent development in the payment instruments literature.

¹⁴ We cannot observe what type of rewards (miles, cash-backs, discounts, etc.) the consumer received.

¹⁵ Credit cards include general purpose credit/charge cards and proprietary credit cards (i.e., store cards). For respondents who own rewards credit (debit) cards, it is possible that they also own non-reward credit (debit) cards and we cannot observe whether they choose rewards credit (debit) cards or non-reward credit (debit) cards for transactions.

consumer heterogeneity of choice set, which could also lead to bias in parameter estimates.

We construct our sample by excluding consumers who have missing information regarding consumer characteristics, perceptions, and card-related status, such as a balance on credit card and rewards on credit and/or on debit cards. We also exclude consumers who do not have a bank account or do not hold either a credit or debit card because our focus is to examine the difference in payment choice between rewards receivers and non-rewards receivers, not between cardholders and non-cardholders. This process leaves a total of 1979 responses. Compared with the general US population, income, educational levels, and technology adoption rates are relatively higher in our sample. However, our sample is quite close to a subsample of the 2004 Survey of Consumer Finances (SCF), which includes only households with one or more bank accounts as well as both types (i.e., credit and debit) of cards (see the 2nd and 3rd columns of Table 1). This subsample consists of 60% of the entire SCF sample. Since SCF has a nationally representative sample, this indicates that our data set may represent this sub-population fairly well.

The bottom of Table 1 shows statistics regarding rewards. About 36% of consumers receive rewards via either credit card, debit card, or both.¹⁶ Approximately 32% of our sample receives rewards on credit cards and 14% receive rewards on debit cards. About 9% of our sample receive rewards on both credit and debit cards. Almost all consumers who receive rewards on debit cards receive rewards when they make signature-debit transactions and only half of them receive rewards when they make PIN-debit transactions.

Table 1 also compares the characteristics of rewards receivers (either on credit cards or debit cards) with those of the entire sample. Consumers who have higher income, educational levels, and tendency to adopt new technology are more likely to hold rewards cards. Rewards card holdings also vary by gender, ethnicity, and residential region, but less so by age.

Table 2 provides summary statistics on consumer perceived payment method attributes. For each payment method, our data set contains 11 attributes perceived by consumers: Comfortable, Fast, Convenient, Easy to use, Preferred by stores, Safe, (money) Taken right away, Help me budget, For small amount, Control over money, and Easy-to-get refund. The average scores for cash and check are calculated using all consumers in the sample, and those for credit, PIN-debit, and signature-debit cards are calculated separately for reward card holders and for non-reward card holders. Cash tends to be perceived more positively, while check tends not to. As expected, credit and signature-debit cards are perceived more positively by consumers with credit card rewards and signature-debit rewards, respectively, than consumers without those rewards. Compared with these two cards, the differences in perceptions for PIN-debit cards by consumers with and without PIN-debit rewards are less clear.

Table 3 presents the percentage of consumers who perceive each payment method to be accepted by retail type. Cash is perceived to be the most widely accepted by all retail types but department stores, by which credit card is perceived to be the most accepted. The perceived acceptance rates of checks lie between those of cash and credit cards at all retail type except fast food restaurants, at which it is perceived to be the least accepted payment method. PIN-debit cards are perceived to be less widely accepted than credit cards but more widely accepted than signature-debit cards. Interestingly, a significant portion of consumers are not aware that almost all stores that accept credit cards also

Table 1
Summary statistics on consumer characteristics.

	Census	2004 SCF ^b	Our sample	
			All	Reward receivers
<i>Demographic</i>				
Female	.514	.231 ^c	.491	.458
<i>Race</i>				
African American	.123	.096	.117	.100
Caucasian	.669	.794	.703	.725
Hispanic	.144	.070	.070	.055
Asian	.042		.067	.090
Other	.022	.041 ^d	.043	.029
<i>Age</i>				
18–34	.312	.212	.269	.282
35–44	.197	.233	.253	.259
45–54	.191	.241	.174	.161
55–64	.136	.162	.208	.196
65 and over	.165	.144	.096	.103
<i>Education</i>				
Less than high school	.160	.070	.011	.006
High school	.510	.510	.536	.429
College	.250	.257	.311	.359
Some graduate school	.080	.164	.142	.207
<i>Financial (income)</i>				
\$0–\$40,000	.463	.325	.352	.244
\$40,000–\$59,999	.178	.206	.240	.219
\$60,000–\$99,999	.209	.248	.282	.333
\$100,000 and over	.151	.221	.126	.204
<i>Census division</i>				
New England	.051	n.a.	.050	.065
Mid-Atlantic	.142	n.a.	.118	.141
South Atlantic	.191	n.a.	.209	.200
ES Central	.061	n.a.	.050	.037
EN Central	.105	n.a.	.106	.087
WS Central	.160	n.a.	.168	.180
WN Central	.069	n.a.	.072	.074
Mountain	.058	n.a.	.070	.067
Pacific	.163	n.a.	.158	.148
<i>Technology adoption</i>				
Direct deposit	n.a.	.803	.776	.816
Online banking	.370 ^a	n.a.	.573	.642
<i>Rewards</i>				
Either credit or debit	n.a.	n.a.	.364	1.00
Credit	n.a.	n.a.	.320	.879
Debit	n.a.	n.a.	.136	.373
PIN-debit	n.a.	n.a.	.066	.182
Signature-debit	n.a.	n.a.	.123	.336
Credit and debit	n.a.	n.a.	.092	.252
Balance on credit cards	n.a.	.514	.431	.434
			N = 1979	N = 721

^a Online Banking Report March 2005.

^b The 2004 Survey of Consumer Finances. Only households with at least one bank account as well as both types (i.e., credit and ATM/debit) of cards are included in this table. Percentages of households are weighted.

^c The unit of observation in the SCF is a household. If a household in the SCF has both a male and a female, it is coded as a male headed household.

^d Other includes Asian.

accept signature-debit cards. This indicates that it is potentially important to control for heterogeneity in consumers' perceived choice set when studying their payment choice.

Fig. 1 presents the share of consumers who chose a particular payment instrument as their primary (i.e., most frequently used) payment method by retail type. Panel A shows the overall share by retail type. It is clear that consumer payment choice varies by store type, which likely implies that transaction characteristics significantly affect consumer payment choice. Panel B shows more

¹⁶ Whether the share of consumers who receive rewards in our sample is too low or high and how it affects the results are discussed in Ching and Hayashi (2008).

Table 2
Summary statistics on consumer perceived payment method attributes.

Attribute	Cash	Check	Credit card		PIN-debit		Signature-debit	
	All consumers	All consumers	w/ rewards	w/o rewards	w/ rewards	w/o rewards	w/ rewards	w/o rewards
Comfortable (0–5) ^a	4.63	3.69	4.49	3.74	4.18	3.45	4.43	3.27
Fast (0–5) ^b	4.53	2.42	4.13	3.66	3.99	3.29	4.03	2.98
Convenient ^c	0.84	0.21	0.82	0.61	0.54	0.57	0.61	0.44
Easy to use ^c	0.85	0.22	0.84	0.61	0.55	0.55	0.62	0.44
Preferred by stores ^c	0.76	0.07	0.65	0.54	0.38	0.41	0.43	0.30
Safe ^c	0.56	0.22	0.54	0.33	0.39	0.38	0.46	0.28
Taken right away ^c	0.26	0.12	0.12	0.13	0.72	0.75	0.58	0.48
Helps me budget ^c	0.60	0.30	0.27	0.14	0.50	0.43	0.50	0.31
For small amounts ^c	0.89	0.11	0.14	0.10	0.29	0.28	0.27	0.18
Control ^c	0.62	0.34	0.39	0.18	0.51	0.47	0.53	0.35
Easy-to-get refund ^c	0.57	0.17	0.80	0.59	0.33	0.41	0.53	0.34

^a Scale 0: not use; 1: not comfortable, 5: completely comfortable.

^b Scale 0: not use; 1: very slow, 5: very fast.

^c Scale 0: no; 1: yes.

Table 3
Consumer perceived acceptance of payment methods by retail type.

Retail types	Cash (%)	Check (%)	Credit card (%)	PIN-debit (%)	Signature-debit (%)
Grocery	89.3	77.0	81.0	81.6	58.1
Department	84.9	72.3	90.3	64.7	60.2
Discount	85.3	64.9	74.0	63.4	44.1
Drug	88.8	65.8	81.6	67.9	52.8
Fast food restaurants	96.1	11.2	55.5	35.7	34.1

detailed share for grocery store transactions.¹⁷ Consumers are grouped into eight groups, according to their credit card balance, debit card rewards, and credit card rewards status. The card rewards dummies and credit card balance status appear to be highly correlated with consumer payment choice. In particular, consumers in Group 6, which consists of individuals without a credit card balance, without debit card rewards, and with credit card rewards, are more likely to choose credit card as their primary payment method than consumers in any other groups. Nevertheless, one should not draw inference about the effects of rewards on payment choice from this figure because whether a consumer chooses to obtain a rewards credit card or rewards debit card may depend on his/her preference for credit cards or debit cards in the first place. The next section discusses how we address this endogeneity issue using the data on consumer perceived attributes of payment methods.

4. Econometric model

This section discusses our estimation approach and econometric model specifications. For each retail type, we estimate four specifications of a multinomial logit model that explains which payment method is chosen by the consumers as the most frequently used method.

We first discuss a specification by assuming a typical situation faced by econometricians, where the data on consumer perceptions toward each payment method were not available. This specification will help us explain the endogeneity problem of the rewards program. We assume that utility to consumer i from using payment method j when making a transaction at retail type h is defined as follows:

$$U_{ijh} = \alpha_{jh} + X_i \beta_{jh} + C_{ij} \delta_{jh} + \varepsilon_{ijh} + e_{ijh}, \quad (1)$$

where X_i is a vector of consumer characteristics; C_{ij} is a vector of card-related dummies, such as rewards and credit card balance; ε_{ijh} captures the unobserved consumer preferences for payment

method j at retail type h ; and e_{ijh} captures the measurement errors and is assumed to be *i.i.d.* α_{jh} measures the mean utility from payment method j at retail type h , regardless of consumer characteristics and card-related status. β and δ are vectors of utility weight for X_i and C_{ij} , respectively. In particular, δ captures the *direct* effect of the card-related dummies—it measures the immediate impact of credit/debit card reward feature on the utility of choosing credit/debit cards for transactions. For each retail type h , consumer i chooses a payment method j to maximize his/her utility. There are five payment options: credit card, PIN-debit card, signature-debit card, check, and cash.

If C_{ij} is uncorrelated with ε_{ijh} , one can estimate this specification using a multinomial logit or probit model and obtain consistent estimates on the reward dummies. However, it is likely that the dummies for rewards are positively correlated with ε_{ijh} . This could be due to three reasons. First, some consumers choose to get a rewards credit/debit card because they had been using this payment method relatively more often due to higher ε_{ijh} . The benefits of obtaining rewards cards for them are relatively higher and hence they are more likely to spend search costs (or in some cases they may pay an annual fee) to join a rewards program that suits them well. Second, in order to compete for market shares, card issuers may send pre-approved rewards credit/debit card invitations to consumers who have been heavily using credit/debit cards. It is likely that these consumers have higher ε_{ijh} . Third, rewards may have an *indirect* effect on consumers' choice of credit/debit cards by improving consumers' attitudes toward those cards (i.e., improving ε_{ijh} over time). Some consumers may have had seldom used credit/debit cards prior to receiving a rewards card, but the incentive of earning rewards may have induced them to use the card more often. Since then, they may have learned the good features of credit/debit cards and changed their attitudes toward credit/debit cards more favorably. Because of this positive correlation between C_{ij} and ε_{ijh} , the effects of the reward dummies in Eq. (1) would probably be overestimated.

To handle this positive correlation, our approach here is to use the data on consumer perceptions toward payment methods as a proxy for ε_{ijh} . The idea is that if we can control for ε_{ijh} , then it is

¹⁷ Similar observations are made for transactions at the other four retail types. See Ching and Hayashi (2008).

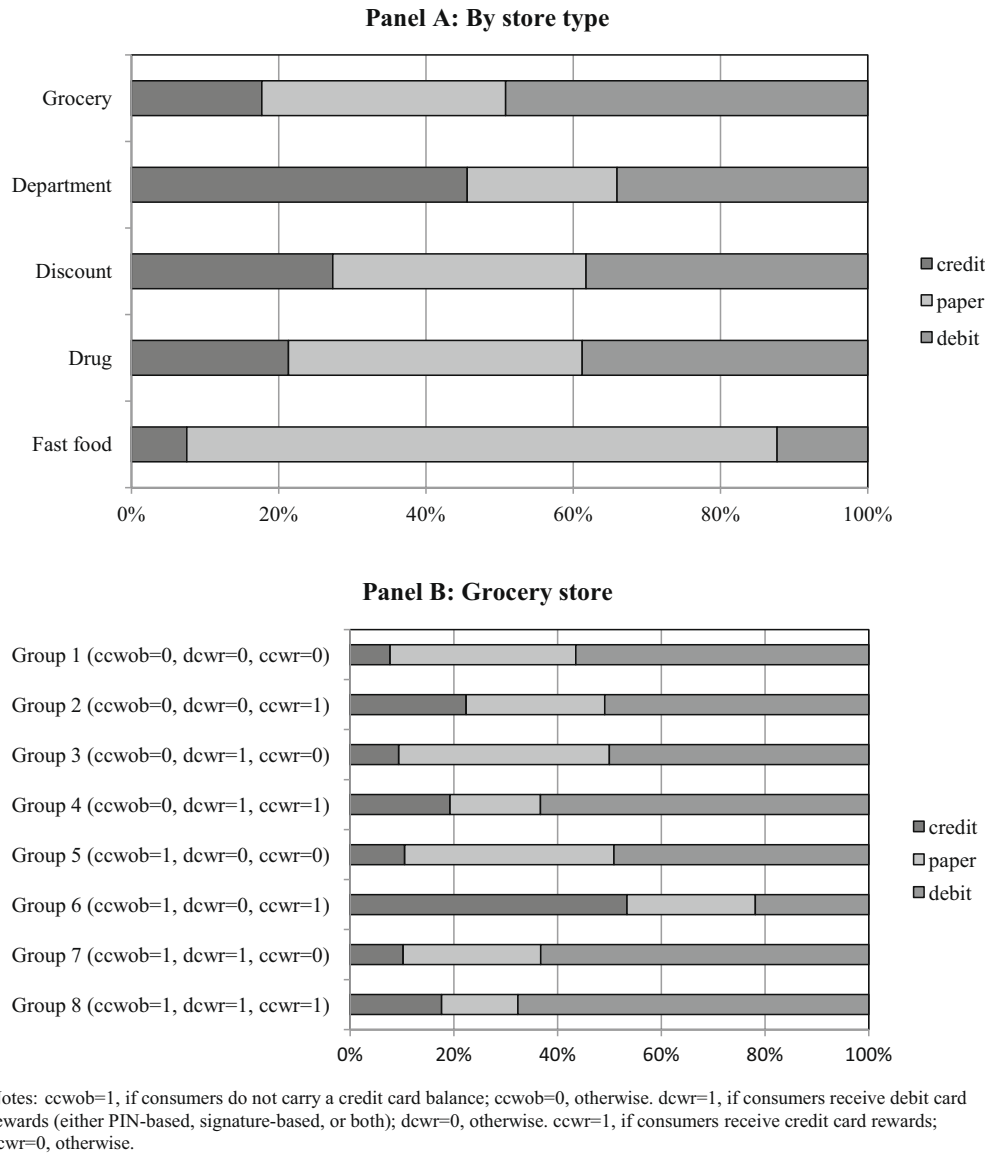


Fig. 1. Share of the payment method as the most frequently used method.

possible to obtain consistent estimates of the effect of rewards programs. As pointed out by Harris and Keane (1999) and Keane (2004), using consumer attitudinal data to control for unobserved consumer heterogeneity provides an alternative to the conventional econometric approach of using instrumental variables.¹⁸ But, unlike instrumental variables, this approach works in non-linear models, such as the multinomial logit model considered here. As for the attitudinal data, we use the 11 consumer perceived attributes of each payment method discussed in Section 3. It is important to note that: (i) this type of attitudinal data is not typically observed; and (ii) all of them are subjective measures reported by individual consumers. In particular, the second feature suggests that our attitudinal data could potentially capture a significant amount of consumer heterogeneity in preferences. In the full specification of our model, utility to consumer i from using payment method j when making a transaction at retail type h is defined as follows:

$$U_{ijh} = \alpha_{jh} + X_i\beta_{jh} + C_{ij}\delta_{jh} + Z_{ij}\gamma_h + e_{ijh}, \quad (2)$$

¹⁸ Horsky et al. (2006) also discuss how to use attitudinal data in choice models.

where Z_{ij} is a vector of attributes of payment method j evaluated by consumer i . We normalize the utility of choosing cash as:

$$U_{icashh} = Z_{icash}\gamma_h + e_{icashh}. \quad (3)$$

It is worth pointing out that we do not assume a priori that the attitudinal data are a good proxy for individual level preferences. Instead, we will let the estimated choice model tell us whether the attitudinal data are informative or not.

There are two limitations in our approach. First, the full specification does not capture the indirect effect of rewards. To estimate the indirect effect, one would need a panel data set that follows the individual consumer's perception changes over time. Our cross-sectional data set only allows us to estimate the direct effect of rewards. Another limitation of our econometric specification is that the coefficients for reward dummies (δ_{jh}) are assumed to be homogeneous across consumers. Conceivably, they could be heterogeneous; especially, consumers who chose to obtain a rewards card may have higher δ_{jh} than consumers who did not. The potential heterogeneity in δ_{jh} , however, cannot be controlled for by using our attitudinal data because none of the questions asked about how consumers value rewards (see Table 2). To check whether

Table 4
Multinomial logit model: Log-likelihood.

Perceptions Choice set		Specifications			
		1 No Homogeneous	2 Yes Homogeneous	3 No Heterogeneous	4 Yes Heterogeneous
Grocery	(N = 1915)	–2570.88	–1650.80	–2008.14	–1369.60
Department	(N = 1798)	–2266.67	–1637.62	–1733.26	–1336.83
Discount	(N = 1761)	–2487.85	–1885.18	–1631.47	–1278.67
Drug	(N = 1846)	–2559.81	–1856.88	–1883.21	–1479.99
Fast food	(N = 1813)	–1242.72	–1010.97	–800.77	–682.24

Note: N is the sample size used.

δ_{jh} is heterogeneous across consumers, we estimate a specification that includes interaction terms between reward dummies and consumer characteristics (results not reported here due to space constraints). We find that none of the interaction terms are significant. This gives us some comfort in our assumption that δ_{jh} is homogeneous across consumers.

We estimate four model specifications. They depend on whether the specification includes consumer attitudinal data, and whether the set of payment methods available to consumers is homogeneous or heterogeneous across consumers. The homogeneous choice set specification assumes that all five payment methods are available for consumers to choose, while the heterogeneous choice set specification assumes that a consumer's choice set consists of payment methods that he/she believes are accepted at a given type of store.

A priori it is difficult to tell which choice set specification is more appropriate. If consumers only visit stores which accept payment methods that they want to use, then the homogeneous choice set assumption will be more appropriate. On the contrary, if consumers first decide at which store they shop, and then choose a payment method from the methods accepted at this particular store, the heterogeneous choice set assumption will be more accurate.¹⁹ In general, the reality probably lies somewhere between these two extreme situations. This is why we estimate both specifications to see how robust our results are.

5. Results

5.1. Estimation of the most frequently used payment method by retail type

Table 4 shows the log-likelihood of all four specifications for the five types of retail stores. The sample size varies slightly by type of stores, because of the missing information about payment method in a given type of stores. The table confirms that including attitudinal data improves the fit of our model significantly. For both choice set specifications, including attitudinal data improves the log-likelihood, although the magnitude of improvement under heterogeneous choice set is slightly smaller. The results suggest that the data on consumer's perceptions toward each payment method capture a large amount of consumer heterogeneity in preferences for payment method at all five types of stores. The table also reveals that allowing for heterogeneous choice set improves log-likelihood significantly. For example, with perception variables

(specifications 2 and 4), the improvement for grocery store is 281. This indicates that including the information on choice set has also improved the goodness-of-fit significantly.

Table 5 reports coefficients for perception variables, which are included in specifications 2 and 4. Comfortable and Fast are measured by 0–5 scale, while the other variables are dummies. For both specifications, all of the perception variables have expected signs and most of them are highly statistically significant across retail types except fast food restaurants. Overall, Comfortable and Convenient seem to be the most crucial perception variables. Fast is significant for all types of stores but the magnitude of the coefficient for Fast is much smaller than that for Comfortable.²⁰

Coefficients of consumer characteristics for specification 4 are presented in Table 6. The results are generally aligned with findings of previous studies. Technology adoption and race dummies are statistically significant across retail types, while other characteristics, such as gender, education, income, and age, are statistically significant for only a few retail types. Table 7 presents coefficients for reward dummies as well as for a dummy that indicates whether a consumer has zero balance on credit cards or not. The results are consistent with our endogeneity arguments discussed in the previous section. Regardless of whether we model choice sets to be homogeneous or heterogeneous, these dummies have consistently become less significant across retail types after controlling for the perception variables (see specification 1 vs. 2 and 3 vs. 4). In particular, rewards on PIN-debit are significant in specifications 1 and 3 for grocery and drug stores, but they become insignificant in specifications 2 and 4. This suggests that the endogeneity problem is not merely a theoretical concern. The point estimates of the reward dummies have also consistently reduced after incorporating the perception variables.²¹

It should be emphasized that even after controlling for the perception variables, the credit card reward dummy remains statistically significant for all types of retail stores and the signature-debit reward dummy remains significant for all retail types but fast food restaurants. It seems reasonable that rewards on debit cards are insignificant at fast food restaurants because rewards on debit cards are typically less generous and the dollar value of transactions at fast food restaurants is usually small. Overall, we interpret this as evidence that the rewards on credit and signature-debit cards increase consumers' likelihood of choosing these payment methods, i.e., the direct effect of rewards is present. Also, the

¹⁹ For instance, a consumer who generally prefers credit card to the other payment methods hardly uses a credit card at fast food restaurants because she perceives that fast food restaurants she goes to (or in general) do not accept credit cards. If an empirical model assumes that this consumer can choose a credit card, the intercept term that measures the mean utility for credit card will be biased downward. Due to the non-linear nature of our discrete choice models, this could also lead to bias in other parameters, including the rewards dummies.

²⁰ For Comfortable/Fast variables we treat 0 as "least comfortable/slowest," and 5 as "completely comfortable/ fastest," in the estimation, although 0 refers to "not use this payment method" in the survey. Our interpretation could be problematic for Fast. In one robustness check, we exclude the Fast variable. The estimation results have hardly changed.

²¹ Due to the non-linear nature of the multinomial logit model, this does not necessarily imply that their effects are overestimated if the perception variables are not included. But as we will discuss in our counterfactual exercises, the bias due to ignoring the perception variables is quite substantial.

Table 5
Multinomial logit model: Coefficients for perceptions.

	Perceptions Choice set	Specifications			
		2 Yes Homogeneous	4 Yes Heterogeneous		
Grocery	Comfortable	0.670***	(0.060)	0.680***	(0.066)
	Fast	0.323***	(0.052)	0.308***	(0.060)
	Convenient	0.809***	(0.129)	0.702***	(0.143)
	Easy-to-use	0.650***	(0.131)	0.618***	(0.148)
	Preferred by stores	0.275***	(0.090)	0.337***	(0.099)
	Safe	0.132 [†]	(0.080)	0.125	(0.088)
	Money taken right away	-0.041	(0.093)	-0.113	(0.100)
	Help me budget	0.328***	(0.090)	0.279***	(0.098)
	For small amount	0.239**	(0.098)	0.301***	(0.108)
	Control over money	0.567***	(0.095)	0.565***	(0.104)
	Easy-to-get refund	0.153 [†]	(0.085)	0.113	(0.093)
Department	Comfortable	0.585***	(0.055)	0.557***	(0.064)
	Fast	0.281***	(0.056)	0.292***	(0.066)
	Convenient	0.511***	(0.129)	0.421***	(0.143)
	Easy-to-use	0.429***	(0.131)	0.504***	(0.146)
	Preferred by stores	0.318***	(0.095)	0.225**	(0.105)
	Safe	0.175**	(0.086)	0.131 [†]	(0.095)
	Money taken right away	-0.115	(0.100)	-0.142	(0.107)
	Help me budget	0.232**	(0.097)	0.136	(0.107)
	For small amount	0.020	(0.102)	0.096	(0.112)
	Control over money	0.565***	(0.105)	0.543***	(0.115)
	Easy-to-get refund	0.385***	(0.089)	0.400***	(0.098)
Discount	Comfortable	0.548***	(0.053)	0.557***	(0.065)
	Fast	0.161***	(0.046)	0.204***	(0.058)
	Convenient	0.541***	(0.120)	0.437***	(0.144)
	Easy-to-use	0.288**	(0.120)	0.346**	(0.150)
	Preferred by stores	0.319***	(0.088)	0.219**	(0.108)
	Safe	0.158**	(0.075)	0.123	(0.094)
	Money taken right away	0.020	(0.090)	-0.075	(0.105)
	Help me budget	0.301***	(0.085)	0.319***	(0.102)
	For small amount	0.143	(0.095)	0.205 [†]	(0.115)
	Control over money	0.407***	(0.090)	0.449***	(0.108)
	Easy-to-get refund	0.169**	(0.080)	0.225**	(0.095)
Drug	Comfortable	0.649***	(0.060)	0.648***	(0.069)
	Fast	0.203***	(0.049)	0.186***	(0.057)
	Convenient	0.667***	(0.120)	0.577***	(0.132)
	Easy-to-use	0.395***	(0.125)	0.320**	(0.138)
	Preferred by stores	0.309***	(0.082)	0.292***	(0.091)
	Safe	0.243***	(0.070)	0.204***	(0.079)
	Money taken right away	-0.031	(0.086)	-0.060	(0.096)
	Help me budget	0.158 [†]	(0.084)	0.096	(0.094)
	For small amount	0.316***	(0.089)	0.356***	(0.100)
	Control over money	0.398***	(0.086)	0.392***	(0.096)
	Easy-to-get refund	0.274***	(0.076)	0.227***	(0.085)
Fast food	Comfortable	0.341***	(0.063)	0.368***	(0.081)
	Fast	0.223***	(0.065)	0.234***	(0.077)
	Convenient	0.466***	(0.168)	0.547***	(0.199)
	Easy-to-use	0.199	(0.186)	-0.047	(0.224)
	Preferred by stores	0.158	(0.120)	0.156	(0.139)
	Safe	0.110	(0.102)	0.062	(0.117)
	Money taken right away	-0.134	(0.122)	-0.088	(0.136)
	Help me budget	0.241**	(0.116)	0.267**	(0.134)
	For small amount	0.706***	(0.108)	0.614***	(0.136)
	Control over money	0.197	(0.121)	0.138	(0.142)
	Easy-to-get refund	0.207 [†]	(0.114)	0.295 [†]	(0.132)

Note: Standard errors are in ().

[†] Significant at .1 level.

** Significant at .05 level.

*** Significant at .01 level.

dummy indicating zero balance on credit cards remains positive and significant for grocery stores, drug stores and fast food restaurants. This indicates that carrying a credit card balance discourages consumers to use a credit card at these three retail types, while it does not have any significant effects on their choice at department

and discount stores. The differential impacts of credit card balance could be explained by the differences in transaction value across retail types.

Finally, Tables 5 and 7 show that the coefficients for card-related status and perceptions variables are remarkably similar

Table 6
Multinomial logit model: Coefficients for consumer characteristics (Specification 4).

		Credit		PIN-debit		Signature-debit		Check	
Grocery	Constant	2.393	(1.695)	2.344	(1.396)	-1.793	(1.937)	0.148	(1.685)
	Female	0.482**	(0.217)	0.482***	(0.179)	0.591***	(0.229)	1.012***	(0.227)
	Education	-0.185	(0.747)	0.266	(0.616)	1.136	(0.861)	-0.124	(0.674)
	Education ²	0.073	(0.105)	0.011	(0.090)	-0.111	(0.126)	0.046	(0.101)
	Income	0.033	(0.079)	0.028	(0.068)	0.057	(0.101)	0.221**	(0.092)
	Income ²	-0.001	(0.004)	0.000	(0.004)	-0.003	(0.006)	-0.010 [†]	(0.006)
	Age	-0.126***	(0.046)	-0.058	(0.042)	0.005	(0.059)	0.024	(0.058)
	Age ²	0.001**	(0.000)	0.000	(0.000)	0.000	(0.001)	0.000	(0.001)
	Direct deposit	0.717***	(0.266)	0.638***	(0.205)	0.868***	(0.300)	0.253	(0.262)
	Online banking	0.420*	(0.224)	0.351*	(0.183)	0.327	(0.242)	0.041	(0.240)
	Asian	-0.098	(0.370)	-1.489***	(0.423)	-1.255 [†]	(0.645)	-0.284	(0.562)
	Other race	-0.829***	(0.295)	-0.735***	(0.203)	-0.907***	(0.257)	-0.750**	(0.303)
	Department	Constant	-0.103	(1.535)	-0.983	(1.715)	-2.462	(1.988)	-1.316
Female		0.386*	(0.222)	0.157	(0.237)	0.407	(0.252)	0.203	(0.275)
Education		1.415*	(0.734)	1.211	(0.798)	1.000	(0.905)	0.415	(0.844)
Education ²		-0.160	(0.113)	-0.152	(0.121)	-0.094	(0.137)	-0.037	(0.129)
Income		0.012	(0.116)	-0.008	(0.119)	-0.003	(0.132)	-0.054	(0.133)
Income ²		0.004	(0.008)	0.003	(0.008)	0.000	(0.009)	0.005	(0.010)
Age		-0.051	(0.048)	0.024	(0.053)	0.089	(0.066)	0.099	(0.065)
Age ²		0.001	(0.001)	0.000	(0.001)	-0.001 [†]	(0.001)	-0.001	(0.001)
Direct deposit		0.454*	(0.246)	0.382	(0.268)	0.850***	(0.293)	0.351	(0.312)
Online banking		0.439**	(0.223)	0.633***	(0.249)	0.374	(0.258)	0.309	(0.284)
Asian		0.909	(0.651)	0.163	(0.717)	0.476	(0.753)	1.052	(0.757)
Other race		-1.071***	(0.250)	-0.771***	(0.258)	-1.045***	(0.272)	-0.807**	(0.341)
Discount		Constant	1.174	(1.369)	0.055	(1.557)	-2.935	(2.055)	-2.435
	Female	-0.043	(0.201)	0.019	(0.203)	0.171	(0.248)	0.646***	(0.234)
	Education	-0.051	(0.643)	0.493	(0.738)	1.119	(0.907)	0.470	(0.816)
	Education ²	0.054	(0.097)	-0.011	(0.110)	-0.088	(0.132)	-0.041	(0.118)
	Income	0.003	(0.078)	0.028	(0.082)	-0.039	(0.096)	0.034	(0.089)
	Income ²	0.003	(0.005)	0.002	(0.005)	0.003	(0.005)	0.003	(0.005)
	Age	-0.026	(0.041)	-0.026	(0.043)	0.055	(0.064)	0.098*	(0.059)
	Age ²	0.000	(0.000)	0.000	(0.000)	-0.001	(0.001)	-0.001 [†]	(0.001)
	Direct deposit	0.584**	(0.250)	1.035***	(0.244)	1.001***	(0.298)	0.605**	(0.276)
	Online banking	0.428**	(0.205)	0.317	(0.210)	0.382	(0.262)	0.545**	(0.244)
	Asian	0.507	(0.447)	0.037	(0.555)	-0.250	(0.738)	-0.193	(0.685)
	Other race	-1.183***	(0.247)	-0.812***	(0.224)	-1.001***	(0.280)	-1.258***	(0.330)
	Drug	Constant	0.479	(1.470)	1.762	(1.342)	-1.237	(1.590)	-0.965
Female		0.153	(0.185)	0.259	(0.170)	0.306	(0.204)	0.379 [†]	(0.222)
Education		0.403	(0.641)	0.451	(0.582)	1.007	(0.695)	0.278	(0.762)
Education ²		-0.006	(0.090)	-0.036	(0.085)	-0.109	(0.103)	-0.015	(0.112)
Income		0.102	(0.068)	0.159**	(0.064)	0.118	(0.080)	0.095	(0.093)
Income ²		-0.004	(0.004)	-0.006*	(0.003)	-0.006	(0.004)	-0.006	(0.006)
Age		-0.112***	(0.040)	-0.101***	(0.039)	-0.039	(0.051)	0.044	(0.059)
Age ²		0.001***	(0.000)	0.001**	(0.000)	0.000	(0.001)	0.000	(0.001)
Direct deposit		0.282	(0.233)	0.304	(0.210)	0.981***	(0.264)	0.209	(0.262)
Online banking		0.123	(0.192)	0.015	(0.177)	0.020	(0.217)	-0.365	(0.231)
Asian		0.379	(0.389)	-0.719*	(0.409)	-0.900	(0.636)	-1.325	(0.881)
Other race		-0.244	(0.243)	-0.369 [†]	(0.200)	-0.696***	(0.251)	-0.775***	(0.336)
Fast food		Constant	0.428	(2.134)	-0.751	(2.033)	-4.332*	(2.386)	-13.200
	Female	-0.391	(0.290)	0.078	(0.251)	-0.241	(0.286)	-0.233	(0.831)
	Education	-0.532	(0.958)	0.546	(0.813)	2.391**	(1.108)	5.861	(5.222)
	Education ²	0.101	(0.131)	-0.092	(0.121)	-0.261 [†]	(0.159)	-0.904	(0.882)
	Income	-0.144	(0.089)	0.216	(0.152)	-0.048	(0.118)	0.211	(1.171)
	Income ²	0.007*	(0.004)	-0.011	(0.010)	0.000	(0.006)	-0.104	(0.190)
	Age	0.086	(0.053)	-0.100*	(0.060)	-0.075	(0.067)	0.200	(0.200)
	Age ²	0.001	(0.001)	0.001	(0.001)	0.001	(0.001)	-0.002	(0.002)
	Direct deposit	0.543	(0.359)	0.201	(0.319)	1.014**	(0.460)	0.943	(1.029)
	Online banking	0.254	(0.312)	0.029	(0.286)	-0.193	(0.300)	-0.748	(0.879)
	Asian	0.351	(0.399)	0.135	(0.644)	-1.313	(1.143)	0.972	(3.253)
	Other race	1.163***	(0.335)	0.596**	(0.282)	0.253	(0.306)	-0.905	(1.656)

Note: Standard errors are in ().

[†] Significant at .1 level.

** Significant at .05 level.

*** Significant at .01 level.

whether the consumers' choice sets are homogeneous or heterogeneous.²² These likely indicate that our results are robust regardless of how we model consumers' choice sets.

5.2. Counterfactual: effects of removing rewards

How would consumers change their payment choice if their payment cards no longer offer rewards? The answer to this question is relevant to the current policy debates in the payment card industry. One of the policy proposals in the current debate is to prohibit card issuers from offering rewards (Hayashi, 2008).

²² The coefficients for consumer characteristics are also very similar across different specifications. The coefficients for consumer characteristics for specifications 1, 2 and 3 are available upon request.

Table 7
Multinomial logit model: coefficients for reward dummies.

		Specifications			
		1 No Homogeneous	2 Yes Homogeneous	3 No Heterogeneous	4 Yes Heterogeneous
Grocery	Rewards on credit	1.632*** (0.145)	1.013*** (0.174)	1.579*** (0.159)	1.019*** (0.192)
	Rewards on PIN-debit	0.563*** (0.201)	0.150 (0.237)	0.452** (0.225)	0.085 (0.253)
	Rewards on signature-debit	1.626*** (0.174)	1.187*** (0.208)	1.507*** (0.199)	1.092** (0.231)
	Zero balance on credit	0.800*** (0.147)	0.516*** (0.175)	0.847*** (0.161)	0.558*** (0.191)
Department	Rewards on credit	1.324*** (0.123)	0.720*** (0.145)	1.203*** (0.135)	0.720*** (0.156)
	Rewards on PIN-debit	0.469* (0.258)	0.034 (0.287)	0.343 (0.304)	0.007 (0.313)
	Rewards on signature-debit	1.434*** (0.176)	0.821*** (0.204)	1.344*** (0.198)	0.843** (0.222)
	Zero balance on credit	-0.061 (0.107)	-0.049 (0.125)	0.020 (0.120)	-0.008 (0.138)
Discount	Rewards on credit	1.094*** (0.125)	0.516*** (0.145)	0.991*** (0.152)	0.541*** (0.179)
	Rewards on PIN-debit	0.195 (0.225)	-0.241 (0.246)	0.174 (0.302)	-0.226 (0.300)
	Rewards on signature-debit	1.244*** (0.192)	0.656*** (0.207)	1.063*** (0.228)	0.658** (0.245)
	Zero balance on credit	0.114 (0.120)	-0.009 (0.134)	0.210 (0.142)	0.052 (0.161)
Drug	Rewards on credit	1.284*** (0.136)	0.656*** (0.164)	1.136*** (0.151)	0.633*** (0.177)
	Rewards on PIN-debit	0.499* (0.216)	0.233 (0.237)	0.573** (0.271)	0.388 (0.292)
	Rewards on signature-debit	1.299*** (0.181)	0.808*** (0.207)	1.198*** (0.207)	0.771** (0.228)
	Zero balance on credit	0.717*** (0.134)	0.593*** (0.156)	0.769*** (0.147)	0.571*** (0.169)
Fast food	Rewards on credit	1.008*** (0.202)	0.614*** (0.227)	0.825*** (0.238)	0.531** (0.274)
	Rewards on PIN-debit	0.354 (0.348)	0.241 (0.389)	-0.291 (0.466)	-0.170 (0.465)
	Rewards on signature-debit	0.555* (0.268)	0.100 (0.295)	0.147 (0.325)	-0.120 (0.346)
	Zero balance on credit	0.604*** (0.225)	0.539** (0.245)	0.759*** (0.253)	0.559** (0.279)

Note: Standard errors are in ().

* Significant at .1 level.

** Significant at .05 level.

*** Significant at .01 level.

In addition, public authorities of many countries have regulated or scrutinized the payment card fee structure, especially fees paid by merchants. For example, in 2003 the Reserve Bank of Australia mandated three credit card networks to set interchange fees (which are a part of merchant fees) based on the cost-based benchmark, which excludes the costs of providing rewards. As a result, interchange fees have been lowered substantially and the value of reward points has been greatly reduced.²³ The counterfactual policy experiments conducted here allow us to shed light on how consumers would change their payment choice if similar regulations would be implemented in the United States.²⁴ Since a substantial portion of the merchant fees is used to fund rewards programs in US, a cost-based merchant fee (interchange fee)

regulation that excludes the cost of rewards would likely reduce the fee levels substantially, and cause card issuers to have less incentives to offer rewards programs.²⁵ Our counterfactual experiments would also shed light on the effects of a policy that allows merchants to surcharge or set different prices based on which particular card is used (e.g., high-end vs. no- or low-end reward cards). Currently, the card networks' rules do not allow merchants to surcharge customers based on payment cards (e.g., signature-debit vs. credit; high-end vs. no- or low-end reward credit cards) even though the merchant fees vary across cards. Since the magnitude of the merchant fees is likely tied to the generosity of the rewards, merchants might set higher fees for more generous rewards cards if they are allowed to surcharge. As a

²³ See Table 7 (p. 12) of the Reserve Bank of Australia (2006).

²⁴ The US Congress currently discusses bills regarding interchange fees and other network rules.

²⁵ About 70–90% of merchant fees are interchange fees, and about 44% of interchange fees are estimated to be used to fund rewards programs in the United States (Dawson and Hugener, 2006). Some industry experts also believe the majority of rewards are funded by interchange fees (Bruno-Britz, 2006).

Table 8

Effects of removing credit card rewards on consumers with credit card rewards.

	CC rewards only				CC&DC rewards			
	Initial prob.	Change in probability			Initial prob.	Change in probability		
		Credit	Debit	Paper		Credit	Debit	Paper
Grocery	0.415	-0.114	0.049	0.064	0.200	-0.069	0.050	0.019
Department	0.748	-0.093	0.050	0.043	0.503	-0.101	0.081	0.020
Discount	0.497	-0.066	0.029	0.038	0.307	-0.055	0.037	0.018
Drug	0.446	-0.085	0.030	0.055	0.220	-0.051	0.033	0.018
Fast food	0.140	-0.033	0.004	0.029	0.126	-0.025	0.007	0.018

Notes: CC rewards only: Consumers who receive rewards on credit card only. CC&DC rewards: Consumers who receive rewards on both credit and debit cards.

result, surcharges may offset the impacts of rewards on payment choice.²⁶

We conduct three counterfactual policy experiments that remove the reward features of (1) credit cards, (2) debit cards and (3) both credit and debit cards to see how they would affect consumers who currently receive rewards. Specification 4, which includes perception variables and assumes heterogeneous consumer choice set, is used because of its superior goodness-of-fit. We note that the results are robust even if we use specification 2, which includes perception variables and assumes homogeneous consumer choice set. Our key identification assumption is that the 11 consumer perceptions toward payment methods used in this study would remain unchanged after rewards were removed. We believe that this is a reasonable assumption. Some consumers may have improved their perceptions toward payment cards after joining a rewards program, which induces them to use payment cards more frequently. However, once they learned the cards' features, their perception about payment cards, such as how fast the card transactions are, whether the payment cards are easy to use, and whether the payment cards keep money and accounts safe, would likely remain unchanged even if consumers no longer receive rewards.

5.2.1. Effects of removing rewards on credit cards

We now discuss the results from our first policy experiment: what would happen if rewards on credit cards were removed today? Note that this experiment only affects consumers who currently receive rewards on credit cards. We divide these consumers into two groups: (i) consumers who receive rewards on credit cards only (CC rewards only) and (ii) consumers who receive rewards on both credit and debit cards (CC&DC rewards). For each group, we calculate the average probability of choosing each of the five payment methods before and after the policy is implemented.²⁷ Table 8 shows the effect of the policy on these two groups of consumers in five retail types separately. The first four columns are for consumers with CC rewards only and the second four are for consumers with CC&DC rewards. For each group, the first column is the initial probability of choosing credit card before the policy is implemented, and the next three columns are the changes in probability of choosing credit cards, both types of debit cards, and paper-based methods (cash and checks), respectively.

Both groups of consumers would reduce their probabilities of choosing to pay with a credit card at all types of stores if rewards on credit cards were removed. The reductions range from 3.3 to

11.4 percentage points for consumers with CC rewards only, and from 2.5 to 10.1 percentage points for consumers with CC&DC rewards. Grocery and department stores have the largest percentage point reduction (around 10 percentage points), while fast food restaurants have the smallest. This is probably because rewards are typically expressed in terms of percentage of the transaction value. The average transaction value at department store is typically larger, while that at fast food restaurants is much smaller. Thus, the effect of rewards on consumer's payment choice is greater at the stores where the average transaction value is higher. Overall, although the reductions in probability of choosing credit cards vary across retail types, their magnitudes are moderate, compared with the initial probability of choosing credit card. Assuming that reward credit cardholders always use the rewards credit card for their credit card transactions before the policy is implemented, our results indicate that the majority (at least two-thirds) of rewards credit card transactions would be replaced by non-rewards credit card transactions.

How do the substitution patterns vary between two groups of reward credit card holders and across types of stores? For consumers with CC&DC rewards, the likelihood of switching to debit cards is much higher than that to paper-based methods except at fast food restaurants. In contrast, for consumers with CC rewards only, the likelihood of switching to debit cards is slightly lower than that to paper-based methods except at department stores. This is quite intuitive because consumers with CC&DC rewards have more incentives to use a debit card than consumers with CC rewards only. The results are also consistent with the common beliefs that consumers prefer cash for small value transactions and they prefer payment cards for large value of transactions.

It is worth discussing what happens if the same policy experiment is conducted under specification 3, which does not include perception variables. The importance of controlling for consumers' attitudes toward payment methods can be quantified by comparing the policy experiment results from specifications 3 and 4. Under specification 3, the predicted reductions in the probability of choosing credit cards due to the policy are about twice as much as those under specification 4.²⁸ This suggests that policy experiments based on a model without perception variables could seriously over-predict the impacts of these policies.

5.2.2. Effects of removing rewards on debit cards

The second policy experiment is to remove rewards on debit cards. Note that only consumers who currently receive rewards on debit cards are influenced by this policy. We divide such consumers into two groups: (i) consumers who receive rewards on debit cards only (DC rewards only) and (ii) consumers who receive rewards on both credit and debit cards (CC&DC rewards). Similar to the first policy, we calculate each group's average probabilities of

²⁶ This is a theoretical prediction by Gans and King (2003). They argue that if merchants appropriately surcharge their customers based on the payment methods, interchange fees (and thus rewards) would become neutral in determining payment choice. However, the empirical evidence on whether merchants would surcharge is mixed (Hayashi, 2008).

²⁷ This is equivalent to the average partial effect of the credit reward dummy for each group.

²⁸ Due to space constraints, the policy experiments results based on specification 3 are not reported. They are reported in Ching and Hayashi (2008).

Table 9

Effects of removing debit card rewards on consumers with debit card rewards.

	DC rewards only				CC&DC rewards			
	Initial prob.	Change in probability			Initial prob.	Change in probability		
		Debit	Credit	Debit		Paper	Debit	Credit
Grocery	0.614	0.013	-0.053	0.040	0.626	0.036	-0.064	0.029
Department	0.515	0.035	-0.055	0.020	0.413	0.063	-0.075	0.012
Discount	0.473	0.007	-0.022	0.014	0.487	0.020	-0.033	0.014
Drug	0.512	0.017	-0.060	0.043	0.525	0.029	-0.068	0.039
Fast food ^a	0.179	-0.002	0.008	-0.006	0.175	-0.002	0.009	-0.007

Notes: DC rewards only: Consumers who receive rewards on debit card only. CC&DC rewards: Consumers who receive rewards on both credit and debit cards.

^a The effect of debit card rewards at fast food is negative but not statistically significant.

choosing credit cards, debit cards, and paper-based methods before and after the policy is implemented.

The results are presented in Table 9. At all types of stores except fast food, both groups of consumers would reduce their probability of choosing debit cards if rewards on debit cards were removed.²⁹ In general, the reductions are much smaller than those of choosing credit cards under the first policy. They range from 2.1 to 6 percentage points for consumers with DC rewards only, and from 3.4 to 7.5 percentage points for consumers with CC&DC rewards. This may reflect the fact that rewards on debit cards are typically much less generous than those on credit cards. Consumers with CC&DC rewards would be more likely to substitute credit cards than paper-based methods for debit cards, while consumers with DC rewards only would be more likely to do the opposite. The main message of this experiment is the same as the first experiment: if we assume that reward debit cardholders always use the rewards debit card for their debit card transactions before the policy is implemented, at least 80% of rewards debit card transactions would be replaced by non-rewards debit card transactions if rewards on debit card were removed.

5.2.3. Effects of removing rewards on both credit and debit cards

Finally, we consider the policy of removing rewards on both credit and debit cards. This policy affects three groups of consumers: (i) consumers with rewards on credit cards only (CC rewards only), (ii) consumers with rewards on debit cards only (DC rewards only), and (iii) consumers with rewards on both credit and debit cards (CC&DC rewards). Because the effects of this policy on the first two groups of consumers are the same as those of the first and second policies analyzed above, we will focus on discussing the effects on the third group.

In Table 10, the first three columns show the initial probabilities of choosing credit cards, debit cards, and paper-based methods, respectively, before the policy is implemented, and the last three columns show the change in probabilities after the policy is implemented. There are three main findings. First, similar to the first policy, consumers with CC&DC rewards would reduce their probabilities of choosing credit cards at all types of stores although the levels of reduction are much smaller than those by consumers with CC rewards only (see the left half of Table 8). Second, while consumers with CC&DC rewards would become less likely to use debit cards at grocery and drug stores, they would actually become more likely to use debit cards at the other three types of stores. In contrast, under the same policy, consumers with DC rewards only would reduce their probabilities of choosing debit cards at all retail types but fast food restaurants (see the left half of Table 9). Third, assuming that consumers with CC&DC rewards always use their reward cards before the policy is implemented, our results imply

Table 10

Effects of removing both credit and debit card rewards on consumers with both credit and debit card rewards.

	CC&DC rewards					
	Initial probability			Change in probability		
	Credit	Debit	Paper	Credit	Debit	Paper
Grocery	0.200	0.626	0.174	-0.048	-0.005	0.054
Department	0.503	0.413	0.084	-0.043	0.005	0.038
Discount	0.307	0.487	0.205	-0.038	0.004	0.034
Drug	0.220	0.525	0.255	-0.030	-0.033	0.063
Fast food ^a	0.126	0.175	0.699	-0.026	0.016	0.010

Note: CC&DC rewards: Consumers who receive rewards on both credit and debit cards.

^a The effect of debit card rewards at fast food is negative but not statistically significant.

that more than 90% of their rewards card transactions would be replaced by non-reward card transactions under this policy. This message is similar to the one we find in the first two policies.

5.3. Comparison with related studies

It is worth comparing our results with two closely related studies. Borzekowski et al. (2008) examined how imposing PIN fee on debit cards would affect US consumers' debit card usage. They found that consumers would reduce their probability of using a debit card for at least one transaction by 12 percentage points. Our results suggest that removing rewards on debit cards would have much smaller effects (2–7.5 percentage point reduction in consumers' probability of choosing debit cards as their primary payment method for certain retail types). The difference here could be explained by the difference between the average PIN fee level (which is 1.8% of the transaction value, according to Borzekowski et al. (2008)) and the average debit card reward level (which is 0.25% of the transaction value, according to Carten et al. (2007)).

The study by Carbó-Valverde and Liñares-Zegarra (2009) (hereafter CL) is similar to ours in several ways. Both studies estimate the effects of payment cards rewards on consumer payment choice across retail types, and use consumer perceived payment attributes to control for heterogeneity in consumer preferences. There are three key differences. First, CL's sample includes debit-only cardholders and credit cardholders (the majority of them hold both credit and debit cards), while our sample only includes cardholders of both credit and debit cards. Second, CL observe the nature of rewards (cash-back, discounts, points and gifts) each consumer receives and hence they can include this information in their model. Third, unlike ours, CL do not observe whether consumers use credit or debit cards (they only observe whether consumers use cards or cash), and whether cards rewards are associated with credit or debit cards. Consequently, they can only allow consumers to choose either cards or cash in their model.

²⁹ The probability of choosing debit cards increases at fast food restaurants under this policy experiment because debit reward dummies are estimated to be negative, although they are statistically insignificant.

Because of these differences in the data and model specification between our study and CL, we view that these two studies complement each other. On the one hand, our study is able to provide more detailed analysis of the substitution patterns in payment choice because, unlike CL, we can separate credit and debit cards in our model. On the other hand, CL is able to provide evidence about how consumer may respond to different reward type (i.e., cash-back, discounts, gifts, and points), while our study cannot. Interestingly, both studies find that the effects of rewards vary across retail types.

5.4. Policy implications

The policy experiments results presented in Section 5.2 concentrate on consumers who have rewards cards. Policymakers, however, would likely be interested in a broader issue, e.g., how the market shares of payment methods would change after the policies are implemented. Unfortunately, our results cannot be used to examine this question because we only analyze a sub-population of consumers who hold both credit and debit cards at five retail types. In this section, we therefore address a narrower but more focused issue: How would the policies affect the shares of payment methods in terms of the number of transactions made by this sub-population (i.e., the payment mix among this sub-population) at five retail types? Although our analysis does not provide a complete picture for the policy impacts, we believe that it is still worth carrying out because the sub-population, who hold both credit and debit cards, likely represents 60% of general population (according to 2004 SCF), and the transactions at these five retail types likely account for a large share of in-store transactions.

Before discussing the policy implications, we should note two additional limitations of our results. First, although policy implications of our results are rather straightforward for the policy of disallowing card issuers to offer rewards, they are likely more complicated for other policies, such as imposing interchange fee caps or allowing merchants to set surcharges for different credit/debit cards. Extending our results to these two policies would require additional assumptions or additional steps of analysis. For example, unless interchange fee caps or surcharges set by merchants completely offset the effects of rewards, our results could either overestimate or underestimate the effects of these policies. Second, our results are derived from partial equilibrium. In other words, we assume that a ban on payment card rewards does not affect the decisions of other players in the payment cards market. It is conceivable that card issuers may react to this policy by changing other card features (e.g., lowering interest rates, offering travel/

rental car insurance, etc.), and this would likely have an additional effect on consumer payment choice. To address this issue, one would need to develop a general equilibrium model which includes all the players in the payment system. This is beyond the scope of this paper.

Keeping these limitations in mind, we now discuss the policy implications. Our model predicts payment choice probabilities when a consumer makes a transaction. To draw inference about the payment mix, it would be ideal if we could weigh each consumer i 's choice probabilities using the number of transactions he/she typically makes at each retail type j (n_{ij}). However, our survey data does not provide n_{ij} . Instead, it provides the typical total number of weekly in-store transactions each consumer made (n_i). We therefore use n_i to weigh the choice probabilities of each consumer when we compute the payment mix. In other words, the share of payment method l among this sub-population at retail type j is calculated as follows: $S_{ij} = (\sum_i n_i \text{Pr}_{ij}(l)) / \sum_i n_i$, where $\text{Pr}_{ij}(l)$ is consumer i 's probability of choosing payment method l at retail type j . Using n_i as the consumer weight implicitly assumes that for each retail type j , n_{ij}/n_i is fixed across consumers (i.e., $n_{ij}/n_i = n_{kj}/n_k$ for all i and k). This assumption will certainly introduce measurement errors to our results and one needs to be aware of this limitation when extending our results to conduct welfare analysis.

Panel A of Table 11 reports the effects of removing rewards on the payment mix of the sub-population. We consider three policies of removing: (1) credit card rewards, (2) debit card rewards, and (3) both credit and debit card rewards. The first three columns show the initial payment mix (the shares of credit, debit, and paper-based methods), and the rest of the columns show the share changes in absolute term. Policy 1 would reduce the share of credit card, ranging approximately from 1% to 3%. More than half of these reductions would be replaced by debit cards at grocery, department and discount stores, while more than half would be replaced by cash or checks at drugstores and fast food restaurants. Policy 2 would reduce the share of debit card by less than 1%, and the substitution patterns are similar to those under policy 1. Under policy 3, the credit card share would decrease by about 1–3%; the debit card share would increase by less than 1%; and the cash/checks share would increase by 2% at most.

One caveat of the results in Panel A is that the share of reward cardholders in the sub-population is much lower than that of today. Recall that there are 36% of the consumers who receive rewards in our sample. However, according to the 2008 Hitachi Consumer Payment Preferences Study, there are about 66% of credit cardholders who received rewards in 2008. Consequently, if the policies of removing rewards were implemented today, it is likely

Table 11
Effects of removing rewards on the payment mix among consumers who hold both credit and debit cards.

	Initial payment mix			Policy 1 Removing credit card rewards			Policy 2 Removing debit card rewards			Policy 3 Removing both credit and debit card rewards		
	Credit	Debit	Paper	Credit	Debit	Paper	Credit	Debit	Paper	Credit	Debit	Paper
<i>Panel A: Smaller share of reward receivers (Unit: percentage points)</i>												
Grocery	16.53	52.97	30.50	-3.01	1.63	1.38	0.42	-0.89	0.48	-2.75	0.83	1.92
Department	44.03	37.01	18.96	-3.09	2.02	1.07	0.83	-1.05	0.22	-2.32	0.96	1.36
Discount	25.72	41.41	32.87	-1.95	1.04	0.91	0.24	-0.46	0.22	-1.74	0.59	1.15
Drug	20.29	41.91	37.80	-2.24	1.01	1.22	0.36	-0.95	0.59	-1.96	0.09	1.87
Fast food ^a	7.60	14.35	78.04	-0.97	0.18	0.79	-0.03	0.14	-0.11	-0.99	0.32	0.67
<i>Panel B: Larger share of reward receivers (Unit: percentage points)</i>												
Grocery	22.23	50.24	27.53	-5.29	2.87	2.43	0.73	-1.57	0.84	-4.82	1.46	3.36
Department	51.41	33.44	15.15	-5.39	3.52	1.87	1.44	-1.83	0.39	-4.05	1.68	2.37
Discount	31.45	39.37	29.18	-3.43	1.83	1.60	0.42	-0.80	0.38	-3.06	1.04	2.03
Drug	25.94	39.86	34.20	-3.94	1.78	2.15	0.64	-1.67	1.03	-3.44	0.16	3.28
Fast food ^a	10.09	13.72	76.19	-1.71	0.32	1.39	-0.05	0.24	-0.20	-1.74	0.56	1.18

Notes: To produce this table, we use the typical total number of weekly in-store transactions each consumer made to weigh the choice probabilities of each consumer. We also assume 36% of consumers receive rewards for Panel A and 63% for Panel B.

^a The effect of debit card rewards at fast food is negative but not statistically significant.

that their impacts would be stronger. To obtain a better estimate of the policy impacts to the payment mix among the sub-population today, we adjust the weights of the consumers who receive rewards in our original sample so that the share of reward cardholders in our new sample is more aligned with the share of reward cardholders in the sub-population today. More specifically, we weigh three times more to reward receivers than to non-reward receivers in our original sample, and as a result, the share of reward cardholders in our “new” sample becomes 63%.³⁰ Panel B of Table 11 reports the results by using our new sample. The impacts of the policies have been nearly doubled compared with our original sample (reported in Panel A). For example, if rewards were removed from both credit and debit cards today, the share of credit card among this sub-population would be reduced by about 2–5%, the share of debit card would increase by less than 2%, and the share of cash and checks would increase by 1% to slightly over 3%.

The results should be interpreted with cautions. Although the impacts might appear to be small, to evaluate the welfare consequences of removing rewards on payment cards on the sub-population focused here, we need to take at least two more factors into account: (i) the average value of transactions that are replaced by paper-based methods, and (ii) as emphasized before, the social costs and benefits of each payment method. Furthermore, we only analyze the payment mix among consumers who hold both credit and debit cards, the sub-population not covered here may represent 40% of the population. Since our data does not contain consumers who hold either credit or debit cards (but not both), it could be problematic to use our results to predict how this sub-population would respond to the policies. Also, we only focus on five retail types. It is possible that consumers may react differently to the policies of removing rewards for other types of transactions, such as bill payments or online purchase transactions.

6. Conclusion

This paper estimates the direct effect of credit and debit card rewards on consumer choice of payment methods. By using a unique data set that contains rich information on consumer payments, such as consumer perceived attributes of each payment method and consumer perceived payment method acceptance by each type of retail stores, we are able to control for the consumer heterogeneity in preferences and choice sets. We find the effects of rewards to be statistically significant. Our policy experiments suggest that for the sub-population who hold both credit and debit cards, removing rewards would increase their share of paper-based payment methods, measured in terms of in-store transactions, by no more than 4 percentage points. Our results show that including perceived payment method attributes produces a substantial improvement in model fit and allows us to alleviate the endogeneity problem of rewards. This suggests that when conducting future surveys to study consumer payment choice, it is important to collect this type of data in order to lessen the potential omitted variable bias.

We provide the first effort to understand how rewards affect consumer payment choice. Although we believe that our paper provides some useful information for the current policy debate on the payment industry, there are still many unanswered questions due to data limitations. Collecting more information on rewards programs is crucial to further improve our understanding about how rewards affect consumer payment choice. Knowing

the nature of rewards (e.g., Carbó-Valverde and Liñares-Zegarra, 2009), the reward earning and redemption rates (e.g., the percentage of cash rebate, the number of points required for exchange an air-ticket and the average costs of the ticket, etc.) could help us calculate the rewards elasticity of payment choice. It is also vital to collect more detailed information about consumer payment adoption and usage, e.g., the number of rewards cards each consumer holds, the number of transactions he makes with each of his cards, the average number of transactions he makes by retail type, etc. The additional information outlined here could help address the limitations of the existing studies of this topic.

Another limitation of our study is that our sample only includes consumers who hold both credit and debit cards and we only examine their payment choices for in-store transactions. How does removing rewards affect consumers who only hold either debit or credit cards (but not both)? How would the market shares of payment methods change if rewards on payment cards are no longer offered? We leave these important questions for future research.

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References

- Amromin, G., Jankowski, C., Porter, R., 2005. Transforming payment choices by doubling fees on the Illinois tollway. Working paper 2006-16, Federal Reserve Bank of Chicago.
- Bradford, T., Hayashi, F., 2008. Developments in interchange fees in the United States and abroad. Payment System Research Briefing, Federal Reserve Bank of Kansas City.
- Borzekowski, R., Kiser, E., Ahmed, S., 2008. Consumers' use of debit cards: patterns, preferences, and price responses. *Journal of Money, Credit, and Banking* 40, 149–172.
- Bronnenberg, B., Vanhonacker, W., 1996. Limited choice sets, local price response, and implied measures of price competition. *Journal of Marketing Research* 33, 163–174.
- Bruno-Britz, M., 2006. Growing rewards. *Bank Systems and Technology*.
- Carten, M., Littman, D., Schuh, S., Stavins, J., 2007. Consumer behavior and payment choice: 2006 conference summary. Public Policy Discussion Paper 2007-4, Federal Reserve Bank of Boston.
- Carbó-Valverde, S., Liñares-Zegarra, J., 2009. How effective are rewards programs in promoting payment card usage? Working paper, Fundación BBVA.
- Ching, A., Erdem, T., Keane, M., 2009. The price consideration model of brand choice. *Journal of Applied Econometrics* 24, 393–420.
- Ching, A., Hayashi, F., 2008. Payment card rewards programs and consumer payment choice. Working paper, Rotman School of Management, University of Toronto. Available at SSRN: <<http://ssrn.com/abstract=1114247>>.
- Dawson, A., Hugener, C., 2006. A New Business Model for Card Payments. Diamond Management & Technology Consultants, Inc.
- Dove Consulting, 2007. The Pulse 2007 Debit Issuer Study.
- Gans, J., King, S., 2003. The neutrality of interchange fees in payment systems. *Topics in Economic Analysis and Policy* 3, Article 1.
- Garcia-Swartz, D., Hahn, R., Layne-Farrar, A., 2006. The move toward a cashless society: calculating the costs and benefits. *Review of Network Economics* 5, 199–228.
- Goeree, M.S., 2008. Limited information and advertising in the US personal computer industry. *Econometrica* 76, 1017–1074.

³⁰ This is equivalent to creating two identical copies of consumers who receive rewards in the sample. Implicitly, we assume that the direct effects of rewards remain the same over time and across early and late reward card adopters.

- Hayashi, F., 2008. The economics of payment card fee structure: policy considerations of payment card rewards. Working paper #RWP 08-08, Federal Reserve Bank of Kansas City.
- Hayashi, F., Klee, E., 2003. Technology adoption and consumer payments: evidence from survey data. *Review of Network Economics* 2, 175–190.
- Harris, K., Keane, M.P., 1999. A model of health plan choice: inferring preferences and perceptions from a combination of revealed preference and attitudinal data. *Journal of Econometrics* 89, 131–157.
- Hirschman, E., 1982. Consumer payment systems: the relationship of attribute structure to preference and usage. *Journal of Business* 55, 531–545.
- Horsky, D., Misra, S., Nelson, P., 2006. Observed and unobserved preference heterogeneity in brand choice models. *Marketing Science* 25, 322–335.
- Humphrey, D., Kim, M., Vale, B., 2001. Realizing the gains from electronic payments: costs, pricing, and payment choice. *Journal of Money, Credit and Banking* 33, 216–234.
- Jonker, N., 2005. Payment instruments as perceived by consumers – a public survey. Working Paper No. 053/2005, De Nederlandsche Bank.
- Klee, E., 2006. Paper or plastic? The effect of time on the use of check and debit cards at grocery stores. Finance and Economics Discussion Series 2006-2, Board of Governors of the Federal Reserve System.
- Keane, M.P., 2004. Modeling health insurance choice using the heterogeneous logit model. Working paper, Department of Economics, Yale University.
- Kennickell, A., Kwast, M., 1997. Who use electronic banking? Results from the 1995 Survey of Consumer Finance. In: Proceedings from the 33rd Annual Conference on Bank Structure and Competition, Federal Reserve Bank of Chicago, pp. 56–75.
- Mantel, B., 2000. Why do consumers pay bills electronically? An empirical analysis. Federal Reserve Bank of Chicago Economic Perspectives, 32–47.
- Mehta, N., Rajiv, S., Srinivasan, K., 2003. Price uncertainty and consumer search: a structural model of consideration set formation. *Marketing Science* 22, 58–84.
- Reserve Bank of Australia, 2006. Payment System Board Annual Report. Reserve Bank of Australia, 2007. Payment Costs in Australia.
- Rochet, J.C., Wright, J., 2010. Credit card interchange fees. *Journal of Banking and Finance* 34, 1788–1797.
- Rysman, M., 2007. An empirical analysis of payment card usage. *Journal of Industrial Economics* 55, 1–36.
- Scholnick, B., Massoud, N., Saunders, A., Carbo-Valverde, S., Rodríguez-Fernández, F., 2008. The economics of credit cards, debit cards and ATMs: a survey and some new evidence. *Journal of Banking and Finance* 32, 1468–1483.
- Simon, J., 2005. Payment systems are different: shouldn't their regulation be too? *Review of Network Economics* 4, 364–383.
- Simon, J., Smith, K., West, T., 2010. Price incentives and consumer payment behaviour. *Journal of Banking and Finance* 34, 1759–1772.
- Stavins, J., 2001. Effect of consumer characteristics on the use of payment instruments. Federal Reserve Bank of Boston New England Economic Review 2001 (3), 19–31.
- Zinman, J., 2009. Debit or credit? *Journal of Banking and Finance* 33, 358–366.