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Why Are (Some) Consumers (Finally) Writing Fewer Checks? The Role of Payment Characteristics

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Abstract:

Since the mid-1990s, the U.S. payment system has undergone a transformation featuring a significant decline in the use of paper checks that is quite uneven across consumers and not well understood. This paper shows that characteristics of payment instruments are the most important determinants of their use, by estimating econometric models of consumers' adoption (extensive margin) and use (intensive margin) of checks plus six other payment instruments, using data from a comprehensive new data source. Changes in the relative convenience and cost of checks can explain directly about 34 and 11 percent, respectively, of the 8.4 percentage point decline in check share from 2003 to 2006. Changes in the relative characteristics of substitute payment instruments also likely contributed indirectly to the decline in check use through an increase in the number of payment instruments adopted per consumer, but the exact magnitude of this indirect channel cannot be identified with available data.

JEL Classifications: D14, D12, E41, G21

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1. Introduction

Two facts about checks motivate this paper. First, check use in the United States is finally declining, as shown in Figure 1. After a long, steady increase, aggregate U.S. check volume declined 33 percent from 1995 to 2006, according to the best but scarce available data.[1] This decline had been predicted at least since the 1960s, one forecast declaring that, "Between 1989 and 1994, personal check volume should decline sharply…" (Federal Reserve Bank of Atlanta, 1983, p. 5). Although the check decline was not surprising, its (late) timing, magnitude, and swiftness were, and the forecast of check use remains quite uncertain.

Second, some consumers are writing fewer checks. Figure 2 shows that between 2003 and 2006—while aggregate check volume declined 16 percent—only 32 percent of U.S. consumers reduced their check use. Furthermore, a scant 0.4 percent stopped using checks altogether. During this era of supposed check demise, 19 percent of consumers actually reported *increasing* their check use. Nevertheless, the consumer *share* of check use likely declined because most consumers reduced or held steady the number of checks they wrote (Figure 2) and because the number of payments likely increased with personal income over time. Although the Federal Reserve data do not break down check use by consumers and businesses, Gerdes (2008) shows evidence that consumers' use of checks declined faster than businesses' use.

The reduction in check use is part of a broader U.S. "payments transformation."[2] Table 1 shows that consumer adoption of checks and credit cards (traditional payment instruments) remained flat from 1995 to 2004, while consumer adoption of debit cards, Automatic Bill Payments (ABP), and online banking jumped significantly.[3] Table 1 also shows that the share of

[1] For details, see Gerdes and Walton (2002), Gerdes, Liu, Parke, and Walton (2005), and Gerdes (2008). The Federal Reserve increased the frequency of its check data collection in part to better understand the decline. Check volume as a share of real GDP declined even earlier, so if the real dollar value per check did not increase, then checks have been declining as a payment choice since before the mid-1990s.

[2] Cash (currency and coins) is often included in characterizations of this transformation, but hard data on the use of cash are even scarcer than hard data on the use of checks.

[3] Receiving an ACH credit (as an automatic paycheck deposit, for example) is not considered a payment in our study.

all noncash payments (by consumers, businesses, and government) made using checks fell from 77 percent to 36 percent, while the shares of three other instruments increased, especially the shares of debit cards and ACH (Automated Clearing House) payments. Although checks remain the single most common form of noncash retail payment, electronic payments together now account for the majority of noncash payments.

Many aspects of this payments transformation are not well understood. Why did it begin in the mid-1990s and not earlier or later? Why did check volume decline as much and as fast as it did, rather than more or less, or faster or more slowly? How much more will check volume decline, and what payment instruments will dominate in the coming years? And why are only one-third of U.S. consumers writing fewer checks, especially given that checks are so costly relative to other payment instruments?[4] Knowing the answers to these questions is vitally important for the Federal Reserve and U.S. payment system.[5] But answers have been elusive.

One reason the payments transformation is not well understood has been a lack of research on consumer behavior and payment choice (Schreft 2006 and Benton, Blair, Crowe, and Schuh 2007).[6] In 2006, for example, fewer than 5 percent of the entries in the "Consumer Payment Bibliography" (Federal Reserve Bank of Philadelphia) were studies with theoretical or empirical work focusing on *consumer* payment demand. Another reason has been a lack of comprehensive and publicly available data on consumer payment choice (Carten, Littman, Schuh, and Stavins 2007). Since the payments transformation began, some new research and data on payments behavior have emerged.[7] But they have primarily improved our

[4] Garcia Swartz, Hahn, and Layne-Farrar (2006) suggest that the marginal cost to consumers is highest for cash and checks, while marginal benefits are similar across payment instruments. Social marginal costs of cash and checks have also been estimated to exceed those of credit or debit cards (Hancock and Humphrey 1998).

[5] Declining check volume has severely affected the business operations of the Federal Reserve, which reduced its check processing sites by 51 percent and total employment by 15 percent through 2006 (for more details, see Benton, Blair, Crowe, and Schuh 2007).

[6] For more details, see the Consumer Behavior and Payment Choice conferences sponsored by the Federal Reserve Bank of Boston in 2005, 2006, and 2008 (http://www.bos.frb.org/economic/eprg/conferences.htm).

[7] The payment studies by the Federal Reserve are one important example (see Gerdes and Walton 2002, Gerdes, Liu, Parke, and Walton 2005, and Gerdes 2008). Private industry firms, such as Dove Consulting, have also contributed.

understanding of *how* consumers pay and *what types* of consumers make those payments. Much less is understood about *why* consumers choose their payments instruments.

This paper attempts to determine why (some) consumers are (finally) writing fewer checks, by estimating a comprehensive system of reduced-form econometric models of demand for payment instruments. Following the literature, we model payment adoption (extensive margin) and payment use (intensive margin).[8] However, our econometric models extend the literature in two dimensions. First, we estimate models of both adoption and use for all payment instruments held by each consumer, where use is the number of payments per month (continuous, quantitative, intensive margin) rather than a qualitative measure. Second, we estimate adoption and use simultaneously, using the Heckman (1976) selection model, which controls for potential selection bias in payment use. Our application is the first of its kind applied to noncash payment instruments.[9]

Our econometric estimation also extends the literature by using a comprehensive new data source with unique information on the characteristics of U.S. payment instruments. For purposes of this paper, we use the term "2006 Survey of Consumer Payment Choice" (SCPC) to refer to a survey sponsored by the AARP with the assistance of the Boston Fed that contains data on adoption and monthly use of checks plus six other payment instruments, as well many characteristics of adult U.S. consumers.[10] The SCPC also includes consumers' assessments of seven characteristics of payment instruments: cost, convenience, safety, privacy, accuracy, timing, and record keeping. Together, these data are a more comprehensive source of information on consumer payment choice than was previously available. Although we are not the first to include payment instrument characteristics in models of payment demand, our models and data are more comprehensive than those of previous studies.

The econometric results indicate that payment characteristics—especially convenience, cost, timing, and record keeping—are the most important determinants of payment use.

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[8] For examples, see Stavins (2001), Mester (2003), Hayashi and Klee (2003), and Zinman (2009).

[9] For applications of this model to cash, see Attanasio, Guiso, and Jappelli (2002) and Lippi and Secchi (2008).

[10] The Survey of Consumer Payment Choice is a program developed by the Boston Fed to collect data on consumer payment choice. Other SCPC surveys in this series were conducted in 2003, 2004, and 2008. For more details, see Schuh (2009).

Although commonly used, the convenience characteristic is not well defined and requires more research. Like previous studies, our study also finds roles for some demographic information and income-related variables in determining payment instrument adoption and use, but these variables are economically and statistically less significant than the number of payment instruments and the instrument characteristics. The number of payment instruments adopted by a consumer is an important determinant of the cross-sectional variation in the use of checks and other payment instruments.

Our simulated results suggest that plausible changes in the primary determinants of check use can explain substantial portions of the actual 8.4 percentage point decline in check share from 2003 to 2006. A decrease in the relative convenience of checks and an increase in the relative cost of checks can explain directly about 34 percent and 11 percent, respectively, of the decline in check share. Changes in the relative characteristics of substitute payment instruments contributed indirectly to the decline in check use. A significant part of the decline in check use (25 percent) occurred via an increase in the number of payment instruments per consumer, which likely was influenced by payment characteristics as well, but this indirect effect cannot be identified with available data. A key factor driving the success of payment characteristics in explaining the decline in check use is that payment demand is far more heterogeneous within narrow demographic groups than across them, and consumers' assessments of the characteristics explain a significant portion of the within-group variation.

2. Literature Review

Although the literature on the supply side of payments is fairly extensive, relatively little research has been done on the demand for payment instruments. Data on individual consumer payment behavior are especially difficult to obtain.[11] Several papers have analyzed the effects of individual consumers' socio-demographic characteristics on the adoption of payment

[11] Some studies estimate payment instrument use or adoption using *country*-level data, such as Amromin and Chakravorti (2007), Humphrey, Kim, and Vale (2001), and Humphrey, Pulley, and Vesala (1996). However, heterogeneity within each country can be substantial, and one cannot infer what payment or consumer characteristics induce specific payment behavior based on aggregate international comparisons.

instruments or have shown adoption rates by demographic cohort.[12] Most of these studies used data from the Federal Reserve Board's Surveys of Consumer Finances (SCF), and many found strong effects of demographic characteristics on the adoption of payments. However, the SCF has very limited information on the *use* of payment instruments, the characteristics of those instruments, or consumers' attitudes regarding the instruments. Rysman (2007) and Fusaro (2008) used detailed proprietary data to explore consumer payment behavior but also lacked data on payment characteristics and consumer attitudes.

The empirical results in the literature show that both socio-demographic attributes and payment instrument characteristics affect consumer payment behavior.[13] Although demographic attributes have been found to influence consumer payment behavior, heterogeneity across consumers within narrow demographic groups can be much greater than heterogeneity across the demographic groups (see Benton, Blair, Crowe, and Schuh 2007), and most of the cross-sectional variation in consumer payment use remains unexplained. Therefore, including the characteristics of the payment instruments and consumers' perceptions of these instruments may explain much of consumer payment behavior. And if consumer demographics are correlated with payment characteristics, including the characteristics as explanatory variables may reduce or alter the influence of demographic variables.

Prior research in more limited settings has examined the effect on payment behavior of payment characteristics and consumer attitudes.[14] Hayashi and Klee (2003), Anguelov, Hilgert, and Hogarth (2004), and Kim, Yilmazer, and Widdows (2005) used very limited measures of experience with technology. Even the papers that include a broader set of payment characteristics or consumers' attitudes towards payments in the estimation of payment behavior

[12] Stavins (2001), Mester (2003, 2006), Anguelov et al. (2004), Bertaut and Haliassos (2005), Kim, Yilmazer, and Widdows (2005), Klee (2006), and Zinman (2009).

[13] We wish to distinguish payment instrument characteristics, which are more objective and measurable, from consumers' perceptions or attitudes, which are more subjective, emotional, and less well measured. Much of the literature relies on perceptions and attitudes. Our characteristics (cost, convenience, safety, privacy, accuracy, timing, and record keeping) are self-reported assessments but reasonably objective and measurable, except perhaps for convenience. We assume that consumers can assess characteristics accurately, and that characteristics are heterogeneous across consumers for rational reasons. However, future research should clarify the distinction between characteristics and perceptions/attitudes.

[14] See Appendix Table 1 for a comparison of papers that used payment instrument characteristics to model consumer payment behavior.

have limited data—a small subset of payment instruments or a single venue. Some focus on a single payment instrument (Borzekowski and Kiser 2007, Borzekowski, Kiser, and Ahmed 2008, Mantel 2000) or a single venue (Carow and Staten 1999, Klee 2008). Klee (2008) used real transaction data to estimate the effect of transaction time on the choice between check and debit at checkout, but lack of data on the intensity of use or demographic information for individual consumers precluded analysis separating the effect of payment characteristics from the effect of demographic or income variables. Ching and Hayashi (2008) showed the importance of consumers' perceptions in payment behavior, but the only measure of use in the paper was each consumer's preferred payment instrument, and no estimation of either the extensive or intensive margins of payment use was included. Jonker (2005) found that perceptions are correlated with payment behavior, but did not explore their effect on payment adoption or use.

A primary advantage of our data source is that it contains information on each consumer's decision to adopt (extensive margin) and use (intensive margin) nearly all common payment instruments (seven). Therefore, we can simultaneously model these two decisions at the individual consumer level and control for selection effects. The only other papers that employ the Heckman (1976) two-step procedure in the context of payments— Attanasio, Guiso, and Jappelli (2002) and Lippi and Secchi (2008)—lack data on payment characteristics and are limited to the demand for one payment instrument (currency) only.[15]

3. Models of Payment Demand

This section describes the models of payment demand and the econometric issues associated with them. First, we provide some theoretical intuition to motivate the reduced-form approach to deriving demand equations for payment instruments. Next we summarize the Heckman (1976) selection model used to characterize consumers' joint decisions to adopt and use payment instruments, and the qualitative model of change in payment use. The remainder

[15] Another way to estimate a two-step process is by using the Dubin-McFadden (1984) framework, where the first stage is the selection of a payment instrument estimated using multinomal logit, and the second stage is the volume or share of transactions performed using that instrument, as applied in Klee (2008). However, in the Dubin-McFadden model, a consumer would have to select one payment option only, whereas in our model, consumers can adopt any number of available payment instruments.

of this section describes the payment instrument characteristics and our instrumental variables estimation to control for potential endogeneity of the characteristics.

3.1. Intuition from Monetary Theory

The comprehensive scope of the Survey of Consumer Payment Choice permits estimation of demand models of seven common U.S. payment instruments: cash (CS), paper check (CK); debit card (DC); credit card (CC); stored-value card (SVC); automated clearing house payments (ACH); and online banking (OB).[16] Following the literature, we appeal to intuition from models of money demand for guidance on specifying reduced-form models of the demand for payment instruments and combine them with the insights of the applied payments literature summarized earlier.

To begin, consider the relation of the payment instruments to the definitions of money.[17] The classic simple definition of money is $M1 = CS + DD$, where DD denotes demand deposits held at depository institutions.[18] Thus, cash is money by definition. The dollar value stored on a stored-value card is essentially a form of electronic cash for consumers (although it is likely held in a business demand deposit account), and thus it is reasonably classified as cash from the perspective of consumers.

Although demand deposits are money, the payment instruments used to access the deposits—checks, debit cards, and the two electronic payments (ACH and OB)—are not. Rather, these instruments are probably better viewed as technologies that provide access to money (demand deposits). It is well known that credit cards are not money. However, about 55 percent of all consumers who have a credit card use it primarily for payments and do not carry over (or "revolve") unpaid credit card debt across months.[19] Thus, nonrevolvers

[16] Although data are available on the adoption and use of money orders, data on the characteristics of money orders are not available. Therefore, money orders are omitted from the analysis.

[17] Another way to classify payment instruments is by physical characteristic: Paper (CS, CK); cards (DC, CC, SVC); and electronics (ACH, OB). For more details, see Schuh (2009).

[18] The actual definition of $M1$ includes currency, traveler's checks, demand deposits (held by consumers and businesses), other checkable deposits, and super NOW accounts held at commercial banks and thrifts.

[19] This result is from the 2004 Survey of Consumer Finances. For more details, see Sprenger and Stavins (2008).

essentially use their credit cards as a modified debit card with up to 30 days of free float. To summarize, two payment instruments (CS and SVC) are money, while the remaining five are technologies that provide access to money (demand deposits) and facilitate monetary exchange.

The literature lacks a fully specified, structural theoretical model of the simultaneous demand for all seven types of payment instruments we consider, but studies with multiple payment instruments provide some guidance. General models of demand for multiple monetary assets are found in Barnett, Fisher, and Serletis (1992) and Rotemberg, Driscoll, and Poterba (1995), but these abstract from the specific details of payment instruments. Most theoretical models focus on the choice of allocating resources between the two main monetary assets, cash and demand deposits, with some degree of specificity about the type of demand deposit access. Examples include Whitesell (1989), which examines the role of transaction costs with "debitable accounts," and He, Huang, and Wright (2006), which examines the role of safety (from theft) with checks.

In each case, these theoretical models introduce money into the consumers' optimization problem either directly through the utility function (money-in-utility, or MIU) or through the budget constraint (cash-in-advance, or CIA). Monetary assets are distinguished by differential rates of return (costs of capital) or by differential characteristics (physical or other). The demand for monetary assets is derived in the usual fashion and depends on monetary rates of return, consumer income, and monetary characteristics, which are assumed to yield utility either directly (MIU) or indirectly (CIA).

3.2. Adoption and Use of Payment Instruments

The standard continuous MIU or CIA model abstracts from a discrete practical decision that typically is included in the empirical literature on payment choice. Consumers must first decide whether or not to incur a fixed cost to adopt a payment instrument (the extensive margin) before they can actually use it. Exceptions are the standard Baumol-Tobin money demand model, which finds the optimal policy of cash withdrawal, and Duca and Whitesell (1995), which estimates a reduced-form model of cash demand and credit card adoption.

We estimate models with a two-step payment choice for each payment instrument, modified to include the determinants of money demand. The first step is adoption of the payment instrument, as defined by the discrete binary variable,

$$A_{ijt} \equiv \begin{cases} 1 & \text{if consumer } i \text{ has adopted payment instrument } j \text{ in period } t \\ 0 & \text{otherwise,} \end{cases}$$

where $j = \{CS, CK, DC, CC, ACH, OB, SVC\}$. Thus, the first stage of the model is a probit regression that characterizes the consumer's probability of adopting the payment instrument.

Once a consumer adopts a payment instrument, the second step is to decide how often (intensively) to use it to pay for their purchases. Use (intensity) is the absolute number of payments, n_{ijt}, made by consumer i using instrument j during period t. Empirically, payment instrument use is measured by respondents' answers to the survey question, *"About how many payments do you make in a typical month with* [Payment Instrument j]*?"* To minimize the effects of potential reporting error by respondents, we define use as the share of a consumer's monthly payments,

$$U_{ijt} \equiv \left(\frac{n_{ijt}}{N_{it}} \right),$$

where $N_{it} \equiv \sum_j n_{ijt}$ is the total number of payments made by consumer i in a typical month using all of his or her payment instruments.[20] Thus, the second stage of the model is an OLS regression that fits the share of payment instrument use in a typical month (see Section 3.4 for details on the estimation of the Heckman selection model).

Schuh (2008) highlights two features of the microeconomic data on consumer payment choice that are important for the econometric models in this paper. First, payment use is measured only for instruments used in a "*typical month*," and most consumers do not use all of their adopted payment instruments in a typical month. The survey data indicate whether a consumer used each of the adopted payments instruments during the past five years, but no

[20] This decision assumes that the relative number of payments is reported accurately. If respondents have a systematic bias in their payment use reporting across all instruments, such as undercounting due to memory loss, then the share of total payments may still provide an accurate estimate of relative payment use.

data are available on the intensity of use during the past five years. Thus, we do not model the margin between typical and nontypical use.

The second important microeconomic fact is that consumers are very heterogeneous in terms of their adoption of payment instruments. The median consumer has adopted approximately four of the seven instruments measured in the survey data. Because we model the *share* of payment use, it is crucial to adjust the econometric models of payment use for J_{it}, the number of payment instruments adopted by consumer i at time t. For example, a consumer who has adopted only two payment instruments is expected to have a larger average payment share (50 percent) than a consumer who has adopted all seven payment instruments (14 percent). We assume that when consumers choose a payment instrument in period t, their adopted instruments are predetermined and J_{it} is a valid independent variable.[21]

3.3. Change in Use Estimation

Some retrospective questions in the survey data permit us to specify qualitative models of the *change* in the use of payment instruments. Change in use for each payment instrument is defined as the discrete variable

$$CU_{ijt} \equiv \begin{cases} 1 & \text{if use increased} \\ 0 & \text{if use stayed the same} \\ -1 & \text{if use decreased} \end{cases}$$

Empirically, change in use is measured from 2003 to 2006 by respondents' answers to the survey question, *"For each of the payment methods that you use, indicate whether your use of each method has increased, decreased, or stayed the same over the past THREE years."* The change in payment use model is a proportional-odds, ordered logit regression that characterizes the consumers' probability of being in a higher change-in-use category.

[21] Of course, at some horizon this assumption is not true, and a consumer may decide to adopt a new payment instrument simultaneously with, or even in advance of, making the payment (especially in the case of credit cards). However, we believe this assumption is reasonable in most cases.

3.4. Heckman Selection Model and Estimation

Estimating the consumer's adoption and use decisions as independent events can lead to sample selection problems because the only consumers who use a payment instrument are those who have adopted it first. To correct for potential sample selection problems, we estimate models for A_{ijt} and U_{ijt} simultaneously, using the two-step Heckman (1976) procedure known as "Heckit."[22] The Heckit procedure allows a different set of explanatory variables to predict the binary choice (adoption) from those that predict the continuous choice (use); this procedure is appropriate in the presence of sample selection bias and heteroscedasticity. Heckit estimation is an improvement over the standard Tobit estimation, where the two sets of explanatory variables are constrained to be the same. To our knowledge, we are the first to estimate a Heckman selection model applied to payment choice.

Absent a deep theory of simultaneous consumer choice of payment adoption and use, we estimate the broadest possible reduced-form models to allow the data to identify the most empirically relevant factors and to inform future theoretical development. Table 2 lists and describes all of the explanatory variables used in the regression models.

One advantage of the SCPC data is $CHAR_{ijt}$, a unique set of consumer-specific assessments of seven fundamental characteristics of each payment instrument: cost or fees, convenience, safety, privacy, accuracy, payment timing, and record keeping. Consumers assess the absolute values of the characteristics on scale of 1 to 10 for each payment instrument. In principle, the characteristic assessments may vary widely across consumers because of heterogeneity in payment instruments, consumer demographics, and consumer preferences; the next section demonstrates the extent of this heterogeneity. Due to limitations in the survey design, the characteristics data are available only for consumers who had adopted the payment instrument ("adopters") and thus can be included only in the U_{ijt} models.[23]

Because the U_{ijt} models form a system of demand equations in which consumers choose among seven payment instruments, we use log relative characteristics as explanatory variables,

[22] For details, see Greene (1997) or Wooldridge (2002).

[23] The 2008 Survey of Consumer Payment Choice remedies this survey design flaw.

$$RCHAR_{kit}(j, j') \equiv \log\left(\frac{CHAR_{kijt}}{CHAR_{kij't}}\right),$$

where k indexes the seven characteristics. This transformation puts the relative characteristics into units similar to the payment use shares and facilitates the interpretation of their marginal effects on use. In principle, all 42 relative characteristics (7 characteristics × 6 instruments[24]) could influence a consumer's choice for any payment instrument. However, because $1 \leq J_{it} \leq 7$ and $CHAR_{kijt}$ are missing for all payment instruments that a consumer has not adopted, including all 42 relative characteristics yields too many missing values and reduces the sample size too much. Instead, we construct the average relative characteristic for each payment characteristic,

$$\overline{RCHAR}_{kit}(j) \equiv \frac{1}{J_{it}} \sum_{j' \neq j} RCHAR_{kit}(j, j'),$$

over all payment instruments adopted by consumer i. For example, $\overline{RCHAR}$ for cost in the check use equation is the average of the log ratios of check cost to the cost of each of the other payment instruments adopted by the consumer. Ideally, $\overline{RCHAR}$ would be constructed by weighting each relative characteristic by the relevant instrument use to account for variation in use across the consumer's payment instruments. However, such weighting would put the dependent variable on the right-hand-side of the regression models, so we do not weight.

In addition to the payment characteristics variables, the empirical literature on payment choice emphasizes the importance of demographic variables, DEM_{it}. The data include a relatively comprehensive set of consumer demographics: age, gender, race, education, marital status, and household composition. The monetary theory literature emphasizes the importance of the determinants of money demand, Y_{it}. The data include several determinants of consumer demand for money and payments: income, checking account interest, labor force status, and financial responsibility in the household. We include DEM_{it} and Y_{it} in both adoption and use regressions.

[24] There are 7 payment instruments, or 6 *other* instruments for each of them.

In standard monetary models, money and its determinants (primarily income and interest rates) are endogenously determined, so one might argue that we need to account for potential simultaneity bias in the payment demand models. Although the aggregate stock of money held by a consumer may be endogenous, it seems unlikely that the consumer's particular choice of payment instrument adoption or use influences his/her income or wealth, so we take income as exogenous to payment choice. However, a stronger case for simultaneity can be made with regard to the checking account interest rate, INT_{it}, and the adoption of payment instruments, especially those linked closely to the checking account (check, debit card, ABP, etc.).[25] For this reason, we define $Y_{it}^{A} \equiv \{INC_{it}, LFS_{it}, FR_{it}\}$, excluding INT_{it}, for the A_{ijt} models.

Assuming by revealed preference that consumers actually use each payment instrument they adopt, the share of payment use generally will be negatively related to the number of adopted payment instruments. For example, a consumer who has adopted only two payment instruments is expected to have a larger average payment share (50 percent) than a consumer who has adopted all seven payment instruments (14 percent). However, the average payment share likely is related to the particular combination of instruments adopted. In particular, four of the instruments are technologies for accessing a demand deposit account (CK, DC, ABP, and OB). The newer vintage technologies may complement or substitute for the older technology (check), so the actual effect of adopting an additional payment instrument on payment share could be zero or negative. Similar considerations apply to the other three payment instruments.

To control for heterogeneity in consumer-specific adoption of payment instruments, we take an approach similar to a fixed effect in panel data. The *complementary* number of instruments, $\tilde{J}_{ijt} = \sum_{j' \neq j} A_{ij't}$, is the number of adopted payment instruments *excluding* instrument j (thus $\tilde{J}_{ijt} \in [0,6]$) and denoted by a tilde. By assumption, in the two-step selection model, consumers adopt payment instruments prior to their decisions to use the instruments, so $\tilde{J}_{ijt}$ is predetermined, thus a valid independent variable in the share equation

[25] This argument likely does not hold for the use of payment instruments that have already been adopted because use likely has little or no influence on whether a checking account pays interest.

for instrument j.[26] Nevertheless, we instead use $\tilde{J}_{ijt}$ to create a set of dummy variables for the number of other adopted payment instruments to avoid any potential remaining concerns about simultaneity:

$$NUM_{kijt} = \begin{cases} 1 \text{ if consumer } i \text{ has adopted } k \text{ payment instruments besides } j \\ 0 \text{ otherwise} \end{cases},$$

where $k = 0, \ldots, 6$ and NUM_{3ijt} is omitted. These dummies essentially allow for estimation of a group-specific average payment share.

The final group of explanatory variables, $MISC_{it}$, includes the intensity of Internet use, NET_{it}, which may signal experience with electronic and information technology and could contribute to consumers' decisions to adopt payment instruments. In the case of online banking, however, the payment instrument itself is, by definition, Internet use. For this reason, we exclude NET_{it} from the A_{ijt} model for online banking and from all of the U_{ijt} models.[27]

Summarizing these reduced-form model specification arguments, the Heckman selection model of adoption and use for payment instrument j can be written as:

$$\Pr\left(A_{ijt} = 1\right) = A(DEM_{it}, Y_{it}^{A}, NET_{it}) + \varepsilon_{ijt}^{A} \quad (1)$$

$$U_{ijt} = U(\overline{RCHAR}_{ijt}, DEM_{it}, Y_{it}, NUM_{0ijt} \ldots NUM_{6ijt}, MR_{it}^{-1}) + \varepsilon_{ijt}^{U} \quad (2)$$

[26] Of course, at some horizon this assumption is not true and a consumer may decide to adopt a new payment instrument simultaneously with, or even in advance of, making the payment (especially in the case of credit cards). However, we believe this assumption is reasonable in most cases at the moment of the use decision. Omitting own adoption, A_{ijt}, from $\tilde{J}_{ijt}$ in the share equation for instrument j is necessary to preserve the distinction between adoption and use in the two-step selection model.

[27] Internet use exhibits the problem of simultaneity (by definition) for the online banking use model and hence is excluded from that model. Because the other use models are based on shares of payment instrument use, endogeneity of Internet use may be a problem for the other models as well. However, we estimated all the adoption models without the Internet use variable, and all of the econometric results were robust to its exclusion.

where MR_{it}^{-1} is the inverse Mills Ratio generated from the first-stage Heckman probit model that controls for the simultaneity of the payment adoption decision in the payment use decision. We estimate this model for each of the seven payment instruments.[28]

3.5. Econometric Issues with Payment Characteristics

In theory, using payment characteristics to explain the demand for payment instruments is valid provided the characteristics satisfy two criteria: (1) they are exogenous; and (2) they are objective and measurable. In practice, however, the reported characteristics may not satisfy these conditions. This section discusses these potential difficulties and our proposed econometric solution to them.

One way to think about the characteristics failing to satisfy these two criteria is in terms of a linearly additive errors-in-variables framework,

$$CHAR_{ijt} = C_{ijt}^{*} + \eta_{ijt} \ , \qquad (3)$$

where C_{ijt}^{*} represents the true (objective) consumer-specific characteristic for payment instrument j, and η_{ijt} is an error or deviation from that true value. As long as $\text{Corr}\left(CHAR_{ijt}, C_{ijt}^{*}\right) > 0$, a condition we assume to be true, then the reported characteristics should provide at least some empirically valid information about their role in consumer payment choice. One reason the payment characteristics offer so much promise as an explanatory variable is that they are consumer and instrument-specific. For example, two consumers may have different assessments of the cost of a credit card relative to a check because of factual differences in their idiosyncratic choices of the fees, interest rates, and rewards associated with each of these payment instruments. However, one could reasonably argue that each of these cost factors is chosen endogenously by the consumer, certainly at the time of adoption but perhaps also simultaneously with the payment use decision because certain types of use decisions also influence the cost of the payment instrument. Similar arguments can be made for the other characteristics.

[28] We can estimate our system of payment use models independently because use is the share of all payments (shares sum to 1.0) and the explanatory variables are the same across models (see Theil 1971).

If $CHAR_{ijt} \neq C^*_{ijt}$, which may well be true, then the explanatory variables contain an error, η_{ijt}. To some extent, each payment characteristic is objective and potentially measurable. The cost (which is essentially a price), the timing of the deduction from a bank account, the accuracy of the transaction, and record keeping features are probably the most objective. At the other end of the spectrum is convenience, a term that is used often but is imprecise. Some aspects of convenience may be objective—such as the speed, physical dimensions, and acceptability of the payment instrument—but these concepts are jumbled together in this catchall characteristic and it is easy to imagine consumers forming subjective perceptions of convenience. Safety and privacy likely are related to probabilities of theft and the associated losses of money and information, both of which are relatively objective.

However, even if the characteristics are objective in principle, they can be very difficult to measure, even for the most educated payments expert. We can think of at least three types of errors that might arise in consumers' assessments of payment characteristics:

$$\eta_{ijt} = \eta^I_{ijt} + \eta^M_{ijt} + \eta^P_{ijt} \ . \qquad (4)$$

The first potential error is associated with limited information (superscript I). Limited-information errors may arise because the consumer's information set does not contain all relevant information—for example, a consumer may not know all the fees charged for a payment instrument or may be unaware of the risks associated with identity theft. A second potential error is classic measurement error (superscript M), which may arise simply because data collected on the characteristics may be incomplete, biased, or noisy, for example. Finally, a third potential error is subjective perceptions (superscript P), which may arise from behavioral effects of decisionmaking, irrational fears, advertising, or other psychological and emotional factors. However, we do not attempt to identify the separate components of η_{ijt} individually.

3.6. IV Estimation

As we stated above, the U_{ijt} models may be subject to simultaneity bias because C^*_{ijt} is endogenous or to errors-in-variables due to the presence of η_{ijt}. A traditional correction for both of these potential econometric problems is instrumental variables (IV) estimation, which

we explore with the U_{ijt} model for checks. To obtain instruments, we identified a set of 11 variables defined from questions in the 2006 SCPC data set. We selected only variables that seemed likely to be relevant (that is, correlated with the payment characteristics)—for example, types of bills paid, Internet access, and returned checks experience. Also, we selected only variables that were predetermined with regard to the payment use decision, thus exogenous (at least theoretically) and valid. We estimated three different IV models with three sets of instruments—we label them "large" (a full set of 11 instruments), "medium" (a subset of 8 instruments that are more likely to be exogenous) and "small" (the smallest subset of 4 instruments most likely to be exogenous). In addition, some of the demographic variables were used as instruments in each set. See Appendix Table 2 for the list of instruments.

4. Consumer Payments Data

This section describes the data and some basic facts about consumer payment choice. We first describe the 2006 Survey of Consumer Payment Choice. Then we summarize the evidence on adoption and use of payment instruments by major consumer demographic characteristics, as well as the data on characteristics of payment instruments.

4.1. The Survey of Consumer Payment Choice Program

Our data come from the 2006 Survey of Consumer Payment Choice (SCPC). The SCPC is an ongoing research program initiated by the Federal Reserve Bank of Boston in 2003 designed to produce publicly available, nationally representative data on consumer payment choices. Pilot surveys were conducted with convenience samples of Federal Reserve employees from Boston (2003) and the entire System (2004) and are described in Benton, Blair, Crowe, and Schuh (2007). In 2006, the AARP and the Boston Fed developed a revised SCPC, which the AARP conducted with a random sample of adult U.S. consumers aged 25 and up (not just AARP members). For more details of the 2006 SCPC, see AARP (2007) and Schuh (2009).

The SCPC program is motivated by the payments transformation and is designed to gain a better understanding of the main determinants of demand for payment instruments by U.S. consumers. Each survey thus far contains questions pertaining to three main goals. First,

the SCPC asks questions about the adoption and use of a wide range of payment instruments to gain breadth of understanding about the consumer payment decision. Second, the SCPC asks questions about both actions and attitudes to provide a better understanding of consumers' perspectives on their payment choices. And third, the SCPC contains a variety of additional questions that probe consumers' experience and reasoning behind payment decisions to help researchers gain a better understanding of why consumers make their payment choice.

4.2. The 2006 SCPC

The 2006 SCPC is a revised and slightly longer version of earlier surveys. It contains 69 questions with the following components:

- *Adoption and use*—The central part of the survey elicits information about whether respondents have the payment instruments (adoption) and how often respondents use them. The survey also asks questions about the following aspects of payment use:
    - Change in the use of payments over the past three years
    - The types of payment use by location (retail shopping versus the Internet), by types of bill payments, and by dollar amounts.
- *Reasons for payment behavior*—The survey asks direct questions about the respondents' adoption and use decisions. These include:
    - Why they have not adopted payment instruments ("barriers")
    - What changes would lead them to change their adoption and use
    - How they responded to particular payment choices and why.
- *Respondent assessments of their payment characteristics*—The survey elicits information about how respondents rate the fundamental characteristics of payment instruments.
- *Respondent characteristics*—The survey includes questions about the characteristics of respondents, such as demographic information, income and wealth, financial sophistication and experience, and other relevant factors.
- *Miscellaneous payment attitudes and experiences*—The remainder of the survey includes various questions about respondents' views about payment instruments and what their

experiences have been (or have not been) when using them, especially particular aspects of checks, such as conversion of checks to electronic forms by banks, stores, and billers.

Relative to earlier versions, the 2006 SCPC survey made several improvements. Most importantly, it surveyed U.S. consumers rather than Federal Reserve employees. Also, it includes questions about cash, an instrument that was excluded from the 2003–2004 surveys. The survey also contains more variables, including a greatly expanded number of demographic variables, and it provides a more balanced treatment of payment instruments, whereas the 2003–2004 surveys focused mainly on checks. Finally, the SCPC survey corrected a number of the methodological problems in earlier surveys.

The 2006 SCPC was sponsored by the AARP with the assistance of the Boston Fed and was administered as a voluntary telephone survey by a private survey firm. The sample of 1,500 was drawn using standard list-assisted Random Digit Dialing (RDD), or Weighted (Type B) RDD, which screens out business and other non-household telephone numbers. Sample weights for four demographic characteristics (race, education, age-gender jointly) are available and, when applied to the data, help make the survey responses *ex post* consistent with U.S. Census population statistics. However, the 2006 SCPC sample has two limitations relative to previous versions: (1) it excludes respondents under the age of 25; and (2) it includes only respondents who have or share most of the financial responsibility in their household.

4.3. Payment Instrument Adoption and Use

Despite significant changes during the paper-to-electronics transformation, traditional payment instruments are still the most widely held. Appendix Figure 1 shows that checking account adoption[29] is about 90 percent and credit card adoption is about 75 percent. In contrast, adoption rates of the newer payment instruments are still generally below 50 percent, although use (and therefore adoption) of these instruments is rising as noted earlier (Figure 2). The adoption rate of debit cards is approaching that of credit cards.

[29] The Survey of Consumer Finances does not have data on check adoption other than the checking account question. The 2006 SCPC shows a check adoption rate of 87 percent. A check adopter has a checking account and has used a check in the last five years.

Table 3 reports the rates of adoption of the seven payment instruments in this study. The first row contains estimates for all U.S. consumers.[30] Despite significant changes during the payments transformation, traditional payment instruments were still the most widely held by consumers in 2006: cash adoption (consumers who report having used cash during the past five years) was 95 percent; check adoption 87 percent, and credit card adoption 74 percent. Debit card adoption was 62 percent, but fewer than half of all consumers had adopted the other new payment instruments. Adoption rates of debit and credit cards are becoming very similar. Because these cards share many similar payment characteristics but have very different financial characteristics, differences in adoption and use patterns of the two payment cards across consumers offer an interesting study in consumer behavior (Zinman 2009, Fusaro 2008).

The remainder of Table 3 provides details of payment adoption rates by consumer demographics. Adoption rates generally are correlated with most consumer demographic characteristics, especially age, education, and income. Adoption of newer electronic payment instruments, especially debit cards and online banking, tends to decline with age, but adoption of traditional payment instruments does not exhibit large age effects.[31] Adoption of most payment instruments tends to rise with education and income. Adoption rates by marital status and race show many potentially interesting differences. Gender differences in adoption rates are relatively small, except for online banking (male higher) and stored value cards (female higher). More detailed information on the number of payments made with each payment instrument can be found in Appendix Figure 2.

Table 4 reports the average shares of use (as percentages) of the seven payment instruments in this study. Shares are calculated at the individual level for payment adopters

[30] The 2006 SCPC aggregate data compare favorably with the estimated rates of adoption from the Federal Reserve's 2004 Survey of Consumer Finances. See Appendix Figure 1 for more details.

[31] The 2006 SCPC distinguishes between online bill payments made from a bank's website and online bill payments made from a payee's website. Online bill payments made at a payee's website—such as a utility company or an insurance provider—are frequently deducted from a bank account in a manner similar to the way payments made on the bank's website are deducted, but they can also be charged to a credit or debit card. Because we cannot distinguish among the various ways the payments are made online, we limit the category to the bills paid at a bank website. The results showed no significant differences between the two categories of online bill payments, although the online banking adoption and share numbers are lower as a result.

only, using the number of typical monthly payments as the denominator. The shares thus sum to 100 for each consumer, regardless of the number of payment instruments held by the consumer. The shares are not weighted by the total number of payments per month per consumer, so they reflect the means of the dependent variables in our cross-sectional econometric models of use. Traditional paper methods, checks (38 percent) and cash (30 percent), have the highest average shares of payment use. The average share of debit cards (24 percent) is the highest share among newer payment instruments—about twice as large as the credit card share (13 percent).

Payment instrument use is often correlated with consumer demographics, even among instruments for which adoption is fairly uniform across demographic cohorts. Check use is rising in age, and declining in education and income. Check use also varies widely by race and marital status. Cash use does not exhibit any clear demographic effect except for decline in income, mainly at the very lowest (high use) and highest (low use) income categories. Debit card use is declining in age, but other demographic variation is not strong. Credit card use rises in age, education, and income, and varies widely by race. Use of ABP declines with education, but use of online banking does not show large demographic effects; thus consumers' choices concerning the use of these instruments differ from consumers' choices concerning their adoption. An important issue for the econometric models is to determine the extent to which correlation between consumer demographics and payment choice remains statistically and economically significant when the payment characteristics are included.

4.4. Payment Characteristics

Table 5 provides information about the payment characteristics. The top panel of Table 5 reports averages of the absolute ratings (10-point scale) of the 49 instrument characteristics by adopters of payment instruments. These absolute characteristics are used to form the relative characteristics used in the payment-use econometric models.[32] The bottom panel of Table 5

[32] As indicated earlier, payment instrument characteristics data are available only for adopters because the 2006 SCPC did not ask nonadopters to rate these characteristics. The original rationale for this survey design choice was that nonadopters are unlikely to be familiar enough with a payment instrument to provide meaningful and accurate ratings of the characteristics embodied in it. However, this rationale is

reports averages of the log relative characteristic ratings (relative to the relevant check characteristic). Thus, table entries represent the differences between the characteristic for a particular instrument and the same characteristic for checks (positive values indicate that the instrument is better than checks, negative values indicate worse than checks). These relative ratings are used to construct the average relative characteristics used in the econometric models.

The first notable conclusion from the top panel of Table 5 is that the average of all payment instrument characteristics is 7.9.[33] On this absolute scale, consumers rate checks about average (7.8). For record keeping, checks are rated highest (8.9, tied with online banking), a result that accords with the view that U.S. consumers who love checks seem to like the ability to keep careful records of spending and account balances with them. But checks are rated relatively low in cost (7.3) and especially privacy (6.7). Consumers rate cash as the worst overall (7.2) and worst in five characteristics: convenience, safety, accuracy, timing, and record keeping. ABP is rated most favorably overall (8.6) and rated highest (or tied for highest) in five characteristics: cost, convenience, safety, accuracy, and timing. Online banking is also rated high (8.5).

The relative scales in the bottom panel of Table 5 show that other payment characteristics are only about 3 percent better on average than check characteristics. Across all characteristics (last column), consumers rate checks better than cash by 18 percent, credit cards by 9 percent, and stored value cards by 2 percent. But consumers rate checks worse than online banking by 23 percent, ABP by 14 percent, and debit cards by 8 percent—the three most likely substitutes for checks. Across all instruments, consumers rate checks as best in record keeping by 29 percent, with slight advantages in safety (4 percent) and accuracy (5 percent). But

faulty. Even nonadopters have assessments of the payment characteristics and those assessments—no matter their accuracy—almost surely influence the payment choice, or nonchoice, of consumers. Beginning in 2008 the SCPC solicits assessments of payment characteristics from all respondents.

[33] This average is well above the numeric average of 5.5 on a 10-point scale. This result may suggest that each of the payment instruments is literally "above average." But it may reflect the lack of an "anchor," or relative value, in the survey design against which respondents could judge the payment instrument characteristics. In contrast, the 2003 and 2004 SCPC explicitly asked respondents to assess the characteristics of each noncheck payment instrument relative to the same characteristic of checks.

consumers rate checks worse than other instruments in privacy (21 percent), convenience (16 percent), timing (13 percent), and cost (5 percent).

5. Econometric Results

This section reports and describes the regression results for the two-stage Heckman selection models of the adoption and use of each payment instrument, and the ordered logit models of the change in use of payment instruments. Categories of the DEM_{it} and Y_{it} variables are converted to binary dummy variables and included separately. One category from each type of explanatory variable is omitted from the regression. This control group represents the baseline of the relative results of all other groups.

5.1. Adoption Models

5.1.1. General Results

Table 6 reports probit regression results of the first-stage adoption models for seven payment instruments (all consumers, excluding missing data observations). In general, the effects of the demographic variables in the adoption models are qualitatively consistent with the simple correlations observed in the data as reported in Table 3. However, once the adoption models control for all of the explanatory variables simultaneously, few of the variables are statistically significant. The most statistically significant determinants of adoption are age, income, and race; education is much less often significant. The intensity of Internet use has a very significant positive effect on adoption of all payment instruments except cash,[34] but the degree of financial responsibility in the household is not significant—perhaps because consumers who have little responsibility are dropped from the survey. The pseudo R^2 of the models runs from 0.09 to 0.32.

[34] Kim, Yilmazer, and Widdows (2006) obtain qualitatively similar results for the adoption of Internet banking.

5.1.2. Check Adoption

The check adoption model explains a higher proportion of the adoption probability than any other payment instrument (pseudo R^2 of 0.32). Consumers who have very low income or education, who are black, and who are not employed all have significantly lower probabilities of adopting checks for payment. The probability of adopting checks rises with income. Otherwise, there are no systematic demographic effects on check adoption.

5.1.3. Other Instrument Adoption

The determinants of the probability of adopting payment instruments other than checks vary widely across instruments. For example, cash, a traditional alternative to checks, is more likely to be adopted by consumers who have the highest education level or are single, or are in the second-highest income bracket. Note, however, that the cash adoption results may be somewhat less reliable because adoption is measured from observed use (in a typical month or the past five years), and cash adoption may be universal but not reported in the survey.

Consumers who adopt the two main card alternatives to checks—credit cards and debit cards—also exhibit notable differences. The most significant difference is the effect of age on adoption, which is positive for credit cards but negative for debit cards, and highly statistically significant in both cases. Respondents over 65 years old are 18 percent more likely to adopt credit cards and 35 percent less likely to adopt debit cards than members of the control cohort of 35–44 year olds. The effect of income on adoption is positive for both cards, but quantitatively more important for credit cards: respondents in the lowest income group are 45 percent less likely to adopt credit cards than those in the control group. Several of the effects of race and gender are significant for credit cards but not for debit cards, and education appears to have no effect on the adoption of either type of card. Interestingly, consumers with more financial responsibility are less likely than other respondents to adopt a debit card (the only case in which financial responsibility is significant). Overall, the model explains credit card adoption better than debit card adoption (pseudo R^2 of 0.30 versus 0.16).

Consumers who adopt the two main electronic alternatives to checks—ABP and online banking—are generally quite similar. The adoption of these electronic instruments is declining

in age, although the age effect is stronger and more significant for online banking, where respondents in the oldest cohort are 14 percent less likely to adopt online banking than the control group, compared with a statistically insignificant difference of 6 percent for ABP. The effect of income on the adoption of both instruments is rising and significant, again larger for online banking (respondents in the highest income group are 16 percent more likely to adopt online banking and 12 percent more likely to adopt ABP than the control group); the education effect also is rising but generally not statistically significant. Retired consumers are more likely to have adopted ABP, perhaps because the payment of retirement income is more likely to occur through direct deposit. The adoption of stored value cards is not explained well by the models (pseudo R^2 of 0.09). Consumers who are male, black, Asian, or retired are less likely to adopt them.

5.2. Use Models

5.2.1. General Results

Table 7 reports OLS regression results of the second-stage use models for seven payment instruments (adopters only). The estimated coefficients, when multiplied by 100, represent the marginal effects of the explanatory variables on the payment shares in percentage points. Coefficients on the relative payment characteristics are expected to be positive—that is, consumers who rate the characteristic of a payment instrument higher (lower) should have higher (lower) use of the instrument.

In general, the results suggest that payment characteristics, along with the number of payment instruments, tend to have larger, more significant effects on instrument use than demographic and income-related variables. Several of the coefficients on the number of other payment instruments are statistically significant, especially in the check use regression. For most payment instruments, at least two payment characteristics are significant; only online banking has no statistically significant characteristics. Among payment characteristics, convenience—which is not well defined—and cost are most important. Although the point estimates continue to suggest some correlation of use with demographic and income-related

variables, the majority of estimates are statistically insignificant. The R^2 statistics also reveal that most of the cross-sectional variation is explained primarily by payment characteristics and the number of instruments adopted. The inverse Mills ratio is significant only for checks and ABP, suggesting that we do not consistently identify selection problems in our econometric models.

5.2.2. Check Use

Two payment characteristics and three other variables have strong influences on the use of checks for payment. Convenience (0.10) and cost (0.03) are economically and statistically significant determinants of check use. Recalling that most consumers rated checks lower than other payment instruments in cost and convenience (see Table 5), these characteristics help to explain why the check share is lower than it would be based on the other explanatory variables alone. Consumers aged 45–54 tend to write more checks (0.08), while lower-income consumers and Latinos, respectively, tend to write more than middle-income (0.05 to 0.07) and non-Latino (0.10) consumers. American Indians write fewer checks (-0.18), although they represent only 1 percent of the sample. Altogether, the model explains nearly one-third of the cross-sectional variation in the use of checks (R^2 of 0.30).

Because check use is strongly affected by the number of instruments a consumer holds that can substitute for checks, this number plays a crucial role in explaining check use. The number of complementary adopted payment instruments is a statistically and economically important cross-sectional determinant of check use. The dummy variable coefficients are deviations from the omitted category, $\tilde{J}_i = 3$ or NUM_{3ij}. Conditional on the other explanatory variables, check adopters with only one other instrument have an average payment share that is .19 higher, and check adopters with six other instruments have a share that is .23 lower, than shares of adopters with three other instruments. As expected, the complementary number of adopted instruments is negatively related to check use for each category. These coefficients exert the largest economic influence on check use in the cross-sectional data, and are highly statistically significant. Altogether, the model explains nearly one-third of the cross-sectional variation in check use (R^2 of .30). Adoption dummies contribute .13 to the cross-section R^2

compared with .06 for the payment characteristics; all other variables combined account for .11.[35]

These results provide a preliminary indication of four possible ways to explain a decline in check use. One possibility is demographic changes—an increase in the shares of young, Latino, or American Indian consumers, but demographics tend to change more slowly than the rapid decline in check use observed recently. Another possibility is an increase in the proportion of poor consumers. Much attention has been given to widening income inequality in the United States in recent years, but the income gap between rich and poor does not necessarily translate into a larger share of poorer consumers. A third possibility is a change in the characteristics (especially cost and convenience) of checks relative to alternative payment instruments. Although these characteristics could change quickly and account for the large decline in check use, there are no complete and consistent time series-data on payment characteristics to test this conjecture. Finally, an increase in the number of alternative payment instruments would have a large, negative effect on check use—provided that consumers adopted the instruments and merchants accepted them for payment. The latter two explanations seem more likely to be consistent with the econometric models and available data, so we explore them in Section 6.

5.2.3. Other Instrument Use

Payment characteristics are particularly important determinants of the use of cash and credit cards. In both cases, payment characteristics explain half or more of the cross-sectional variation in payment use across consumers. Convenience and record keeping (0.06 and 0.04,

[35] We also estimated the use regressions with each of the six other payment method adoption dummies entered separately in each use equation (that is, whether or not the consumer adopted each of the other payment methods). This specification potentially identifies the specific substitute instrument(s) that contribute(s) to the decline in the use share. For checks, the coefficients on all but one of the other adoption variables (credit cards) are negative and significant, and similar in magnitude. Thus, there does not appear to be one particular payment instrument, or group of payment instruments, that is most responsible for the decline in check share via this channel. Results were more mixed for other payment instruments; the coefficients generally were statistically significant but not consistently intuitive. Overall, all other model coefficients are remarkably robust, remaining essentially the same regardless of the particular method used to control for heterogeneity in average payment shares.

respectively) are economically and statistically significant determinants of cash use. For both characteristics, cash is rated lowest and thus these characteristics help to explain the lower shares of cash use relative to other explanatory variables. Consumers who are male (0.04) and those who are most highly educated (0.06) tend to use cash more intensively. Consumers who are black (-0.06) use cash less often. Credit card use is positively influenced by cost, convenience, and timing, but negatively influenced by privacy and accuracy. The latter result is a puzzle and occurs only two other times in the use regressions.[36] The other economically and statistically significant determinants of credit card use are employment status and a particular aspect of education level: consumers who are not employed (0.07) use them more and consumers with the second-lowest education level (-0.04) use them less.

One of the most common substitutions of payment use from checks to another payment instrument has occurred with debit cards. Safety (0.06) and timing (0.08) are economically and statistically significant determinants of debit card use. On average, most consumers view debit cards as having better timing than checks, which explains the result on timing. But they view debit cards as about equally safe as checks, so heterogeneity among consumers in their valuations of the safety of checks versus debit cards likely explains this result. Age effects are strongest for debit cards: the youngest consumers appear to use debit cards much more often (0.05, although this is not quite significant), whereas older consumers use debit cards much less (-.11 for ages 55–64), reflecting a large generation gap in debit card use.[37]

For the electronic payment instruments, ABP and online banking, most of the payment characteristics are not statistically significant. Online banking convenience is economically but not statistically significant (0.11). ABP cost (0.03) is significant at the 10 percent level. Consumers who are Latino (0.07), black (0.12), widowed (0.06), or not employed (0.05) tend to use ABP more often. Consumers with some post-graduate education tend to use ABP less often (-0.05). No demographic or income-related variables are statistically significant for online banking. However, in terms of point estimates, online banking generally appears to be declining in age and rising in income. Convenience (0.09) and record keeping (0.03) are

[36] ABP and SVC each have one significant, negative characteristic coefficient as well.

[37] There are several possible explanations for the large age effect, such as differences in technology preferences, differences in concern about debt, or greater credit constraints on the young.

economically and statistically important determinants of stored value card use. Consumers who have very low education (.22) tend to use stored value cards more often.

Results for the number of complementary instruments adopted are quite significant for most payment instruments. Consumers with fewer than three other instruments have higher shares of cash, credit card, ABP, and SVC use; consumers with more than three other instruments have lower shares of online banking and SVC use. In most cases, the marginal contribution of these dummy variables to R^2 is larger than that of the payment characteristics.

5.3. IV Estimates of Check Use

To correct for the potential problems described in Section 3.4, we re-estimated the model of check use with instrumental variables (2SLS) and report the results in Table 8. We used three sets of instruments in our estimation—large, medium, and small, as described in Appendix Table 2. Noting that demographic variables qualify as valid instruments, we estimated a restricted model using eight of them as additional instruments.[38] The large set of instruments includes the variables that we believe to be exogenous with respect to consumer payment choice. The medium set restricts that list somewhat to eliminate the variables that might be endogenous, and the small set is the most restrictive set of variables that are least likely to be endogenous. Although we believe that all the variables in the large set provide appropriate instruments, we ran all three IV regressions in order to test the robustness of our results. As Table 8 shows, the results of all three models are similar.

The Heckman OLS estimates of the restricted model—without education, gender, or household composition variables—are reported in the first column for comparison, and they do not differ much from those of the full model. Columns 2–4 show the IV results with the large, medium, and small set of instruments, respectively. The last column shows the average values from all three IV regressions. The table includes p-values from the Sargan test for

[38] We excluded education, gender, and household composition variables because they were jointly insignificant in the full model. In separate regressions similar to those in Jonker (2005) but not reported here, we find that the full set of demographic variables have very modest explanatory power for the payment characteristics (cross-section R^2 statistics of about 0.08 or less).

overidentifying restrictions. All of the p-values in Table 8 are greater than 0.1; therefore, the overidentifying restrictions cannot be rejected.

The IV results are relatively encouraging. Although none of the coefficients on the characteristics is statistically significant, most point estimates increase (as expected) by reasonable magnitudes and the over-identifying restrictions cannot be rejected. In particular, note that record keeping—the most positive check characteristic—now becomes nearly as important economically as convenience, which is the most statistically significant characteristic in the OLS estimation. The income effect of checks disappears (statistically) in the IV estimates, but most remaining estimates are quantitatively and qualitatively similar to OLS. Instrumental variable estimates of several coefficients are significant, as they are in the OLS estimates of the restricted model (ages 45–54, Latino, American Indian, and several of the complementary adoption dummies). In addition, the "other" race category becomes statistically significant in two of the three IV specifications.

Although less precise, the IV estimates generally affirm that cost and convenience, as well as record keeping, are more economically important than suggested by the OLS estimates (IV estimates are larger than the OLS estimates). The 2006 SCPC offers a limited number of valid instruments, which generally appear to be relevant and exogenous. The 2008 SCPC data will include many more valid and promising instruments and better econometric options for future research.

5.4. Change-in-Use Models

5.4.1. General Results

Table 9 reports the ordered logit regression results for the models of change in use of the seven payment instruments. The table entries are odds ratios, which reflect the relative probability of being in a higher change-in-use category (increased or same relative to decreased, and increased relative to same or decreased) associated with the explanatory variable. Odds ratios greater than 1.0 indicate a greater probability of being in the higher use category; an odds ratio of 1.5 means that the probability is 50 percent greater. Odds ratios below 1.0 indicate an analogously lower probability of being in the higher use category.

Broadly speaking, the qualitative results for change in use are similar to the results for use. Payment characteristics tend to have larger, more significant effects on the change in use of payment instruments from 2003 to 2006 than demographic and income-related variables, as measured by coefficient estimates and pseudo R^2 values with and without the characteristics. Overall, the change-in-use models do not fit the data nearly as well as the use models (pseudo R^2 values of 0.10 to 0.25), perhaps because we lack changes in the payment characteristics over the same period. The specific payment characteristics that are significant in explaining the change in use of payment instruments generally are similar to the characteristics that are significant in explaining the use of payment instruments (compare Tables 7 and 9), but there are interesting differences between the models as well.

5.4.2. Change in Check Use

Consumers who rated checks relatively high in convenience, privacy, or timing were more likely than other consumers to have increased or held constant their check use from 2003 to 2006. Convenience (2.96) was particularly important: consumers who rated checks high on convenience were substantially more likely than others to have increased their use of checks. However, consumers who rated checks high in record keeping (0.69) were more likely to have decreased or held constant their check use. By itself, this result is a bit puzzling, but it may be partly explained by the importance of record keeping in explaining higher use of ABP and online banking, which together also have good record keeping potential. Older, male, Latino consumers, as well as consumers with dependent children, were 50 to 100 percent more likely to have increased or held constant their check use; less educated consumers were twice as likely. In contrast, consumers who were not employed or American Indian were more likely to have decreased or held constant their check use. Cost, which was an important determinant of check use, was not important in determining the change in check use.

5.4.3. Change in Other Instrument Use

According to Figure 2, a higher percentage of consumers decreased than increased their use of cash and credit cards between 2003 and 2006. Consumer ratings of convenience were

also important for explaining which consumers were more likely to have increased or held constant their cash and credit card use. Cost was also important for changes in credit card use, and record keeping was important for changes in cash use. Consumers with lower education were especially likely to have increased or held constant their cash use, while those not employed were more likely to have decreased or held constant their use of cash. Consumers who were single or retired were more likely to have increased or held constant their credit card use, while those who were black or had lower incomes were more likely to have decreased or held constant their use of credit cards.

Debit card use was more likely to have increased or stayed constant among consumers who liked the safety and especially the timing of debit cards. The youngest consumers were twice as likely as others to have increased or held constant their debit card use as well. Consumers who were male and had lower incomes were more likely to have decreased or held constant their debit card use. Debit card use was about 50 percent more likely to have decreased or held constant for all education groups included in the regression—college degree was the omitted category—a result that seems hard to explain.

Cost was important in explaining higher use of ABP and online banking, while timing and record keeping were important in explaining higher use of ABP. The youngest consumers were more likely to have increased or held constant ABP use, perhaps because they were more likely to have entered the work force and taken advantage of payments through direct deposit of income. But older consumers were more likely to have increased or held constant their use of online banking, perhaps because of increased efforts to help older consumers learn and take advantage of this newer technology. Few other variables were important in explaining changes in the use of ABP or online banking. Record keeping is the only characteristic significant for change in use of stored value cards, which was not explained well by the model.

6. Why Did Check Use Decline?

In this section, we use the econometric model in Table 7 to interpret the actual decline in the U.S. check share from 31.0 percent in 2003 to 22.6 percent in 2006 (a decline of 8.4 percentage

points). We focus on this period because of the availability of reliable data and because some of the payment instruments modeled in our econometric system were not widely used in the mid-1990s when check volumes began to decline. Our estimated decline in actual check share of seven payment instruments is estimated with industry data on the volume of transactions made with the three payment types omitted from the Federal Reserve's studies.[39]

We performed simulations of the model for the three largest and most significant factors affecting check use: the number of payment instruments per consumer, the relative convenience of checks, and the relative cost of checks. The simulations are independent because we did not model the explanatory variables in the check use model. Consequently, the simulated changes in check share do not represent a complete decomposition of the change in aggregate check share and cannot be summed. The results appear in Table 10.

We estimate that the number of payment instruments per consumer increased by 0.25 per consumer.[40] The marginal effect of the number of payments on check share is –0.085, so the increase in payment instruments leads to a change in check share of –0.021 = 0.25 x (–0.085), which amounts to 25 percent of the actual decline in check share and is the largest effect in Table 10. Payment characteristics do not affect check share directly in this simulation, but they most likely have an indirect effect. The increase in the number of payment instruments reflects consumer adoption of newer electronic payment instruments whose relative characteristics influence consumers' decisions to adopt them. However, as explained earlier, the 2006 SCPC data do not permit the inclusion of characteristics in our models of adoption. Therefore, we cannot identify the extent to which characteristics influenced adoption directly, hence check share indirectly.

[39] The Federal Reserve data are from Gerdes (2008). For details on deriving the other data, see Appendix Table 3.

[40] Based on the SCF data for four payment instruments, we estimate that the number of payments increased from 2.91 to 3.14, or 0.23. However, this estimate excludes cash, online banking, and stored value cards. We do not have hard data for adoption of the latter two in 2003, but their adoption likely increased from 2003 to 2006 so we add 0.02 to obtain a total change of 0.25. Cash adoption is assumed to be constant at 100 percent.

We estimate that the relative cost of checks increased by about 30 percent and the relative convenience of checks decreased by about 30 percent.[41] Given the marginal effects on these characteristics in the model, we estimate that changes in relative check characteristics can account directly for 34 percent and 11 percent, respectively, of the actual change in aggregate check share from 2003 to 2006. Changes in the relative characteristics of other payment instruments reduce check share indirectly, but these effects are smaller.

7. Conclusions

Three factors appear to explain why some consumers are finally writing fewer checks. First, because certain payment characteristics are important determinants of the use of checks and other payment instruments, relative changes in these characteristics are likely to have induced consumers to change their use of the instruments. Convenience, cost, record keeping, and timing appear to have been most important in the payments transformation. Second, some consumers use fewer checks because of the increased availability and acceptance of alternative payment instruments with presumably more appealing characteristics than checks—at least more appealing to these consumers. Other consumers do not find the characteristics of the newer payment instruments more appealing and do not use fewer checks. Third, some demographic attributes are important, but they are more important for the use of payment instruments that substitute for checks than for the direct use of checks.

At least two caveats apply to these conclusions. First, there are no comparable data on characteristics of U.S. payment instruments before 2006, so we cannot tell for sure whether or how much the payment characteristics may have changed. For this reason, we cannot distinguish between changes in check use caused by changes in the payment characteristics and changes in consumers' understanding (financial literacy) and attitudes (preferences) toward the payment characteristics. This distinction is crucial to understanding and especially influencing

[41] According to Dove Consulting (2005), the share of consumers who reported that checks were convenient decreased from 50 percent in 2001 to 37.5 percent in 2003 and 25.7 percent in 2005—a decline of about 50 percent over four years, slightly more than our 30 percent estimate for three years. The decline was similar for other characteristics of checks in the Dove data.

consumer payment choice. Second, because our econometric models are reduced form we cannot link the results back to the parameters of a structural model of demand for money and payments based on preferences (utility) and technology (production of payments services).

Both caveats suggest two future directions for research. First, more and better data on consumer payment choice are needed. Towards this end, the Federal Reserve Bank of Boston is sponsoring new versions of the Survey of Consumer Payment Choice in 2008 and 2009 conducted with the American Life Panel by the RAND Corporation. Other data development efforts, in the United States or elsewhere, would be helpful too. Second, structural models of consumer demand for money and payments that incorporate realistic features of actual U.S. payment instruments are needed to better guide econometric modeling.

References

AARP. 2007 Consumer payment study. February. http://assets.aarp.org/rgcenter/consume/consumer_payment.pdf

Amromin, Eugene and Sujit Chakravorti. 2007. Debit card and cash usage: a cross-country analysis. Federal Reserve Bank of Chicago. Working Papers WP-07-04, March.

Anguelov, Christoslav E., Marianne A. Hilgert, and Jeanne M. Hogarth. 2004. U.S. consumers and electronic banking, 1995–2003. *Federal Reserve Bulletin* Winter: 1–18.

Attanasio, Orazio, Luigi Guiso and Tullio Jappelli. 2002. The demand for money, financial innovation, and the welfare cost of inflation: an analysis with household data. *Journal of Political Economy* 110(2): 318–351, April.

Barnett, William A., Douglas Fisher, and Apostolos Serletis. 1992. Consumer theory and the demand for money. *Journal of Economic Literature* 30(4): 2086–2119, December.

Benton, Marques, Krista Blair, Marianne Crowe, and Scott Schuh. 2007. The Boston Fed study of consumer behavior and payment choice: a survey of Federal Reserve System employees. FRB Boston Public Policy Discussion Paper No. 07-1.

Bertaut, Carol C. and Michael Haliassos. 2005. Credit cards: facts and theories. *The Economics of Consumer Credit*. G. Bertola, R. Disney and C. Grant, eds. MIT Press, April.

Borzekowski, Ron and Elizabeth Kiser. 2007. The choice at the checkout: Quantifying demand across payment instruments. *International Journal of Industrial Organization* 26(4): 889–902.

Borzekowski, Ron, Elizabeth Kiser and Shaista Ahmed. 2008. Consumers' use of debit cards: patterns, preferences, and price response. *Journal of Money, Credit and Banking* 40(1): 149–172.

Carow, Kenneth A. and Michael E. Staten. 1999. Debit, credit, or cash: survey evidence on gasoline purchases. *Journal of Economics and Business* 51(5): 409–21.

Carten, Margaret, Dan Littman, Scott Schuh, and Joanna Stavins. 2007. Consumer behavior and payment choice: 2006 conference summary. Public Policy Discussion Paper No. 07–4.

Ching, Andrew and Fumiko Hayashi. 2008. Payment card rewards programs and consumer payment choice. Working Paper.

Dove Consulting. 2005. *2005–2006 Study of Consumer Payment Preferences.*

Dubin, J.A. and D.L. McFadden. 1984. An econometric analysis of residential electric appliance holdings and consumption. *Econometrica* 52(2): 345–362.

Duca, John V. and William C. Whitesell. 1995. Credit cards and money demand: a cross-sectional study. *Journal of Money, Credit, and Banking* 27(2): 604–623 May.

Federal Reserve Bank of Atlanta. 1983. *A Quantitative Description of the Check Collection System: A Report of Research Findings on the Check Collection System*. Volumes 1 and 2. http://www.frbatlanta.org/fi_services/1979_ckstudy/check_study.htm. Accessed February 14, 2007.

Federal Reserve Bank of Philadelphia. *Consumer Payments Bibliography*. http://www.philadelphiafed.org/pcc/bibliography/bibliography.pdf .

Federal Reserve Board. *Survey of Consumer Finances*. http://www.federalreserve.gov/pubs/oss/oss2/scfindex.html

Fusaro, Marc A. 2008. Debit vs. credit: a model of self-control with evidence from checking accounts. Department of Economics. East Carolina University Working Paper, April.

Garcia Swartz, Daniel D., Robert W. Hahn, and Anne Layne-Farrar. 2006. The move toward a cashless society: a closer look at payment instrument economics. *Review of Network Economics* 5(2), June.

Gerdes, Geoffrey R. and Jack K. Walton II. 2002. The use of checks and other noncash payment instruments in the United States. *Federal Reserve Bulletin*, August.

Gerdes, Geoffrey R., May X. Liu, Darrel W. Parke, and Jack K. Walton II. 2005. Trends in the use of payment instruments in the United States. *Federal Reserve Bulletin* Spring: 180–201.

Gerdes, Geoffrey R. 2008. Recent payment trends in the United States. *Federal Reserve Bulletin* October: A75-A106.

Greene, William H. 1997. *Econometric Analysis*. Upper Saddle River, NJ: Prentice-Hall Inc., Third Edition.

Hancock, Diana and David B. Humphrey. 1998. Payment transactions, instruments, and systems: a survey. *Journal of Banking and Finance* 21.

Hayashi, Fumiko and Elizabeth Klee. 2003. Technology adoption and consumer payments: evidence from survey data. *Review of Network Economics* 2(2): 175-190, June.

He, Ping, Lixin Huang, and Randall Wright. 2006. Money, banking, and monetary policy. Unpublished working paper.

Heckman, James J. 1976. The common structure of statistical models of truncation, sample selection and limited dependent variables and a simple estimator for such models. *The Annals of Economic and Social Measurement* 5: 475–492.

Hitachi Consulting. 2008. *2008 Study of Consumer Payment Preferences.*

Humphrey, David B., Moshe Kim, and Bent Vale. 2001. Realizing the gains from electronic payments: costs, pricing, and payment choice. *Journal of Money, Credit and Banking* 33(2) Part 1: 216–234, May.

Humphrey, David B., Lawrence B. Pulley, and Jukka M. Vesala. 1996. Cash, paper, and electronic payments: a cross-country analysis. *Journal of Money, Credit and Banking* 28(4) Part 2: 914–939, November.

Jonker, Nicole. 2005. Payment instruments as perceived by consumers—a public survey. De Nederlandsche Bank Working Paper, September.

Kim, Byoung-Min, Tansel Yilmazer, and Richard Widdows. 2006. Adoption of Internet banking and consumers' payment choices. Purdue University Working Paper.

Klee, Elizabeth. 2006. Families' use of payment instruments during a decade of change in the U.S. payment system. Finance and Economics Discussion Paper No. 2006–01, February.

_____. 2008. How people pay: evidence from grocery store data. *Journal of Monetary Economics* 55(3): 526-541.

Lippi, Francesco and Alessandro Secchi. 2008. Technological change and the households' demand for currency. forthcoming, *Journal of Monetary Economics*.

Mantel, Brian. 2000. Why do consumers pay bills electronically? an empirical analysis. Federal Reserve Bank of Chicago *Economic Perspectives* 25(4): 32–48.

Mester, Loretta J. 2003. Changes in the use of electronic means of payment: 1995–2001. Federal Reserve Bank of Philadelphia *Business Review* Q3:18–20.

_____. 2006. Changes in the use of electronic means of payment: 1995–2004. Federal Reserve Bank of Philadelphia *Business Review* Q2: 26-30.

Rotemberg, Julio J., John C. Driscoll, and James M. Poterba. 1995. Money, output, and prices: evidence from a new monetary aggregate. *Journal of Business and Economics Statistics* 13(1): 67–83, January.

Rysman, Marc. 2007. An empirical analysis of payment card usage. *Journal of Industrial Economics* LV(1): 1–36.

Schreft, Stacey. 2006. How and why do consumers choose their payment methods? Federal Reserve Bank of Kansas City *Research Working Paper* RWP 06-04.

Schuh, Scott. 2008. The mechanics of money: adoption and use of payment instruments by U.S. consumers. Unpublished working paper.

Schuh, Scott. 2009. The survey of consumer payment choice, 2003–2008: Purpose and Methodology. Unpublished working paper.

Sprenger, Charles and Joanna Stavins. 2008. Credit card debt and payment use. Federal Reserve Bank of Boston Working Paper No. 08-2.

Stavins, Joanna. 2001. Effect of consumer characteristics on the use of payment instruments. Federal Reserve Bank of Boston *New England Economic Review* 3Q: 19–31.

Theil, Henri. 1971. *Principles of Econometrics*. New York: John Wiley & Sons, Inc.

Whitesell, William C. 1989. The demand for currency versus debitable accounts: note. *Journal of Money, Credit, and Banking* 21(2): 246–251, May.

Wooldridge, Jeffrey M. 2002. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: MIT Press.

Zinman, Jonathan. 2009. Debit or credit? forthcoming, *Journal of Banking and Finance*.

Table 1: U.S. Payment Adoption and Use (Percent)

		Checks	Credit Cards	Debit Cards	ABP	ACH	Online Banking
Adoption Rate	1995	85	74	18	22		3
	2004	89	75	59	47		32
Use (Share of Noncash Payments)	1995	77	16	2		4	
	2006	36	24	27		13	

SOURCES: Adoption: 1995 and 2004 Survey of Consumer Finances.
Use: Gerdes et al. (2002), 2007 Federal Reserve Payments Study.
NOTES: The adoption rate is the percent of U.S. consumers who had adopted the payment method. The use numbers are percentage of noncash payments, but they include both consumer payments and payments made by business and government. The use numbers only include payments made with checks, credit cards, debit cards, and ACH. ACH payments are deducted directly from a bank account using the Automated Clearing House network. Automatic bill payment (ABP) is a type of ACH payment made automatically from the consumer's bank account.

Table 2: Regression Variable Definitions

Class	Variable	Definition
CHAR	*COST*	Cost or fees (1-10)
	CONV	Convenience (1-10)
	SAFE	Safety (1-10)
	PRIV	Privacy (1-10)
	ACC	Accuracy (1-10)
	TIME	Payment timing (1-10)
	REC	Record keeping (1-10)
DEM	*AGE*	25–34; 35–44; 45–54; 55–64; 65+
	GEN	Male; female
	RACE	White; black; Latino; Asian; American Indian; other
	EDU	Less than HS; high school; less than college; college; some post-graduate or more
	MS	Married; divorced; widowed; single
	HH	Size; variable telling if the respondent has any children (=1 if yes)
Y	*INC*	Less than $25,000; $25,000–49,999; $50,000–74,999; $75,000–99,999; $100,000 or more
	INT	Does your checking account earn interest? (Yes=1)
	LFS	Labor force status: employed, not employed, retired
	FR	Financial responsibility: shared=1; most=2; all=3
MISC	NUM_{kij}	Set of dummy variables equal to 1 if consumer *i* adopted *k* other payment instruments besides *j*, where *k* ranges from 0 to 6.
	NET	Internet use: None=0; less than monthly=1; less than weekly=2; less than daily=3; daily or more=4

SOURCE: 2006 *Survey of Consumer Payment Choice*
NOTES: "Married" includes respondents who are living with a partner; "divorced" includes respondents who are separated. "Not employed" includes respondents who are unemployed (i.e., in the labor force but not employed) and who are not retired and not employed (i.e., not in the labor force). Due to the survey design, *FR* excludes all respondents with some or none of the financial responsibility in the household.

Table 3: Rates of Adoption of Payment Instruments by U.S. Consumers (percent)

		Cash	Checks	Credit Cards	Debit Cards	ABP	Online Banking	SVC
Total		**95**	**87**	**74**	**62**	**49**	**24**	**26**
Age	**25–34**	94	88	73	83	54	45	27
	35–44	98	81	67	68	49	27	24
	45–54	95	85	79	56	42	20	27
	55–64	95	92	76	59	50	16	30
	65 or Over	92	89	74	40	49	8	22
Education	**HS or Less**	94	76	60	49	39	11	22
	Some College	97	94	78	73	53	31	27
	College Degree	94	94	89	71	58	36	30
	Post-Graduate School	98	97	93	67	60	42	36
Marital Status	**Married**	94	91	82	65	53	30	27
	Divorced	98	77	56	56	40	17	16
	Widowed	92	87	66	43	48	8	24
	Single	98	79	61	63	39	18	31
Ethnicity	**Latino**	91	80	79	70	47	32	31
Race	**White**	95	91	76	61	51	23	28
	Black	98	64	48	61	43	13	13
	Asian	100	92	89	82	47	35	22
	American Indian	93	73	49	74	63	20	48
	Other	97	88	73	59	36	28	21
Gender	**Male**	95	86	75	60	48	28	23
	Female	95	87	73	63	49	20	29
Income	**<25,000**	95	70	41	49	31	7	19
	$25,000–$49,999	94	89	76	63	47	22	28
	$50,000–$74,999	94	97	84	77	61	37	26
	$75,000–$99,999	100	91	90	66	57	34	30
	>100,000	97	94	95	84	74	54	29

SOURCE: 2006 Survey of Consumer Payment Choice.

NOTES: The definition of adopter varies by payment type. A check adopter must have a checking account and must have used checks in the past five years or in a typical month. An adopter of credit card or debit card must have at least one card. An ABP adopter must use ABP in a typical month. An SVC adopter must either have a stored value card or use one in a typical month. An online banking adopter may either use it in a typical month or may have used it in the past five years.

Table 4: Use of Payment Instruments by Adopters (percent share, unweighted)

		Cash	Checks	Credit Cards	Debit Cards	ABP	Online Banking	SVC
Total		**30**	**38**	**13**	**24**	**17**	**18**	**8**
Age	**25-34**	27	24	9	31	20	20	8
	35-44	36	35	11	24	14	14	7
	45-54	29	42	13	23	14	20	11
	55-64	28	43	15	18	15	18	8
	65 or Over	28	49	16	15	20	20	5
Education	**HS or Less**	37	44	10	24	20	24	12
	Some College	26	37	10	23	16	17	6
	College Degree	23	32	16	26	15	19	5
	Post-Graduate School	24	32	20	20	12	14	4
Marital Status	**Married**	26	38	13	23	16	19	5
	Divorced	38	40	9	27	19	19	10
	Widowed	31	50	13	17	21	20	8
	Single	36	30	12	28	17	10	14
Ethnicity	**Latino**	31	35	10	22	20	24	13
Race	**White**	27	41	13	23	15	16	7
	Black	45	32	8	30	26	14	11
	Asian	34	29	24	13	8	13	2
	American Indian	45	24	7	33	13	11	8
	Other	32	32	12	31	13	14	9
Gender	**Male**	29	36	12	25	18	22	9
	Female	30	40	13	23	15	14	7
Income	**<25,000**	46	44	8	23	20	16	15
	$25,000-$50,000	28	40	12	23	16	14	10
	$50,000 - $74,999	24	32	11	23	18	20	5
	75,000-100,000	25	32	16	29	14	13	4
	>100,000	18	29	15	23	14	20	5

SOURCE: 2006 Survey of Consumer Payment Choice.

NOTES: Share is calculated as the number of monthly payments made with each instrument divided by the total number of monthly payments made with all seven instruments. These individual shares are then averaged across all adopters of that payment type, but they are not weighted to account for the total number of monthly payments made by each consumer. Therefore, these numbers should not be interpreted as aggregate share numbers. The rows do not sum to 100 because this table is measuring share among adopters only.

Table 5: Ratings of Payment Characteristics

Average Absolute Ratings

Payment Method	Characteristic							
	Cost	Convenience	Safety	Privacy	Accuracy	Timing	Record Keeping	Row Average
Cash	8.0	7.5	6.1	8.2	8.0	7.1	5.3	7.2
Checks	7.3	8.0	7.6	6.7	8.7	7.6	8.9	7.8
Credit Cards	5.6	8.8	6.6	6.4	8.1	8.0	8.2	7.4
Debit Cards	7.4	9.1	7.3	7.1	8.5	8.6	7.8	8.0
ABP	8.5	9.1	8.3	7.9	8.9	8.9	8.5	8.6
SVC	7.9	8.2	7.7	8.3	8.2	8.3	6.0	7.8
Online Banking	8.2	9.0	8.0	7.9	8.9	8.7	8.9	8.5
Column Average	7.6	8.5	7.4	7.5	8.5	8.2	7.7	7.9

Log Relative (to Checks) Ratings

Payment Method	Characteristic							
	Cost	Convenience	Safety	Privacy	Accuracy	Timing	Record Keeping	Row Average
Cash	0.08	-0.10	-0.39	0.26	-0.17	-0.16	-0.81	-0.18
Checks	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Credit Cards	-0.38	0.14	-0.19	-0.07	-0.09	0.08	-0.12	-0.09
Debit Cards	0.06	0.25	0.02	0.16	-0.01	0.24	-0.16	0.08
ABP	0.19	0.21	0.13	0.23	0.03	0.24	-0.07	0.14
SVC	0.11	0.05	-0.01	0.35	-0.13	0.10	-0.59	-0.02
Online Banking	0.26	0.41	0.22	0.34	0.06	0.31	0.03	0.23
Column Average	0.05	0.16	-0.04	0.21	-0.05	0.13	-0.29	0.03

SOURCE: 2006 Survey of Consumer Payment Choice.

NOTES: The absolute ratings are on a 1–10 scale, where 10 is the best and 1 is the worst. The averages of these ratings are taken across all respondents who have adopted the payment method. The log relative ratings are calculated using the RCHAR formula in the text.

Table 6: Adoption Model Regressions (Probit, Marginal Effects)

Explanatory Variables	Cash	Checks	Credit Cards	Debit Cards	ABP	Online Banking	SVC
Age:							
25-34	.00	.01	.01	.07	.12 *	.13 **	-.03
35-44							
45-54	-.02	-.01	.10 **	-.19 ***	-.09 *	-.07 **	.00
55-64	-.02	.03 *	.14 ***	-.16 **	-.12 *	-.09 ***	.06
>65	-.10	.02	.18 ***	-.35 ***	-.06	-.14 ***	.04
Education:							
Some High School	-.09	-.13 *	-.07	-.12	-.09	-.08 *	-.03
High School	.01	-.02	-.01	-.04	-.02	-.10 ***	.00
Some College/Assoc. Degree	.02	.02	.00	.07	.05	.02	.01
College Degree							
At Least Some Post Grad.	.04 ***	.00	.04	-.04	.09	.04	.04
Marital Status:							
Divorced	.02	-.01	-.05	.10	.01	.03	-.06
Widowed	-.01	.00	.00	.11	.02	-.01	.06
Single	.04 ***	-.04	.03	.02	-.08	-.06	.08
Household Composition:							
Size	.00	-.01	.00	.00	-.02	-.01	.02 *
Children	.02	-.01	-.13 **	.00	.03	.04	-.01
Ethnicity: Latino	-.08	-.05	.11 **	.12	-.10	-.01	.01
Race:							
Black	.02	-.10 **	-.14 **	.07	-.02	.01	-.12 ***
Asian		-.23	.09	.13	-.09	-.03	-.12 **
American Indian		-.06	-.33 **	.26 *	.11	-.03	.08
Other	-.02	.03 **	-.02	-.06	-.13	.03	-.04
Gender: Male	-.01	-.02	-.09 **	-.02	-.04	.00	-.10 ***
Income:							
<$25,000	.00	-.08 *	-.45 ***	-.16 **	-.16 ***	-.14 ***	-.03
$25,000-$49,999	-.01	-.02	-.08	-.03	-.09 *	-.05	.06
$50,000-$74,999							
$75000-$99,999	.04 ***	.03 *	.05	-.03	.02	.02	.08
>$100,000	-.02	.03 **	.14 ***	.12 *	.12 **	.16 ***	.01
Retired	.01	.01	.06	.06	.10 *	.01	-.11 ***
Not Employed	-.06	-.05 *	-.03	-.07	-.05	-.06 *	-.05
Financial Responsibility	-.01	.00	-.02	-.05 *	.01	.01	-.01
Internet Use	.01	.01 **	.07 ***	.06 ***	.05 ***		.03 ***
Number of Observations	648	924	916	850	988	1057	992
Pseudo R-squared	.19	.32	.30	.16	.09	.18	.09

SOURCE: 2006 Survey of Consumer Payment Choice.

NOTES: * significant at 10%; ** significant at 5%; *** significant at 1%.

Table entries are the marginal effects estimates from the probit regression in the first stage of the Heckman selection model. The dependent variable is set equal to 1 if the respondent has adopted the payment type. Otherwise, it equals zero. The Heckman 2-step procedure excludes respondents that have missing values in the second stage only if the dependent variable of the first stage is equal to 1, i.e. they had adopted the payment method.

Table 7: Use Model Regressions (2nd Stage of Heckman)

Explanatory Variables	Cash	Checks	Credit Cards	Debit Cards	ABP	Online Banking	SVC
Characteristics:							
Cost	-.01	.03 *	.06 ***	-.01	.03 *	.03	-.01
Convenience	.06 ***	.10 ***	.10 ***	-.02	.02	.11	.09 **
Safety	.02	.02	.02	.06 *	.04	.01	.01
Privacy	-.02	.01	-.04 **	.01	.00	.03	-.04
Accuracy	.02	.04	-.05 **	.01	.02	.00	-.07 *
Timing	.02	.02	.04 **	.08 *	.02	.00	.02
Record Keeping	.04 ***	.02	.03	.04	-.06 **	.02	.03 *
Age:							
25-34	-.01	-.04	-.04	.05	.01	.17	-.01
35-44							
45-54	-.01	.08 **	-.01	-.06	.03	-.02	-.04
55-64	.00	.05	-.01	-.11 ***	.04	-.06	-.04
>65	.03	.05	.01	-.06	.05	-.16	-.02
Education:							
Some High School	.08	.05	-.02	.00	.06	.01	.22 ***
High School	-.01	.03	-.04 *	.02	.03	-.04	-.01
Some College/Assoc. Degree	.00	.02	-.03	.00	-.01	.09	.00
College Degree							
At Least Some Post Grad.	.06 *	-.01	.02	-.02	-.05 **	.02	-.02
Marital Status:							
Divorced	.02	-.03	-.02	-.03	.02	.06	.02
Widowed	.01	-.04	.02	-.08 *	.06 **	-.05	.03
Single	-.01	-.03	.01	.03	.00	-.08	-.01
Household Composition:							
Size	.00	.01	-.01	.01	.01	-.04	.01
Children	-.02	.01	-.02	-.03	-.01	.13	-.05
Ethnicity: Latino	-.04	.10 **	.00	-.05	.07 *	-.01	.07
Race:							
Black	-.06 *	.03	-.01	.02	.12 ***	-.04	.10
Asian	.08	.07	-.01	-.12	.04	-.06	-.04
American Indian	.12	-.18 **	.00	.10	-.11	-.04	-.13
Other	-.02	-.07	-.02	.00	.03	.12	.05
Gender: Male	.04 **	-.02	.01	-.03	.03 *	-.02	.01
Income:							
<$25,000	.05	.07 *	-.02	-.05	.02	-.31	.01
$25,000-$49,999	.00	.05 *	-.03	-.02	.00	-.07	-.01
$50,000-$74,999							
$75000-$99,999	-.03	.01	.01	-.01	-.01	.08	-.03
>$100,000	.00	-.02	.02	-.02	-.03	.21	.01
Check Interest	-.01	.01	-.02	.02	.01	.03	-.01
Retired	-.03	-.02	.03	.03	.00	-.02	.03
Not Employed	-.02	.00	.07 ***	.03	.05 *	-.15	.04
Financial Responsibility	.00	-.01	.00	.02	.00	.02	.02
No Other Instruments Adopted	.73 ***						
1 Other Instrument Adopted	.22 ***	.19 ***	.11	.21	.19 ***		.17 ***
2 Other Instruments Adopted	.06 **	.08 ***	.09 ***	-.06	.10 ***		.03
3 Other Instruments Adopted^							
4 Other Instruments Adopted	-.03	-.10 ***	.02	-.02	-.02	-.08	-.03
5 Other Instruments Adopted	-.02	-.17 ***	.00	-.02	.00	-.17 **	-.07 **
6 Other Instruments Adopted	-.02	-.23 ***	.04	-.01	.01	-.22 **	-.05
Inverse Mills Ratio	-.15	-.20 **	-.02	.03	-.13 *	.49	-.06
Number of Observations	619	839	665	458	491	217	204
R-squared	.32	.30	.20	.14	.17	.33	.29
Without CHAR	.25	.24	.10	.10	.14	.27	.25
Without CHAR and Adoption Dummies	.07	.11	.08	.09	.11	.17	.19

SOURCE: 2006 Survey of Consumer Payment Choice.

NOTES: * significant at 10%; ** significant at 5%; *** significant at 1%. Table entries are coefficient estimates from the second stage of the Heckman model in which adoption is the first stage. Results from the first stage are found in Table 6.

For each column, the dependent variable is the share of total payments made with that payment type.

^The excluded variable for online banking is 3 or less other instruments adopted because of lack of sufficient observations.

Table 8: Comparison of Heckman 2nd Stage Results and IV Regression Results for Checks

	Heckman Restricted Model	IV Regressions from the Restricted Model			
		Instrument Set			Average Values
		Large	Medium	Small	
Characteristics:					
Cost	.03 *	.01	.16	.18	.12
Convenience	.10 ***	.30	.29	.19	.26
Safety	.02	.03	-.09	-.39	-.15
Privacy	.01	.03	.03	.00	.02
Accuracy	.04	-.10	.06	.24	.06
Timing	.02	.16	.12	.21	.16
Record Keeping	.02	.09	.15	.37	.20
Age:[a]					
25–34	-.05	.01	.00	-.02	.00
45–54	.07 **	.07 *	.06	.06	.06
55–64	.03	.00	-.02	-.03	-.02
≥65	.03	.01	.00	-.01	.00
Marital Status:[a]					
Divorced	-.04	-.03	-.01	.01	-.01
Widowed	-.04	-.07	-.07	-.05	-.06
Single	-.06 *	-.06	-.07	-.08	-.07
Ethnicity: Latino	.11 **	.14 **	.17 **	.16 *	.16
Race:[a]					
Black	.02	.02	.02	.04	.03
Asian	.05	.11	.13	.20	.15
American Indian	-.17 **	-.23 **	-.22 **	-.20	-.22
Other	-.07	-.13 *	-.13 *	-.16	-.14
Income:[a]					
<$25,000	.07 **	.05	.05	.04	.05
$25,000–49,999	.05 *	.03	.03	.04	.03
$75000–99,999	.01	.01	.02	.05	.03
≥$100,000	-.03	-.01	-.01	-.02	-.02
Check Interest	.01	-.01	-.01	.00	-.01
Employment Status:[a]					
Retired	-.02	-.03	.00	.04	.00
Not Employed	.01	.00	.03	.07	.04
Financial Responsibility	-.01	-.01	-.01	.00	-.01
1 Other Instrument Adopted	.20 ***	.17 **	.17 **	.20 *	.18
2 Other Instruments Adopted	.08 ***	.06	.05	.07	.06
3 Other Instruments Adopted^					
4 Other Instruments Adopted	-.10 ***	-.07 **	-.08 **	-.10 *	-.08
5 Other Instruments Adopted	-.17 ***	-.13 ***	-.14 ***	-.17 **	-.15
6 Other Instruments Adopted	-.24 ***	-.17 ***	-.17 **	-.22 **	-.19
Inverse Mills Ratio	-.17 **	-.19 **	-.20 *	-.18	-.19
Number of Observations	924	795	795	795	
R-squared					
Sargan p-value		.35	.57	.79	.57

SOURCE: 2006 Survey of Consumer Payment Choice.

NOTES: * significant at 10%; ** significant at 5%; *** significant at 1%.

The restricted model excludes education, household size, number of children, and gender from the regression. These variables are used as instruments in the IV regressions. The IV regressions are two-stage least square regressions that include the inverse mills ratio obtained from the first stage of the Heckman model. The instrument sets and instruments are explained in Appendix Table 2.

[a] One category omitted from each of these variable groups.

Table 9: Change in Use Model Regressions (Ordered Logit)

Explanatory Variables	Cash	Checks	Credit Cards	Debit Cards	ABP	Online Banking	SVC
Characteristics:							
Cost	.87	.97	1.36 ***	1.39	1.62 *	2.78 **	1.19
Convenience	1.69 ***	2.97 ***	2.46 ***	.79	1.10	2.84	.97
Safety	1.02	1.01	1.18	1.62 *	.76	1.23	1.06
Privacy	.89	1.44 **	.91	1.10	.95	.61	.69
Accuracy	1.01	.79	1.13	1.66	.92	.82	1.10
Timing	1.09	1.39 *	.94	3.31 ***	2.53 ***	2.22	.94
Record Keeping	1.60 ***	.69 **	1.30	.93	2.26 ***	2.08	1.39 **
Age:[a]							
25–34	.71	1.27	.72	2.09 **	3.07 ***	.85	.58
45–54	1.42	1.46	1.13	.69	1.11	.94	1.28
55–64	1.26	1.95 **	.86	.89	1.00	2.92 *	1.22
≥65	1.12	2.06 **	.91	.85	1.03	4.00 *	1.87
Education:[a]							
Some High School	3.33 **	1.88 *	.92	.54	.47	.39	.93
High School	2.44 ***	2.01 ***	1.36	.45 **	.78	2.38	.54 *
Some College/Assoc. Degree	1.32	1.17	.86	.61 *	1.12	.71	.71
At Least Some Post Grad.	1.10	.89	1.50 *	.51 **	1.09	1.18	.81
Marital Status:[a]							
Divorced	1.94 **	.93	1.32	1.25	1.05	1.55	1.15
Widowed	2.06 **	1.19	1.53	1.02	.80	1.27	1.06
Single	1.33	1.30	1.62 *	.92	.73	3.10 *	1.00
Household Composition:							
Size	1.04	1.04	.96	1.18	.98	1.13	1.21 *
Children	1.59 *	1.51 *	1.12	.74	1.25	1.37	.56 *
Ethnicity: Latino	1.51	1.87 *	.75	.73	.55	2.90	.54
Race:[a]							
Black	1.16	1.12	.47 **	1.68	.72	1.19	.89
Asian	2.95	2.51	.76	1.28	.51	.87	1.17
American Indian	1.11	.25 *	3.09	5.00	.37	2.93	8.01
Other	1.57	.70	1.67	.75	1.78	2.12	.54
Gender:[a] **Male**	1.08	1.52 ***	1.10	.71 *	1.07	.74	.80
Income:[a]							
<$25,000	1.44	1.33	.51 **	.53 *	1.05	.73	.69
$25,000–49,999	1.19	1.07	.70 *	.94	1.21	1.02	.74
$75000–99,999	1.19	1.06	.86	.73	1.06	1.31	.89
≥$100,000	1.30	.76	.96	.63	1.65 *	1.62	1.36
Check Interest	1.50 **	.94	.74 **	1.58 **	1.24	1.51	1.58 **
Employment Status:[a]							
Retired	1.26	.71	1.63 **	.66	.85	.29 **	.58
Not Employed	.54 **	.52 **	1.53	.54 *	1.12	.84	1.82
Financial Responsibility	.88	.99	1.01	1.07	1.30 **	1.04	.98
Number of Observations	634	865	715	497	533	217	391
Pseudo R-squared	.10	.09	.06	.13	.10	.13	.06
Pseudo R-squared without characteristics (same sample)	.06	.05	.03	.07	.05	.04	.06

SOURCE: 2006 Survey of Consumer Payment Choice.

NOTES: * significant at 10%; ** significant at 5%; *** significant at 1%. Table entries are odds ratios.

For the dependent variables, 1 represents an increase in use, 0 represents no change, and -1 represents a decrease in use during the previous 3 years.

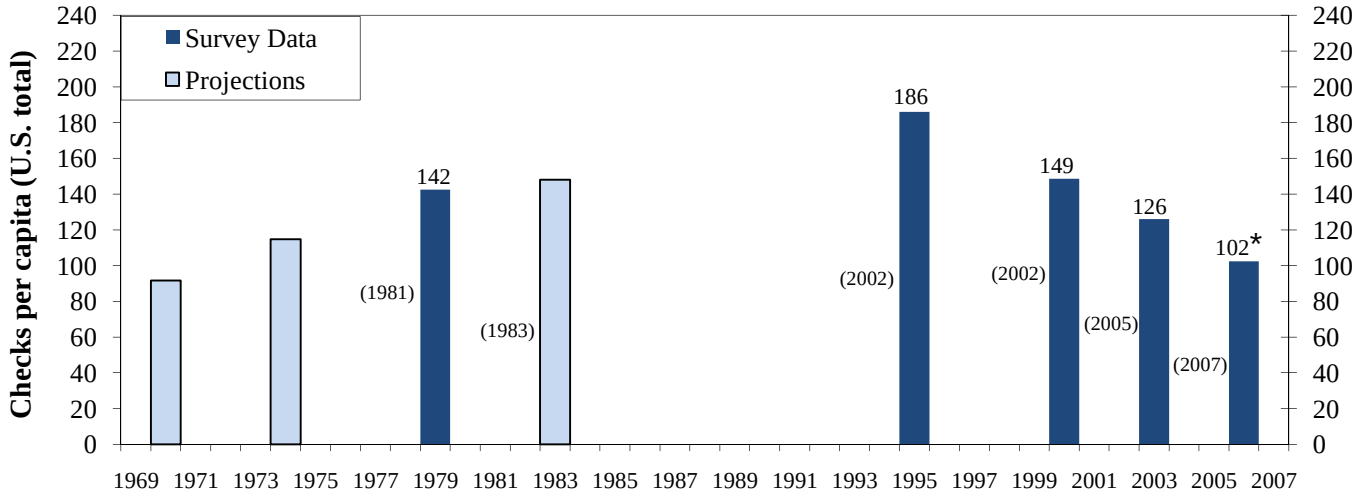
[a] One category omitted from each of these variable groups.

Table 10: Simulated Changes in Actual Check Share, 2003–2006

SIMULATION	Estimated change in check share	Percent of actual change in check share
Actual change (.310 to .226)	–0.084	100
Increase in number of payment instruments (0.25 per consumer)	–0.021	25
Decrease in relative convenience of checks (30 percent)	–0.029	34
Increase in relative cost of checks (30 percent)	–0.009	11

Notes: Each simulation is independent and the results are not a complete decomposition of the actual change in check share. The actual change in check share is estimated from Federal Reserve payment volume estimates (Gerdes 2008) and authors' calculations with industry data. See Appendix Table 3 for details of the derivations.

Figure 1: U.S. checks per capita

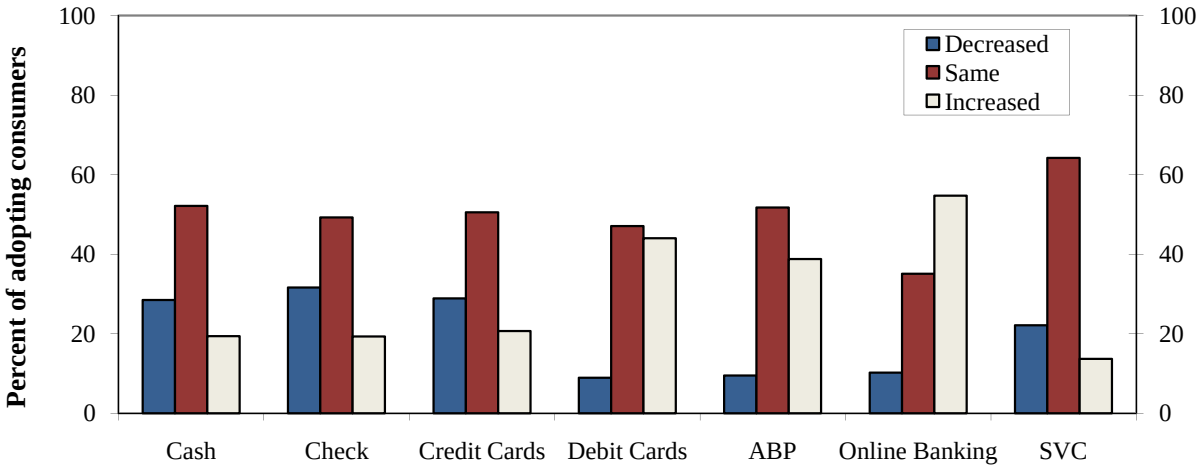


SOURCES: Federal Reserve Bank of Atlanta (1981, 1983); Federal Reserve System (2002, 2004); Gerdes and Walton (2002); Gerdes et al. (2005); Gerdes (2008); Benton et al. (2007).

NOTES: Numbers in parentheses are the years when the data were published.

*The 2006 number does not include paper checks written and converted to ACH.

Figure 2: Change in consumer payment use, 2003–2006



SOURCE: 2006 Survey of Consumer Payment Choice.

NOTES: The change in use question was only asked to respondents who had used the given payment type in the previous five years. Adopters who had not used the payment type in the previous five years were counted as "same." Non-adopters were excluded.

Appendix Table 1: Payment Method Characteristics in the Literature

Paper	Payment Instruments							Dependent Variable		Characteristics	Location
	cash	check	credit	debit	ACH	SVC	online bill pmt	Adoption	Use		
Schuh and Stavins (2008)	✓	✓	✓	✓	✓	✓	✓	Y	Y (number of payments)	1, 2, 3, 4, 5, 6, 7	point of sale, bill payments, online
Carow and Staten (1999)	✓		✓	✓					Y (choice at checkout)	1, 2, 7, 8	gasoline stations
Mantel (2000)							✓	Y		1, 2, 3, 4, 9	bill payments
Klee (2008)		✓		✓					Y (choice at checkout)	1, 7, 10	supermarkets
Borzekowski, Kiser and Ahmed * (2008)				✓				Y	Y (number of payments)	1, 2, 3, 7, 8, 10, 11	point of sale
Ching and Hayashi (2008)		✓	✓	✓					Y (most frequently used payment method, number of payments)	2, 3, 6, 8, 9, 10, 11	point of sale

NOTES: Characteristics are coded as follows: 1 - cost, 2 - convenience, 3 - safety, 4 - privacy, 5 - accuracy, 6 - timing, 7 - record keeping, 8 - acceptance, 9 - control, 10 - speed, 11 – budgeting

* Borzekowski, Kiser and Ahmed (2008) also estimate substitution patterns between debit and other payment instruments.

Appendix Table 2: Instrumental Variable Definitions

Instrument	Large	Medium	Small	Definition
AARP membership	✓	✓	✓	Equals 1 if respondent or spouse is AARP member
Bill payment: car	✓	✓		Equals 1 if respondent makes car payments
Bill payment: college tuition	✓	✓		Equals 1 if respondent makes college tuition payments
Bill payment: mortgage	✓	✓		Equals 1 if respondent makes mortgage payments; 0 otherwise
Bill payment: student loan	✓	✓		Equals 1 if respondent makes student loan payments
Check truncation	✓	✓	✓	Equals 1 if respondent has ever had a cashier immediately hand their check back to them after a completed purchase
Internet access: work	✓	✓	✓	Equals 1 if respondent has access to the Internet for personal use at work
Internet access: other location	✓			Equals 1 if respondent has access to the Internet for personal use at another location
Retirement Income	✓	✓	✓	Equals 1 if respondent currently receives any form of retirement income such as Social Security, pensions, or any other type of retirement account
Returned checks: cancelled checks	✓			Equals 1 if their bank returns their cancelled checks to them
Returned checks	✓			Equals 1 if their bank returns cancelled checks, paper copies of checks, or electronic copies of checks to them

NOTES: There were seven demographic variables which were excluded from the full Heckman model and used as instruments in all three instrument sets. These variables were the four education dummies, household size, number of children, and gender.

Appendix Table 3: Estimating Change in Check Share 2003-2006

Volume and Share of each Payment Instrument

	2003		2003 revised		2006		2006 revised	
	Number (billion)	Share (%)	Number (billion)	Share (%)	Number (billion)	Share (%)	Number (billion)	Share (%)
cash			36.4	30.0			43.91	30.0
check *	**37.6**	47	**37.6**	31.0	**33.1**	36	**33.10**	22.6
checks converted to ACH	0.3				2.6			
credit	**19.0**	24	**19.0**	15.7	**21.7**	24	**21.70**	14.8
debit	**15.6**	19	**15.6**	12.9	**25.3**	27	**25.30**	17.3
ACH (excl. checks converted to ACH)	**8.5**	11	**8.5**	7.0	**12.0**	13	**12.0**	8.2
SVC			1.2	1.0			2.93	2.0
OB			3.0	2.5			7.32	5.0
Total (incl. EBT)	**81.4**				**93.3**			
Total (w/out EBT)	**80.7**	100	121.4	100	**92.2**	100	146.35	100

SOURCE: The numbers in **bold** are from the Federal Reserve check studies (see Gerdes 2008). The other numbers are estimated as described in the text below.
* total checks written (including checks converted into ACH)

We started with the Federal Reserve's estimates of the number of payments made with each of the following payment instruments: check, credit, debit, and ACH in 2003 and in 2006 (Gerdes 2008). Because we are explaining check *writing* behavior, and not check *processing*, we included checks converted to ACH in the number of checks and not in the number of ACH payments, in contrast to Gerdes (2008). We excluded electronic benefit transfers (EBT), because the 2006 SCPC data did not include EBT. In addition to the four instruments, our data also include cash, stored-value cards (SVC), and online banking (OB). Because the Federal Reserve study did not include those payment instruments, we estimated the number of payments made with each of them in 2003 and 2006.

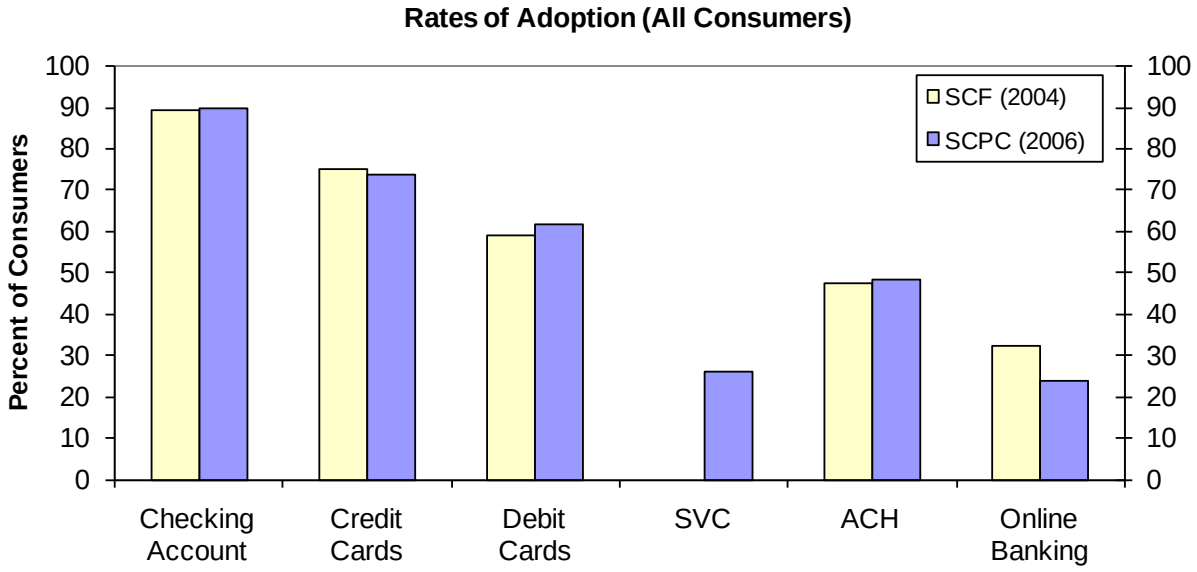
Using the estimates from Hitachi Consulting (2008) and from the 2006 SCPC, we assumed that cash transactions amounted to a steady 30 percent share of all transactions during

the 2003–2006 period.[42] For SVC, we used the 2006 SCPC estimates of 2 percent share in 2006. We assumed that the share doubled from 2003 to 2006, and was therefore 1 percent of all transactions in 2003. For OB, we used the 2006 SCPC estimate of a 5 percent share in 2006 and assumed that the share doubled during the 2003–2006 period, thus deriving the 2.5 percent share in 2003. Using those shares, we derived the total number of payments in each of the two years for each of the three payment methods excluded from the Federal Reserve study. Finally, we calculated the shares of all seven payment instruments based on that revised total number of payments. The calculations are shown in the table above.

Our revised estimates of the shares of each payment show that the share of checks dropped from 31 percent in 2003 to 22.6 percent in 2006, a drop of 8.4-percentage points.

[42] Hitachi Consulting (2008) estimates the share of cash transactions at 32 percent in 2003, 33 percent in 2005, and 29 percent in 2008. According to the 2006 SCPC, the share of cash transactions was 27 percent in 2006. Gerdes (2008) shows that the constant-dollar value of currency in circulation per capita has been flat since 1980—another indicator that cash share did not change during the 2003–2006 period.

Appendix Figure 1: Comparison between 2006 SCPC and 2004 SCF



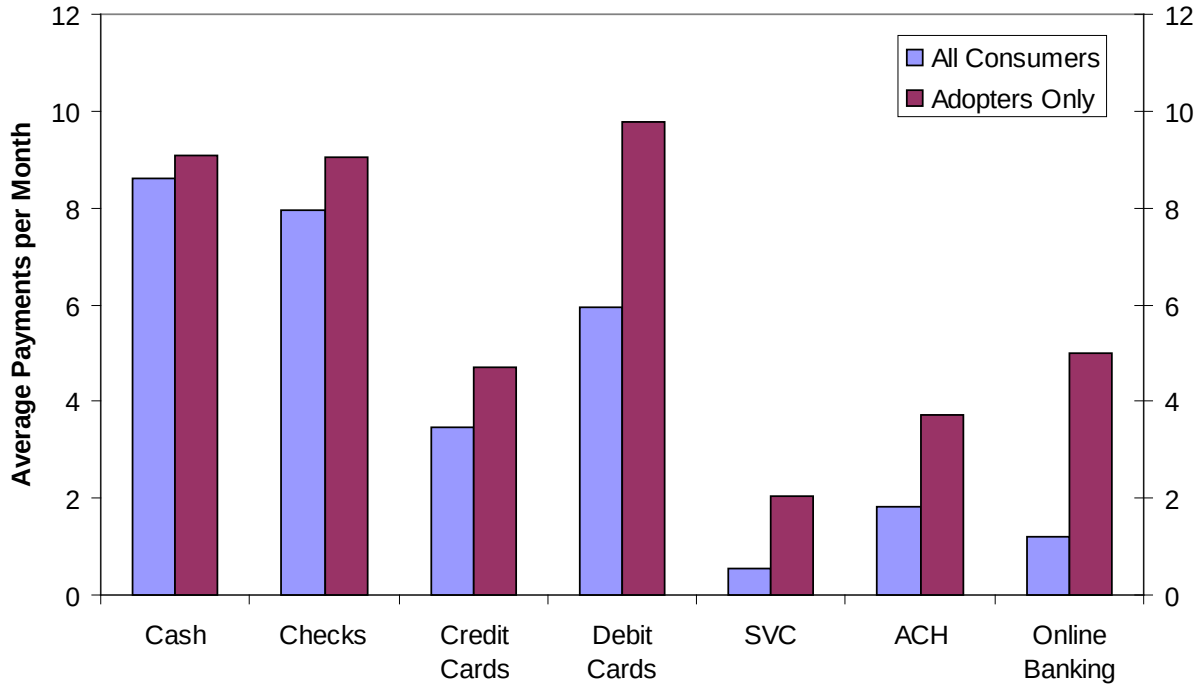
SOURCES: 2004 Survey of Consumer Finances and 2006 Survey of Consumer Payment Choice
NOTES: Checking account adoption was used because the SCF did not have information on check use specifically. SVC data are not available from the SCF. Online banking definitions differed between the two sources: in the SCPC, an online banking adopter is defined as someone who paid a bill directly from their bank account at their bank's website; in the SCF, we defined an online banking adopter as anyone who does business with a financial institution by computer, Internet, online service, or e-mail. The SCF definition is broader and could include people who use their bank's website to check their balances but never make an online bill payment.

The figure above compares rates of adoption for each payment instrument from the 2006 SCPC to the adoption rates from the 2004 Survey of Consumer Finances (SCF), a triennial representative survey conducted by the Federal Reserve that is widely considered to be among the most reliable public data sources on consumer financial behavior.[43] The 2006 SCPC data compare favorably to the 2004 SCF data for the five payment instruments common to the two surveys (cash and stored value cards are excluded from the SCF). The 2006 SCPC adoption rates for credit cards are slightly lower than those in the 2004 SCF data, and the adoption rates of newer payment instruments (debit cards, ACH) are slightly higher, perhaps reflecting the

[43] For more information about the SCF, see http://www.federalreserve.gov/PUBS/oss/oss2/scfindex.html.

paper-to-electronics transformation during the additional two years between surveys. The adoption rate of checking accounts was nearly identical in the two data sources. Unfortunately, the SCF does not include any more detailed information on the adoption of checks. The SCF also lacks estimates of stored-value card adoption, and the online banking definitions differ between the SCPC and the SCF (see notes under Appendix Figure 1).

Appendix Figure 2: Number of Payments per Month



SOURCE: 2006 Survey of Consumer Payment Choice

This figure shows monthly use of payment instruments from the 2006 SCPC data. The figure plots the average number of payments per month per consumer for two groups: all consumers and only consumers who have adopted the payment instrument (adopters). The latter grouping removes the influence of variation in adoption rates across payment instruments and provides a clearer indication of how important each instrument is for those who have the option of using it. Among all consumers, cash (more than 8 payments per month) and check (nearly 8 payments per month) account for the bulk of the volume of payment use in 2006. Debit cards (almost 6 per month) and credit cards (about 3 per month) account for most of the remaining payments. Among adopters of payment instruments, however, debit cards (about 10 per month) had become the most frequently used instrument among adopters. Cash and checks (each about 9 per month) remained important among adopters; adopters of online banking (about 5 per month) used it about as frequently as adopters of credit cards.