Why Use Debit Instead of Credit?
Consumer Choice in a Trillion Dollar Market

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ABSTRACT

What is in it for the user? They are losing the 'float'.

- Warren G. Heller, Director of Research, Veribanc, Inc.
(quoted in American Banker, June 29, 2000)

This shift to debit cards could mark an important turning point as far as personal finances.... Because the cards act like cash, there is no chance of running up a large debt. "It forces discipline..."

- (Christian Science Monitor, December 1, 1997.
Quote from Lawrence Chimerine, Chief Economist, Economic Strategy Institute)

Debit cards are overtaking credit cards as the most prevalent form of electronic payment at the point-of-sale (POS), yet the determinants of a ubiquitous consumer choice-- "debit or credit?"— have received relatively little scrutiny. Raw data and anecdotes suggest that debit card use is driven by "behavioral" explanations such as mental accounting and the need for commitment devices to prevent "overborrowing". The credit card's comparative advantages-- free float and, until very recently, superior rewards and fraud protection-- further reinforce the perception that debit card users forego nontrivial arbitrage opportunities.

This paper tests whether consumers actually fail to optimize their payment choice at the POS in the traditional sense. It develops a simple model of debit use based on minimizing the pecuniary marginal cost of payments, and finds support for the model in microdata that captures the essence of the consumer choice problem. Most notably, households that revolve credit card balances, and who hence must "borrow-to-charge" on the margin, appear to be at least 16% more likely to use debit cards than non-revolvers. Moreover, this observed price sensitivity is shown to be a conservative lower bound on the true effect, due to several different types of data limitations. The findings thus cast some doubt on the need to appeal to behavioral explanations for debit card use, and motivate more direct tests of alternatives to the traditional model.

1. Introduction

Debit cards have surpassed credit cards to become the most common form of Visa point-of-sale ("POS") transaction (Visa 2002). Overall, debit cards were used for over 15.5 billion POS transactions totaling $700 billion in the year 2002 (CPSS 2003).[1] This represented about 35% of electronic payment transaction volume and 12% of POS noncash payments.[2] Debit's ascension has been sudden; in 1995, debit comprised only 2% of retail noncash payments (Gerdes and Walton 2002). Industry observers predict continued strong growth for debit, while forecasting relatively weak growth in credit card charge volume.[3]

Despite debit's growth and prominence, the determinants of debit card use have largely escaped academic scrutiny.[4] Meanwhile, many commentators, drawing on market research, assert that debit cards serve as a form of commitment device against the type of "overborrowing" with credit cards posited by Ausubel (1991) or Bertaut and Haliassos (2002).[5] And indeed, certain raw data suggest that one or more "behavioral" explanations drive debit use. Debit cards tend to be used for smaller transactions involving instantaneous consumption, with credit cards used to purchase larger, more durable items (Reda 2003)— a pattern consistent with the mental accounting model in Prelec and Loewenstein (1998). Yet neither behavioral nor more traditional explanations for debit use have been put to the test.[6]

This paper tests the ability of a standard consumer choice model to explain debit card use by focusing on consumer sensitivity to the (implicit) relative price of electronic payments at the POS. The lack of consumer-level data on explicit transaction fees is not much of a constraint, as I show that the dominant determinant of relative payments price at the POS is often whether the consumer has been revolving balances on her credit card-- and hence must "borrow-to-charge". By boiling down the POS payment choice to one between debit and credit, one thus can test whether the consumer jointly optimizes over her payment options using widely available data. Specifically, a standard model of consumer choice generates the following testable predictions: 1. consumers who revolve credit card balances ("revolvers") should be more likely to use debit than those who don't ("nonrevolvers"); 2. revolvers facing binding credit constraints should be discretely more likely to use debit than revolvers who don't; 3. bankcard holders should be less likely to

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[1] Virtually all debit volume is attributable to consumers— businesses rarely use debit at the point-of-sale.
[2] Credit card transaction volume totaled $1.6 trillion in 2002 (CPSS 2003).
[3] See, e.g., McDonald and Wasserstrom (2003), Lyons (2004).
[4] Hancock and Humphrey (1998) note a lack of studies on the determinants of payments choice generally. But see footnote 6 for some more recent studies.
[5] See e.g., Mann (2002). The time-inconsistency implied by concerns about "overspending" or "undersaving" has been formalized via quasi-hyperbolic preferences; see, e.g., Laibson (1997).
[6] Rysman (2004) uses transaction-level data to estimate network effects in payment card networks. Hayashi and Klee (2003) examine complementarities between electronic payment use and other types of technology adoption. Kennickell and Kwast (1997), Carow and Staten (1999), Mantel (2000), and Stavins (2001) find effects of consumer demographic characteristics on payment choice. Boeschoten (1998) examines demographic and transaction size effects on payment choice in the Netherlands. Humphrey, Kim, and Vale (2001) find that retail payments choice is responsive to price in aggregate data from Norway.

use debit than those without bankcards, conditional on revolving status (since they should exploit the free float).

I find statistically and economically significant support for each of these predictions (especially the first two); overall, the results cast doubt on the need to invoke behavioral explanations to explain debit card use. This has implications for understanding high-frequency intertemporal choice generally. In particular, the lack of an obvious "payments puzzle" stands in apparent contrast to other aspects of consumer financial behavior that have proven difficult to explain with straightforward applications of canonical models.[7]

The paper proceeds as follows. Section 2 details the consumer choice problem at the POS. I describe how debit and credit offer essentially identical advantages relative to alternative payments media, and how they enjoy virtually identical acceptance. It is therefore straightforward to boil down the POS payments choice to one between debit and credit. In comparing debit to credit, then, it is easy to show that while credit offers free float to non-revolvers, and superior fraud protection and reward incentives during the sample period, debit is a relatively cheap alternative for certain consumers. Specifically, standard consumer choice theory generates tight predictions on who consumers should be more likely to use debit—those who revolve credit card balances, those who face binding bankcard credit limits, and those who lack a bankcard.

Section 3 describes the data and empirical model used to test these predictions. The Survey of Consumer Finances' information on credit and debit use, combined with its rich detail on household characteristics, financial attitudes, and elements of credit and transactions demand, make it well-suited to test the theory and explore threats to identification.

Section 4 briefly considers some descriptive statistics that further motivate studying debit use as a consumer choice problem. In the raw, the Surveys of Consumer Finances and December 1996 Survey of Consumer Attitudes and Behavior appear to suggest that 34% of users employ debit despite the absence of any obvious cost advantage; not surprisingly, however, endogeneity and measurement concerns motivate econometric approaches.

Section 5 presents the core results. The findings support the standard model's key predictions. Revolvers do appear to be about 6 percentage points more likely to use debit than non-revolvers, and there is a discrete additional effect for consumers with plausibly binding credit limits. These results are robust to controls for credit and payments demand, supply, and related tastes; i.e., conditional on exogenous household demographics, adding additional proxies for transacting and borrowing motives, for access to debit and credit, and for secular tastes that might effect payments choice do not change the results meaningfully. The findings are also consistent with the prediction that

[7] See, e.g., Canner, et al. (1997) and Moskowitz and Vissing-Jorgensen (2002) on asset allocation, and Gross and Souleles (2002) and Laibson, et al. (2003) on the simultaneous holding of expensive credit card debt and low-yielding liquid assets.

bankcard holders should take the free float where possible, and therefore be less likely to use debit, but this result generally lacks statistical significance.

Section 6 refines the point estimates and their interpretation as a test of the canonical consumer choice model. It shows that several types of data limitations (including the lack of SCF data on cash back, rewards programs, and individual bankcard balances) imply that the observed price sensitivity of debit use is a lower bound of the true one, and almost certainly a conservative lower bound at that. The results thus cast doubt on the need to appeal to behavioral theories in explaining the rise of debit use; rather, consumer price sensitivity in the face of steady debit supply increases could well be sufficient.

Section 7 concludes by briefly discussing the findings' implications for the study of electronic payment adoption and consumer choice more generally.

2. Consumer Choice at the Point-of-Sale

This section details the consumer choice problem at the POS. I describe how debit and credit offer essentially identical advantages relative to alternative payments media, and how they enjoy virtually identical acceptance. Therefore it proves straightforward to boil down the POS payments choice to one between debit and credit. Turning to the choice between debit and credit, it is shown that while credit offers free float to non-revolvers, and superior fraud protection and reward incentives during the sample period, debit is a relatively cheap alternative for certain consumers. Specifically, standard consumer choice theory generates tight predictions on which consumers should be more likely to use debit— those who revolve credit card balances, those who face binding bankcard credit limits, and those who lack a bankcard.

Debit card payment mechanics

There are two types of debit card transactions, "online" and "offline".[8] Online transactions are processed using a POS terminal and personal identification number (PIN), and involve some real-time verification of the cardholder's available funds. Offline transactions are signature-based, and are processed much like traditional credit card transactions, with no immediate attempt to verify funds availability.[9] In either case payments are deducted "directly" from the cardholder's checking account; in practice this takes 0-3 days, with online transactions typically settling more quickly.

Payments choice

Traditionally, the literature on media of exchange have focused on acceptance, security, portability, time costs, and pecuniary costs as the key elements of payments choice (Jevons 1918). I begin by briefly comparing debit, credit, and alternative payments media along each of the first four dimensions, and then develop a simple model of consumer choice between debit and credit based on pecuniary costs.

[8] Hayashi, et al. (2003) provides a thorough guide to the debit card industry's institutions and operations.

[9] In 2001, there were 4.1 billion online transactions and 6.7 billion offline transactions in the U.S. (Financial 2003).

Acceptance: Debit and credit enjoy similarly widespread acceptance as a payments device; indeed, Shy and Tarkka (2002) treat them as equivalent. Rough equivalence has come about due to the rise of "offline" debit, whereby an ATM card with a Visa or Mastercard mark can be used, as a debit card, anywhere the credit card brand is accepted. In essence then, one can use debit wherever one can use credit (with a few exceptions, including online purchases, car rentals, etc.)[10] Consequently debit and credit are essentially equivalent along this margin when compared to cash or check.[11]

Security: Debit and credit now offer essentially identical fraud protection (this is a relatively recent advent and is discussed further in Section 6), and hence offer similar protection against theft compared to cash or check.

Portability: Obviously, debit and credit are plastic card-based media, offering identical advantages over bulkier cash and checkbooks.

Time costs: Debit and credit transactions are typically processed exactly the same way, using either a POS terminal or signature-based transactions. These methods may be more or less time-consuming than cash or check, depending on the situation. Debit does offer the additional advantage of "cash back" in some cases, but empirically this is not a dominant feature of debit use, and I postpone detailed consideration of this feature until Section 6.[12]

Clearly, debit and credit offer very similar attributes along the acceptance, security, portability, and time cost margins. Presume then for a moment that transaction demand is exogenous, and that an optimizing consumer holding one bank credit card, when confronted with a POS transaction, chooses her payment medium in two steps by:

1. Deciding whether to use "paper" (cash, check) or "plastic" (debit, credit), based on the four margins discussed above.
2. Minimizing pecuniary costs, conditional on the choice in step 1.

Then in the case where the consumer is using plastic, she faces the following problem:

(1) $\text{Min } [C_d(p), C_c(H, f, r(R, r_{purch}, B, L))]$

C_d and C_c and represent the marginal (implicit) pecuniary cost of using debit and credit, respectively. The direct cost of C_d debit depends on p, the amount of the transaction fee

[10] Imperfect substitutability between debit and credit on the acceptance margin will generate bias in favor of the null hypotheses developed below. See Section 6 for discussion.

[11] For simplicity, I ignore "smart" or prepaid cards (only 3% of US households used them regularly in 2001), and Automatic Clearing House payments ("autodebits", which tend to be used for recurring bill payments and not at the POS).

[12] About 17% of debit transactions involve cash back (Breitkopf 2003), and only about 29% of regular debit users ever get cash back (December 1996 Survey of Consumer Attitudes and Behavior). Note also that cash back is only available in the 25% of merchant locations where there are the POS terminals required for online (PIN-based) debit (Breitkopf 2003). See also Section 4.

that is sometimes levied.[13] During the sample period under consideration in this paper only about 15% of debit cardholders faced transaction fees (Marlin 2003), and the modal nonzero fee was 25 cents (Consulting 2001). Most fees were and are charged on online debit transactions only; charges per offline or credit card transaction have been very rare in the United States.

The cost C_c of using credit depends first on H, whether the household has a bankcard. Assume for simplicity that households lacking a bankcard (H=0) do so only for supply reasons[14] (alternative explanations are considered in Section 5). Then C_c as infinite for these households.

C_c also depends on f, the "rewards" benefits available per unit charged. These typically have been more prevalent and generous for credit than debit, and can be valued at approximately one cent per dollar charged for the 50% or so of cardholders earning rewards. (More too on this in Section 6.)

C_c depends finally on r, the effective interest rate at which the consumer must borrow (or float) to charge at the point of sale. r in turn is determined by R, a discrete variable capturing whether the consumer "revolved" a balance at her last credit card payment due date (assume for the moment that the consumer holds only one credit card; I consider the complication of multiple cards below). In cases where R =1, i.e., where the consumer did not pay her balance in full, then she must borrow-to-charge— each dollar charged on the margin begins accruing interest immediately at the consumer's "purchases" rate, r_{purch}. In contrast, when R = 0 the consumer typically enjoys the free float of a zero-interest loan for up to 60 days, so $r<0$.[15] Consequently, the stakes of making the "correct" payments choice at the POS, conditional on R, can be substantial: a revolver with nonzero but nonincreasing demand for credit card debt, who used her credit card to borrow-to-charge rather than using debit and made credit card payments only once per month, would spend about $12 more per month to charge an amount equal to one-half of one month's median income ($2,000) at the median rate revolvers face (14.5% APR).[16]

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[13] For the purposes of discussion I assume that the effective interest rate on debit transactions is zero, ignoring settlement lags (which can provide a day or two of free float) and costly checking account overdrafts (Fusaro 2003).

[14] This seems plausible in a standard consumer choice framework, since holding a bankcard is essentially costless in the pecuniary sense, given the prevalence of no-fee cards and strong fraud protection.

[15] For example, say I paid my MBNA balance in full on September 10th (a payment due date, typically one month after a statement closing date). Then my MBNA balance netting charges and credits during the period from September 11st to October 10th must be paid in full on or before *November* 10th in order for me obtain free float on purchases made between November 11th and December 10th.

[16] This assumes no debit transaction fees (see below). Thus far we have considered an optimizing consumer facing a marginal decision. This begs the question, however, of why, if the revolving consumer does not wish to borrow more on the margin and is capable (in a cash flow sense) of using money from her checking account (via a debit transaction) to settle marginal transactions over time, does she not: a) simply pay down any credit card balance *in advance* (say immediately after getting paid), and then b) use her credit card to transact until the next pay date. One possibility is that the foregone arbitrage is relatively small. Consider a worker who is paid every two weeks and carries the median bankcard balance ($1,800) at the median interest rate (14.5% APR) for SCF revolving households. Even under the extreme assumptions that the household has sufficient cash flow to pay off the entire balance upon salary receipt, and that the credit card is a perfect substitute for checking account balances as a payments device, foregone arbitrage for the two-

r also depends discretely on whether B, the amount outstanding on the credit line L, exceeds L. When B>L typically three adverse things happen to the consumer: i) the rate on the outstanding balance increases substantially, i.e., $r_{over} >> r_{purch}$; ii) an overlimit fee ranging from \$20-\$30 is incurred, and iii) her credit rating worsens.[17] r may also vary smoothly with B and L, depending on the option value of borrowing (more on this in Section 5).

The key insights from framing the choice problem in this way are straightforward: we find that debit card use is relatively attractive to households lacking a credit card, revolving a credit card balance, or facing a binding credit card limit constraint, because each of these conditions raises the marginal cost of using credit relative to debit. This suggests the following empirical test:

$$(2)\ Y_i = \alpha + \beta_H H_i + \beta_R R_i + \beta_F F_i + \delta X_i + \varepsilon_i$$

Where i indexes consumers, Y is a measure of debit use, H and R are defined above, F is a 1/0 measure of whether the household faces a binding credit card limit constraint, and X includes several variables that can be used to help identify the model by capturing other payments costs, payments and credit demand, and tastes. The canonical consumer choice model predicts that β_R and β_F will be positive, and that β_H will be negative. In each case the null hypotheses is that $\beta = 0$.

For the moment the model ignores (or subsumes in X) debit transaction fees, cash back motives, rewards incentives, and differences in acceptance. This approach is motivated by data limitations discussed below. Note however that in each case the unobserved information will bias the estimates towards acceptance of the null, if at all, since any effect is to produce revolvers who rationally do not use debit (due, e.g., to rewards incentives), or non-revolvers who rationally do use debit (due, e.g., to cash back transactions). The nature and magnitude of these potential biases are discussed in greater detail in Section 6. For now I focus on the empirical implementation of equation (2) subject to data constraints.

3. Data and Identification

This section details the data and identifying assumptions employed to implement equation (2), a test of the discrete effects of marginal cost on payments choice. I use data from the 2001 Survey of Consumer Finances (SCF), a nationally representative cross-section of approximately 4,000 U.S. households, which contains some information on debit use and detailed data on credit card use, financial status, and household

week period is only around \$3.50 (assuming that the payment takes a few days to settle, and that charges are incurred smoothly over the two week period). This seems comparable to the time, hassle, and transaction costs of making an extra credit card payment per month; Brito and Hartley (1995) show that transaction costs can induce consumers to use credit cards instead lower-cost personal loans.

[17] Furletti (2003) is an excellent source of information on credit card pricing and related developments.

characteristics.[18] The SCF does not contain any information on debit transaction fees, rewards incentives, or cash back usage.

Let us begin by limiting the sample to households with bankcards (H=1), and ignoring the credit constraint variable (F), for simplicity. Equation (2) then becomes:

(3) $Y_i = \alpha + \beta_R R_i + \delta X_i + \varepsilon_i$

Now Y = 1 if the household reports using a debit card and zero otherwise,[19] and R =1 if the household did not pay its most recent balance in full on *any* bank credit card. (I maintain the linear functional form for notational simplicity, despite the binary dependent variable.) Unfortunately, the SCF does not report balances for individual bankcards, but rather totals balances outstanding over *all* of the household's bankcards. This creates a downward bias on the effect of R if some households use separate bankcards for borrowing and transacting, and motivates close consideration of samples that are restricted to the 25% of households with only a single bankcard. As above, X contains households characteristics and other marginal cost variables designed to remove any unobserved correlation between debit use and revolving behavior. These covariates are detailed in Section 5.[20]

In some cases it will be useful to pool SCF cross-sections. The survey has been conducted every three years since 1983, and asked questions on debit use since 1992 (Table 1a shows the rapid growth of debit use among SCF households from 1992 to 2001). As the SCF lacks any panel component in the years under consideration, the pooled specifications simply add year effects T to produce:

(4) $Y_i = \alpha + \beta_R R_i + \delta X_i + \tau T_t + \varepsilon_i$

To reiterate, standard consumer choice theory predicts that the true β_R should be positive. Note the commonly told self-control story, whereby households use debit to control their credit card borrowing, implies a *negative* relationship between Y and R. More generally, estimating (3) or (4) using OLS (linear probability), probit, or logit will, under the usual distributional assumptions about the error term, produce the true causal effect of revolving credit card debt on debit use if there are no unobserved characteristics that are correlated with both revolving status and debit use. I therefore use the richness

[18] For more information on the SCF see, e.g., Aizcorbe, et al. (2003).

[19] See Appendix 1 for the debit use survey question. The SCF yields proportions of debit users comparable to other surveys; e.g., the Standard Register's *National Consumer Survey of Plastic Card Usage*, a random phone survey of 1,202 households, found that 37% were debit users in March 1999. The 1998 SCF (collected January-August) found that 34% of households were debit users.

[20] One issue not captured in the notation is that the SCF produces 5 implicate observations per household in the interest of maximizing precision in the presence of substantial imputation of certain financial variables; see, e.g., Kennickell (1998) or Little (1992). Although I use the full dataset of 5 observations per household (and correct standard errors accordingly, using the routine provided by the 2001 SCF codebook at http://www.federalreserve.gov/pubs/oss/oss2/2001/codebk2001.txt), reported sample sizes will be based on the number of *households.*

of SCF data to condition on several characteristics and behaviors that potentially confound interpretation of β_R. Specifically:

- β_R will be biased downward if R is positively correlated with latent credit demand, given that the SCF only captures a single snapshot of behavior; e.g., if a household is ramping up their credit card balances (as opposed to having reached a steady-state debt level), it will be less inclined to use debit since it is using the credit card to *borrow* as well as charge at the POS (i.e., not simply using the credit card as a payment device). Accordingly, I include behavioral, life-cycle, and attitudinal proxies for credit demand among the X (control) variables. These are described in Section 5. Table 1a shows two examples of how debit use does appear to vary systematically by demographics (age and education).
- β_R also might be biased downward if R is correlated with transactions demand; e.g., in the absence of data on cash back transactions, we might confound revolving behavior with high transaction volume. This motivates incorporating information on income, spending, and wealth into certain specifications.
- conversely, β_R will be biased upward as a test of the canonical model if consumers are indifferent (and hence randomly choose debit or credit at the POS), or if both revolving behavior and debit use are driven by some unobserved "taste for plastic". The former source of bias can be addressed by introducing additional information on wealth, along with data on credit card interest rates and line utilization that affect the marginal cost of charging and are of independent interest. The latter problem should be ameliorated by adding data on use of other electronic payments instruments to the set of covariates.

Adding measures of F, the binding credit constraint variable, to this model is then straightforward. The natural measure is based on bankcard credit line utilization. Section 5 lays out the various specifications in greater detail, but first let us turn briefly to some raw data to further motivate testing cost-based hypotheses of debit use.

4. Debit Use in the Raw

In this section I supplement data from the SCF with data from the December 1996 Survey of Consumer Attitudes and Behavior (University of Michigan, 1996). The December 1996 SOC is the only publicly available household-level nationally representative survey with data on debit usage intensity, cash back transactions, and transaction fees. The December 1996 SOC surveyed 501 households.

The raw tabulations in Table 2 cast some doubt on whether a traditional consumer choice model can fully explain debit use. Although 20% of debit users do not have a bankcard, and another 42% revolve balances, it appears that perhaps 34% of users employ debit despite the absence of any obvious cost advantage. Three measurement caveats are in order here however. The "Exclusive Cash back User" estimate of 4% is based on a very small, somewhat dated SOC sample. Moreover, revolving behavior is

probably *under*estimated in the SOC and SCF.[21] So in these two respects the 34% "puzzle" may be overstated. On the other hand, revolving behavior in the SCF is captured merely as a snapshot, and certainly includes revolvers who still have unmet demand for consumer credit, and who therefore rationally use credit rather than debit at the POS. So in this sense the SCF measure of revolving behavior *over*estimates the number of households with pecuniary incentives to choose debit. On balance then this simple attempt to account for debit users appears consistent with an important role for pecuniary cost-based drivers of POS payments choice, but raises the possibility of significant nontraditional motives as well.

The rightward six columns of Table 1a show some tabulations that are closer to the spirit of the regression models developed in the previous section, as they highlight whether households facing higher marginal costs of credit card use at the POS appear *more likely* to use debit. In this case households without bankcards actually appear *less* likely to use debit than households with bankcards, counter to the prediction developed in Section 3, while revolving and high utilization households do seem more likely to use debit as predicted.

Overall, not surprisingly, the raw data are more provocative than definitive. Simple tabulations appear consistent with several different types of explanations for debit card usage, and they reinforce the intuition, developed in Section 3, that controlling for certain observable characteristics and constructing homogeneous samples will be important.

5. Core Results

This section presents results obtained from estimating equations (3) and (4), which are designed to identify the effect of bankcard use on regular debit card usage. The results suggest that, as predicted, both revolving a card balance and facing a binding credit limit significantly increase debit usage. Evidence on the effect of holding a bankcard is weaker, but still yields some support for the standard consumer choice model. In all, the results suggest the consumers respond strongly to the relative marginal cost of payment instruments at the POS.

Revolving

I estimate β_R, the effect of revolving credit balances on debit card usage, by implementing models (3) and (4) on several samples from the SCF.[22] The key results, presented in Table 3, suggest that revolvers are significantly more likely to use debit cards, to the tune of perhaps 6 percentage points. The base specification contains several covariates in the X vector that are designed to identify β_R as a test of the canonical

[21] *Total* credit card borrowing in the SCF falls far short of aggregate figures compiled from issuers. Comparison on the *extensive* margin is less definitive, but Gross and Souleles (2002) find revolving prevalence in issuer data that is consistent with substantial underreporting in the SCF.

[22] Throughout the paper I report probit marginal effects with SCF sample weights; using linear probability or logit produces virtually identical results. The results are also robust to using unweighted estimation on samples that exclude wealthy households *a la* Hayashi and Klee (2003).

consumer choice model. These variables include controls for debit card supply (census region,[23] housing type, and ATM cardholding status); and for life-cycle and transient proxies for transaction demand and secular tastes which might effect payment choice (income last year, last year's income relative to average, number of household members, homeownership status, marital status, attitudes toward borrowing for luxury items, occupation, age, gender, educational attainment, military experience, race, and 1-digit industry).[24] Appendix 2 details the covariate definitions.

The first two columns of results in Table 3 show the effects of omitting some or all of these control variables. Column 1 omits all of the X's, and simply produces a univariate correlation between debit usage and revolving behavior. Column 2 includes only those X's that plausibly are determined independently of R, namely housing type, household size, age, marital status, homeownership, race, gender, education, and income. Column 3 includes all the variables in the base specification.[25] Overall these results suggest, not surprisingly, that the covariates are critical to identification, with the base specification producing point estimates that are generally one-half the size of the raw correlation between debit use and revolving status. Importantly, the base specification appears robust to adding additional information designed to control for the particularly worrisome types of heterogeneity discussed in Section 3. Adding covariates that plausibly capture additional information on transactions demand (including functions of wealth, and of the level of spending relative to income) tends to reduce the point estimates slightly but not significantly (results not shown). Adding covariates that might be correlated with a "taste for plastic", including usage of other electronic payments and/or computer banking, does not change the results either (not shown).

Reading down rows in Table 3, the estimation samples include the individual SCF cross-sections from 1995, 1998, and 2001, as well as the three samples pooled together.[26] This strategy is motivated by the rapid growth in debit usage over time, as Table 1a indicates. Comparing results across the three sample years individually suggests stability in the relationship between revolving any credit card debt and debit use from 1998 to 2001, but not between 1995 and the other two survey years. Estimates using the base specification on the 1995 cross-section are substantially smaller, and insignificant.

Table 3 also exhibits the effects of limiting the sample based on cardholding and charging behavior. These cuts are motivated by the measurement issues discussed in Section 3, but in fact leave the results unchanged in most cases. The results are also robust to other alternative measures of revolving behavior (not shown), including using

[23] Census region is not available in the 2001 SCF public release; results estimated on the 1995 and 1998 do not change if region is omitted.

[24] Results do not change if one-digit occupation code is used instead of, or in addition to, industry.

[25] Appendix 3 displays the correlations between debit usage and the control variables from a regression using this specification on the 1995-2001 pooled sample.

[26] I omit the 1992 data because the question on debit lacks the later emphasis on regular usage (see Appendix 1). Adding 1992 data to the pooled sample tends to reduce the point estimates slightly. I omit households lacking a checking account (14% of households) or with nonpositive income (0.7% of households). Including these households does not change the results.

total credit card balances or self-reported habitual revolving behavior to define R instead of the most recent bankcard revolving balance.

Table 4 presents estimates of the effect of bankcard holding on debit use. Except for the 1995 sample one finds the expected effect that cardholding reduces debit use, *ceteris paribus*, but the results are imprecisely estimated. The second column of Table 4 shows that adding bankcard holding, H, to the base specification including R does not change the effect of revolving status (compare this column to column 1, which replicates the base covariate specification estimated on the cardholding sample in Table 3). This regression is estimated on the "full" SCF, which excludes only those households without a checking account or nonpositive income. The third column presents the estimates of β_H from the same regression. The fourth column includes only H as the regressor of interest, and excludes revolvers from the sample in order maximize sample homogeneity (by including only those households without bankcard debt). Overall the effect of H is often large-- with reductions in debit use of up to 7.5 percentage points— but significant only in the 1998 sample.[27] The data thus preclude drawing firm conclusions as to whether bankcard holding actually reduces debit use.

Table 5 presents estimates of the effect of binding credit constraints on debit use. The first panel presents results from a regression where revolvers are divided into three utilization categories based on the ratio of their most recent bankcard balances to their credit limit, with non-revolvers as the omitted category.[28] As predicted in Section 3, the most intense credit card borrowers-- the 7% of the sample with utilization rates of 75% or greater-- appear discretely and significantly more likely to use debit than the least intense revolvers.[29] The result holds in every sample but the 1995 cross-section.

Additional results suggest that future credit constraints may be as important as current ones in driving debit use. If only current credit constraints matter, than we would expect discrete jumps in debit use only at the bottom and top of the utilization distribution. The jumps capture the revolving and credit limit effects, respectively. But if the anticipation of future credit constraints matters, we might find that the credit limit begins to bind at utilization levels substantially below 100%, if consumers hold buffer stocks of available credit. The latter case appears to hold. Whether one demarcates line usage as in panel one, or by conditional terciles (producing much lower cutoffs for medium and high intensity, shown in panel two), it appears that debit usage jumps discretely and

[27] The power problem could stem in part from biases. Attenuation bias could result since cardholding mechanically effects revolving behavior (this type of econometric problem is discussed in Angrist and Krueger 1999). An unobserved self-control motive would also attenuate β_H, if consumers somehow use debit to avoid over-charging *while holding* bankcards. (On the other hand, β_H will be strengthened if consumers don't *take* bankcards due to self-control concerns.)

[28] I use total bankcard balances and the credit limit variable (x414) in constructing the utilization measures; using total credit card balances instead has little impact on the results.

[29] Gross and Souleles (2002) use utilization categories of 0-50%, 50-90%, and >90% in their analysis of the impact of credit constraints on interest rate elasticities and propensities to consume out of available credit. This demarcation is impractical in my sample since only 3% of households have utilization >90%. Presumably this low proportion is due to: a) underreporting of credit card borrowing, and b) the fact that the SCF credit line variable may include lines from multiple cards.

significantly for medium but not high intensity users.[30] Panel three explores this further by dividing revolvers based on conditional quartiles of line utilization, and finds again that the second discrete jump in debit use seems to occur somewhere in the middle of the utilization distribution. Finally, it also appears that households reporting no emergency access to capital from family or friends are much more likely to use debit at lower utilization levels, although none of the differences by this proxy for buffer liquidity are statistically significant.

Table 6 displays evidence suggesting that the utilization and revolving effects on debit use operate through reductions in bankcard charges, as one would expect. Mechanically, that is, one expects to find revolvers charging less on their bankcard if they are in fact minimizing the marginal cost of POS payments by not borrowing-to-charge. This appears to be true, resoundingly, regardless of how one measures revolving behavior.[31] The table presents results only from the 2001 and pooled samples for brevity's sake, and in both samples one finds large reductions in the level of bankcard charges for revolvers relative to non-revolvers. The $428 and $344 reductions in the 2001 and pooled samples (column 1), respectively, each amount to 60% of the sample mean; estimating mean charges using tobit instead of OLS, or estimating median charges using least-absolute-deviations, produces equal or greater proportional reductions (not shown). Debit users do not exhibit significantly greater reductions than non-users, however, suggesting that some revolvers may switch to cash or check rather debit to manage their payments costs. This makes sense if, as hinted earlier, credit may actually dominate debit as a medium of exchange along certain dimensions (e.g., fraud protection, acceptance), a possibility discussed further in Section 6. Another possibility, suggested weakly by the point estimates on the utilization variables, is that there is some fixed cost of adopting debit use.

Overall, the evidence on the effect of revolving, utilization, and (to a lesser extent) bankcard holding suggests that consumers respond strongly to discrete differences in the marginal cost of payments alternatives at the POS. The findings are less conclusive on the impacts of smaller cost differences. Specifically, a higher interest rate on bankcard balances makes it more expensive to borrow-to-charge, all else equal; accordingly, we might then expect to find debit use increasing in this rate for revolvers. The data produce point estimates (not shown) that are generally "right-signed", but small and imprecisely estimated; e.g., in the pooled sample, the probability of debit usage appears to increase by .09 percentage points (0.2%) for every 100 basis point increase in the interest rate for revolvers (but not for non-revolvers), with a t-statistic of only 0.43. Some of the imprecision may be due to the fact that we observe only the household's current rate on

[30] The finding here seems analogous to the discrete jump in the propensity to consume out of available credit among medium intensity users found in Gross and Souleles (2002).

[31] A data limitation in the SCF motivates experimentation with the alternative measures of R presented in the second and third columns of results in table 6. The problem is that the SCF only captures *the previous month's* charges, and presumably some fraction of households started revolving only *after* choosing not to pay the previous month's balance in full. For this fraction one would not necessarily expect to observe lower charges in the previous month. Accordingly, the regressions presented in column 2 define revolvers as those who are currently revolving a balance and report habitually revolving a balance; column 3 regressions take the more extreme step of excluding current-but-not-habitual revolvers from the sample.

the card with the largest balance. Given the prevalence of teaser rates, for example, we might underestimate the effect of credit card interest rates on *regular* debit use if the observed interest rate understates the typical rate. As such I replicate the analysis on the 78% of households reporting interest rates greater than 9.99%, and find that the estimated point estimate in the pooled sample does increase twofold (but with a t-statistic of only 0.53).

In all, the standard errors and measurement limitations do not rule out large effects on the intensive rate margin. The confidence intervals allow for debit usage increases of up to 0.9 percentage points per 100 basis point increase in the bankcard interest rate. This would imply a substantial price response, given the base probability of debit use (40%) and the observed spread of interest rates (1st percentile = 1.99%, 99th percentile = 23.9%). Transaction-level data could be used to estimate this effect more precisely in future research (see Section 7).

Summarizing the key results presented in this section, it appears that households do in fact respond strongly to discrete changes in the marginal cost of payments at the POS. This is evidenced by the significant effects on debit use of revolving status and credit limit constraints in particular. Pecuniary marginal cost minimization accounts for a roughly estimated 25% of cross-sectional debit use-- if we simply sum the absolute values of β_R and β_H in the base pooled sample, and scale by proportion of debit-using households. The next section refines and interprets this estimate by considering measurement issues and the null hypothesis in greater detail.

6. Measurement Error and Interpretation

This section refines interpretation of the paper's core results by exploring how measurement error might impact the key estimates presented in Section 5. In particular, seven different measurement issues could bias β_R downward and thereby understate the role of canonical consumer choice in driving debit use. The discussion below draws on regression results presented in Table 7. Appendix 4 contains more detail on related variable construction and estimation procedures.

Mismeasurement of R, revolving behavior. Section 5 considered alternative definitions of R based on different *reported* measures of credit card borrowing. A deeper problem is that the reports themselves may systematically understate revolving prevalence (see footnote 21). I address this "misclassification" problem in two ways. The first approach exploits SCF interviewer observations on the quality of a household's responses. Limiting the sample to those most likely to respond truthfully (Table 7, column A) and accurately (column B) increases the estimated effect of revolving on debit use by up to 4 percentage points, but not significantly so. The second method implements the (Mahajan 2004) corrections for misclassification error in binary regressors, using my habitual measure of revolving as the true R of interest, and the behavioral measure of bankcard revolving as the instrument. If we assume that misclassification in R is independent of the covariates, then β_R rises to [] in the base specification; more realistically, allowing the

misclassification to vary with race, income, and education increases β_R to [a precisely estimated]. Overall then it appears that misclassification of R [does/not] significantly attenuate estimates of β_R.

Omitted strategic default motives. β_R might also understate the extent of rational cost minimization if the model fails to capture strategic default. In particular, a revolver who is contemplating bankruptcy, or simply not making interest payments, might rationally elect to continue borrowing-to-charge rather than using debit.[32] Accordingly, I use SCF credit scores to re-estimate the base specification on a sample of high-risk borrowers. Column A shows that the point estimate in the high-risk pooled sample increases slightly; this result is driven by stability in the 1995 and 1998 estimates, as the 2001 point estimate (column B) increases sharply. Alternately, conditioning on functions of the credit score in the pooled base sample *reduces* the point estimate by about 2 to 2.5 percentage points but also leaves the qualitative results unchanged. Overall then there is little to suggest that omitted strategic default motives dramatically impact the results.

"Cash back" motives for debit use. The ability to get cash back at the POS via an online debit transaction makes debit use attractive by eliminating a separate trip to the ATM (which consumes time, and may require a transaction fee). Practically, the absence of data on cash back usage in the SCF confounds interpreting β_R as a test of the canonical consumer choice model because some proportion C of *non-revolvers* should use debit regularly (and exclusively) to obtain cash back. I explore the magnitude of this bias via a simulation that randomly assigns an "exclusive cash back" motive to non-revolving debit users in the SCF. Raw data suggests that C is low-- calculating it directly in the SOC yields 7%. This is not surprising in light of other data showing that cash back transactions are relatively infrequent, and that relatively few debit users initiate them (only 18% in the April/May 1999 PSI Global Survey, 29% in the 1996 SOC). As such I conduct simulations allowing for weak and strong exclusive cash back motives, where C = 7% and C = 40%, respectively. β_R rises to 0.079 in the former case (column A), and to 0.158 in the latter case (column B). Thus it appears that unobserved cash back motives could produce substantial downward bias on the estimate of consumer responsiveness to the marginal cost of payments.

Fraud costs/security precaution. Credit cards offered superior fraud protection during the sample period studied in the paper (Financial 2002). As such, some revolvers might rationally borrow-to-charge rather than using debit, if the expected fraud loss on a marginal transaction exceeds the expected marginal finance charge. But adding the SCF's categorical measures of appetite for financial risk as additional covariates leaves β_R unchanged. The SCF variable is likely to be an imperfect proxy for expected fraud loss, however, so I tap market research on preferences for online debit to help develop a rough idea of the extent to which unobserved security concerns might influence estimates of β_R. The *STAR 2000 Consumer Awareness, Trial and Usage Study* found that 51% of debit users preferred online debit, among whom 54% cited better security (due to the PIN

[32] Thanks to Bob Avery for suggesting this line of inquiry. About half of bad credit card debts are written off without the debtor filing for bankruptcy (Dawsey and Ausubel 2002).

requirement) as the primary reason for their preference. Accordingly, let us assume that (.51*.54) = 27.5% of debit users will use *only* online debit; given the relative scarcity of PIN terminals (compared to offline facilities), this implies that debit is an unobservably poor substitute for credit for these consumers. I simulate the effect this might have on β_R by randomly assigning a "security precaution" motive to a proportion S of revolvers who do not use debit, taking 27.5% as the strong case, and an arbitrary 5% as the weak case.[33] β_R rises to 0.085 in the weak case (column A) and to 0.134 in the strong case (column B). Overall, it seems that unobserved security precautions might lead to some attenuation of β_R.

Rewards incentives favoring credit use. Credit cards typically offer more generous "rewards" (e.g., frequent flier points, cash back, etc.) than debit.[34] The marginal benefit of these rewards might exceed the marginal cost of borrowing-to-charge for many consumers, implying that any unobserved net benefit could bias estimates of true price sensitivity downward. Assume then that some fraction Z of revolvers prefer to borrow-to-charge, rather than use debit, in order to obtain rewards. I simulate a "strong" version of the rewards motive by setting Z to 60%, in light of recent survey evidence that "rewards dominate the reasons to use a specific card for 6 in 10 Americans".[35] The "weak" version is motivated by the roughly 20% of SCF households who report credit card interest rates of less than 10%. The latter case produces a β_R of 0.115, with the former yielding a huge increase to 0.274. In all it seems likely that omitted information on rewards usage leads to substantial downward bias on the core estimates of consumer sensitivity to the marginal cost of payments.

Multiple bankcards—as discussed earlier, the SCF captures total bankcard balances across *all* bankcards. R therefore must be derived from this aggregate measure, whereas a true test of a canonical consumer choice model would require information on whether the consumer has the ability to "float" on any *single* bankcard. The most direct test of the degree to which this biases β_R is to limit the sample to households holding a single bankcard (Table 3); however, this approach invites sample composition effects. Alternatively, one could make assumptions on the degree to which those *appearing* to borrow-to-charge in the data are in fact rationally floating. The rewards and security simulations, which also treat revolvers who do not use debit, give a sense as to how large the bias could be.

Debit card supply and merchant acceptance. Although debit is available and accepted widely today-- as 80% of ATM cards sport the offline Visa logo alone (Consulting 2002), and as PIN terminals steadily increase in prevalence— this was much less true in 1995.

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[33] Note that this strong case is almost certainly too extreme, since presumably many consumers who refuse to use offline debit still use online debit regularly and the outcome of interest is a binary measure of regular debit use.

[34] Despite widely publicized new programs on the debit side, the *STAR 2002 Annual Consumer Survey* found that only about 6% of consumers get ATM or debit rewards (c.f. Marlin 2003). In contrast, credit card incentives have been prevalent for years. The December 1996 SOC found that 56% of credit card holders had a card with rewards.

[35] Quoted from summary of Edgar, Dunn, and Company's *PaymentDynamics 2004 Preferred Card Study* at http://www.edgardunn.com/uploads/PaymentDynamicsOverview.pdf .

Practically, this implies the during the early part of the sample period under consideration in this paper, there were nonusers who would have used debit given the right supply conditions. If some of these consumers instead borrowed-to-charge, then our estimate of marginal cost sensitivity would again be biased downwards. This effect probably helps explain why β_R is so much lower in 1995 than in later years.

Overall then, it seems plausible that data limitations significantly dampen β_R, the observed effect of revolving on debit use.[36] Better data on cash back, rewards, and individual card balances would be particularly useful for generating more accurate estimates of the importance of marginal cost, traditionally defined, on debit use.

7. Conclusion

I close by summarizing evidence on the predictive power of alternative consumer choice models in the market for retail payments, and by discussing related implications. The results presented in this paper suggest that consumers respond strongly to the relative cost of payments at the point-of-sale, with the core findings implying that canonical cost minimization can explain perhaps 25% of regular debit use. Adjustments for measurement error and other biases admit the possibility of much larger "true" point estimates.

These results have at least two implications for the evolution of the retail payments industry and related policy issues. First, they suggest that debit and credit are substitutes, and thus cast doubt on the widespread notion that debit's growth has come largely at the expense of cash and checks (Reosti 2000). Second, they imply that the adoption of general purpose stored-value cards will likely depend not only on network effects and safety/convenience advantages relative to paper-based media, but also on the marginal cost faced by the consumer relative to credit and debit.[37] For example, if, in equilibrium, the pecuniary transaction cost for stored-value proves less than for debit (due, e.g., to lower verification costs), then stored-value will become a viable way for revolvers to avoid borrowing-to-charge.

Clearly, however, the data do not rule out less traditional explanations for debit card use and payments choice generally. The point estimates, confidence intervals, and raw household data each leave room for a large residual number of debit users who are not motivated by canonical marginal cost minimization. Moreover, other raw data appear consistent with particular behavioral explanations for debit use. The aforementioned fact that average debit transaction size is significantly smaller than that for credit seems puzzling in the presence of fixed transaction fees for debit, but might square with mental

[36] Note that missing information on the prevalence of debit transaction fees is *not* likely to bias estimates on β_R, since fees are: 1. not very prevalent (see Section 3); and 2. typically charged only on *online* debit transactions. As such fees are unlikely to influence the *extensive* margin of debit use, all else constant, since in most cases consumers will have the option of a fee-free offline transaction.

[37] Santomero and Seater (1996), motivated in large part by prepaid cards, model a consumer choosing among several media of exchange.

accounting (Thaler 1985). More specifically, market research suggests that debit helps many households "control spending" (Financial 2001), suggesting a "pain of paying" (Prelec and Loewenstein 1998) relative to credit that might be optimal for sophisticated consumers with self-control problems.

The market for retail payments is thus a fertile ground for refining and testing models of high-frequency intertemporal consumer choice. [Next steps....]

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Table 1a. Debit Use in the Raw, Over Time

		Has Checking Account and Positive Income (The "Screened Sample")										
Year(s)	*Full Sample*	*Screened Sample*	*No High School*	*College Degree*	*Age 18-34*	*Age 65+*	*No Bankcard*	*Has Bankcard*	*One Bankcard*	*Not Revolving*	*Revolving*	*High Utilization*
1992	0.09 3906	0.11 3429	0.01 226	0.16 1917	0.14 620	0.04 829	0.06 682	0.13 2747	0.10 9645	0.13 1724	0.13 1023	0.14 134
1995	0.18 4299	0.20 3795	0.09 188	0.25 2072	0.30 701	0.10 881	0.14 643	0.23 3152	0.19 914	0.19 1876	0.25 1275	0.20 156
1998	0.34 4305	0.39 3821	0.14 183	0.44 2156	0.57 642	0.17 832	0.33 674	0.40 3147	0.36 952	0.32 1880	0.48 1267	0.54 176
2001	0.47 4442	0.51 3989	0.31 199	0.58 2301	0.72 656	0.22 847	0.43 608	0.53 3380	0.45 996	0.44 2027	0.61 1353	0.72 183
1995-2001	0.34 13046	0.37 11605	0.18 570	0.43 6529	0.53 1999	0.16 2560	0.30 1925	0.40 9679	0.34 2862	0.33 5783	0.45 3895	0.51 515

Each cell presents the proportion of U.S. households in a given SCF (sub-)sample that report using debit, and the number of households in the sample under consideration. Proportions obtained by weighting SCF means by variable x42001. The "screened sample" includes only households with a checking account and positive income. "Not revolving" sample includes bankcard holders only. High utilization is defined as revolving bankcard balances greater than 75% of available credit limit. Sub-samples may not aggregate exactly to full samples due to rounding (recall that the unit of observation in the SCF is an implicate, not a household).

Table 1b. Means for Selected Regressors and Covariates

Bankcard Holders Sample

SCF Year(s)	*Has Bankcard*	*Revolves*	*Vacation borrow*	*Jewelry borrow*	*ATM card*	*Income > normal*	*Income < normal*	*Spend > income*	*E-Payments*	*Computer Banking*
1995	1.0	0.56	0.17	0.07	0.74	0.08	0.14	0.18	0.66	0.04
1998	1.0	0.55	0.15	0.06	0.77	0.10	0.13	0.17	0.80	0.08
2001	1.0	0.53	0.16	0.07	0.79	0.13	0.13	0.15	0.84	0.25
Pooled	1.0	0.54	0.16	0.07	0.77	0.11	0.13	0.16	0.77	0.13

Full Sample

SCF Year(s)	*Has Bankcard*	*Revolves*	*Vacation borrow*	*Jewelry borrow*	*ATM card*	*Income > normal*	*Income < normal*	*Spend > income*	*E-Payments*	*Computer Banking*
1995	0.76	0.42	0.16	0.07	0.70	0.08	0.15	0.18	0.63	0.04
1998	0.76	0.41	0.14	0.06	0.73	0.10	0.14	0.17	0.76	0.07
2001	0.80	0.42	0.15	0.07	0.76	0.12	0.13	0.16	0.81	0.21
Pooled	0.77	0.41	0.15	0.06	0.73	0.10	0.14	0.17	0.74	0.11

Each cell presents a weighted SCF sample mean for the variable listed in the column heading. The first panel considers the "base" sample, containing only bankcard holders with checking accounts and positive annual income. The second panel includes households without a bankcard as well. Please refer to Appendix 2 for variable definitions.

Table 2. Debit Use in the Raw
A Puzzle for Standard Consumer Choice Theory?

Household Type	Percentage of Debit-Using Households
No bankcard	20%
Revolves bankcard balances	42%
Exclusive cash back user	4%
No obvious cost advantage to debit use	**34%**

Bankcard variables from 2001 SCF. "Revolves bankcard balances" is constructed based on whether the household is currently revolving; the percentage of debit-using households accounted for by revolvers rises to 46% if ones adds households that are not currently revolving but report typically doing so. "Exclusive cash back user" is based on the December 1996 SOC, and captures households that report using debit only for transactions involving cash back (total debit transactions per month equal to cash back debit transactions per month), have a credit card, but don't typically revolve balances.

Table 3. The Effect of Revolving Credit Card Balances on Debit Use

SCF Survey(s)					
1995	.059*** (.019) 3152	.034 (.021) 3152	.014 (.020) 3152	.018 (.031) 914	.011 (.029) 2139
1998	.159*** (.022) 3147	.101*** (.025) 3147	.087*** (.025) 3147	.122*** (.041) 952	.098** (.039) 2170
2001	.167*** (.021) 3380	.098*** (.024) 3380	.083*** (.026) 3380	.053 (.047) 996	.089** (.043) 2319
Pooled	.137*** (.013) 9679	.082*** (.014) 9679	.063*** (.014) 9679	.064*** (.024) 2862	.068*** (.022) 6628
Covariates	None	exogenous only	base	base	base
Sample	base	base	base	one card only	R=1 if no charges last month only

*** Significant at the 99% level. ** Significant at the 95% level.

Each cell shows the probit marginal effects coefficient and standard error on R, as well as the regression sample size, from estimating a version of equation (3) or (4) on SCF data. Debit use is the dependent variable, and point estimates can be multiplied by 100 to translate the magnitudes into percentage point terms. All standard errors are calculated using the imputation correction provided in the SCF codebook. Covariate specifications are described in Section 5 of the text. All samples exclude households without a checking account or with nonpositive income. The "base" sample includes only bank credit card holders; regressions featured in the last column assign R=1 only to those households that compiled no bankcard charges on their most recent statement and exclude other revolvers from the sample.

Table 4. The Effect of Bankcard Holding on Debit Use

Results On:	***Revolving***	***Revolving***	***Cardholding***	***Cardholding***
SCF Survey(s)				
1995	.014 (.020) 3152	.007 (.017) 3795	.029 (.021) 3795	.032 (.020) 2519
1998	.087*** (.025) 3147	.097*** (.025) 3821	-.075** (.035) 3821	-.060* (.032) 2554
2001	.083*** (.026) 3380	.091*** (.026) 3989	-.057 (.036) 3989	-.046 (.037) 2636
Pooled	.063*** (.014) 9679	.064*** (.014) 11605	-.031 (.019) 11605	-.019 (.018) 7709
Regressors Included	R only	R and H	R and H	H only
Sample	base	full	full	nonrevolvers only

*** Significant at the 99% level. ** Significant at the 95% level. * Significant at the 90% level.

Each cell shows the probit marginal effects coefficient and standard error for the variable listed in the column heading, as well as the regression sample size, from estimating a version of equation (3) or (4) on SCF data. Debit use is the dependent variable, and point estimates can be multiplied by 100 to translate the magnitudes into percentage point terms. All standard errors are calculated using the imputation correction provided in the SCF codebook. All regressions here include the "base" covariate specification described in Section 5 of the text. The "base" sample includes only bank credit card holders (and the first column of results here therefore replicates the Table 3 base covariate specification results for reference). The two "full" sample columns present results on R (the revolving dummy) and H (the bankcardholding dummy) from the same regression (reading across any row), on a sample that includes both cardholders and noncardholders and excludes only those without a checking account or nonpositive income. The final column includes only nonrevolvers in the sample and hence omits the variable R from the regression.

Table 5. Bankcard Credit Limit Utilization and Debit Use

SCF Sample	N	*0<utilization<0.25*	*0.25-0.75*	*>0.75*	*0<utilization<0.13*	*0.13-0.42*	*>0.42*	*0<utilization<0.10*	*0.10-0.25*	*0.25-0.50*	*>0.50*
1995	3152	.028 (.023)	.009 (.026)	-.040 (.033)	.032 (.027)	.023 (.026)	-.020 (.026)	.038 (.030)	.020 (.030)	.016 (.031)	-.027 (.028)
1998	3147	.061* (.031)	.121*** (.035)	.115** (.051)	.054 (.036)	.111*** (.036)	.111*** (.035)	.048 (.039)	.086** (.041)	.123*** (.042)	.114*** (.039)
2001	3380	.053* (.031)	.100*** (.034)	.183*** (.047)	.046 (.036)	.104*** (.036)	.111*** (.036)	.057 (.037)	.054 (.042)	.128*** (.040)	.111*** (.039)
Pooled	9679	.050*** (.017)	.081*** (.020)	.089*** (.028)	.046** (.020)	.082*** (.020)	.071*** (.021)	.053** (.022)	.052** (.023)	.094*** (.023)	.069*** (.022)
Emergency Funds	2782	.044 (.035)	.093** (.040)	.186*** (.059)	.037 (.040)	.086** (.042)	.116*** (.042)	.048 (.042)	.043 (.049)	.107** (.048)	.120*** (.045)
No Emergency Funds	599	.098 (.076)	.189*** (.072)	.175* (.098)	.092 (.088)	.191** (.078)	.134* (.077)	.114 (.100)	.097 (.089)	.246*** (.080)	.117 (.083)

*** Significant at the 99% level. ** Significant at the 95% level. * Significant at the 90% level.

Each cell presents the probit marginal effects coefficient and standard error on the bankcard credit limit utilization variable listed in the column heading, for a regression on a sample of bankcard holders with checking accounts and positive income from the SCF survey year listed in the row heading. Debit use is the dependent variable, and point estimates can be multiplied by 100 to translate the magnitudes into percentage point terms. Households with zero utilization (non-revolvers) comprise the omitted category. Each regression contains the base specification covariates described earlier. Each panel presents results for a different demarcation of utilization categories, as motivated in the text. Emergency funds variable is taken from SCF variable x6443, "In an emergency could you or your (spouse/partner) get financial assistance of $3,000 or more from any friends or relatives who do not live with you?", which first appeared in the 2001 SCF.

Table 6. Revolvers Have Lower Bankcard Charges

R defined as:	*Currently revolving*	*Habitual too*	*Non-habitual revolvers excluded*	*Low intensity utilization*	*Medium intensity utilization*	*High intensity utilization*
Sample						
2001 Sample	-428*** (58)	-364*** (51)	-454*** (61)	-418*** (66)	-429*** (77)	-441*** (71)
Pooled sample	-344*** (33)	-355*** (29)	-395*** (32)	-345*** (35)	-305*** (46)	-387*** (41)
2001 debit users	-430*** (79)	-398*** (62)	-480*** (78)	-405*** (83)	-423*** (92)	-464*** (89)
2001 nonusers	-393*** (89)	-276*** (89)	-374*** (99)	-430*** (105)	-386*** (133)	-332** (124)
Pooled debit users	-328*** (53)	-390*** (44)	-412*** (48)	-305*** (59)	-269*** (77)	-417*** (56)
Pooled nonusers	-343*** (40)	-314*** (39)	-364*** (43)	-370*** (43)	-317*** (55)	-334*** (60)

*** Significant at the 99% level. ** Significant at the 95% level.

Each cell presents the coefficient and standard error on a measure of revolving behavior R, from a weighted OLS regression of level bankcard charges in the previous month on R and the usual ("base") set of covariates. Bankcard charges are measured in 2001 dollars and censored at the 99th percentile to reduce the influence of outliers. All definitions of R start with the standard 1/0 variable for whether the household revolved bankcard balances after their most recent statement (Column 1). Column 2 modifies this definition by only counting those who are both currently revolving *and* report habitually revolving as R==1; column 3 modifies it by excluding current revolvers who do not report habitual revolving from the sample. The final three columns present results from a single regression (reading across any row), with utilization measured by conditional terciles and non-revolvers (standard definition) serving as the omitted category.

Table 7. Measurement Issues and the Effect of Revolving on Debit Card Use

Baseline Results	
Pooled:	2001:
0.063	0.083
(0.014)	(0.026)

Alternate Methods	Alternate Results A	Alternate Results B
Misclassified R/ Use Interviewer Observations	0.088 (0.020)	0.104 (0.036)
Misclassified R/ Mahajan Correction		
Strategic Bankruptcy/ Incorporate SCF Credit Scores	0.079 (0.072)	0.186 (0.139)
Cash Back Motive/ Simulate	0.079 (0.015)	0.158 (0.015)
Security Precaution/ Simulate	0.085 (0.015)	0.134 (0.015)
Rewards Motive/ Simulate	0.115 (0.015)	0.274 (0.018)

Each cell presents the probit marginal effects coefficient and standard error on R, for a regression described in the row title, using the base covariate specification described earlier. As in tables 3-5, debit use is the dependent variable and one can multiple the point estimates by 100 to translate the magnitudes into percentage point terms. Please see Appendix 4 for additional details on sample restrictions, variable construction, and estimation procedures. Estimates are based on the pooled sample of bankcard holders unless noted otherwise.

Interviewer observation regressions limit the sample to those who report "truthfully" (column A), and both "truthfully" and "accurately" (column B).

The Mahajan correction regressions are done two ways: first, assuming misclassification of R to be independent of other covariates (column A); second, allowing the misclassification to vary with other covariates (column B)—specifically race, education, and income.

Strategic bankruptcy regressions are estimated on a sample of "high-risk" borrowers only, using the pooled sample (column A) and 2001 sample (column B).

Cash back motive regressions simulate the impact of an "exclusive cash back" motive assigned to 7% (column A) and 40% (column B) of non-revolving debit users.

Security precaution regressions simulate the impact of a fraud risk motive that leads consumers to prefer online debit and credit card transactions over offline debit, and hence to borrow-to-charge due to the relative scarcity of PIN terminals. Columns A and B explore cases where 10% and 27.5% of revolvers who do not use debit are assumed to have this preference, respectively.

Rewards motive regressions simulate the impact of borrow-to-charge motive arising from rewards that produce marginal benefits exceeding the marginal financing cost. Columns A and B explore cases where 20% and 60% of revolvers who do not use debit are assumed to have this motive.

Appendix 1. Debit Card Variable Construction

Question wording and interviewer instruction is identical across the 1995, 1998, and 2001 surveys, and goes as follows:

```
X7582      A debit card is a card that you can present when you buy
           things that automatically deducts the amount of the
           purchase from the money in an account that you have.

           Do you use any debit cards?

           Does your family use any debit cards?

           INTERVIEWER: WE CARE ABOUT USE, NOT WHETHER R HAS A DEBIT
           CARD

            1.  *YES
            5.  *NO
```

Source:
Codebook for 2001 Survey of Consumer Finances, Board of Governors of the Federal Reserve System

Question wording and interviewer instructions differ in 1992, producing less emphasis on debit *use*:

```
7582        B4.     Do you (or anyone in your family living here) have
                    any debit cards?
                    (A debit card is a card that you can present when
                    you buy things that automatically deducts the
                    amount of the purchase from the money in an account
                    that you have).

                    1.  YES
                    5.  NO
```

Source:
Codebook for 1992 Survey of Consumer Finances, Board of Governors of the Federal Reserve System

Appendix 2. Data Definitions

Variable	Definition and SCF variable number(s)
Revolves a bankcard balance ("behavioral measure")	Total bankcard balances after last payments made were greater than zero (from x413)
Has a bankcard	x7973 = 1
Reports carrying a credit card balance regularly ("habitual measure")	Doesn't always pay off balances each month on bankcards and store cards; (x432=3 or x432=5)
Bankcard credit limit utilization*	(Bankcard balances)/(total credit card limit), where latter variable is x414; censored at 1
Has one bankcard	x411= 1
Bankcard interest rate	x7132 (interest rate on new balances); censored at 99th percentile, missing for those without bankcards
Bankcard charges	x412; censored at 99th percentile
Age categories	18-34, 35-54, 55-64, 65+; from x14 (household head's age)
Married	Married and living together; x8023=1
White	Household head is white; x6809=1
Male	Household head is male; x8021=1
Education (highest attainment categories)	Maximum of spouses' attainment where relevant (from x5901 and x6101); Categories are: no high school, high school, some college, college degree+
Number of persons in household categories	Censored at 5 in base specification; from x101
Housing type categories	Ranch/farm, mobile home/RV, and other; from x501.
Owns home	(x508=1 or x601=1 or x701=1)
Industry, occupation	x7402, x7401 (public use data provides only seven industry and six occupation categories). Omitted category is "not doing any work for pay".
Self-employed	x4106 = 2
Ever in Military	x5906 = 1
Region (9-level Census Division)	x30074 (not available in 2001 public use data)
Income: total last year	x5729 censored at 99th percentile, then divided into four categories (approximately quartiles) based on pooled sample distribution in 2001 dollars.

Income last year relative to normal	High/Low/Normal categories, from x7650
Has an ATM card	x306 = 1
O.K. to borrow for vacation	"whether you feel it is all right for someone like yourself to borrow money... to cover the expenses of a vacation trip"; x402 = 1
O.K. to borrow for fur coat/jewelry	see above for question scripting; x404 = 1
Net worth	Calculated per routine provided in SCF codebook; censored at 99th percentile; then divided into four quartiles (approximately) based on pooled sample distribution in 2001 dollars.
Spending relative to income in past year	x7510 (exceeded/equaled/less)
Uses electronic payments (direct deposit, auto billpay, and/or smart card)	(x7122 = 1 or x7126 = 1 or x7130 = 1)
Uses computer banking	x6600 = 12, or any other "institution" variable = 12; see Stata code below**
Emergency Funds Available	x6443 = 1
Reported truthfully (interviewer observation)	please see Appendix 4
Reported accurately (interviewer observation)	please see Appendix 4
Appetite for financial risk	x3014
Sample weight	x42001

* I use bankcard balances rather than total credit card balances in the numerator of the utilization variable in part for conceptual reasons, and in part because a) the credit limit variable (x414) is always >0 for those with bankcards (but sometimes zero for those with other credit cards but no bankcard), and b) total credit card balances exceed the credit limit variable far more frequently than bankcard balances do.

** gen computerbank=0; for var x6600 x6601 x6602 x6603 x6604 x6605 x6606 x6607 x6870 x6871 x6872 x6873 x6608 x6609 x6610 x6611 x6612 x6613 x6614 x6615 x6874 x6875 x6876 x6877 x6616 x6617 x6618 x6619 x6620 x6621 x6622 x6623 x6878 x6879 x6880 x6881 x6624 x6625 x6626 x6627 x6628 x6629 x6630 x6631 x6882 x6883 x6884 x6885 x6632 x6633 x6634 x6635 x6636 x6637 x6638 x6639 x6886 x6887 x6888 x6889 x6640 x6641 x6642 x6643 x6644 x6645 x6646 x6647 x6890 x6891 x6892 x6893: replace computerbank=1 if X==12

Appendix 3. Correlations Between Debit Use and Base Specification Covariates

Regressor of Interest	Result	
revolving	.063***	(.014)
Covariate	**Result**	
age 35-54	-.099***	(.018)
age 55-64	-.128***	(.022)
age 65+	-.162***	(.025)
2 household members	.016	(.023)
3 household members	.022	(.027)
4 household members	.039	(.029)
5+ household members	.036	(.032)
mobile home/RV	.060	(.039)
ranch/farm	-.032	(.045)
industry: not working	.007	(.029)
industry: ag/forestry	.006	(.066)
industry: mining/construct.	.058*	(.032)
industry: wholesale/retail	.030	(.027)
industry: FIRE, etc.	.083***	(.027)
industry: transport/services	.020	(.022)
industry: gov't/military	-.034	(.032)
high school	-.002	(.044)
some college	.046	(.046)
college+	.039	(.044)
has ATM card	.434***	(.010)
owns home	-.042**	(.017)
income: 2nd quartile	.050	(.033)
income: 3rd quartile	.049	(.034)
income: 4th quartile	.086**	(.033)
income > normal year	.016	(.022)
income < normal year	.029	(.021)
male	.003	(.023)
married	-.002	(.022)
Ever served in military	-.015	(.017)
o.k. finance jewelry	.026	(.026)
o.k. finance vacation	.006	(.018)
self-employed	-.067***	(.019)
white	.002	(.019)
2001	.344***	(.017)
1998	.210***	(.018)

*** Significant at the 99% level. ** Significant at the 95% level. * Significant at the 90% level.

This table shows the probit marginal effects on each covariate included in the base covariate specification estimated on the base SCF pooled sample. Please see Appendix 2 for detailed variable definitions. The omitted industry category is manufacturing. The "FIRE" industry category also includes "business & repair services". The "transport" industry category also includes communications, utilities, personal services, entertainment and recreational services, and professional & related services. Industry dummies are jointly significant, household size dummies are not jointly significant.

Appendix 4.
Sample Construction and Estimation for Selected Regressions in Table 7

Exploiting interviewer observations: I label a household "truthful" if the interviewer judges that the respondent had at least good understanding of the questions (variable x6525), was not suspicious about the study before the interview (x6527), and exhibited average or better interest in the interview (x6529). I label a household "accurate" if the household referred to documents at least "sometimes" when answering questions (x6536). 55% of households are labeled truthful in the pooled sample, 22% are labeled accurate, and 15% qualify as both.

Strategic Bankruptcy: Estimates are calculated on a sample including only "high-risk" borrowers, where "high-risk" is defined by applying a standard industry cutoff to an imputed credit rating in the SCF (see Barakova, et al. 2004 for more details on this variable). Specifically, SCF credit scores were transformed to match the distribution of FICO scores, and only households with scores below 660 (approximately the 15th percentile) were included in the estimation. In regressions where the score was included as a control variable, linear and quadratic functions produced virtually identical results.

Cash back motive: This is simulated by randomly assigning an "exclusive cash back" motive to a proportion C of non-revolving debit users in the SCF. I do this by generating a binary variable E that takes the value of one for those assigned the exclusive cash back motive, and including E as an additional covariate in the base specification. I conduct simulations with two alternative values of C, a weak version (7%) drawn from the 1996 SOC, and a strong version (40%) chosen with reference to other survey findings (see text).

Security precaution: This is simulated using the same procedure described above for the cash back motive; in the security case, however, the simulated motive is assigned to a different sub-sample, namely revolvers who do not use debit. The hypothetical weak and strong versions of this motive are discussed in the text and Table 7.

Rewards motive: This is simulated using the same procedure described above for the security case.