Debit vs Credit:
A Study of Self-Control in Shopping Behavior, Theory and Evidence

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Abstract:

Debit cards are the fastest growing consumer payment method despite being more expensive and less convenient than credit cards. Explanations for this phenomenon are both neoclassical/cost-based and behavioral. This paper shows that people use debit cards as a form of spending control, generally considered a behavioral explanation. The paper contains two parts, empirical and structural. The empirical tests show that spending control is a driver of debit card use. Evidence is found to support the critical element of the structural model. Also, the data show that debit users make more and smaller ATM withdrawals, another spending control move. In the model, consumers use debit cards to avoid a costly budgeting process. The model provides a scenario where spending control is a cost-driven motivation for using debit cards.

Keywords: debit cards, credit cards, search model, payment choice, self control, behavioral, neo-classical,

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1. INTRODUCTION

Debit cards are the fastest growing segment of electronic payments. Table (1) shows that while the growth in credit card transactions averaged 10% per year between 1998 and 2004, debit card transactions have grown by 22% and 26% during the same period. Debit transactions have grown from 28 to 45 percent of point-of-sale card transaction during that period.

The puzzle of debit's popularity is that the structure of explicit costs favors credit over debit. With debit the money is immediately subtracted from the bank account. Whereas, with the credit card, the customer is billed for the goods at the end of the month and has further grace period to pay. As long as no balance is carried on the card, the consumer pays no interest. Evaluating this float at a savings account interest rate, this float may be minor. But for consumers in need of cash, payday loans or bank bounce protection are quite expensive alternatives. Credit cards also offer the option of converting the payment into an uncollateralized loan with zero transaction cost.

Table 1:Growth in Transactions

	Credit	Online Debit	Offline Debit
2004	5.0%	23.6%	20.0%
2003	7.1%	23.3%	20.0%
2002	7.1%	4.0%	22.0%
2001	8.9%	31.8%	26.2%
2000	19.0%	25.5%	30.3%
1999	12.7%	25.0%	40.1%
99-04	75.8%	228%	305%

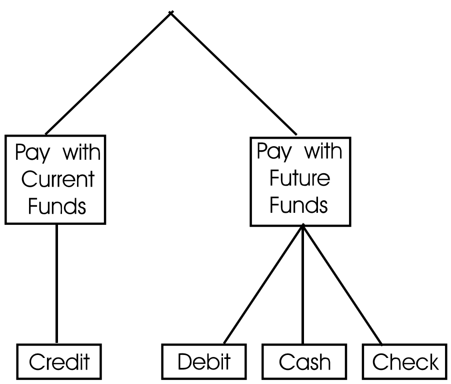
Source: EFT Data Book

Most credit cards offer rewards (cash back, airline miles, gift certificates, charitable donations, warranty on purchase, sweepstakes, etc.) or a below market interest rate. Debit cards in contrast offer few benefits and some costs. Visa check card and debit MasterCard often have December sweepstakes for those who use their debit cards but other rewards are extremely rare.

For *PIN* debit, a July 2005 survey found that 15% of financial institutions charge a fee for debit card purchases. The fee ranged from 10 cents to 2 dollars per transaction. Customer experience and merchant acceptance is virtually identical between credit and signature debit. PIN debit is accepted at far fewer locations. In 2003, there were 5.25 million merchant locations accepting Visa and MasterCard; there were only 3.98 million online debit terminals.[1]

Much of the growth in debit card use is substitution from paper check and cash. From 1995 to 2003, electronic payments moved from 23% to 55% of all payments. Borzekowski and Kiser (2006) find that the closest substitutes for debit are cash, checks and credit in that order. It seems that consumers have a two-tiered decision process where they choose, first to pay with current or future funds. Then if using current funds they can use cash, check or debit (see Figure 1). The subject of this paper is the first decision: current or future funds. The subject addressed herein is not a new phenomenon of the digital payments age; rather it is an old phenomenon: borrowing versus contemporaneous payment. The advantages of the debit age are that it allows us to make a cleaner comparison – debit and credit are similar in many dimensions considered by Klee (2006) – and that we can witness debit transactions

Figure 1: Nesting Structure of Payments



[1]There are often several terminals per location so these numbers represent a severe deficit in PIN debit acceptance compared to credit.

as opposed to the anonymity of cash – data is now available. Although the puzzle could be stated as contemporaneous payment versus borrowing, we will henceforth refer to the two options as debit and credit.

Answers to the debit use puzzle fall into two categories, neoclassical/cost-based and behavioral. Zinman (2005) argues the case for a neoclassical motive for debit use. He also provides some evidence against "behavioral explanations" such as spending control. This paper argues (1) that spending control is a driver of debit card use and (2) spending control is a rational/neoclassical motive for using debit.

Zinman provides several neoclassical reasons to use debit. People who are credit constrained could rationally choose debit for payment. Second, debt revolvers, having no grace period before paying interest (no float), would see less benefit of using credit. Zinman also argues that his results contradict some "behavioral explanations" (bounded rationality and rational indifference). Borzekowski, Kiser and Ahmed (2006) [henceforth BKA] also argue against spending control motives. Both of these papers use household survey data. This is the only study to use actual customer transactions. This paper departs from Zinman and BKA in two respects. The data used here is sufficiently rich to test and support spending control as a motive for using debit. Second, Zinman refers to spending control as a "behavioral explanation" for using debit. In the model described in section 3, consumers use debit cards to restrain themselves to only purchases for which money is currently available. They do this as a substitute for budgeting which is costly.

Thus debit cards, even when used as a spending control mechanism, is a rational, neoclassical method of consumer financial management. Zinman finds evidence that 38% of households are motivated by cost based factors, such as balance revolving and credit constraints. He suggests that this is a conservative lower bound but he also notes that up to 31% of the households have no rational, cost-based explanation for debit use that can be identified in the survey data. The model and empirical tests dispute Zinman's view that spending control motives are unlikely to be driving debit card use. But the model supports his view that rational motivations drive debit use.

While the academic research dismisses spending control motives, players in the industry recognize the spending control motive for using debit cards. Visa's web site lists the following as an "advantage of paying with Visa check cards": "Use your Visa check card as a budgeting tool to help you track your expenses and manage your money better." This statement could be taken as an expression of the card's benefits over cash ("track expenses"), but it clearly also hints at the card as a tool for restraining spending. Specifically, it says "a budgeting tool". And it says " manage your money better" rather than " manage your money more easily".

The model makes three predictions that can be verified using a data set containing checking account records for 2310 customers. First, debit users will be paying down a credit card balance; second, they will patronize a variety of stores; third, they will make more and smaller ATM withdrawals. Though we do not witness their credit card balance, we do see payments to credit card issuers. Debit users tend to make identical payments in different months and they tend to make round payments. We see the location of debit card purchases, but we can not see any credit card purchases, making a test of the second fact difficult. We are able to test the location of ATM withdrawals to find the debit card users use (shop in) a greater variety of locations. Finally, evidence is found that debit card users tend to have more and smaller ATM withdrawals. These three tests provide strong evidence that spending control is a motive for using debit.

Section (2) contains a brief description of the credit and debit card industry structure. Section (3) describes the model. A brief discussion of testable hypothesis and other issues is in section (4). Section (5) describes the data and Section (6) provides the empirical evidence to support the claim that debit use is a form of spending control. Section (7) concludes.

2. Industry Structure

Debit cards have evolved from two older electronic services, the credit card and the ATM. Credit cards are accepted by many merchants worldwide. Consumers sign a receipt to authorize the transfer of money. Visa and MasterCard brand credit cards and process the transactions. Visa is organized as a joint venture owned by the members of the banking industry. MasterCard was a similar organization but is now a public company[2]. Visa leads the debit market with the Visa Check Card. MasterCard offers the Debit MasterCard. Transactions are processed by technology and infrastructure parallel to that of credit card. These debit cards are called *signature* or *offline debit*. Transactions using these cards are authorized when the customer signs a receipt. Marginal cost to the consumer is nearly always non-positive for

[2]The minor players, Discover and American Express, issue their own cards in addition to processing. These companies are not bank owned. Since they do not issue debit cards they are omitted from mention.

signature debit transactions. Merchants who accept credit cards were required by Visa and MasterCard to accept these debit cards. This "Honor All Cards" policy has been retracted as a result of court action, but few merchants who accept credit fail to accept signature debit.

ATMs have been offered by banks since the late 1960s. Consumers enter a 4-digit number (PIN) in order to authorize the transfer of money. The transactions are processed by electronic funds transfer (EFT) networks which historically were owned by banks but consolidation has lead to third party processors dominating the industry. The EFT networks also offer a debit product called *PIN* or *online* debit. Retailers install card readers at cash registers and customers are prompted to enter their PIN to authorize payment of funds. The payment is then processed through the EFT network. As noted above, merchant acceptance is less than for credit and signature debit. Many merchants offer customers the option of getting cash back with their PIN debit purchase. Many consumers use this feature to avoid ATMs with high fees. Some banks (15% as mentioned above) charge a per-transaction fee for using PIN debit.

Most banks issue one card that can be used as either a signature debit, PIN debit or ATM card. In July of 2005, 55% of financial institutions issued Visa Check Cards; 25% offered Debit MasterCard; the rest did not offer debit cards. Therefore, nearly all consumers have the option of using either type of debit. Since either type of debit satisfies the basic requirement of restraining spending, henceforth "debit card" will refer to either type of debit.

The following section details the model.

3. A Model of Household Expenditure

In this section, we consider a mode of consumption including budgeting and shopping. Because of random variation in the prices, expenditure – even for a well planned consumer – is variable from period to period. Resulting variation in both prices and quantities purchased cause the consumer to undergo a costly process of calculating how much consumption her income can support. As an as an alternative to the costly budget calculation, a consumer could forego the benefits of a credit card by spending only out of a checking account via a debit card. When the checking account is exhausted, all future transactions are declined; thus restraining the consumer's spending. In this model, consumers use debit cards for spending control reasons. But such motives are not behavioral; they are cost based.

3.1 Model Setup

At the beginning of a period, the consumer has an income, y. This income should be considered to be disposable income after taxes, necessities and recurrent, fixed expenditures. The model contemplates a portion of a consumer's spending that involves those extras of life which are discretionary such as entertainment, food or drink away from home, or upgrades to necessities (e.g. replace the usual hamburger with steak could be considered a good in the model). Major purchases will be financed and are outside the scope of this model.

The consumer creates a shopping list containing N goods out of a total set of $\mathcal{N}$ goods.[3]

[3]We should consider $\mathcal{N}$ to be larger than any consumer can afford even after accumulating durable goods for several periods.

The consumer goes shopping for a single unit of each good on the shopping list. At time $\frac{1}{N}$ of the period the consumer enters a store offering good n on the shopping list and must choose to purchase or defer consumption. The price of this good, (p_{nt}), is stochastic and drawn from a distribution with pdf, $f(p)$. Quality of good n is fixed across time and stores. It imparts a utility, b_n , per period which is measured in price units.

If the consumer does not purchase the good, the next opportunity to purchase good n is the next period. At time $\frac{2}{N}$ the consumer will find another good from the list. The opportunities to purchase goods continue to arrive in random order. The process continues until the consumer has found one offer for each good on the list. There is no discounting within a period, only between periods. The price of each good is drawn from the same distribution, $f(p)$. Thus, we are abstracting away from issues of differing purchase size, where credit is more likely to be used for large purchases. Goods, however, are not identical; they have varying benefits, b_n .

For this shopping trip, the consumer has a choice between paying with funds available in a checking account via a debit card, or being billed at the end of the period if using a credit card. Upon receipt of the bill, if the consumer does not have enough money in the checking account to pay the bill, the balance due may be converted to a loan with zero transaction cost. Naturally, if a debit card is used, then money must be available in the account or the transaction is declined at the point-of-sale. When using debit, a fee, φ, is charged. This fee encompasses an explicit fee, foregone benefits of credit cards or the flexibility of being able to borrow.

The discount factor between periods is β . The goods purchased are durable with a fixed probability, λ ,($0<\lambda\leq 1$) each period of wearing out and needing replacement[4]. The benefit, b_n , will be received each period into the future until the good wears out.

At the beginning of period t , the consumer knows income, y ; the distribution of prices, $f(p)$; the benefits, b_n ; the discount factor, β ; the wear out factor, λ . The consumer must calculate – or estimate – a level of expenditure, N , that does not exceed available funds.

According to the above, the consumer has three decisions to make. The consumer makes a shopping list to match income. The consumer shops for the goods on the list. The consumer selects a payment method. Let us proceed to analysis of the shopping trip.

Table 2: **Table of Variable Definitions**
y = per period income
N = length of individual's shopping list number of goods available
$f(p)$ = pdf of prices
$F(p)$ = cdf of prices
b_n = benefit derived from consuming good n
φ = fee for using debit
β = discount factor
λ = probability the good wears out in a period.
V_{0n} = value of owning good n into the future.
$V(p_n)$ = value of buying good n (V_{0n}–p_n).
U_n = option value of next period's search.
p_{nt} = price realized of good n in period t.
p_n* = reservation price of good n.
$F^* = F(p_n^*)$
$\overline{p_n}$ = ex-anti expected price of good n.
$\overline{p}$ = average price per good across goods.
ρ = portion of over(under) spending reduction
γ = cost of over(under)spending reduction
B_t = debt at period t.

3.2 Bargain Hunting for Good *n*

The experience of shopping for each good on the list is identical so consider the consumer's experience shopping for good n. A consumer has only one opportunity to purchase

[4]A good for which $\lambda=1$ is not durable. But we might consider some goods that are fully consumable in the first period to have a λ high but less than unity. The interpretation would be that they provide some lasting memory such that it is not necessary to purchase the good again the next period. E.g. I might not want to eat at the same restaurant in consecutive periods.

good n each period. A consumer could purchase the good at the realized price or wait until the following period for a potentially lower price. If price is high, the consumer will tend to wait; if it is low, the consumer will tend to buy.

Let $V(p_{nt})$ be the value to the consumer of purchasing good n at price, p_{nt} ; V_{0n} is the value of using good n after it is purchased; U_n is the option value of going a period without good n. Then V_{0n} , the value of owning the product, is the current benefit plus the discounted weighted average of the utility (U_n) of not having the product next period and the utility of having it.

$$V_{0n} = b_n + \beta\left[\lambda U_n + (1-\lambda)V_{0n}\right] = \frac{b_n + \beta\lambda U_n}{1-\beta(1-\lambda)} \tag{1}$$

The second equality shows the value once V_{0n} is isolated on the left hand side.

The value of drawing a price, p_{nt} , is $V(p_{nt})$, which is $V_{0n} - p_{nt}$ or:

$$V(p_{nt}) = b_n - p_{nt} + \beta\left[\lambda U_n + (1-\lambda)V_{0n}\right]$$

Substituting V_{0n} into $V(p_n)$ and combining terms gives:

$$V(p_{nt}) = \frac{b_n}{1-\beta(1-\lambda)} - p_{nt} + \frac{\beta\lambda}{1-\beta(1-\lambda)}U_n \tag{2}$$

The value of foregoing purchase in period t is the opportunity to search again next period, U_n, which is the discounted expected value of the result of next period's search.

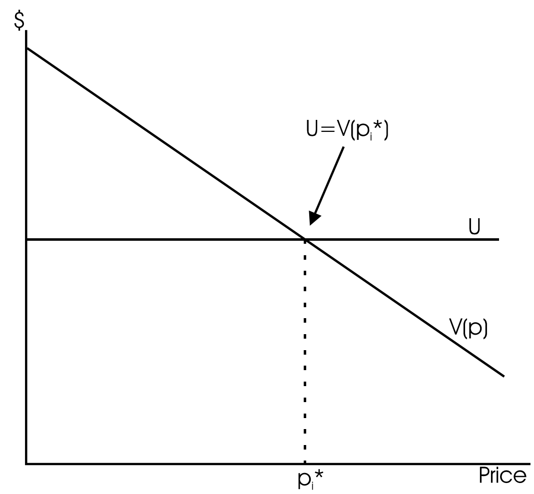
$$U_n = \beta E \max\left[V(p_{n,t+1}), U_n\right]$$

Searching next period would yield the higher of either purchasing at the realized price, $V(p_{n,t+1})$, or again opting to wait another period, U_n.

Proposition 1: *Conditional on having decided to purchase good n, the optimal strategy for* *obtaining the good at the highest possible after-price value is to use a reservation price strategy with reservation price (p_n*).*

Proof: It is clear from equation (2) that the value of purchasing good n in period t is declining in period t price, p_{nt} (i.e. $V'<0$). The option value of waiting for another draw next period, U_n, is constant in p_{nt} since current period realized price p_{nt} does not enter its definition. Thus, there is a single crossing at $V(p_n^*) = U$. When $p_{nt}<p_n^*$, then $V(p_{nt})<U$ and the consumer's optimal decision is to wait. When $p_{nt}>p_n^*$, then $V(p_{nt})>U$ and the consumer's optimal decision is to purchase in period t. ❑

Figure 2: **Reservation Price**



The idea behind the preceding proof is depicted in figure 2.

In the equations above, V_{0n} , $V(p_n^*)$ and U are expressed in terms of each other. We can use the reservation price condition [i.e., $V(p_n^*) = U$] to express these values in terms of p_n^* and other coefficients. Evaluating equation (2) at p_n^*, substituting U_n for $V(p_n^*)$ and combining terms we get:

$$U_n = \frac{b_n}{1-\beta} - \frac{1-\beta(1-\lambda)}{1-\beta} p_n^* \tag{3}$$

Substituting this into equations(1) and (2) for U_n and rearranging we get respectively:

$$V_{0n} = \frac{b_n}{1-\beta} - \frac{\beta\lambda p_n^*}{1-\beta} \tag{4}$$

and

$$V\left(p_{nt}\right)=\frac{b_n}{1-\beta}-\frac{\beta\lambda p_n^*}{1-\beta}-p_{nt} \tag{5}$$

We are now in a position to discuss the prices paid by consumers for good n . First, abbreviate the probability of purchase, $F^* = F(p_n^*)$. Propositions 2 and 3 discuss the reservation prices and the ex-anti expected price.

Proposition 2: *The reservation price for good (n) can be expressed as a function of the benefit (b_n) derived from the good.*

$$p_n^* = \frac{b_n}{1-\beta(1-\lambda)} - \frac{\beta}{1-\beta(1-\lambda)} \int_0^{p_n^*} F(p)dp \tag{6}$$

And the derivative of p_n with respect to b_n is positive and given by:*

$$\frac{dp_n^*}{db_n} = \frac{1}{1-\beta(1-\lambda-F^*)} > 1$$

Proof: See Appendix C.

This equation implicitly solves for p_n* as a function of the distribution of prices, $F(p)$, the benefit of good n and parameter values. Now that we have expressions for U_n and p^* we can state corollary 1.

Corollary 1: *The value of good n, U_n , varies positively and at a greater rate than b_n under reasonable levels of the discount rate, β.*

Proof: See Appendix C.

Finally, the third proposition relates the reservation price to the ex-anti expected price.

Consider the expected expenditure on good *n*. Define $\overline{p_n}$, the expected expenditure on good *n*, to be inclusive of the case where good *n* is not purchased, i.e.,

$$\overline{p_n} = \int_0^{p_n^*} p\, dF(p) + (1 - F^*)0$$

Certainly it is true that the second term is zero and disappears. The difference between this and the average price conditional on purchase is that in this case the probabilities (integral) sums to *F**. If we had calculated the average price conditional on purchase, the probabilities would sum to one. Proposition 3 relates this expected expenditure value to the reservation price.

Proposition 3: *The ex-anti expected price paid for good n,* $\overline{p_n}$, *can be expressed as a function of the reservation price for good (n).*

$$\overline{p_n} = \frac{-b_n}{\beta} + \frac{1 - \beta(1 - \lambda - F^*)}{\beta} p_n^* \qquad (7)$$

Proof: See Appendix C.

In an environment where a consumer has already chosen to purchase good *n*, we have three important results. First, the consumer will follow a reservation price strategy. Second, the relationship between $\overline{p_n}$ and p_n*, the ex-anti expected price paid and the reservation price is specified by proposition 3. And third, the level of p_n* as a function of parameter value b_n is set by proposition 2. Thus, reservation price for good *n* is determined in order to maximize the expected benefit net of cost which flows from consuming good *n* in a multi-period time frame. This section assumed that the good in question is on the consumer's shopping list. The following section describes how goods end up on the shopping list.

3.3 The Consumer's Budget Constraint

In this section, the consumer's budget constraint is described with the options for fulfilling that budget constraint. The consumer can compute the budget at a cost. Or the consumer could avoid the cost of computation if, instead, a debit card is used to make purchases since the debit card will not allow the consumer to overspend.

The consumer has an income, y, to spend on goods. The ex-anti expected price spent on good n is $\overline{p_n}$. Denote the average price across goods on a shopping list as $\overline{p} = \frac{1}{N}\Sigma\overline{p}_n$. Then if a consumer purchases N goods, expected expenditure is $\overline{p}\,N$. Note that the average price, $\overline{p}$, is not conditional on a purchase being made (i.e., it includes the possibility that price paid for some goods is zero – those goods which had realized prices above p^* and consequently are not purchased). Thus, N is the number of goods which will be sought rather than the number that will ultimately be purchased. Define N^* to be the value of N which solves the budget equation: $\overline{p}\,N^* = y$. A consumer who wants a balanced budget will desire to choose N^*. Over a lifetime, consumers must have a balanced budget, but in any individual period a consumer has the ability to borrow (with a credit card) or save.

If the consumer operated based on $\overline{p}$, she could easily set shopping to N^* . However, the consumer's decision rule for purchasing or passing on a product is based on the reservation price p^*. So the consumer must map p^* into $\overline{p}$ and then select N to fit within income. This is not trivial for two reasons. First, the mapping is not simple (see proposition 2). Second, $\overline{p}$ is an abstraction from $\overline{p_n}$. According to equation (7, 9) $\overline{p_n}$ varies with b_n. Therefore, consumers must use their intuition and learn through experience. (More on this process of learning in section 3.5).

The consumer has two options for obtaining a value *N*. The consumer can calculate the budget satisfying level *N** at a cost. If a consumer does not calculate the optimal *N**, then she will need to pick a starting point for *N*. Without knowledge of the correct *N**, the starting point, *N*, must be a random draw from around *N*.

Assumption 1*: Each consumer randomly draws a value N from the range [N*–P , N*+P]. This level of N is drawn once in the beginning. Assume also that the distribution is symmetric around N*.*

The level of *N* is persistent because our lives dictate that we purchase largely the same types of goods period-to-period; our lifestyles do not change drastically. The distribution of *N* has mean *N** because forecasts are accurate in the mean.

From this starting point, each consumer has two methods to abandon this randomly drawn starting point and move to – or closer to – a balanced budget. As the consumer realizes several periods, she will deduce more about her level of *N** (see section 3.5) and potentially, then, choose one of the two options for moving to or toward *N**. As an alternative to paying the cost of calculating *N** the consumer can restrict spending to the money that is available in her checking account by using a debit card to pay for purchases. This option is described in the following section. Next the process of calculating *N** is described.

Consumers do not initially know their value of N but they do know that it will be in a range. They may expend resources to reduce or eliminate the range. Specifically assume:

Assumption 2*: Each consumer can select a value ρ from the set $\mathcal{P}$, such that $0 \leq \rho \leq 1$. A consumer who draws N and has chosen ρ will actually purchase $N_i^*+\rho(N–N^*)$. A consumer who selects ρ must also pay an accounting cost $\gamma(1-\rho)$ where γ varies across consumers.*

Consumers have control over their purchases, but they must expend resources to calculate N^*. If ρ is an boolean decision (i.e., $\mathcal{P} = \{0,1\}$) with a fixed cost, γ , then each consumer will go through a decision process which looks very much like the decision to use a debit card described below. But if consumers can choose any value for ρ between zero and one (i.e., $\mathcal{P} = [0,1]$), then they will chose the value that maximizes their utility. Naturally, those with a lower cost of budgeting will do more budgeting bringing their purchases closer to N^*. Appendix B contains the solution to the optimal level of ρ conditional on γ, for a particular utility function.

3.4 Selecting a Card

Consumers have two payment technologies at their disposal, credit and debit. The credit card allows borrowing which is convenient in this environment of stochastic purchases. Indeed, recall that even a consumer who chooses to calculate an exact N^* will have variation in purchases due to the variation in prices described in section (3.2). Debit cards restrict purchases to be equal to or less than income plus any available savings.

To make the ensuing discussion easier, let us define a few terms. When someone uses a credit card and has $N > N^*$ (and thus accumulates debt), we refer to this situation as $\mathcal{D}^-$. When someone uses either card and $N < N^*$ (and thus accumulates savings), we refer to this situation as $\mathcal{D}^+$. When someone either calculates the exact level of spending, N^*, or uses a debit card to force average spending to equal income, call this situation $\mathcal{D}^0$. Finally, we refer to any situation in which the consumer pays a debit card fee as $\mathcal{F}$. Recall that the fee incorporates all costs of debit including explicit per transaction fees, loss of float, loss of benefits and loss of flexibility. Further, define d^x to be the utility associated with situation $\mathcal{D}^x$ and f to be the utility associated with $\mathcal{F}$.

Consider a consumer who with $N > N^*$ (or one who has not chosen to fully calculate N^*, i.e., $N^* + \rho(N - N^*) > N^*$). If the consumer uses credit she will accumulate debt. Let B_t be the outstanding debt[5] at period t. Since consumers must pay off this debt before the end of time, this implies an uneven consumption over the life cycle and will experience $\mathcal{D}^-$. In contrast, if the consumer choose debit she would have more even consumption patterns paying with cash (via debit card) but pay a fee, φ. Thus, the consumer will experience $\mathcal{D}^0$ and $\mathcal{F}$. This consumer would prefer to use a debit card if the latter dominates the former:

$$\mathcal{D}^- \prec \mathcal{D}^0 \cup \mathcal{F}$$

A consumer who has $N < N^*$ would accumulate savings. When a credit card is used the consumer can pay off the balance every month and not need to borrow, on average (i.e., $\mathcal{D}^+$). If the consumer uses a debit card, she would still spend less than income, on average (i.e., $\mathcal{D}^+$), but

[5]For a further description of B^t see Appendix B.

also pay the fee. Reall that the fee includes a loss of flexibility (i.e., during periods when an unusually large number of low prices are realized and she desires to spend more, she would be restrained from doing such). In any situation, we would expect the credit card to dominate the debit card.

$$\mathcal{D}^{+} \succ \mathcal{D}^{+} \cup \mathcal{F}$$

Unfortunately, consumers do not know whether their natural level of purchases, N, exceeds N^*. Thus, consumers would choose based on the expected likelihood of these events.

***Proposition 4**: There is a range of parameter values such that consumers would choose to use credit if they are unsure whether N>N* but switch to debit if they learn that this is the case.*

Proof: For the purpose of exposition, let us view the fee as separable from the rest of the respective terms[6]. In the case where the consumer is unsure whether $N>N^*$, she will choose credit over debit if the combined expected outcomes of credit dominates debit:

$$(0.5)\mathcal{D}^{-} + (0.5)\mathcal{D}^{+} \succ (0.5)(\mathcal{D}^{0} \cup \mathcal{F}) + (.05)(\mathcal{D}^{+} \cup \mathcal{F})$$

This statement is equivalent to

$$(0.5)\boldsymbol{d}^{-} + (0.5)\boldsymbol{d}^{+} > (0.5)(\boldsymbol{d}^{0} \cup \boldsymbol{f}) + (.05)(\boldsymbol{d}^{+} \cup \boldsymbol{f})$$

Since we have assumed that the fees are separable, we can replace the union symbol with addition and write this expression as:

$$(0.5)\boldsymbol{d}^{-} + (0.5)\boldsymbol{d}^{+} > (0.5)\boldsymbol{d}^{0} + (0.5)\boldsymbol{f} + (.05)\boldsymbol{d}^{+} + (0.5)\boldsymbol{f}$$

The saving terms ($\boldsymbol{d}^{+}$) cancel (i.e., if I am a saver, my card specification does not affect

[6]This is a strong condition but the idea behind this derivation should hold under most typical utility specifications.

my finances). The fee terms combine, (i.e., if debit is used, pay the fee regardless of N). And move the $\boldsymbol{d^{\mathcal{O}}}$ term to the left side. Then we have:

$$(0.5)(\boldsymbol{d^{-}} - \boldsymbol{d^{\mathcal{O}}}) > \boldsymbol{f}$$

Note that both sides of this expression represent negative utility events. The right side expression represents the utility hit from paying a fee. The left side represents the utility difference between a pattern of debt ($\mathcal{D}^{-}$) and $\mathcal{D}^{\mathcal{O}}$. Since debt is less desirable than following a budget ($\boldsymbol{d^{-}} < \boldsymbol{d^{\mathcal{O}}}$), we know that the left side is negative. This expression says that credit dominates debit if the utility hit from paying the fee is less (more negative) than half of the difference between the two financial patterns. The intuition behind this is simple. A fee is always paid if debit is used; choosing debit is beneficial only if $N{>}N^*$. If, however, the consumer were to learn that $N{>}N^*$, then she would be inclined to use debit in the case where:

$$\boldsymbol{d^{-}} < \boldsymbol{d^{\mathcal{O}}} + \boldsymbol{f}$$

as discussed above. Under the assumed separability, this could be rearranged to:

$$\boldsymbol{d^{-}} - \boldsymbol{d^{\mathcal{O}}} < \boldsymbol{f}$$

This says that a consumer who knows that $N{>}N^*$ would choose debit if the impact on utility from the fee is greater (less negative) then the utility difference between a $\mathcal{D}^{-}$ and $\mathcal{D}^{\mathcal{O}}$. Combining this condition with that derived under uncertainty, we get:

$$\boldsymbol{d^{-}} - \boldsymbol{d^{\mathcal{O}}} < \boldsymbol{f} < (0.5)\,(\boldsymbol{d^{-}} - \boldsymbol{d^{\mathcal{O}}})$$

which says that if the utility hit from the fee is between the utility difference and half of that utility difference, then consumers will choose credit under no knowledge but switch to debit if they learn that $N{>}N^*$. If we were to relax the assumption of separability, we would lose the clean result that the fee needs to be between the full difference and half the difference but the presence of a range would remain. ❑

Thus, under certain parameter values, consumers would not (fully) calculate their optimal purchases (i.e., select $\rho>0$) and they would choose credit when unsure about their type but switch to debit when they become aware that $N>N^*$. The following sub-section describes how consumers would discover that $N>N^*$ or $N<N^*$.

3.5 Discovering One's Type

Consumers do not initially know their draw, N. Further, if in any one period a consumer spends too much and needs to borrow, this is not sufficient cause to suspect that $N>N^*$. Borrowing could be a result of N being too high (greater than N^*) or the result of favorable draws from the price distribution (everything was on sale today – see section 3.2)[7]. Even if a consumer sees a string of deficit periods, how would that consumer differentiate a random string of favorable price periods from systematic borrowing? When has accumulated borrowing reached a level such that a consumer may be confident that debt is not a string of fortunate price events?

Proposition 5 provides an answer to this question. The null hypothesis is $N = N^*$ which corresponds to zero expected debt. If the individual's debt, B_t, exceeds the confidence interval around $B_t = 0$, then the individual can reject the null hypothesis and conclude that $N>N^*$. If

[7]It may seem counterintuitive that lower prices lead to overspending; and indeed, if prices are low enough, the consumer could get more without going over budget. But it will sometimes also be the case that low prices lead to more consumption which causes overspending.

debt is below the lower bound of the confidence interval (savings), then she can conclude that $N<N^*$. The consumer is free to choose the confidence level; proposition 5 shows a two-standard-deviation confidence interval. The confidence interval will depend on the distribution of prices, specifically standard deviation of prices, σ_p.

Proposition 5*: The two-standard-deviation confidence interval around zero debt is:*

$$0 \pm \sigma_p \rho \sqrt{N \frac{(1+r)^{2t+2} - 1}{2r + r^2}}$$

Proof: See Appendix C.

This is the two-standard-deviation confidence interval. The exact α-level of this confidence interval depends on the distribution of B_t which depends on the distribution of p. Recall that the realizations of p that govern σ^2_p consist of purchases (i.e., $0<p<p^*$)and non-purchases (i.e., $p=0$). We can decompose the variance into components attributable to purchase/non-purchase variation and price variation.

$$\sigma_p^2 = \tfrac{N}{N-1}\left\{ F^*\left[\tfrac{NF^*-1}{NF^*}\sigma^2_{p<p^*} + \left(E(p|_{p<p^*}) - \bar{p}\right)^2 \right] + (1 - F^*)\bar{p}^2 \right\}$$

Alternately, the individual could count the number of deficit periods. Under the null hypothesis that $N=N^*$, the probability of a deficit period is 0.5. A series of t periods constitutes a Bernoulli distribution $B(t, 0.5)$. A confidence interval can easily be constructed for any number of periods, t. The individual would know that $N>N^*$ if the number of deficit periods exceeds the critical value for t, or that $N<N^*$ if the number of saving periods exceeds the critical value.

Corollary 2*: When a consumer discovers that N is greater than N* and switches to debit, she has* *positive debt. Such consumers will have more debt than those who continue to use credit.*

Proof: The first statement follows directly from proposition 5; those who switch to debit have a level of debt indicated by proposition 5. Those who do not switch to debit do so because their level of debt does not reach such a level. Either they are saving or their debt is not at such a level. Thus, debit users will tend to have more debt than credit users. ❏

The following section summarizes some of the important results that can be tested using the data. It also contrasts these results with other research on why people use debit cards.

4. Discussion and Analysis

The purpose of this section is to discuss some of the key results of the model. First, testable hypotheses are highlighted. Second, the results of this paper are compared to those of other research on why people use debit cards.

4.1 Implications and Analysis

This model provides three testable hypotheses. First, consumers with high levels of N relative to N^* will tend to accumulate debt. Second, debit card users will shop in a larger variety of locations. Third, they tend to use their payment media to restrain their spending. They use debit cards to restrain spending, they may also use cash holding to restrain spending (i.e., hold less cash).

Consumers discover their assigned level of purchases, N, only after a long period of using a credit card and accumulating credit card debt (or saving). To restrain their spending, they switch to debit cards but still have outstanding credit card debt that they are paying off over time. This observation is formalized in Corollary 2 and leads to Hypothesis 1:

Hypothesis 1 (H1)*: Debit card users will tend to have more debt than credit card users.*

In any scenario where consumers use a debit card to control spending and did not start doing so from their initial period, this will be the case. H1 is not just a test of the section 3 model but of spending control as a motive for debit card use.

The second implication stems from the search model. A consumer selecting N is not only selecting the number of goods for which to search, but is also selecting which goods. Recall from Corollary 2 that goods vary in value. Each good, n, provides a differing benefit, b_n, which leads to an even greater variation in value, U_n . Since value varies and expected price is equal[8], consumers should have a well defined preference ranking over goods. The model discusses only how many goods would be chosen, but it should be noted that consumers will select not just any N goods, but the best N goods. This leads to Hypothesis 2:

Hypothesis 2 (H2)*: Consumers who use debit will purchase lower value goods than a credit user searching for N^* goods.*

To see why this is true, consider that consumers searching for the budgeted number of goods, N^*, select the products for which they will shop. In contrast, debit users with high N search for

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[8]This can also be viewed as a normalization. Prices of all goods are normalized to the common distribution but differences in both prices and utilities of goods are captured in the parameter b_n.

N products but then end up shopping for only a random[9] subset totaling N^* of them (the first N^* goods to be found on average). A simple example illustrates this point well. Suppose there are 10 goods. Good 1 provides the most utility; good 2 provides the second most; etc. Both consumers can afford to shop for only 5. The credit card user chooses and shops for the best 5 goods. The debit card user chooses the best 7 and shops until the money is depleated, possibly consuming goods 6 and 7 but never searching for goods 1 and 2.

We should expect Hypothesis 2 to hold in any instance where self control is an issue. This hypothesis reflects the tendency of some consumers to be more disciplined (they use credit in this model) than others. The less disciplined consumers spend all over the place and use debit to restrain that.

A final hypothesis is not implied by the model but is an extension of the model to cash holding. Specifically, the essence of the model is that consumers use debit cards because they have less liquidity than do credit cards. Debit users may tend to limit their liquidity by holding less cash. In this case, we would expect to see debit users visiting the ATM more often taking out less cash each time.

Hypothesis 3 (H3)*: Consumers who use debit will visit the ATM more often making smaller withdrawals.*

In section 6, these three hypotheses are tested and evidence is found to support all three. Before getting to the empirical results, let us discuss how these results relate to other research on why people use debit cards.

[9]Recall that consumers shop for goods on the shopping list in random order.

4.2 Discussion

As noted earlier, the conventional view of spending control motivations for debit card use is behavioral or non-rational. Zinman (2005) suggests that a rich data set, such as the one employed here, is needed to study this. He lists three findings that, he suggests, cast doubt on spending control motivations. Finding #1 cites the lack of support for spending control in open ended survey questions. First, it is very difficult to dismiss a possibility based on open ended survey questions; second, these surveys often have more evidence for spending restraint than it first appears. More on this below.

Finding #2 shows some evidence for some consumers using debit to minimize time costs (e.g. get cash back to save a trip to the ATM). But as table (7) shows, debit users tend to have more and smaller ATM withdrawals. This is also true if we restrict the sample to non credit users (non revolvers are the group of interest in Finding #2). They do not appear to be minimizing their financial or time cost of getting cash. There seems to be little evidence, at least across individuals, that consumers substitute debit transactions for ATM withdrawals. Further this finding does not refute spending control, it merely tries to offer other possibilities for a group of consumers who do not fit other explanations.

Finding #3 suggests that debit users who lack credit cards do so not by choice. This argument refutes a stronger version of spending control than is contemplated in the present model. This refutes the idea that a consumer with a credit card will purchase items which she knows she can not afford. The mechanism in the present paper is more subtle. Consumers do not know that their purchase is going to push them into deficit. Indeed, Hypothesis 1 states that debit users pay down credit card balances; they have both credit and debit available.

Open ended survey evidence is said to refute spending control. Table 4 of BKA reports that 5.8% of debit card users report in open ended questions that they use debit cards for spending restraint. For convenience, BKA's Table 4 is reprinted here. BKA consider four payment options: cash, check, debit and credit. Return for a moment to the idea that debit cards are merely one method of paying with current funds. Under this framework, cash, check and debit are contemporaneous payment instruments and so could be used for spending restraint. Credit is a form of debt. As noted above, this nesting structure is verified by BKA's and Borzekoswki and Kiser's result that the closest substitutes of debit are cash and check.

Table 4 from BKA:
Payment Choice Drivers

Reasons for:	Debit Use	No Debit Use
Time	14.1	5.5
Convenience	88.1	8.3
Money	11.7	21.1
Restraint	5.8	5.5
Tracking	10.2	40.4
Acceptance	4.9	0.0
Other	3.0	35.8
N	674	109

Categories not mutually exclusive

Most of the reasons for using debit reported in BKA's table 4 are reasons for using debit over cash and check (i.e., reasons for preferring debit within that category rather than reasons for preferring current funds over future funds). Credit and debit are very similar along dimensions of "Time", "Convenience", and "Tracking". These categories differ much more between debit and cash or check. "Time" is an advantage primarily over check (Klee, 2006). Debit is slightly more convenient than credit which requires a second action – paying the bill. "Tracking" is actually slightly better with some credit cards. "Money", a category which represents all pecuniary motives, is mostly a reason for using credit. But to the extent that debit is used for pecuniary motives it is likely to avoid ATM fees. This category is likely a statement of debit's preferability over cash. 4.9% or 33 respondents cite "Acceptance" but only 61% of these, or 20 respondents substitute credit for debit. Some wholesale club retailers do not accept credit but in this case debit is probably not the primary card of the respondent.

Most of the respondents who report using debit cards are expressing their preference for debit over other restraining payment methods. This fact as well speaks to the idea of a nesting structure based on current funds versus future funds. Certainly, since these are open ended questions it should be considered a lower bound rather than definitive proof that this type of use is rare. Many consumers, when asked “why do you use debit?”, report their preference over other restraining methods. It is highly likely that using credit is a last option for spending control motives.

Table 4 of BKA reports the percent of all debit users who report spending control as a motive for using debit 5.8%. A more telling measure would be the percentage of people reporting debit as an alternative to credit who cite spending control motives. Using the data from Table 3 of BKA we can calculate this. Table 3 reports that 19.4 percent of debit users chose debit as an alternative to credit and another 21.4% mention no alternative to debit. Allocating these proportionately to cash, check and credit[10], the percentage of those using debit instead of credit rises to 24.7% or 166 respondents. From Table 4 of BKA, 5.8% or 39 respondents cite spending control motives. Therefore, 39 of 166, or 23.5%, of people reporting debit as an alternative to credit cite spending control motives. This is too large a share to dismiss spending control as unimportant.

[10]This assumes that not mentioning an alternative to debit is independent of the true alternative to debit. Since those surveyed were not asked explicitly for an alternative to credit the missing data likely does not stem from respondents hiding something. Therefore, independence is reasonable.

To the extent that one considers spending control a behavioral motivation, a few related studies have found evidence to support behavioral considerations in personal financial management. According to Ausubel (1991), a consumers's willingness to accept a high credit card interest rate implies an expected likelihood of credit card borrowing. This implied likelihood of carrying a credit card balance is below actual credit card debt. Thus, credit users are underestimating their future level of credit card purchases.

Thaler and Shefrin (1981) and Bertaut and Haliassos (2002) have models where financial units are divided into two persons: a planner/accountant and a shopper. The planner/accountant then uses a commitment technology to restrain the spending of the shopper. Liabson, Repetto and Tobachman (2004) likewise find a difference between long range planning – retirement saving – and short term spending decisions. Ashraf Karlin and Yin (2006) find in a field experiment that consumers are willing to open a savings account with differs from the standard account in that it embodies forced savings.

Prelec and Loewenstein (1998) and Prelec and Simester (2001) predict that credit cards are used to separate the pain from paying from the pleasure of consumption that makes consumers more willing to spend.

The following section describes the data that are used to test hypotheses 1, 2 and 3.

5. Data

This paper employs a sample of bank account transaction records from 2,310 checking accounts to test the theory that consumers use debit cards to control their spending. The data was obtained from a small depository institution in the Midwest. It includes customer information and all transactions with associated balances from June, July and August 2003.

In addition to the date, amount and balance of each transaction the data contain additional information on the source or destinations of the transaction. For instance, ACH[11] transactions show a descriptive field which allow us to identify the destination of the funds. Therefore, any ACH payment made to “American Express” or “Discover” or “Cred Crd Pmt” are payments toward credit card balances. A full list of the descriptions identifying credit card payments is provided in Appendix A. For ATM or debit card transactions the address and/or store name is listed. For paper checks which were not converted to electronic transactions no information is available. The major credit card issuers in the data set convert received checks to an ACH transactions and thus all payments to these issuers should be identified. This data set allows us to identify most, but not all payments to credit card providers.

Table (3) shows summary statistics for the data set. Average annual income for a customer is $31,000. Note that any income not passing through this account is not observed. They maintain an average checking account balance of $1843. The median customer is 44 years old.

[11] Automated Clearing House is the system through which, for example, direct deposit and direct billing operates.

Over 60% of customers use debit cards. The average customer makes 125 withdrawal transactions in the three month sample, and the average debit card user makes 49 debit card transactions. This rate of usage is roughly in line with the survey reported in Borzekowski, Kiser and Ahmed (2006). A debit card user is defined at anyone who makes more than four transactions with a debit card during the three month sample period. The level four was arbitrarily chosen but any small number of debit transactions yields the same results.

Nearly 20% of accounts can be identified as making at least one payment toward a credit card balance. On average they make 4 such payments but the mode is 3 payments generally to the same card. Credit card users are customers who can be identified as making any credit card payments.

Two variables are chosen to indicate consumers who are not using their credit card for

Table 3: **Summary Statistics**

Variable	Obs	Mean	Std. Dev.	Min	Max	Units
Total Transactions	2310	125.3	87.1	0	523	Count[b]
Debit User	2310	.606	–	0	1	Indicator
Debit Transactions	1517	48.9	37.3	1	256	Count[b]
Pin Debit Transactions	819	7.96	9.73	1	66	Count[b]
Signature Debit Trans.	1478	44.7	35.9	1	245	Count[b]
Credit User[a]	2310	.195	–	0	1	Indicator
Credit Card Payments	450	3.94	4.02	1	39	Count[b]
Round Payments	300	2.86	2.46	0	16	Count[b]
Repeat Amount Payments	450	.333	–	0	1	Indicator
ATM Withdrawals	1340	12.6	11.6	1	148	Count[b]
Different Locations	1340	6.17	5.08	1	35	Count[b]
Age	2310	45.0	13.5	17	94	Years
Female	2107	.496	–	0	1	Indicator
Average Account Balance	2310	1.84	4.39	–2.43	97.7	Thousand $
Annual Income	1484	31.3	22.3	1.2	275	Thousand $

[a]Credit users can be identified only when their bills are paid electronically (either web pay or payee conversion).
[b]All count variables are for the entire 3 month sample.

Table 4: **Variable Definitions**

debit user	= 1 if more than 4 debit card transactions are made
credit user	= 1 if any payments are made toward credit card balances (See Appendix)
transactions	= number of withdrawals: check, card, ATM, electronic or transfer
round payments	= number of credit card payments which are multiples of $10
same payment	= 1 if customer makes two credit card payments for the same amount
locations	= percent of ATM withdrawals at distinct locations
no. withdr.	= number of ATM withdrawals
withdr. size	= average withdrawal amount / total expenditure
age	= age of primary account holder in years
female	= 1 if primary account holder is female
account balance	= average daily account balance
income	= average paycheck size * days between paychecks / 365

NB: income is observed for only those accounts which receive a paycheck through direct deposit. Included in all regressions is an indicator variable denoting them.
NB: The portion of income which does not flow through this account is unobserved. This variable will then be biased down but it is still a reasonable control for income.

payments but are rather paying off a debt balance. These are round payment and same payment. Round payments are any credit card payments which are made in multiples of $10. Same payment is any consumer who makes two payments of identical amounts. Two thirds of these credit card users make at least one round payment and they make an average of 3 round payments in the three months. One third of credit users make two payments of the same amount.

In order to test Hypothesis 2 define the variable "locations" to be the number of distinct ATM locations where an individual withdraws cash. Since the locations of debit card purchases are observed but credit card purchases are not, all purchases can not be compared directly in the two groups. Rather we compare the locations of ATM withdrawals in the two groups. To the extent that consumers withdraw cash before spending cash, ATM withdrawal locations should be correlated with purchase locations (at least cash purchase locations). One benefit of this variable is that it measures a characteristic of interest (purchase location variety) in a portion of spending which is distinct from credit or debit card use. Therefore, while it measures that characteristic it is free of complicating differences between credit and debit such as merchant acceptance.

The regressions also control for the age, gender, wealth, and income of the account holder. Wealth is proxied by the average daily balance in the checking account. Income is observed in those accounts which receive a paycheck by direct deposit. Income is missing for the rest of the sample; an indicator variable marks such observations.

6. Evidence

This section details the results of empirical tests of hypotheses 1, 2, and 3. The results support spending control as a motive for using debit. The show that (1) debit card users are paying down debt, (2) that debit card users shop in a larger variety of locations and (3) that debit card users tend to make more and smaller ATM withdrawals.

In order to test H1 we search for evidence that when debit card users are paying off credit card balances, they are not paying for recent transactions but rather are paying off a balance carried from a previous statement period. A consumer who is paying off a balance in full would be paying the whole balance right down to the penny. Whereas, someone paying off a balance is unlikely to be paying off pennies but more likely will pay in round increments. Therefore we look for evidence that debit card users, when making payments toward credit card balances pay in $10 increments[12]. Second, people paying off balances are likely to be paying the same amount each month, whereas those paying off recent purchases are very unlikely to have equal payments across months.

Column 1 of table (5) shows tobit regressions of an indicator for being a debit card user on personal characteristics and the variables of interest. In models (1a) and (1b) respectively the coefficients on round payment and same payment are positive and significant. This indicates that debit card users, when also using a credit card are likely to be paying down a balance rather than paying for recent purchases.

In models (1c) and (1d) which include both variables together significance drops quite a bit. High correlation between these two variables causes the drop in significance, something to be expected since they both proxy for the same underlying variable – paying down borrowed

Table 5: **Model 1 – Debit Users Are Paying Down Credit Card Balances**

	Model (1a)		Model (1b)		Model (1c)		Model (1d)	
	Coeff	Std Err	Coef	Std Err	Coef	Std Err	Coef	Std Err
balance[a]	−.150*	.031	−.149*	.031	−.148*	.031	−.149*	.031
credit user[b]	.082†	.034	.088*	.031	.072†	.035	.090†	.039
round pmt	.036*	.036			.018	.016	−.003	.027
same pmt[b]			.172*	.048	.134†	.062	.077	.091
interaction							.035	.035
age	−.010*	.001	−.010*	.001	−.010*	.001	−.010*	.001
male[b]	−.043†	.022	−.042‡	.022	−.043†	.022	−.043†	.022
Income[a c]	.020*	.007	.020*	.007	.020*	.007	.020*	.007

Significant at: ‡90% †95%, *99% Number of Observation: 2310
Probit Estimates – Reported Figures are Marginal Effects Dependant Variable: Debit Card User
[a]Figures are denominated in thousands of dollars.
[b]Coefficient values reported for Indicator variables are for discrete change of the variable.
[c]Income is unobserved for those 826 observations who do not have direct deposit. Therefore the coefficient on income reflects only 1484 observations.

[12]Other rounding levels were also tested with no significant effect on the results. Tested were rounding to the ($1), ($5), and ($10 or $25).

balances. These variables, thought not individually significant are jointly significant at the 99% level. Likelihood ratio test scores are 11.70 and 12.69 respectively.

Note also that the coefficient on credit card user is positive and significant across the regressions. This can be interpreted as a comfort for/aversion to plastic, but, it also supports the idea that debit card users are former credit card users who got into trouble with credit and are now either paying off those balances, or reserve credit for only large purchases of durables.

H2 predicts that debit users should have a greater variation in purchase locations – they should purchase a greater variety of goods. Practically this can be thought of as debit card users being impulse purchasers. Thought we do not observe the goods being purchased we do observe the locations of purchases. Table (6) shows the results of a regression which includes the number of different purchase locations as an explanatory variable. Model (2a) gives the result

Table 6: **Model 2 – Debit Users Are Paying Down Credit Card Balances**

	Model 2a (All Accounts)		Model 2b (Plastic Users)		Model 2c (Credit Users)		Model 2d (All Accounts)	
Dep Var:	Debit User		Debit User		Debit User		Credit User	
	Coef	Std Err	Coef	Std Err	Coef	Std Err	Coef	Std Err
balance[a]	−.069*	.026	−.012	.008	−.377*	.082	−.130†	.064
credit user[b]	.068*	.022						
debit user[b]							.084*	.027
locations	.286*	.036	.038†	.017	.162*	.057	.050	.042
age	−.0041*	.0010	−.0007	.0004	−.0026‡	.0014	−.0009	.0010
male[b]	−.015	.021	.011	.009	.035	.029	−.007	.022
Income[a c]	−.006	.006	−.0034‡	.0018	−.0004	.0064	.024*	.005
no. of obs	1488		1238		360		1488	

Probit Estimates – Reported Figures are Marginal Effects Significant at: ‡90% †95%, *99%
[a]Figures are denominated in thousands of dollars. Dependant Variable: Debit Card User
[b]Coefficient values reported for Indicator variables are for discrete change of the variable.
[c]Income is unobserved for those 826 observations who do not have direct deposit. Therefore the coefficient on income reflects only 1484 observations.

that debit card users shop at a greater variety of locations than non debit users.

We would see the same result if plastic users (both debit and credit) use more purchase locations than paper users (checks and cash). To weed out this possibility consider models (2b), (2c) and (2d). Models (2b) and (2c) restrict the regression to plastic users and credit users respectively and still debit card users do indeed show a greater variety of locations. Finally, using the whole sample again, model (2d) regresses credit card users on the same factors as model (2a) but the number of purchase locations does *not* predict *credit card* use. These results indicate that debit card users use more purchase locations than do credit card users, in support of Hypothesis 2.

A note should also be make about the variables used here. Since the data comes from checking accounts, the location of debit card purchases is witnessed but credit card purchases are not. To side-step this missing data problem, number of locations represent ATM withdrawals only. The location of ATM withdrawals gives us a peek at the extent to which a person gets around. To the extent that ATM withdrawal locations will be correlated with the location of the cash spending this gives us a peek at the extent to which a shopper gets around. See section (5) for more on this.

Finally, consider H3 – if debit users are trying to restrain spending they also limit their cash holding, withdrawing small amount more often ("Money burns a hole in my pocket"). The evidence to support this hypothesis is less strong then the others. The variables "no. withdr" and "withdr size" are the number of ATM withdrawals and average withdrawal amount as a fraction of total expenditure respectively. If debit users tend to withdraw more often but less each time (no withdr > 0, withdr size < 0) then we have some support for the H3.

Table 7: **Model 3 – Debit Users Hold Less Cash**

	Model 3a (All Accounts)		Model 3b (Plastic Users)		Model 3c (Credit Users)		Model 3d (All Accounts)	
Dep Var:	Debit User		Debit User		Debit User		Credit User	
	Coef	Std Err	Coef	Std Err	Coef	Std Err	Coef	Std Err
balance[a]	−.056†	.027	−.0081	.0081	−.032*	.008	−.136†	.065
credit user[b]	.077*	.022						
debit user[b]							.093*	.027
no withdr.	.0057*	.0011	.0015*	.0005	.0040†	.0016	−.0011	.0010
withdr. size	−.264†	.113	−.035	.048	−.185	.236	−.087	.173
age	−.0044*	.0009	−.0006	.0004	−.0030†	.0014	−.0012	.0010
female[b]	.025	.021	.0008	.0088	.0003	.0298	−.018	.022
Income[a c]	−.0013	.0059	−.0046†	.0018	.0013	.0062	.025*	.006
no. of obs	1488		1238		360		1488	

Probit Estimates – Reported Figures are Marginal Effects Significant at: ‡90% †95%, *99%
[a]Figures are denominated in thousands of dollars. Dependant Variable: Debit Card User
[b]Coefficient values reported for Indicator variables are for discrete change of the variable.
[c]Income is unobserved for those 826 observations who do not have direct deposit. Therefore the coefficient on income reflects only 1484 observations.

The four columns of table (7) are similar to those in table (6). Model (3a) uses all consumers who make ATM withdrawals. Model (3b) and (3c) are restricted to plastic users and credit users respectively. And model (3d) uses all consumers who make ATM withdrawals but the dependent variable is credit users. The basic model (3a) does indeed show that debit users make more and smaller withdrawals. As with model (2) the following columns are designed to weed out the possibility that it is a technology effect rather than a debit effect. In models (3b) and (3c) number of withdrawals remains significant but withdrawal size does not. Note, thought, that several other variables which were significant in other equations are not significant in this equation. Model (3d) shows that credit users do not have smaller more frequent withdrawals, indicating that Model (3a) is not showing a technology effect but rather a debit card effect.

In summary, model (3a) shows the desired result – that debit card users do have smaller, more frequent ATM withdrawals. Model (3d) shows that the same is not true for debit card users which is one strike against a in interpretation as a technology effect. But models (3b) and (3c) deliver only weak evidence against the technology effect interpretation of the model (3a) result.

Other Interesting Results

Before concluding a few other interesting results deserve note. When controlling for income, our measure of wealth, is negatively related to the likelihood of using a debit card. Especially since this is liquid wealth this supports the theory that debit cards are used to restrain spending.

Second, when we control for ATM use in models (2) and (3) income has no recognizable impact on debit card use. These results are similar to Stavins' (2001) and Borzekowski and Kiser (2006) findings so they are not new, but it is interesting that income and wealth do not have a positive relationship with debit cards as they tend to have with other forms of electronic payment and as they tend to have with new technology in general.

7. CONCLUSION

This paper attempts to explain why such large numbers of consumers are choosing debit cards (current balances) as their primary method of payment for purchases despite a seemingly more cost effective alternative in credit cards (future balances). Theory presented posits that debit cards, being a method for accessing cash on hand, provide a needed level of spending restraint for consumer who lack self control (have high cost of calculating the budget set) when using a payment method which embodies debt – short-term and zero-interest if used responsibly but high-interest if used in the longer term.

A data set containing transaction records for 2310 checking accounts including debit card purchases and credit card payments is employed to test key aspects of the theory. Findings support the theory of debit cards as spending control. They show that debit card users, when making credit card payments are more likely to be paying off a large balance. And they show that debit card users are likely to have a greater profusion of shopping locations as is predicted by the model. Finally, they show that debit users are more likely to withdraw smaller amount of cash more often.

One much noted predictor of payment method is purchase size. Large purchases are more likely to be credit transaction. Larger purchases, however, are more likely to be one-time purchases thus are better candidates for intentional borrowing. This work abstracts away from issues of intentional borrowing or purchase size. Rather, purchase size is held constant and purchases are part of recurrent expenses. Exploring the connection between intentional long-term credit card borrowing and using a credit card to facilitate transaction (often without carrying a balance) seem to be fruitful avenues for future research.

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APPENDIX A

Transaction Descriptions which denote credit card payment:

AMERICAN EXPRESS
BANK ONE IC PAYMENT
BANKCARD
BANKCARD PAYMENT
BK OF AM CRD ACH
BK OF AMER VI/MC
CAPITAL ONE CRCARDPMT
CAPITAL ONE ONLINE PMT
CAPITAL ONE PHONE PYMT
CHASE CARD SERV PAYMENT
CHASE CREDIT CAR BILL PAY
CHASE MANHATTAN ONLINE PMT
CHASE MANHATTAN RE PAYMENT
CITI-CLICK 2 PAY
CITIBANK CRDT CD ONLINE PMT
CITIBANK-AUTOPAY PAYMENT
CREDIT CARD
CROSS COUNTRY BA CC PAYMENT
DISCOVER
FIRST NATIONAL PAYMENT
FIRST PREMIER BK
FIRST USA CARD
FIRSTCONSUMERS CARD PMT
FLEET CREDIT CRD
GM CARD
HOUSEHOLD CREDIT ONLINE PMT
JUNIPER BANK CREDITCARD
MBNA AMERICA
NATIONAL CITY PAYMENT
NEXTCARD
PAY CARD SERVICE
PAY-BY-PHONE PYM
PEOPLES BANK
PREMIER CR CARD
PROVIDIAN PAYMT CREDITCARD
RNB - TARGET BILL PAY
SAM'S CLUB ONLINE PMT
SEARS ROEBUCK PHONE PMT
SEARS WEB PAY
TARGET VISA
UCS - AUTOPAY
UCS - CLICK TO PAY"
VISA
WELLS FARGO
WELLS FARGO CARD
WELLSFARGO CARD

APPENDIX B

Here we look at the consumer's choice of a level of budgeting. Before we can calculate ρ we must assume a utility function. First, not that in section 3 each good carried a benefit, b_n. Substituting equation (6, 8) into equation (7, 9) and rearranging gives an expression for $\overline{p_n}$ primarily as a function of b_n. Therefore, rather than expressing utility as a function of the vector of parameters, $(b_1, b_2, \ldots, b_N)$, we can express utility as a function of expenditure, $\overline{p}\, N_i$. Consider the discounted log utility functional form, $U = \Sigma\beta^t \; ln(\overline{p}\, N_{it})$.

In this case, consumers overspend early in life, until period t. They accumulate s debt B_t, as described in equation (11). After period t they must repay the debt over time. In order to determine a consumer's optimal level of ρ, given the above utility function and this scenario about borrowing over the lifecycle, we solve

$$\max_\rho \sum_{\tau=0}^{t} \beta^\tau \ln\left[y + \left(\overline{p}N_i - y_i\right)\rho - \gamma(1-\rho)\right] + \sum_{\tau=t+1}^{T} \beta^\tau \ln\left[y - \frac{B_t}{T-t}\right]$$

which reduces to

$$\max_\rho \frac{1-\beta^{t+1}}{1-\beta} \ln\left[y + \left(\overline{p}N_i - y_i\right)\rho - \gamma(1-\rho)\right] + \frac{\beta^{t+1} - \beta^{T+1}}{1-\beta} \ln\left[y - \frac{\left(\overline{p}N_i - y_i\right)\rho}{T-t} \frac{(1+r)^{t+1} - 1}{r}\right]$$

this problem implies an optimal level of ρ:

$$\rho = \frac{y \frac{(T-t)r}{(1+r)^{t+1}-1} + \mathrm{B}\Gamma\gamma}{\left(\overline{p}N_i - y_i\right)\left(1 + \mathrm{B}\Gamma\right) + \mathrm{B}\Gamma\gamma}$$

$$\text{where} \quad \Gamma = \frac{\overline{p}N_i - y_i}{\overline{p}N_i - y_i + \gamma} < 1 \quad \text{and} \quad \mathrm{B} = \frac{\beta^{t+1} - \beta^{T+1}}{1-\beta^{t+1}}$$

We can see, from this equation that consumers with lower levels of γ will choose lower levels of ρ, i.e., consumers with lower cost of budgeting will budget more. To see this consider the derivative of ρ with respect to γ:

$$\frac{d\rho}{d\gamma} = \frac{\left[\left(\overline{p}N_i - y_i\right)\left(1+\mathrm{B}\Gamma\right) + \mathrm{B}\Gamma\gamma\right]\left[\frac{d\Gamma}{d\gamma}\mathrm{B}\gamma + \mathrm{B}\Gamma\right] - \left[y\frac{(T-t)r}{(1+r)^{t+1}-1} + \mathrm{B}\Gamma\gamma\right]\left[\left(\overline{p}N_i - y_i\right)\frac{d\Gamma}{d\gamma}\mathrm{B} + \frac{d\Gamma}{d\gamma}\mathrm{B}\gamma + \mathrm{B}\Gamma\right]}{\left[\left(\overline{p}N_i - y_i\right)\left(1+\mathrm{B}\Gamma\right) + \mathrm{B}\Gamma\gamma\right]^2}$$

The denominator is obviously positive. The numerator is also positive, to see this consider that $\rho<1$ implies that $\left(\overline{p}N_i - y_i\right)\left(1+\mathrm{B}\Gamma\right) + \mathrm{B}\Gamma\gamma > y\frac{(T-t)r}{(1+r)^{t+1}-1} + \mathrm{B}\Gamma\gamma$ and since $\frac{d\Gamma}{d\gamma}$ is negative, $\frac{d\Gamma}{d\gamma}\mathrm{B}\gamma + \mathrm{B}\Gamma\gamma > \left(\overline{p}N_i - y_i\right)\frac{d\Gamma}{d\gamma}\mathrm{B} + \frac{d\Gamma}{d\gamma}\mathrm{B}\gamma + \mathrm{B}\Gamma\gamma$.

APPENDIX C

Proposition 2: *The reservation price for goon (n) can be expressed as a function of the benefit (b_n) derived from the good.*

$$p_n^* = \frac{b_n}{1-\beta(1-\lambda)} - \frac{\beta}{1-\beta(1-\lambda)} \int_0^{p_n^*} F(p)\,dp \tag{8}$$

And the derivative of p with respect to b_n is positive and given by:*

$$\frac{dp^*}{db_n} = \frac{1}{1-\beta\left(1-\lambda-F^*\right)} > 1$$

Proof of Proposition 2: By definition $U = \beta \max\{ E[V(p_n)] , U \}$. Substituting for U_n and $V(p_{nt})$ from equations (3) and (5) respectively, combining terms and recognizing that we know the region of p_{nt} over which $V(p_{nt})$ is higher than U_n we get.

$$\left[1-\beta(1-\lambda-F^*)\right]p_n^* = b_n + \beta\int_0^{p_n^*} p_n dF(p)$$

integration by parts gives

$$b_n - \left[1-\beta(1-\lambda-F^*)\right]p_n^* = -\beta p_n^* F^* - \beta\int_0^{p_n^*} F(p)dp$$

which simplifies to

$$p_n^* = \frac{b_n}{1-\beta\left(1-\lambda\right)} - \frac{\beta}{1-\beta\left(1-\lambda\right)}\int_0^{p_n^*} F(p)dp$$

This proves the first statement. The derivative of this with respect to b_n is found by using Leibnitz's rule:

$$\frac{dp^*}{db_n} = \frac{1}{1-\beta\left(1-\lambda\right)} - \frac{\beta}{1-\beta\left(1-\lambda\right)}F^*\frac{dp^*}{db_n}$$

Which simplifies to the desired expression. Since $1-\lambda-F^* < 1$, $\beta(1-\lambda-F^*) < 1$ which implies that the numerator is positive. So $\frac{dp^*}{db_n}$ is positive. ❑

***Correlary 1**: The value of good n, U_n varies positively and at a greater rate than b_n under reasonable levels of the discount rate β.*

Proof:

$$\frac{dU_n}{db_n} = \frac{1}{1-\beta} - \frac{1-\beta\left(1-\lambda\right)}{1-\beta}\frac{dp^*}{db_n}$$

After substituting $\frac{dp^*}{db_n}$

from proposition 2 we can find that this expression is greater than unity if and only if:

$$\left(\frac{1-\beta}{\beta}\right)^2 + \left(\frac{1-\beta}{\beta}\right)\lambda < F^*$$

When $\lambda=1$ the left side of this inequality is largest. When this is true, consider a reasonable level of F^* of 0.5 and notice that for the inequality to be violated β would have to be less than 0.73 . Even for lower level of F^* reasonable level of β make the equality hold: When F^* is 40% any β above 0.77 make the inequality hold. In fact as long as $\beta > 0.90$ the inequality will hold for all F^* down to 12%. Thus both F^* and β would have to be at unreasonably low levels in order for the inequality to fail even when $\lambda=1$. ❑

Proposition 3: *The ex-anti expected price paid for a good,* $\overline{p_n}$, *can be expressed as a function of the reservation price for good (n).*

$$\overline{p}_n = \frac{-b_n}{\beta} + \frac{1-\beta(1-\lambda-F^*)}{\beta} p_n^* \tag{9}$$

Proof: By definition $U = \beta \max\{ E[V(p_n)] , U \}$. Substituting for U_n and $V(p_{nt})$ from equations (3) and (5) respectively, combining terms and recognizing that we know the region of p_{nt} over which $V(p_{nt})$ is higher than U_n we get:

$$b_n - [1-\beta(1-\lambda)]p_n^* = \beta\int_0^{p_n^*} p_n^* dF(p) - \beta\left\{\int_0^{p_n^*} p_n dF(p) + \int_{p_n^*}^{\infty} 0 dF(p)\right\} \tag{10}$$

Notice that the term in braces is the ex-anti expected outlay for good n in a period, $\overline{p_n}$, not conditional on purchase. Rearranging a little more gives the desired result. ❑

Proposition 5*: The two-standard-deviation confidence interval around zero debt is:*

$$0 \pm \sigma_p \rho \sqrt{N \frac{(1+r)^{2t+2} - 1}{2r + r^2}}$$

Proof of Proposition 5: First we must derive an equation for the level of borrowing. If consumer i has expenditure

$$\sum_{n=1}^{N_i} p_{nt}$$

then her typical deficit is $\left(\sum p\right) - y_i$ each period – or $\left[\left(\sum p\right) - y_i\right]\rho$ if she chooses to reduce her deficit by ρ. If she borrows this amount from period 0 to period t, then the borrowed balance at time t will be:

$$B_t = \left(\sum p - y\right)\rho(1+r)^t + \left(\sum p - y\right)\rho(1+r)^{t-1} + \ldots + \left(\sum p - y\right)\rho$$

where r is the interest rate. The expected value of this simplifies to:

$$E(B_t) = (\overline{p}N_i - y_i)\rho\frac{(1+r)^{t+1} - 1}{r} \tag{11}$$

Next consider the variance of this accumulated debt. The variance of B_t can be written as:

$$V(B_t)=V\left[\left(\sum p-y\right)\rho(1+r)^t+\left(\sum p-y\right)\rho(1+r)^{t-1}+\ldots+\left(\sum p-y\right)\rho\right]$$

Since the price received in one period is independent of prices found in other periods the variance of this can be written as:

$$V(B_t)=V\left[\left(\sum p-y\right)\rho\right]\left[(1+r)^{2t}\right]+V\left[\left(\sum p-y\right)\rho\right]\left[(1+r)^{2t-2}\right]+\ldots+V\left[\left(\sum p-y\right)\rho\right]$$

which simplifies to:

$$V(B_t)=V(p)N\rho^2\,\frac{(1+r)^{2t+2}-1}{2r+r^2}$$

The square root of this is the desired expression. ❑