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THE EFFECTS OF CREDIT CARDS ON MONEY DEMAND

DISSertation

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the
Graduate School of The Ohio State University

By

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ABSTRACT

As a recently expanded alternative technology for conducting transactions, credit cards have the potential to alter consumers' demand for money. A look at how credit cards have changed money balances spotlights the traditional monetary theme that transactions costs influence a consumer's level of liquid assets.

A cross-sectional study of family-level transactions account holdings explores the impact of credit card usage. Credit card usage is positively related to the dollar amount a consumer keeps in the sum of their checking and savings, ceteris paribus.

Credit cards may change the timing of flows through these accounts, for example by replacing a continual outflow of money with discreet monthly card payments, in a way that offsets any reduction in the precautionary demand for money. An inventory management model of money holdings is analyzed for cases where the ability to aggregate transactions would match the observed positive impact on money holdings.

To examine the effects of the increase in credit card usage in the economy in general, time series regressions model revolving consumer credit against monetary aggregates, controlling for interest rates and economic growth. Revolving consumer
credit usage has a positive effect on M1, which is consistent with my cross-sectional results, but has a negligible effect on M2.

The price of consumer credit is relatively non-responsive to the change in the cost of funds following a monetary policy shock; revolving consumer credit provides an independently priced substitute for money balances. To analysis the impact of increased liquidity from credit cards, revolving consumer credit outstanding was incorporated into a model of money holdings following a monetary policy shock. Higher levels of revolving consumer credit outstanding are associated with more transitory monetary policy shocks, indicating that the expansion of revolving consumer credit in the economy coincides with a decrease in consumer liquidity effects that propagated monetary policy shocks.
Dedicated to Dirk
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CHAPTER 1

INTRODUCTION

1.1 MOTIVATION

Many assumptions are made about how credit cards “should” affect money demand. Consider this typical explanation, found in the best selling introductory economics textbook:

Even though credit cards are not considered a form of money, they are nevertheless important for analyzing the monetary system. People who have credit cards can pay many of their bills all at once at the end of the month, rather than sporadically as they make purchases. As a result, people who have credit cards probably hold less money on average than people who do not have credit cards. Thus, the introduction and increased popularity of credit cards may reduce the amount of money that people choose to hold.

--- Mankiw (1998) pg. 319, emphasis added
This passage makes the relationship seem much more straightforward than it is. Embedded in the passage, beneath the appearance of logical reasoning, is a series of assumptions about how agents receive and retain their income, and the transactions costs between money and non-money holdings. Few of these assumptions have been adequately measured in the existing economic literature.

There are at least three reasons why a review of both the logic of these assumptions and the empirical evidence is necessary. First, there is a pedagogical value to discussing credit cards and how they relate to money holdings. This relationship is often highlighted in introductory economics textbooks, but usually in an oversimplified manner that may actually detract from the presentation of monetary theory. The typical textbook example printed above glosses over the definition of money by minimizing the importance of transactions account holdings in the definition of monetary aggregates. Teachers who follow this text miss a fine pedagogical opportunity to explain precisely how money is measured, and therefore to clarify exactly what money is.

Second, discussions about non-monetary transactions technologies have a much wider impact in the way they inform the direction of monetary research, and the study of economics in general. This practice has a long intellectual tradition; Knut Wicksell’s writings were significantly shaped by his belief that credit based transactions could entirely supplant money, reducing the power of the Quantity Theory of Money to determine the price level. [See Trautwein (1995) for a discussion of the extent to which Wicksell believed credit was the evolutionary ideal of an economy.]. Hancock and Humphrey (1998) survey several prominent economic institutions, including the Working
Group on EU Payment Systems and the Congressional Budget Office that are currently
pursuing reports on how the evolution of the newest form of transactions payments, e-
money, could undermine the effectiveness of monetary policy. Careful analysis of the
relationship between new payment technologies and money demand is necessary because
inaccurate assumptions detract from economics as a science.

Finally, if there is an empirical relationship between credit cards and currency or
transaction account holdings, this relationship may be of interest in a variety of studies
that measure money demand over time. This will become increasingly important as credit
cards usage continues to expand. From 1970 to 1995, both the percentage of households
owning a credit card and the average monthly household usage of credit cards
quadrupled. In 1997, the yearly volume of transactions on credit cards was $860 billion
(Evans and Schmalensee 1999).

This paper examines the effects of credit card use on transaction account holdings.
After presenting an overview of the topic, the first section contains a literature review of
earlier empirical efforts. This section also presents a review of literature on the
transactions demand for money. The second chapter contains several theories for
incorporating credit card usage. The third chapter presents empirical results that measure
the effect of credit cards on transactions accounts in a cross-sectional survey; this paper
finds that the empirical relationship between credit card use and money demand is
positive. An attempt is made to reconcile this positive relationship with earlier research
that had found a negative relationship. The fourth chapter discusses time series results
that support the findings of a positive relationship between credit cards and money

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demand. The fifth chapter investigates whether credit cards act as a substitute for money holdings in the sense that they allow consumers an alternative response to monetary policy shocks. Finally, this paper outlines future research on this topic in chapter six.

1.2 WHAT IS A CREDIT CARD AND WHAT IS MONEY?

Credit cards offer a natural foil for money, and introductory textbooks often take a few sentences to define how the two are distinct. A credit card can function as a medium of exchange, which is a defining attribute of money. The distinction between a credit card and money is often in terms of the timing of payment: money is a means of immediate payment, and credit cards are a method of deferred payment.¹

For this paper, a credit card will be defined as a service in which payment is provided to the seller while payment by the consumer is deferred. These deferred charges are then aggregated into periodic payments for the consumer. This definition of a credit card is sufficiently general to include both revolving and non-revolving credit arrangements. With this definition of credit, money is still the eventual means of payment, because bills rung up on a credit card must be settled in money. Money therefore retains the unique role of a standard of measurement and unit of account.
1.3 LITERATURE REVIEW

1.3.1 APPROACHES TO CREDIT CARD ISSUES

Research on the relationship between credit card usage and monetary aggregates is not common in the academic literature. Most of the empirical attempts to measure this relationship were conducted before changes in interstate branch banking dramatically increased the size and scope of the credit card industry.

Most studies of credit card usage have focused instead on consumer’s choices among credit cards; specifically, most studies on credit cards were seeking to explain the apparent existence of profit in a seemingly competitive industry, and the corollary high sticky interest rates (Ausubel (1991), Kim (1999) and Goldberg (1975)). The most prominent of these studies is by Ausubel (1991), who argues that consumers pay relatively high interest costs on credit cards because of a failure to accurately anticipate their credit card usage. Subsequent papers, such as Brito and Hartley (1995), argue that persistent high credit rates result from customers trying to avoid fixed costs of loans when seeking alternative funds. On the way to justifying persistently high credit card rates, Brito and Hartley develop a theoretical model of money demand that is similar in spirit, but dissimilar in functional form to the model presented in this paper.

The few theoretical papers that investigate directly the effect of credit card usage on money demand, (Akhand and Milbourne (1986)), or explore why more general forms

\[\text{1 Of course, money can also been defined as ‘a method of deferred payment,’ when an author highlights how money removes the dual coincidence of wants. Money is a unit of account in the first half of a barter trade (the seller receives money for goods) and a means of deferred payment in the second half of the bartered}\]
of credit payment do not drive out all money holdings within an economy, such as Prescott (1987), rely on the presence of fixed costs of obtaining various forms of credit to model economies where credit cards and money interact. Akhand and Milbourne used this model to show that the introduction of credit cards (available at a fixed annual fee) increases the interest elasticity of money demand. My research differs from these approaches because my theoretical explanation eschews the idea of credit card charges as a “pure credit”; payments deferred using a credit card service still must be reconciled from money rather than from income earning assets. This refocuses the explanation on the “convenience use” of credit.

This paper is focused on the most common use of credit cards, for conducting transactions. This requires more careful attention to the current institutional structure; this means not only looking at the portfolio of payment options each customer has when he chooses to consume the goods, but also how the timing of deferred payments from the credit card influences the consumers portfolio of asset holdings.

1.3.2 CREDIT CARDS AND TRANSACTIONS ACCOUNTS

There are few empirical studies on credit cards and money holdings. The majority of the empirical research has found that the relationship between credit card usage and transactions accounts is largely negative. In a review of the first set of credit card data from the 1970 Survey of Consumer Finance, Mandell (1972), found a negative result, so trade (the seller then uses the money for other goods). At this level of grammatical detail, credit delays the
that each dollar charged on credit cards reduced checking account balances by 12 cents, but this result was not statistically significant. White (1976) studied a set of private bank data for cardholders who had both a credit card and a checking account at the same bank. White found evidence that bank customers used credit cards to reduce their checking balance; for each dollar on a credit card, checking balances were less than one-tenth as large as balances were for other transactions, and these results were statistically significant at traditional confidence levels.

Duca and Whitesell (1995) used 1983 Survey of Consumer Finance data and found a statistically significant negative relationship between credit cards and a constructed variable that measured the probability of credit card ownership. Using this construction allowed the authors to avoid the problem of selectivity bias resulting from the fact that only individuals with credit cards and a non-negative checking balance can be directly sampled. Using the estimated probability of card ownership also reduced possible simultaneity bias, such as a higher propensity to consume leading to both larger money holdings and a greater propensity to obtain a card. My research draws upon this technique. With this construction, the authors found a statistically significant negative relationship between their created variable to proxy for having a card, and a negative, but not statistically significant, relationship between a dummy variable for reported credit card ownership.

transfer of the means of deferred payment.

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1.3.3 CREDIT CARDS AND AGGREGATE VARIABLES

Few studies have used macro-level data to test the relationship between credit cards and various measures of money. Viren (1992) presented data from time series evidence from Finland from 1973 through 1990 that showed the demand for currency is negatively related to credit card usage. Credit cards appear to be a substitute; a one percent increase in credit card charges leads to a one percent decrease in the level of currency demanded. Garcia (1977) detected a smaller statistically significant negative relationship between credit card credit outstanding and household money demand with U.S. data from 1968 through 1975; each one percent increase in log credit card use decreased money demand by nearly one half of a percentage change in log M1.

1.3.4 CREDIT CARDS AND THE PRECAUTIONARY DEMAND FOR MONEY

In addition to the transactions relationship mentioned in this paper, credit card ownership may also reduce the precautionary demand for money. Gross and Souleles (2000) show that credit card usage changes in response to changes in the available credit line in a manner consistent with credit card limits being viewed as a substitute for precautionary demand for money. Gross and Souleles find consumption rises as credit limits expand and this effect is noticeable even in cases where individuals have not exhausted their credit limit. Gross and Souleles interpret this rise in consumption to be a reflection that credit lines are considered a substitute for a reserve of money.
This would indicate that a variable capturing credit limits would be informative in measurements of how credit cards affect money demand; alternatively, this effect may be captured in a variable which is positive if the individual has a credit card, and zero otherwise. (In the empirical analysis that follows, access to a credit card is controlled to some extent by the use of the two-stage least squares regression. To the extent that this effect is not completely controlled, the results are biased towards reporting a more negative relationship.)
CHAPTER 2

INCORPORATING CREDIT CARDS INTO MODELS OF THE
TRANSACTIONS DEMAND FOR MONEY

2.1 TRANSACTIONS WITH MONEY AND WITH CREDIT FROM OVERDRAFT

In modeling how agents retain their income and make decisions about their money holdings, this paper begins with a traditional starting point, the inventory control model of Baumol (1952) and later work by Tobin and Allais. The Baumol-Tobin model shows that for an individual who minimizes the opportunity cost of holding currency along with minimizing brokerage fees, the optimal level of money holdings is not linear in the overall level of transactions, but instead is the square root of a quantity which is the overall level of transactions times brokerage fees divided by the opportunity cost of foregone interest rates.

The Baumol-Tobin model was extended in a deterministic framework by Rama Sastry (1970) and later by Bar-Ilan (1990), to include the possibility that individuals
could, for a fee, obtain credit when they ran out of money. This credit was extended in the form of overdraft credit with interest charged continuously as debt was accumulated in a continuous stream of transactions. Both papers demonstrated that, unless the interest rate on overdraft credit approached infinity, rational individuals would use credit as they minimized their overall cost of handling funds. The distinction between overdraft services and credit card services relies on the timing of transactions; overdraft services are still a continual flow of assets from an individual. An outline of the Bar-Ilan model is presented in Appendix A, so that the interaction between of overdraft services and credit card use can be examined in detail.

2.2 MATHEMATICAL MOTIVATION

As noted by White (1976), it is not obvious how the introduction of a credit card changes optimal money holdings. The relationship depends on whether the expenses that were charged on the credit cards are paid from money that had been recently withdrawn from the investments, or if the expenses are paid from assets that had been held as money. This is equivalent to asking how long it takes to pay a credit card bill, expressed as a proportion of a banking cycle, the time between deposits. The rate at which credit card transactions are paid, $k$, is the fraction of a banking cycle that passes, after assets are transferred into the transactions accounts and before funds are transferred to a credit card company.
This approach is quite distinct from the theoretical approach other papers on the interaction of credit cards and money demand, such as Akhand and Milbourne (1986), or Brito and Hartley (1995). Most studies assume (and Akhand and Milbourne explicitly state) that when credit cards are accepted, they function as a perfect substitute to currency. This is equivalent to always setting \( k \) equal to zero in this framework. This paper rejects that assumption as potentially too restrictive.

2.3 TRANSACTIONS WITH A CREDIT CARD SERVICE WITH EXOGENOUSLY TIMED TRANSFERS FROM BONDS

Individuals are endowed with wealth of amount \( T \), and have (an exogenously defined) \( n \) opportunities to move money from an interest-paying bond to non-interest earning money. Money or credit can be used to purchase goods and services, but only money can be used to pay off credit card bills. Since money pays no interest, an individual maximizes his wealth by withdrawing only enough to pay for what is consumed between each transfer time; to consume this regular endowment, each withdrawal would be \( T/n \).

In an economy which allowed \( Q \) percent of all consumption goods to be placed on a credit card and the payment for these goods is delayed for \( k \) percent of the asset deposit period, then average money holdings, following White (1976), are defined as:
Thus transactions accounts adjust by some factor, \( F \) (for the float adjustment for credit), which is defined by the interaction of the amount charged on the credit card and the length of time these charges are deferred. The graphic representation of this adjustment for one time period is Figure 2.1. Periodic currency holdings are \( F \) times larger than currency holdings had there been no credit card available.

\[
\bar{m} = \frac{1}{2} (1 - Q) \frac{T}{n} + kQ \frac{T}{n}
\]

\[
= \frac{F}{2} \frac{T}{n}
\]

\[
F = 1 + (2k - 1)Q
\]

Figure 2.1: Money holdings with credit cards are affected by both the amount charged on the credit card \( Q(T/n) \), and the amount of time assets are floated in the account before they are transferred to the credit card company, \( k(1/n) \).
Given this specification, credit cards increase money holdings when \( k \) is greater than one half, and decrease money holdings if \( k \) is less than one half. Thus, theoretically, there may be an ambiguous relationship between money demand and credit card transactions. This can be seen from Figure 2.2, which shows the interaction when an individual always maintains a positive supply of money.

Figure 2.2: With exogenously defined periods where an individual can transfer assets between money and bonds, the average money holdings can either be decreased, as in the null hypothesis, or increased, as in the alternative hypothesis, depending upon the timing of payment to the credit card company.
2.4 TRANSACTIONS WITH A CREDIT CARD SERVICE WITH ENDOGENOUSLY TIMED TRANSFERS FROM BONDS

These results can be generalized to include the opportunity for individuals to endogenously decide upon the timing of transactions between interest earning investments and money holdings. This section follows the ABT tradition of making the timing of transactions responsive to brokerage costs and the opportunity cost of holding money.

Individuals are endowed with wealth of amount T, and may move money from an interest-earning bond to non-interest earning money, for a brokerage fee, b, for each transaction. As in the previous section, investments cannot be used to purchase goods and services directly. Goods can be purchased with money or with a credit card and only money can be used to pay off credit card bills. Since money pays no interest, an individual maximizes his wealth by minimizing the cost of holding money. The cost of holding money is the opportunity cost of money holdings plus the cost of brokerage fees.

When an individual chooses how many times, n, to transfer assets into his money holdings, this defines c, his optimal periodic withdrawal, as \( c = \frac{T}{n} \). The optimal choice for the periodic withdrawal solves:

\[
\min_c \left[ b \frac{T}{c} + \frac{1}{2} (1 - Q)c + kQc \right] = \min_c \left[ b \frac{T}{c} + \frac{k}{2} c \right],
\]
where \( c \) is the dollar amount of his periodic withdrawal. The credit card allows an exogenously defined percentage of transactions, \( Q \), to be postponed for a fraction \( k \) of the chosen payment period. The amount \( c \) is chosen by each individual to minimize the cost of holding money, which is defined as the sum of fixed price brokerage services for each withdrawal, \( b \), and the opportunity cost of holding money \( i \).

Following Baumol (1952), in models with no overdraft services, minimizing the opportunity cost of holding money plus the cost of broker services yields optimal average monthly balances given by

\[
\bar{m} = \sqrt{\frac{F^2 b T i}{2}} ,
\]

where \( i \) is the market rate of interest on bonds, \( b \) is the brokerage fees charged for selling income earning securities, and \( T \) is an individual’s total income. Thus optimal currency holdings with credit cards differ from standard Baumol-Tobin optimal currency holdings by a square root of \( F \). Optimal currency withdrawals will be lower, but occur more frequently, with a credit card whenever the pay date of a credit card comes after the middle of an average payment period. This timing is shown in Figure 2.3.
Figure 2.3: With endogenously defined periods where an individual can transfer assets between money and bonds, the average money holdings can either be decreased, as in the null hypothesis, or increased, as in the alternative hypothesis, depending upon the timing of payment to the credit card company. Credit card services change the timing of withdrawals, as well as the amount removed each period, but this result does not remove the ambiguity of the effect of credit cards on money demand.
2.5 ON THE TIMING OF TRANSACTIONS

2.5.1 THE IMPORTANCE OF TIMING OF REPAYMENT, $k$

This model produces the standard to the Baumol-Tobin result when $F = 1$, which requires $k = 1/2$. If the credit card's due date, $k$, was uniformly distributed between 0 and 1, then in models where no overdraft services are used, credit cards would have no aggregate effect on the demand for money. Personal correspondence with a local bank (Coons 2000) confirms that there was no attempt by the bank to manage the distribution of charge card due dates, and therefore this data may be seen as uniformly distributed. Contrary to common assumptions that credit cards may have reduced the transactions demand for transactions accounts, this theory implies the effect is neutral.

As detailed in Appendix A, in models where individuals have overdraft services, for credit cards to have no effect on money demand, the due date of credit cards would have to be uniformly distributed across the time frame when individuals have not used the overdraft services. It is difficult to construct a scenario when this is the case (but not impossible; for example lenders might arrange their payments to come in at a time that minimizes default risk, which would be when cash holdings are still positive for an average person on a monthly billing cycle.)
2.5.2 WHO CAN CHOOSE THE TIMING OF REPAYMENT $k$?

Alternatively, the timing of credit repayment $k$ may be modeled as a choice variable for the consumer. Commonly, employees receive pay in money at regular intervals; the length of each pay period may have been decided through negotiations to maximize the joint welfare of each firm and their workers, but often individual workers treat their payment periods as an exogenously defined feature of the employment contract. Appendix B contains sample advertisements that indicate that a number of credit card companies would allow customers to change the timing of their credit card payment within a monthly payment cycle. An appropriate modeling choice for the American economy may be consumers with externally defined pay periods where assets flow into transactions accounts, like the traditional monthly or periodic paycheck, but $k$ is a variable that can be chosen.

The interpretation that $k$ is a choice variable is even more compelling in models, like the variation of the ABT model discussed in 2.4, where the transfer of payments is endogenous; if an individual is able to determine when he receives money, it seems contrived to prevent him from aligning those transfer periods with the payments to credit cards. The assumption that this is the “natural” thing to do is prevalent:

If the [outgoing] payments are lumpy but foreseen, cash may perhaps be employed even more economically. For then it may well pay to obtain cash just before large payments fall due with little or no added cost in “brokers’ fees” and considerable savings in interest payments. (Baumol 1952)
If one started with a model where the transfer of assets from money into bonds were *endogenously* determined, economists would assume that rational, cash balance minimizing individuals who have control of their credit card payment cycles would move their cycles to minimize $k$.

If one started with a model where the transfer of assets from bonds into money were *exogenously* determined, however, there is no impetus to minimize $k$, as long as there were no interest paid on money holdings. The opportunity cost of not holding bonds is forfeited at each exogenously determined time period, regardless of whether the money is held as money by the consumer herself, or transferred as a payment to the credit card company.

If there were any benefits to retaining the float on money that is owed to the credit card company, individuals with exogenously defined inflows of assets may seek to maximize $k$. One way to generate that effect is to acknowledge that a small interest payment may be available on transactions counts that would not be paid to consumers if the money was not in their account. This would leave the analysis in this paper unchanged, as long as the interest rate $i$ is interpreted as the interest rate differential between investment holdings and money holdings.

### 2.5.3 Interpreting the Upcoming Regression Results in Terms of $k$

The regressions which follow in this paper, both the cross sectional results in Chapter Three and the time series results in Chapter Four, show a positive relationship
between credit cards and money demand. This result implies that the average individual is using credit cards to defer the transfer of money from the consumer to the credit card company relatively late in each payment cycle.

The result that credit card transactions do not minimize money balances can be interpreted as evidence that, in practice, the timing of flows into and out of money accounts are treated as if they were exogenously imposed. Either individuals have control over the timing of flows into money holdings, and a significant cost in changing the timing of payments to their credit card service, or individuals have little incentive to change the timing of payments to their credit card company because they have little control over the timing of inflows into their money holding.
CHAPTER 3

CREDIT CARDS AND TRANSACTIONS ACCOUNTS

3.1 DATA SOURCE

To test how credit cards have affected transactions holdings, this chapter examines survey research in which families were directly asked about their credit card use, their checking and savings account holdings, and a number of variables that make it possible to scale for income and lifecycle changes.

The primary data source is the Survey of Consumer Finance (SCF), a triennial survey of the Federal Reserve Board. There are currently six data sets, with a set collected every three years starting in 1983. Each data set contains family level financial information of about 4,500 families. Each data set includes an over-sample of high-income families, but weights are given to adjust the sample to reflect national averages (Fed. Res. Board 2000).

Each data set contains imputed variables when certain key values are missing. In the 1983 and 1986 versions, the missing data was singly imputed. In subsequent
versions, the data was multiply imputed; missing data was replaced with five different estimates of the true value, generating five different implicates. See Montalto and Sun (1996) for a detailed discussion of the merits of multiple imputation.

Each set of survey data was estimated separately using a repeated imputation inference (RII) technique to accommodate the appropriate variance created by multiple implicates. The RII technique reports the average coefficient across each of the five implicates as the regression coefficient for each variable, and creates a measure of variance by adding the average variance within each of the five implicates to a measure of the variance across the five implicates which are weighted by an adjustment factor. Coding for the RII technique was derived from Lee and Montalto (1996), and Sun and Montalto (1996).

3.2 MEASURING CREDIT CARD USE

This paper focuses on a different measurement variable than is found in the existing literature. Most current work on credit card usage, including Duca and Whitesell (1995) and Evans and Schmalensee (2000), is focused on whether families have a credit card; it is unclear exactly what behavior these studies were tracking. Access to credit cards can affect money holdings through both the precautionary motive and transactions motive. The SCF, starting with the 1989 data set, included a measure of monthly credit card use distinct from the amount of debt held on the credit card between payment periods. This variable, monthly use between payment periods, is the variable of
interest in this paper because from all the choices, it most clearly isolates the transactions demand for money. In 1998, average monthly use of credit cards was $372, or roughly 8.5% of the average monthly family income. Selected descriptive statistics are included in Table 3.1.

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Checking</td>
<td>21525</td>
<td>3,245.73</td>
<td>0</td>
<td>5,052,400</td>
</tr>
<tr>
<td>Savings</td>
<td>21525</td>
<td>4,442.50</td>
<td>0</td>
<td>14,680,000</td>
</tr>
<tr>
<td>Liquid Assets</td>
<td>21525</td>
<td>15,242.01</td>
<td>0</td>
<td>34,209,000</td>
</tr>
<tr>
<td>Total Assets</td>
<td>21525</td>
<td>269,195.29</td>
<td>0</td>
<td>514,740,500</td>
</tr>
<tr>
<td>Yearly Income</td>
<td>21525</td>
<td>52,335.26</td>
<td>0</td>
<td>176,900,000</td>
</tr>
<tr>
<td>Credit Card Monthly Use</td>
<td>21525</td>
<td>372.25</td>
<td>0</td>
<td>105,000</td>
</tr>
<tr>
<td>Credit Card Balance</td>
<td>21525</td>
<td>1,505.66</td>
<td>0</td>
<td>98,000</td>
</tr>
</tbody>
</table>

Table 3.1 Selected Descriptive Statistics from the 1998 Survey of Consumer Finances. Means adjusted with sample weights provided by the SCF to accommodate over-sampling of high income households.

3.3 INTERPRETING REGRESSION RESULTS IN TERMS OF $k$

Chapter Two described a set of theoretical models of the interaction between credit cards and money demand based on the institutional structure of credit cards. In brief, optimal money holdings with credit cards are a simple multiple of optimal money holdings without credit cards. This relationship is a direct relationship to the amount of
float created with credit card transactions when an individual receives assets at exogenously defined time periods. When time periods are defined endogenously, as in a Baumol-Tobin framework, the impact of credit cards is related by the square root of the float. Mathematically, that is

\[ \bar{m}_{\text{with cc}} = F \bar{m}_{\text{without cc}} \]

in the exogenous model,

and

\[ \bar{m}^*_{\text{with cc}} = \sqrt{F \bar{m}^*_{\text{without cc}}} \]

in the endogenous model, where \( \bar{m} \) is the average money holdings, * indicates the optimal money holdings which minimize transactions costs, and \( F \) is the adjustment to money holdings which comes from the timing of transactions. As detailed in Section 2.2,

\[ F = 1 + (2k - 1)Q, \]

where \( k \) is the timing of transactions as a portion of the payment period, and \( Q \) is the portion of consumption goods that can be deferred with a credit card.

Following a model where consumer money holdings are defined by their exogenous payment periods,

\[
\bar{m}_{\text{with cc}} = \left[1 + (2k - 1)Q\right] \bar{m}_{\text{without cc}} \\
\bar{m}_{\text{with cc}} - \bar{m}_{\text{without cc}} = \left[(2k - 1)Q\right] \bar{m}_{\text{without cc}}
\]

Recalling that the variable for credit card use measured in these regressions would be \( QT \), where \( T \) is the overall dollar level of transactions for consumer goods per unit time, then the coefficients reported below would measure the change in money holdings as:

25
\[ \hat{\beta}_{\text{cc use}} = [2k - 1]\left(\frac{m_{\text{with cc}}}{T}\right), \text{ or} \]

\[ \hat{\beta}_{\text{cc use}} = [2k - 1]\text{(length of a payment period)} \]

The coefficient of the credit card variable in the regressions in this chapter can be interpreted as directly measuring the increase in float from credit card usage. The positive relationship would then indicate that the float on credit cards has increased due to the fact that credit cards delay the flow out of transactions account holdings.

The interpretation of the coefficients in these regressions is less straightforward if one chooses the model based on endogenous payment periods as described in the ABT model, however even in this case, the sign of this relationship is a function of the timing of transactions, \( k^{*}\text{length of payment period} \).

3.4 ON SIMULTANEITY BIAS

Credit card usage and money demand may be correlated as a result of some relationship not captured in the transactions equations; for example individuals with a high propensity to consume may have higher levels of both credit cards and transactions deposits (Duca and Whitesell 1995). To eliminate any problems arising from simultaneity biases, two-stage least squares regressions are performed for the majority of the results presented in this section. The 2SLS results are similar to the OLS results in sign, even though the 2SLS reduces the bias towards positive results. (OLS results are included in table 3.4 presented in section 3.7).
In the first stage, estimations are made for credit card usage, expressed in terms of monthly use. The regressors include scale variables such as income and assets, expressed in logs. The level of education of the head of household is also included as a measure of the financial state of the household. Education is entered as a set of dummy variables: no high school education, high school education, and having a college degree. The dummy variable “some college” was the excluded dummy variable in the regression. A number of regressors capture lifecycle issues. These include the age of the head of the household, whether the head is married, which is entered as a dummy variable that is one for a marriage and zero otherwise, and the household size expressed in logs.

Variables for race and sex were included in the first stage of the two-stage regression, but excluded in the second. The race variables are entered as a series of dummy variables from a self-reported response. The included variables identify a response of white or black, with the excluded variable coming from those that reported a different race. These variables serve as the excluded exogenous variables because they were believed to be influential in an individual’s ability to obtain credit, in the first stage, but not likely to affect the ability to manage assets and credit once the line of credit is open. These variables are a subset of the variables considered by Duca and Whitesell (1995). A test for sample selection bias did not show any statistically significant bias in transactions account holdings from non-cardholders.

The first stage regressions were computed separately for each data implicate. Table 3.2 shows one set of results from the first implicate of the 1998 data of the first stage regressions. The signs on most of these coefficients follow some standard
assumptions about credit card usage. Credit card usage is higher among the young, the college educated, and usage increases with household size. Credit card use is higher among those with more assets and income. The exogenous excluded variables of race and gender show that credit card use is relatively less common among households with a female head. Credit card usage is lower among blacks and whites than other racial backgrounds. In the implicate presented in the chart below, race is significant at a five percent significance level, and having a female head of household misses the ten percent cut-off. The three instrumental variables are jointly significant, with a F-test value of 4.88 and an associated p-value of 0.002.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.036</td>
<td>(0.333)</td>
<td></td>
</tr>
<tr>
<td>ln(Assets)</td>
<td>0.2152</td>
<td>(0.0217)</td>
<td>**</td>
</tr>
<tr>
<td>ln(Income)</td>
<td>0.3524</td>
<td>(0.0341)</td>
<td>**</td>
</tr>
<tr>
<td>ln(House size)</td>
<td>0.0307</td>
<td>(0.0566)</td>
<td></td>
</tr>
<tr>
<td>Home Owner</td>
<td>-0.0488</td>
<td>(0.0853)</td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>-0.0799</td>
<td>(0.0743)</td>
<td></td>
</tr>
<tr>
<td>No High School</td>
<td>-0.151</td>
<td>(0.134)</td>
<td></td>
</tr>
<tr>
<td>High School</td>
<td>-0.0940</td>
<td>(0.0650)</td>
<td></td>
</tr>
<tr>
<td>College Degree</td>
<td>0.3150</td>
<td>(0.0607)</td>
<td>**</td>
</tr>
<tr>
<td>Age</td>
<td>-0.00538</td>
<td>(0.00173)</td>
<td>**</td>
</tr>
<tr>
<td>Female Head</td>
<td>0.0583</td>
<td>(0.0755)</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>-0.2421</td>
<td>(0.0856)</td>
<td>**</td>
</tr>
<tr>
<td>Black</td>
<td>-0.433</td>
<td>(0.116)</td>
<td>**</td>
</tr>
<tr>
<td>Adj. R squared</td>
<td>0.24</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3.2: Determinants of Credit Card Usage. Data Source: 1998 Survey of Consumer Finances, First Implicate. Standard errors are in parenthesis. One or two stars indicate significance above five or one percent significance level, respectively.
3.5 MEASURING THE EFFECT ON TRANSACTIONS HOLDINGS

The created estimate of each individual's credit card usage was then included as a regressor in a second-stage regression of checking account holdings, along with the included exogenous variables, that is all variables except race and sex. Thus, the model estimated in the second stage is:

\[
\ln(\text{CHECKING}) = \text{INTERCEPT} + \beta_1 \ln(\text{ASSETS}) + \beta_2 \ln(\text{INCOME}) + \beta_3 \ln(\text{HOUSE SIZE}) + \beta_4 \text{HOME OWNER} + \beta_5 \text{MARRIED} + \beta_6 \text{NO HIGH SCHOOL} + \beta_7 \text{HIGH SCHOOL} + \beta_8 \text{COLLEGE DEGREE} + \beta_9 \text{AGE} + \beta_{10} \text{estimated ln(CREDIT CARD USE)}
\]

Table 3.3 shows the results, using data from 1998, for the baseline regression measuring the effect of credit cards on checking account holdings, as well as alternative measures of money holdings. These regressions show that credit card usage is positively related to holdings in checking accounts as well as savings accounts. This result is statistically significant for savings account holdings at a five percent significance level, and for total transactions accounts holdings above a one percent significance level. Credit card usage does not have any statistically significant relationship to a family's non-liquid financial asset holdings. This set of results indicates that credit cards are not actively used to increase portfolio balances, and neither are they used to decrease money holdings. Interpreting the results as demand functions given a constant yearly supply of money, the checking demand function elasticity for credit cards is 0.25. Credit card usage complements money holdings.
<table>
<thead>
<tr>
<th></th>
<th>ln(Checking)</th>
<th>ln(Savings)</th>
<th>ln(Transactions Accounts)</th>
<th>ln(Nonliquid Financial Assets)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.850 **</td>
<td>-2.319 **</td>
<td>-3.165 **</td>
<td>-3.978 **</td>
</tr>
<tr>
<td></td>
<td>(0.315)</td>
<td>(0.584)</td>
<td>(0.325)</td>
<td>(0.462)</td>
</tr>
<tr>
<td>ln(Assets)</td>
<td>0.2806 **</td>
<td>0.2926 **</td>
<td>0.3694 **</td>
<td>1.0015 **</td>
</tr>
<tr>
<td></td>
<td>(0.0553)</td>
<td>(0.0893)</td>
<td>(0.0569)</td>
<td>(0.0910)</td>
</tr>
<tr>
<td>ln(Income)</td>
<td>0.2948 **</td>
<td>0.016</td>
<td>0.2812 **</td>
<td>0.124</td>
</tr>
<tr>
<td></td>
<td>(0.0897)</td>
<td>(0.147)</td>
<td>(0.0936)</td>
<td>(0.146)</td>
</tr>
<tr>
<td>ln(House size)</td>
<td>-0.2901 **</td>
<td>-0.3121 **</td>
<td>-0.3469 **</td>
<td>-0.2892 **</td>
</tr>
<tr>
<td></td>
<td>(0.0574)</td>
<td>(0.0905)</td>
<td>(0.0574)</td>
<td>(0.0869)</td>
</tr>
<tr>
<td>Home Owner</td>
<td>-0.4109 **</td>
<td>-0.228 *</td>
<td>-0.4879 **</td>
<td>-0.7797 **</td>
</tr>
<tr>
<td></td>
<td>(0.0659)</td>
<td>(0.109)</td>
<td>(0.0679)</td>
<td>(0.0988)</td>
</tr>
<tr>
<td>Married</td>
<td>0.1924 **</td>
<td>-0.038</td>
<td>0.0355</td>
<td>-0.121</td>
</tr>
<tr>
<td></td>
<td>0.003</td>
<td>0.729</td>
<td>0.605</td>
<td>(0.103)</td>
</tr>
<tr>
<td>No High School</td>
<td>-0.272 *</td>
<td>0.760 **</td>
<td>-0.238</td>
<td>-0.229</td>
</tr>
<tr>
<td></td>
<td>(0.128)</td>
<td>(0.235)</td>
<td>(0.141)</td>
<td>(0.228)</td>
</tr>
<tr>
<td>High School</td>
<td>-0.1869 **</td>
<td>0.186</td>
<td>-0.1763 *</td>
<td>0.0791</td>
</tr>
<tr>
<td></td>
<td>(0.0671)</td>
<td>(0.109)</td>
<td>(0.0715)</td>
<td>(0.0980)</td>
</tr>
<tr>
<td>College Degree</td>
<td>0.090</td>
<td>-0.105</td>
<td>-0.044</td>
<td>0.235</td>
</tr>
<tr>
<td></td>
<td>(0.101)</td>
<td>(0.161)</td>
<td>(0.103)</td>
<td>(0.154)</td>
</tr>
<tr>
<td>Age</td>
<td>0.01345 **</td>
<td>0.02536 **</td>
<td>0.01975 **</td>
<td>0.02194 **</td>
</tr>
<tr>
<td></td>
<td>(0.00211)</td>
<td>(0.00398)</td>
<td>(0.00248)</td>
<td>(0.00316)</td>
</tr>
<tr>
<td>ln(CC Use est.)</td>
<td>0.250</td>
<td>0.954</td>
<td>0.669 *</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td>(0.240)</td>
<td>(0.383)</td>
<td>(0.248)</td>
<td>(0.387)</td>
</tr>
</tbody>
</table>

Table 3.3: Credit Cards Effect on Transactions Accounts. Data Source: 1998 Survey of Consumer Finances. Standard errors are in parenthesis. One or two stars indicate significance above a five or one percent significance level, respectively.

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In order to accommodate the log format, the regressions reported in Tables 3.2 and 3.3 only report the relationship between credit cards and transactions account holdings when the amount of credit card usage was positive. That is, Tables 3.2 and 3.3 isolate the transactions usage for credit cards. An alternative format is present in Table 3.4, which shows each family's monthly usage of credit cards as a percentage of their yearly income. Table 3.4 confirms the same general results from Table 3.3; an increase in credit card use is associated with an increase in the amount of money held in transactions accounts in proportion to income. This result is statistically significant for savings accounts, and for liquid assets, at a five percent significance level.
Table 3.4: Credit Cards Effect on Transactions Accounts. Data Source: 1998 Survey of Consumer Finances. Standard errors are in parenthesis. One or two stars indicate significance above a five or one percent significance level, respectively.
3.6 DATA CONSISTENCY ACROSS SURVEY YEARS

Regression results from the data surveys collected in three earlier years follow similar patterns. Table 3.5 presents the 2SLS results for these alternative data sets. The sign on the variable measuring credit card usage is consistently positive, although the variable is not statistically significant in early years of the sample. Pooled data from all four sets show a positive relationship between credit cards and checking, which is not statistically significant. Dummy variables for each survey year are significant for only the last survey year, 1998.

The 1986 SCF survey omitted a question on credit card usage as distinct from credit card debt. The 1983 survey included a question on credit card usage, but answers were collected in self-defined qualitative terms, such as “hardly ever” or “often”. 2SLS regressions, using the same variables as those reported in Table 3.2 and 3.3 show that ln(checking) increases as individual monthly credit card use moves up a scale from “never use, but have” to “use often.”
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ln(Checking)</td>
<td>-0.615</td>
<td>-3.78</td>
<td>-0.976</td>
</tr>
<tr>
<td></td>
<td>(0.354)</td>
<td>(2.29)</td>
<td>(0.216)</td>
</tr>
<tr>
<td>ln(Assets)</td>
<td>0.1396 **</td>
<td>0.035</td>
<td>0.12076</td>
</tr>
<tr>
<td></td>
<td>(0.0204)</td>
<td>(0.128)</td>
<td>(0.00800)</td>
</tr>
<tr>
<td>ln(Income)</td>
<td>0.3262 **</td>
<td>0.102</td>
<td>0.4215</td>
</tr>
<tr>
<td></td>
<td>(0.0826)</td>
<td>(0.345)</td>
<td>(0.0450)</td>
</tr>
<tr>
<td>ln(House size)</td>
<td>-0.2413 **</td>
<td>-0.4537 **</td>
<td>-0.1014</td>
</tr>
<tr>
<td></td>
<td>(0.0556)</td>
<td>(0.0790)</td>
<td>(0.0303)</td>
</tr>
<tr>
<td>Home Owner</td>
<td>-0.1208</td>
<td>-0.0694</td>
<td>-0.1109</td>
</tr>
<tr>
<td></td>
<td>(0.0702)</td>
<td>(0.0729)</td>
<td>(0.0338)</td>
</tr>
<tr>
<td>Married</td>
<td>0.1860 **</td>
<td>0.3084 **</td>
<td>0.0369</td>
</tr>
<tr>
<td></td>
<td>(0.0642)</td>
<td>(0.0782)</td>
<td>(0.0345)</td>
</tr>
<tr>
<td>No High School</td>
<td>-0.389 **</td>
<td>0.117</td>
<td>-0.2959</td>
</tr>
<tr>
<td></td>
<td>(0.125)</td>
<td>(0.492)</td>
<td>(0.0669)</td>
</tr>
<tr>
<td>High School</td>
<td>-0.1285</td>
<td>0.130</td>
<td>-0.1923</td>
</tr>
<tr>
<td></td>
<td>(0.0893)</td>
<td>(0.265)</td>
<td>(0.0375)</td>
</tr>
<tr>
<td>College Degree</td>
<td>0.0709</td>
<td>-0.246</td>
<td>0.1003</td>
</tr>
<tr>
<td></td>
<td>(0.0784)</td>
<td>(0.258)</td>
<td>(0.0364)</td>
</tr>
<tr>
<td>Age</td>
<td>0.02101 **</td>
<td>0.01724 **</td>
<td>0.023850</td>
</tr>
<tr>
<td></td>
<td>(0.00168)</td>
<td>(0.00387)</td>
<td>(0.00912)</td>
</tr>
<tr>
<td>ln(CC Use est.)</td>
<td>0.333</td>
<td>1.64</td>
<td>0.205</td>
</tr>
<tr>
<td></td>
<td>(0.194)</td>
<td>(1.36)</td>
<td>(0.113)</td>
</tr>
</tbody>
</table>

Table 3.5: Determinants of ln(Checking) in four surveys. Data Source: Survey of Consumer Finances, various years. Standard errors are in parenthesis. One or two stars indicate significance above a five or one percent significance level, respectively.
3.7 MEASURES OF CREDIT CARD USAGE

The result that credit card usage is positively related to money demand differs from earlier studies on similar data. This paper differs from earlier studies by focusing on the dollar amount transacted on a credit card, as opposed to ownership of the credit card. As discussed earlier, these variables differ in that studies of credit card ownership may highlight the importance of precautionary spending. Table 3.6 considers the impact of measuring credit card usage rather than credit card ownership. In all cases the positive relationship was maintained.
<table>
<thead>
<tr>
<th></th>
<th>OLS</th>
<th>2SLS</th>
<th>OLS</th>
<th>2SLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.840</td>
<td>-0.850</td>
<td>-0.772</td>
<td>0.2524</td>
</tr>
<tr>
<td></td>
<td>(0.355)</td>
<td>(0.315)</td>
<td>(0.315)</td>
<td>(0.0771)</td>
</tr>
<tr>
<td>ln(Assets)</td>
<td>0.3056</td>
<td>0.2806</td>
<td>0.3223</td>
<td>0.265</td>
</tr>
<tr>
<td></td>
<td>(0.0251)</td>
<td>(0.0553)</td>
<td>(0.0193)</td>
<td>(0.110)</td>
</tr>
<tr>
<td>ln(Income)</td>
<td>0.3579</td>
<td>0.2948</td>
<td>0.3629</td>
<td>-0.192</td>
</tr>
<tr>
<td></td>
<td>(0.0386)</td>
<td>(0.0897)</td>
<td>(0.0343)</td>
<td>(0.105)</td>
</tr>
<tr>
<td>ln(House size)</td>
<td>-0.2327</td>
<td>-0.2901</td>
<td>-0.2638</td>
<td>-0.3992</td>
</tr>
<tr>
<td></td>
<td>(0.0622)</td>
<td>(0.0574)</td>
<td>(0.0577)</td>
<td>(0.0668)</td>
</tr>
<tr>
<td>Home Owner</td>
<td>-0.3705</td>
<td>-0.4109</td>
<td>-0.4198</td>
<td>0.069</td>
</tr>
<tr>
<td></td>
<td>(0.0723)</td>
<td>(0.0659)</td>
<td>(0.0642)</td>
<td>(0.120)</td>
</tr>
<tr>
<td>Married</td>
<td>0.1709</td>
<td>0.1924</td>
<td>0.1557</td>
<td>-0.073</td>
</tr>
<tr>
<td></td>
<td>(0.0700)</td>
<td>(0.0653)</td>
<td>(0.0619)</td>
<td>(0.273)</td>
</tr>
<tr>
<td>No High School</td>
<td>-0.422</td>
<td>-0.272</td>
<td>-0.268</td>
<td>-0.121</td>
</tr>
<tr>
<td></td>
<td>(0.156)</td>
<td>(0.128)</td>
<td>(0.124)</td>
<td>(0.106)</td>
</tr>
<tr>
<td>High School</td>
<td>-0.1504</td>
<td>-0.1869</td>
<td>-0.1901</td>
<td>0.073</td>
</tr>
<tr>
<td></td>
<td>(0.0751)</td>
<td>(0.0671)</td>
<td>(0.0643)</td>
<td>(0.105)</td>
</tr>
<tr>
<td>College Degree</td>
<td>0.0977</td>
<td>0.090</td>
<td>0.1603</td>
<td>0.01363</td>
</tr>
<tr>
<td></td>
<td>(0.0655)</td>
<td>(0.101)</td>
<td>(0.0640)</td>
<td>(0.00212)</td>
</tr>
<tr>
<td>Age</td>
<td>0.01383</td>
<td>0.01345</td>
<td>0.01272</td>
<td>1.29</td>
</tr>
<tr>
<td></td>
<td>(0.00196)</td>
<td>(0.00211)</td>
<td>(0.00169)</td>
<td>(1.28)</td>
</tr>
<tr>
<td>CC use</td>
<td>0.0773</td>
<td></td>
<td>0.0000512</td>
<td>**</td>
</tr>
<tr>
<td></td>
<td>(0.0251)</td>
<td></td>
<td>(0.0000233)</td>
<td></td>
</tr>
<tr>
<td>CC use (from 2SLS)</td>
<td>0.250</td>
<td></td>
<td>(240)</td>
<td></td>
</tr>
<tr>
<td>Owns CC</td>
<td>0.2064</td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td></td>
<td>(0.0637)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owns CC (from 2SLS)</td>
<td></td>
<td></td>
<td>1.29</td>
<td>(1.28)</td>
</tr>
</tbody>
</table>

Table 3.6: Estimates for ln(Checking) using various measures of credit card use. Data from the 1998 SCF. Standard errors are in parenthesis. One or two stars indicate significance above a five or one percent significance level, respectively.
3.8 CREDIT CARDS FOR BORROWING

A second hypothesis for why early literature shows a negative relationship where this paper's results with more recent data show a positive relationship is that credit card usage has changed over time. Specifically, this section focuses on the way people are using credit cards for debt management purposes. If an individual were liquidity constrained to the extent that, if he had not had credit cards he could not maintain his desired money balances, then the introduction of credit cards could directly increase money holdings. That is, some individuals may have no access to money without the ability to borrow on credit cards.

To test whether the positive relationship is due to a change in the number of people using credit cards as a means of debt holdings, the basic regression equations were re-calculated to measure whether a credit card is used to hold a balance in the second half of the two-stage regression. Having a credit card balance proxies for an individual being liquidity constrained. The number of individuals who are using their credit cards to hold balances has risen in previous decades, as shown in Figure 3.1.
Credit cards are interacted with a dummy variable, HAS DEBT, that is positive only if individuals have a positive credit card balance. The new specification is:

\[
\ln(\text{CHECKING}) = \text{INTERCEPT} + \beta_1 \ln(\text{ASSETS}) + \beta_2 \ln(\text{INCOME}) + \\
\beta_3 \ln(\text{HOUSE SIZE}) + \beta_4 \text{HOME OWNER} + \beta_5 \text{MARRIED} + \beta_6 \text{NO HIGH SCHOOL} + \beta_7 \text{HIGH SCHOOL} + \beta_8 \text{COLLEGE DEGREE} + \beta_9 \text{AGE} + \beta_{10} \text{est.} \\
\ln(\text{CREDIT CARD USE}) \ast \text{HAS DEBT} + \beta_{11} \text{est.} \ln(\text{CREDIT CARD USE})
\]

where the coefficient $\beta_{10}$ picks up whether running into debt each month changes how monthly use of a credit card effects transactions account holdings. The result of this regression on data for a 2SLS regression on 1998 data is reported in Table 3.7.
Table 3.7: Two Stage Least Squares Regression on ln(Checking) using 1998 SCF data. Standard errors are in parenthesis. One or two stars indicate significance above a five or one percent significance level, respectively.
The combination of having a debt across time periods and the level of credit card usage within a time period is negative, although this result is not statistically significant over the ten percent significance level. This does not support the hypothesis that families with credit card debt are using credit card use as a way to increase holdings in household transactions accounts. Thus, the data does not give strong support to the hypothesis that a change in the relationship between credit cards and transactions accounts across data samples can be attributed to changes in the composition of credit card users to include more borrowers across time.

3.9 CHAPTER SUMMARY

The regressions in this chapter show that individual holdings of some important components of the money supply, checking and savings accounts are positively correlated with credit card usage. Ownership of non-liquid financial assets is not affected by credit card use. Thus, one cannot assert that credit cards are used to minimize money holdings for investment purposes.
CHAPTER 4

CONSUMER CREDIT AND AGGREGATE MONEY HOLDINGS

4.1 MOTIVATION

The research presented in Chapter Three on cross-sectional surveys of account holdings found a positive relationship between the level of credit card use and holdings in transactions counts. There are several reasons why it is not straightforward to extend those results to M1 and M2.

First, the scale of credit card use must be considered. While credit cards are a common mode of transactions for consumers, consumers do not conduct the bulk of money transactions. The small contribution of consumer money holdings to the monetary aggregates of the entire economy may make the overall importance of credit cards to money holdings negligible. As Table 4.1 indicates, while payment cards account for roughly 17% of the number of transactions in the economy, they barely account for 1% of the value of transactions (from 1992 data reported in Johnson (1998)). Most money transactions, as measured by volume, are transfers between financial institution facilitated...
by the FedWire or the Clearing House Interbank Payment System (CHIPS). Paper checks and the electronic equivalent direct Automated Clearing House (ACH) transfers facilitate much of the remaining monetary transactions. This chapter will argue that, while the percentage of transactions originating from payment cards may be small, this does not preclude payment cards from affecting the levels of money balances in an economy because payment cards can alter the amount of float in consumer's money holdings.

<table>
<thead>
<tr>
<th>Volume</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Checking</td>
<td>81 %</td>
</tr>
<tr>
<td>CHIPS &amp; FedWire</td>
<td>0.1 %</td>
</tr>
<tr>
<td>ACH transfers</td>
<td>3 %</td>
</tr>
<tr>
<td>Payment cards</td>
<td>17 %</td>
</tr>
</tbody>
</table>

A second area of concern is that the data used in Chapter Three did not contain any information on cash holdings, and it may be the case that the prime effect of credit cards is to replace currency directly. This certainly appears to be the case from casual observation of transactions payments, such as the data shown in Figure 4.1. In the twelve years between 1984 and 1996, the percentage of expenditures charged on credit cards increase by almost exactly the decrease in currency use. The percentage of payments by check appears to be similar across time.

Figure 4.1: Payment media as a share of consumers' expenditure. Note that the increase in credit cards appears to be directly offset by the decrease in cash payments. Source: Evans and Schmalensee (1995).
Note that subject of this graph is how consumers pay for goods at the point of sale. The result from Chapter Two, that credit card use causes an increase in checking account holdings, is consistent with Figure 4.1 because the theory espoused in this paper relates to levels of transactions counts, and not the value of transactions. The theoretical model in Chapter Two emphasized the timing of transactions in the checking account while holding the level of transactions constant. Figure 4.1 supports this hypothesized constant level of spending from checking accounts. The question of whether credit cards have reduced money holdings is equivalent to asking if the float incurred in checking by credit card use is greater than or less than the decrease in the dollar amount of goods transacted in cash.

If the relationship between credit cards and currency demand is strongly negative, and the relationship between credit cards and transactions demand is small but positive, then the two variables may cancel. Thus, analyzing the effect of credit cards directly on monetary aggregates M1 and M2 is necessary.

4.2 DATA SOURCES AND MEASUREMENT ISSUES

The level of credit card usage in the economy is approximated by data on revolving consumer credit outstanding; the two measures are often reported as identical in the popular press. Revolving Consumer Credit outstanding (as reported in Federal Reserve Table G.19 (2000)) is composed primarily of outstanding loans on credit cards, with additional amounts from medical lending and student loans. To more closely match
the theory presented in Chapter One, the ideal variable would be total dollars transacted on a credit card, a number that would not include balances rolled over from period to period. Unfortunately, this variable is not available for long time periods from standardized sources. Two different short histories of annual nominal reports of total credit card transactions (McLeod (1977) and Bank of International Settlements (1996, 2000)) are available.

The relationship between the proxy variable of revolving consumer credit outstanding and the ideal measure of monthly transactions on credit cards can be seen in Figures 4.2 and 4.3. The simple correlation coefficient between the two measures of credit card usage in levels is 0.9987, and is similar across the two sub-samples: 0.9978 from 1967-1975 and 0.9914 from 1990-1998. Further, the correlation between revolving consumer credit and the dollar amount of credit card transactions is higher for any time period than the correlation between revolving consumer credit and a measure of payment (which includes debit) card transactions.

In both sample time-spans, total yearly credit card transactions are roughly twice as large as the annual measure of credit outstanding, in levels, with the ratio varying from 1.6 to 2.1; casual inspection suggests that this measure may have been trending upwards during the nascent years of credit card use from 1967-1975, as shown in Figure 4.2. This would be explained by the increase in the percentage of individuals holding carryover credit card debt during those years. According to SCF survey results, the percentage of families with carryover debt rose from 37% to 44% from 1970 to 1977, and was 55% by
1998 (Durkin 2000); Figure 3.1 in Chapter Three of this paper shows that in the most recent decade this number increased at a decreasing rate.

![Graph of transactions volume for credit card purchases vs. revolving consumer credit outstanding from 1968 to 1998.](image)


The regressions presented in sections 4.3 and 4.4 use monthly data on revolving consumer credit outstanding from Q1 1977 to Q4 1999. All variables are reported in
billions of 1982-1984 dollars. This paper measures credit card usage with two specifications. The first specification reports credit card use directly in log real variables. The second specification reports as the percentage of the output of the economy, measured using real GDP, paid for with revolving consumer credit.

Measurement of M1 has been adjusted to include the addition of sweep accounts, provided by the Federal Reserve Board of St. Louis (2000), as suggested by Anderson (1995). This adjustment accommodates another innovation in money holdings, the recent practice of banks transferring certain under-utilized consumer accounts into accounts where they are not counted as monetary aggregates. Interest rates on six month corporate paper, as reported by the Federal Reserve, were included in the regression on money demand as a control for the opportunity cost of money, and log (GDP) was included to measure the scale of the economy. Nominal quarterly GDP data was collected from the BEA (1999), linear interpolation helped fit this data to the month-long interval, and values were converted to real prices using the same CPI based adjustments performed on the monetary aggregates mentioned previously.
4.3 DESCRIPTIVE STATISTICS

Histories of the credit card industry (Mandall (1990), Evans and Schamalensee (2000)) peg the birth of the credit card industry to the invention of the Diner's Club card in 1949; however widespread credit card usage is a more recent phenomenon. This may well be because the publicly available credit cards were originally curtailed by extensive banking regulations. There was a significant change in the way credit cards were supplied to the public in 1978, when the Supreme Court ruled on Marquette National Bank vs. First Omaha Service Corporation.
The Supreme Court ruling clarified the principle that credit card companies had to answer to usury laws only from the state in which the company was located, rather than observing the patchwork of legislation for each location where the credit cards were used. In addition to removing substantial transactions costs for all credit card issuers, this decision created the opportunity for companies that chose to locate in states with weak usury laws, such as South Dakota, to offer credit cards with substantially higher interest rates nationwide. (For further discussion see Evans and Schmalensee (1999)). This judicial ruling was the first substantial step towards the trend of consumers holding credit card accounts from banks other than those banks that held their primary transactions accounts.

Compounding this historical effect, there is a discrete jump in the data between 1976 and 1977 when nearly $15 billion worth of consumer gas card debt was permanently reclassified as revolving consumer credit (FRB 2001). For these two reasons, the bulk of the regressions in this paper will begin with data from 1977. (Results for regressions including data from extended time frames are discussed in Section 4.6.)

Revolving consumer credit outstanding has been increasing in real terms over time. Figure 4.4 shows the relationship between revolving consumer credit outstanding and the GDP. In the figure, seasonal effects are apparent on this non-seasonally adjusted data. There has been a noticeable, exponentially shaped trend in the ratio of revolving consumer credit outstanding to GDP. For the last five years, revolving consumer credit has been roughly 6% of the size of GDP.
Figure 4.4: Revolving Consumer Credit Outstanding as a Ratio of GDP has been trending strongly over time. Seasonality is evident. The discrete jump in revolving consumer credit at the end of 1976 is due to reclassification of the components of revolving credit.
4.4 EMPIRICAL TESTS

The empirical tests in this paper are based upon the model:

\[ \ln M1 \text{ (or } M2) = \alpha + \beta_1 CC + \beta_2 y + \beta_3 r + \epsilon. \]

The foundation of this model is a simple money demand model, updated to explicitly test whether consumer credit shifts this demand, ceteris paribus. Log real GDP is denoted by \( y \), and \( r \) refers to the annual interest rate. CC represents one of two alternative specifications for credit card use, either log real revolving credit balances (as shown in Figure 4.3) or the ratio of revolving consumer credit card outstanding to GDP, as a proxy for the extent of credit card use in the economy (as shown in Figure 4.4).

Monetary aggregates are known to be non-stationary variables. An augmented Dickey Fuller test determined that the percentage of GDP spent on revolving consumer credit was also not a stationary time series, but rather was I(1). A DGLS technique (suggested by the money demand analysis of Stock and Watson (1993)) was used because of the non-stationary data. Since the key regressors were all I(1), the dynamic GLS technique includes leads and lags of the first differences of left hand side variables. Only one pair of leads and lags was included. DGLS was used to remove substantial serial correlation; the Durbin-Watson statistics from DOLS models were almost an order of magnitude smaller than those reported with each DGLS regression.

The dynamic GLS results, reported in Table 4.2, indicate that revolving consumer credit outstanding has a positive relationship to both monetary aggregates, but the primary model was not statistically significant at standard confidence intervals of five percent. Two specifications for measuring the size of consumer credit are present in Table 4.2.
The first specification introduces log real consumer credit outstanding directly into the model. The second specification scales real consumer credit outstanding by real GDP, measuring the growing impact of credit cards relative to economy-wide expenses. This second specification, while it is less straightforward than the first, is useful in subsequent sections of this paper that deal with an extended time frame that includes zero and near zero values for revolving consumer credit outstanding.

Table 4.2 presents results for money demand measured with M1. This second specification shows that the balance of revolving consumer credit scaled by GDP has a statistically significant, economically positive impact. Over the previous twenty years, the ratio of revolving consumer credit has risen from 0.00157 at the beginning of 1968 to 0.0649 at the end of 1999. This increase of 0.063 would imply that credit card demand has been responsible for an increase of $1.78 billion in M1, or to 0.2% of the current level of M1. This result is statistically significant at a five percent significance level, although the same coefficient in the specification one is not.

Caution must be taken with these figures because of the high probability of multicollinearity between GDP and the percentage of spending on consumer credit. Evidence of this effect can be seen in the reduction in significance of GDP in this set of data, compared to more traditional studies of money demand. However, in the second specification it should be noted that the interaction between credit cards and GDP would bias the sign of the coefficient in the opposite direction than the observed (positive) coefficient; the benchmark regression indicates that increases in GDP relates positively to...
the rate of money demand growth, then scaling credit card use by the inverse of GDP may bias the coefficient to a negative result.

The effects of credit cards on money demand are less evident on M2, as reported in Table 4.2, than upon M1. The standards for statistical significance would have to be notably more lax, and the contribution of regressions to the explanatory power of the model is barely noticeable.

The signs on the coefficients for revolving consumer credit outstanding are consistent with my findings in Chapter Three that there is a positive relationship between credit cards and holdings of money in checking and savings accounts. The fact that the coefficients of my primary specification fail to meet traditional standards for statistical significance, either at the ten or the five percent level, indicates that one cannot clearly reject the statement that there is no effect of credit cards on money demand. Importantly, however, there is no evidence, either from the sign or the significance, that individuals are using credit cards to minimize their money holdings.
<table>
<thead>
<tr>
<th>\text{Ln M1}</th>
<th>Benchmark</th>
<th>\text{Specification 1}</th>
<th>\text{Specification 2}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.647</td>
<td>0.184</td>
<td>0.029</td>
</tr>
<tr>
<td></td>
<td>(0.62)</td>
<td>(0.923)</td>
<td>(0.909)</td>
</tr>
<tr>
<td>ln (y_t)</td>
<td>0.657 **</td>
<td>0.428</td>
<td>0.373</td>
</tr>
<tr>
<td></td>
<td>(0.166)</td>
<td>(0.25)</td>
<td>(0.248)</td>
</tr>
<tr>
<td>D ln (y_{t+1})</td>
<td>0.329</td>
<td>0.124</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>(0.329)</td>
<td>(0.341)</td>
<td>(0.321)</td>
</tr>
<tr>
<td>D ln (y_t)</td>
<td>-0.354</td>
<td>-0.312</td>
<td>0.057</td>
</tr>
<tr>
<td></td>
<td>(0.332)</td>
<td>(0.362)</td>
<td>(0.323)</td>
</tr>
<tr>
<td>ln (C_C)</td>
<td>0.0744</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.059)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ln (C_C)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.059)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>r_t</td>
<td>-0.00234</td>
<td>-0.00203</td>
<td>-0.0014</td>
</tr>
<tr>
<td></td>
<td>(0.00211)</td>
<td>(0.00206)</td>
<td>(0.0019)</td>
</tr>
<tr>
<td>D r_{t-1}</td>
<td>0.00273</td>
<td>0.0022</td>
<td>0.00177</td>
</tr>
<tr>
<td></td>
<td>(0.00149)</td>
<td>(0.00146)</td>
<td>(0.00134)</td>
</tr>
<tr>
<td>D r_t</td>
<td>-0.00042</td>
<td>-0.00026</td>
<td>0.00071</td>
</tr>
<tr>
<td></td>
<td>(0.00148)</td>
<td>(0.00144)</td>
<td>(0.00133)</td>
</tr>
<tr>
<td>Durbin-Watson</td>
<td>2.1279</td>
<td>2.2561</td>
<td>1.8178</td>
</tr>
<tr>
<td>Total Rsq</td>
<td>0.9896</td>
<td>0.9903</td>
<td>0.9918</td>
</tr>
</tbody>
</table>

Table 4.2: Dynamic GLS result estimates of \text{ln M1} and \text{ln M2} demand from 1978-1998. Standard errors are in parenthesis. One or two stars indicate significance above a ten or five percent significance level, respectively. (continued)
Table 4.2: Dynamic GLS result estimates of ln M1 and ln M2 demand from 1978-1998. Standard errors are in parenthesis. One or two stars indicate significance above a ten or five percent significance level, respectively.

<table>
<thead>
<tr>
<th>Ln M2 Benchmark</th>
<th>Specification 1</th>
<th>Specification 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.736 *</td>
<td>0.874 *</td>
</tr>
<tr>
<td></td>
<td>(0.296)</td>
<td>(0.379)</td>
</tr>
<tr>
<td>ln(y_0)</td>
<td>0.6453 **</td>
<td>0.608 **</td>
</tr>
<tr>
<td></td>
<td>(0.079)</td>
<td>(0.102)</td>
</tr>
<tr>
<td>D ln(y_{t-1})</td>
<td>0.05</td>
<td>0.032</td>
</tr>
<tr>
<td></td>
<td>(0.122)</td>
<td>(0.128)</td>
</tr>
<tr>
<td>D ln(y_0)</td>
<td>-0.043</td>
<td>0.021</td>
</tr>
<tr>
<td></td>
<td>(0.123)</td>
<td>(0.135)</td>
</tr>
<tr>
<td>ln(CC_0)</td>
<td>0.0128</td>
<td>CC/yt</td>
</tr>
<tr>
<td></td>
<td>(0.0222)</td>
<td>(0.842)</td>
</tr>
<tr>
<td>D ln(CC_{t-1})</td>
<td>0.01009</td>
<td>DCC/yt_{t-1}</td>
</tr>
<tr>
<td></td>
<td>(0.00852)</td>
<td></td>
</tr>
<tr>
<td>D ln(CC_0)</td>
<td>-0.0005</td>
<td>DCC/yt_{t-1}</td>
</tr>
<tr>
<td></td>
<td>(0.0179)</td>
<td></td>
</tr>
<tr>
<td>r_t</td>
<td>-0.002549 **</td>
<td>-0.002444 **</td>
</tr>
<tr>
<td></td>
<td>(0.000777)</td>
<td>(0.000777)</td>
</tr>
<tr>
<td>D r_{t-1}</td>
<td>0.001934 **</td>
<td>0.001773 **</td>
</tr>
<tr>
<td></td>
<td>(0.000547)</td>
<td>(0.000544)</td>
</tr>
<tr>
<td>D r_t</td>
<td>-0.000198</td>
<td>-0.000112</td>
</tr>
<tr>
<td></td>
<td>(0.000541)</td>
<td>(0.000537)</td>
</tr>
<tr>
<td>Durbin-Watson</td>
<td>1.882</td>
<td>1.9079</td>
</tr>
<tr>
<td>Total R^2</td>
<td>0.9972</td>
<td>0.9972</td>
</tr>
</tbody>
</table>

Table 4.2 (continued):
4.5 EVIDENCE OF STRUCTURAL CHANGE

A recent structural change of interest is the innovation of the alternative payment card, the debit card. The rapid increase in the trends in debit card use followed the standardization of electronic fund transfer lines around 1993. In 1993, Visa launched an extensive ad campaign to familiarize people with the concept of debit cards. (For a history of debit cards, see Evans and Schmalensee (1999)).

Families may use payment cards as a substitute for currency at a point of sale but do not actively manage their transactions accounts balances to reduce money holdings. Therefore, it is worth considering whether the inclusion of debit cards, which act as an alternative substitute for currency at the point of sale, changes the composition of credit card users. Perhaps, debit cards attract convenience users of payment cards who have no interest in actively managing their transactions account balances, thereby increasing the concentration of credit card holders who do actively seek to manage their account balances. This hypothesis would indicate that the coefficient that measures the effect of credit cards on money demand, specifically M1, might be more negative in recent decades.

A Chow test on both specifications of the data rejects the hypothesis that there are no breaks in 1993 either for M1 or M2, above a 0.0001 percent significance level. (The Chow test statistic for M1 was 75.9 and the test statistic for M2 was 101.5 for specification 2.) Given this information, regressions were run to include a direct measure of the effect of debit card transactions. Data on the total annual dollar amount of credit
card transactions is available in annual increments from 1993 to 1999. This data is collected by The Nilson Report, and reported in the Statistical Abstract of the United States (2000).
Table 4.3: Dynamic GLS result estimates of money demand from 1978-1998. Including both credit and debit card spending. Standard errors are in parenthesis. One or two stars indicate significance above a ten or five percent significance level, respectively.

<table>
<thead>
<tr>
<th></th>
<th>M1</th>
<th>M2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.036 (0.914)</td>
<td>0.947 (0.346) **</td>
</tr>
<tr>
<td>$y_t$</td>
<td>0.371 (0.250)</td>
<td>0.5694 (0.0955) **</td>
</tr>
<tr>
<td>$D y_{t+1}$</td>
<td>0.008 (0.323)</td>
<td>-0.012 (0.127)</td>
</tr>
<tr>
<td>$D y_t$</td>
<td>0.059 (0.325)</td>
<td>0.069 (0.128)</td>
</tr>
<tr>
<td>$CC/Y$</td>
<td>9.27 (2.15) **</td>
<td>1.906 (0.844) *</td>
</tr>
<tr>
<td>$D(CC/Y)$</td>
<td>1.52 (1.27)</td>
<td>0.489 (0.499)</td>
</tr>
<tr>
<td>$D(CC/Y)$</td>
<td>0.75 (1.26)</td>
<td>0.063 (0.498)</td>
</tr>
<tr>
<td>$r_t$</td>
<td>-0.00139 (0.00191)</td>
<td>-0.002341 (0.000754) **</td>
</tr>
<tr>
<td>$D r_{t-1}$</td>
<td>0.00177 (0.00135)</td>
<td>0.001677 (0.000534) **</td>
</tr>
<tr>
<td>$D r_t$</td>
<td>0.00071 (0.00133)</td>
<td>0.000063 (0.000527)</td>
</tr>
<tr>
<td>$D(bitC/Y_t)$</td>
<td>-2.19 (5.02)</td>
<td>-2.58 (1.99)</td>
</tr>
<tr>
<td>$D(bitCt+1/Yt+1)$</td>
<td>1.44 (2.91)</td>
<td>1.14 (1.15)</td>
</tr>
<tr>
<td>$D(bitCt/Y_t)$</td>
<td>-0.41 (2.91)</td>
<td>-0.73 (1.15)</td>
</tr>
</tbody>
</table>

Total R^2 | 0.8863 | 0.9437 |
These coefficients for the variables on debit card usage do not meet the standards for significance at either the five or ten percent levels, indicating this variable does not directly capture changes in money demand in the 1990s. Certainly problems of statistical significance for debit card transactions are compounded by the short time series data available. To the extent that debit card use has changed nationwide money holdings, debit cards reduce the demand for M1, but not in a statistically significant way.

The results of these regressions, presented in Table 4.3, indicates that debit cards may be part of a technological innovation that does reduce holdings of M1 money balances, but credit cards are not. The inclusion of debit card variables produces a model where the positive relationship between credit cards and money is statistically significant at the five percent significance level for M1.

4.6 EXPANDING THE TIME FRAME

This section of the paper attempts to extend the data sample to incorporate data from before the 1977 start date of the primary results reported in Section 4.3. Specifically, this data extends from 1971-1998. The results are included in Table 4.4. Dummy variables for the known change in data classification are included, although these results are not statistically significant for M1.

Presented in Table 4.5 are results that extend the sample back to 1954. This sample incorporates an alternative interest rate, the effective federal funds rate in order to extend the timeframe covered in the data. Federal Reserve reports of revolving consumer
credit began in January 1968. This first observation was quite small in magnitude, at 0.16% of GDP. For this data set, I manually coded the level of credit cards usage before 1968 to be zero. Due to the high number of zero and near zero variables, credit card use is measured using specification two.

These extended time frame regressions presented in Table 4.4 and 4.5 have the largest statistical significance, as well as economic significance for revolving consumer credit outstanding. While many prominent researchers have noted a decrease in money demand in the past few decades, these long time frame regressions show that the growth of credit cards as an alternative payment technology is not adequate in explaining changes in money demand.
<table>
<thead>
<tr>
<th></th>
<th>M1</th>
<th>M2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Specification 1</td>
<td>Specification 1</td>
</tr>
<tr>
<td>Intercept</td>
<td>1.867 **</td>
<td>3.047 **</td>
</tr>
<tr>
<td></td>
<td>(0.132)</td>
<td>(0.133)</td>
</tr>
<tr>
<td>ln(y)</td>
<td>-0.0215</td>
<td>0.0084</td>
</tr>
<tr>
<td></td>
<td>(0.032)</td>
<td>(0.0136)</td>
</tr>
<tr>
<td>Δ ln(y_{t+1})</td>
<td>-0.008</td>
<td>-0.0123</td>
</tr>
<tr>
<td></td>
<td>(0.0288)</td>
<td>(0.0122)</td>
</tr>
<tr>
<td>Δ ln(y)</td>
<td>-0.0358</td>
<td>-0.0124</td>
</tr>
<tr>
<td></td>
<td>(0.0289)</td>
<td>(0.0122)</td>
</tr>
<tr>
<td>ln(CC)</td>
<td>0.0991 **</td>
<td>0.0656 **</td>
</tr>
<tr>
<td></td>
<td>(0.0291)</td>
<td>(0.0148)</td>
</tr>
<tr>
<td>Δ ln(CC_{t+1})</td>
<td>0.0562 **</td>
<td>0.00297</td>
</tr>
<tr>
<td></td>
<td>(0.0202)</td>
<td>(0.00896)</td>
</tr>
<tr>
<td>Δ ln(CC)</td>
<td>0.0549 **</td>
<td>0.02595 **</td>
</tr>
<tr>
<td></td>
<td>(0.0201)</td>
<td>(0.00894)</td>
</tr>
<tr>
<td>r_t</td>
<td>-0.00176</td>
<td>-0.002009 *</td>
</tr>
<tr>
<td></td>
<td>(0.00189)</td>
<td>(0.000802)</td>
</tr>
<tr>
<td>Δ r_{t+1}</td>
<td>0.00213</td>
<td>0.00177 **</td>
</tr>
<tr>
<td></td>
<td>(0.00135)</td>
<td>(0.00057)</td>
</tr>
<tr>
<td>Δ r_t</td>
<td>-0.00074</td>
<td>0.000009</td>
</tr>
<tr>
<td></td>
<td>(0.00135)</td>
<td>(0.000569)</td>
</tr>
<tr>
<td>D1977</td>
<td>0.0149</td>
<td>0.00409</td>
</tr>
<tr>
<td></td>
<td>(0.0159)</td>
<td>(0.00671)</td>
</tr>
<tr>
<td>Total R2</td>
<td>0.9888</td>
<td>0.9976</td>
</tr>
</tbody>
</table>

Table 4.4: Dynamic GLS result estimates of money demand from 1971-1998. Standard errors are in parenthesis. One or two stars indicate significance above a ten or five percent significance level, respectively.

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<table>
<thead>
<tr>
<th></th>
<th>M2</th>
<th>M2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Specification 2</td>
<td>Specification 2</td>
</tr>
<tr>
<td>Intercept</td>
<td>1.574</td>
<td>2.584</td>
</tr>
<tr>
<td></td>
<td>(0.111)</td>
<td>(0.365)</td>
</tr>
<tr>
<td>ln(yt)</td>
<td>0.0067</td>
<td>0.0351</td>
</tr>
<tr>
<td></td>
<td>(0.0286)</td>
<td>(0.014)</td>
</tr>
<tr>
<td>Δ ln(yt+1)</td>
<td>0.0167</td>
<td>-0.0117</td>
</tr>
<tr>
<td></td>
<td>(0.0268)</td>
<td>(0.0122)</td>
</tr>
<tr>
<td>Δ ln(yt)</td>
<td>-0.0243</td>
<td>-0.0025</td>
</tr>
<tr>
<td></td>
<td>(0.027)</td>
<td>(0.0123)</td>
</tr>
<tr>
<td>CC/yt</td>
<td>6.03</td>
<td>3.64</td>
</tr>
<tr>
<td></td>
<td>(1.16)</td>
<td>(0.752)</td>
</tr>
<tr>
<td>Δ CC/yt,t-1</td>
<td>3.159</td>
<td>0.304</td>
</tr>
<tr>
<td></td>
<td>(0.884)</td>
<td>(0.439)</td>
</tr>
<tr>
<td>Δ CC/yt,t</td>
<td>2.174</td>
<td>1.245</td>
</tr>
<tr>
<td></td>
<td>(0.881)</td>
<td>(0.439)</td>
</tr>
<tr>
<td>r2,t</td>
<td>-0.00225</td>
<td>-0.002045</td>
</tr>
<tr>
<td></td>
<td>(0.00158)</td>
<td>(0.000712)</td>
</tr>
<tr>
<td>Δ r2,t+1</td>
<td>0.00341</td>
<td>0.002213</td>
</tr>
<tr>
<td></td>
<td>(0.00119)</td>
<td>(0.000535)</td>
</tr>
<tr>
<td>Δ r2,t</td>
<td>-0.00013</td>
<td>0.000154</td>
</tr>
<tr>
<td></td>
<td>(0.00119)</td>
<td>(0.000535)</td>
</tr>
<tr>
<td>D1977</td>
<td>0.0116</td>
<td>0.00359</td>
</tr>
<tr>
<td></td>
<td>(0.0147)</td>
<td>(0.00664)</td>
</tr>
<tr>
<td>Total R2</td>
<td>0.9896</td>
<td>0.9994</td>
</tr>
</tbody>
</table>

Table 4.5: Dynamic GLS result estimates of money-demand from 1971-1998 Standard errors are in parenthesis. One or two stars indicate significance above a ten or five percent significance level, respectively.
4.7 CONSUMER CREDIT CONTROL LEGISLATION

One natural test of the impact of restricting the growth of credit cards occurred in the 1980s. In March of 1980, President Carter invoked the Credit Control Act as a way to dampen the expansion of credit, with many measures specifically targeting consumer credit. The 1980 Credit Restraint Program, which was enacted under the Credit Control Act, contained provisions which discouraged lending by domestic banks, and included voluntary limits to loan growth, a surcharge on discount window borrowings for large banks, and increases in the reserves on managed liabilities of large banks. Additionally, the CCA created special deposit requirements on money market mutual funds and on consumer credit, including credit card lending. Lenders had to hold reserves with the Federal Reserve on any increase in consumer credit after the date of March 14, 1980. Car and mortgage loans were specifically exempted from the deposit requirements, thus the majority of the relevant loans were from credit card use; expanding the impact of the CCA on the credit card industry, the Fed explicitly assumed all credit card usage was for consumer credit and therefore potentially covered by the CCA.

Credit card companies had already been reducing their issuance of new cards, as the combination of high inflation and state usury laws were making credit cards unprofitable, and the credit restraint program halted further expansions of credit cards. Consumer usage of credit cards also decreased dramatically, which has been attributed to

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ii The Credit Control Act is the name commonly given to the Sullivan-Reuss amendment, Title II of P.L. 91-151 (12 U.S.C. 1901-1909 (1969)).
the feeling that using credit during the economic crises was "unpatriotic" (Schreft, 1990). The trend in credit card usage can be inferred from Figure 4.5, which shows the change in revolving consumer debt outstanding.

The credit controls had a dramatic effect on the economy, which surprised economists because it appeared to be disproportional to the size of consumer credit as a percentage of GDP. Figure 4.6 shows some the change in the money aggregates while the credit restraint program was in effect. The restraints were enacted on March 14, 1980, quickly eased by March 22, and then removed on July 3, 1980. During this time period, M1 dipped and then recovered $10 billion, or by roughly 2.5% of the initial value of M1. The currency deposit ratio shows a marked increase during the same time; as seen in Figure 4.7.

Examination of Figure 4.8, which shows the predicted result of changes in M1 using data on revolving consumer credit outstanding from 1978-1998, shows that the restriction of the percentage change in the money holdings in the economy is well modeled by the model of consumer credit holdings, income and interest rates reported in Table 4.2 specification 1. The change in M1 in the predicted series leads the observed change slightly. The model including consumer credit card outstanding had a lower sum of squared residuals than the predicted results from the benchmark model without credit card use. However, both of these models appear to have overstated the potential impact of other changes in the economy at the same time.
Visual inspection of Figure 4.7 indicates that M1 holdings were more responsive to the restrictions in consumer credit during this time-period than the relationship captured in the long-term relationship modeled in this paper.
Figure 4.5: Revolving Consumer Credit during the Credit Restraint of 1980.
Figure 4.6: (a) The Monetary Aggregate M1. The Credit Restraint Program time period is shaded. (b) The Currency Deposit Ratio. The Credit Restraint Program time period is shaded.


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Figure 4.7: Values of M1 and Revolving Consumer Credit in real terms reported in 1983 dollars.

Figure 4.8: Observed values of M1 versus the M1 predicted by the coefficients in Table 4.2.
4.8 CHAPTER SUMMARY

While the results in this chapter are not as straightforward, either in terms of economic or statistical significance, as those presented in previous chapters, this chapter has presented some mixed evidence that a positive relationship between credit card usage and money holdings exists. While the primary specification did not show a statistically significant relationship, alternative specifications, and alternative time frames did meet standard criteria for statistically significant relationships. The elasticity of substitution between credit cards and money holdings were lower than predicted from the previous chapter, probably due to the impact of currency demand.

To the extent that the models in this paper have shown a statistically significant relationship, credit cards have been positively related to money holdings for M1 (although not for M2.) Further, this chapter has established that there is no statistically significant evidence that credit cards are a technology that is used to reduce money holdings.
CHAPTER 5

REVOLVING CONSUMER CREDIT AND CONSUMER RESPONSE TO MONETARY POLICY

5.1 MOTIVATION

The last two chapters have focused on how the introduction of transactions technology has affected the level and the rate of change of money demand. An examination of money holdings has implications for any attempt to measure stable monetary demand, or further, monetary equilibrium. This section explores whether changes in credit cards as a payment technology have had real effects on the conduct of monetary policy. This research builds on the body of literature that tracks how changes in monetary policy affects real variable, particularly those studies which measure a liquidity effect in money holder’s reactions to changes in the money supply.
5.2 COMPLEMENTARY THEORETICAL JUSTIFICATIONS

If credit cards were shown to be a service individuals use to reduce money holdings, the introduction of a credit card technology may change the consumer's response to changes in the opportunity cost of money. Specifically, if credit card usage is a substitute for money holding, then a consumer's demand for money would be more elastic in general, and therefore more responsive to a monetary shock.

5.2.1 A DECREASE IN “CREDIT MARKET IMPERFECTIONS”

Work by Gertler and Gilchrist (1993) has shown that the response to monetary policy shocks is relatively more pronounced for consumers than for businesses, indicating that one transmission mechanism for monetary policy arises from imperfections in the credit market. Unlike large businesses, consumers (and small businesses) endure real effects of monetary policy changes because they lack full access to alternatives like credit. Residential investment shows the most sensitivity to monetary shocks, and the sensitivity of durable and non-durable spending are both notably larger than investments. These categories of durable and non-durable consumer items have both been affected by the prominence of credit cards. As seen in Figure 5.1, revolving consumer credit now constitutes roughly half of the outstanding balance of consumer credit.
Figure 5.1: Consumer Credit in Nominal Terms Over Time. Revolving Consumer Credit has grown to nearly half of total consumer credit.

Credit cards offer an open line of credit, and further, the potential liquidity provided by revolving credit lines is most likely an order of magnitude larger than the measured balances outstanding. If the impact of monetary policy on consumer spending was magnified by the high fixed costs for consumers to obtain installment loans in response to monetary contractions, the increased liquidity in the system due to the expansion of consumer credit cards can reduce the impact of a monetary policy shock.
Given the stylized fact that credit cards offer an open line of credit at a sticky interest rate (following Ausubel (1991) and discussed below in section 5.3.2), attempts to constrict the economy-wide growth rate by raising the costs of funds to banks would not have an immediate effect on the opportunity set of the consumer sector. A discussion of inter-temporal lending with credit cards is beyond the scope of the transactions models presented in this paper.

5.2.2 A CHANGE IN THE TIMING OF TRANSACTIONS

A number of models, including Grossman and Weiss (1983), Grossman (1987) and Alvarez, Atkeson, and Kehoe (2000), explain the real effects of monetary injections by modeling economies where public money holdings cannot be instantly adjusted. Segmentation in the market between consumers and investors, which creates this liquidity effect, is modeled as a result of the fixed costs of transferring between money and income earning assets. In the model presented in this paper, credit cards provide a method of changing when charges are paid, then the liquidity effect of monetary injections will have changed as well.

In Section 2.2, this paper modeled credit cards as a cost free way of aggregating an exogenously defined percentage of monthly bills and deferring them, within a traditional payment period defined by the intervals between conducting investment transactions, without occurring any additional cost. At an extreme, if all transactions could be charged, and all charges could be paid on the same day as a withdrawal from an

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investment account, the economy would move towards a "pure credit" society like that proposed by Knut Wicksell (1907), where monetary policy is no longer relevant.

In models like Grossman and Weiss (1983), when there is a real wealth effect between those individuals who are approaching an (exogenously) defined time for conducting transfers between money and investment and those individuals who are not ready to invest, a credit card technology like that discussed in Appendix A could alter the impact of monetary policy shock, albeit asymmetrically. If credit cards allowed consumers to spend even after they ran out of money, as in the modified Bar-Ilan model developed in Appendix A, consumers who observe an expansionary monetary policy before their defined investment period can begin to increase their spending.

Alternatively, evidence present in Chapters Three and Four can be interpreted as indicating that consumers do not actively minimize their money holdings. The evidence supporting the interpretation that credit cards are used to stretch the time between investment transactions, disregarding the interest rate opportunity cost, supports the theory that the current level of credit card holdings lengthens the impact of monetary policy shocks as the frequency of investment transactions decreases.

5.3 EMPIRICAL RESULTS

5.3.1 INTERPRETING IMPULSE RESPONSE BASED ON LEVELS

The approach used here is to incorporate revolving consumer credit borrowing into the existing literature on monetary policy shocks. This was done by incorporating
revolving credit, measured in logs, in an impulse response model derived from a vector auto-regression (VAR). A helpful survey of this literature is Christiano, Eichenbaum, and Evans (1998), which will be referred to as CEE. The variables considered in this paper are designed to mirror the variable choices in CEE, although the general price level was measured using the log CPI index rather than GDP inflators, and disregarding their proposed variable to measure commodity prices. The variables in this paper include monthly data on the price level, log M1, the federal funds rate and monthly interpolation of quarterly data on log real GDP, as in Chapter Four. This paper uses four lags of each variable, similar to the choice in CEE, although higher order lag structures did not change the direction of any key relationships, nor improve the significances.

The monetary shock in the economy was measured as a change in the Fed Funds rate, specifically an increase in the Fed Funds rate equal to a one standard deviation shock. As argued by Sims (1996), this standard econometric practice builds upon the stylized fact that most monetary policy changes are announced as changes in the Fed Funds rate.
Figure 5.2: The impulse response of an increase in the Fed Funds rate equal to a one standard deviation shock. This VAR incorporates Revolving Consumer Credit Outstanding. Time is measured in monthly units, and graphs cover 36 months.
Figure 5.3: The impulse response of an increase in the Fed Funds rate equal to a one standard deviation shock. These graphs are for the Benchmark VAR without the log Revolving Credit. Time is measured in monthly units, and graphs cover 36 months.
As seen in Figure 5.3, money holdings in nominal terms are responsive to this monetary policy contraction, and moreover, this permanent response of money holdings is not found in the published CEE benchmark models of the liquidity effect of monetary policy shocks, which had not included the role of revolving credit. Incorporating the extra variable to measure revolving consumer credit outstanding into the model affects all the endogenous terms, and so the relationship between revolving credit and money holdings is obscured. This result indicates that when changes in credit holdings are incorporated into the model, the effect of a Fed Funds shock on money holdings is more permanent than previous literature has found.

The benchmark result, which is reported in Figure 5.3, also found a statistically significant transitory decrease in the real output of the economy following a monetary contraction; this model, shown in Figure 5.2, does not. To the extent that the level of revolving consumer credit captures the ability of the consumer to respond with more flexibility to a monetary policy, when the financial system incorporates an increasing level of consumer revolving credit the economic and statistical significance of the real response of the monetary to economic contractions decreases.

5.3.2 THE EXTENT REVOLVING CONSUMER CREDIT IS PRICED DIFFERENTLY THAN MONEY

Figure 5.2 shows that revolving consumer credit outstanding responds negatively to increases in one measure of a bank's interest rates, although the possibility of no
response is well within the confidence intervals. The lack of a distinctly statistically significant relationship accords with the traditional assumption that credit card lending is not particularly responsive to interest rates. Belief in this stylized fact is based on Ausubel's (1991) finding of the non-responsiveness of the interest rates of credit cards to changes in the Fed Funds interest rates; however Ausubel did not attempt to measure the volume of loans outstanding on credit cards at any interest rate, only the relatively constant interest rates charged to consumers. Explanations for these sticky interest rates have evolved to incorporate the idea that the rates are stabilized by the credit card companies as a mechanism to differentiate between creditworthy customers (Stavins 1996).

Table 5.1 shows my attempts to replicate Ausubel's research using data from the most recent decade. The results in this paper differ from those by Ausubel in both the time-period covered and the variable used to measure the cost of funds. Table 5.1 does indicate that, in the most recent decade, credit card interest rates are five times more responsive to market interest rates than in the 1980s. That responsiveness is still distinctly different than a unitary response that would be seen if the cost of funds to the banks was the sole influence on the cost of credit to the customers. Specifically, Federal Reserve Table G.19 reports the credit card interest rate as the representative interest rate loan on all credit card accounts quarterly, a composite from their bank survey data. This survey based on average interest rates may understate the stickiness of the interest rate presented to the consumer who already is affiliated with a credit card company, although Ausubel (1991) found this was not the case.

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Table 5.1: Modeling Credit Card Interest Rates as a Function of Cost of Funds. Numbers in parenthesis are standard errors.

<table>
<thead>
<tr>
<th>Model</th>
<th>Constant</th>
<th>Cost of Funds</th>
<th>Lagged Credit Card Interest Rate</th>
<th>Number of Obs.</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarterly 1994-2000</td>
<td>9.262</td>
<td>0.255</td>
<td>0.318</td>
<td>24</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>-2.62</td>
<td>-0.103</td>
<td>-0.182</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ausubel's model Quarterly 1982-1987</td>
<td>1.51</td>
<td>0.0422</td>
<td>0.895</td>
<td>24</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>-0.807</td>
<td>-0.0058</td>
<td>-0.044</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Allowing that the cost of borrowing consumer credit is not responsive to changes in the cost of funds allows us to interpret the movement in individual money balances as due to changes in the in the cost of money. Simply put, if theoretically most credit cards have nearly fixed interest rates, Table 5.1 shows that changes in credit card lending are brought about by complementary changes in money holdings.
5.3.3 IMPULSE RESPONSE BASED ON FIRST DIFFERENCES

In addition to the caution raised by the fact that the confidence interval on the change in revolving credit could include the possibility of no change, there are problems involved in using impulse response models derived from VARs where all the variables are I(1). While evaluating these impulse responses in levels is a common practice, the interaction of these non-stationary series tends to produce explosive results. Thus, a different model was run using differences of each variable to achieve stationary series. Figure 5.4 looks at how a positive increase (by one standard deviation) of the rate of change in the fed funds rate influences that rate of change of each of the included variables. In this model the confidence intervals could incorporate a result of no response. These results show the rate of change of the money supply responding negatively to an increasingly contractionary Fed Funds rate, where the rate of change on revolving consumer credit is positive after only one quarter, although again the result of no change falls within confidence intervals defined by two standard errors.
Figure 5.4: The impulse response of an increase in the differenced Fed Funds rate equal to a one standard deviation shock on differences of the following variables: log M1 and log Revolving Consumer Credit Outstanding. Time is measured in monthly units, and graphs cover 12 months.
5.4 DIRECT RELATIONSHIPS

An alternative method of measuring the complementary relationship between money balances in the hands of the public and high levels of revolving consumer credit outstanding is to isolate the response of revolving consumer credit to a direct shock to log M1. This is shown in Figure 5.5 The impulse response function used the same set of control variables in the previous VAR. This relationship is permanent, stable, and positive. Curiously, the reverse relationship, which is the effect of money holdings to a unit shock to credit card lending, is transitory, and negative. Therefore, it is unclear from this model whether credit cards act as a substitute for money holdings. This approach is not developed into a full model because of the theoretical difficulty in presenting either M1 or revolving consumer credit as affected by exogenous shocks.

What can be concluded is that while there is little discernable effect of contractionary monetary holdings on revolving consumer credit outstanding itself, including this variable in a model of monetary holdings does change our model in a way that would indicate that the response of monetary aggregates to contractionary shocks is more permanent than indicated in the benchmark regression.
Figure 5.5: The impulse response of an increase in Revolving Credit on Money use, and for an increase in Money on Revolving Consumer Credit Outstanding. The shock is a one standard deviation positive increase. This VAR incorporates Revolving Consumer Credit Outstanding. Time is measured in monthly units, and graphs cover 36 months.
6.1 SUMMARY OF THE THEORETICAL APPROACH

In essence, this is a paper about how institutional factors influence the economy. The institution studied in this paper is the American-style credit card, which is defined as a card which, when paid off in full, periodically and regularly, offer cardholders amenities in terms of ease of use in conducting transactions. Sixty percent of Americans who own credit cards use credit cards solely for transactions purposes.

Since credit cards are an alternative to money as a means of payment at the point of sale, it is natural for some people to think of them as substitutes. However, the fact that these transactions services require the card to be paid off in full periodically and regularly, in cash, means that American style credit cards can behave as something other than a substitute for money, and credit cards are not a "pure credit" good. Although the majority of economists who discuss credit cards ignore the technicalities of how credit
cards payments are structured, these institutional factors do influence how consumers divide their assets between money and investment holdings.

By evaluating transactions models of money demand, this paper has shown that in theory the institution of the credit card could either increase or decrease money holdings. Indeed, the effect of credit card holdings is expressed as a function of the percentage of overall charges placed on credit cards, and the amount of time these charges float in an individual’s transactions accounts. The amount of time charges float in the account is the key variable to define whether the relationship between credit cards and money holdings is positive or negative.

In the course of this thesis a number of money demand models were discussed. Specifically, Section 2.3 discussed models where payments from investment withdrawal, or equivalently from salary payments are made at exogenously defined increments. In the appendix, this model was adapted to allow for credit cards to provide additional liquidity, specifically for credit cards to allow spending when there is no money on hand, at a continually compounding rate. Section 2.4 covered models where the payments from investment accounts were defined by an individual’s effort to minimize the opportunity cost of money, through minimizing the interest lost from removing money from investments, and the transactions costs of “brokerage services.”

The models presented in this paper demonstrate how exogenously defined payments to credit card providers can either increase or decrease money holdings, since traditional determinants of money demand models, the interest rates or the cost of liquidating funds held in investments, have not changed. In these cases the theory
predicts that if credit card payments are uniformly distributed, credit cards will have no
effect on the economy. This is the null hypothesis maintained through the paper.

Economic effects are noticeable when the timing of credit card payments can be
endogenously defined. When individuals have control over both the flow of money into
their transactions accounts and the timing of their credit card payments, intuitively
economists understand that individuals would time their credit card transactions with
their payment periods to minimize the opportunity costs of holding money.

When deposits into monetary accounts are exogenously defined, the impetus to
pay off credit cards is diminished. It is easy to imagine minor changes in the model
specification, such as an interest payment on checking accounts, which would encourage
individuals to maximize the amount of float they maintain in their account.

Since in Chapter Three and Chapter Four, the empirically measured effect of
credit cards on the economy has been an increase in the amount of money holding, this
paper presents evidence that individuals behave as if either the timing of their deposits
into money holdings, or their payments to the credit card companies were exogenously
deefined.

6.2 SUMMARY OF EMPIRICAL FINDINGS

Credit cards are not currently used to reduce money holdings for the majority of
the transactions in the economy. When individual transactions accounts are examined
directly, credit cards have increased transactions account holdings, indicating that credit
cards increase the float on transactions accounts. An increase in one's credit card usage raises one's money demand, by less than the amount of the increase; a one unit increase in log credit card use raises log money demand by 0.25. A positive relationship holds for checking and savings accounts, and small time deposits, but does not hold for larger aggregates of assets, such as total non-liquid assets, indicating that the relationship detected in the model was dominated by the transactions relationship, and not by alternative simultaneous relationships in terms of consumption or wealth.

This positive relationship between transaction-account holdings and money demand has not been previously reported. The most likely reason for this difference is that recent studies have focused on credit card ownership rather than credit card usage. In all likelihood, owning a credit card reduces one's precautionary money demand, but using a credit card raises one's transactions demand, through institutional factors arising the timing of transactions.

The effect of credit cards on the monetary aggregates of the economy were not as pronounced as the relationship between credit cards and transactions accounts, indicating that credit cards are reducing a consumer's demand for currency, but not reducing the consumer's demand for money. A unit increase in log credit card use increase log money demand by a small, positive amount, 0.074. Alternatively, the low statistical significance of some models would indicate that one can not reject the hypothesis that credit cards have no impact on money holdings at any given interest rate.

The evidence in both Chapters Three and Four would indicate that individuals do not behave as if the timing of their credit cards can be aligned with the inflow of assets.
into a credit card account. To this extent, credit cards, as we now know them are not functioning as assumed in textbooks; that is they are not a useful substitute for money.

To directly address the whether credit cards are a substitute or a complement to monetary holdings using more traditional economic definitions, one would have to measure whether the quantity of charges on credit cards responded positively or negatively to a change in the price of money holdings. Chapter Five reviewed Ausubel’s hypothesis that credit card prices are non-responsive to the interest rate schedules faced by banks. Given this non-responsiveness in the price of credit cards, we can interpret the permanent decrease in credit card lending following an increase in the Fed Funds rate as direct evident that credit cards and monetary holding are complementary goods.

While revolving consumer credit outstanding is relatively non-responsive to interbank lending and the cost of funds, including them as a scale variable in a VAR measure of the economy-wide response to monetary policy shocks increases the measured permanence of the monetary shock. Including revolving consumer credit outstanding as a scaling variable reduces the weight in the regression of monetary responses that were more transient. The largest observations of revolving consumer credit were coupled with the more transient shocks. This would indicate that consumers become more responsive to monetary policy shocks when there is a credit change.
6.3 PROPOSALS FOR FUTURE WORK

This thesis has demonstrated that the response of money demand to credit card use can be explained by institutional factors arising from payment of credit cards. Further, those institutional effects are unique for Americans. American credit cards are fundamentally different than European style credit cards because American style cards are divorced from the primary bank account until the consumer initiates the periodic payment. In contrast, most charge cards in Europe function more closely to what is called a debit card in the United States. If the institutional factors discussed in this paper were generating the positive relationship between credit cards and money demand, the result should be less apparent in other countries.

Similarly, research on U.S. data could be enhanced as more data on American use of debit cards becomes available. This paper has speculated on potential effects of consumers sorting themselves into debit card and transactions credit card users, but no formal model has been developed. Indeed, the growing phenomena of debit card use remains under-explored in the literature.

6.4 ON CASHLESS SOCIETIES AND MONEY-LESS ECONOMIES

Many students of prophecy see a cashless society as a sign of the approach of the end times and the coming of a world leader known as the Antichrist. Should this then have an effect on the way we live and the economic choices we make? (Ice and Demy 1996, page 21)
Credit cards may be replacing currency, and moving the American economy towards a "cashless" society, analogous to the "paperless" office previous generations had predicted we would see today. However, there is no clear evidence that credit cards in any way minimize the holding of money, and indeed some evidence shows that credit cards are increasing the money holdings at any given interest rate.

Several scholars, notably those aligned with the Federal Reserve Bank of Chicago's Center for Electronic Payments, have been pursuing an active research agenda discussing e-currency and the future of monetary policy. By construction most of the proposed models of e-currency produce money-less economies. However, most experiments to introduce e-currency have not been successful, and much of the impetus to create e-currency (such as handling transactions over the phone or internet) is to solve problems currently being addressed by the credit card market. To the extent that American consumers have expressed a preference for credit card transactions, this paper predicts there will not be a notable reduction aggregate money holdings.

More Americans own credit cards each year, and each American is conducting more transactions on credit cards. That trend does not create a new regime for money holdings, and for the immediate future of money holding will not look radically different than the past.
COMBINING CREDIT CARD SERVICES WITH ALTERNATIVE
OVERDRAFT PAYMENTS

A.1 MONEY DEMAND WITH OVERDRAFT SERVICE, AND ENDOGENOUS TIME
PERIODS

An agent has a yearly endowment, $T$, from which to purchase goods, which he
does at a constant rate. His initial investment is held in an income-earning asset, such as
bonds, which earns an interest rate $r$, which the agent forgoes when he holds assets in the
form of money. The individual can obtain credit, such as overdraft check-writing
privileges, which covers his continuous spending, at the rate $p$. The agent decides how
often to make a transaction, with cost $b$ for each transaction, from bonds to money, to
maximize the total cost. In doing so, he defines an optimal amount to withdraw from
bonds per period $M-\mu$, which defines both the maximum cash, $M$, to hold in each period
and the maximum debt, $\mu$, in overdrafts each period. Figure A.1 shows these boundaries.
In a Bar-Ilan model, the agent minimizes the cost of holding money, which is:

\[
\text{cost} = n \left( \frac{M}{T} \right) \left( \frac{M}{2} \right) r + n \left( \frac{\mu}{T} \right) \left( \frac{\mu}{2} \right) \rho + nb
\]

by choosing variables M, \( \mu \) and n subject to:

\[n(M - \mu) = T\]

where n is the number of transactions, M is the highest level of money holdings each period, and \( \mu \) is the highest level of debt each period.

Figure A.1: Money balances with deterministic spending in an overdraft model.
The first term of the argument to be minimized represents the opportunity cost of holding money, the second term represents the cost of holding a deficit, and the third term represents the periodic transactions cost.

A.2 OVERDRAFTS, CREDIT CARDS, AND EXOGENOUS PAYMENT PERIODS

In this model, a credit card provides a service of staunching the flow of funds out of an individual’s money holdings. A credit card can be used for Q percent of all transactions, and staunches the flow of funds out of money holdings for \( k \) percentage of a time-period. Individuals then pay for credit card bills with money or with overdraft services.

One way to relate this model to common American experience is to think of an individual using one credit card with no existing balance to generate an interest free loan for \( k \) percentage of a time-period. Eventually, the individual must pay off that interest free loan by rolling over the balance to another line of credit where interest is accumulating continually. In short, the individual juggles two forms of loans to minimize transactions costs.

An individual pays an opportunity cost, \( r \), on money he holds in his checking account, and an interest cost, \( p \), on money he borrows from an overdraft style service.

How the credit card service effects the cost of transactions depends on when the credit card float comes due; specifically there is a difference between cases where an
individual pays off this float early in a payment cycle, when he has money in his transactions account, or not.

For exposition, this will be discussed for the case where the transfer of assets into his money account is exogenously determined at N times a payment period with a value of T/N for each asset deposit.

A.2.1 CASE 0: NO CREDIT CARDS POSSIBLE

Figure A.2: In one exogenously defined subperiod, an individual spends with both money and an overdraft service.
Case 0 money holdings

\[ \frac{m^2}{2T} \]

Case 0 transactions costs:

\[ \frac{rm^2 N}{2} - \frac{N \mu \rho}{2} \left( \frac{1}{n} - \frac{m}{T} \right) \]

\[ \frac{rm^2 N}{2} - \frac{N \mu \rho}{2} \left( -\frac{\mu}{T} \right) \]

Minimum cost gives Case 0 FOC:

\[ \frac{Nmr}{T} - \frac{N}{T} \left( \frac{T}{N} - m \right) \rho = 0 \]

\[ m(r + \rho) = \rho \frac{T}{N} \]

\[ m = \frac{T \rho}{N (r + \rho)} \]

since \( m - \mu = \frac{T}{N} \)

then \( \mu = m - \frac{T}{N} = -\frac{T}{N} \frac{r}{(r + \rho)} \)
Case 0 optimal average money holdings:

\[
\left( \frac{T - \rho}{N (r + \rho)} \right)^2
\]

A.2.2 INFLECTION POINTS

How credit cards affect money holdings and overdraft balances depends on the timing of payments. Specifically, the cost of holding money changes when the credit card bills are paid out of cash on hand, as opposed to rolling the balance over onto a credit card. Thus, this appendix addresses three different scenarios: payment from cash, payment that exhausts the cash supply and requires overdraft credit, and payment from overdraft credit. The next set of equations generates the coordinates of inflection points that will be pivotal in calculating whether credit card bills are paid from cash on hand or from overdraft credit.

Applying \( y = mx + b \) format to cases where the slope is:

\[
\mu - m + Q \frac{T}{N} \frac{1}{1/N} = (Q - 1) \frac{T}{N} = (Q - 1)T
\]

yields

\[
y = (Q - 1)Tx + \left( m - Q \frac{T}{N} \right)
\]
0 = (Q - 1)TA + m - Q \frac{T}{N}

m - Q \frac{T}{N} = (1 - Q)TA

A = \frac{m - Q \frac{T}{N}}{1 - Q}T

Alternately applying \( y = mx + b \) format to cases where the slope is \((q-1)T\) yields:

\( y = (Q - 1)Tx + m \)

\( 0 = (Q - 1)TB + m \)

\( m = (1 - Q)TB \)

\( B = \frac{m}{(1 - Q)T} \)
A.2.3 CASE I: CREDIT CARDS DUE WHEN MONEY SUPPLIES ARE POSITIVE

\((K/N<A)\)

Figure A.3 In one exogenously defined subperiod, an individual spends with both money and an overdraft service. A portion of spending is deferred on a credit card until \(k\). Credit cards are repaid before the money supply runs out, \(k/N<A\).

Case 1 money holding:

\[
\frac{1}{2} \left( m - Q \frac{T}{N} \right) \left( m - Q \frac{T}{(1-Q)T} \right) + kQ \frac{T}{N} \frac{1}{N}
\]
Case 1 Cost of transactions:

\[
N \left[ \frac{1}{2} \left( \frac{m - Q T}{N} \right) \left( \frac{m - Q T}{N} \right) + kQ \frac{T}{N} \frac{1}{N} \right] r + N \left[ \frac{1}{2} (-\mu) \left( \frac{1}{N} - \frac{m - Q T}{(1-Q)T} \right) r \right]
\]

minimum cost gives Case 1 FOC:

\[
r N \left( \frac{m - Q T}{N} \right) \left( \frac{T}{N} \right) \left( \frac{1}{1-Q} \right) - \rho N \left( \frac{T}{N} - m \right) \left( \frac{1}{1-Q} \right) = 0
\]

\[
m = \frac{T}{N} (\rho + Qr)
\]

\[
\mu = m - \frac{T}{N} = -\frac{T}{N} \frac{(1-Q)r}{r + \rho}
\]

This next set of equations compares money holdings between Case 0 where credit cards are not available, and the case where Case 1 when credit cards are available.
Case 0 or Case 1
\[
\frac{T}{N} \left( \frac{\rho}{r+\rho} \right)^2 \gtrless \frac{1}{2} \left( \frac{m-Q}{T} \right)^2 + kQ \frac{T}{N} \frac{1}{N}
\]
\[
\left( \frac{T}{N} \frac{\rho}{r+\rho} \right)^2 \gtrless \frac{1}{2} \left( \frac{T}{N} \frac{\rho + Qr - Qr - Q\rho}{r+\rho} \right)^2 + 2kQ \frac{T}{N} \frac{T}{N} \frac{1}{N}
\]
\[
\left( \frac{\rho}{r+\rho} \right)^2 \gtrless \frac{1}{1-Q} \left[ \frac{\rho + Qr - Qr - Q\rho}{r+\rho} \right]^2 + 2kQ
\]
\[
\left( \frac{\rho}{r+\rho} \right)^2 \gtrless (1-Q) \left[ \frac{\rho}{r+\rho} \right]^2 + 2kQ
\]
\[
0 \gtrless -\left[ \frac{\rho}{r+\rho} \right]^2 + 2kQ
\]
\[
k \gtrless \frac{1}{2} \left[ \frac{\rho}{r+\rho} \right]^2
\]

As long as \( \rho \) is close to \( r \), the probability that money holdings will be smaller when an individual has a credit card is relatively large. When \( \rho = r \), money holdings are reduced with credit cards whenever \( k \) is greater than \( \left( \frac{1}{2} \right)^3 \). As the opportunity price of \( \rho \) in terms of \( r \) rises, this probability increases.
A.2.4 CASE 2: CREDIT CARDS DUE WHEN MONEY SUPPLIES ARE NEAR ZERO

\[(A < K/N < B)\]

Figure A.4: In one exogenously defined subperiod, an individual spends with both money and an overdraft service. A portion of spending is deferred on a credit card until \( k \). Credit cards are repaid near the time when money supplies are running low, \( A < k/N < B \).

Expression 1: Average money holdings:

\[
\frac{m}{Q(T/N)} - \frac{(kN, m(B-k)/B)}{(A, 0)} = \frac{(B, 0)}{(1/N, 0)} = \frac{(kN, (k-AN)/(AN))}{(1/N, \mu)}
\]
\[ \frac{1}{2} Bm - \frac{1}{2} \left( B - k \right) \left( \frac{m \left( B - \frac{k}{N} \right)}{B} \right) \]

\[ \frac{1}{2} m \left( B - \left( \frac{B - k}{N} \right)^2 \right) \]

\[ \frac{1}{2} m \left( -\frac{k}{N} + 2 \frac{k}{N} \right) \]

\[ \frac{1}{2} m \left( \frac{1 - Q}{m} \left( \frac{k}{N} \right)^2 + 2 \frac{k}{N} \right) \]

Expression one, average money balances: \(-\frac{1}{2} m(1 - Q)\left( \frac{k}{N} \right)^2 + m\frac{k}{N}\)

Expression two, average debt holdings:

\[ \frac{1}{2} \left( -\mu \left( \frac{1}{N} - A \right) \right) - \frac{1}{2} \left( \frac{k}{N} - A \right) \left( -\mu \left( \frac{k}{N} - A \right) \right) \]

\[ \frac{1}{2} \left( -\mu \left( \frac{1}{N} - A \right)^2 - \left( \frac{k}{N} - A \right)^2 \right) \frac{1}{1 - A} \]
\[
\frac{1}{2}(-\mu) \left[ \frac{\left( \frac{1}{N} \right)^2 (1-k^2) - 2A \frac{(1-k)}{N}}{1 - A} \right]
\]

\[
\frac{1}{2}(-\mu) \left[ \frac{\left( \frac{1}{N} \right)^2 (1-k^2) - 2A \frac{(1-k)}{N}}{1 - \frac{m - Q \frac{T}{N}}{(1-Q)T}} \right]
\]

\[
\frac{1}{2}(-\mu) \left[ \frac{\left( \frac{1}{N} \right)^2 (1-k^2) - 2A \frac{(1-k)}{N}}{\frac{(1-Q)T - mN - Q \frac{T}{N} - N}{(1-Q)TN}} \right]
\]

\[
\frac{1}{2}(-\mu)(1-Q)NT \left[ \frac{\left( \frac{1}{N} \right)^2 (1-k^2) - 2A \frac{(1-k)}{N}}{T - mN} \right]
\]

\[
\frac{1}{2}(-\mu)(1-Q)NT \left[ \frac{\left( \frac{1}{N} \right)^2 (1-k^2) - 2A \frac{(1-k)}{N}}{-\mu N} \right]
\]

\[
\frac{1}{2}(1-Q)T \left[ \left( \frac{1}{N} \right)^2 (1-k^2) - 2A \frac{(1-k)}{N} \right]
\]
\[
\frac{1}{2}(1-Q)\frac{T}{N}\left[\frac{1}{N}(1-k^2)-(1-k)^2\frac{m-Q}{(1-Q)T}\right]
\]

Again, as calculated above Case 2 money holdings:

\[
\frac{1}{2}(1-Q)T \frac{k^2}{N} - \frac{k}{N} - m
\]

and Case 2 transactions costs:

\[
N\left[\frac{1}{2}(1-Q)T \frac{k^2}{N} + \frac{k}{N} + m\right] + N\left[\frac{1}{2}N(1-k)^2\frac{T}{N}(1-Q) - \frac{1}{N}(1-k)\left(m-Q\frac{T}{N}\right)\right] \rho
\]

minimizing transactions costs yields Case 3 FOC:

\[
N\frac{k}{N}r + N\left(-\frac{1}{N}\right)(1-k)\rho = 0
\]

\[
k\rho - (1-k)\rho = 0
\]

Therefore, in this case, there is no singular optimal solution to how an individual can balance the cost of money, overdraft services, and the float of a credit card.
A.2.5 CASE 3: CREDIT CARD BILLS ARE PAID OFF WITH OVERDRAFT SERVICES

Figure A.5: In one exogenously defined subperiod, an individual spends with both money and an overdraft service. A portion of spending is deferred on a credit card until \( k \). Credit cards are repaid near the time when money supplies are running low, \( B < k/N \).

Money holdings:

\[
\frac{1}{2} \cdot m \cdot \frac{m}{(1 - Q)T}
\]

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Transactions costs:

\[
\begin{align*}
    rN\left( \frac{1}{2} \frac{m}{(1-Q)T} \right) + \rho N \left[ \frac{1}{2} \left( -\mu \right) \left( \frac{m - \frac{Q}{N}}{1 - \frac{Q}{N}} \right) - \frac{1}{2} \left( \frac{m}{(1-Q)T} - \frac{m - \frac{Q}{N}}{1 - \frac{Q}{N}} \right) - \frac{T}{N} \left( \frac{k}{N} - \frac{m}{1 - \frac{Q}{N}} \right) \right] \\
    + \rho N \left[ \frac{1}{2} \left( -\mu \right) \left( \frac{(1-Q)T - (mN - QT)}{(1-Q)NT} \right) - \frac{1}{2} \frac{1}{(1-Q)T} \left( \frac{T}{N} \right)^2 - \frac{T}{N} \left( \frac{k}{N} - \frac{m}{1 - \frac{Q}{N}} \right) \right] \\
    + \rho N \left[ \frac{1}{2} \left( -\mu \right) \left( \frac{T - m}{1 - \frac{Q}{N}} \right) - \frac{1}{2} \frac{1}{(1-Q)T} \left( \frac{T}{N} \right)^2 - \frac{T}{N} \left( \frac{k}{N} - \frac{m}{1 - \frac{Q}{N}} \right) \right] \\
    + \rho N \left[ \frac{1}{2} \left( \frac{T}{N} - m \right) - \frac{1}{2} \frac{1}{(1-Q)T} \left( \frac{T}{N} \right)^2 - \frac{T}{N} \left( \frac{k}{N} - \frac{m}{1 - \frac{Q}{N}} \right) \right]
\end{align*}
\]

So FOC:

\[
\begin{align*}
    rN \frac{1}{(1-Q)T} - \rho N \frac{T}{N} \left( \frac{T}{N} - m \right) + \rho NQ \frac{T}{N} \frac{1}{(1-Q)T} = 0 \\
    mr + \rho \left( m - \frac{T}{N} \right) = -\rho Q \frac{T}{N}
\end{align*}
\]
\[ m(r + \rho) = \frac{T}{N} \rho (1 - Q) \]

\[ m = \frac{T}{N} \frac{\rho}{r + \rho} (1 - Q) \]

\[ \mu = \frac{T}{N} \frac{\rho}{r + \rho} (1 - Q) \]

A.3 COMPARING MONEY HOLDINGS

A.3.1 CASE 0  A.3.2 CASE 3

\[ \frac{1}{2} \left( \frac{T}{N} \frac{\rho}{r + \rho} \right)^2 \]

\[ \frac{1}{2} \left( \frac{m^2}{(1 - Q)T} \right) \]

\[ \frac{1}{2} \left( \frac{T}{N} \frac{\rho}{r + \rho} (1 - Q) \right)^2 \]

\[ \frac{1}{2} \left( \frac{T}{N} \right)^2 \left( \frac{\rho}{r + \rho} \right)^2 \]

\[ \frac{1}{2} (1 - Q) \left( \frac{T}{N} \right)^2 \left( \frac{\rho}{r + \rho} \right)^2 \]

In this case it can be seen that credit cards decrease money holdings whenever the percentage of goods that can be held on credit \( Q \) is not exactly equal to zero.
A.4 SUMMARY

Therefore, in all three of the cases, as a byproduct of minimizing the costs of overdraft and money holdings and withdrawal from bonds, most individuals reduce their money holdings when credit card services are available. In only one case, and only under very specific timing constraints could credit cards increase average money holdings. This follows from the intuition that individuals with access to both payment deferment, and overdraft lines of credit use these services to reduce the rate at which goods flow from their account.
APPENDIX B

EVIDENCE THAT CONSUMERS CONTROL THE TIMING OF FLOWS THROUGH FUNDS

Figure B.1: Advertisement for Citigroup credit cards. Smithsonian Magazine May 2001 Volume 32 Number 2 page 57.
Cardmember Tips:

Your First USA card gives you many choices to take control of your credit and manage your:

- **Avoid Late Fees and Keep Your APR Low**
  - Choose a convenient due date. Call us for a due date that fits your bill-paying schedule.
  - Send your payment 1-2 days before it's due. A postmark is not enough — be sure your payment is on time.
  - Please be on time. All you need is your account number and checking account information to make a payment by phone. Call 1-800-853-9990.
  - Pay your bill online. Go to www.FirstUSA.com click on Cardmember Services for easy instructions.

- **Stay Under Your Limit**
  - Monitor your balance. Check your available credit regularly to avoid over-the-limit fees.
  - Stay at least 5% under your limit at all times.
  - Call us to request a credit increase. We may be able to raise your limit.

- **Your Right to Privacy**
  - If you would prefer not to receive our offers of goods and services, write to us at the address listed below.
  - Allow 90 days to remove your name from future First USA marketing programs.

- **Receive Problems With Your Account Quickly**
  - Call First USA’s Customer Service Department.
  - Call toll-free 24 hours a day, 7 days a week. See the reverse side of your card or your statement for toll-free number.
  - Ask for the advisor’s name and site location.
  - Ask to speak with a team manager if you are not satisfied with the service advisor’s resolution.
  - Send an e-mail to us from our web site www.FirstUSA.com.
  - Write to us at P.O. Box 8408, Wilmington, DE 19899-8408.

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**Figure B.2:** Direct Mailing First U.S.A. Credit Card January 2001. Choosing a due date is the first of the numbered credit card tips.
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