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Do Credit Cards Really Reduce Aggregate Money Holdings?

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Abstract This paper discusses whether the use of credit cards reduces aggregate money holdings in an economy. Applying and modifying the Baumol-Tobin model (Baumol Quarterly Journal of Economics 66:545–556, 1952 and Tobin Review of Economics and Statistics 38(3):241–247, 1956), it studies how much money a credit card bank would normally maintain to support retail trade, and shows that whether or not the use of credit cards actually reduces the aggregate demand for money depends on how often consumers visit the bank and how long it takes to clear a check. With innovations in the banking industry such as ATMs, online banking, and other electric funds transfer services, the cost of visiting banks (i.e., switching funds between a checkable account and an interest-earning account) is now very low. For the whole economy, as a result, the use of credit cards may not necessarily reduce aggregate money holdings.

Keywords Aggregate money holdings · Credit card

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Introduction

As the number of non-cash transactions moves more and more toward electronic forms of payment, it becomes more important to understand the impact that these

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media have on the economy. In 21 years, from 1979 to 2000, the percentage of non-cash transactions made with checks fell by 26.2 percentage points (Gerdes and Walton 2002). From 1983 to 1995 there was a 179% real increase in credit card borrowing (King 2004). These statistics confirm that changes in the ways households make purchases have been occurring in the economy. Given the magnitudes of these changes, we need to ask how the new payment methods impact our understanding of money demand and money creation process.

Akhand and Milbourne (1986) have investigated how growth in the use of credit cards affects aggregate household money holdings. With credit cards as a means of deferring payment, indeed, households may make payments to credit card banks periodically and hence hold less money on a regular basis. Certainly, this has been shown to be true for individual households (Duca and Whitesell 1995; King 2004). On the other hand, however, credit card banks must make payments to merchants constantly on behalf of cardholders. Hence, credit card banks need to maintain a certain level of money for this purpose.

This paper attempts to examine whether, and how much, the use of credit cards really reduces the aggregate demand for money in an economy. We develop a modified Baumol-Tobin model (Baumol 1952, and Tobin 1956) to study how much money a credit card bank would normally maintain. Aggregate money demand has two components: money holdings by households and money holdings by credit card banks. We show that whether or not the use of credit cards reduces the aggregate demand for money depends on how often consumers visit the bank and how long it takes to clear a check. With innovations in the banking industry such as ATMs, online banks, and other automatic funds transfer services, the cost of "visiting the bank" (i.e., switching funds between a checkable account and an interest-earning account) is very low. For the whole economy, therefore, the use of credit cards may not really reduce aggregate money holdings as the previous studies suggested.

The rest of the paper is organized as follows. The next section briefly discusses the concept of money and points out that credit card banks do demand money to support retail transactions, but they do not create money. Then a section which examines household money holdings with and without credit cards is presented. Then, the money holdings of a credit-card bank is analyzed. Then the next section compares aggregate money holdings with and without credit cards. The section after that considers some of the institutional aspects of the credit card bank. The last section concludes the paper.

Credit Cards and Money

A credit card (service) is a means of deferring payment (Mankiw 2006, p.231). At the time of the transaction, a credit card holder does not have to have any money in either her own account or in an account at her credit card bank. Instead, the credit card bank makes payment with its own money immediately on behalf of its cardholders. Alternatively, one can imagine that the credit card bank has purchased the goods or services and loaned them to its cardholders. Later, the cardholder repays the credit card bill. As a constant big buyer, therefore, a credit card bank must hold money on a regular basis.

Table 1 Balance sheet of a credit card bank

Assets	Liabilities
Reserves	Short-term debt instruments
Credit Card Loans	

Table 1 shows a simplified balance sheet for a credit card company. Normally a credit card bank issues short-term debt or securitizes its receivables (the source of funds) to provide short-term credit (the use of funds) in order to support retail trade. Hence, the credit card bank's assets primarily consist of reserves and credit card loans. For ease, assume a pure credit card company deposits its reserves in a checkable account with another commercial bank, while for a bank-holding company that also runs a credit card business, the reserves may be deposited in an account in its own commercial bank division. Clearly, the reserves regularly maintained to support retail transactions are money held by credit card companies, while the outstanding credit card loans are not money.

Unlike commercial banks, a credit card bank does not create money. When the reserves of a credit card bank are deposited in a checkable account with a commercial bank, additional money may be created in the banking system. However, it is because of the function of the commercial bank and not because of the credit card service itself that the money is created. Hence, credit card banks demand, but do not supply money.

Consider an example of how the daily activities of the credit card bank might proceed. On its first day of operation, the credit card bank has issued lines of credit but in reality will not receive payment for 30-45 days.[1] For ease of discussion, let's assume that the credit card bank will receive its first payment 3 days after opening and that card acceptors (merchants) expect payment the day after the transaction takes place.[2] Credit card holders may begin making transactions using their cards as soon as the lines of credit are issued and therefore make charges on day one. Thus, card acceptors will expect payment on day 2, before the credit card bank receives its first payments. We can assume that the credit card bank starts with some reserves, but due to uncertainty about payouts, these reserves may not be enough to cover the payouts required. In this case, the credit card bank will have to issue a short-term debt instrument to cover the payouts. This could be achieved by issuing commercial paper or by securitizing the credit card receivables. The credit card bank pays the card acceptors on day 2, and can pay back the loan it received by issuing the short-term debt on day 3 when payments are received. Thus the credit card bank does not create money, it spends its reserves (just as a consumer would if she had paid with cash or check) either before or after accumulating the reserves.[3]

[1] Credit card billing cycles are generally about one month with a due date approximately 15 days after the end of the cycle.

[2] In reality there is a great deal of variability in the number of days it takes for a merchant to receive payment from the credit card bank but between 1 and 7 days would not be unreasonable.

[3] Special thanks to Joe Evans, President and CEO, United Bankers, LLC for insight into this process.

The remaining question is how much money do credit card banks need to hold in order to support their cardholders' transactions? From the balance sheet, we can see that a credit card bank has to make payments on behalf of its cardholders for their daily spending. On the other hand, everyday is a due date for some cardholders to repay their credit card bills, in full or in part. On average, cash in-flows and out-flows may offset each other if the spending is at a flat rate and the repayment is in full. As a result, the money holdings by a (profit-maximizing) credit card bank should be minimized subject to liquidity management. The section after next develops a model to formally analyze how much money a credit card bank would normally hold and hence to examine how the introduction of credit cards affects aggregate money holdings.

Money Holdings by Consumers With and Without Credit Cards

The framework employed in the analysis of money holdings by consumers is the Baumol-Tobin model (Baumol 1952; Tobin 1956). It is assumed that all consumers have a planned expenditure of C per period at a flat rate [4] and that they all receive paychecks at the beginning of each period.[5]

Aggregate Money Holdings Without Credit Cards

Assume that a consumer visits the bank (i.e., either withdraws cash or switches between an interest earning account and checkable account) N times per period.[6] The total length of a period is normalized to one, and the total mass of consumers is denoted D. Thus, a consumer's money holdings at time $t \in [0, 1]$ is given by:

$$m^{NC}(t) = \begin{cases} (\frac{1}{N} - t)C & t \in [0, \frac{1}{N}) \\ (\frac{2}{N} - t)C & t \in [\frac{1}{N}, \frac{2}{N}) \\ \ldots\ldots & \\ (\frac{k}{N} - t)\,C, \quad \text{for} & t \in [\frac{k-1}{N}, \frac{k}{N}) \\ \ldots\ldots & \\ (\frac{N}{N} - t)C & t \in [\frac{N-1}{N}, 1) \end{cases}$$

[4] The homogeneity in consumers' spending is not essential in the analysis, and it can be readily shown that heterogeneity in consumers' spending does not change the outcome.

[5] In the real world, most employers pay their employees monthly or biweekly at the end of the period which can also be interpreted as the beginning of the next period.

[6] Akhand and Milbourne (1986) studied the determination of the optimal N, taking the interest rate of bonds and switching cost as the parameters. We treat N as an exogenous variable here, since our focus is on aggregate money holdings, including those held by credit card banks. Nonetheless, the current innovation in banking service makes the switching cost almost negligible.

The superscript NC stands for "No credit cards". Hence, the average aggregate money holdings, M^{NC}, over the period are

$$\begin{aligned} \mathrm{M}^{\mathrm{NC}} &= \mathrm{D}\int_0^1 m^{NC}(t)\,dt = \mathrm{D}\,[\sum_{k=1}^{N}\int_{(k-1)/N}^{k/N} C\,(\frac{k}{N}-t\,)\,dt] \\ &= \mathrm{DC}\{\sum_{k=1}^{N}[\frac{k}{N}-\frac{1}{2}\,(\frac{k}{N}+\frac{k-1}{N})]\,(\frac{k}{N}-\frac{k-1}{N})\} \\ &= \frac{1}{2N}DC \end{aligned} \tag{1}$$

Proposition 1 (Baumol and Tobin) Without credit cards being introduced, average household money holdings are proportional to total expenditure and inversely related to the number of visits to the bank.

This is the standard outcome for average money holdings by consumers in the Baumol-Tobin model without using credit cards. As a benchmark, we will compare it with aggregate money holdings when credit cards are used.

Aggregate Household Money Holdings With Credit Cards

Though all consumers receive paychecks in the beginning of a period, the due date for individual consumers to pay their credit card bills differs. We label a consumer by her due date to repay her credit card bill, i.e., $x \in [0, 1]$. Assume that $x \sim f(x)$ with $\int_0^1 f(x)\,dx = \mathrm{D}$. Then, $f(x)/D$ is a density function. Let $F(t) = \frac{1}{D}\int_0^t f(x)\,dx$ be the corresponding distribution function. It implies that $\int_0^t f(x)\,dx = \mathrm{DF(t)}$.

If using credit cards in all transactions, consumer x does not need to hold any money except for a very short period of time τ right before the due date x when repaying the credit card bill. Then, consumer x's money holdings at time t is given by:

$$\mathrm{m}^{\mathrm{CC}}(\mathrm{t;x}) = \begin{cases} \mathrm{C, \ if \ t} \in [\mathrm{x}-\tau, \mathrm{x}]; \\ 0, \ \mathrm{if \ t} \notin [\mathrm{x}-\tau, \mathrm{x}], \end{cases}$$

where the superscript CC indicates the money holdings by consumers who use credit cards exclusively to pay for transactions. Then, the average aggregate money holdings of those consumers are:

$$\begin{aligned} \mathrm{M}^{\mathrm{CC}} &= \int_0^1\int_0^1 m^{CC}(\,t;\ x\,)f(x)\,dtdx = \int_0^1 (\int_{x-\tau}^{x} C\,dt)f(x)\,dx \\ &= \tau\,C\int_0^1 f(x)dx = \tau\,\mathrm{CD} \end{aligned} \tag{2}$$

Proposition 2 With the credit card being used exclusively for payment, average household money holdings are proportional to total expenditure and the time needed to clear checks.

This outcome is very intuitive. In order to pay the credit card bank, each credit cardholder only needs to put enough money to cover the credit card bill into her account for a few days around the due date of the bill. For all credit cardholders, the higher the total spending, the more money is needed for transactions, on average. The quicker a check clears, the less (fraction of) time a consumer needs to hold money. Hence, the lower average money holdings.

Comparing (2) with (1), we can see that the introduction of credit cards may indeed lower household money holdings. In practice, it would normally take 3 to 5 days to have a check clear, namely, τ is from 1/10 to 1/6 of a month. Note that $N \geq 1$. Thus, average household money holdings would be lower with credit cards used than otherwise.

It is worth noting that consumption spending by consumers in our model is given exogenously as in the standard Baumol-Tobin model. A possible critique could be that the use of a credit card could in and of itself increase spending by a household. Though it is an interesting empirical question, we justify our assumption of exogenous consumption spending with Friedman's (1956) permanent income hypothesis (PIH). Indeed, credit cards provide consumers with convenience in making payments as well as in getting instant loans. As a result, they may help consumers carry less money and also smooth their consumption over time. However, spending is primarily determined by a household's permanent income which a credit card *per se* cannot improve. Therefore, it is plausible to treat consumption spending as a parameter that is independent of the use of credit cards.

Money Holdings by Credit Card Banks

While consumers with credit cards only have to hold money for a few days around the due date of the credit card bill, credit card banks must constantly retain a certain level of reserves to support retail trade. This is because credit card banks need to pay merchants shortly after the transaction takes place even though consumers may defer payment by repaying their credit card banks periodically.

As shown in Table 1, the credit card bank's primary source of funds comes from selling debt instruments in the financial market. The main use of these funds is to provide short-term credit to support cardholders' retail trade by maintaining a certain pool of reserves every day. Assuming that consumers spend at a constant rate and a fraction, α ($\in [0, 1]$), of credit card bills are paid on the due date, then over a time interval of dt, reserves, R(t), have an out-flow of DCdt on the one hand and an in-flow at a rate of αCf(t)dt from the repayment by cardholders on the other hand. When the credit card bills are not repaid in full, the credit card bank has to issue additional commercial papers to make up the difference. Hence, the rate of change in R(t) can be described in the following differential equation:

$$\frac{dR(t)}{dt} = -\mathrm{DC} + \alpha\,\mathrm{Cf(t)} + (1-\alpha)\mathrm{DC} \tag{3}$$

From (3), we have the balance of reserves at time t as follows:

$$\mathrm{R(t)} = -\mathrm{DC\,t} + \alpha\,\mathrm{CDF(t)} + (1-\alpha)\mathrm{DCt} + \mathrm{R_0} \tag{4}$$

where R_0 is the initial balance of reserves and $DF(t) = \int_0^t f(x)\,dx$. Thus, we can derive the average reserve balance as follows:

$$\begin{aligned}\overline{R} &= \int_0^1 R(t)\,dt \\ &= \int_0^1 [-DC\,t + \alpha\,CD\,F(t) + (1-\alpha)\,DC\,t]\,dt + R_0 \\ &= \alpha\,CD \int_0^1 [F(t) - t]\,dt + R_0\end{aligned} \tag{5}$$

Recall that the distribution function F describes when a cardholder's due date is. It is plausible to assume that F follows, or at least, is very close to, the uniform distribution on [0, 1]. Let's first look at the case that F follows the *uniform* distribution on interval [0, 1]. Then, $F(t) = \int_0^t \frac{1}{D} f(x)\,dx = t$ for $t \in [0, 1]$. From (5), we have:

$$\overline{R} = \int_0^1 R(t)\,dt = R_0 \tag{6}$$

Intuitively, a credit card bank makes payments daily to cover the spending of its cardholders (cash outflow). These payments may be covered, on average, by the payments of cardholders if credit card bills are paid in full (cash inflow). If only a fraction of the bills are paid, however, the credit card bank's reserves would fall unless the difference between the repayment and payouts is made up from newly raised funds from issuing more commercial papers. Hence, in either case (i.e., whether α is equal to or less than 1) the average reserve balance would remain constant at the initial reserve balance, as long as the due dates to repay credit card bills are evenly arranged. This can be justified by the fact that the due date is usually set when the application is received and processed, which should follow the uniform distribution very closely.

Proposition 3 Assume that spending occurs at a constant rate and the due dates for cardholders to repay credit card bills are uniformly distributed.

(a) If all credit card bills are fully paid on the due date, then average reserves are maintained at their initial value.
(b) If only a fraction of credit card bills are paid on the due date, then the credit card bank must issue additional debt to cover the unpaid bills and to keep average reserves constant at their initial value.

Though it is plausible to assume that the due dates follow approximately the uniform distribution, some other random factors may make the distribution not so even. For example, even if a potential cardholder may at random send in her or his application for the credit card, the time needed for the credit card bank to receive the application in the mail or for the application to be processed may make the due dates not exactly uniformly distributed. In that case, it may be more realistic to assume that the due dates follow a mean-preserving spread (Rothschild and Stiglitz 1970, 1971) of the uniform distribution, i.e., there is an additional degree of noise to the uniform distribution. Rothschild and Stiglitz showed that the mean-preserving spread of a distribution is second-order stochastically dominated by the (original) distribution. Applied to the case here, the due date's distribution F is second-order stochastically dominated by the uniform distribution, U(t) = t, for t ∈ [0, 1]. By definition, this means

$$\int_0^x F(t)\,dt \geq \int_0^x U(t)\,dt = \int_0^x t\,dt, \quad \text{for all x} \in [0, 1] \tag{7}$$

From (5) and (7), we have:

$$\overline{R} = \alpha\, CD \int_0^1 [F(t) - t]\; dt + \mathrm{R}_0 \geq \mathrm{R}_0 \tag{8}$$

Intuitively, when the due dates are not so uniformly distributed, a credit card bank needs to maintain more reserves on average because of the extra fluctuation in repayment flow.

In theory, the initial value R_0 is arbitrary in Eq. 5; it may be any nonnegative value, including zero. Thus, a profit-maximizing credit card bank would set it as low as possible, subject to liquidity management. However, in the credit card business liquidity management is not very costly, because it is always profitable for a credit card company to have either more spending by cardholders (from fees as income for credit card banks) or more carry-over credit card loans (from the gap in interest rates between credit card loans and short-term debt). What is more, a credit card bank may simply tell a merchant that "the check is in the mail" while issuing more commercial papers or getting short-term loans to maintain its balance of reserves. Nevertheless, it must keep enough reserves when checks are written and sent. Assume that the same fraction of time,τ, is needed for the check-clearing process from a credit card bank to a merchant. Then, the average money holdings of credit card banks should be given by

$$\mathrm{M}^{\mathrm{CB}} \geq \mathrm{R}_0 = \int_0^1 \int_0^1 \tau\, Cf(x)\, dxdt = \tau\, \mathrm{C\,D} \tag{9}$$

where the superscript CB stands for credit card banks.

Proposition 4 The average money holdings of credit card banks are, at least, the same as those of their cardholders.

It is interesting that the money holdings of credit card banks and aggregate household money holdings by cardholders are the same. Intuitively, though a credit card bank allows its cardholders to make payment periodically, it has to smooth out its regular payment to merchants. So, a cardholder may only need to hold money over a fraction of time when writing a check, but her credit card bank has to constantly maintain a regular balance of reserves to make payment on behalf of all cardholders. The total amount of payment should be, not surprisingly, determined by the total spending of all cardholders. The (same) fraction of time interval τ for both consumers and credit card banks is determined by the time needed to clear a check. Figure 1 illustrates this point.

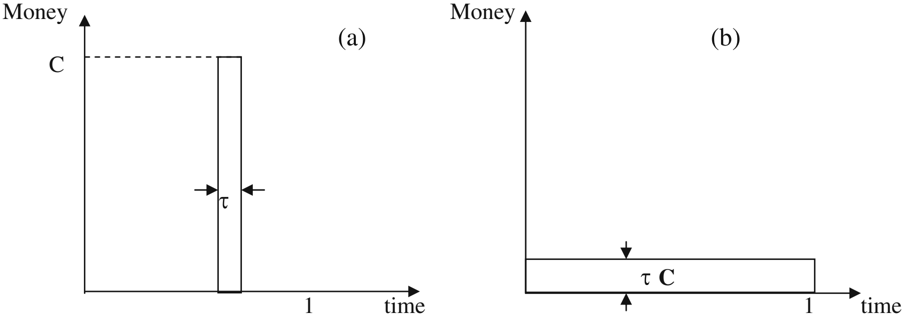

Fig. 1 Money holdings by a cardholder (**a**) and by credit card bank (**b**)

Do Credit Cards Really Reduce Aggregate Money Holdings?

Combining (2) and (9), we can obtain that the aggregate money holdings of consumers and credit card banks are:

$$M^{CC} + M^{CB} \geq 2\tau CD \tag{10}$$

From inequality (10), we see that the aggregate money holdings in an economy with credit cards are determined by aggregate spending and the check-clearing process.

Now, we are ready to compare the aggregate money holdings in an economy with and without credit cards. From (1) and (10), it is equivalent to compare 1/(2 N) with 2τ. Obviously, it depends on how often a consumer visits the bank (N) and how long it takes for a check to be clear (τ). Note that it has been a long-time practice to take 3 to 5 days to clear a check. Namely, $\tau \in [1/10, 1/6]$ out of a month. On the other hand, innovation in banking services since the credit card was introduced also allows consumers to visit banks at a much lower cost and hence N increases, say, $N \geq 2$ per month. Hence, from a macroeconomic perspective, we have the following proposition.

Proposition 5 Though the popularity of using credit cards may reduce household money holdings, aggregate money holdings will not necessarily decrease unless the check-clearing process can be significantly shortened.

Linking to the classical Cambridge money equation ($M^D = kPY$) and the quantity equation of money ($MV = PY$), Proposition 5 immediately implies the following (testable) implications:

Proposition 6 The introduction and popularity of credit cards will not affect the velocity of money unless the time needed to clear checks can be significantly shortened.

An empirical issue is whether and what fraction of consumers actually uses credit cards regularly to make payments. Evidence from *The* 2007 *Federal Reserve Payments Study* shows that the volume and value of transactions paid with checks and debit cards exceeds the volume and value of transactions made with credit cards. Hence, a more realistic version of aggregate money holdings should reflect such a mixed pattern. Assume that a fraction, λ, of consumers use credit cards, while the rest of consumers use cash, checks or debit cards. Then, the above analysis shows that aggregate money holdings should be given by:

$$M = [2\lambda\tau + (1-\lambda)/2N]\,C\,D \qquad (11)$$

From (11) we can see that aggregate money holdings, and hence the velocity of money, would change either because the time needed to clear checks can be shortened, or because it is more convenient to visit banks, i.e., to switch between money and interest bearing assets.

Institutional Evidence

Credit card banks do not make loans in the same way as commercial banks. Instead of using consumer deposits to fund their lending, they borrow in financial markets to raise the funds with which to pay acceptors (merchants) for the goods and services that cardholders have already taken home. Lang, *et al* (2008) find that around 60% of credit card loans are funded through securitization, although this activity is concentrated almost exclusively amongst the largest credit card issuers. From March 31, 2004 to September 31, 2006 the average monthly amount of credit card loans that was securitized and sold was $405.5 billion based on data from the FDIC Quarterly Banking Profile, and Bank of America directly discusses card securitization in its annual report (2004) as a means of financing credit card lines of credit.[7] Another funding option is for credit card banks to issue commercial paper. This option is detailed along with its namesake in Credit Card Securitization Manual published by the FDIC. In either case, the credit card bank is not creating money when it makes loans to its credit cardholders. Instead an asset is created and money is redistributed from the saver to the borrower. As no new deposits are created, the money creation multiplier will not go into effect and no new money will be created in the economy. This evidence supports the theoretical results from above.

Concluding Remark

This paper attempts to show that though the introduction of credit cards may reduce household money holdings (Akhand and Milbourne 1986), it will not lower aggregate money holdings in an economy when the money demand from credit card banks is included, unless the check-clearing process can be significantly shortened. It also articulates that credit card banks do not create money as commercial banks do. Hence, the introduction and popularity of credit cards can not affect either the aggregate demand for, or the supply of, money. An empirical implication is that the popularity of credit cards should not affect money velocity.

[7] For an example of credit card securitization, see the Credit Card Securitization Manual published by the FDIC and available online at http://www.fdic.gov/regulations/examinations/credit_card_securitization/ch3.html.

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