OFF-BALANCE-SHEET LIQUIDITY
AND MONETARY CONTROL

by
Reuven Glick
Steven E. Plaut
RESEARCH PROGRAM IN FINANCE AT THE
WALTER A. HAAS SCHOOL OF BUSINESS,
UNIVERSITY OF CALIFORNIA, BERKELEY

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and Monetary Control

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Reuven Glick
Federal Reserve Bank of San Francisco

Steven E. Plaut
University of California at Berkeley

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I. Introduction

One of the most dramatic recent developments in financial markets has been the rapid growth in off-balance-sheet credit facilities provided by financial institutions. Today the bulk of commercial bank lending, and much agricultural, land development, and even consumer lending takes place "under commitment" through loan contracts of one form or another. The increasing role of these facilities has important implications for the structure of credit markets, the stability and risk exposure of financial institutions, and the operation of monetary policy.

Until now most of the research on these credit facilities has concentrated on issues of pricing and contract structure. Recent contributions include Campbell (1978), Thakor (1982), Thakor, Hong and Greenbaum (1981), Melnik and Plaut (1986a, 1986b), and Ham and Melnik (1988). An important role of credit facilities is to provide liquidity, supplementing "ordinary" transactions account balances. The implications of this form of "substitute-money" for monetary policy have received little attention.

In this paper we will analyze the effects of off-balance-sheet liquidity on monetary control, that is, on the effectiveness of monetary policy. It will be shown that off-balance-sheet liquidity in the form of credit facilities creates an alternative and in some sense a "competing" form of liquidity that can be used by the private sector to undo the effects of monetary policy changes. The result is then a loss in control over interest rates and real activity by the monetary authorities under a broad set of circumstances. The growth in credit facilities might thus explain part of the apparent trend toward rising interest rate volatility in recent decades.

The potential ineffectiveness of monetary policy arises in this paper from the creation of an alternative form of liquidity produced through private sector
contracting. This is somewhat similar to the question of monetary stability that is central to much of the long-running debate over "free banking." Recent work that has reviewed this debate and contributed new insights includes King (1983), Klein (1984), Rolnick and Weber (1983), Selgin (1987), Selgin and White (1987), and White (1984). This literature has shown that — at least theoretically — private sector production of "money" in the form of fiat currency can lead to financial instability and loss of control over market prices and quantities by monetary authorities. We shall argue that private sector production of off-balance-sheet liquidity can do the same.

The analysis of markets where "money" or liquidity take alternative forms has been undertaken in other contexts. In Santomero's paper (1979), for example, cash and transactions balances both produce liquidity, but in different ways and with different pricing mechanisms. The growing literature on currency substitution has explored the implications of a transactions role for foreign currencies. In our model "money" and credit facilities similarly coexist as alternative forms of liquidity, each priced differently, each held for transaction purposes.

A related body of work focuses on how monetary changes are transmitted to the real sector through changes in interest rates and credit availability. The role of credit rationing has received renewed attention following the pioneering work by Jaffee and Modigliani (1969) and Jaffee and Russell (1976), and the more recent important contribution by Stiglitz and Weiss (1981). Blinder (1987) and Blinder and Stiglitz (1983) have analyzed the workings of monetary policy when rationing occurs. Bernanke (1986); King (1986); Soflanos, Wachtel, and Melnik (1987); and Wojnilower (1980, 1985) have provided empirical analyses of the transmission channels of monetary policy.

As discussed later in this paper, credit facilities provide the main banking institutional arrangement through which many types of credit are allocated to
the private sector. Monetary changes may induce changes in the demand for credit by agents who have previously signed contracts establishing facilities. When pushed to a contract limit, borrowers are "rationed" out of the credit market.\(^1\) Below we will argue that monetary policy becomes potent only when agents are rationed by credit ceilings, and otherwise loses its effectiveness when credit facility liquidity may be used to supplement transaction account balances. These results are obtained by incorporating credit facilities into a model of a transactions demand for liquidity.

The plan of the paper is as follows. In Section II we review the growth and operation of credit facilities. In Section III we describe the mechanism of payments through credit line facilities. In Section IV we describe the assumptions that form the basis of the model. In Section V we describe the equilibrium pricing processes in the model. In Section VI and VII we analyze monetary policy effectiveness in the short and long run, respectively. We end the paper with a discussion of policy implications and conclusions.

II. The Growth of Off-Balance-Sheet Credit Facilities

Off-balance-sheet credit facilities provide a source of liquidity for making transactions that supplement the ordinary transactions account balances held by households and firms at banks and other depository institutions. They provide funds on short or no notice that can be used to finance transactions, generally as conveniently as writing checks or using cash.

Off-balance-sheet credit facilities have been used to finance transactions for a long time. Many stores and firms traditionally sold goods on credit by "keeping books" on household and other business customers.\(^2\) In recent decades supplier credit has been largely (but not completely) replaced by credit facilities provided by financial institutions that extend liquidity at customer discretion.
Credit facilities take many forms, including loan commitment contracts, revolving underwriting and credit facilities, note-issuing facilities, credit cards, and, most recently, home-equity lines of credit.

Off-balance-sheet credit facilities have grown rapidly in recent years. Today they are the most common institutional form for continuing bank-customer relationships in the United States. A significant fraction of all bank credit is advanced under commitment through facilities. Seventy-nine percent of commercial and industrial loans are made under commitments; the proportion is even higher for large banks (about 88 percent). Eighty-seven percent of construction and land development loans are made under commitments (94 percent for large banks). For farm loans, forty seven percent are made under commitments (79 percent for those advanced by large banks). Continuing credit facilities in the form of credit cards and lines of credit are important sources of funds for consumer loans as well. Investment banks and brokerage houses often offer credit to customers under arrangements somewhat like commercial bank credit facilities.

The growth of off-balance-sheet facilities also has been dramatic outside the United States. In the Euromarket credit advanced under note-issuing facilities (NIFs) has grown from $1 billion in 1981 to $69 billion in 1986. This off-balance-sheet credit has largely displaced syndicated Eurobank loans, which fell by $72 billion over the same period.

Off-balance-sheet credit facilities of all types generally have several characteristics in common. They establish maximum credit ceilings, which either may not be exceeded by the customer or may be exceeded only at substantial penalty. They are continuing medium- or long-term arrangements, often extending over several years. They often employ multiple-pricing components, including an interest charge and facility fees of one sort or another. Floating interest rates are
used in many facilities, including most loan commitments and NIFs, and some credit cards and consumer credit lines. Facility fees are sometimes specified as a fixed amount, sometimes assessed on the total credit commitment, and other times assessed on unutilized funds. We will incorporate these features in the formal model below.

III. The Mechanics of Payments through Credit Facilities

Credit lines entitle the customer to utilize additional funds besides demand deposit balances in order to make payments. Technically when funds are drawn down under a credit line, they are credited to the customer's transaction account and are then used to complete transactions. The technology of credit line payments is illustrated in Figure 1.

In this example firm 1 buys an asset costing N dollars from firm 2. In the first step, firm 1 takes down N dollars under its credit facility and the bank credits its transaction account by an equivalent amount.

If firm 2 uses its extra funds to reduce the outstanding balance under its own credit line (as illustrated in Figure 1), then -- taking the two firms in aggregate -- the "firm sector" balance sheet is left unchanged. Note that without any net change in demand deposit balances, the required reserve level of the banking sector remains unchanged as well.

Alternatively, firm 2 (or firm 1) could use the extra funds utilized under credit lines in order to acquire some "outside" asset, i.e., an asset obtained from an agent outside the firm sector, such as new issues of government bonds. In this case the aggregate takedown value would not be restored to its original level, and the "outside" asset entry on the firm's balance sheet would rise by the corresponding amount. As in the previous case, once the "transaction" is completed (in this case the "transaction" being the purchase of the "outside"
Figure 1

<table>
<thead>
<tr>
<th></th>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Firm 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1st step</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transaction Account</td>
<td>+N</td>
<td>Takedown under +N Credit Line</td>
</tr>
<tr>
<td><strong>2nd step</strong></td>
<td>-N</td>
<td></td>
</tr>
<tr>
<td><strong>2nd step</strong></td>
<td>+N</td>
<td></td>
</tr>
<tr>
<td><strong>Firm 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2nd step</strong></td>
<td>+N</td>
<td>Takedown under -N Credit Line</td>
</tr>
<tr>
<td><strong>3rd step</strong></td>
<td>-N</td>
<td></td>
</tr>
<tr>
<td><strong>2nd step</strong></td>
<td>-N</td>
<td></td>
</tr>
</tbody>
</table>

Only if firms utilize their credit lines in order to add funds to transaction accounts and leave them there would the required reserve level of banks rise permanently. This could be illustrated if firm 2 had decided to retain the extra N dollars in its transaction account. Total aggregate transaction balances would then rise. Assuming that banks were originally holding no excess reserves, some asset or credit contraction would then have to occur to reduce total transaction balances, restoring them to the level corresponding with the initial bank reserve level. In reality firms have no motivation to utilize credit lines just to add balances to deposit transaction accounts and leave them there as “liquidity.”
This is because credit lines already provide liquidity and there is no point in exercising them and paying for a takedown until the funds are actually needed for transactions.

A takedown that is undertaken immediately before a transaction and that is offset immediately after the transaction necessitates additional reserve holdings for banks only for the interim period. If this interim is quite short, then the change in required bank reserves is small. For example, if funds are utilized in the morning to conduct transactions, and are repaid before closing time, no net change in reserves is required.\(^6\) The same conclusion would hold if any increment to transaction balances stemming from credit line utilization were taken off the books of banks at closing times through repurchase agreements or through same-day securitization (i.e. sale) of the loan advanced under the credit line. In addition, no reserve costs would be borne by those financial institutions granting credit through facilities that are exempt from reserve requirements, such as off-shore banks and investment banks.

Currently bank reserves in the United States are assessed on two-week averages. In the model below, the interim period between takedown and repayment following a transaction will be either intraday or "small" relative to such a two-week computation period, and so no change in the required level of reserves will occur whenever takedowns temporarily supplement money balances. The points in time before and after transactions payments (periods 1 and 2 in the model below) will be deemed sufficiently close to one another so that bank reserve requirements do not change during the interim.\(^7\) While the assumption simplifies the presentation, all conclusions below hold even when credit line utilization does impose extra reserve costs on the bank sector. In Section VIII we will discuss what happens when this assumption of no reserve costs is relaxed.
In reality credit facilities serve both as a source for liquidity and as a source for short or medium-term credit used in liability management by firms. For purposes of expediting the presentation, in our model takedowns under credit lines will serve only the former function, and will arise only when transaction considerations dictate. Therefore, before transactions-related liquidity needs arise, credit utilization is assumed to be zero.

IV. The Setup of the Model

The key assumptions of our model are:

1. A large number of homogeneous corporations are held by stockholders who maximize an intertemporal utility function of corporate income. Corporations hold all bank deposits and also all bank lines of credit. Money and lines of credit are held for the purpose of completing transactions that generate revenue. They are perfectly substitutable in a transactions capacity, although they are priced differently. There is an exogenous probability of default on debt by firms. Firms may not issue debt other than through bank loans.

2. Banks are pure intermediaries with zero operation costs. They offer only one kind of liability, transaction deposits, all held by corporate customers. Transaction balances are swapped among firms in order to clear accounts through the usual payments mechanism. Transaction balances deposited by firms are backed by reserves. Reserves and transaction balances earn zero interest. Bank equity is constant for the duration of the model and, without loss of generality, will be set equal to zero. Bank managers are risk neutral. For the duration of the model, no entrance nor exit of banks occurs, including bank bankruptcy.

3. Banks hold two kinds of assets besides reserves. First, they hold claims on firms for funds utilized under credit line facilities. Second, banks hold
other financial market assets, earning the going market rate. Lines of credit are provided by banks on a competitive basis. They are priced with two components: a facility fee charged on funds not used and a contingent market-based floating interest rate for funds utilized. Banks are not required to hold reserves against unused lines of credit.

The initial combined balance sheet of the banking sector (at time 0) is shown in the left panel of Figure 2. Banks offer transaction deposit accounts, whose initial balance, denoted by M, arises from the deposits by firms. M will be referred to as “money”. Banks hold reserves R against these accounts in the amount of αM, 0 < α < 1. On the asset side of their balance sheet, banks also hold takedowns under loan commitments and other financial assets, the initial amounts outstanding being 0 and A_B, respectively. Bank equity is assumed to be zero.

**Figure 2**

<table>
<thead>
<tr>
<th>Banks - Time 0</th>
<th></th>
<th>Banks - Time 1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Assets</td>
<td></td>
<td>Liabilities</td>
<td></td>
</tr>
<tr>
<td>Reserve Accounts</td>
<td>R</td>
<td>Transaction Accounts</td>
<td>M</td>
</tr>
<tr>
<td>Takedowns under Credit Lines</td>
<td>0</td>
<td>Equity</td>
<td>0</td>
</tr>
<tr>
<td>Other Financial Assets</td>
<td>A_B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assets</td>
<td></td>
<td>Liabilities</td>
<td></td>
</tr>
<tr>
<td>Reserve Accounts</td>
<td>R</td>
<td>Transaction Account</td>
<td>M + T</td>
</tr>
<tr>
<td>Takedowns under Credit Lines</td>
<td>+ T</td>
<td>Equity</td>
<td>0</td>
</tr>
<tr>
<td>Other Financial Assets</td>
<td>A_B</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

When funds are utilized under credit lines immediately prior to transactions, a liability in amount T is created for firms, with 0 ≤ T ≤ LC. Funds are
advanced to the borrowers by crediting their transaction accounts, and they may then use these funds to perform transactions. At the same time, the banking sector's assets and liabilities both rise by T dollars. (See the right panel of Figure 2.) Once T has been added to the transactions account balance, it may be "spent" by the firm as easily as the original M balance.\textsuperscript{12} (As noted in the previous section, the presumption that funds obtained under credit lines are spent immediately and that subsequently transactions account balances are restored implies that bank reserve requirements are unaffected.\textsuperscript{13})

Off-balance-sheet items consist of loan commitments. These are obligations on the part of banks to provide funds on demand by a customer up to the maximum ceiling LC. The customer pays \( r_c \) for funds taken down under the commitment, and a facility fee of \( f \) on unused funds.\textsuperscript{14} The interest rate \( r_c \) is a contingent interest rate, based on prevailing market rates. For example, \( r_c \) could be indexed to the prime rate.

All customers are charged the same \( r_c \) and \( f \). They all have the same level of utilization in all states of nature. The total cost to the representative corporate borrower from using credit facilities is

\[
r_c T + f(LC-T) = (r_c-f) T + fLC, \tag{1}
\]

where \( T \) is the "takedown" or amount utilized under the facility. That is, there is a fixed component of cost, \( f \) \( LC \), for establishing the line and a marginal component, \( r_c-f \), charged for each dollar utilized.

While there is no risk associated with bank holdings of \( A_B \), there is default risk associated with loans under commitments. Specifically, there is a probability \( \psi \) that default on these loans will occur, in which case the bank receives neither principal nor interest in return.\textsuperscript{15} \( \psi \) is an exogenous variable, and does
not depend on interest rates, loan size, etc. Default is a "catastrophic" kind of event that involves zero profit for the borrower. It is not "chosen rationally" but just "happens." Default incidence is independent of transaction amounts or credit utilization.

The combined balance sheet of all firms at time 0 appears in the left panel of Figure 3. The firms have an initial liability to banks under credit facilities of zero. They hold all of bank deposit liabilities as their assets, and in addition hold other financial assets in the amount \( A_F \). The balancing item is corporate equity, \( E \). Takedowns through lines of credit raise the aggregate liabilities of the firms by \( T \). The firms' holdings of transaction account balances similarly rise by \( T \).

\begin{figure} 
\centering 
\begin{tabular}{|c|c|c|c|c|}
\hline 
Firms - Time 0 & Firms - Time 1 \\
\hline 
\multicolumn{2}{|c|}{Assets} & \multicolumn{2}{c|}{Liabilities} & \multicolumn{2}{c|}{Assets} & \multicolumn{2}{c|}{Liabilities} \\
\hline 
\multicolumn{2}{|c|}{Transaction Accounts} & M & Takedowns Under Credit Lines & 0 & Transaction Accounts & M + T & Takedowns Under Credit Lines + T \\
\multicolumn{2}{|c|}{Other Financial Assets} & A_F & Equity & E & Other Financial Assets & A_F & Equity & E \\
\hline 
\end{tabular} 
\caption{}
\end{figure}

We assume firms hold liquidity for the sole purpose of making transactions. All transactions must be made with liquidity, which can be obtained either through using existing demand deposit balances (money) or through using funds under credit lines. The volume of these transactions is chosen by the firms after the lines of credit have been established. The liquidity used to finance these
transactions consists of both M and T. Since the opportunity cost of using funds already in the transaction account is zero, these are used "first." Once this money is used up, funds obtained under the credit line are utilized for all additional transactions.

\(A_F\) and \(A_B\) are assumed to represent holdings of the same homogeneous market financial asset by firms and banks, respectively, so the expected return on both is identical, \(r_a\). That is, \(A_F\) and \(A_B\) are the dollar value of the principal invested in these assets by each set of agents. It is assumed that these assets are coupon bonds with no default risk and always sell at par. They may be thought of as government securities. All investors are price-takers in this market.

The outstanding amount of these bonds changes only through government policy, such as an open-market operation. The coupon rate, \(r_a\), is assumed to adjust to clear the market. Since all such bonds are held by either banks or firms, \(A_F + A_B = A^S\), where \(A^S\) is the aggregate supply of these bonds. The reserve level \(R = \dot{R}\) and hence the money supply, \(M^S = R/a\), are also exogenously determined by the government.

Note that since bank equity is assumed zero, the bank balance sheet constraint implies that \(A_B = (1 - a) \dot{M}^S\), and hence that bank bond holdings are determined by the money supply. The bond market equilibrium condition in turn implies \(A_F = A^S - (1 - a) \dot{M}^S\). Thus government policies with respect to the money supply (or, equivalently, the reserve ratio \(a\) and level \(R\)) and the total supply of bonds pin down the supply of bonds to firms as well.

V. Pricing of Bank Services and Financial Assets

The model has three distinct time points. At time 0 loan commitments are signed and cash balances are deposited with the bank. The loan commitment contract establishes \(LC\) and \(f\), but \(r_e\) is left undetermined, to be set by market
forces at time 1. At time 1 the total volume of transactions financed by liquidity, \( M + T \), is chosen in a manner to be described, \( r_a \) adjusts to clear the market, and \( r_c \) is determined. At time 2 all interest payments are made, all principal is returned, and the lines of credit are terminated. (See Figure 4.) All corporate decision are sequentially made at times 0 and 1; time 2 is the termination point.

![Figure 4](image)

\[
\begin{align*}
\text{LC} \quad \{ \text{Determined} \} \quad \varepsilon \text{ Revealed} \quad \{ \text{Determined} \} \quad \text{T Repaid} \\
\tilde{f} \quad T \quad r_a, r_c \quad \text{Interest Paid} \\
0 \quad 1 \quad 2 \quad \text{LC Ends}
\end{align*}
\]

(a) Bank Services

As noted above, \( A_B \) is simply a residual term that clears the balance sheets of banks, given \( M^S \) and \( R \), and so banks are "passive" in the financial asset market. Once credit lines are established, banks are also "passive" in terms of credit utilization. Firms may choose any quantity of \( T \) they wish, subject only to \( 0 \leq T \leq LC \). At time 0, bank customers negotiate the credit-line pricing component \( f \) as well as the credit limit \( LC \); \( r_c \) is then determined at time 1 on the basis of market conditions. Banks are risk neutral and perfectly competitive in providing credit lines.

At time 1 lines of credit are assumed to be priced so that the marginal payment to banks from takedowns (or \( r_c - f \), as in equation (1)) equals the marginal opportunity cost of obtaining funds for the borrower, or \( r_a \). If the former were greater than \( r_a \), customers would sell off financial assets \( A_F \) as an alternative to utilizing their credit lines. If \( r_c - f \) were less than \( r_a \), customers
would arbitrage by taking down funds and buying financial assets. Therefore in equilibrium \( r_a = r_c - f \).

Banks also bear an additional cost from lending under commitments due to the default risk assumed when takedowns are made. Banks recover this cost through the fixed facility fee \( f \) set at time 0. The expected net marginal profit to banks from offering lines of credit at time 0 is given by the difference between the expected facility revenue and the expected loss from corporate default:

\[(1 - \psi) f L C - \psi E_0 \{ T (1 + r_a) \}. \tag{2} \]

\( E_0 \) is the expected value operator conditional on information at time 0. In states of nature where default does not occur, the marginal revenue to the bank from utilization of credit lines equals the marginal opportunity cost from not holding \( A_B \), and so the "marginal profit" to the bank from utilization is zero. Therefore \( LC \) and \( f \) are based only on the default states of nature. Competition among banks ensures that (2) is set equal to zero. Banks can be considered to be always standing ready to offer corporate borrowers a menu of loan commitment facilities for which equation (2) is zero. Any pair of \( LC \) and \( f \) for which this is so are feasible market solutions.\(^{16}\)

Differentiating, we derive

\[
\frac{d f}{d LC} = \frac{\psi (1 + r_a^*) \text{Prob}(T = LC) - f}{1 - \psi \frac{LC}{LC}}. \tag{3}
\]

Here \( r_a^* \) is the expected value of \( r_a \) for those states of nature where \( LC \) is binding, and \( \text{Prob}(T = LC) \) is the probability of such states occurring.
The sign of (3) appears to be ambiguous. However, if borrowers always prefer smaller \( f \) and greater \( LC \), other things equal, then in fact the market will always equilibrate where \( df/dLC \) is positive. This is because if it were negative, Pareto superior \((LC, f)\) combinations would be feasible. Therefore, when \( LC \) rises, \( f \) rises. In effect, the "credit risk exposure" by banks increases when \( LC \) rises. In at least some states of nature takedowns will rise, some of which will be lost in default. To compensate, banks charge a higher \( f \).

(b) **Corporate Decisions**

Corporations make decisions at both time 0 and time 1 governing their investments and operations in order to maximize stockholder utility. At time 0, firms establish lines of credit and negotiate \( LC \) and \( f \) with banks. At time 1, firms decide how much of the exogenously given stockholder wealth, \( \tilde{W} \), to retain as equity and how much to pay out in dividends. The latter is denoted by \( \Pi_1 \). Since the total initial assets of the firms are \( E = M + A_F \), it follows that

\[
\Pi_1 = \tilde{W} - (M + A_F).
\]

(4)

At time 1 firms also choose the level of utilization of their credit facilities \( T \), such that \( 0 \leq T \leq LC \). The terminal value of the firm to stockholders at time 2, \( \Pi_2 \), is given by

\[
\Pi_2 = 0, \text{ when default occurs},^{17} \text{ and } \ni \Pi_2 = M + (1 + r_o) \ A_F - (r_c - f) \ T - f \ LC + P(\mathcal{X}, \varepsilon), \quad \text{(5)}
\]

when default does not occur. It depends on initial equity, capital income and costs stemming from the balance sheet and banking relationship, and also on
operating revenues and costs. The latter is expressed as $P(X, \varepsilon)$ where $X$ is some measure of current transactions undertaken by the firm and $\varepsilon$ is an exogenous random variable that is revealed after time 0. $P$ may be thought to be a simplified representation of a more complex function of operating revenues and costs where input and output transactions among firms are aggregated under the composite variable "transactions." The revenue $P$ is the net value added arising from these interfirm transactions.

$P$ will be zero for all cases where default occurs, the probability of which is $\psi$. For non-default states of nature, it is assumed that $P_x = \partial P/\partial X > 0$, meaning that -- at least in the range that will be relevant -- the operating profit of the firm is strictly increasing in $X$. We also assume that $P_{xx} = \partial^2 P/\partial X^2 < 0$ and that $P_{xe} > 0$. The last inequality says that an increase in the random variable $\varepsilon$ raises the marginal revenue that stems from an additional transaction of $\$1$.

The volume of transactions undertaken by the firm is limited by $X \leq M + T$. That is, transactions may occur only when sufficient liquidity exists, in the form of $M + T$. $T$, in turn, is of course constrained by $0 \leq T \leq LC$.

Firms seek to maximize the expected value of stockholder utility $U = U(\Pi_1, \Pi_2)$, where $\partial U/\partial \Pi_1 > 0$, $\partial U/\partial \Pi_2 > 0$, $\partial^2 U/\partial (\Pi_1)^2 < 0$, and $\partial^2 U/\partial (\Pi_2)^2 < 0$.

Firms optimize sequentially at times 0 and 1, with different instruments and different information, but with the same utility function. At time 0 they maximize $E_0[U]$ by choosing $LC$ (and $f$). At time 1, they choose $M$, $A_F$, and $T$ to maximize $U$, when $LC$ and $f$ are predetermined, and $\varepsilon$ has been revealed. We will examine the decision making of the firm and the consequent pricing process at the two time periods, 0 and 1. We begin the analysis with time 1.

At time 1, firms (i.e. firm stockholders) seek to adjust all portfolio items in order to maximize $U(\Pi_1, \Pi_2)$. $\Pi_1$ and $\Pi_2$ are defined in equations (4) and (5), respectively, subject to $X \leq M + T$ and $0 \leq T \leq LC$. Recalling that in market
equilibrium $r_a = r_c - f$, the first-order conditions for an optimum with respect to $A_F, M,$ and $T$ are\textsuperscript{19}

\[
\frac{\delta U}{\delta \Pi_1} = (1 + r_d)(1 - \psi) \frac{\delta U}{\delta \Pi_2},
\]  

(6)

and

\[
P_x(M + T, \varepsilon) = r_a \quad \text{for} \: T \leq LC,
\]  

(7)

or

\[
P_x(LC, \varepsilon) \geq r_a \quad \text{for} \: T = LC.
\]  

(7')

Second-order conditions may be shown to hold.\textsuperscript{20}

Equation (6) implies that the interest factor that clears the market, $1 + r_a$, must equal the risk-adjusted intertemporal marginal rate of substitution, that is, the rate at which stockholders agree to exchange current income for future income. Equation (7) says that whenever LC is not binding the firm will take down its credit line to the point where the marginal benefit of a dollar takedown just equals the interest rate charged. In cases where LC is binding, a corner solution will occur where $P_x \geq r_a$.

Equations (6) and (7) may be thought of as market-clearing equations that determine the interest rate $r_a$ and the level of total liquidity $M + T$ at time 1, for cases where LC is not binding. Equilibrium depends on the way in which firms allocate their portfolio between the level of total liquidity $M + T$ and net interest earning assets $A_F - T$, where $r_a(A_F - T)$ is the net interest income to firms from the latter. Note that these two portfolio "components" sum to initial firm equity: $(A_F - T) + (M + T) = E$. As long as both "components" remain unchanged, then liquidity, transactions volume, and net interest income remain unchanged.

In order for equilibrium to hold, the demand for the stocks of money and financial assets must equal their exogenous outstanding supplies, and firms must
satisfy their equity constraints. As noted in Section IV, the money supply held by firms $M^S$ is exogenously determined by the government. The supply of bonds to firms is the total amount minus holdings by banks, $A^S = (1-\alpha)M^S$. This is pinned down as well through the bank balance sheet constraint and bond market equilibrium condition. Initial firm equity $E = M + A^F$ is given in turn. Accordingly, the equilibrium conditions $M = M^S$, $A^F = A^S - (1-\alpha)M^S$, and $r_a = r_c - f$ and the balance sheet relation above imply that $\Pi_1 = W - E$ and $\Pi_2 = (1 + r_a)E + P(M + T, \varepsilon) - r_a(M + T) - fLC$. Equations (6) and (7) thus constitute a system of two equations that determines $r_a$ and $M + T$.

The market equilibrium is depicted in Figure 5. The $P_x$ curve balances the marginal benefit and marginal cost of liquidity, as required by equation (7). The marginal benefit derives from the marginal increase in operational revenue provided by an extra dollar in transactions. The marginal cost of liquidity arises from the reduction in income at time 2 when less interest-earning assets are held. Thus for each dollar that a firm would shift from net interest earnings assets
(\(A_F-T\)) to liquidity (\(M+T\)), other things equal, the firm would lose \(r_a\) and gain \(P_X\). The latter gain decreases with volume since \(P_{XX}<0\), implying that the \(P_X\) curve is negatively sloped. The MRS curve shows the opportunity cost of holding liquidity in terms of the risk-adjusted intertemporal marginal rate of substitution implicit in equation (6). Specifically, it describes the loss in utility from not paying out higher \(\Pi_1\) at time 1 when liquidity is increased. The MRS curve rises with \(M+T\), i.e., falls with \(A_F-T\), because of the concavity of the \(U\) function. The market equilibrium interest rate and level of liquidity is found at the intersection point of the \(P_X\) and MRS curves. Here the marginal benefit of liquidity just equals the marginal loss in utility (from not "consuming" more \(\Pi_1\)).

The market interest rate depends on \(\varepsilon\), of course. Fluctuations in the market interest rate when \(\varepsilon\) changes result from shifts in the \(P_X\) curve according to

\[
\frac{dr_a}{d\varepsilon} \bigg|_{M+T} = P_{xx},
\]

where \(P_{xx}\) is evaluated at the levels of \(X\) and \(T\) that were optimal before the change. In terms of Figure 5, an upward (downward) shift in \(\varepsilon\) appears as an upward (downward) shift in the \(P_X\) function. When \(\varepsilon\) rises, the marginal revenue from undertaking transactions increases, and so the demand for liquidity increases. Given the MRS curve, \(r_a\) must rise to clear the market.

At time 0, firms choose \(LC\) in order to maximize \(E_o[U]\) subject to the same constraints as above, plus the constraint that equation (2) equals 0. The first-order condition is

\[
E_o \left[ \frac{dr_a}{dLC} (A_F - T) - r_a \frac{dT}{dLC} \right] + \mu_x \frac{dX}{dLC} = \frac{df}{dLC}.
\]
where \( \frac{df}{dLC} \) is given by equation (3).

Equation (9) says that the expected marginal benefit from an increase in LC (in terms of operations and investment revenue) must just offset the marginal cost of a higher credit line. Since in equilibrium \( P_x \) always equals \( r_a \) and \( dX = dT \), equation (9) may then be reduced to

\[
f + LC \frac{df}{dLC} = (A_p - LC) E_0^* \left[ \frac{dr_a}{dLC} \right] \text{Prob}(T = LC).
\]

(10)

Here \( E_0^* \) is the expected value operator conditional on information at time 0 and on \( T = LC \). Equation (10) may be simplified using (3) to yield

\[
LC = -A_p \frac{\psi}{1 - \psi} \frac{(1 + r_a^*)}{E_0^* [dr_a/dT]} > 0.
\]

(11)

The inequality follows from the fact that \( E_0^* [dr_a/dT] \) is negative. Equation (11) will be used below in the discussion on monetary policy.

It should be noted that banks, as pure intermediaries, play only a passive role in interest rate determination in this model. Market rates are ultimately determined by costs and benefits to non-bank firms.

We are now ready to turn to the effects of monetary policy on the market participants.

VI. Monetary Policy in the Short Run

Let us distinguish between the "short run" and "long run" in describing the impact of monetary policy. The "short run" refers to the period when lines of credit are already in effect, i.e. where LC and \( f \) have previously been set. This corresponds to the period after point 0, and at or immediately before point 1, in
Figure 4. The "long run" refers to the time when LC and f have yet to be set, or point 0 in Figure 4. We begin with the short run.

Monetary policy in our model consists of open market sales or purchases of financial assets from corporations. An open market purchase in amount Q causes initial changes in the balance sheets of banks and firms as shown in Figure 6.

Figure 6

<table>
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<tr>
<th>Banks</th>
<th></th>
<th>Liabilities</th>
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</thead>
<tbody>
<tr>
<td>Assets</td>
<td>Liabilities</td>
<td></td>
</tr>
<tr>
<td>Reserves</td>
<td>+Q</td>
<td>Transaction Accounts +Q</td>
</tr>
<tr>
<td>Takedowns under Credit Line</td>
<td></td>
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</tr>
<tr>
<td>Other Financial Assets</td>
<td></td>
<td>Equity</td>
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<th>Firms</th>
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<tr>
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<tr>
<td>Other Financial Assets</td>
<td>-Q</td>
<td>Equity</td>
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</table>

Immediately following the open market transaction, two further sets of changes occur. First, the money expansion multiplier will lead to a total change in transaction account balances of Q/α, where α is the reserve ratio. Second, now that firms hold an extra Q/α in money, it will be shown shortly that they reduce their takedowns (T) at time 1 by precisely that amount for all states of nature where LC was not binding, other things equal. The total set of changes in the balance sheets are shown in Figure 7 for states where LC is not binding. The set of portfolio changes generated by the open market operation are represented by
the terms not in square brackets. The set of countervailing changes made by the firms in response to the open market operation through changing credit line utilization are given by the terms in square brackets. Under these circumstances we derive the following proposition:

**Proposition 1:** In the short run, for all states of nature where the $T$ value chosen by firms is strictly below LC and strictly greater than 0, monetary policy has no effect on interest rates, real activities (transactions), or corporate revenue and profits.

**Proof:** The proof is quite simple. If the initial mix of liquidity and net interest-earning assets is optimal and the markets clear, monetary policy would produce no changes in this equilibrium. Whatever level of liquidity and portfolio allocation were optimal before the monetary change remain optimal after the
change. The individual portfolio items change according to $-\Delta A_F = \Delta M = -\Delta T$, leaving the two portfolio components, liquidity ($M+T$), and net interest earning assets ($A_F-T$), as well as the interest rates, unchanged. If any other allocation were preferred, it would have been feasible and chosen before the monetary change. \textit{Q.E.D.}

The intuition here is that firms can perform counterveiling portfolio adjustments that offset the portfolio changes induced by monetary policy. Open-market operations force firms to swap liquidity for interest-bearing securities. But credit lines allow firms to "unswitch," to restore initial levels of both. Liquidity remains constant because $T$ is adjusted to offset $M$ changes. The net holdings of income-bearing securities do not change when $A_F$ changes because $T$ offsets and neutralizes the change.\textsuperscript{22}

The government controls only a subsegment of the liquidity and interest-bearing asset markets. It can change $M^g$, but has no control over total liquidity, $M+T$. It can change $A^g$, but not the net position of firms in securities, $A_F-T$. By controlling only pieces of these markets, the government loses control over the total aggregates, and hence over real economic variables, such as interest rates and transaction volume.\textsuperscript{23}

Another way of stating the result is to note that the velocity of "high-powered money" or bank reserves ($R$) adjusts endogenously to prevent open-market operations from having any effect. With less $R$, firms utilize more $T$, implying that the remaining $R$ must "work more" to clear transaction payments. Total transactions do not change, and so velocity must rise. Velocity is ultimately controlled by firms, who alter it in a way that neutralizes the effects of monetary policy.\textsuperscript{24}

This result is predicated on the ability of firms to adjust credit utilization under the credit lines to countervail open market operations. If these utilizations
were at a "corner," so that adjustments in $T$ were not possible, then Proposition 1 would not hold.

**Corollary:** In the short run interest rates, real activity, and corporate revenue are affected by a monetary *contraction* in states of nature where $T = LC$, and by monetary *expansion* when $T = 0$.

The reason for this is that the ability to offset a fall (rise) in $\tilde{M}^S$ depends on the possibility of increasing (decreasing) $T$. If $T$ already equals LC, no further increase is possible. Similarly, since $T$ must remain non-negative, once $T = 0$ it cannot fall further in order to offset increases in $\tilde{M}^S$. When change in $T$ is impossible, any increase (decrease) in $\tilde{M}^S$ must be accompanied by a decrease (increase) in interest rates to induce firms to hold money.

We illustrate the effects of money supply changes from the point of view of the monetary authorities in Figure 8. As long as the takedown constraints are not binding, the money demand curve appears infinitely elastic to the

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**Figure 8**
authorities. This range corresponds to the horizontal section of the \( M^d \) curve in Figure 8, whose length, BC, equals LC. To the left of point B, T equals LC; to the right of point C, T equals 0. If LC equals zero, the BC segment of the money demand curve collapses to zero. The money demand curve then has the standard shape, downward sloping throughout. A positive open market purchase causes the money supply to shift to the right. As long as the old and new equilibria lie on the BC segment, money demand increases by exactly the same amount. This is because takedowns T fall by precisely that amount, and the extra money is picked up by firms as substitute liquidity. Monetary policy can only alter interest rates if it pushes the money stock wide enough to move into the tail areas of the money demand curve, \( M^d \), where the slope is negative.

It should be noted that the location of the money demand curve in Figure 9 and hence of interest rates depends on \( \varepsilon \). When \( \varepsilon \) increases (decreases), the entire \( M^d \) curve shifts to the northeast (southwest). If \( M^s \) is changed before \( \varepsilon \) is revealed and hence before the transactions volume is determined (though after time 0), the effect on interest rates would be unknown \textit{ex ante} to all agents, including the monetary authorities.\(^{25}\)

If the monetary authorities undertake a monetary change before \( \varepsilon \) is revealed, they can expect to have an impact on the state-specific interest rates and real variables only with probability \( K \), where

\[
K = \text{Prob} \{ T = LC \} + \text{Prob} \{ T = 0 \}.
\] (12)

The probability \( K \) in turn depends on \( \bar{M}^s \). The larger (smaller) is \( \bar{M}^s \), the smaller (larger) is the first term on the right hand side of (12), and the larger (smaller) is the second. Thus overall effect on \( K \) is ambiguous.
Let \( Z_1 = r_a(T = LC) \cdot \text{Prob}(T = LC) \) and \( Z_2 = r_a(T = 0) \cdot \text{Prob}(T = 0) \), where \( r_a(T = i) \) is the interest rate that prevails when \( T \) equals \( i \). When \( M^3 \) increases, \( Z_1 \) must decrease, but \( Z_2 \) could rise or fall. Define the "stochastic effectiveness" of monetary policy as the expected value of the change in the interest rate when \( M^3 \) changes, or \( d[Z_1 + Z_2]/dM^3 \). An increase (decrease) in \( M^3 \) leads to a fall (rise) in \( r_a \) whenever \( T = LC \) or \( T = 0 \). However, as \( M^3 \) changes, the probabilities of realizing corner solutions, \( \text{Prob}(T = LC) \) and \( \text{Prob}(T = 0) \), also change, but in opposite directions. Hence, the net expected change in the value of the interest rate due to a monetary change, once \( \epsilon \) has been revealed, could be in either direction -- depending on the stochastic characteristics of \( \epsilon \). Monetary expansion (contraction) could possibly lead to an expected increase (decrease) in interest rates, producing "perverse" effects of monetary policy. In the special case where \( dZ_1/dM = -dZ_2/dM \) the "stochastic effectiveness" of monetary policy is zero.

VII. Monetary Policy in the Long Run

It is recalled that the "long run" is defined as that period beginning at point 0 in Figure 4. Monetary changes in the "long run" occur before loan commitments are negotiated. Money supply changes in the long run must then take into account endogenous changes in \( f \) and LC.

Inspection of (6) and (7) indicates that changes in \( f \), given LC, have no effect on \( M + T \) or \( r_a \) at time 1. This is because \( r_c \) adjusts so that the marginal takeaway cost remains unchanged. A change in LC, given \( f \), affects \( T \) and \( r_a \) at time 1 only for those states of nature where LC is binding (\( T = LC \)). For all other states, the effect on \( M + T \) and \( r_a \) at time 1 from changing LC at time 0 is zero.

Since LC changes have no effect on time 1 decisions when credit ceilings are not binding, long-run monetary changes (through open market operations) at time 0 have exactly the same impact on \( r_a \) and \( M + T \) as if they were short-run
(performed after time 0) in all states of nature where LC is not binding. They will, however, change $r_a$ and $M + T$ for all states of nature where LC is binding.

When $\bar{M}^S$ is altered at time 0, banks and firms know that future state-specific takedowns will change. This in turn is reflected in the pricing of credit lines. The "marginal" pricing component of the credit line remains $r_c - f = r_a$ in all states of nature for the same reasons as those described in Section V above. However, the fixed pricing component, $f$, and the size of the credit line, LC, change, and the state-specific level of $r_a$ itself could change.

The effect of "long-run" monetary policy on LC may be found by differentiating (11) with respect to $M$. An increase (decrease) in $\bar{M}^S$ reduces (raises) $r_a$ in states of the world when LC is binding. Therefore by (11), LC must fall (rise). When the monetary authorities expand (contract) $\bar{M}^S$, LC contracts (expands). The probability of LC becoming binding consequently increases (decreases). Since monetary policy only affects real variables ($r_a$ and $X$) when it is binding, the chances of long-run monetary expansion (contraction) producing "real effects" on $r_a$ and $X$ are higher (lower) than for similar short-run monetary changes. However, for contractionary policy, the monetary authorities have less control over $r_a$ and $X$ in the long run than in the short run, because of the increase in LC. The probability that long-run monetary policy has no effect on real variables (other than corporate profits) remains $\text{Prob}\{0 < T < LC\}$.

While the "stochastic effectiveness" of long-run monetary expansion is greater than for short-run policy, it is still possible for it to be "perverse" in the sense used above in Section VI.

VIII. Discussion and Conclusions

Regulators have been increasingly turning their attention toward off-balance-sheet banking activities, both in the United States and abroad. Until
now their concern has been largely focused on the implications of these activities with respect to the risk exposure of financial institutions, the exposure of deposit insurance agencies, and the stability of financial markets. The Federal Reserve System is currently considering new capital requirements that would be assessed against off-balance-sheet lending, and there have been discussions about requiring reserves as well. Similar regulations are in effect or under consideration in Belgium, Canada, France, Germany, the Netherlands, Sweden, the United Kingdom, and elsewhere.

Little if any of the debate over regulation of off-balance-sheet activity seems to have been motivated by monetary or macroeconomic considerations. Yet off-balance-sheet liquidity is a large and growing phenomenon that represents a large share of all credit activity. Central banks generally exercise much less control over off-balance-sheet items than over on-balance-sheet liquidity.

We have demonstrated that as a result of credit advanced through off-balance-sheet facilities, the monetary authorities can lose control over liquidity, interest rates, and real activity, at least when "control" is being exercised in the form of fine tuning through open-market operations. Because loan commitment contracts with commercial banks allow the private sector to generate its own liquidity, when the monetary authorities constrict the money supply, off-balance-sheet liquidity is expanded to take its place. Correspondingly, when the monetary authorities purchase securities in the open market, the private sector reduces its debts by utilizing less credit under credit lines, and net private holdings of debt remain unchanged.

By countervailing portfolio adjustments, the private sector neutralizes monetary policy, in a manner somewhat reminiscent of the Modigliani-Miller (1958) view of corporate finance. Monetary policy becomes irrelevant, except when it is so extreme that the private sector is pushed to a corner where
countervailing portfolio adjustments are impossible. Moreover, even large swings in monetary policy can create ambiguous effects due to uncertainty in liquidity demand. These "irrelevancy" results are not restricted to the short run. When recontracting of loan commitments and credit facilities occurs, the loss of monetary control persists and in some cases is even worse.

When interpreting the implications of the paper for real-world monetary policy, two forms of heterogeneity must be borne in mind. First, unlike the simple assumptions used in our model, not all loan contracts or credit facilities are the same. In particular, at any time there will be a distribution of different sizes of unused credit line funds across bank customers. This means that shifts in the money supply will push some customers to "corners", as set according to individual contracts, before others.

Rather than all customers hitting their credit ceilings together, there will be a gradual escalation of binding credit constraints across the market. This means that as monetary policy swings more widely, its effectiveness increases gradually, rather than discontinuously leaping from zero to full effectiveness as in our model. (In terms of Figure 8, the money demand curve corners would be smoothed.) For small fine tunings of the money supply, monetary policy effectiveness would still vanish.

The second relevant form of heterogeneity concerns the timing of contract renewals. In our model all contracts are signed simultaneously. In reality, there is an ongoing process of staggered loan-contract renewal and termination. Therefore, the "short run" and "long run" in the model should be seen as limiting polar cases; real world monetary policy effectiveness and control would generally be somewhere in between.

In our model the exercise of utilization rights under a credit contract did not impose reserve costs on the financial intermediary because utilization caused
reservable demand deposit balances to rise for only a short interim before they were subsequently reduced (once transactions were completed). This is the case in the use of credit lines for intra-day financing, or sector-wide transactions involving goods or assets that were culminated within the same day, as well as credit facilities provided by financial institutions or other firms not subject to reserve requirements. It would also apply to situations where credit-line use leads to additions to demand deposit balances that are removed from the balance sheets of banks before closing time through repurchase arrangements or through same-day securitization (as typically occurs in Eurocredit NIF financing).

In other situations use of real-world credit facilities may in fact cause demand deposit balances to swell long enough to involve reserve costs. In such cases reserves held against these increments cannot be held against other funds in transactions accounts, and hence some monetary contraction would be caused by the use of facilities. The system-wide bank money multiplier would fall.

Such reserve costs would necessitate an adjustment in our model in the form of a narrowing of the range over which monetary policy loses effectiveness. In terms of Figure 8, the flat area of the money demand curve would be shortened. Within this range, all conclusions about policy irrelevance would continue to hold.

Ultimately the monetary role of off-balance-sheet liquidity must be examined empirically. In one of the only attempts to do so, Sofianos, Wachtel and Melnik (1987) found that money supply changes "caused" (in the sense of Granger causation) changes in commercial borrowing, particularly for borrowing through credit facilities. On the basis of our model, we would expect future research to find a reduction in the correlation between the narrower monetary aggregates and interest rates or prices when off-balance-sheet liquidity is expanded. If so, tighter monetary control might be restored through the further
regulation of off-balance-sheet activities or the adoption of alternative reserve computation systems (such as averaging continuously over the day).
Notes

1. Melnik and Plaut (1986a) have argued that loan contracts are the main real-world institutional form under which credit rationing occurs.

2. For a review of the literature on "trade credit" and a recent analysis see Smith (1987).

3. There is debate as to why they have grown so rapidly. See Melnik and Plaut (1986b).


5. For a detailed description of loan commitment contracts, see Ham and Melnik (1988).

6. The Federal Reserve Bank is currently considering regulation of such "daylight overdrafts."

7. If the credit utilized is immediately securitized, as it would be typically under Note Issuing Facilities (NIFs) in the Eurocredit market, no new reserves would be held by the bank.

8. In reality the bulk of transaction account balances and other deposits are indeed held by the business sector.

9. There would be no loss of generality if demand deposits carried some interest rate, as long as it were below the general level of return on bank loan and financial assets, to be called $r_a$ below. If set competitively, the deposit interest rate would be $(1 + r_a) (1-a) - 1$, and banks would earn zero profits. However, a zero interest rate simplifies the model by precluding the need to carry the deposit rate along through the analysis. A zero deposit rate does imply that banks earn rents from transactions account deposits and these do not dissipate because of the regulations on interest. Since we will be working with banks whose initial equity is zero, this implies that positive equity will be observed at the end of the model (time 2). In a more complex model where transactions and portfolio decisions continue over longer periods, bank equity would change unless deposit interest rates were unregulated or unless rents were taxed away.

10. As noted in Section II, this is in line with real-world institutional features. In some real-world contracts the facility fee is zero.
11. Since there is no currency, the "money supply" is equal to deposit balances held with banks.

12. Banks are assumed to have sufficient funds in reserves to cover all payments movements generated by transactions. This could be due to their ability to run short-term overdrafts in their reserve accounts at the central bank (as U.S. banks are permitted to do during daylight hours). Therefore, bank liquidity does not constrain the banks' ability to provide credit lines. Note also that since initial takedown levels at time 0 were zero, all firms *must* first utilize their credit lines before they reduce any outstanding liability (as did firm 2 in Figure 1).

13. See note 7 above.

14. This assumption is in line with actual practice in the United States. In the Euromarket credit facilities a front-end fee is often assessed on the entire credit line. Incorporation of this form of the fee into the model would make no difference in the conclusions.

15. It is assumed that the bank is unable to repossess the $A_F$ or $M$ held by firms defaulting on loans.

16. See Melnik and Plaut (1986a) for a discussion of the set of credit line "menus" offered by banks to corporate customers.

17. In default, the firm loses its holdings of $M$ and $A_F$.

18. "Liquidity" could be thought of as an input in the production process used in fixed proportions with $X$.

19. Note that under the balance sheet identity $A_F$ and $M$ are not chosen independently, and (6) represents the first-order condition with respect to both.

20. In equilibrium, (7') may hold only as a strict equality. Otherwise an excess supply of $A$ would result.

21. By the envelope theorem.

22. Bond holdings by firms fall by $Q/a$, an amount larger than the open-market purchase of $Q$. The difference in these amounts, $(1 - 1/a) Q$, is purchased by banks from firms as part of the monetary expansion process. Note that the demand by firms for bonds falls by the same amount as supply because firms also take down their credit lines less. Thus net holdings of interest-earning assets do not change.
23. This is the same result that one might expect to find if, say, the government controlled cash, but some private-sector industry produced demand deposits free of government regulation, at customer discretion.

24. Note that the same conclusions regarding loss of effectiveness would apply if $M$ were changed through altering the reserve ratio $\alpha$ rather than through open-market operations.

25. For a recent discussion of monetary policy in a stochastic environment, see Santomero and Siegel (1981).

26. The segment $BC$ would have length $(\alpha - \beta) / \alpha \text{ LC}$, where $\beta (\beta < \alpha)$ is the reserve cost level imposed on banks by the exercise of utilization rights under credit facilities.
References


