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Money Supply

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Money Supply

by

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Chapter 9

MONEY SUPPLY

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Handbook of Monetary Economics, Volume I, Edited by B.M. Friedman and F.H. Hahn
1. Introduction

Conjectures about aggregate effects of intermediation, debt, financial regulation and deregulation are common in economists' discussions. Standard macroeconomic models provide no basis for these discussions. Models in the IS–LM tradition do not distinguish between inside and outside money or, more relevantly for present purposes, money produced by governments and central banks and money produced by intermediaries. These models also fail to recognize the role of credit and the interaction between the credit market and the money market closely associated with the intermediation process. Recent work in the rational expectations tradition typically treats the production of money as a stochastic process; the money stock changes randomly, and the stochastic process is not affected by the institutional structure or by economic processes. Textbooks continue to present the traditional multiple expansion of deposits as an activity separate from macroeconomic analysis; money changes in a deterministic way that is independent of market forces.

Strong assertions about the role of money and the controllability of the money stock contrast with the weak or non-existent analysis. Some claim that money cannot be reliably defined. Others, most recently real business cycle theorists, claim that money has no systematic relation to any real variable at any time. Still others claim that, while money can be defined, efforts to control money encourage substitution of other assets to a degree that renders monetary control impractical. This view, a version of the banking school claims of the nineteenth century, was revived in the Radcliffe report on British monetary policy in the 1960s and continues to influence discussions of monetary policy and monetary control in the United States and, even more, in Britain. An extreme version of this position is taken by Kaldor (1982) who argues that money is simply a residual in the economic process and is without causal significance. If this assertion is to be taken seriously and appraised, a theory of money supply is required for the appraisal.

Money supply theory addresses these assertions, and others, found in discussions of monetary theory and policy. In addition, money supply theory provides a means of including the behavior of intermediaries and intermedia-

\[ \text{A recent example is "Goodhart's law". This law claims that there will be a shift in the demand for any monetary aggregate chosen as a target of monetary policy. Versions of this proposition were common in the United States following the introduction of credit cards and a wider range of substitutes for money in the 1970s. A common claim was that the demand for conventional money - currency and demand deposits - would go to zero and monetary velocity would approach infinity. Shortly after these predictions, monetary velocity declined.} \]
tion as part of a macroeconomic analysis of interest rates, asset prices, output and the price level. Such analysis is a prerequisite for analyzing short- and long-term macroeconomic effects of the regulation of deposit interest rates, portfolio restrictions, reserve requirement ratios, credit ceilings, secondary reserve requirements and other institutional restrictions.

A related set of issues arises in the literature on monetary control. Models in which money is restricted to currency issued by a central bank, or is determined exogenously, or is a residual, or is produced stochastically, cannot clarify issues about monetary control. Money supply theory can and does clarify these issues and permits economists to compare control procedures based on interest rates and monetary aggregates both when there is, and when there is not, a rich array of financial intermediaries and a developed system of financial markets.

An often contentious issue about monetary control concerns the central banks’ use of an interest rate or a monetary aggregate as a target or control variable. Conclusions often depend on analysis of restricted cases and do not hold generally. For example, in a model with one interest rate and with debt and real capital perfect substitutes in portfolios, the financing of deficits by issuing debt has no effect on the economy if the interest rate is controlled. In a model with multiple interest rates or with interest rates and asset prices, this is not so. Asset prices change leading to a reallocation of portfolios and effects on output and commodity prices.

A main reason given for interest rate control or interest rate targets is to insulate the economy from shocks to the demand for money. Insulation is achieved in a model with a single rate of interest and a single asset that serves as the only alternative means of holding wealth. Analysis of the money supply process introduces a broader set of assets, so pegging a single rate of interest by supplying bank reserves does not prevent changes in relative prices of assets, with further repercussions on output and the price level. Once these additional assets have a distinct role in portfolios, an interest rate target does not insulate the economy from changes in the demand for money. The reason is that control of a single interest rate, by supplying or withdrawing reserves or money, does not prevent substitution between money and other assets. Money supply theory provides an explanation for the observed differences in the movement of output and prices resulting from substitution with an unchanged interest target fixed by the central bank.

Standard IS–LM analysis treats government debt as a perfect substitute for private capital. The array of assets is characterized by money, usually outside money or currency, and a mix of debt and capital. Changes in the latter mix have no effect on interest rates, asset prices or other aggregates. More recent analysis, following Barro (1974), shows that the value of the debt is just equal to the present value of taxes required to pay interest on the debt, so debt does
not change net wealth or asset prices. There are many reasons for treating this conclusion with skepticism. One reason, which has been explored within the framework provided by Barro’s model, is that the model ignores redistribution of income and wealth, the major activity of most governments. Once the effects on intergenerational redistribution are included in Barro’s model, debt is valued and part of net wealth.\(^2\) Debt issues crowd out real capital. In general, debt does not fully replace capital in portfolios, however. Interest rates and wage rates change, so there are macroeconomic effects of financing deficits by issuing debt. Money supply theory that incorporates asset market decisions considers money, debt and real capital as distinct assets and analyzes the effects of crowding out of capital and the response of interest rates to debt.

Although models that neglect money supply theory are useful for some purposes, the neglect of money supply theory often leads to erroneous conclusions. An example is the comparison of the relative responses to monetary and fiscal policy. In IS–LM models, the relative importance of monetary and fiscal policies depends on the magnitude of the interest elasticity of the demand for money. The introduction of a market for debt or bank credit as part of money supply analysis alters this standard conclusion. The responses to fiscal and monetary policy involve a wider range of substitutes, so analysis of the responses to fiscal and monetary policy must include the effect of changes in prices of the larger set of assets. The absolute size of the interest elasticity of the demand for money no longer plays a critical role. In particular, the monetary effect on output does not vanish with convergence of the interest elasticity of the demand for money to (minus) infinity. This follows from the interdependence of the interest elasticities on the money and credit markets due to the wealth constraint.

There are several alternative approaches to the analysis of money supply and intermediation. Three have been used most extensively in recent work. One approach, illustrated by the work of Benjamin Friedman, considers a wide range of financial assets. Friedman seeks to estimate structural equations representing demand and supply functions for particular assets and liabilities [see Friedman (1977)]. A second approach, used in many large-scale econometric models, remains within the IS–LM paradigm. Disaggregation of asset markets achieves a more complete statement of many details of the money market without altering the structure of the model. Typically the entire system of asset market equations can be reduced to a single money market equilibrium condition, the LM curve, and a single interest rate for analytic purposes. A third approach extends the range of assets and the number of

\(^2\)Cukierman and Meltzer (1989) obtain this result in a model similar to Barro (1974). The differences arise because individuals have different ability and productivity, different wealth and different desired bequests; some desired bequests are negative. A present value preserving change in taxes and debt affects intergenerational allocation, wages and interest rates.
relative prices that affect aggregate demand. Examples of the latter are Brunner (1971, 1973), Brunner and Meltzer (1968, 1972, 1976), Fratianni (1976), Heremans et al. (1976), Korteweg and van Loo (1977), and Neumann (1974).

This approach is developed here. Recent methodological arguments reject the approach taken here and in other studies of financial markets. The reason is that behavior patterns are not derived from first principles expressed by tastes and technology but often reflect institutional arrangements or are expressed in demand or supply functions. We understand the effort initiated by Robert Lucas (and pursued by the Minnesota group under the leadership of Thomas Sargent and Neil Wallace) to generalize Marschak's argument about structure and to achieve structures that are invariant to changes in policy. While such efforts may be useful up to a point, they are ultimately futile in economics. There exists no level of ultimate invariance, whatever the depth of the "analytic excavation". Complete invariance is a denial of the probing, searching, experimenting activities of human beings, emphasized particularly by Hayek, in a world where information is scarce and uncertainty about future states of the world is omnipresent. These broader issues aside, there is, at present, no theory of intermediation capable of generating the broad and complex structure of modern financial arrangements from tastes and technology.

The analysis of institutional arrangements such as the monetary system or structure of financial markets is in its infancy. The history of science shows that scientific progress begins with the successful statement of empirical regularities. Further exploration may eventually express these regularities as implications of relatively complex theories. Insistence on developing first principles first impoverishes science.

Our approach is guided by the empirical regularities of the money supply process. We formulate a market model relating existing institutional arrangements, the behavior of the banks and of the non-bank public and explore the consequences for money, credit, interest rates and asset prices. The framework can be expanded to develop interactions with prices and output, as in Brunner and Meltzer (1976), and to analyze the relation between financial markets and macroeconomic variables.

Section 2 presents a model of money, debt and real capital in an economy without intermediaries. Section 3 extends the model to include banks and shows how the model can be extended to include other intermediaries without altering the basic structure. Sections 4 through 6 discuss applications including interest rate targeting, monetary variability and uncertainty, and monetary control. These applications are followed by a brief conclusion.

Some extensions to an open economy with interrelated credit markets are in Brunner (1976b), Korteweg and van Loo (1977) and in Brunner and Meltzer (1974). We do not distinguish between domestic and foreign assets or consider an open economy in this chapter.
2. The markets for money and bonds

In the economy we consider initially, non-human wealth consists of money, debt and real capital. There are no banks or intermediaries. Real capital, $K$, is productive, earns a real return, and sells at a price, $P$, so the nominal value of the capital stock is $PK$. There is a government that finances its spending by issuing base money (currency), $B$, and bonds, $S$. Debt is valued at the current rate of interest; $vS$ is the market value of outstanding debt. Since much of the government's spending is for redistribution between and within generations, changes in debt change interest rates and asset prices and, thus, have macroeconomic effects.\(^4\)

Figure 9.1 shows the balance sheets of the government and the private sector. Wealth, $W$, is the market value of the public’s assets, net of its liabilities. In this simple model, the public as a whole has no liabilities.

The consolidated balance sheet of the central bank and government shows one asset, $Au$, consisting of gold, foreign exchange and special drawing rights. Since we do not consider extensions to an open economy, we do not go beyond recognizing that in an open economy with fixed exchange rates, $Au$ is the main source of base money.\(^5\) On the liability side, the stocks of base money and debt expand and contract with budget deficits or surpluses and with open market operations. In many countries, central bank direct purchases of government debt are restricted. The central bank acquires government debt by purchases in the open market, i.e. by exchanging base money for government securities. The sum of base money and government debt minus $Au$ is the cumulated sum of fiscal deficits and surpluses.

With given market value of wealth, there are two independent asset demand equations. Our interest in financial markets, and more accurate measurement,
determines the choice of \( B \) and \( S \) (or \( vS \)).\(^6\) The demand functions for base money and debt are shown as equations (1) and (2), and the market value of wealth is shown as equation (3).

\[
B = \lambda(i, P, p, ap, W, H, e),
\]

\[
S = \beta(i - \pi, P, p, ap, W, H, e),
\]

\[
W = PK + vS + B.
\]

The plus and minus signs below the variables show the responses to the principal arguments of the asset demand functions. The anticipated rate of inflation, \( \pi \), and the anticipated return to real capital per unit of capital, \( e \), are two of the channels by which anticipations affect the asset markets. Anticipated prices, \( ap \), the anticipated rate of inflation, \( \pi \), and the nominal rate of interest, \( i \), are the main channels for the effects of anticipated prices on current portfolios.\(^7\) \( H \) is human capital. We use equations (1) and (2) and the wealth equation (3) to solve for the equilibrium values of \( i \) and \( P \) and the stocks of base money, bonds and real capital. Note that the response of \( \beta \) to \( P \) is positive. The reason is that an increase in \( P \) with the real return, \( e \), constant lowers the real rate of return on real assets, inducing substitution to securities.

The \( MM \) curve of Figure 9.2 shows the combinations of interest rates and asset prices at which a constant amount of base money is willingly held. The curve is positively sloped to reflect the fact that higher interest rates offset the effect of higher asset prices on the demand for base money. The \( CM \) curve shows the combinations of interest rates and asset prices at which the outstanding stock of government debt is willingly held. The curve is negatively sloped to show that interest rates must fall as asset prices rise to induce the public to hold a given stock of government securities.

The asset markets are in equilibrium at \( i_0 \) and \( P_0 \). At these prices, with given anticipations, the stocks of base money, government debt and capital are willingly held. Changes in base money and debt change \( i \) and \( P \) by shifting the \( CM \) and \( MM \) curves; changes in \( ap \), \( p \), \( e \), \( W \), \( H \) and \( \pi \) induced by policy and other changes shift \( CM \) and \( MM \) simultaneously.

\(^6\)Measurement of the aggregate capital stock presents conceptual and operational difficulties that are much greater than measurement of money and debt. The common complaint about the difficulties of accurately measuring money does not apply to the monetary base. The base can be read from the central banks' balance sheet.

\(^7\)The difference between \( ap \) and \( \pi \) is the difference between a one-time change in the price level, producing a transitory change in the rate of price change, and a change in anticipated inflation—a persistent change in the rate of price change.
Figure 9.2

2.1. Solutions for $i$ and $P$

The solutions for $i$ and $P$ from the asset market equations are obtained from equations (1) and (2) holding human wealth, the price level and anticipations constant. Differentiating the bond market ($CM$) and the money market ($MM$) equations and using subscripts to denote partial derivatives, we have the slopes of the $MM$ and $CM$ curves expressed as derivatives:

\[
\begin{align*}
& MM: \quad \frac{di}{dP} = -\frac{\lambda_i + \lambda_w K}{\lambda_i + \lambda_w v_S} > 0, \\
& CM: \quad \frac{di}{dP} = -\frac{\beta_i + \beta_w K}{\beta_i + \beta_w v_S} < 0.
\end{align*}
\]

To facilitate comparison of orders of magnitude, we rewrite the derivatives as equivalent elasticities:

\[
\begin{align*}
& \text{slope of } MM: \quad e(i, P \mid MM) = -\frac{\varepsilon(MM, P)}{\varepsilon(MM, i)} > 0, \\
& \text{slope of } CM: \quad e(i, P \mid CM) = -\frac{\varepsilon(CM, P)}{\varepsilon(CM, i)} < 0,
\end{align*}
\]

where $\varepsilon(MM, i) = -[\varepsilon(\lambda, i) + \varepsilon(\lambda, W)\varepsilon(v, i)v_S/W]$ and $\varepsilon(MM, P) = -[\varepsilon(\lambda, P) + \varepsilon(\lambda, W)PK/W]$ and similarly for $e(CM, i)$ and $e(CM, P)$.
\( \varepsilon(MM, i) \) and \( \varepsilon(MM, P) \) are the interest elasticity and the asset price elasticity of the excess supply of money. Similarly, \( \varepsilon(CM, i) \) and \( \varepsilon(CM, P) \) are the interest rate and asset price elasticities of the excess supply of bonds. When intermediation is introduced, the \( CM \) elasticities become the interest and asset price elasticities of the excess supply of bank (or intermediary) credit, as noted below. The signs of these elasticities are determined by the signs of the components, the derivatives or partial elasticities of the \( \lambda \) and \( \beta \) functions. These signs are:

\[
\varepsilon(MM, i), \varepsilon(CM, i), \varepsilon(CM, P) > 0; \\
\varepsilon(MM, P) < 0.
\]

Similar expressions can be used to describe the vertical shifts of \( MM \) and \( CM \) induced by changes in variables other than \( i \) and \( P \). Expressed in geometric terms (as mixtures of shifts and slopes) and converted to elasticities, these expressions are:

\[
\varepsilon(i, B \mid AM) = \frac{slope(CM) \cdot shift(MM)}{slopes(MM) - slope(CM)},
\]

\[
\varepsilon(P, B \mid AM) = \frac{-shift(MM)}{slopes(MM) - slope(CM)},
\]

where, for a change in the base,

\[
shift(MM) = \frac{1}{\varepsilon(MM, i)}.
\]

The conditioning expression \( AM \) indicates that the elasticity is a total elasticity of the asset market system, holding the output market constant.

We now use these formulas to show the responses of \( i \) and \( P \) to several of the variables that shift the \( MM \) and \( CM \) curves of Figure 9.2. The next three subsections discuss these shifts.

### 2.2. Responses to \( B \), \( S \) and open market operations

The positions of the \( MM \) and \( CM \) curves in Figure 9.2, and the solution values for \( i \) and \( P \), depend on \( B \) and \( S \) and on all variables, other than \( i \) and \( P \), that enter as arguments of the \( \lambda \) and \( \beta \) functions. An increase in \( B \) shifts the \( MM \) curve to the right, lowering interest rates and raising asset prices. The effect of an increase in \( B \) is shown in Figure 9.2 by the broken line \( MM_i \). Formally, the
responses of log $i$ and log $P$ to a change in log $B$ are

$$
\epsilon(i, B \mid AM) = \frac{\epsilon(CM, P)}{\Delta} < 0,
$$

$$
\epsilon(P, B \mid AM) = -\frac{\epsilon(MM, i)}{\Delta} > 0,
$$

where $\Delta = \epsilon(CM, i) \cdot \epsilon(MM, P) - \epsilon(MM, i) \cdot \epsilon(CM, P) < 0$.

The three-asset system, with separate markets for money and debt, introduces a broader range of substitution than the IS–LM framework. Changes in base money (and other variables) affect aggregate demand and output by changing relative prices and wealth. Some familiar propositions of IS–LM analysis no longer hold. The response of the interest rate to the base, $\epsilon(i, B \mid AM)$, is neither necessary nor sufficient for a positive response of aggregate demand or output to monetary policy. Furthermore, in the IS–LM framework, convergence of the interest elasticity of the demand for money to minus infinity implies that the responses to money converge to zero. In the money-credit market framework, this is not so. The reason is that we cannot assume that $\epsilon(MM, i)$ converges to infinity without imposing a similar convergence on $\epsilon(CM, i)$. It follows that as $\epsilon(i, B \mid AM)$ converges to zero, $\epsilon(P, B \mid AM)$ remains constant at a positive level.

The interaction of the asset markets prevents the emergence of a liquidity trap. Large interest elasticities weaken the transmission of monetary policy via interest rates on financial assets, but the transmission via asset prices remains fully operative. A liquidity trap requires that $\epsilon(MM, i)$ converges to infinity more rapidly than $\epsilon(CM, i)$. This condition is excluded by Walras' law and the postulated substitution [see Brunner and Meltzer (1968)]. The proposition follows from the responses of $\epsilon(i, B \mid AM)$ and $\epsilon(P, B \mid AM)$ in equations (4). A uniform convergence of $\epsilon(CM, i)$ and of $\epsilon(MM, i)$ to (plus) infinity produces convergence of $\epsilon(i, B \mid AM)$ to zero but $\epsilon(P, B \mid AM)$ remains bounded.

Changes in debt affect the asset market equilibrium by changing both $i$ and $P$. These changes, in turn, change aggregate spending and output, and, thus, change the price level. Consequently, the analysis of fiscal policy differs from the IS–LM analysis. The effects of financing deficits or surpluses are in addition to any effects of taxes and government spending on aggregate demand, and the effects of issuing or withdrawing debt on $i$ and $P$ continue even if the budget deficit or surplus remains unchanged.

The responses to a change in debt are obtained by differentiating the money and debt market equations with respect to $S$ and expressing the results in terms
of the partial elasticities that are components of \( \varepsilon(i, S \mid AM) \) and \( \varepsilon(P, S \mid AM) \):

\[
\varepsilon(i, S \mid AM) = \frac{\varepsilon(MM, P)}{\Delta} > 0,
\]

\[
\varepsilon(P, S \mid AM) = -\frac{\varepsilon(CM, i)}{\Delta} > 0.
\]

In geometric terms:

\[
\varepsilon(i, S \mid AM) = \frac{-\text{slope}(MM) \cdot \text{shift}(CM)}{\text{slope}(MM) - \text{slope}(CM)},
\]

\[
\varepsilon(P, S \mid AM) = \frac{\text{shift}(CM)}{\text{slope}(MM) - \text{slope}(CM)}.
\]

Equations (5) show that debt issues raise interest rates and asset prices on
real capital, so the response of aggregate demand depends on the relative
magnitudes of \( \varepsilon(CM, i) \) and \( \varepsilon(MM, P) \) and on the relative size of the response
of aggregate demand to \( i \) and \( P \). Many empirical studies of the effect of debt on
interest rates suggest that the effect is hard to detect in the data. Findings of
this kind do not imply that the size of the debt is irrelevant once we extend
the model beyond the standard IS–LM framework; the effect may be larger or
more reliable if money, debt and capital are treated as distinct assets in the
empirical studies. Or, the effect of the induced change in asset prices may
offset the effect of interest rates wholly or in part.

An open market operation is an exchange of money for debt. Open market
purchases increase the base creating an excess supply of money. The \( MM \) curve
shifts to the right. The reduction of the stock of securities in the public’s
portfolio shifts the \( CM \) curve to the left. A new position of equilibrium
following the purchases is shown at the intersection of \( MM \) and \( CM \) in Figure
9.3. Interest rates fall. Asset prices rise provided the interest elasticity of \( CM \)
exceeds the interest elasticity of \( MM \). We assume, throughout, that this
condition is met.

Open market sales have the reverse effect. The monetary base declines and
the stock of securities held by the public increases. In Figure 9.3 an open
market sale raises the market interest rate from \( i_1 \) to \( i_0 \) and lowers the asset
price from \( P_1 \) to \( P_0 \). Both changes reduce aggregate demand and thus lower
output and the price level.

Tests of this restriction by Korteweg and van Loo (1977, p. 66) for the Netherlands and by
Brunner and Meltzer (1968) for the United States support the restriction.
2.3. The Gibson paradox

In his *Treatise on Money*, Keynes described as a paradox the observed positive relation between interest rates and the price level of current output. He named the paradox for A.H. Gibson who had noted the relation earlier. A large literature has grown up that attempts to explain the Gibson paradox.

In the money–debt–capital model, the paradox disappears. A rising trend in the price level due to inflationary finance produces a positive correlation between the price level and nominal interest rates in two ways. First, the expected relation between market prices and market interest rates is positive, reflecting the effect of the price level on the demands for debt and money weighted by the asset price elasticities of the excess supply functions for credit and money. Second, prices and interest rise with the gradual adjustment of inflationary expectations. Higher expected inflation raises both \( p \) and \( i \).

The responses of the interest rate and asset price level to \( p \) are:

\[
\begin{align*}
\epsilon(i, p \mid AM) &= - \frac{\epsilon(CM, p) \cdot \epsilon(MM, p) - \epsilon(MM, p) \cdot \epsilon(CM, p)}{\Delta} > 0, \\
\epsilon(P, p \mid AM) &= - \frac{\epsilon(CM, i) \cdot \epsilon(MM, p) - \epsilon(MM, i) \cdot \epsilon(CM, p)}{\Delta} ,
\end{align*}
\]

where \( \epsilon(CM, p) = \epsilon(\beta, p) < 0 \) and \( \epsilon(MM, p) = -\epsilon(\lambda, p) < 0 \). The size of \( \epsilon(P, p \mid AM) \) is ambiguous; \( |\epsilon(MM, p)| > |\epsilon(CM, p)| \) is sufficient to assure that the sign is negative. To assure a positive sign, \( |\epsilon(CM, p)| \) must be large.
enough to compensate for the relatively low weight, $e(MM, i) < e(CM, i)$, with which it appears. The implication of this analysis is that an increase in the price level probably lowers asset prices, including prices of traded shares, with the expected rate of inflation unchanged. This effect supplements the effects of non-indexed taxes and depreciation on asset prices.

2.4. Responses to supply shocks

Supply shocks affect $i$ and $P$ by changing the expected return to capital, $e$, and the two measures of wealth, $H$ and $W$. The distribution of the responses depends on the type of shock. A shock to labor productivity mainly affects $H$. A shock to oil prices affects the value of existing capital, included in $W$, and the expected return, $e$. A change in tax rates on capital also affects $e$ and $W$ directly. A reduction in taxes on new and existing capital raises the expected after-tax return and the value of existing capital.

Increases in $e$ raise asset prices, and reductions in $e$ lower asset prices. Productivity shocks that increase the expected return to capital also increase the value of existing capital, since existing capital is a close substitute for new capital. The effect of $e$ on the market rate of interest depends on the relative responses of the demands for bonds and money to the change in expected return:

$$
\frac{\Delta}{\Delta} e(i, e | AM) = - \frac{e(CM, e) \cdot e(MM, P) - e(MM, e) \cdot e(CM, P)}{\Delta}
$$

$$
\frac{\Delta}{\Delta} e(P, e | AM) = - \frac{e(CM, i) \cdot e(MM, e) - e(MM, i) \cdot e(CM, e)}{\Delta} > 0
$$

If the reduction in the demand for bonds is relatively large, $|e(CM, e)|$ is large, so interest rates rise with $e$. Conversely, a relatively large $e(MM, e)$ implies that market rates decline as the expected return rises.

2.5. Output market responses

This chapter discusses asset market responses and the determination of equilibrium stocks and asset values when money, bonds and capital are distinct assets competing for a place in portfolios. Output and the price level remain fixed throughout. To bring out some of the differences between this analysis and the IS–LM model, this subsection briefly shows the way in which the asset and output markets are joined.

In a closed economy, equilibrium on the output market requires that real
output, \( y \), equals real private spending, \( d \), plus real government spending, \( g \):

\[
y = d + g.
\]

\[
d = d(i - \pi, p, ap, P, e, W, H).
\]

To study the interaction of asset and output markets, including the effect of monetary or fiscal policy on spending and output, substitute the solutions for \( i \) and \( P \) obtained from the asset market equilibrium into the spending function. The responses to \( B \), \( S \), and policy changes other than \( g \) have the form:

\[
e(y, x) = c_1 e(i, x \mid AM) + c_2 e(P, x \mid AM) + \cdots,
\]

where

\[
c_1 = \frac{e(d, i)}{\Delta}, \quad c_2 = \frac{e(d, P)}{\Delta},
\]

and

\[
\Delta = 1 - e(d, i)e(i, y \mid AM) + e(d, P)e(P, y \mid AM) + e(d, p)e(p, y)
\]

\[
+ e(d, H)e(H, y).
\]

In the model with money, bonds and capital, a change in \( B \) or \( S \) by open market operations or to finance current government deficits or surpluses affects the output market even if government spending and tax rates are unchanged. These effects are the output market responses to the relative price changes on the asset markets. They are distinct from any real wealth or real balance effects.

Friedman (1978) and Tobin and Buiter (1976) also introduce a third asset into their models. They then reduce their models with three assets and output to two equations and draw diagrams that look like the standard IS–LM diagram. The analogous procedure in our model would be to draw the output market and asset market relations as two curves in the \( i, y \) plane, using the implicit dependence between \( e \) and \( H \) and \( y \). After substituting the solution for \( P \) from the credit market into the output market and the remaining asset market equation the output market relation could be called IS and the asset market relation could be called LM.

The meaning of the diagram and the two equations is not the same as in the two-asset IS–LM model, however. In the two-asset IS–LM model with only money and capital or money and bonds (or where bonds are treated as a perfect substitute for money or capital), the IS and LM relations are indepen-
dent equilibrium relations. In models with three assets and two relative prices, the two relations are interdependent. Any change in the stocks of assets or in the demands for assets necessarily shifts both the output (or IS) and the asset market (or LM) relation. Open market operations, deficit finance, changes in productivity or in expectations can no longer be analyzed as a shift in IS along LM or as a shift in LM along IS. Both curves shift in response to these and other changes. A change in the base, for example, changes the positions of the IS and LM curves directly and by changing the asset price level \( P \). If \( P \) is replaced by its determinants, the base (and other determinants) affect the positions of IS and LM through the effect of the base on \( P \) and of \( P \) on the demands for output and assets.

3. Intermediation

The distinction between credit and money was at the center of the banking and currency controversy in the nineteenth century [see Viner (1965) and Thornton (1965)]. Aspects of a modern treatment of many of the same issues can be found in the discussions of intermediation by Gurley and Shaw (1960), Tobin (1963), and Pesek and Saving (1967). This section extends the model of money, bonds and capital to incorporate banks and other financial institutions as part of a theory of intermediation. A main conclusion is that the extension introduces many details that are useful for analyzing the operations of a modern financial system without altering the main implications of the model of money, bonds and capital. Intermediaries provide opportunities for people to increase utility by offering types of assets and liabilities that the public prefers. Intermediaries increase wealth by lowering costs of transacting. Since we abstract from transaction costs, the contribution of intermediaries to wealth is not explored.

Figure 9.4 introduces the balance sheets of banks and non-bank inter-

<table>
<thead>
<tr>
<th>Public</th>
<th>Banks</th>
<th>Non-bank intermediary</th>
<th>Monetary account of the government</th>
<th>Fiscal account of the government</th>
</tr>
</thead>
<tbody>
<tr>
<td>( C_p )</td>
<td>( L_b )</td>
<td>( R )</td>
<td>( D_p )</td>
<td>( D_b )</td>
</tr>
<tr>
<td>( D_p )</td>
<td>( L_{nb} )</td>
<td>( T_b )</td>
<td>( T_{nb} )</td>
<td>( vS_{nb} )</td>
</tr>
<tr>
<td>( T_{nb} )</td>
<td>( W )</td>
<td>( PK )</td>
<td>( W )</td>
<td>( W )</td>
</tr>
</tbody>
</table>

Figure 9.4
mediaries. The development of intermediaries permits the public to hold a wider range of financial assets including demand and commercial bank time deposits, $D_p$ and $T_b$, and non-bank time deposits, $T_{nb}$. The public can change its risk position, anticipate future consumption, or exploit opportunities by borrowing from banks ($L_b$) or non-bank ($L_{nb}$) financial institutions and by acquiring real assets.

The central bank can acquire securities in the open market, as before, and it can also lend to financial institutions. The remaining symbols on the balance sheets are: $R$, the volume of bank reserves; $A$, the amount of borrowing by financial institutions from the central bank; $C_p$, the stock of currency held by the public; $D_{nb}$, the deposits of non-banks at commercial banks; $W_b$ and $W_{nb}$, the values of equity in financial institutions; $AGA$, advances by the central bank to government agencies; $S_{cb}$, government securities held by the central bank; and $oac$, other accounts at the central bank.

Intermediaries hold demand deposits at banks ($D_{nb}$) and a small amount of currency ($C_{nb}$) in their tills. Most of their reserves are held as government debt, $vS_{nb}$. The wealth or net worth of banks and intermediaries is the market value of their charters. Since governments typically do not permit free entry into the industry, there are some potential monopoly profits accruing to banks and financial institutions [see Pesek and Saving (1967)]. $W_b$ and $W_{nb}$ are the capitalized values of these profits.\footnote{Changes in reserve requirement ratios, changes in regulations affecting interest rates paid on deposits or received on assets, and changes in merger, entry and branching restrictions affect $W_b$, $W_{nb}$ and $W$. In many countries, banks are required to lend on favorable terms but can borrow from the central bank on favorable terms also. The net tax or subsidy falls on $W_b$ and $W_{nb}$. To simplify the analysis, non-deposit liabilities are combined with net worth in the wealth variable. Such liabilities exhibited substantial variation during the past twenty years.}

The underlying structure of the economy remains as in Figure 9.1. After consolidation, the wealth of the public is the same as before. The stock of base money is now divided between currency outstanding and reserves. The source base, $SB$, is

$$C_p + C_{nb} + R = SB,$$  \hspace{1cm} (6)

and the total outstanding stock of government debt, $S_T$, is

$$S_p + S_b + S_{nb} = S_T - S_{cb} = S,$$  \hspace{1cm} (7)

where $S$ is the stock of debt held by the banks and the public. The structure of claims and debts is built on these financial assets.
3.1. The government sector

We begin with the monetary authority, the consolidation of all accounts of government agencies that issue money. The agencies differ across countries and over time. Two accounts currently matter in the United States: the consolidated account of the Federal Reserve System and the Treasury's monetary account. Consolidating these accounts provides the framework for the definition, measurement and explanation of the monetary base. The source base, in the terminology developed by the Federal Reserve Bank of St. Louis, is defined as the sum of monetary liabilities of the government's consolidated monetary accounts that are held as assets by banks, other financial institutions and the public.

The consolidated statement implies the relation between the source base and its counterparts— the other components of the consolidated monetary account of the government shown in Figure 9.4. The statement is presented in a relatively general way to suggest opportunities for flexible adjustment of the counterparts to the source base—the net assets acquired by the monetary authority—under different institutional arrangements:

\[
SB = Au \text{ (gold + foreign exchange + special drawing rights)} + A \text{ (loans to banks under various titles and conditions)} + AGA \text{ (loans under various titles and conditions to government agencies)} + S_{cb} \text{ (government securities)} - oac \text{ (Treasury deposits + deposits of foreign governments and their agencies – other items, including float).}^{10}
\]

(8)

"Other items" consists of "other assets", "other liabilities" and net worth. A, AGA and S_{cb} usually dominate the movement of the source base.

An empirical examination of the money supply process requires investigation of the supply conditions of the major components on the right-hand side of equation (8). These conditions differ between countries reflecting the variety of institutional arrangements for conducting policy operations. Despite these differences, the arrangements can be analyzed in terms of the effect on the base.

One interesting arrangement was considered by the Banco d'Espagna in the 1970s. The Spanish money market was undeveloped, so open market operations could not be conducted in the usual way. To control the base, the Bank proposed to let the commercial banks bid for the right to supply loans. The

\text{\footnotesize{^{10}An excellent description of these accounts and the consolidation is given in Shaw (1950).}}}
bidding process was designed to set the equivalent of the discount rate and, of course, affect interest rates on loans and securities.

Since the middle of the 1970s, the Swiss National Bank has set a target for the growth rate of the monetary base. There is no market for Treasury bills in Switzerland, and the National Bank is prohibited from holding long-term bonds, so open market operations in government securities are not an available option. By far the largest asset on the Bank’s balance sheet is the portfolio of gold and foreign exchange. To control the base, the Bank conducts open market operations in the foreign exchange market.

The Deutsches Bundesbank also holds relatively few government securities. The principal assets on its balance sheet are various types of loans to private borrowers that have been sold or discounted by the commercial banks. The Bundesbank also has set a target for the monetary base, or central bank money in the Bundesbank’s parlance. The Bundesbank sets interest rates on the assets that it buys, and it changes these rates to control the size of its portfolio and the growth of the monetary base.

The Banca d’Italia’s portfolio of government securities was regulated for many years by an arrangement making the Central Bank the residual buyer of new issues of Treasury securities. The prevailing deficit, the choice of coupon rate and of the issue price, in the context of given market conditions, determined the portion of new issues which the central bank was legally obliged to buy. Under these conditions, the Italian Parliament and Treasury controlled the source base. Advances to government agencies, AGA, the third component in the monetary account of the government shown in Figure 9.4, also contributed to the source base in Italy, in contrast to the United States where this item has played no role.

The U.S. base is dominated by $S_{cb}$ and decisions about $S_{cb}$ remain with the central bank. Its choice of strategy determines the conditions under which $S_{cb}$, and the source base, increase or decrease. A strategy of rigid interest control would reproduce the Italian experience. The United States closely approximated the postwar Italian system during the 1940s, under the interest pegging regime and large, wartime budget deficits. An agreement between the Treasury and the Federal Reserve in March 1951, known as the Accord, permitted the Federal Reserve to let interest rates change at all maturities. Following the Accord, the Federal Reserve conducted monetary policy by various means designed to stabilize short-term interest rates including, at different times, Treasury bill rates, control of the rate on one-day loans of reserves (the Federal funds rate), or member bank borrowing. Under these procedures, the monetary base responds to the excess demand on the markets for credit or debt. As a consequence, the stocks of base money and money often have moved procyclically, reinforcing inflation and recession. The reason is that the Federal Reserve’s procedures held short-term rates fixed and supplied base
money when the public supplied assets to the banks and withdrew base money when the public's supply of assets to banks declined.

In the 1950s and 1960s, the Bank of Japan held the market rate below the rate of inflation by supplying base money to banks through the discount window at a subsidized borrowing rate. "Window guidance", a form of direct control on borrowing, inhibited the banks from raising rates, and the relatively low rates charged by banks discouraged the development of money market instruments [Suzuki (1980)]. This policy ended after the government increased the stock of debt. After a market for debt developed, the Bank of Japan relied more on open market operations and less on window guidance.

The examples of diverse supply conditions governing the source base bring out that differences in monetary regimes are associated with differences in supply conditions of the source base. Comparison of monetary regimes involves a comparison of these supply conditions and their consequences. Any major change in supply conditions is a change in the monetary regime. Both short-run monetary and long-run price uncertainty can be influenced by the choice of monetary regime. Some arrangements lower the size of unexpected monetary shocks or prevent misinterpretation of the effects of such shocks on output and employment. The choice of supply conditions for the base can lower long-run price uncertainty and the resource cost of uncertainty. A rational choice of policy regime requires an understanding of this link between supply conditions and the excess burden imposed by some types of monetary regime.

The monetary base is obtained from the source base by adding the reserve adjustment magnitude, $RAM$, to the source base:\(^{11}\)

$$B = SB + RAM$$

\(^{11}\)The source base differs from the amount of outside money by the amount of base money issued against loans to the private sector. This amount is relatively large in many countries. The distinction between outside and inside money, while useful for assessing the monetary sector's contribution to wealth, is not useful for analysis of the money supply.
is the average reserve requirement on non-transaction accounts, $T_b$. Both $r^d$ and $r'$ are expressed as decimals. The change in RAM measures the reserves liberated from required reserves, or the reserves impounded into required reserves, by lowering or raising a reserve requirement ratio. The existing level of $RAM$ is the cumulated sum of all past changes.

The monetary base summarizes the actions, other than discount rate changes, taken by the monetary authorities. The monetary multiplier, to be introduced presently, reflects the public's and the banks' behavior. This decomposition of the money stock into multiplier and base offers an opportunity to separate the influence of the monetary authority on money and credit from the influence of the banks and the public. Furthermore, the framework offers an opportunity to examine the consequences of institutional constraints imposed on banks, to assess the strategies and tactical procedures chosen by the central banks and to evaluate the institutional choices available to the monetary authorities.

The expanded model of the money-credit process differs in four principal ways from the model in equations (1)-(3). First, the monetary base consists of currency and reserves. Shifts between the two components alter the stocks of money held by the public and the stock of outstanding credit in different degrees. Second, banks offer types of deposits that differ in maturity, turnover and the rate of interest paid to holders. Shifts from one type of deposit to another, for example from bank time deposits to demand deposits, change the stocks of money – defined as currency and demand deposits – and bank credit in opposite directions. Third, partly as a consequence of the regulation of interest rates paid on different types of deposits, changes in the level of interest rates affect credit and money in different ways. Fourth, differences in reserve requirement ratios and regulations prohibiting payment of interest on required reserves encourage substitution between types of deposits. Banks and other financial institutions are encouraged to develop substitutes for demand (or time) deposits that have many of the properties of these deposits but are subject to lower reserve requirements.

For the present we ignore non-bank institutions and concentrate on a system with banks, government and the public. From the balance sheet of the consolidated banking system, we can define bank credit or earning assets as

$$L_b + nS_b = D_p + T_b - (R - A) + W_b.$$  (11)

Money is defined as

$$M = C_p + D_p.$$  (12)

Demand deposits include all types of transaction account; time deposits include
all non-transaction accounts. Since the source base, $SB$, in the absence of non-bank intermediaries, is $C_p + R - A$,

$$L_o + vS_b = M + T_b - SB.$$ (13)

Neglecting the small amount of banks' net worth, equation (13) shows that, from the definitions of credit and money, we obtain the implication that growth of time deposits (intermediation) increases credit relative to money.

### 3.2. The U.S. monetary system

The details of each monetary system differ. This subsection develops a framework for the United States' monetary system that encompasses the public, the banks and the monetary authority. The reader who wishes to avoid these details can go to the next subsection where the results are summarized as part of the equilibrium conditions for the stocks of money and credit.

Historically, banks' holding of reserves under the Federal Reserve Act depended on the distribution of deposits between type and size of deposits, location of the bank, and status of membership in the Federal Reserve System. The Monetary Control Act of 1980 extended reserve requirements to other financial institutions, including mutual savings banks, saving and loan associations, credit unions, agencies and branches of foreign banks, and Edge Act corporations. Required reserve ratios for accounts subject to check now vary with the size of the account. For time deposits, required reserve ratios vary with the term to maturity and the type of account. The total required reserve is a weighted average with weights dependent on these characteristics. Let $r^d$ and $r^t$ be the weighted average reserve requirement ratios for demand and time deposits, respectively. Banks satisfy these requirements, by holding deposits at Federal Reserve Banks and by holding currency. (Non-member banks and non-banks hold currency also. Some of these details are neglected.)

Required reserves, $R'$, are defined by

$$R' = r^dD_p + r^tT_b = r^*(D_p + T_b).$$

The banks' desired net average reserve ratio, $(R - A)/(D_p + T_b)$, depends on the discount rate, $disc$, the market rate, $i$, the structure of reserve requirements, and the variance of interest rates and reserves, $v(i)$ and $v(R)$. Inclusion of the last term reflects the experience of the U.S. monetary system in the 1930s when the increased variability of the supply of reserves increased uncertainty about reserve supply and encouraged banks to hold relatively large excess reserves. Interest rate variability, $v(i)$, affects the desired reserve
position. A well-organized money market, with relatively small transaction
costs, lowers $v(i)$ and the desired reserve position. The desired ratio of
reserves to total deposits is given by (14) with the signs of derivatives written
below the variables:

$$r = \frac{R - A}{D_p + T_b} = r(r^*, i, \text{disc}, v(i), v(R)).$$  \hspace{1cm} (14)

Changes in reserve requirements ratios affect both the RAM component and
the desired ratio of reserves to total deposits. To combine these two sources of
change in a single parameter, we define the adjusted reserve ratio, $\tilde{r}$:

$$\tilde{r} = r + \frac{\text{RAM}}{D_p + T_b}.$$  \hspace{1cm} .

The adjusted reserve ratio is invariant with respect to changes in the reserve
requirement ratios. The entire effect of changes in the ratios can be analyzed as
a change in the monetary base.

In addition to the allocation between reserves and earning assets, banks
allocate between borrowed and non-borrowed reserves. The desired ratio of
borrowing to total deposits, $b$, is:

$$b = b(\text{disc}, i, \ldots).$$  \hspace{1cm} (15a)

where disc is the discount rate charged on loans or advances from Federal
Reserve banks and the omitted items in the $b$ function include institutional
restrictions, occasional rationing by the Federal Reserve and other administra-
tive arrangements. The ratio $b$ is defined by

$$A = b(\cdot)(D_p + T_b).$$  \hspace{1cm} (15b)

Specification of the credit market requires one additional allocation param-
eter. The banks’ wealth (and non-deposit liabilities) satisfies the relation:

$$W_b = n(i^n, i, \ldots)[1 + t(\cdot)]D_p,$$

where $n$ depends on the market rate, $i$, and the yield $i^n$ offered by banks on
$W_b$. The parameter $n$ assures consistency of the balance sheet items and the
market value of bank wealth, $W_b$.

For many years the Federal Reserve used the level of free reserves as an
indicator of the policy stance. Free reserves is the difference between member
bank excess reserves and member bank borrowing. At other times, excess
reserves fluctuated around a very low level; the Federal Reserve ignored excess reserves and concentrated on member bank borrowing [Meigs (1962), Brunner and Meltzer (1964)]. The level of free reserves is \( R - R' - A \). For a given reserve requirement ratio, the reserve ratio and the ratio of free reserves to total deposits fluctuate together. For a given required reserve ratio and relatively small and unchanging excess reserves, the ratio of borrowing to total deposits dominates movements of the free reserve ratio. Hence the relation of free reserves or member bank borrowing to money, bank credit, interest rates and asset prices can be studied within the framework presented here.

The allocation of the public's financial assets between currency and deposits and the allocation of deposits between demand and time (or saving) accounts affects the stocks of money and credit and, therefore, affects interest rates and asset prices. The ratio of currency to demand (transaction) balances, \( k \), depends on the user cost of currency and deposits and on their respective holding costs. The user costs and holding costs explain major movements in the \( k \) ratio. An increase in the frequency of theft raises the holding cost of currency and lowers desired balances. In countries like Japan, where crime rates are low, currency is used for a large share of the public's transactions. The rapid spread of banking facilities lowers the user cost and the holding cost of deposits. Increased uncertainty about bank failures, as in the thirties, raises the holding costs of deposits, while increased geographic mobility, as in wartime, raises the user cost of deposits. Both types of change increase the \( k \) ratio.

Financial commentators and some economists have speculated that the spread of credit cards, debit cards, automated tellers and other innovations in banking will reduce desired money balances to zero. Automated transfers are predicted to reduce desired demand deposits toward zero. Credit cards and other innovations are predicted to eliminate the use of currency in transactions. These conjectures are implausible. The marginal productivity of currency as a transaction medium is not likely to approach zero. Currency is used to evade taxes, for illegal transactions and for convenience in small transactions [Cagan (1958), Hess (1971)]. It is instructive to note that during the past fifteen years, the currency ratio in the United States has exceeded the level observed in 1929 by more than 100 percent. This suggests that currency continues to be used in optimal payment arrangements.

Banks offer many different types of time and saving deposits. Johanes and Rasche (1987) find it useful to distinguish between small saving and time deposits and large deposits, mainly negotiable certificates of deposit, to represent current U.S. arrangements. We compress the detail into a single ratio, the ratio of non-transaction, \( T_b \), to transaction accounts, \( D_p \). The latter include all checkable deposits. The allocation between transaction and non-transaction accounts depends on the interest rates paid on each type, \( i^d \) on transaction accounts and \( i^l \) on time or non-transaction accounts. In addition,
the allocation depends on the market interest rate, asset price level and on human and non-human wealth. Signs of partial derivatives appear below the arguments of equation (16). These signs indicate the effect of substitution and wealth on the time deposit ratio. An increase in open market interest rates, holding time deposit rates fixed, encourages direct holding of securities, so intermediary deposits – particularly time deposits – decline. Increases in asset prices lower the return on assets; intermediation increases:

\[ t = \frac{T_o}{D_p} = t(i^d, i^t, P, W, H). \] (16)

Banks supply deposit and non-deposit liabilities of various kinds by setting prices or interest rates at which deposit may be taken. For some deposits, interest rates have been controlled by government rulings. The ceiling rate for checkable deposits remained at zero for several decades, but banks offered non-pecuniary returns to deposit holders. We summarize the supply conditions in the price-setting functions shown in (17):

\[ i^d = f_d(i, \ldots), \]
\[ i^t = f_t(i, \ldots), \] (17)
\[ i^n = f_n(i, \ldots), \]

where the omitted variables represent institutional restrictions that condition the degree of competition. The difference between the two deposit interest rates reflects market evaluations of the comparative risk and convenience associated with the different bank liabilities. The various rates are tied together in the market place.

The framework can be expanded to take account of the many different types of deposit accounts that banks hold. Treasury or government agency deposits may be less sensitive to interest rates. Foreign deposits may be more dependent on relative rates of interest at domestic and foreign banks. Each of these different types of deposits could be expressed as a ratio to total deposits with the ratio depending on the relevant variables. These liabilities would then be incorporated explicitly into the money and credit market framework, and the effects of changes in these liabilities could be analyzed.

The stocks of money and bank earning assets, or credit, can be expressed as the product of the monetary base and a multiplier. For the condensed framework with one type of demand or checkable deposits and one type of time (or non-transaction) account, we obtain the money, \( m \), and bank credit, \( a \), multipliers starting with equation (6). Denote the monetary base net of borrowing as \( B^a \). Substituting (14) and the currency ratio, \( k \), and using (16),
we solve for demand deposits and money:

\[ D_v = \frac{1}{(\bar{r} - b)(1 + t) + k} B^a, \quad (18) \]

\[ M = \frac{1 + k}{(\bar{r} - b)(1 + t) + k} B^a, \]

where

\[ m = \frac{1 + k}{(\bar{r} - b)(1 + t) + k} \quad (19) \]

and the components of \( m \) depend on the factors discussed. Similarly, using (13), we solve for the bank credit multiplier:

\[ a = \frac{(1 + n + b - r)(1 + t)}{(\bar{r} - b)(1 + t) + k}. \quad (20) \]

The allocation ratio \( n \) in the numerator of the asset multiplier assures consistency between the values on the balance sheet and market value of wealth, \( W^b \).

If non-bank intermediaries hold currency and deposits at banks, their holdings can be included by letting

\[ C_{nb} = k_2 D_{ab} \quad \text{and} \quad D_{nb} = k_3 T_{ab}. \]

The ratios \( k_2 \) and \( k_3 \) depend on market rates and costs of transacting. The rates paid by non-bank intermediaries affect their share of deposits, so

\[ T_{ab}/T_b = t_2 \]

depends on the rate paid by intermediaries. These adjustments change the precise form of the \( m \) and \( a \) multipliers without changing the general framework.

The detail incorporated in the multipliers extends the analysis of the money-credit process, described in equations (1) and (2), by including many of the institutional arrangements that characterize the U.S. financial system. The equations determine the amount of money supplied by banks and the amount of earning assets demanded by banks given the monetary base, the public's demand for money and supply of earning assets to banks. We can now bring these elements together to solve for interest rates and asset prices and the equilibrium stocks of money and bank credit.
3.3. Money and credit

In the expanded system that includes banks and other intermediaries, the demand for money, \( M^d \), is juxtaposed to the supply of money offered by banks. The demand for money is:

\[
M^d = \lambda(i, P, p, ap, W, H, e),
\]

(21)

where the functional \( \lambda \) is retained for convenience. The equilibrium condition for the money market is:

\[
\lambda(i, P, p, \ldots) = m(i, P, \ldots; i^*)B. \]

(22)

The missing items in the demand function are shown in equation (21); the missing items in the supply function are variables representing institutional arrangements and arguments of the functions determining the ratios such as \( k, t, \) etc. that are components of the money and credit multipliers.

The credit market replaces the market for government debt, equation (2) in the system without intermediaries. On the credit market, interaction of the public and financial intermediaries distributes the stock of debt among asset portfolios. For the public, buying government securities is an alternative to repaying loans, and selling securities is an alternative to borrowing from intermediaries. The choice depends on the relative costs and returns. We define the public’s supply of earning assets as:

\[
\sigma = L_b + S - S_p.
\]

(23)

Equilibrium on the bank credit market requires:

\[
\sigma(i - \pi, P, p, ap, W, H, e, S) = a(i, P, \ldots; i^*)B.
\]

(24)

Equations (22), (24) and (17) determine the market interest rate, the asset price level and the rate paid by banks on their deposit liabilities, given the monetary base, the stock of securities and the stock of capital. The missing signs under \( W \) and \( H \) suggest that the responses of \( \sigma \) to human and non-human wealth are ambiguous as a result of the offsetting responses of \( L_p \) and \( -S_p \).

\[12 \text{The negative responses of } m \text{ to } P \text{ and } i^* \text{ reflect primarily the effects on the deposit ratio.} \]
3.4. Solutions for $i$ and $P$ in the expanded system

We differentiate the money and credit market equilibrium conditions, form partial elasticities, and express the results as interest rate and asset price elasticities of the excess supplies of money ($MM$) and bank credit ($CM$). The signs of these elasticities are identical to the signs of the corresponding elasticities of the system without intermediaries. Their components differ, reflecting the additional information in the expanded system. Equations (25) are the excess supply elasticities:

$$
e(CM, i) = e(a, i) - e(\sigma, i) > 0,$$
$$
e(MM, i) = e(m, i) - e(\lambda, i) > 0,$$
$$
e(CM, P) = e(a, P) - e(\sigma, P) > 0,$$
$$
e(MM, P) = e(m, P) - e(\lambda, P) < 0.$$(25)

The responses of $i$ and $P$ to the policy variables, $B$ and $S$, for given wealth, output, prices and anticipations follow immediately. These responses, expressed as elasticities, summarize the interaction on the asset market and specify the magnitude of the responses transmitted to the output market.\(^{13}\) Equation (26) is the analogue in the system with intermediaries of the responses in equations (4) and (5) earlier. The denominators, denoted $\Delta$, contain the same terms as in the system without intermediaries, although the components of these terms have been modified to encompass intermediary responses as shown in equation (25):

$$
e(i, B | AM) = \frac{e(CM, P) - e(MM, P)}{\Delta} < 0,$$
$$
e(P, B | AM) = \frac{e(MM, i) - e(CM, i)}{\Delta} > 0,$$
$$
e(i, S | AM) = \frac{e(MM, P) e(\sigma, S)}{\Delta} > 0,$$
$$
e(P, S | AM) = -\frac{e(MM, i) e(\sigma, S)}{\Delta} > 0.$$(26)

\(^{13}\)The output market responses can be represented as a linear combination of the asset market responses with coefficients that are ratios of output elasticities on the output and asset markets. See Brunner and Meltzer (1976) and Subsection 2.5 above.
Since \( \varepsilon(CM, i) \) and \( \varepsilon(MM, i) \) are both positive, the sign of \( \varepsilon(P, B) \) requires an assumption about relative orders of magnitude. A basic feature of our analysis is that the responses to interest rates on the credit market are much larger than the corresponding responses on the money market. This reflects the hypothesis that interest rates are proximately determined on the credit market and asset prices are proximately determined on the money market. Empirical work by Brunner and Meltzer (1968) and Korteweg and van Loo (1977) supports the hypothesis. Consequently, we assume:

\[
\varepsilon(CM, i) > \varepsilon(MM, i).
\]

If the two elasticities are equal, the extended range of substitution induced by changes in the base is restricted to the narrower range considered in the IS–LM framework. In general, however, the range of substitution is larger. Monetary impulses are transmitted from the asset markets to the output market by means of asset prices, interest rates and wealth.

The monetary base affects output by changing \( i \) and \( P \). These effects are reinforcing. An increase in the base lowers \( i \) and raises \( P \); both changes are expansive. The corresponding responses of output to government debt are offsetting; an increase in \( S \) raises both \( i \) and \( P \), and a reduction in \( S \) lowers \( i \) and \( P \). The positively correlated changes in \( i \) and \( P \) reduce the effect of debt-financed fiscal policy on aggregate demand and output. Debt-induced crowding out of new investment is small and hard to detect if the two effects are approximately equal.

Figure 9.5 combines the \( MM \) and \( CM \) relations with the price-setting function for \( i^* \), shown as equation (17). The slope of the \( CM \) relation is:

\[
- \frac{\varepsilon(CM, P)}{\varepsilon(CM, i)} < 0,
\]

and the slope of \( MM \) is:

\[
- \frac{\varepsilon(MM, P)}{\varepsilon(MM, i)} > 0,
\]

as in the earlier discussion. The slope of the \( i^* \) relation is unity (up to the level at which interest rates are controlled). If the analysis is extended to include other intermediaries, an additional price-setting function must be added for each intermediary.

The solid lines, \( MM_0 \) and \( CM_0 \), show an initial position of the money and credit-market equilibrium. The position depends on \( B \) and \( S \) and on all of the other variables and institutional arrangements summarized in equations (22)
and (24). The positions of the CM and MM relations determine $i_0$ and $P_0$, the equilibrium values of the interest rate and asset price level. The banking system sets the rate $i'_0$ to correspond to the rate earned on its portfolio, summarized by $i_0$. At the equilibrium position shown in Figure 9.5, the rate $i'_0$ makes wealth owners indifferent between owning securities directly and holding time deposits at banks (or financial institutions). Interest rate $i_0$ and asset price $P_0$ sustain the allocation of assets between money, debt and capital and the allocation of wealth between assets and liabilities. Whenever the open market rate of interest is above the associated rate paid on time deposits, owners of time deposits seek higher yields. They reduce time deposits and purchase debt for their portfolios. Banks (or other financial institutions) lose time deposits and, as the public acquires a larger share of the stock of outstanding securities, the banks' holdings of securities decline. In the terminology that has become common, there is disintermediation. Disintermediation continues as long as the rate paid on time deposits, $i'$, is held below the level consistent with the market rate, $i$.

The analysis shows why efforts to regulate deposit rates in the inflationary conditions of the 1960s and 1970s produced large reductions in time deposits whenever market rates rose above the maximum rate on time deposits. The public bought government securities directly, and new, unregulated intermediaries arose to offer the public assets with attributes very similar to time deposits with regulated rates. The new intermediaries, mainly money market funds, purchased securities directly or purchased unregulated large denomination time deposits, called negotiable certificates of deposit, from banks. Banks indirectly repurchased their deposits by paying rates on the certificates of
deposit consistent with the market rate. In this way, with some excess burden, equilibrium was restored between \( i^* \) and \( i \).

3.5. Response to the base

Figure 9.5 shows the responses to an increase in the stock of base money by the central bank. The increase is shown by the shifts of \( MM \) to the right and \( CM \) to the left, to the positions shown by the broken lines \( MM_1 \) and \( CM_1 \). The shift in \( MM \) is given by

\[
\frac{-1}{\varepsilon (MM, i)} < 0, 
\]

and the shift in \( CM \) by

\[
\frac{-1}{\varepsilon (CM, i)} < 0. 
\]

At the new equilibrium, interest rates are lower and, under the constraint \( \varepsilon (CM, i) > \varepsilon (MM, i) \), asset prices are higher. These initial or impact effects on the asset markets are followed (or accompanied) by changes in output and prices, in the market value of human and non-human wealth, in the expected return to capital and in anticipated prices. The response of these variables to the base and to the reduction in interest rates and the rise in asset prices induced by the increase in base money modifies the initial effects on interest rates and asset prices. Each of the subsequent effects can be analyzed within the framework using the partial elasticities \( \varepsilon(i, p | AM) \), \( \varepsilon(P, p | AM) \), \( \varepsilon(i, e | AM) \), etc. developed in the previous section and in the general equilibrium analysis of Brunner and Meltzer (1976) and Brunner (1976a).

The initial decline in market interest rates, shown in Figure 9.5, reduces the market rate relative to the banks' posted rate on time deposits, \( i_0 \). At the prevailing rates, the public acquires time deposits and sells securities on the open market. Intermediaries acquire a larger share of the outstanding stock of securities. They respond by reducing the posted rate on time deposits toward \( i_1 \). At \( i_1 \), the rate paid by banks on time deposits has adjusted to the equilibrium on the asset markets, so the degree of intermediation remains at its new level.

Reductions in the base have opposite effects. The movement from \( P, i_1 \) to \( P, i_0 \) in Figure 9.5 shows the initial effect of a reduction in the base. If interest rates on time deposits had been fully adjusted to \( i_1 \), time deposit rates are low relative to \( i_0 \). The public acquires securities in the open market and reduces time deposits.
Zero rates of interest on demand deposits induce the public to hold less than the optimal amount of demand deposits. The long-run effect of ceilings on interest rates is expansion of alternatives that avoid the restrictions and the relative decline in the size of institutions that are prohibited from offering substitutes.

3.6. Solutions for money

The response of the money stock to the base and the stock of securities can be written using either the demand or supply equations for money and credit. The two solutions are logically equivalent but not identical. The responses to the base are

\[ e(M, B \mid AM) = e(m, i)e(i, B \mid AM) + e(P, P) + 1 < 1, \]  
\[ e(M, B \mid AM) = e(\lambda, i)e(i, B \mid AM) + e(\lambda, P)e(P, B \mid AM). \]

The two expressions are not equally useful for judging orders of magnitude or for forecasting. We have much more reliable information about some of the elasticities than about others. In the case at hand, the knowledge that \( e(M, B \mid AM) \) is close to unity restricts the values of the elasticities in (27a) and facilitates forecasting the response of the money stock to changes in the base.

The responses of the money stock to \( S \) are given in equations (28):

\[ e(M, S \mid AM) = e(m, i)e(i, S \mid AM) + e(P, P) + e(P, S \mid AM), \]  
\[ e(M, S \mid AM) = e(\lambda, i)e(i, S \mid AM) + e(\lambda, P)e(P, S \mid AM). \]

Offsetting components and small multiplier elasticities suggest that the effect of \( S \) on \( M \), with \( B \) unchanged, is relatively small. Changes in \( S \) induce some substitution between direct ownership of securities and ownership of time deposits – intermediation and disintermediation – but, if deposit interest rates are not controlled, banks respond by changing interest rates paid on their liabilities and quantitative effects on money are small.

The response of the money and credit multipliers to interest rates depends on the response of the multipliers to the time deposit ratio, since the time deposit ratio is a main channel for effects of interest rates on the banks and the money stock. Interest rate ceilings lower \( t \) and reduce the responses of money and credit, mainly by reducing the size of the multipliers’ elasticities. Differen-
tiating (19) and expressing the result as an elasticity, we have:

\[
\frac{\partial m}{\partial t} \cdot \frac{t}{m} = \varepsilon(m, t) = \frac{-(\tilde{r} - b)t}{(\tilde{r} - b)(1 + i) + k} < 0,
\]

which falls in absolute value as \( t \) falls. The effect of \( t \) on the credit multiplier is positive; at a lower \( t \) the multiplier is smaller, and the elasticity with respect to \( t \) is smaller.

The difference between the elasticities of asset and monetary multiplier with respect to the time deposit ratio explains much of the difference in behavior between the money stock and bank credit–bank earning assets. Let \( E \) be the stock of earning assets, loans and securities, held by banks. The response of \( E \) can be represented, analogously to equations (27) and (28), from the banks’ or the public’s accounts:

\[
e(E, B | AM) = \varepsilon(a, i)\varepsilon(i, B | AM) + \varepsilon(a, P)\varepsilon(P, B | AM) + 1
= \varepsilon(\sigma, i)\varepsilon(i, B | AM) + \varepsilon(\sigma, P)\varepsilon(P, B | AM),
\]

and correspondingly:

\[
e(E, S) = \varepsilon(a, i)\varepsilon(i, S | AM) + \varepsilon(a, P)\varepsilon(P, S | AM)
= \varepsilon(\sigma, i)\varepsilon(i, S | AM) + \varepsilon(\sigma, P)\varepsilon(P, S | AM).
\]

More generally, the different response patterns of \( E \) and \( M \) reflect all the relevant multiplier elasticities. We can express this as follows. Let \( x \) refer to any event modifying financial allocations:

\[
e(E, x) - e(M, x) = \left[\varepsilon(a, k) - \varepsilon(m, k)\right]\varepsilon(k, x) + \left[\varepsilon(a, t) - \varepsilon(m, t)\right]\varepsilon(t, x)
+ \left[\varepsilon(a, r) - \varepsilon(m, r)\right]\varepsilon(r, x)
+ \left[\varepsilon(a, b) - \varepsilon(m, b)\right]\varepsilon(b, x) + \varepsilon(a, n)\varepsilon(n, x).
\]

The following patterns can be shown to hold:

\[
es(a, k) < \varepsilon(m, k) < 0; \quad \varepsilon(a, t) > 0 > \varepsilon(m, t); \quad \varepsilon(a, t) > |\varepsilon(m, t)|;
es(a, r) < \varepsilon(m, r) < 0; \quad \varepsilon(a, b) > \varepsilon(m, b) > 0.
\]

The non-deposit liability ratio, \( n \), which occurs in the asset multiplier plays no role in the monetary multiplier. All five components \((k, t, r, b, n)\) produce a larger numerical response of the asset multiplier than of the monetary multi-

plier. The responses of $E$ and $M$ differ. Money and credit do not behave as two sides of a coin.

The responses of the money stock to $B$ and $S$ are shown in Figure 9.6. As before, increases in the base shift the $MM$ line to the right and the $CM$ line to the left, lowering $i$ and raising $P$. The left-hand panel shows the effects on the demand and supply for money. The slope of $\lambda$ depends on the interest elasticity of the demand for money, and the slope of $mB$ depends on the interest elasticity of the money multiplier. The latter reflects the responses of time deposits, borrowing from the central bank and excess reserve holding of banks. The positions of $mB$ and $\lambda$ depend on $P$. An increase in the base moves $mB$ to the left by an amount

$$\left[1 + \varepsilon(m, P) \cdot \varepsilon(P, B|AM)\right] \frac{dB}{B}.$$

The new intersection at $\lambda_i$ and $mB_i$ occurs at the interest rate that clears the money and credit markets, shown at the intersection of $MM_i$ and $CM_i$. The movement from the initial equilibrium at $\lambda_0$, $mB_0$, to the new equilibrium at $\lambda_i$, $mB_i$, can be described using the responses summarized in equations (27a) and (27b). Similarly, the responses of $mB$ and $\lambda$ to a change in $S$ are summarized by the elasticities in equations (28).

An open market operation, $dB = -dS$, has effects on $i$, $P$ and $M$ given in
equation (29):
\[
\frac{di}{i} = \left[ \varepsilon(i, B \mid AM) - \varepsilon(i, S \mid AM) \frac{B}{S} \right] \frac{dB}{B},
\]
\[
\frac{dP}{P} = \left[ \varepsilon(P, B \mid AM) - \varepsilon(P, S \mid AM) \frac{B}{S} \right] \frac{dB}{B},
\]
\[
\frac{dM}{M} = \left[ \varepsilon(M, B \mid AM) - \varepsilon(M, S \mid AM) \frac{B}{S} \right] \frac{dB}{B}.
\]

An implication of (29) is that the magnitude of the responses of \( i \) and \( P \) to changes in the base are not the same for a pure change in the base and an open market operation. When the base changes as part of an open market operation, the response of interest rates to \( S \) strengthens the effect on \( i \) of a pure change in the base. The effect on \( P \) is weaker, since \( \varepsilon(P, S) > 0 \). The effects of open market operations and base changes on the money stock are approximately the same, given the small value of \( \varepsilon(M, S) \) and the weight \( B/S \) which is less than \( \frac{1}{2} \) in the United States.

4. Interest targets, the "engine of inflation" and reverse causation

The monetary authorities in the United States and many other countries adopt interest rate control as a tactical procedure for implementing policy. Interest rate control requires the central bank to adjust the monetary base to offset changes in interest rates. In a formal sense the base replaces the interest rate as an endogenous variable. In the context of the IS–LM framework, interest rate targeting implies that financial shocks can be fully neutralized by passive adjustment of the money stock. This implication is invalid once we introduce a credit market and consider its interaction with the money market.

Let \( u \) be a shock positively affecting \( \sigma \), and \( v \) a shock positively affecting \( \lambda \). The responses of \( P \) and \( B \) to these shocks, under a policy of maintaining the interest rate at a given target level, are given in (30) and (31):

\[
\varepsilon(P, u) = \frac{\varepsilon(\sigma, u)}{\varepsilon(CM, P) - \varepsilon(MM, P)} > 0,
\]

\[
\varepsilon(P, v) = \frac{-\varepsilon(\lambda, v)}{\varepsilon(CM, P) - \varepsilon(MM, P)} < 0;
\]

\[
\varepsilon(B, u) = \frac{-\varepsilon(\sigma, u) \cdot \varepsilon(MM, P)}{\varepsilon(CM, P) - \varepsilon(MM, P)} > 0,
\]

\[
\varepsilon(B, v) = \frac{\varepsilon(\lambda, v) \cdot \varepsilon(CM, P)}{\varepsilon(CM, P) - \varepsilon(MM, P)} > 0.
\]
Positive shocks to $\sigma$ and $\lambda$ have opposite effects on $P$; an increased demand for money reduces $P$ while an increased demand for credit raises $P$. Under quite general conditions, interest rate targeting does not offset the effects of financial shocks.

Under interest rate control policies, positive shocks to $\sigma$ and $\lambda$ increase the stock of base money to offset the movement of interest rates. The response of the base to a unit credit market shock exceeds the response to a unit money market shock if $|\varepsilon(MM, P)| > \varepsilon(CM, P)$. This condition implies that the movements of the base under an interest target procedure are dominated by shifts in the demand for credit and not, as usually described by central bankers, by shifts in the demand for money. The usual conclusion reflects the IS–LM framework in which all financial shocks are analyzed as shocks to the demand for money. A particular example, discussed in Brunner and Meltzer (1966), concerns the interest pegging period. During this period Federal Reserve policy was described frequently as “an engine of inflation”. Our analysis suggests that the IS–LM analysis, on which this conclusion was based, was seriously flawed.

4.1. Engine of inflation

During the years 1941–51 the Federal Reserve held the rate on Treasury bills fixed. The outstanding stock of government securities rose during the first four years of the period under the wartime policy of relying heavily on bond-financed deficits. Equation (30) implies that $P$ should rise under these policies. Fisher and Lorie (1977, pp. 25–26) report that one index of $P$, the time-weighted rate of return on common stocks, rose at a compound annual rate of 51.5 percent in the four years ending December 1945. The base expanded and consumer prices rose at an annual rate of 5 percent, despite price controls during the period. The interest control policy was properly labelled “an engine of inflation” for this period.

After the war, the situation changed. The interest control policy continued, but budget deficits declined, and there were budget surpluses in fiscal year 1947–49 and 1951. The surplus for fiscal 1948 was nearly 20 percent of federal government receipts and more than 24 percent of federal government outlays. Our analysis implies that the large surplus induced a decline in the monetary base under the interest targeting policy and a decline in asset prices. The time-weighted rate of return on common stocks fell to a compound annual rate of 5.7 percent for 1946–49. This is only 11 percent of the return earned under the wartime policies. Consumer prices remained unchanged on average from

\[14\text{The annual rate of increase rose to 11 percent in the two years 1945–57 which include the removal of price controls in 1946.}\]
1948 to 1950. The “engine of inflation” did not function. Instead, the decline in
the monetary base contributed to the first postwar recession.

The experience under the interest rate control policy gives a clear message:
once monetary policy is committed to an interest target, movements of money
are dominated by the principal shocks affecting the credit market. During the
period 1947–50 the shift from wartime budget deficits to relatively large
surpluses was a major factor affecting the credit market. The shift from deficits
to surpluses dominated the movement of the monetary base, the money stock
and the prices of assets and output. The failure of the interest pegging policy to
produce inflation after 1946–47 is largely the result of the evolution of fiscal
policy.

4.2. Reverse causation

The relation between money and aggregate demand is often attributed to
“reverse causation” – the effect of income on money. In the absence of a
theory of money supply, analysis of reverse causation is limited to empirical
studies, most recently so-called tests of “causality” using vector autoregression.
Money supply theory offers an opportunity to go behind the frequently
uninformative patterns of correlation to consider the mechanisms responsible
for reverse causation.

If the base is controlled, the principal means by which output can affect
money is by changing the multiplier. Cyclical changes in the shocks \( u \) and \( v \)
produce corresponding changes in the interest rate. The resulting responses of
the time-deposit ratio and the reserve ratio induce changes in the money (and
asset) multipliers. The currency ratio is also affected by cyclical changes in the
costs of holding and using currency and checkable deposits. In most periods,
the movements of the multipliers induced by the changes in these ratios are too
small to explain the observed positive correlation between money and output
as the consequence of reverse causation.\(^{15}\)

There are some apparent exceptions. One is the period 1931–33. During
these years the failure of the Federal Reserve to serve as lender of last resort
substantially changed the perceived costs of holding currency and bank de-
posits. A series of bank failures induced a flight to currency and a collapse of
the money multiplier. The money stock fell, inducing a further decline in
aggregate income and prices and additional flight to currency. This period
provides evidence on the high cost of an interest target policy and the failure of
the Federal Reserve to function as lender of last resort. It provides little

\(^{15}\)Using Kalman filters to compute unanticipated changes, Meltzer (1985, 1986) finds little
evidence of reverse causation in Britain, Canada, Germany, Japan and the United States under
fixed or fluctuating exchange rates.
information about the determinants of the money stock under less extreme conditions.

The 1870s furnish a second example often used as evidence of reverse causation. Banking facilities expanded rapidly, lowering the cost of using and holding transaction accounts, thereby changing the money multiplier [see Friedman and Schwartz (1963)]. This experience does not fit the pattern described as reverse causation. Movements of the multiplier were not the result of movements of income. Common underlying forces simultaneously increased real income and the multiplier.

Substantial and persistent reverse causation occurs most often when central banks, under fixed exchange rates or interest rate control policies, supply base money or demand. A very elastic supply of loans by the central bank to banks or private groups at comparatively rigid interest rates is a related example. In the absence of such supply conditions governing the monetary base, reverse effects of output or income on money are negligible.

The dependence of reverse causation on institutional conditions offers an opportunity to assess the alternative explanations of the correlation between money and income. If the correlation is the result of reverse causation, the correlation should vanish in some periods and reappear in others. The money–income correlation is not closely or reliably associated with changes in institutional arrangements. It persists under a wide variety of arrangements. This suggests that the correlation is dominated by the effect of money on income.

5. Monetary variability and uncertainty

In 1979 the Federal Reserve announced that greater emphasis would be given to monetary aggregates in the conduct of monetary policy. Market interest rates were permitted to increase to levels not experienced for a century. Control procedures were changed to give increased emphasis to member bank borrowing. Short-term interest rates were allowed to vary over a wider range.

The Federal Reserve did not adopt procedures capable of achieving reliable control of the monetary base. Two features of the institutional arrangements were particularly troublesome. Banks' required reserves were computed based on deposits held two weeks earlier (known as lagged reserve accounting), and the discount rate paid by banks was kept substantially below prevailing market interest rates. Lagged reserve accounting fixed the amount of reserves banks in the aggregate were required to hold. When the Federal Reserve attempted to reduce money growth, reserves declined relative to the amount banks were required to hold to meet reserve requirements. Banks borrowed from the Federal Reserve, at a subsidized rate, thereby increasing money. The Federal Reserve had the options of refusing to supply the additional borrowing or raising the cost of borrowing, but they did not use these options.
One result of this flawed procedure for controlling money was an increase in the variability of money growth and interest rates. Mascaro and Meltzer (1983, p. 494) show that measures of the variability of money growth and short-term interest rates are three times greater when the nine quarters following the change in procedure are compared to the nine quarters preceding the change. The variability of interest rates on long-term debt increased also.

The effects of increased variability of money on interest rates and asset prices can be analyzed if we let the public’s demand for money and short-term securities increase with variability and uncertainty. Our hypothesis is that variability and uncertainty reduce the demand for long-term capital, thereby increasing demand for other portfolio assets. With the change to include $V$, the variability of unanticipated changes in the stock of money, the money and credit market equilibrium conditions are:

$$m(i \ldots)B = \lambda(i, P, V, \ldots),$$

$$a(i \ldots)B = \sigma(i, P, V, \ldots).$$

As before, the money market proximately determines the asset price level, and the credit-market equation proximately determines the interest rate on short-term loans and securities. The responses of interest rates and asset prices to $V$ are:

$$\varepsilon(i, V) = -\frac{\varepsilon(\lambda, V)\varepsilon(CM, P) - \varepsilon(\sigma, V)\varepsilon(MM, P)}{\Delta} > 0,$$

$$\varepsilon(P, V) = \frac{\varepsilon(\lambda, V)\varepsilon(CM, i) - \varepsilon(\sigma, V)\varepsilon(MM, i)}{\Delta} < 0.$$  

Market interest rates increase with variability and uncertainty, and the asset price level falls.

The analysis again suggests the importance of monetary control procedures and other institutional arrangements. By increasing the variability of shocks and, thus, the demand for money and securities, Federal Reserve procedures raised interest rates, lowered asset prices, and imposed an excess burden on the economy during the period. The relatively high level of interest and the lengthy recession brought an end to the attempt to control money growth in the fall of 1982.

6. Monetary control

An ancient theme in monetary economics concerns the inability of the central bank to control money when there are close substitutes for the particular
measure of money the central bank chooses to control. This theme reappeared with heightened emphasis following the deregulation of financial markets. A popular argument is that substitution between types of financial assets weakens monetary control.

James Johannes and Robert Rasche have made semi-annual forecasts of the money multiplier based on the approach discussed in this chapter. These forecasts can be combined with any given path of the monetary base, resulting from the decisions of the central bank, to provide forecasts of the money stock and its rate of growth. Their book [Johannes and Rasche (1987)] summarizes their forecasts and their procedures.

Johannes and Rasche separate the determinants of the money stock into a multiplier and the monetary base, \( M = mB \). They interpret the multiplier as a solution reflecting the interaction of asset markets, and they develop an expression for the money multiplier that differs from equation (19) principally by distinguishing between large and small time deposits. Johannes and Rasche estimate a time-series model for each of the components of the money multiplier separately and obtain a forecast of each component. Combining the separate forecasts, using an equation like (19), yields a forecast of the money multiplier. Each month or quarter forecasts are extended and revised using new information.

Monthly forecast errors have been computed for the entire sample, nearly seven years, and for several subperiods. Forecast errors are unbiased and serially uncorrelated. There is no evidence that forecast errors increased during the recent period of financial deregulation and rapid innovation in financial market instruments and practices.16

Table 9.1 shows the forecast errors for forecasts made beyond the sample period used in the estimation. Forecasts were made for periods up to twelve months ahead.

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<th>Number of observations</th>
<th>Forecast period</th>
<th>Mean absolute percentage error</th>
<th>Standard deviation of percentage error</th>
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<tr>
<td>82</td>
<td>one month</td>
<td>0.0405</td>
<td>0.745</td>
</tr>
<tr>
<td>74</td>
<td>three-month moving average (overlapping)</td>
<td>0.0300</td>
<td>0.439</td>
</tr>
<tr>
<td>62</td>
<td>six-month moving average (overlapping)</td>
<td>0.0335</td>
<td>0.266</td>
</tr>
<tr>
<td>43</td>
<td>twelve-month moving average (overlapping)</td>
<td>0.0453</td>
<td>0.145</td>
</tr>
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16An exception is the period during spring 1980 when President Carter imposed credit controls. After the period ended, forecast error variances returned to their previous range.
The mean absolute percentage forecast error is negligible for periods up to twelve months ahead. The standard deviation declines as the period lengthens. These data suggest that effective monetary control, within ±1 percent of the announced target, is feasible and the case for monetary control much stronger than the case against. One reason is that reported results include periods of substantial variability in money and major changes in financial arrangements. The relatively small forecast errors and variability of errors suggest that even under conditions of substantial innovation, the multiplier is predictable and the money stock controllable if the central bank adopts procedures to control the monetary base.

7. Conclusion

Analysis of the money supply process should provide a framework to guide systematic examination of the implications of alternative institutional arrangements and policy decisions. This chapter presents a framework containing many features of modern financial systems. The system can be extended to include many additional features and a wide variety of financial arrangements. The framework moves beyond standard analyses like IS–LM where bonds and capital are perfect substitutes and where there is only a single interest rate. In such models, control of the single rate permits the central bank to control intertemporal substitution by setting the interest rate at the appropriate level. When there is more than one asset price or interest rate, this is not so. Changes in the stocks of money and debt, to finance the government or to carry out open market operations set off substitution between money, bonds and capital even if a market rate of interest is controlled.

Money supply theory, as presented here, analyzes intermediation and money creation and reduction when money, bonds and capital are less than perfect substitutes in portfolios. The analysis shows the central role of the credit market and its interaction with the money market. A number of applications bring out the differences between the extended model and standard models such as IS–LM. By moving beyond IS–LM, the analysis changes, in a major way, propositions concerning the transmission of monetary impulses and the

17Lindsey et al. (1984) objected to the findings presented by Johannes and Rasche. They emphasize the possible occurrence of a bias in the variance estimation due to the endogeneity of the monetary base produced by an interest target policy. The argument is flawed, however. First, the argument is, at best, suggestive of possible bias. Possibility does not establish relevance. Second, Johannes and Rasche (1987) demonstrate that an endogenous base does not necessarily imply an underestimate of the error variance. Third, the illustrative cases offered by Lindsay et al. involve essentially simultaneous adjustments of multiplier and base in response to various shocks. The estimation techniques based on univariate Arima processes eliminate simultaneous, mutual adjustments.
interpretation of shocks to the demand for money. Furthermore, the framework can be exploited to analyze a wide range of institutional issues encountered in policy discussions. Some examples are given in the chapter.

The chapter analyzes the financial markets on the assumption of given income and price level and given anticipations. Analysis is restricted to a closed economy. These limitations facilitate the discussion of monetary control, the variability of money growth, interest rate targets and other issues used to illustrate the analysis. These limitations can be removed. Interaction with the output market [Brunner and Meltzer (1976)] and the rest of the world [Brunner (1973), Brunner and Meltzer (1974)] does not modify the general emphasis of this chapter.

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*The Employment Game . . . Where Do You Fit?* C. Douglas Mintmier, GSIA. Price: $5.95.