Money, Credit, and Prices in a Real Business Cycle

By ROBERT G. KING AND CHARLES I. PLOSSER*

An important recent strain of macroeconomic theory views business cycles as arising from variations in the real opportunities of the private economy, which may include shifts in government purchases or tax rates as well as technical and environmental conditions.[1] These models are often viewed as incomplete or wrong because they do not generate the widely emphasized, but not easily explained, correlation between the quantity of money and real activity.

This paper integrates money and banking into real business cycle theory. The result is a class of models that can account for the correlation between money and business cycles in terms that most economists would label reverse causation.[2] The main focus of the analysis is on the banking system, building on the earlier work of James Tobin (1963) and Eugene Fama (1980). In our real business cycle model, monetary services are privately produced intermediate goods whose quantities rise and fall with real economic developments.

In the absence of central bank policy response, the model predicts that movements in external money measures should be uncorrelated with real activity. Some preliminary empirical analysis (using annual data from 1953 to 1978) provides general support for our focus on the banking system since the correlation between monetary measures and real activity is primarily with inside money.

Our proposed explanation of the correlation between money and business fluctuations stands in sharp contrast to traditional theories that stress market failure as the key to understanding the relation and interpret monetary movements as a primary source of impulses to real activity. Given the controversies surrounding the main contending hypotheses concerning money and business cycles—the incomplete information framework of Robert Lucas (1973) and Keynesian sticky wage models as revitalized by Stanley Fischer (1977)—it seems worthwhile to consider alternative hypotheses.[3]

*Department of Economics and Graduate School of Management, respectively, University of Rochester, Rochester, NY 14627. A preliminary version of this paper was presented at the Seminar on Monetary Theory and Monetary Policy, Konstanz, West Germany, June 1981. We have benefited from the comments of Robert Barro, Herschel Grossman, John Long, Bennett McCallum, anonymous referees, and participants of seminars at the universities of Rochester, Chicago, Pennsylvania, Harvard, and Princeton. The National Science Foundation and the Center for Research in Government Policy and Business of the University of Rochester have supported this research. The above individuals and institutions should not be regarded as necessarily endorsing the views expressed in this paper.

[1]Robert Lucas (1980) provides an overview of the general equilibrium approach to business cycles. Recent work by Fynn Kydland and Edward Prescott (1982) and by John Long and Plosser (1983) illustrate how these models can mimic key elements of business cycles, including complex patterns of persistence and comovement in economic time-series.

[2]The idea that monetary quantities are endogenous is an old one, but has received little recent emphasis. We find it useful to categorize earlier stories into two broad classes: (*i*) banking system explanations such as ours; and (*ii*) explanations that stress central bank policy response. For example, James Tobin (1970) provides an analysis of a model with endogenous money that emphasizes central bank policy response. Tobin's deterministic treatment involves the Keynesian idea that money and real activity respond to the same causal influence—aggregate demand. In Fischer Black's (1972) analysis, external money passively responds to all variations in money demand including those arising from fluctuations in real activity.

[3]In our view, there are good reasons for dissatisfaction with existing macroeconomic theories. Keynesian models typically rely on implausible wage or price rigidities, from the textbook reliance on exogenous values to the recent more sophisticated effort of Fischer (1977) that relies on existing nominal contracts. As Robert Barro (1977) points out, a key feature of the Fischer model is that agents select contracts that do not fully exploit potential gains from trade. In addition, Costas Azariadis' (1978) micro-based model of wage-employment contracts implies that perceived monetary disturbances do not alter output.

Recent analyses of monetary nonneutrality that stress expectation errors based on "imperfect information" (Lucas, 1977, provides a summary of this viewpoint)

The organization of the paper is as follows. In Section I we describe a simple model that is capable of generating real business cycles. The model is used to discuss correlations between an internal monetary quantity and real activity. In Section II, with fiat money included in the model, we analyze the relation between monetary quantities, output, and the price level in both an unregulated and regulated banking environment. In Section III we discuss some of the empirical implications of the theory and provide a preliminary analysis of the postwar U.S. experience.

I. The Real Economy

In this section we describe a simple model economy in which business cycles arise as a consequence of the intertemporal optimizing behavior of economic agents. Our model has two productive sectors with one intermediate and one final good. The output of the final goods industry is stochastic and serves as either a consumption good or as an input into future production. The output of the financial industry is an intermediate good called transaction services that is used by firms in the final goods industry and by households. The demand for transaction services arises because these services economize on time and other resources required to accomplish the exchange of goods.

Recent real general equilibrium theories of the business cycle (such as Finn Kydland and Edward Prescott; John Long and Plosser) stress produced inputs and interrelations between sectors as central to understanding the persistence and comovement of macroeconomic time-series. The simple model economy that we study has only one final product and thus does not possess such a rich set of dynamics or sectoral interactions. Nevertheless, the framework embodies our view that the output of the financial-banking industry is an input into production and purchase of final goods. This view is consistent with the general focus on produced inputs and sectoral interactions that is the hallmark of real business cycle models.

A. *Final Goods Industry*

The single final product (y) is produced by a constant returns to scale production process that uses labor (n), capital (k), and transaction services (d) as inputs. The production technology is summarized by

$$(1) \qquad y_{t+1} = f(k_{yt}, n_{yt}, d_{yt})\phi_t \xi_{t+1},$$

where k_{yt} is the amount of capital, n_{yt} is the amount of labor services, and d_{yt} is the amount of transaction services used in the final goods industry. Capital services are measured in commodity units allocated to production at time t, labor services are hours worked, and transaction services can be viewed as the number of bookkeeping entries made (described more fully below). We also make the standard assumptions of positive and diminishing marginal products to each factor. The production process is subject to two random shocks, ϕ_t and ξ_{t+1}, that are dated by the time of their realization.

Transaction services in (1) are viewed as an intermediate good purchased by final good producers from the financial industry (to be described below). Although not involved directly in the production of output in the same sense as labor and capital, transaction services are part of a cost-reducing activity similar to other organizational and control inputs.

The sequences $\{\phi_t\}$ and $\{\xi_t\}$ are assumed to be strictly positive stationary stochastic processes that are mutually and serially independent with $E(\phi_t) = E(\xi_t) = 1$. The roles played by the two shocks are quite different. At this point it is sufficient to note that ϕ_t alters *expected* time $t+1$ output and affects time t input decisions by altering intertemporal opportunities. On the other hand, ξ_{t+1} represents the basic uncertainty of the production process by altering output in an *unexpected* manner. The multiplicative na-

similarly rely on an apparent failure in the market for information. For example, information on monetary statistics is cheap and readily available. King (1981) demonstrates that in Lucas' (1973) model, real output should be uncorrelated with contemporaneously available monetary information. John Boschen and Herschel Grossman (1982) empirically investigate this proposition and find that it is rejected by the data.

ture of the randomness in total production implies a technological neutrality of the shocks with respect to individual factors of production. Alternatively, different stochastic elements could be associated with particular factors.

Production is assumed to be under supervision of identical competitive firms. Firms operate by selling claims against the future output and using the proceeds to purchase factors of production. Labor, capital, and transaction services are rented at rental prices w_t, q_t, and ρ_t, respectively. Each firm is assumed to sell one unit of claim for each unit of expected output as determined by $f(k_{yt}, n_{yt}, d_{yt})$, which amounts to defining a "share" in the firm. If the market price of claims is v_t, the firm faces a static maximization problem involving the choice of inputs that maximizes profits, $v_t f(k_{yt}, n_{yt}, d_{yt}) - w_t n_{yt} - q_t k_{yt} - \rho_t d_{yt}$. The assumption of constant returns to scale implies that the firm has a supply of claims that is horizontal at the price v_t^*, corresponding to minimum unit cost at prices q_t, w_t, and ρ_t.

B. *Financial Industry*

The financial industry provides accounting services that facilitate the exchange of goods by reducing the amount of time and other resources that otherwise would be devoted to market transactions. The production of this intermediate good, which we call transaction services, is summarized by the production function (2) in which n_{dt} and k_{dt} are the amounts of labor and capital allocated to the financial sector:

$$d_t = h(n_{dt}, k_{dt})\lambda_t. \tag{2}$$

This instantaneous production structure embodies the hypothesis that production of transaction services requires less time than production of the consumption-capital good. Technological innovation in this industry is captured by λ_t, which is assumed to be a strictly positive stochastic process with a mean of one. Finally, we assume (2) represents a constant returns to scale structure so that, at given factor prices w_t and q_t, the financial industry has a supply curve that is horizontal at a particular rental price, ρ_t^*.

Although at this stage of our analysis we focus on the flow of transaction services, the transaction (banking) industry typically (but not necessarily) provides these services in conjunction with portfolio management or intermediary services. It is convenient to imagine, therefore, that the financial industry holds claims (shares) on the probability distribution of output and issues other claims (deposits). In the process of market exchange, the claims that individuals and firms hold on the bank's portfolio (deposits) are altered through simple bookkeeping entries. Banks pass on to depositors the return to the portfolio of assets less a fee for transaction services.

The structure of the financial industry implies that the direct cost of bookkeeping services, ρ_t, does not depend on the character or composition of the bank's portfolio. As discussed by Fama (1980), it follows that there is no reason to expect homogeneous deposits in an unregulated financial industry. More generally, this conclusion holds so long as the respective portfolio costs and transaction services are borne by portfolio holders and transaction users.

C. *Households*

The individual households in the model are consumers, suppliers of labor services and capital goods, purchasers of transaction services, and ultimate wealth holders. The representative individual is assumed to be infinite lived and possess the intertemporal utility function,

$$U_t \equiv \sum_{j=0}^{\infty} \beta^j u(x_{t+j}, \bar{n} - n_{t+j}), \tag{3}$$

where β is a fixed utility discount factor and $u(\cdot)$ is a single period utility function that depends on consumption (x_{t+j}) and leisure $(\bar{n} - n_{t+j})$ with $\bar{n}$ indicating the total hours available in each period. The utility maximand is the expected utility measure $E_t U_t$, where E_t denotes the conditional (rational) expectation based on all information available at time t.

The representative agent arrives at date t with total wealth equal to the sum of current realized output (y_t) and the depreciated value of the previous period's capital stock ($k_{t-1} - \delta k_{t-1}$). The agent's current decisions involve the selection of the levels of consumption (x_t) and of total effort (n_t) as well as allocation of effort to market and nonmarket activities. These decisions imply a level of saving that then must be efficiently allocated, along with current wealth, to purchases of investment goods (i_t) and financial assets (for example, real bonds, shares, etc.).

Households are assumed to combine time and transactions services to accomplish purchases of consumption and investment goods. In particular, the time required for this nonmarket activity is

$$(4) \qquad n_{\tau t} = \tau(d_{ht}/(x_t + i_t))(x_t + i_t),$$

where $\tau' < 0$, $\tau'' < 0$. Our individual selects an amount of transactions services d_{ht} so as to minimize the total transactions cost, $w_t n_{\tau t} + \rho_t d_{ht}$. So long as hours are freely variable, w_t is the opportunity cost of effort, and this minimization problem can be treated separately from the household's general allocations. (However, efficiently selected transactions patterns will have wealth and substitution effects on desirable household allocations.)

Minimizing the total cost of transactions activities implies a derived demand for purchases of transaction services of the form $d^*_{ht} = g(\rho_t / w_t)(x_t + i_t)$, where $g' = (\tau'')^{-1} < 0$. Similarly, hours allocated to transactions activities are proportional to expenditures, taking the form $n^*_{\tau t} = \tau(g(\rho_t / w_t))(x_t + i_t)$.

The presence of transaction costs for the purchase of consumption and investment goods implies that the total cost of a unit of consumption or investment goods in terms of a unit of output is greater than unity (i.e., $1 + [w_t \tau(g(\rho_t / w_t)) + \rho_t g(\rho_t / w_t)]$). Selection of an optimal pattern of consumption (x_t), total effort ($n_t = n_{yt} + n_{dt} + n_{\tau t}$), and portfolio allocations involves the usual sort of intertemporal efficiency conditions with the exception of this modification. Fischer (1982) provides an interpretation of the altered efficiency conditions in a similar context.

D. *Equilibrium Prices and Quantities*

Analysis of dynamic, stochastic general equilibrium models is a difficult task. One strategy for characterizing equilibrium prices and quantities is to study the planning problem for a representative agent (see Lucas, 1978, or Long and Plosser). This procedure is valid so long as the competitive equilibrium is Pareto optimal. The planning problem can also be used to generate specific equilibria if explicit functional forms for preferences and technologies are assumed.

We do not pursue this strategy in detail as our objective is more modest. Instead, we make a number of simplifying assumptions regarding the general framework proposed above that allow us to highlight the conditions necessary to obtain certain business cycle comovements in general equilibrium.

The state of the economy at date t is summarized by the values of four variables; y_t, $(1-\delta)k_{t-1}$, ϕ_t, and λ_t. The first is a measure of national income, the second is the current stock of depreciated capital, ϕ_t is a technical factor affecting current opportunities to transfer resources intertemporally, and λ_t is a technical factor influencing the production of transaction services. The agent's vector of decisions variables is (n_{yt}, n_{dt}, $n_{\tau t}$, d_{ht}, d_{yt}, k_{yt}, k_{dt}).

In order to simplify the problem, we make three assumptions that are sufficient to reduce the state vector to two elements and the decision vector to two elements while preserving the essential features of the model. First, we assume a depreciation rate of 100 percent, eliminating $(1-\delta)k_{t-1}$ as a state variable. Second, we assume that transaction services are produced deterministically ($\lambda_t = 1$, for all t) and depend only on labor input ($d_t = h_0 n_{dt}$). Deterministic production of transaction services eliminates λ_t as a state variable and the simplified production technology implies that the competitive price is $\rho^*_t = w_t h_0$. This implies that households (and firms below) use time and purchased transaction services in fixed proportions.

The third assumption is to restrict the final goods production function to employ financial services in a manner that is symmetric to households. This means that firms (like households) purchase transaction services, d_{yt}, and allocate labor services to transaction activities in fixed proportions where the scale variable corresponds to total payments to factors of production and thus is closely related to next period's output (for households the scale variable is $x_t + i_t$). The second and third assumptions eliminate n_{dt}, $n_{\tau t}$, d_{ht}, d_{yt}, and k_{dt} from the vector of decision variables.

There is a discounted dynamic programming problem whose solution corresponds to the competitive equilibrium of this simplified model economy. The decision rules for the problem are stationary functions of the state variables y_t and ϕ_t. Rather than solve this problem for an explicit specification of preferences and technologies, the essential features of the interactions between the final goods industry and the financial industry can be analyzed by employing the following restrictions on the decision rules; $0 < \partial k_{yt}/\partial y_t < 1$, $\partial k_{yt}/\partial \phi_t \cong 0$, $\partial n_{yt}/\partial y_t > 0$, and $\partial n_{yt}/\partial \phi_t > 0$.

These restrictions follow from assumptions about preferences and production opportunities. For example, an increase in the amount of the initial stock, y_t, involves additional wealth so that the consumption of final product and leisure are expected to rise. Agents, however, choose to spread some portion of this wealth increment over time and do so by increasing the amount of commodity allocated to capital services so that $0 < \partial k_{yt}/\partial y_t < 1$. The other conditions on the decision rules require stronger restrictions on preferences and production possibilities. For example, an increase in y_t raises the marginal product of labor if capital and labor are complements in production. If the wealth effect on labor supplied, which arises from the increased output of final goods next period, is outweighed by the increase in the real wage (marginal product of labor) then hours worked rises.[4]

Analogously, an increase in ϕ_t involves both wealth and substitution effects. Given current inputs, future production is higher and the current returns to additional units of factors of production are higher. These offsetting effects are analogous to the income and substitution effects of a real interest rate change. Essentially, the small impact of a shift in ϕ_t on the amount of output allocated to capital accumulation ($\partial k_{yt}/\partial \phi_t \cong 0$) reflects the idea that the income and substitution effects on consumption are roughly offsetting. On the other hand, the substitution effect of such shifts on labor supply is presumed to dominate so that $\partial n_{yt}/\partial \phi_t > 0$, which generates procyclical work effort.

Once quantity behavior is determined, equilibrium factor prices, interest rates, and share prices are straightforward to construct. In particular, competitive prices correspond to marginal rates of substitution at optimal planned quantities. For example, there is a riskless commodity interest rate r_t that we discuss below. We also can construct the expected return to shares, $E_t(r_{yt}) = E_t[\phi_t \xi_{t+1} - v_t)/v_t] = (\phi_t - v_t)/v_t$. In our setup, this expected return exceeds the riskless rate, $E_t(r_{yt}) > r_t$, since the holders of these shares must be compensated for bearing production risk.

E. *Inside Money, Credit, and the Real Business Cycle*

In our real business cycle model, a positive correlation (comovement) of real production, credit, and transaction services arises from the general equilibrium of production and consumption decisions by firms and households. The timing patterns among these variables, however, depends on the source of the variation in real output.

Unexpected output events (ξ_t) operate by altering the initial conditions pertinent for economic agents' plans for consumption, investment, and hours of work. As discussed above, an unexpected wealth increment ($\xi_t > 1$) leads to higher net investment than would otherwise have been the case. Furthermore, hours worked also rises so that real output increases and exhibits positive serial correlation. During the course of such an economic expansion, the volume of credit (shares) is also high as firms finance relatively large

[4]This result also requires that the amount of time allocated to transaction activities by firms and household is small relative to total time allocated to market activity or production.

amounts of goods in process. This positive correlation between the total volume of credit and real activity is potentially an important prediction of our framework, especially since evidence presented by Benjamin Friedman (1981) suggests that there is a tighter relation between total credit and output than between the individual components of credit and real activity.

The movements in final goods production induces a higher volume of transaction services demanded by firms and households. Thus, our model generates the positive comovement of output with measures of bank clearings, long noted by empirical researchers in the business cycle area (for example, Wesley Mitchell, 1930, pp. 116–51). Finally, real rates of return move in a countercyclical direction as agents' opportunities to spread wealth over time are subject to diminishing returns (i.e., total time is in fixed supply).

The predictions of our model focus on the flow of transaction services. It is important to provide a link between these flows and the stock of deposits that has been the more traditional focus of monetary analysis. It is convenient to assume that the stock of deposits is proportional to the flow of transaction services and can be represented by γd_t.[5] Under this assumption, our model implies that the volume of inside money (deposits) is positively correlated with output with a rough coincidence in timing. More generally, this may reflect the role of deposits as a store of wealth or a temporary element of the credit process.

At least some cycle episodes, however, are commonly viewed as involving a different timing pattern. For example, traditional business cycle analysts (Arthur Burns and Mitchell, 1946), modern time-series macroeconometricians (Christopher Sims, 1972; 1980),[6] and monetary historians (Milton Friedman and Anna Schwartz, 1963) view monetary variables as "leading" measures of real activity.[7]

One way of generating a different timing pattern is through shifts in the intertemporal opportunities of the economy as a whole. Real events of this type, respresented by ϕ_t, alter agents' allocations of leisure and consumption between the present and the future for a given level of national wealth. A higher than average shock ($\phi_t > 1$), under the assumptions outlined above, expands hours worked with little accompanying change in consumption or capital. The fact that financial services are an intermediate product—which can be produced more rapidly than the final product—leads to an expansion of the quantity of such services and of bank deposits. Consequently, movements in hours worked, interest rates, and security prices, deposits-financial services, and trade credit all occur prior to the expansion of output.[8] The subsequent increment to time $t+1$ wealth (stemming from the joint impact of the exogenous shift, ϕ_t, and agents' responses to that shift) works much like the above discussion of unexpected output events. Typically, we suspect the initial phases of business fluctuations incorporate a combination of both types of shocks (i.e., shifts in current and expected future production possibilities).

II. Currency, Deposits, and Prices

In order to investigate the relation between nominal aggregates and the real business cycle it is necessary to augment the

[5]It is sufficient for our purposes that deposits be related to transaction services by any monotonic increasing function. Although this assumption is a conventional assumption with physical capital, it is nevertheless an *ad hoc* element that is troubling. For example, transaction services do not, in principle, require any specific asset position, as is clear from checking accounts that have overdraft privileges or carry a zero balance at the end of the day. In addition, there are important secular and cyclical variations in the volume of debits relative to the stock of deposits.

[6]Sims (1980) discusses reverse causation of money and output working through central bank operating policies. The present setup is a first step toward the type of small-scale general equilibrium model that is necessary to evaluate the reverse causation argument.

[7]We deliberately employ the idea of a "leading variable" in a loose manner so as to capture the common elements of these alternative discussions.

[8]It is commonly stressed that asset prices and returns incorporate information about predictable components of future output (i.e., ϕ_t). In general equilibrium models such as ours, however, such information is also incorporated into all quantity decisions such as effort, consumption, and investment.

hypothetical economy developed above. In this section, a non-interest-bearing government-supplied fiat currency (dollars) is introduced and the factors affecting its value are analyzed.

In order for currency to be a well-defined economic good, and thus to have a determinate price in terms of a unit of output ($1/P$), there must be a demand function for currency that reflects the economic value assigned to the services of currency by economic agents. For simplicity, we assume that households are the principal demanders of currency. To generate a stable demand for currency, real currency is viewed as a substitute—but not a perfect one—for transactions services purchased from the financial sector. In particular, currency yields a real service flow in that there are some transactions (either of magnitude or character) that are more efficiently carried out using currency than the accounting system of exchange. We revise the household's time spent in transactions activities, equation (4), to reflect these expanded opportunities:

$$n_{\tau t} = \tau(d_{ht}/y_t, c_t/y_t)\, y_t, \tag{5}$$

where y_t is the total market transactions of our household, c_t is the stock of currency purchasing power, and d_{ht} is the flow of financial services purchased from the financial industry.[9]

Thus, a household minimizing its cost of transaction activities will select amounts of $n_{\tau t}$, d_{ht}, and c_t in a manner that is analogous to our earlier discussion. The demands for each input will be a function of the rental price of real currency, $R_t/(1+R_t)$, the effective cost of financial services $\bar{\rho}_t$ and the opportunity cost of time, w_t.

In forming these rental prices, two important assumptions are made. First, there is a market for one-period nominal bonds that bear interest rate R_t. This nominal rate is the sum of the real component, r_t, and an expected rate of inflation, $E(\pi_t)$. Second, if banks are required to hold non-interest-bearing reserves, the returns earned by depositors may not match market rates. Given the proportional link between financial services (d_t) and deposits (γd_t), the effective cost of a unit of deposit services, $\bar{\rho}$, is influenced by this reserve regulation. In the absence of regulations $\bar{\rho}_t = \rho_t$, where ρ_t is the rental price of deposit services in the competitive environment of Section I.

Transactions cost minimization by households implies real demands for currency and financial services of the following forms,

$$c_t = l(\underset{-}{R_t/(1+R_t)}, \underset{+}{\bar{\rho}_t}, \underset{+}{w_t})\, y_t, \tag{6a}$$

$$d_{ht} = \delta(\underset{+}{R_t/(1+R_t)}, \underset{-}{\bar{\rho}_t}, \underset{-}{w_t})\, y_t. \tag{6b}$$

The signs below the arguments denote the signs of the partial derivative (for example, $\partial c_t/\partial \bar{\rho}_t > 0$). These signs are insured if $\tau(\cdot)$ is such that currency purchasing power and financial services are substitutes.

The structure of the markets for currency and financial services is analogous to Fama (1980). As he points out, determinacy of the price level is insured if the government fixes the nominal quantity of currency—direct or indirect regulation of financial sector quantities and/or characteristics is not necessary. Nevertheless, regulations can be important for two reasons. First, regulations produce a differentiated class of suppliers of financial services (banks) whose deposits are sometimes described as inside money. Second, regulations can influence the price level by altering the effective rental price of financial services.

The analysis below focuses on the implications of alternative banking structures for the behavior of currency, deposits, and prices. For clarity, the bulk of the discussion is conducted under the assumption that the treasury-central bank maintains a policy of controlling the issue of nominal currency so that the stock of currency ($C_t = P_t c_t$) is an exogenous random variable. This assumption means that the behavior of the price level can be analyzed by investigating equilibrium in the currency market. Other models of central bank behavior are discussed in Part B below. In all of our discussions, however, the price level is best viewed as being set in the

[9] We assume that $\tau_1 < 0$, $\tau_2 < 0$, $\tau_{11} < 0$, $\tau_{22} < 0$, and $\tau_{12} < 0$.

market for that nominal asset whose quantity the central bank seeks to control.

A. *Money and Prices — Unregulated Banking*

In an unregulated banking environment we assume that the deposit industry would hold virtually no currency. Consequently, the determination of the price level involves the requirement that the real supply of currency (C_t/P_t) be equal to the real demand for currency given by (6a) above. The equilibrium price level is then

$$P_t = C_t/l(\cdot), \tag{7}$$

where $l(\cdot)$ is the demand function for real currency. Using the arguments of $l(\cdot)$ we can rewrite this condition as

$$P_t = P(\underset{+}{C_t}, \underset{-}{y_t}, \underset{+}{R_t}, \underset{-}{\bar{\rho}_t}, \underset{-}{w_t}). \tag{8}$$

The signs of the respective derivatives in (8) are straightforward and warrant little explanation.

An important feature of (8) is the absence of nominal demand deposits. Thus, as stressed by Fama (1980), there is no need for government control of banking or the supply of deposits to insure a determinate price level. Banks, in a competitive, unregulated environment, simply pass portfolio returns on to their depositors less a fee charged for the provision of transactions services, so that $\bar{\rho}_t = \rho_t$. The only way in which developments in the banking sector are relevant to price level determination is through variations in the cost of financial services (ρ_t).

This view of price level determination implies that once and for all changes in the quantity of currency are completely neutral. The volume of transaction services (d_t) and deposits (γd_t) are determined solely by variations in the real economy as discussed in Section I. Nevertheless, the *nominal* quantity of deposits $(P_t \gamma d_t)$ is likely to be positively correlated with real activity if currency is determined exogenously and prices are not excessively countercyclical (see Part C below).

On the other hand, sustained increases in the growth of currency may have real effects. The resulting increased inflation leads to a rise in the nominal interest rate, R, which implies a fall in the demand for real currency and a rise in real transaction services and time allocated to transaction activities. Since an increase in real transaction services involves the use of real resources, the economy is made worse off by sustained inflation. We assume, however, that this increase in the size of the financial sector has no important implications for the real general equilibrium.[10] It is not obvious that this is a good assumption from an empirical point of view. Nevertheless, it does serve to bring into sharp focus the distinction between inside and outside money, particularly with respect to the neutrality and super-neutrality of government currency issue.

B. *Money and Prices — Regulated Banking*

In an unregulated environment the price level is determined in the currency market and deposits play no essential role. There are, however, a number of regulations that serve to distinguish banks from other financial intermediaries and thereby inside money from credit. Here we discuss the extent to which these regulations alter the nature of price level determination. As it turns out, the impact of regulations depends on (*i*) the interaction of banking regulation with the external money supply policy of the central bank-treasury, and (*ii*) the extent to which government mandates can be offset by countervailing private substitutions.

1. *Portfolio Regulations and Reserve Requirements.* It is useful to start by discussing a set of regulations that do not have any important consequences for the price level.

[10] In other words, we assume that our model is approximately "super-neutral" in the language of monetary growth theory. It is worthwhile pointing out that this literature does not provide a clearcut guide to the nature of departures from super-neutrality. For example, Tobin (1965), has argued that an increase in inflation will lower real rates of return and raise capital formation, by lowering the real value of money and, consequently, raising saving. By contrast, Alan Stockman (1981) argues that inflation acts as a tax on the saving process (in which money is an input) and, hence, depresses capital formation.

Suppose that the government specifies the "risk composition" of the underlying assets against which deposits are claims. As long as agents can offset this restriction by rebalancing the contents of their portfolios (i.e., the distribution of total wealth between the banking sector and other portfolio managers), then this regulation will have no impact on any real variables or the price level. However, such restrictions may serve to distinguish inside money for other forms of credit.

On the other hand, restrictions specifying that banks must hold some fraction, say θ, of their nominal asset portfolio in the form of non-interest-bearing reserves issued by the central bank may have important effects. For example, the central bank could specify that reserve accounts are deposits of securities with nominal interest accruing to the central bank. This mechanism is one way of imposing a deposit tax with the consequence that the cost of deposit services would be $\bar{\rho}_t > \rho_t$. Such a deposit tax results in a reduction in the size of the banking sector and an increase in the real demand for currency. The impact of this reserve requirement on price-level determination depends on the central bank policy. For example, if the treasury-central bank makes currency in the hands of the public an exogenous quantity, unresponsive to developments in the banking sector, then the price level continues to be determined by the requirement that the real stock of currency outstanding (C_t/P_t) be equal to the real demand. In these circumstances, the behavior of deposits and deposit services would be similar to that in an unregulated banking system.

2. *Alternative Central Bank Policies.* The currency market determines the price level if the central bank is assumed to make currency an exogenously controlled quantity. There are, however, other control methods available to the central bank. For example, if the central bank combines a reserve requirement with a policy of controlling the sum of currency and nominal bank reserves (high-powered money), then the price level can be viewed as being determined in the market for high-powered money.

Let $B_t = \theta(P_t \gamma d_t)$ be the nominal stock of bank reserves and $H_t = B_t + C_t$ be the exogenous total of bank reserves and currency. Under this regime, the price level may be viewed as arising from the requirement that the total private demand for fiat money equals the supply. That is, $H_t = P_t\{c_t + \theta\gamma d_t\} = P_t\{c_t + B_t/P_t\}$. The equilibrium price level can be expressed as

$$(9) \qquad P_t = H_t/(l(\cdot)+(B_t/P_t)),$$

or using the arguments of $l(\cdot)$,

$$(10) \qquad P_t = P(\underset{+}{H_t}, \underset{-}{y_t}, \underset{+}{R_t}, \underset{-}{\bar{\rho}_t}, \underset{-}{w_t}, \underset{-}{(B_t/P_t)}).$$

Once again the signs of the partial derivatives are straightforward. Note, in particular, that an increase in the demand for real reserves (B_t/P_t) holding high-powered money fixed necessitates a fall in the price level.

A central bank policy of controlling high-powered money, therefore, implies that the equilibrium price level is determined in the market for this exogenously controlled nominal quantity. Consequently, real activity (including real deposit services and real deposits) is neutral with respect to changes in high-powered money and, as in the case of currency, we assume that high-powered money is approximately super-neutral under this regime.

As discussed in Fama (1980, pp. 52–53), there are other central bank policies that could be used to make the price level determinate. In particular, the central bank could choose to make nominal bank reserves an exogenous quantity and supply currency on demand. In this case (which some argue are the current policies of the Federal Reserve), the price level can be viewed as being determined in the market for reserves. The equilibrium price level would be determined by the exogenous supply of nominal reserves (B_t) and the total real demand for deposit services.[11]

[11] We have not yet analyzed price-level determination when the central bank attempts to control the interest rate. However, this may be important to an appropriate empirical investigation of some time periods.

C. *The Price Level and the Real Business Cycle*

Price-level movements in response to the two shocks (ϕ_t and ξ_t) involve two important factors. First, there is the impact of movements in real output on the demand for outside money. Second, there is the impact of nominal interest rates on the demand for outside money. Since variation in the price level also depends on central bank policy, we focus on the case of a regulated banking system with the central bank assumed to make the quantity of high-powered money exogenous.

It is convenient to summarize household and bank behavior in the following demand function for outside money:[12]

$$h_t^d = p_t + \lambda y_t - \psi R_t, \qquad \lambda > 0, \psi > 0,$$

where h_t is the logarithm of high-powered money, y_t is the logarithm of real output, p_t is the logarithm of the price level, and R_t is the nominal interest rate. Using the fact that $R_t = r_t + (E_t p_{t+1} - p_t)$ and the monetary equilibrium condition that $h_t = h_t^d$, it follows that a rational expectations solution for the price level along the lines of Thomas Sargent and Neil Wallace (1975) can be written as

$$p_t = (1+\psi)^{-1}\left\{ \sum_{j=0}^{\infty} (\psi/(1+\psi))^j \cdot E_t\left[h_{t+j} + \psi r_{t+j} - \lambda y_{t+j}\right]\right\}.$$

Unexpected wealth increments ($\xi_t > 1$) lead to a business cycle where output is high and the real rate of return is low. Consequently, a wealth increment leads to lower prices due to both lower real returns and higher income.

In Section I we describe how a better than average opportunity to transfer resources intertemporally ($\phi_t > 1$) leads to an increase in r_t. In addition, the increase in wealth that is brought about by such a shift leads to lower future returns and higher future outputs. Thus, the overall impact on the price level is ambiguous, involving the positive influence of the higher current real return and the negative influence of the lower expected future returns and higher expected future outputs.

The above two examples suggest that the model produces a price level that is likely to be countercyclical. For some macroeconomists, the procyclical character of the general price level is such a well established empirical regularity that this feature alone is sufficient to reject real business cycle theory (for example, Lucas, 1977, p. 20).[13] If it is indeed necessary to generate procyclical price movements, then there appear to be two principle channels. First, an alternative structure that involves a more permanent, capital-augmenting form of technological change could heighten the real return effects discussed above. Combining this structure with a sufficiently interest-sensitive demand for money could lead to procyclical prices. Second, policy response to real activity also could generate procyclical price movements. For example, a positive response of outside money creation to output could lead to a positive correlation between prices and output.

III. Empirical Analysis

The preceding sections describe a simple model economy with business cycles that are completely real in origin. Nevertheless, correlations between real activity and monetary measures arise from the operation of the banking system and central bank policy responses. Here we discuss some of the predictions that our model makes concerning the joint time-series behavior of output, monetary aggregates, rates of return, and the price level. In addition, we discuss U.S. business cycle experience during the post-World

[12] For simplicity, we ignore movements in the cost of deposit services and real wage as important factors affecting the price level.

[13] Recent work using post-World War II data (for example, Robert Hodrick and Prescott, 1980, and Fama, 1982) suggests that the positive correlation between output and price level movements may be not as robust as sometimes thought.

War II period, providing some preliminary empirical evidence that bears on the potential relevance of our theoretical stories.

Before proceeding, it is useful to consider briefly general strategies for investigating the empirical importance of real business cycle theories, and to discuss how the present analysis of money and the price level could be related to such investigations.

One empirical strategy is to isolate a group of observable real disturbances that provide an explanation of much of a particular nation's business cycle experience, in the sense of delivering a good fit. Candidates for such real shocks include government purchase, tax, and regulatory actions; changes in technological and environment conditions, and movements in relative prices that are determined in a world market. The goal is to provide a direct substitute for the high explanatory power of monetary variables found in other business cycles studies (for example, Friedman and Schwartz, and Barro, 1981a). The natural extension would be to study the explanatory power of such real factors for monetary variables and the price level. In our framework, many of these real variables would be restricted to influence monetary quantities (particularly, inside money) through their influence on output and a small set of relative prices. In this sense, aspects of the present type of monetary theory do provide meaningful restrictions on the data.

Another approach is to treat the fundamental real shocks as unobservable and to focus on the interactions between sectors that arise during business cycles; a strategy that is the empirical analogue of the theoretical analysis of Long and Plosser. Since a particular real business cycle theory restricts own- and cross-serial correlation properties of industry output and relative prices, this route can provide valuable information about the regular aspects of business cycles even though the sources of shocks are not identified. Again, the principal testable restrictions of theorizing along these lines would arise from the restricted fashion that variations in production in other sectors were allowed to influence developments in the monetary sector.

Unfortunately, analysis of monetary phenomena using either of these strategies is not feasible given the state of real business cycle models. Consequently, the present empirical investigation is limited to providing some admittedly crude correlations among the variables suggested by the theory.

A. *Summary Statistics*

Summary measures of the series to be discussed below are presented in Table 1. The data are annual (generally yearly averages) for the period 1953–78. We focus on the 1953–78 interval primarily to avoid the period when the Federal Reserve maintained a policy of pegging the yields on U.S. government securities. The implications of such a policy may be very different from those described in the previous section where the central bank controls some nominal quantity.

The most noticeable feature in Table 1 is the different behavior of nominal and real variables. Typically, the growth rates of real variables display much less serial correlation than the growth rates of nominal variables. For example, the growth of real demand deposits is much less autocorrelated than the growth rate of nominal demand deposits. Indeed, as previously noted by Charles Nelson and Plosser (1982), as well as other authors, many real variables are close to random walks in logarithmic form. The most noticeable exceptions to this random walk behavior are real currency (C_t/P_t) and real service charges (ρ_t), both of which display significant positive and persistent serial dependences in growth rates.

B. *Real Factors and Aggregate Output*

This paper is not the appropriate place for an empirical investigation of the role of real factors as impulses to business fluctuations. Barro (1981b), however, provides some results that are pertinent. Specifically, he finds that temporary increases in government purchases have a significant expansionary impact on real output. These results are suggestive and one could investigate the impact of other governmental tax and expendi-

TABLE 1—SUMMARY STATISTICS, ANNUAL DATA: 1953–78

Series	Mean	Standard Deviation	ρ_1	ρ_2	ρ_3	ρ_4
A. Real Variables						
Growth Rate of Real						
GNP (y_t)	.0327	.0249	−.01	−.24	−.12	.29
Wages (w_t)	.0177	.0324	.59	−.00	−.02	.14
Deposits (γd_t)	−.0002	.0226	.36	−.22	−.19	.20
Currency (C_t/P_t)	.0101	.0209	.65	.39	.26	.25
High-Powered Money (H_t/P_t)	.0027	.0253	.40	.33	.08	.19
Reserves (B_t/P_t)	−.0110	.0449	.32	−.01	−.05	−.02
Service Charges (ρ_t)	−.0252	.0601	.81	.69	.66	.56
B. Nominal Variables						
Growth Rate of						
Price Level (P_t)	.0371	.0233	.84	.64	.66	.84
Deposits ($P_t\gamma d_t$)	.0373	.0211	.58	.35	.43	.58
Currency (C_t)	.0481	.0329	.93	.88	.85	.82
High-Powered Money (H_t)	.0398	.0338	.71	.76	.59	.68
Reserves (B_t)	.0260	.0455	.37	.03	.09	.32
Change in the Short-Term Interest Rate (R_t)	.2177	1.4710	.03	−.71	−.29	.68

Note: ρ_i is the sample autocorrelation coefficient at lag i, for $i=1,\dots,4$. The large sample standard error is .20.
Sources: Real *GNP* and the *GNP* deflator are taken from *The National Income and Product Accounts of the United States, 1929–1941* and various issues of the *Survey of Current Business*. Currency in the hands of the public, demand deposits, and bank reserves are from *Business Statistics, 1979*. High-powered money is the sum of currency in the hands of the public and bank reserves. The interest rate is the 4- to 6-month prime commercial paper rate taken from *Banking and Monetary Statistics 1941–1970* and various issues of the *Annual Statistical Digest*. The real wage is average hourly earnings divided by the producer price index, from *Business Statistics, 1979*. Finally, the service charge variable is the ratio of total service charges on demand deposits accrued by Federal Reserve member banks to total check clearings by the Federal Reserve. Both series are taken from *Banking and Monetary Statistics, 1941–1970*, and various issues of the *Annual Statistical Digest*.

ture measures on real activity. More recently, David Lilien (1982) documents the importance of a measure of the dispersion of sectoral shifts in understanding the movements in aggregate unemployment during the postwar period. James Hamilton (1983) presents evidence on the relation between oil price changes and postwar recessions.

Additional evidence on the importance of real disturbances in output fluctuations is offered in Nelson and Plosser. Using an unobserved components model of output and the observed autocovariance structure of real *GNP*, Nelson and Plosser infer that real (nonmonetary) disturbances are the primary source of variance in real activity. This result is based on the commonly held view that monetary disturbances should have no permanent effects on real output, and thus disturbances that are of a permanent nature must be associated with real rather than monetary sources.

C. *Money-Output Correlations*

The theoretical model stresses that real internal monetary balances should be positively correlated with real activity since transaction services are a produced input. Further, the model predicts that autonomous external nominal money creation/destruction is neutral with respect to output growth. These two ideas suggest the value of analyzing money-output correlations in two forms: real vs. nominal balances and internal vs. external monetary measures.

Table 2 presents information on the contemporaneous relations between output growth and growth rates of alternative monetary measures. Equation (i) shows the strong positive contemporaneous correlation that exists between real demand deposits and economic activity. This strong contemporaneous correlation is shared by real external balances measured as currency or as high-

TABLE 2—CONTEMPORANEOUS MONEY-OUTPUT REGRESSIONS
$\Delta \ln y_t = \alpha_0 + \alpha_1 \Delta \ln M_t + \varepsilon_t$

		Independent Variables (M_t)								
		Real Monetary Measures			Nominal Monetary Measures					
Equation	$\hat{\alpha}_0$	γd_t	H_t/P_t	C_t/P_t	$P_t\gamma d_t$	H_t	C_t	R^2	$SE(\hat{\varepsilon})$	ρ_1
(i)	.033[b] (.004)	.740[b] (.167)						.450	.0188	−.08
(ii)	.031[b] (.004)		.510[b] (.103)					.337	.0206	−.18
(iii)	.025[b] (.005)			.664[b] (.202)				.311	.0211	−.01
(iv)	.015 (.009)				.465[b] (.222)			.155	.0233	.10
(v)	.026[b] (.007)					.171 (.146)		.054	.0247	.00
(vi)	.027[b] (.009)						.111 (.153)	.022	.0251	.01
(vii)	.025[b] (.006)	.742[b] (.161)				.176[a] (.108)		.507	.0182	−.11
(viii)	.023[b] (.006)	.784[b] (.162)					.194[a] (.111)	.514	.0181	−.08
(ix)	.017[a] (.010)				.558[a] (.326)	−.080 (.203)		.161	.0238	.10
(x)	.015 (.010)				.661[b] (.307)		.181 (.197)	.185	.0234	.07

Notes: See Table 1; $\Delta \ln(\cdot)$ indicates the change in the log of the variable; R^2 is the coefficient of determination; $SE(\hat{\varepsilon})$ is the standard error of the regression; ρ_1 is the estimated first-order autocorrelation coefficient of the residuals, which has a large sample standard error of .20. Standard errors of the coefficients are shown in parentheses.
[a]Indicates significance at the 10 percent level.
[b]Indicates significance at the 5 percent level.

powered money (equations (ii) and (iii)). In nominal balance form, equations (iv), (v), and (vi) show demand deposits are more strongly correlated with real activity than either of the nominal external money measures. Finally, (vii) and (viii) indicate that nominal high-powered money and currency growth have a weak positive partial correlation with output given real demand deposits.

From the standpoint of our theoretical discussion, the key aspects of these correlations are as follows. First, the fact that much of the correlation with real activity is with internal monetary measures is consistent with our general view of the relation between money and real activity. Second, the fact that currency or high-powered money may be positively correlated with real activity is at odds with our model so long as the monetary authority makes such nominal monetary measures evolve in an autonomous manner.

Table 3 reports some additional regression results that incorporate lags of the alternative monetary measures. Equation (i) shows the results of adding two years of lagged real deposits to the output regression. The F-statistic pertinent for evaluating the marginal contribution of these lags is 2.48, which is well below the 95 percent critical value of 3.49, so that there is no strong evidence that these lags are important. Equations (ii) and (iii) show analogous results for nominal money growth measures.

Equations (iv) and (v) investigate the extent to which nominal money growth is correlated with real activity after accounting for real deposit growth. The contemporaneous and second lag of high-powered money and currency in the hands of the public are not important explanatory variables (the 95 percent critical value for $F(3,17)$ is 3.20 and the F-statistics for the lags of high-powered

TABLE 3—MONEY GROWTH AND OUTPUT GROWTH REGRESSIONS

$$\Delta \ln y_t = \alpha_0 + \sum_{i=0}^{2} \beta_i \Delta \ln \gamma d_{t-i} + \sum_{i=0}^{2} \gamma_i \Delta \ln H_{t-i} + \sum_{i=0}^{2} \delta_i \Delta \ln C_{t-i} + \varepsilon_t$$

		Independent Variables											
		Real Deposits (γd_t)			High-Powered Money (H_t)			Currency (C_t)					
Equation	$\hat{\alpha}_0$	$\hat{\beta}_0$	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\gamma}_0$	$\hat{\gamma}_1$	$\hat{\gamma}_2$	$\hat{\delta}_0$	$\hat{\delta}_1$	$\hat{\delta}_2$	R^2	$SE(\hat{\varepsilon})$	ρ_1
(i)	.034[b]	.644[b]	.135	−.352[b]							.651	.0152	.01
	(.003)	(.159)	(.166)	(.159)									
(ii)	.035[b]				.489[b]	−.399[a]	−.175				.236	.0225	.05
	(.008)				(.239)	(.210)	(.243)						
(iii)	.032[b]							.342	−.577	.262	.068	.0249	.18
	(.010)							(.487)	(.493)	(.360)			
(iv)	.034[b]	.607[b]	.066	−.296[a]	.263	−.229	−.059				.713	.0150	.00
	(.006)	(.160)	(.189)	(.162)	(.182)	(.145)	(.185)						
(v)	.031[b]	.644[b]	.119	−.333[a]				.302	−.313	.017	.674	.0160	.00
	(.006)	(.173)	(.178)	(.171)				(.317)	(.321)	(.238)			
(vi)	.033	.605[b]	.091	−.305[a]	.233[a]	−.233[a]					.710	.0142	.02
	(.003)	(.150)	(.157)	(.151)	(.118)	(.118)							
(vii)	.033	.642[b]	.114	−.343[b]				.297	−.297		.670	.0152	.00
	(.003)	(.158)	(.167)	(.159)				(.280)	(.280)				

Note: See Table 2. Equations (vi) and (vii) are the results of the regressions that constrains $\gamma_0 = -\gamma_1$ and $\delta_0 = -\delta_1$.
[a,b]See Table 2.

money and currency terms are 1.22 and .40, respectively). However, the estimated coefficient on current and lagged high-powered money are opposite in sign and nearly identical in magnitude, so that the change in high-powered money growth appears to be positively correlated with real activity (see equation (vi)).

Overall, our interpretation is that the correlations reported in Tables 1 and 3 indicate that much of the relation between money and real activity is apparently one with inside money, which is comforting given the key role that the banking system plays in our theoretical story.[14] Nevertheless, somewhat weaker correlations between real activity and nominal outside money may exist, suggesting it may be necessary to analyze policy response in greater detail for the 1953–78 period, or to relax our maintained assumption of super-neutrality.

[14]Although we confine our empirical analysis to a comparison of inside and outside money correlations with output, broader measures of financial assets (or credit) should behave similarly to inside money. Friedman presents additional empirical support for this view. He finds that broader measures of money (or credit) exhibit a higher correlation with real output than more narrowly constructed measures.

D. *Money-Inflation Correlations*

The theoretical model predicts that variations in external money, real activity, the nominal interest rate, and a measure of the cost of banking services should be important in explaining movements in the price level. Table 4 provides estimates of the price-level equations (8) and (10) of Section III under the assumption that a log-linear functional form is appropriate. Although the nominal interest rate is endogenous and the above discussion indicates that high-powered money and/or currency may be endogenous due to policy response, ordinary least squares methods are employed. Since there is a substantial empirical literature on price-level/money demand equations, our discussion focuses principally on new aspects that are raised by the theoretical discussion above.

First, the theory suggests that a measure of external money, such as currency or high-powered money, is the relevant nominal ag-

TABLE 4—INFLATION REGRESSIONS

$$\Delta \ln P_t = \alpha_0 + \alpha_1 \Delta \ln M_t + \alpha_2 \Delta \ln y_t + \alpha_3 \Delta R_t + \alpha_4 \Delta \ln w_t + \alpha_5 \Delta \ln \rho_t + \alpha_6 \Delta \ln(B_t/P_t) + \varepsilon_t$$

Equation	$\hat{\alpha}_0$	$\hat{\alpha}_1$	$\hat{\alpha}_2$	$\hat{\alpha}_3$	$\hat{\alpha}_4$	$\hat{\alpha}_5$	$\hat{\alpha}_6$	R^2	$SE(\hat{\varepsilon})$	ρ_1
A. Currency as External Money										
(i)	.027[b]	.474[b]	−.276[b]	−.000	−.224[b]	−.014		.842	.0103	.32
	(.005)	(.098)	(.115)	(.002)	(.097)	(.056)				
(ii)	.025[b]	.457[b]	−.246[b]	.001	−.201[b]	−.029	−.091	.862	.0099	.33
	(.005)	(.094)	(.112)	(.002)	(.094)	(.054)	(.055)			
(iii)	.008	1.00	−.397[b]	.001	−.134	.178[b]		.519	.0158	.39
	(.005)		(.173)	(.003)	(.145)	(.065)				
(iv)	.007	1.00	−.381[b]	.002	−.118	.712[b]	−.058	.521	.0161	.38
	(.006)		(.177)	(.003)	(.150)	(.067)	(.088)			
B. High-Powered Money as External Money										
(i)	.035[b]	.334[b]	−.240	−.002	−.255[b]	−.070		.753	.0130	.29
	(.005)	(.119)	(.144)	(.002)	(.120)	(.068)				
(ii)	.023[b]	.498[b]	−.208[a]	.001	−.165[a]	−.035	−.240[b]	.870	.0096	−.06
	(.005)	(.097)	(.107)	(.002)	(.092)	(.051)	(.058)			
(iii)	.017[b]	1.00	−.386[a]	−.004	−.157	.163[a]		.464	.0202	.07
	(.007)		(.221)	(.003)	(.186)	(.084)				
(iv)	.007	1.00	−.285[a]	.001	−.057	.129[b]	−.362[b]	.735	.0146	−.32
	(.005)		(.161)	(.003)	(.135)	(.061)	(.080)			

Note: See Table 2.
[a,b]See Table 2

gregate for price level determination (Fama, 1982, also advances this hypothesis and provides relevant evidence). Table 4 presents empirical results for both currency and high-powered money.

Second, in the regulated banking environment described in Section II, the relevant cost of deposit services (denoted $\bar{\rho}_t$) involves both the direct cost of providing an accounting system of exchange (denoted ρ_t) and the interest that the bank-depositor must forego due to reserve requirements. The empirical counterpart to the nominal unit cost of deposit services that we have constructed is the ratio of total service charges on demand deposits accrued by Federal Reserve member banks to total check clearings by the Federal Reserve. Deflating this measure by the price level leads to a measure of the real costs of deposit services, entered in Table 4 as ρ_t. However, during some portions of the period under study, banks faced apparently binding constraints on the level of interest payments that could be paid on demand deposits. It is frequently argued that explicit service charges would be reduced as a means of avoiding the interest rate constraint. As a result, we are not completely comfortable with our interpretation of this variable.

Third, our model of transaction costs implies that the real wage is also a pertinent relative price variable for agents in determining the mix of currency and transaction service purchases. As the real wage rises, individuals substitute toward the use of currency and purchased transaction services in market exchange.

Finally, when reserve requirements are present and the central bank is controlling the quantity of high-powered money the theory predicts that the volume of real reserves should negatively influence the price level given the stock of high-powered money. On the other hand, when currency is the controlled external quantity, real reserves should not be relevant.

In Panel A of Table 4, equations (ii) and (iv) report the results of estimating the price level (inverse money demand) equation over the sample period 1953–78, with currency as the measure of external money. The main features of these equations are broadly consistent with other studies: a negative impact of real activity, positive impact of nominal money growth, and minor or negligible impact of the short-term interest rate (4- to 6-month commercial paper rate). Although not included in many other studies, the real wage enters these equations in a manner that is consistent with our theory. If currency is the appropriate measure of external money the theory predicts a zero coefficient on real reserves. In equation (ii) this coefficient is negative but insignificant by the usual criteria. The tendency of our service charge measure to switch sign with the imposition of the unit constraint on currency (iv) is troubling, casting some doubt on the appropriateness of this relative price measure. There also appears to be marginally significant residual autocorrelation in these equations.

In Panel B of Table 4, equations (ii) and (iv) report analogous results for high-powered money as the measure of external money with general features that are again broadly consistent with other studies. Under our theory, real bank reserves should enter negatively in such price level equations if high-powered money is the controlled measure of external money. This is borne out by significant negative coefficients in both the unconstrained equation (ii) and constrained equation (iv). As before, the service charge variable has a tendency to change sign when the unit constraint on high powered money is imposed.

Overall, the results of Table 4 are broadly consistent with the theoretical stories told in the sections above. The negative influence of real reserves on the price level potentially is important, both in terms of explaining postwar price-level behavior and in explaining the apparently anomalous behavior of the price level during the interwar period. Finally, additional work needs to be done in producing measures of the market prices of bank services.

IV. Conclusions

This paper describes a class of real business cycle models that is capable of accounting for the relation between money, inflation, and economic activity, providing a coherent alternative framework to the monetary theories of the business cycle advanced by Lucas (1973) and Fischer (1977). Although the empirical work presented is simplistic, we draw two main lessons from it. First, much of the contemporaneous correlation of economic activity and money is apparently with inside money, with inflation principally resulting from changes in the stock of fiat (or outside) money and variations in real activity. This empirical observation implies that care should be taken in empirical studies to distinguish inside from outside money. Second, future work along these lines may have to consider policy responses that are broad enough to produce variations in outside money that are correlated with real activity.

A main direction of our future work in this area will be to develop the implications of the analysis for security returns so that the general equilibrium predictions for these variables can be exploited in tests of the model. This topic is especially important because Sims (1980) and Fama (1981) have provided some hints about the interrelationship of money, asset returns, and real activity.

In conclusion, it seems worthwhile to discuss two recurrent comments on this line of research that we have received. First, there has been a surprising willingness on the part of many individuals to simultaneously argue that our model (a real business cycle model with an explicit banking sector and central bank) is probably observationally equivalent to many existing monetary theories *and* that a "common sense" view leads one to prefer alternative models as descriptions of reality.[15] This line of argument puzzles us, since it was presumably on empirical grounds (not common sense) that the profession rejected pre-Keynesian "equilibrium theories" of the business cycle that stressed real causes of economic fluctuations.

Second, some individuals have argued that market failure is central to both the understanding of cyclical fluctuations and the primary reason for economists to study these phenomena. Our view is that widespread market failure need not be a necessary component of a theory of business fluctuations, and that real equilibrium business cycle theory promises to make important contributions to positive economics. This perspective, however, is not inconsistent with the view

[15]Grossman (1982) makes an explicit statement of this view.

that the accumulation of scientific knowledge may lead to the design of more desirable government policies toward business fluctuations (such as tax and expenditure policies) or toward the regulation of the financial sector.

REFERENCES

Azariadis, Costas, "Escalator Clauses and the Allocation of Cyclical Risks," *Journal of Economic Theory*, June 1978, *18*, 119–55.

Barro, Robert, (1981a) "Unanticipated Money Growth and Economic Activity in the U.S.," *Money, Expectations, and Business Cycles*, New York: Academic Press, 1981, ch. 5.

______, (1981b) "Output Effects of Government Purchases," *Journal of Political Economy*, December 1981, *89*, 1086–121.

______, "Long-Term Contracting, Sticky Prices and Monetary Policy," *Journal of Monetary Economics*, July 1977, *3*, 305–16.

Black, Fischer, "Active and Passive Monetary Policy in a Neo-Classical Model," *Journal of Finance*, September 1972, *27*, 801–14.

Boschen, John and Grossman, Herschel, "Tests of Equilibrium Macroeconomics Using Contemporaneous Monetary Information," *Journal of Monetary Economics*, November 1982, *10*, 309–34.

Burns, Arthur A. and Mitchell, Wesley, *Measuring Business Cycles*, New York: National Bureau of Economic Research, 1946.

Fama, Eugene, "Banking in the Theory of Finance," *Journal of Monetary Economics*, January 1980, *6*, 39–57.

______, "Stock Returns, Real Activity, Inflation and Money," *American Economic Review*, September 1981, *71*, 545–65.

______, "Inflation, Output and Money," *Journal of Business*, April 1982, *55*, 201–31.

Fischer, Stanley, "Long-Term Contracts, Rational Expectations, and the Optimal Money Supply Role," *Journal of Political Economy*, February 1977, *85*, 191–205.

______, "A Framework for Monetary and Banking Analysis," Working Paper, Massachusetts Institute of Technology, July 1982.

Friedman, Benjamin, "The Relative Stability of Money and Credit Velocities in the United States: An Overview of the Evidence," Working Paper, Harvard University, November 1981.

Friedman, Milton and Schwartz, Anna, *A Monetary History of the United States*, Princeton: National Bureau of Economic Research, Princeton University Press, 1963.

Grossman, Herschel, Review of James Tobin's *Asset Accumulation and Economic Activity*, in *Journal of Monetary Economics*, July 1982, *10*, 134–38.

Hamilton, James, "Oil and the Macroeconomy Since World War II," *Journal of Political Economy*, April 1983, *91*, 228–48.

Hodrick, Robert and Prescott, Edward, "Post-War U.S. Business Cycles: An Empirical Investigation," Working Paper, Carnegie-Mellon University, November 1980.

King, Robert, "Monetary Information and Monetary Neutrality," *Journal of Monetary Economics*, March 1981, *7*, 195–206.

Kydland, Fynn and Prescott, Edward, "Time to Build and Aggregate Fluctuations," *Econometrica*, November 1982, *50*, 1345–70.

Lilien, David, "Sectoral Shifts and Cyclical Unemployment," *Journal of Political Economy*, August 1982, *90*, 777–93.

Long, John and Plosser, Charles, "Real Business Cycles," *Journal of Political Economy*, February 1983, *91*, 39–69.

Lucas, Robert, "Some International Evidence on Output-Inflation Tradeoffs," *American Economic Review*, June 1973, *63*, 326–34.

______, "Understanding Business Cycles," in K. Brunner and A. Meltzer, eds., *Stabilization of the Domestic and International Economy*, Vol. 5, Carnegie-Rochester Series on Public Policy, *Journal of Monetary Economics*, Suppl. 1977, 7–29.

______, "Asset Prices in an Exchange Economy," *Econometrica*, December 1978, *46*, 1429–48.

______, "Methods and Problems in Business Cycle Theory," *Journal of Money, Credit and Banking*, November 1980, *12*, 696–715.

Mitchell, Wesley, *Business Cycles: The Problem and Its Setting*, New York: National Bureau of Economic Research, 1930.

Nelson, Charles and Plosser, Charles, "Trends and Random Walks in Macroeconomic Time Series: Some Evidence and Implications," *Journal of Monetary Economics*, September 1982, *10*, 139–62.

Sargent, Thomas and Wallace, Neil, "Rational Expectations, the Optimal Monetary Instrument and the Optimal Money Supply Rule," *Journal of Political Economy*, April 1975, *83*, 241–54.

Sims, Christopher, "Money, Income, and Causality," *American Economic Review*, September 1972, *62*, 540–52.

______, "Comparison of Interwar and Postwar Business Cycles: Monetarism Reconsidered," *American Economic Review Proceedings*, May 1980, *70*, 250–57.

Stockman, Alan, "Anticipated Inflation and the Capital Stock in a Cash-in-Advance Economy," *Journal of Monetary Economics*, November 1981, *8*, 387–94.

Tobin, James, "Commercial Banks as Creators of 'Money'," 1963; reprinted in *Essays in Economics*, Vol. 1: *Macroeconomics*, North-Holland: Amsterdam, 1971, ch. 16.

______, "Money and Economic Growth," 1965; reprinted in *Essays in Economics*, Vol. 1: *Macroeconomics*, North-Holland: Amsterdam, 1971, ch. 9.

______, "Money and Income: Post Hoc Ergo Propter Hoc?," 1970; reprinted in *Essays in Economics*, Vol. 1: *Macroeconomics*, North-Holland: Amsterdam, 1971, ch. 24.

Board of Governors of the Federal Reserve System, *Annual Statistical Digest*, Washington, various issues.

______, *Banking and Monetary Statistics, 1941–1970*, Washington, 1976.

U.S. Department of Commerce, *Business Statistics, 1979*, Washington, 1979.

______, *National Income and Product Accounts of the United States, 1929–1974*, Washington.