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Inflation, Output, and Money

Money-demand theory and the quantity theory of money are used to study the inflation process. As predicted by the model, monthly, quarterly, and annual data indicate that inflation is positively related to money growth rates and negatively related to growth rates of real activity. The theoretical and empirical origins of stagflation are explained, and changes in monetary arrangements to simplify the control of inflation are prescribed.

This paper uses money-demand theory and a rational-expectations version of the quantity theory of money to study inflation in the United States during the post–Korean War period. The major results are as follows.

1. The theory and tests explain the phenomenon of stagflation, that is, the negative relation between inflation and real activity observed during the post-1953 period. The analysis calls into question the many variants of the Phillips curve which presume that inflation–real activity relations are positive.

2. Consistent with the models of Patinkin (1961) and Fama (1980), monthly, quarterly, and annual data indicate that the base (currency plus reserves held against deposits) is the relevant monetary variable in the inflation process and that demand deposits are irrelevant. The direct policy implication is that the base is the key monetary variable in the control of inflation.

3. The most convincing evidence for the simple quantity-theory view of inflation proposed here comes from the comparison of the conditional ex-

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pected inflation rates it provides with the assessments of expected inflation rates built into interest rates. In a world of efficient capital markets or rational expectations, interest rates contain the best possible forecasts of inflation. From this viewpoint, the finding that the quantity-theory inflation regressions replicate the forecasts implicit in interest rates suggests that, at least for the post-1953 period, the simple quantity theory is close to the best one can do in modeling inflation.

I. Theoretical Background

The theoretical basis for the analysis of inflation is money-demand theory interpreted from the viewpoint of a simple rational-expectations version of the quantity theory of money of Irving Fisher (1911). We shall not review the money-demand model in detail since good summaries of both theory and empirical evidence (e.g., Laidler 1977) are available. In brief, for empirical purposes, the demand for money function is represented, in differenced form, as

$$\Delta \ln m_t = \Delta \ln M_t - \Delta \ln P_t = b_0 + b_1 \Delta \ln A_t + b_2 \Delta \ln R_t + \epsilon_t, \quad (1)$$

where m_t and M_t are the quantities of real and nominal money, P_t is the price level, A_t is a measure of anticipated real activity, R_t is one plus the nominal interest rate, ϵ_t is a random disturbance, and Δ indicates the difference of the relevant variable.

The theory postulates that $b_2 < 0.0$, that is, the demand for money at time t is negatively related to the rate of interest set at t, since the interest rate is the opportunity cost of holding a unit of money which generates returns in the form of transactions services rather than generalized purchasing power. On the other hand, $b_1 > 0.0$, that is, more real money is demanded at time t to accommodate the larger volume of transactions generated by a higher level of real activity anticipated for the near future. We take the assumption that money demand is forward-looking with respect to real activity to be the essence of a rational-expectations model of money demand.

To specify the endogenous and exogenous variables in (1), we adopt a simple rational-expectations version of the Fisherian quantity theory of money. Thus, real activity is assumed to be determined outside of the monetary sector. Within the monetary sector, the price level is the major endogenous variable, while money is exogenous or causal with respect to prices. Finally, we argue shortly that in an efficient or rational bond market, that is, a market which understands both the simple quantity theory and the model of money demand, the interest rate set at time t is "largely" exogenous with respect to the price level set at t. With real activity, money, and the interest rate exogenous, the money-demand equation becomes a model for inflation. From (1) we obtain:

$$\Delta \ln P_t = -b_0 - b_1 \Delta \ln A_t - b_2 \Delta \ln R_t + b_3 \Delta \ln M_t + \eta_t, \quad (2)$$

where $\eta_t = -\epsilon_t$, $b_3 = 1.0$, and the other parameters are as in (1).

Money-demand theory, interpreted from the viewpoint of the quantity theory of money described above, says that, for given values of the interest rate and anticipated real activity, the demand for real money is unaffected by exogenous changes in nominal money, so the latter must be accommodated by proportionate changes in the price level; that is, b_3 in (2) is equal to 1.0. Likewise, controlling for variation in nominal money and anticipated real activity, a negative relation between real money demanded and the interest rate ($b_2 < 0.0$ in [1]) implies a positive relation between the inflation rate and the change in the interest rate in (2). Finally, money-demand theory says that a fall in anticipated real activity lowers the demand for real money, which, given nominal money and the rate of interest, is accommodated by a rise in the price level. In other words, controlling for variation in other variables, a positive relation between money and real activity in the money-demand equation ($b_1 > 0$ in [1]) implies a negative relation between the inflation rate and the anticipated growth rate of real activity in (2). A major hypothesis of this paper is that this negative relation between inflation and real activity, with real activity assumed to cause inflation, is the key to the post-1953 phenomenon of stagflation.

There is a long debate in the literature as to what is the appropriate measure of real activity in the money-demand function. The original quantity theory of Fisher and modern developments of inventory models of the transactions demand for money (e.g., Baumol 1952; Miller and Orr 1966) call for a measure of real transactions in money. On the other hand, Keynes (1936) and Friedman (1956) treat money as a portfolio asset whose demand depends on wealth. In empirical applications, the difficulties in measuring wealth and transactions have commonly led proponents of both approaches to use some measure of income, for example, real GNP, as the activity variable in empirical money-demand functions. The activity variables used here are real GNP and industrial production.

There is also a long debate in the literature about what is appropriately called money. The transactions approach to money demand leans toward those monetary aggregates, for example, currency and demand deposits, that are used in exchange. Friedman's approach to the demand for money as a portfolio asset leans toward a broader definition, including at least time deposits in addition to currency and demand deposits. In contrast, Patinkin's (1961) analysis of price-level determination suggests that if, as here, money-demand theory is used to model the inflation process, a narrow definition of money is appropriate. Fama's (1980) application of Patinkin's model to U.S. monetary institutions indicates that the relevant monetary aggregate is the base, that is, currency plus the zero interest reserves held by banks against deposits. We consider these arguments in detail later, after having established that base growth rates consistently dominate the growth rates of demand deposits or M1 (currency plus demand deposits) in the inflation regressions.

II. Some Perspective

Money-demand theory is sufficiently flexible to be consistent with different stories concerning which of the variables in (1) and (2) are endogenous or exogenous. The simple quantity theory viewpoint taken here treats real activity as exogenous. This presumption is implicit in most of the empirical money-demand literature since real activity measures are generally used as explanatory variables. There is, however, a segment of the literature, motivated by the work of Friedman (1968), which argues for feedback from the monetary sector to real activity. For example, in the rational-expectations model of Lucas (1972), unexpected monetary shocks impulse real activity. This hypothesis leads to empirical work (e.g., Barro 1978) in which real activity is the dependent variable in regressions that are entirely in the spirit of money-demand theory.

In the classical quantity theory and in the modern quantity theory that has evolved from the work of Friedman (1956), money is treated as exogenous and inflation as endogenous. However, there are models, like those of Black (1972) or even Keynes (1936), that are in the spirit of money-demand theory but in which inflation and real activity are largely exogenous to the monetary sector while money is endogenous. Finally, there are many models and much empirical work (e.g., Mishkin 1981) in which the interest rate is endogenous to the monetary sector because it is in part determined by money growth rates or by expectations of inflation.

Being somewhat of an inexact science, macroeconomics often puts us in the position of learning something from different models which, in a strict sense, are mutually inconsistent. This is the case with respect to the different views of money-demand theory outlined above. We have learned much about money demand from the many direct estimates of (1) in the money-demand literature; and, regardless of quarrels over details, we learn something about the interrelations among output, interest rates, and money from the work of Barro (1978) and Mishkin (1981).

This is the spirit in which I would like the reader to judge the empirical work below. A simplified quantity theory in which real activity and money are assumed to be exogenous with respect to inflation is used to provide theoretical justification for regression estimates of inflation equations. The goal is not to test whether the model is exact in its details (like any model, it surely is not) but rather to examine how far such a simple view can carry us toward a description of inflation. At a minimum, the exercise is worthwhile if it teaches us something about systematic empirical relations even though, like any such empirical analysis, it cannot resolve all issues with respect to causation.

For example, if one interprets (2) as a legitimate inflation function, the regression estimates lead to an explanation of stagflation with definite causal features. However, even interpreted as an exercise in multiple correlation and thus devoid of causal overtones, the estimates of (2) uncover relations among inflation, money, and real activity which are consistent with any version of money-demand theory and which manifest themselves as the phenomenon of stagflation.

III. Annual Inflation, Output, and Money

A. The Data

Table 1 shows summary statistics (autocorrelations, means, and standard deviations) for the variables used in estimating the inflation model on annual data for the post-1953 period. The variable I_t is the inflation rate from December of year $t - 1$ to December of year t as calculated from the seasonally unadjusted U.S. Consumer Price Index

TABLE 1 Summary Statistics for Annual Data: 1953–77

Variable	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	$\bar{x}$	s(x)
I_t	.72	.41	.37	.36	.28	.034	.028
BG_t	.73	.67	.59	.46	.33	.046	.031
DDG_t	.30	.07	.26	.42	.27	.037	.024
$M1G_t$	.50	.33	.45	.51	.36	.039	.024
$DRGNP_t$	−.03	−.24	−.07	.26	−.06	.032	.025
DPR_t	−.09	−.42	.13	.20	−.15	.037	.059
DTB_t	−.01	−.46	−.22	.25	.03	.001	.013

NOTE.—The variable I_t is the inflation rate for year t; BG_t, DDG_t and $M1G_t$ are the growth rates of the base, demand deposits, and M1; $DRGNP_t$ and DPR_t are the growth rates of real GNP and industrial production; DTB_t is the change from the end-of-year $t - 1$ to the end of year t in the annualized, continuously compounded rate of interest on a three-month Treasury bill. The table shows the sample mean of each variable, $\bar{x}$, its standard deviation, s(x), and five autocorrelations, ρ_τ. Under the hypothesis that the population autocorrelations are zero, the standard error of the sample autocorrelations is about .20.

(CPI). The variables BG_t, $M1G_t$, and DDG_t are, respectively, the December–December growth rates of the monetary base, M1, and the demand deposit component of M1, all calculated from seasonally unadjusted data provided by the Federal Reserve Bank of St. Louis. The variable DPR_t is the growth rate of the Federal Reserve Board's seasonally unadjusted Industrial Production Index (IPI) from December of year $t - 1$ to December of year t, and $DRGNP_t$ is the growth rate of total annual real GNP (nominal GNP adjusted by the GNP deflator) from year $t - 1$ to year t. Note that the industrial production growth rate, like the three money growth rates, is based on December–December monthly data, whereas the real GNP growth rate is based on annual totals. One can argue for either sort of measure, but the results do not indicate that the choice is important. Finally, DTB_t is the change in the annualized continuously compounded rate of interest on a 3-month Treasury bill observed at the end of years $t - 1$ and t. The Treasury bill rates are from the quote sheets of Salomon Brothers and are described in more detail in Fama (1976*a*, chap. 6).

Several features of the autocorrelations in table 1 are of interest. The autocorrelations of DPR_t and $DRGNP_t$, the growth rates of industrial production and real GNP, are close to 0.0, as are the autocorrelations of the change in the interest rate, DTB_t. On the other hand, the inflation rate, I_t, and the growth rates of the monetary aggregates, BG_t, DDG_t, and $M1G_t$, have substantial autocorrelations which show little tendency to decay toward zero at longer lags. Thus, even the differenced forms of the money and price variables may be mean nonstationary. When inflation regressions are estimated, it will be important to check that the regressions succeed in transforming the inflation rates into stationary residuals.

Moreover, the autocorrelations in table 1 imply that, if the inflation regressions are to transform the highly autocorrelated inflation rates into stationary residuals, the task falls largely on money growth rates, since the other explanatory variables in (2), the change in the interest rate and the growth rates of real activity, show little autocorrelation. Note also that, of the three money growth rates, the autocorrelations of the base growth rate are most similar to those of the inflation rate.

B. The Inflation Regressions

Table 2 shows the estimates of annual inflation regressions. The first important issue for model specification addressed in these tests is the dating of the explanatory variables in the inflation process. Theory is far from silent on the matter.

1. *Statistical hypotheses.* The rational-expectations view of the transactions model of money demand predicts that real money is demanded at time t to accommodate real transactions expected in the

near future. Thus, money demand is forward-looking with respect to real activity. Real money demanded at t also depends on the opportunity cost of money (the nominal interest rate) observed at t. Conversely, when the money-demand model is viewed as a model of inflation, the hypotheses are that the inflation rate from $t - 1$ to t depends positively on the actual rate of change of money and the change in the interest rate from $t - 1$ to t and negatively on the expected rates of change of real activity from $t - 1$ to t and from t to $t + 1$. Thus, like the rational-expectations-money-demand model from which it derives, the inflation model is forward-looking with respect to the effects of real activity.

The role of the nominal interest rate in the hypotheses about the specification of the inflation equation warrants amplification. The one-period interest rate set by a rational bond market at time t is a complete measure of the opportunity cost of holding a unit of (noninterest-bearing) nominal money from t to $t + 1$. This opportunity cost contains two components: the equilibrium expected real return from t to $t + 1$ on a one-period bond which is as risk free in nominal terms as a unit of money, and the rationally assessed expected inflation rate from t to $t + 1$. The expected inflation rate, in turn, depends on the price level for goods set at t and the expected value at t of the price level to be set at $t + 1$.

Since the bond market is assumed to be rational, it understands that the price level at $t + 1$ will be determined by the money supply and interest rate observed at $t + 1$ and by expectations of real activity from $t + 1$ to $t + 2$. The bond market uses these rational expectations about price-level determination in assessing the expected value at t of the price level to be determined at $t + 1$. Through this process, the interest rate set at t captures the information about money growth beyond time t and real activity growth beyond time $t + 1$ which is relevant in setting the price level at time t. In short, in terms of the inflation equation, the hypothesis is that only actual money growth from $t - 1$ to t and expected real activity growth from $t - 1$ to t and from t to $t + 1$ are directly relevant in determining the inflation rate from $t - 1$ to t. The effects of expectations of money and real activity growth rates further into the future are captured by the change in the interest rate from $t - 1$ to t.

The interest rate and price level set at time t are, of course, simultaneously determined. Moreover, the money-demand model says that the price level depends on the interest rate. The interest rate is in turn related to the price level set at t but only algebraically; that is, to transform its expectation of the price level at $t + 1$ into an expected inflation rate, the bond market needs the price level set at t. However, there is no information in the price level set at t which is needed by a rational or efficient bond market to assess the expected price level for

TABLE 2

ANNUAL INFLATION REGRESSIONS: 1954-76*

Model No.	Estimated Regressions	R^2	$s(\eta)$	ρ_1	ρ_2	ρ_3
	Inflation and the Base					
(1)	$I_t = \underset{(5.62)}{.025} + \underset{(.88)}{.22}\,DTB_t + \underset{(3.04)}{.38}\,BG_t + \underset{(2.44)}{.30}\,BG_{t-1} + \underset{(.25)}{.03}\,BG_{t+1} - \underset{(7.02)}{.31}\,DPR_t - \underset{(-4.20)}{.19}\,DPR_{t+1} - \underset{(-2.79)}{.11}\,DPR_{t-1} + \eta_t$	.91	.0086	.10	-.06	-.06
(2)	$I_t = \underset{(5.77)}{.025} + \underset{(3.07)}{.38}\,BG_t + \underset{(2.77)}{.33}\,BG_{t-1} - \underset{(-.02)}{.00}\,BG_{t+1} - \underset{(-8.38)}{.28}\,DPR_t - \underset{(-5.40)}{.21}\,DPR_{t+1} - \underset{(-2.67)}{.10}\,DPR_{t-1} + \eta_t$	.91	.0085	.05	-.08	-.00
(3)	$I_t = \underset{(6.00)}{.025} + \underset{(3.68)}{.38}\,BG_t + \underset{(3.18)}{.33}\,BG_{t-1} - \underset{(-9.02)}{.28}\,DPR_t - \underset{(-6.24)}{.21}\,DPR_{t+1} - \underset{(-2.86)}{.10}\,DPR_{t-1} + \eta_t$	.91	.0083	.06	-.08	-.01
(4)	$I_t = \underset{(4.99)}{.023} + \underset{(8.51)}{.65}\,BG_t - \underset{(-7.61)}{.29}\,DPR_t - \underset{(-4.89)}{.19}\,DPR_{t+1} + \eta_t$	.86	.0106	.16	-.02	.04
(5)	$I_t = \underset{(8.71)}{.039} - \underset{(-1.03)}{.19}\,DTB_t + \underset{(4.94)}{.48}\,BG_t + \underset{(3.48)}{.33}\,BG_{t-1} - \underset{(-.98)}{.11}\,BG_{t+1} - \underset{(-4.39)}{.34}\,DRGNP_t - \underset{(-10.25)}{.72}\,DRGNP_{t+1} - \underset{(-.59)}{.04}\,DRGNP_{t-1} + \eta_t$	.95	.0066	.28	.08	-.20
(6)	$I_t = \underset{(8.82)}{.039} + \underset{(4.94)}{.44}\,BG_t + \underset{(3.32)}{.31}\,BG_{t-1} - \underset{(-.39)}{.03}\,BG_{t+1} - \underset{(-7.13)}{.40}\,DRGNP_t - \underset{(-10.50)}{.70}\,DRGNP_{t+1} - \underset{(-.98)}{.06}\,DRGNP_{t-1} + \eta_t$	.95	.0066	.28	.06	-.24
(7)	$I_t = \underset{(10.25)}{.037} + \underset{(5.19)}{.41}\,BG_t + \underset{(3.79)}{.31}\,BG_{t-1} - \underset{(-7.25)}{.39}\,DRGNP_t - \underset{(-10.93)}{.68}\,DRGNP_{t+1} + \eta_t$	.95	.0064	.38	.07	-.12
(8)	$I_t = \underset{(8.97)}{.040} + \underset{(10.83)}{.66}\,BG_t - \underset{(-5.03)}{.35}\,DRGNP_t - \underset{(-10.39)}{.77}\,DRGNP_{t+1} + \eta_t$	.91	.0084	.25	-.04	-.25
	The Base versus Demand Deposits and M1					
(9)	$I_t = \underset{(2.94)}{.022} + \underset{(2.04)}{.35}\,M1G_t + \underset{(3.08)}{.57}\,M1G_{t-1} - \underset{(-5.91)}{.31}\,DPR_t - \underset{(-2.46)}{.15}\,DPR_{t+1} - \underset{(-2.27)}{.12}\,DPR_{t-1} + \eta_t$	.79	.0130	.42	.11	-.03
(10)	$I_t = \underset{(4.25)}{.035} + \underset{(2.12)}{.38}\,M1G_t + \underset{(2.59)}{.52}\,M1G_{t-1} - \underset{(-4.60)}{.51}\,DRGNP_t - \underset{(-3.39)}{.56}\,DRGNP_{t+1} + \eta_t$	.80	.0126	.50	.12	-.07
(11)	$I_t = \underset{(2.80)}{.027} + \underset{(1.53)}{.29}\,DDG_t + \underset{(2.66)}{.56}\,DDG_{t-1} - \underset{(-4.74)}{.32}\,DPR_t - \underset{(-1.76)}{.14}\,DPR_{t+1} - \underset{(-1.92)}{.13}\,DPR_{t-1} + \eta_t$	.65	.0167	.52	.22	.02
(12)	$I_t = \underset{(3.64)}{.040} + \underset{(1.39)}{.29}\,DDG_t + \underset{(2.12)}{.53}\,DDG_{t-1} - \underset{(-3.53)}{.56}\,DRGNP_t - \underset{(-2.23)}{.52}\,DRGNP_{t+1} + \eta_t$	.65	.0166	.55	.21	.00
(13)	$I_t = \underset{(4.49)}{.023} + \underset{(2.89)}{.45}\,BG_t + \underset{(1.22)}{.21}\,BG_{t-1} - \underset{(-.60)}{.10}\,M1G_t + \underset{(.86)}{.18}\,M1G_{t-1} - \underset{(-7.89)}{.28}\,DPR_t - \underset{(-4.09)}{.19}\,DPR_{t+1} - \underset{(-2.84)}{.10}\,DPR_{t-1} + \eta_t$	.91	.0086	.08	.02	.00
(14)	$I_t = \underset{(4.71)}{.024} + \underset{(3.33)}{.47}\,BG_t + \underset{(1.52)}{.22}\,BG_{t-1} - \underset{(-.88)}{.11}\,DDG_t + \underset{(.91)}{.14}\,DDG_{t-1} - \underset{(-7.84)}{.27}\,DPR_t - \underset{(-4.19)}{.18}\,DPR_{t+1} - \underset{(-2.90)}{.10}\,DPR_{t-1} + \eta_t$	.91	.0085	.08	.01	-.04

TABLE 2--ANNUAL INFLATION REGRESSIONS: 1954-76 (continued)

Model No.	Estimated Regressions	R^2	$s(\eta)$	ρ_1	ρ_2	ρ_3
	<u>Real Stock Returns as Proxies for Future Real Activity</u>					
(15)	$I_t = .027 + .36\ BG_t + .30\ BG_{t-1} - .25\ DPR_t - .19\ DPR_{t+1} - .12\ DPR_{t-1} - .018\ RS_t + \eta_t$ (5.94) (3.46) (2.86) -4.92) (-5.10) (-2.92) (-.95)	.91	.0083	.14	-.02	-.08
(16)	$I_t = .020 + .31\ BG_t + .28\ BG_{t-1} - .13\ DPR_t - .10\ DPR_{t-1} - .061\ RS_t + \eta_t$ (2.98) (1.90) (1.67) (-1.90) (-1.64) (-2.34)	.78	.0131	.33	.06	.01
(17)	$I_t = .037 + .42\ BG_t + .32\ BG_{t-1} - .39\ DRGNP_t - .74\ DRGNP_{t+1} + .009\ RS_t + \eta_t$ (9.90) (5.14) (3.78) (-7.09) (-6.26) (.64)	.95	.0065	.38	.08	-.16
(18)	$I_t = .025 + .25\ BG_t + .33\ BG_{t-1} - .42\ DRGNP_t - .069\ RS_t + \eta_t$ (4.42) (1.87) (2.21) (-4.31) (-4.96)	.83	.0116	.32	.10	.02

* I_t is the inflation rate for year t. BG_t, DDG_t and $M1G_t$ are the growth rates of the base, demand deposits and M1. $DRGNP_t$ and DPR_t are the growth rates of real GNP and industrial production. DTB_t is the change from the end of year $t-1$ to the end of year t in the annualized, continuously compounded rate of interest on a three-month treasury bill. R^2 is the coefficient of determination and $s(\eta)$ is the standard error of the regression residuals, both adjusted for degrees of freedom. ρ_τ is the residual autocorrelation at lag τ. Under the null hypothesis that the true autocorrelations are zero, the standard error of the sample autocorrelations is about .20. The numbers in parentheses below estimated regression coefficients are t-statistics.

t + 1. The market understands the money-demand-quantity-theory model which will generate the price level at t + 1. It uses this model directly to assess the expected future price level which, with the datum provided by the current price level, determines the expected inflation rate built into the interest rate at t. This is the sense of the earlier statement that the interest rate set at t is largely exogenous with respect to the price level set at t, so that not much harm is done in treating the change in the interest rate as an exogenous variable in the inflation regressions.

2. *Inflation and the change in the interest rate.* Judging that some readers might be piqued by this analysis, we can note quickly that the data resolve any potential quarrels over the exogeneity of the change in the interest rate. Thus, in most alternative stories for the interest rate, any causation proposed from the inflation rate to the change in the interest rate generally reinforces the positive causal relation from the change in the interest rate to the inflation rate hypothesized by the model proposed here. However, regressions (1) and (5) of table 2 produce estimated coefficients for the change in the interest rate, DTB_t, which are about 1 SE from zero. Coefficients for DTB_t which are randomly positive and negative and generally less than 1 SE from zero were also observed in regressions (not shown) in which the growth rates of M1 or demand deposits are substituted for the growth rates of the base that appear in regressions (1) and (5). These results correspond to the general finding in the money-demand literature that the interest rate is the weakest variable in empirical money-demand equations.

The absence of statistically reliable interest rate effects is not necessarily a contradiction of the money-demand model. The surges of inflation or deflation that should be produced by changes in the interest rate may not be measurable simply because annual interest rate changes have low variability (table 1) relative to the annual inflation rate and the other explanatory variables in the inflation regression. Moreover, looking forward a bit, we find that the low variability of interest rate changes is even more evident in the monthly and quarterly data (table 4), giving us little hope of finding reliable interest rate effects in the tests for these shorter differencing intervals.

The absence of measurable interest rate effects produces another interesting result. Our model predicts that the growth rate of money beyond time t should have no marginal explanatory power with respect to the inflation rate, I_t, when the change in the interest rate, DTB_t, is included in the inflation regressions. This hypothesis is confirmed by the estimated coefficients of the future base growth rate BG_{t+1} in regressions (1) and (5). However, since no reliable interest rate effects are observed, it is not surprising that, when DTB_t is dropped in regressions (2) and (6), this does not produce the reliably positive coefficients for BG_{t+1} which would be predicted by the model. Indeed, regressions (2), (3), (6), and (7) show that all coefficients of other variables change very little when both DTB_t and BG_{t+1} are dropped from the estimated inflation models. These results were confirmed in preliminary regressions in which the growth rates of M1 or demand deposits replaced those of the base.

3. *Inflation and money.* We turn next to the measured effects of current and past money growth rates in the inflation regressions of table 2. In regressions (1)–(12), all estimated coefficients of current and past money growth rates are positive, and all coefficients of the base and M1 growth rates are more than 2 SE from zero. More interesting is the finding that the growth rates of the monetary base dominate the growth rates of demand deposits and M1 in the explanation of inflation. The coefficients of base growth rates in regressions (3) and (7) have larger *t*-statistics and contribute more to explanatory power than the growth rates of demand deposits or M1 in the otherwise identical regressions (9)–(12). Moreover, unlike regressions (3) and (7), which show little evidence of residual autocorrelation, regressions (9)–(12) indicate that using demand deposit or M1 growth rates as monetary explanatory variables does not succeed in transforming the highly autocorrelated annual inflation rates into white-noise residuals.

The strongest evidence that the base growth rate is the relevant monetary measure for describing inflation comes from regressions (13) and (14), in which demand deposit or M1 growth rates are used as explanatory variables in combination with base growth rates. In spite of potentially serious problems with multicollinearity, neither demand deposit nor M1 growth rates have much effect on the coefficients of base growth rates, and in all cases the coefficients of demand deposit and M1 growth rates are less than 1.0 SE from zero. Similar results were observed in preliminary regressions in which growth rates of real GNP were used in place of industrial production growth rates and in regressions in which lagged values of money growth rates were deleted. We make much of these results on the dominance of the base after we observe the corroborating evidence to be provided by the monthly and quarterly data.

There are, however, two important respects in which the estimated coefficients of base growth rates do not conform to the predictions of our model. First, the inflation rate for year t, I_t, does not seem to depend only on the contemporaneous growth rate of the base, BG_t; the lagged base growth rate, BG_{t-1}, always has marginal explanatory power.[1] Second, the sum of the estimated coefficients of current and

1. Preliminary regressions indicated that additional lags of the base or of other monetary growth rates do not contribute to the explanatory power of the inflation regressions.

lagged base growth rates is generally about .7, which is rather far from the one-for-one relation between money growth and inflation hypothesized by the model.

There are several possible explanations for these countertheoretical results, and the explanations are not mutually exclusive. There may be a lag in the response of prices of goods to information about the nominal quantity of money, thus producing a significant relation between past money growth rates and current inflation. In other words, real money demand and its effects on the pricing of consumption goods are not so completely rational as our model pretends. It is also possible that money growth rates are not so completely exogenous with respect to inflation as the model pretends. Finally, money growth rates may be measured with error. Given the evidence in table 1 that successive money growth rates are highly correlated and evidence to be presented shortly that the correlations between money and real activity growth rates are low, then either measurement error or endogeneity of money growth rates can produce downward bias in the estimated effect of money growth rates on inflation and a smearing of the effect of the current money growth rate over the most recent past growth rate.

The measurement error explanation is plausible for the base growth rate. The time series for the base (from the Federal Reserve Bank of St. Louis) is adjusted for changes in reserve requirements. Without going into the exact details, reported reserves are, for example, approximately doubled when the reserve requirement is cut in half. Under the presumption that the demand for reserves is derived from the demand for deposits, such an adjustment is in the right direction. However, only under rather extreme assumptions is it exactly the adjustment needed to neutralize the effects of changes in reserve requirements on the demand for measured reserves and thus on the relation between the price level and the base.

Thus, adjusting reported reserves in the manner described above implicitly assumes that a change in reserve requirements does not affect the demand for a given level of deposits, so that the demand for reserves is cut in half when the reserve requirement is cut in half. In this situation, the price level will remain unchanged only if actual reserves are also cut in half. An unchanged demand for deposits implies, however, that returns paid to depositors—either service returns or money returns—are not affected by changes in reserve requirements. This will not be the case if the banking sector is at all competitive. When changes in reserve requirements are passed on as changes in returns paid to depositors, demand for deposits will shift upward when reserve requirements are cut and the demand for reserves will fall by less than the fall in reserve requirements. In this situation, the adjustments in the measured reserve series will not neutralize the effects of changes in reserve requirements on the demand for reserves.

The consequent shifting functional relation between the measured base and the price level then acts like errors in the base in the inflation regressions.

Some of the results in table 2 are consistent with the measurement error argument. Regressions (4) and (8) show that suppressing the lagged base growth rate causes the apparent effect of BG_{t-1} on I_t to be largely subsumed by the coefficient of BG_t; that is, the coefficients of BG_t in regressions (4) and (8) are approximately the sum of the coefficients of BG_t and BG_{t-t} in (3) and (7), and explanatory power (R^2) falls only slightly when BG_{t-1} is dropped. Note also that the sums of the coefficients of $M1G_t$ and $M1G_{t-1}$ or DDG_t and DDG_{t-1} in regressions (9)–(12) are closer to the theoretical value 1.0 than the sums of the coefficients of BG_t and BG_{t-1} in regressions (3) and (7). This could be due to the fact that M1 and demand deposits are less subject to the adjustment errors built into the base. On the other hand, there is still some smearing of the effects of current money growth over past growth rates in regressions (9)–(12). This might be explained by the evidence in regressions (13) and (14) that the base is the relevant monetary aggregate in the inflation process, so that M1 and demand deposit growth rates are subject to measurement error as proxies for the more relevant true base growth rates.

4. *Inflation and real activity*. We come finally to the estimated coefficients of real activity growth rates in the inflation regressions. Note first that, in a rational-expectations view of money demand, there is nothing strange in the finding that current inflation is caused by future real activity. The logic of the model is that real money demanded and thus inflation adjust to anticipations of real activity. Somewhat more difficult to explain is the apparent significant relation between last year's rate of growth of industrial production, DPR_{t-1}, and this year's inflation rate, I_t. One possibility is that industrial production does not correspond to the real transactions measure that would be appropriate in a transactions-oriented view of money demand. Specifically, the transactions associated with some portion of industrial production may occur subsequent to production. In this respect, we can note that industrial production leads real GNP (the correlations of DPR_t with $DRGNP_{t-1}$, $DRGNP_t$, and $DRGNP_{t+1}$ are $-.27$, .55, and .61, respectively). Moreover, only current and future growth rates of real GNP have reliably nonzero regression coefficients in the inflation regressions (5) and (6) of table 2 in which real GNP growth rates are used as real activity measures. In any case, the estimated coefficients of past industrial production growth rates are always much less significant than those of the current and future growth rates.

Other comparisons of industrial production and real GNP growth rates as real activity measures in the inflation regressions are of interest. The sum of the estimated coefficients of $DRGNP_t$ and $DRGNP_{t+t}$, which corresponds to the negative of the "income" elasticity of the demand for money in equation (1), is generally about -1.0, whereas the sum of the coefficients of DPR_{t-1}, DRP_t, and DPR_{t+1} is about $-.50$. In other words, the elasticity estimate depends on the real activity measure used. Note also that real GNP growth rates seem to have more explanatory power than industrial production growth rates in otherwise identical regressions, for example, regressions (3) and (7), but the industrial production growth rates seem to produce lower residual autocorrelations. On the basis of statistical specification, industrial production seems slightly preferable to real GNP as a real activity measure in the inflation regressions.

Finally, an important shortcoming of the tests is the use of actual growth rates of real activity instead of the anticipated growth rates called for by the model. Under the presumption that the anticipations of future real activity on which current money demand is based are fully rational, what we would like are the conditional expected values of future real activity from the true structural model of the business cycle. This holy grail of macroeconomics is more than a bit beyond the range of this paper. Moreover, given the evidence in table 1 that the annual growth rates of industrial production and real GNP are close to white noise, developing models for the expected future growth rates from the information in the time series of past growth rates is not a viable solution to the problem.[2]

On the other hand, the fact that future rates of change of real activity cannot be predicted from current and past rates of change does not imply that future real activity is unpredictable. Fama (1981) reports that the correlation between this year's real return on common stocks, RS_t, and next year's rate of change of real GNP, $DRGNP_{t+1}$, is about .8, suggesting that the stock market does fairly well in forecasting future real activity.[3] Indeed, for those who are bothered by inflation

2. If we had a candidate structural model for the expected rate of change of future real activity, we could test the proposition that real activity is exogenous to the monetary sector. In the Sims (1972)-Geweke (1978) framework, the implication of the exogeneity proposition is that the expected future rate of change of real activity is a function only of current and past variables which are exogenous to the monetary sector. Thus, when the rate of change of future real activity is regressed on the current and past values of these exogenous variables and on current and past measures of the variables that are endogenous to the monetary sector (inflation and money growth), the latter should have no marginal explanatory power. However, the model is almost sure to flunk this test when it is true, and markets are in fact characterized by rational expectations. In particular, since we are not likely to turn up all of the exogenous variables and the exact structural model which are relevant in explaining the rate of growth of future real activity, the past inflation rate set by a rational market for goods will almost surely seem to have marginal explanatory power in the Sims-Geweke tests.

3. The variable RS_t is the nominal continuously compounded return for year t on a value-weighted portfolio of NYSE stocks (from the Center for Research in Security Prices of the University of Chicago) less the CPI inflation rate for year t.

regressions that include future rates of change of real activity as explanatory variables, regressions (16) and (18) of table 2 show that replacing DPR_{t+1} and $DRGNP_{t+1}$ in regressions (3) and (7) with the current real stock return, RS_t, produces significant negative coefficients for RS_t; that is, the current real stock return does a decent job in proxying for anticipations of future real activity. However, regressions (15) and (17) suggest that the future rates of change of real activity are better proxies than the current real stock return for the anticipations of future real activity built into the pricing of goods; that is, RS_t has no marginal explanatory power when added to inflation regressions that also include DPR_{t+1} or $DRGNP_{t+1}$ as explanatory variables.

In short, it is best to regard the past, current, and future growth rates of output that appear as explanatory variables in the inflation regressions as together proxying for the relations between inflation and anticipations of real activity predicted by the rational-expectations version of the money-demand-quantity-theory model. The implied measurement error problems prevent us from putting much emphasis on the specific estimate values of the real activity coefficients, but the evidence nevertheless seems strong that the inflation–real activity relations have the predicted negative sign, and this conclusion is later corroborated by the monthly and quarterly data. Such results seem rather damaging for the widely accepted belief that the inflation rate can be lowered by policies that discourage real activity.

C. *Stagflation*

The negative relation between inflation and real activity predicted by the money-demand model and documented in the regressions of table 2 is negative partial correlation. However, the cross-correlations in table 3 show that, during the post-1953 period, the inflation rate has the negative simple correlations with current and future growth rates of industrial production and real GNP which are implied by the term stagflation.

TABLE 3 **Cross-Correlations: 1953–77**

			τ	
X_t	$Y_{t+\tau}$	−1	0	+1
I_t	$DRGNP_{t+\tau}$	.14	−.26	−.45
	$DPR_{t+\tau}$	.09	−.38	−.33
BG_t	$DRGNP_{t+\tau}$	.03	.05	.17
	$DPR_{t+\tau}$	−.04	.20	−.03

NOTE.—The table shows cross-correlations between the value of the variable X for year t and the value of the variable Y for year $t + \tau$. The variable I_t is the inflation rate for year t; BG_t is the base growth rate; DPR_t is the rate of growth of industrial production; and $DRGNP_t$ is the rate of growth of real GNP.

Moreover, table 3 provides evidence on why the negative partial correlation between inflation and real activity also shows up as negative simple correlation. In addition to real activity growth rates, the important explanatory variable in the inflation regressions is the growth rate of the monetary base, which has a strong positive relation with inflation. In terms of these regressions, transforming the observed negative partial correlations between inflation and real activity into positive simple correlations would require strong positive correlations between the base growth rate and real activity growth rates. Table 3 indicates, however, that the actual correlations are small and not even systematically positive.

Since the base is presumably the monetary measure most directly under the control of the monetary authorities, explanation of the absence of simple relations between the base and real activity growth rates during the post-1953 period is an interesting topic for future research. It is well to note, however, that this finding does not imply the absence of relations between *real* money growth rates and real activity growth rates in the money-demand equation (1). In fact, estimates of (1) yield strong positive relations between real money and real activity growth rates which, as the theory predicts, are symmetric to the negative real activity–inflation relations observed in the estimates of (2). The explanation implied by our model is that changes in real money demanded in response to real activity are largely accommodated through inflation rather than through nominal money growth.

It is also well to note that although we interpret the inflation–real activity relations in terms of real activity causing inflation, there are many stories in the macroeconomics literature (e.g., Friedman 1968; Lucas 1972; Barro 1978) which propose lines of causation from inflation (and money) to real activity. However, the more popular stories are variants of the Phillips curve in which the proposed inflation-output relations are positive. The negative relations between inflation and real activity documented in tables 2 and 3 seem more consistent with a simple money-demand-quantity-theory world, in which increases in anticipated real activity cause increases in real money demanded, which, empirically, are not satisfied by nominal money growth and so must be accommodated by opposite movements in prices.

Finally, the negative relations between inflation and real activity analyzed above suggest an explanation for the previously puzzling evidence (see, e.g., Bodie 1976; Jaffe and Mandelker 1976; Nelson 1976; Fama and Schwert 1977) that common stock returns and inflation rates have been negatively related during the post-1953 period. Since common stock returns respond positively to information about real activity, negative simple relations between stock returns and inflation may be induced by the negative real activity–inflation relations documented here. This line of argument is pursued empirically in Fama (1981), and much success is claimed.

IV. Short-Term Inflation, Output, and Money

Estimating inflation equations on annual data avoids any problems that might be caused by the seasonals in money and real activity growth rates. However, use of annual data has disadvantages. For example, the sample size for parameter estimates is small. Perhaps more important, unless the monetary authorities have a somewhat perverse attitude toward money supply, the seasonals in money are the consequence of money demand and should be explained by any good money-demand model. In the previous empirical literature, when money-demand equations are estimated on data for intervals shorter than a year, seasonally adjusted data are generally used (see, e.g., Goldfeld [1973], who gives many references to earlier work).

A. The Seasonal Behavior of Money and Real Activity

Table 4 documents the seasonals in the unadjusted monthly and quarterly versions of the money and real activity growth rates of table 1. The three money growth rates, BG_t, DDG_t and $M1G_t$, and the two real activity growth rates, $DRGNP_t$ and DPR_t, have strong annual seasonals, that is, large autocorrelations, ρ_τ, at lags 12, 24, 36, and 48 in the monthly data and at lags 4, 8, 12 and 16 in the quarterly data. The only variables that do not show strong annual seasonals are the inflation rate, I_t, and the change in the interest rate, DTB_t. As in the annual data, interest rate changes show little evidence of autocorrelation, while the autocorrelations of monthly and quarterly inflation rates are positive, large, and decay slowly toward zero at higher-order lags.

The last two columns of table 4 show the standard deviations of the monthly or quarterly growth rates of the variables, s(x), and the standard deviations of the seasonal differences of the monthly or quarterly growth rates, s(S.D.). The seasonal difference of a variable is its growth rate for this month or quarter minus that for the same month or quarter 1 year ago. The standard deviations of the seasonally differenced monthly and quarterly money growth rates are about one-third those of the corresponding growth rates themselves, which is direct evidence that seasonals account for most of the short-term variation in money growth. If we assume that these seasonals are the consequence of money demand, they pose serious questions about models, like those of Friedman (1956) and Keynes (1936), that treat money as a portfolio asset whose demand depends primarily on nonseasonal variables like real wealth or permanent income.

B. The Unmet Challenge

In terms of equation (1), a well-specified money-demand function involves explaining the highly seasonal real money growth rates in terms of correspondingly seasonal measures of real activity. In preliminary estimates of (1), a direct measure of transactions, real debits to demand

TABLE 4--AUTOCORRELATIONS OF MONTHLY AND QUARTERLY VARIABLES: 1953-77*

Var. (x)	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_6	ρ_7	ρ_8	ρ_9	ρ_{10}	ρ_{11}	ρ_{12}	ρ_{24}	ρ_{36}	ρ_{48}	s(x)	s(S.D.)
Autocorrelations of Monthly Variables																	
BG_t	.14	-.30	-.06	-.09	.06	.24	.05	-.09	-.08	-.29	.16	.80	.73	.68	.65	.0101	.0057
DDG_t	-.09	-.30	.31	-.23	-.19	.24	-.21	-.22	.27	-.32	-.07	.89	.84	.80	.77	.0167	.0060
$M1G_t$	-.02	-.32	.23	-.19	-.17	.25	-.18	-.19	.20	-.33	-.02	.90	.85	.81	.77	.0138	.0048
DPR_t	-.13	-.16	-.12	.05	.09	.00	.09	.03	-.15	-.20	-.21	.78	.74	.73	.68	.0296	.0186
I_t	.55	.57	.51	.50	.50	.50	.47	.48	.51	.49	.43	.46	.25	.27	.27	.0030	.0030
DTB_t	-.26	.02	.00	.13	.02	-.18	-.02	.09	.10	-.19	.02	.06	.06	-.01	.07	.0004	.0006

Var.(x)	ρ_1	ρ_2	ρ_3	ρ_4	ρ_8	ρ_{12}	ρ_{16}	s(x)	s(S.D.)
Autocorrelations of Quarterly Variables									
BG_t	-.39	.25	-.40	.90	.85	.80	.76	.0224	.0077
DDG_t	-.40	.03	-.42	.88	.83	.80	.77	.0279	.0113
$M1G_t$	-.40	.07	-.43	.90	.85	.82	.78	.0257	.0093
$DRGNP_t$	-.70	.51	-.71	.90	.85	.82	.78	.0566	.0201
DPR_t	.01	-.30	-.17	.45	.45	.50	.50	.0409	.0414
I_t	.74	.72	.69	.61	.32	.32	.33	.0076	.0063
DTB_t	.03	-.22	.14	.12	-.03	-.10	.10	.0017	.0022

*BG_t, DDG_t and $M1G_t$ are the growth rates of the base, demand deposits and M1 from the end of month or quarter $t - 1$ to the end of month or quarter t. $DRGNP_t$ and DPR_t are the growth rates of real GNP and industrial production. I_t is the inflation rate. DTB_t is the change in the one or three month treasury bill rate. All data are without seasonal adjustment. Under the hypothesis that the true autocorrelations are zero, the standard errors of the estimated autocorrelations are about .06 for the monthly results and .10 for the quarterly results.

deposits, explained a substantial portion of the seasonal variation in monthly money growth rates, and the seasonals in quarterly money growth rates were explained in large part by seasonals in the growth rates of real GNP. However, the regressions left substantial seasonal variation in money growth rates unexplained—to the extent that naive forecasts that current monthly or quarterly money growth rates will be equal to those observed for the same period 1 year ago typically did well relative to the conditional expected growth rates provided by the money-demand regressions.

Since the seasonals in the available measures of real activity do not fully capture the seasonals in money, it is not surprising that, using monthly or quarterly data to estimate the inflation, equation (2) is unsuccessful. In particular, direct estimates of monthly and quarterly inflation regressions with monthly and quarterly explanatory variables generally produce residuals that are highly autocorrelated, much in the manner of the inflation rate itself.

C. Inflation Regressions with Annual Money and Real Activity Growth Rates as Explanatory Variables

The fact that inflation rates have weak seasonals suggests that the strong seasonals in money and real activity growth rates have little to do with inflation. When one is estimating inflation regressions, it makes sense as a practical matter (i.e., in the absence of measures of real activity that successfully absorb the seasonals in money) to first net out the seasonals in money and real activity. Our simple method of seasonal adjustment is to use annual rather than monthly or quarterly growth rates of money and real activity. For example, in regression (1) of table 5, the seasonally unadjusted inflation rate for month t, I_t, is regressed on the base growth rate, BG_t, for the year ending in month t, the growth rate of industrial production for the year ending in month t, DPR_t, and the growth rate of industrial production for the following year, DPR_{t+12}. We are, however, estimating monthly and quarterly inflation models. Data on the inflation rate for all months (quarters) of the 1954–76 period (1953 is lost in calculating the first value of BG_t, and 1977 is lost in calculating the last value of DPR_{t+12}) are used, thus implying substantial overlap in successive monthly (quarterly) observations of the annual explanatory variables.

Since short-term inflation rates are explained in terms of annual growth rates of the base and industrial production, the coefficients in the monthly and quarterly regressions must be multiplied by 12 and 4 to estimate the elasticities of monthly and quarterly inflation rates with respect to the average monthly and quarterly growth rates of money and real activity. When this is done, the elasticities from the monthly and quarterly regressions are almost identical and are quite similar to those observed in the annual data. For example, the estimated elastic-

TABLE 5 — MONTHLY AND QUARTERLY INFLATION REGRESSIONS WITH ANNUAL MONEY AND REAL ACTIVITY GROWTH RATES AS EXPLANATORY VARIABLES (1954-76)*

Model No.	Part A: Estimated Monthly Inflation Regression	R^2	$s(\eta)$	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_{12}
(1)	$I_t = .0016 + .059\ BG_t - .013\ DPR_t - .022\ DPR_{t+12} + \eta_t$ (5.78) (12.77) (-6.37) (-10.41)	.50	.0021	.05	.12	-.03	-.02	.00	.12
(2)	$I_t = .0024 + .058\ DDG_t - .018\ DPR_t - .024\ DPR_{t+12} + \eta_t$ (8.63) (8.35) (-7.56) (-9.95)	.36	.0024	.26	.29	.17	.18	.19	.22
(3)	$I_t = .0018 + .070\ M1G_t - .018\ DPR_t - .023\ DPR_{t+12} + \eta_t$ (6.52) (10.96) (-8.32) (-10.24)	.45	.0022	.16	.20	.06	.08	.09	.15
(4)	$I_t = .0015 + .053\ BG_t + .006\ BG_{t+12} - .012\ DPR_t - .022\ DPR_{t+12} + \eta_t$ (5.21) (5.30) (.60) (-6.06) (-10.41)	.50	.0021	.05	.13	-.03	-.02	.01	.13
(5)	$I_t = .0015 + .055\ BG_t + .007\ DDG_t - .014\ DPR_t - .022\ DPR_{t+12} + \eta_t$ (5.50) (8.66) (.88) (-6.06) (-10.43)	.50	.0021	.05	.12	-.04	-.02	.00	.12
(6)	$I_t = .0015 + .049\ BG_t + .015\ M1G_t - .014\ DPR_t - .022\ DPR_{t+12} + \eta_t$ (5.43) (5.62) (1.35) (-6.28) (-10.49)	.50	.0021	.05	.12	-.04	-.02	.00	.12

Model No.	Part B: Estimated Quarterly Inflation Regression	R^2	$s(\eta)$	ρ_1	ρ_2	ρ_3	ρ_4	ρ_8	ρ_{12}
(7)	$I_t = .0072 + .157\ BG_t - .055\ DRGNP_t - .104\ DRGNP_{t+12} + \eta_t$ (7.35) (10.70) (-4.43) (-8.06)	.72	.0039	.09	.16	-.04	.20	-.18	-.04
(8)	$I_t = .0050 + .173\ BG_t - .042\ DPR_t - .066\ DPR_{t+12} + \eta_t$ (5.97) (12.12) (-6.81) (-10.04)	.74	.0038	.00	.07	-.07	.13	-.19	.01
(9)	$I_t = .0100 + .170\ DDG_t - .087\ DRGNP_t - .122\ DRGNP_{t+12} + \eta_t$ (9.62) (7.36) (-5.53) (-7.94)	.60	.0047	.34	.30	.14	.31	.08	.07
(10)	$I_t = .0083 + .194\ M1G_t - .085\ DRGNP_t - .112\ DRGNP_{t+12} + \eta_t$ (8.37) (9.63) (-6.19) (-8.20)	.69	.0042	.19	.19	.02	.22	-.04	-.01
(11)	$I_t = .0048 + .155\ BG_t + .020\ BG_{t+12} - .042\ DPR_t - .066\ DPR_{t+12} + \eta_t$ (5.29) (5.40) (.69) (-6.51) (-10.02)	.74	.0038	.01	.08	-.05	.15	-.19	.01
(12)	$I_t = .0049 + .166\ BG_t + .014\ DDG_t - .044\ DPR_t - .066\ DPR_{t+12} + \eta_t$ (5.69) (8.45) (.53) (-6.30) (-10.00)	.74	.0038	-.00	.06	-.08	.12	-.18	.01
(13)	$I_t = .0048 + .152\ BG_t + .033\ M1G_t - .045\ DPR_t - .066\ DPR_{t+12} + \eta_t$ (5.62) (5.74) (.94) (-6.51) (-10.07)	.74	.0038	-.01	.06	-.08	.12	-.17	.01

*BG_t, DDG_t and $M1G_t$ are the annual growth rates of the base, demand deposits and M1. $DRGNP_t$ and DPR_t are the annual growth rates of real GNP and industrial production. I_t is the inflation rate, monthly in Part A of the table and quarterly in Part B. R^2 is the coefficient of determination and $s(\eta)$ is the residual standard error, both adjusted for degrees of freedom. The numbers in parentheses below regression coefficient estimates are t-statistics. ρ_τ is the residual autocorrelation at lag τ. Under the hypothesis that the true autocorrelations are zero, the standard errors of the estimated autocorrelations are about .06 for the monthly residuals, and .10 for the quarterly residuals.

ity of the monthly inflation rate with respect to the average monthly growth rate of the base in regression (1) of table 5 is $.059 \times 12 = .71$. This is almost identical with the estimated elasticity $.173 \times 4 = .69$ observed in the corresponding quarterly regression (8) and is identical with the combined elasticity, .71, for the current and past base growth rates observed in the annual inflation regression (3) of table 2.

None of the inflation regressions in table 5 includes interest rate changes as explanatory variables, reflecting the fact that, in preliminary regressions, monthly and quarterly changes in interest rates never had marginal explanatory power. As in the annual data, the quarterly regressions (7) and (8) of table 5 show that the growth rates of real GNP work about as well as the industrial production growth rates in describing the quarterly inflation rate. In the remaining quarterly inflation regressions, we use one or the other of these activity variables, depending on which performs better (but always slightly better) when combined with different specific money growth rates.

The monthly and quarterly inflation regressions support the same substantive conclusions as the annual regressions. Strong negative relations between inflation and real activity are again observed, thus reinforcing the analysis of stagflation in the annual data. Again, these results run counter to the common belief that discouraging real activity is likely to produce lower inflation.

As in the annual regressions, the growth rate of the base provides better specified models for monthly and quarterly inflation than demand deposit or M1 growth rates. Regression (1), which uses BG_t as monetary explanatory variable, describes more of the variation in the monthly inflation rate than regressions (2) and (3), which use DDG_t and $M1G_t$. The same conclusion follows from the quarterly regressions (7)–(10). Moreover, few of the residual autocorrelations for the monthly and quarterly regressions (1), (7), and (8) that use BG_t as monetary explanatory variable are reliably different from zero. Thus, these regressions succeed in transforming the monthly and quarterly inflation rates, which have large, slowly decaying autocorrelations, into time series of residuals that behave more like white noise. In contrast, as in the annual data, the monthly and quarterly inflation models based on DDG_t or $M1G_t$ do not do well in absorbing the autocorrelations of the inflation rate.

Most impressive, regressions (5), (6), (12), and (13) of table 5 show that including DDG_t or $M1G_t$ as an additional monetary explanatory variable has little effect on the estimated coefficient of BG_t and produces trivial coefficients for DDG_t or $M1G_t$. This reinforces the evidence on the dominance of the base obtained from the corresponding annual regressions (13) and (14) of table 2. The implications of this result for both policy and intellectual matters are considered later.

Finally, regressions (4) and (11) describe the monthly and quarterly inflation rates in terms of next year's growth rate of the base, BG_{t+12}, as well as last year's growth rate, BG_t. As in the annual data of table 2, the estimated coefficients of the future base growth rate are trivial, and, aside from the expected attenuation of *t*-statistics, inclusion of BG_{t+12} has little effect on the estimated coefficients of BG_t.

V. The Quantity Theory versus Interest Rate Models of Inflation

The ex ante expected inflation rates built into interest rates are output from the inflation model used by the bond market to set interest rates. If we can establish that there is a close correspondence between these market-assessed expected inflation rates and the conditional expected inflation rates from the money-demand-quantity-theory regressions, this will add credibility to the quantity-theory viewpoint that the money-demand function provides a model for inflation.

A. Interest Rates and Expected Inflation Rates

Irving Fisher (1930) shows that the one-period interest rate, TB_{t-1}, observed at the end of period $t - 1$ can be broken into an expected real return for period t, ER_{t-1}, and an expected inflation rate, EI_{t-1}:

$$TB_{t-1} = ER_{t-1} + EI_{t-1}, \tag{3}$$

or

$$EI_{t-1} = - ER_{t-1} + TB_{t-1}. \tag{4}$$

The inflation rate for period t, I_t, can then be expressed as

$$I_t = - ER_{t-1} + TB_{t-1} + \eta_t, \tag{5}$$

where η_t is unexpected inflation.

Given a model of bond market equilibrium that renders the ex ante expected real return ER_{t-1} observable and a bond market that makes rational assessments of expected inflation, (5) can be used to divide an ex post inflation rate into expected and unexpected components. For example, Fama (1975) hypothesizes a rational bond market in which the equilibrium expected real return is constant through time and then estimates time series regressions of ex post inflation rates on ex ante interest rates; that is,

$$I_t = \alpha + \beta TB_{t-1} + \eta_t. \tag{6}$$

If the expected real return in (5) is constant, and if in assessing the expected inflation rate the market uses at least the information in past inflation rates, then the intercept α in (6) is the negative of the constant expected real return, the coefficient β of the interest rate is 1.0, and the regression should transform the autocorrelation in the inflation rates I_t into white-noise disturbances η_t. Fama (1975) reports that these hypotheses stand up well in data for 1–6-month inflation and interest rates for the 1953–71 period. However, Hess and Bicksler (1975), Fama (1976*b*), Nelson and Schwert (1977), and Garbade and Wachtel (1978) document a small amount of variation in expected real returns on bills during the 1953–71 period. Their tests suggest an alternative model for the post-1953 period in which the expected real return behaves like a slow-moving random walk.

Following up on this evidence, Fama and Gibbons (1982) estimate the inflation-interest rate regression

$$I_t = \alpha_{t-1} + \beta TB_{t-1} + \eta_t \tag{7}$$

with a procedure, developed by Craig Ansley (1980), which presumes that the regression intercept α_{t-1}—the negative of the expected real return ER_{t-1} in (5)—follows a random walk. We leave detailed discussion of the approach to Fama and Gibbons; suffice it to say that this model succeeds in the sense that it yields estimates of β that are close to 1.0 (indeed constraining β to equal 1.0 yields models with smaller residual standard errors than when the regressions are allowed to determine β), and it transforms the highly autocorrelated inflation rates into residuals that are indistinguishable from white noise.

The "wandering intercept" regressions estimated from monthly and quarterly inflation and interest rates, and with interest rate coefficients constrained to equal 1.0, are shown as models (2) and (7) in table 6. The fitted values from these regressions, that is, $\alpha_{t-1} + TB_{t-1}$, are henceforth labeled $EITB_{t-1}$ and are our estimates of the ex ante monthly and quarterly expected inflation rates built into one and three month interest rates.[4]

4. Since the coefficient of the interest rate is constrained to equal 1.0, allowing a random-walk intercept in an inflation-interest rate regression is equivalent to extracting a random walk from the time series of the real return $TB_{t-1} - I_t$. That is, α_{t-1} in regression (2) or (7) is the negative of the monthly or quarterly estimated expected real return, and the expected inflation rate, $EITB_{t-1} = \alpha_{t-1} + TB_{t-1} = TB_{t-1} - ER_{t-1}$, is the Treasury bill rate minus the random-walk expected real return. Without going into details, let us state that the estimation of ER_{t-1} is based on a signal-extraction technique which uses the entire sample (future and past) of real returns, $TB_{t-1} - I_t$. Thus, although the interest rate TB_{t-1} is an ex ante variable, $EITB_{t-1} = TB_{t-1} - ER_{t-1}$ is only an estimate of the ex ante expected inflation rate, since it corrects the interest rate for an estimate of the ex ante expected inflation rate return which uses all of the information in the sample. However, Fama and Gibbons show that, although the wandering of expected real returns is statistically reliable, it is small relative to the variation in either expected or unexpected inflation rates. This is consistent with the findings of Hess and Bicksler (1975), Fama (1976*b*), Nelson and Schwert (1977), and Garbade and Wachtel (1978). For present purposes, the implication of these results is that correcting the ex ante Treasury bill rate, TB_{t-1}, with the estimated expected real return, ER_{t-1}, yields an estimate of the ex ante expected inflation rate, $EITB_{t-1}$, whose variation is largely that of the ex ante interest rate, TB_{t-1}.

TABLE 6 - COMPARISONS OF MONEY DEMAND AND TREASURY BILL RATE MODELS OF INFLATION*

Model No.	Estimated Regression	R^2	$s(\eta)$	ρ_1	ρ_2	ρ_3	ρ_4	ρ_8	ρ_{12}
	Monthly Models								
(1)	$I_t = .0016 + .058\ BG_t - .013\ DPR_t - .022\ DPR_{t+12} + \eta_t$ (5.78) (12.77) (-6.37) (-10.41)	.50	.0021	.05	.12	-.03	-.02	-.01	.12
(2)	$I_t = \alpha_{t-1} + TB_{t-1} + \eta_t$	.56	.0020	-.01	.07	-.07	-.11	-.05	.12
(3)	$I_t = -.0002 + .22\ EIMD_t + .85\ EITB_{t-1} + \eta_t$ (-1.01) (1.60) (6.42)	.57	.0020	-.06	.05	-.10	-.11	-.03	.15
(4)	$I_t = .0004 + .005\ BG_t - .004\ DPR_t - .005\ DPR_{t+12} + .91\ EITB_{t-1} + \eta_t$ (1.25) (.60) (-1.88) (-1.68) (6.64)	.57	.0020	-.08	.04	-.11	-.12	-.04	.15
(5)	$I_t = .0001 - .005\ BG_t - .002\ DPR_t + 1.09\ EITB_{t-1} + \eta_t$ (.19) (-.80) (-1.12) (12.87)	.57	.0020	-.07	.05	-.10	-.11	-.03	.15
	Quarterly Models								
(6)	$I_t = .0050 + .173\ BG_t - .042\ DPR_t - .066\ DPR_{t+12} + \eta_t$ (5.97) (12.12) (-6.81) (-10.04)	.74	.0038	.00	.07	-.07	.13	-.19	.01
(7)	$I_t = \alpha_{t-1} + TB_{t-1} + \eta_t$	.76	.0040	-.11	-.12	.03	.12	-.19	.05
(8)	$I_t = -.0006 + .43\ EIMD_t + .64\ EITB_{t-1} + \eta_t$ (-1.07) (3.41) (5.04)	.80	.0034	-.20	-.03	-.04	.18	-.19	-.03
(9)	$I_t = .0022 + .055\ BG_t - .021\ DPR_t - .030\ DPR_{t+12} + .69\ EITB_{t-1} + \eta_t$ (2.33) (2.15) (-2.97) (-3.44) (5.22)	.80	.0034	-.22	-.07	-.07	.16	-.19	-.02
(10)	$I_t = .0001 - .004\ BG_t - .007\ DPR_t + 1.03\ EITB_{t-1} + \eta_t$ (.08) (-.19) (-1.11) (11.42)	.77	.0036	-.14	-.05	.01	.17	-.20	-.03
	Annual Models								
(11)	$I_t = .025 + .38\ BG_t + .33\ BG_{t-1} - .28\ DPR_t - .21\ DPR_{t+1} - .10\ DPR_{t-1} + \eta_t$ (6.00) (3.68) (3.18) (-9.02) (-6.24) (-2.86)	.91	.0083	.06	-.08	-.01			
(12)	$I_t = -.0014 + 1.04\ EITB_{t-1} + \eta_t$ (-.40) (12.17)	.86	.0106	.10	-.54	-.30			
(13)	$I_t = -.0015 + .76\ EIMD_t + .28\ EITB_{t-1} + \eta_t$ (-.59) (5.37) (1.87)	.94	.0070	.12	-.22	-.10			
(14)	$I_t = .0142 + .26\ BG_t + .15\ BG_{t-1} - .17\ DPR_t - .16\ DPR_{t+1} - .03\ DPR_{t-1} + .45\ EITB_{t-1} + \eta_t$ (2.23) (2.42) (1.26) (-2.85) (-4.08) (-.79) (2.22)	.93	.0075	.07	-.19	.02			
(15)	$I_t = -.0051 + .12\ BG_t - .02\ BG_{t-1} - .02\ DPR_t - .08\ DPR_{t-1} + .95\ EITB_{t-1} + \eta_t$ (-.86) (.83) (-.16) (-.37) (-1.83) (4.34)	.86	.0103	.07	-.23	-.30			

*I_t is the inflation rate for month, quarter, or year t. TB_{t-1} is the treasury bill rate observed at the end of month or quarter $t-1$. BG_t, DPR_t, and $DRGNP_t$ are annual growth rates of the base, industrial production, and real GNP. $EIMD_t$ is the fitted value or conditional expected inflation rate from the monthly, quarterly or annual money demand model (1), (6), or (11). $EITB_{t-1}$ is the expected inflation rate from the monthly, quarterly, or annual treasury bill rate model (2), (7), or (12). R^2 is the coefficient of determination and $s(\eta)$ is the residual standard error, both adjusted for degrees of freedom. The numbers in parentheses below estimated regression coefficients are t-statistics. ρ_τ is the residual autocorrelation at lag τ. Under the hypothesis that the true autocorrelations are zero, the standard errors of the estimated autocorrelations are about .06 for the monthly residuals, about .10 for the quarterly residuals, and about .20 for the annual residuals. Regressions (2), (7), and (12) cover the 1953-77 period. The remaining regressions cover the 1954-76 period. The residual standard errors for the treasury bill rate models (2) and (7) are estimated by Ansley's (1980) maximum likelihood method and so are not strictly comparable to those of the other regressions which are estimated by ordinary least squares.

Obtaining an annual expected inflation rate is less straightforward. One-year Treasury bills were not issued regularly prior to 1964, and the wandering intercept regression approach is of dubious value with the small sample available from annual data. Fama and Gibbons (1982) argue, however, that shorter-period expected inflation rates are close to random walks so that annual expected inflation rates can be obtained by annualizing the beginning-of-year monthly or quarterly expected inflation rates. An example of this approach is model (12) in table 6, which shows the regression of the ex post annual inflation rate for year t on $EITB_{t-1}$, the annualized, quarterly expected inflation rate. This annual $EITB_{t-1}$ is just four times the quarterly expected inflation rate, $EITB_{t-1} = \alpha_{t-1} + TB_{t-1}$, for the first quarter of the year obtained from regression (7). Regression (12) indicates that this annualized $EITB_{t-1}$ has good properties as an estimate of the annual ex ante expected rate, and we henceforth use it as such. Its estimated regression coefficient is close to 1.0, and it absorbs about 86% of the sample variance of the annual inflation rate. The only shortcoming of the regression is a substantial negative second-order residual autocorrelation.

B. *The Relative Power of Money-Demand and Interest Rate Forecasts of Inflation*

Most of table 6 is concerned with how well the expected inflation rates from the inflation–interest rate regressions compete against the conditional expected inflation rates from the best of the monthly, quarterly, and annual money-demand-quantity-theory models, repeated, for convenience, as regressions (1), (6), and (11) of table 6. Regressions (3), (8), and (13) pit the fitted values or conditional expected inflation rates from the money-demand inflation regressions, labeled $EIMD_t$, against the expected inflation rates, $EITB_{t-1}$, from the Treasury bill rate models. Since the estimated coefficients of both $EIMD_t$ and $EITB_{t-1}$ are generally reliably different from zero, these regressions suggest that both the money-demand and the Treasury bill rate models contain information about inflation not included in the other.

The source of the marginal descriptive power of the money-demand inflation equations is examined more closely in regressions (4), (5), (9), (10), (14), and (15) of table 6. For example, in regression (9) all of the explanatory variables of the quarterly money-demand inflation equation (the past annual growth rate of the base, BG_t, and the past and future annual growth rates of industrial production, DPR_t and DPR_{t+12}) are included along with $EITB_t$, the ex ante expected inflation rate from the Treasury bill rate model. The coefficients of all variables have substantial *t*-statistics, and similar results are observed in the corresponding monthly and annual regressions (4) and (14). However, in regressions (5), (9), and (15), where the future annual growth rate of industrial production is no longer included as an explanatory variable, the expected inflation rates from the Treasury bill rate models dominate the remaining variables from the money-demand inflation equations. In these regressions, the estimated coefficients of $EITB_{t-1}$ are close to 1.0 and have enormous *t*-statistics, but the coefficients of current and past base and real activity growth rates are not reliably different from zero.

In setting Treasury bill rates, an efficient or rational market would not ignore historical information which is relevant for assessing expected inflation rates. Thus, the fact that the marginal descriptive power of the money-demand inflation equations, relative to the forecasts of inflation provided by the interest rate models, can be attributed to the future annual growth rate of real activity is comforting evidence about the health of the Treasury bill market. Moreover, the market seems to use information about future inflation which is not covered by the money-demand-quantity-theory model, since the expected inflation rates extracted from Treasury bill rates have marginal explanatory power when put against either the fitted values or the separate explanatory variables of the money-demand inflation regressions.

Some subtleties in these conclusions about the efficiency of the Treasury bill market are worth noting. From the viewpoint of our rational-expectations version of the quantity theory, the fact that the inflation rate for month, quarter, or year t is related to the rate of growth of real activity for the following year suggests that markets for goods make forecasts of future real activity which are then used in setting current prices of goods. Moreover, it would seem that, in determining the inflation rate, goods markets make better forecasts of future real activity than the bill market; that is, future real activity has marginal descriptive power in inflation regressions which also include expected inflation rates extracted from Treasury bill rates as explanatory variables.

Note, however, that in setting the end-of-period prices of goods built into the ex post inflation rate, I_t, for month, quarter, or year t, markets for goods have the benefit of increasing amounts (specifically, a month, quarter, or year) of information about future real activity which was not available to the Treasury bill market in assessing ex ante expected inflation rates, $EITB_{t-1}$, at the beginning of the period. These increasing amounts of information about future real activity are built into the monthly, quarterly, and annual conditional expected inflation rates, $EIMD_t$, estimated from the money-demand models of inflation since the latter explain the ex post inflation rate in part in terms of future activity. Consistent with this story, as one passes through the monthly, quarterly, and annual regressions (3), (8), and (13) of table 6, the marginal explanatory power of $EIMD_t$, the *conditional* expected inflation rate from the money-demand inflation regression, increases systematically relative to that of $EITB_{t-1}$, the expected rate extracted from the ex ante interest rate.

For our purposes, however, the similarities between the assessments of the expected inflation rate that come out of the money-demand and Treasury bill rate models are more interesting than the differences. For example, in the inflation regressions where the fitted values or explanatory variables of the money-demand regressions are included along with the expected inflation rates from the Treasury bill rate models, there is little if any increase in explanatory power beyond what is observed when the models are viewed separately. The major effect of combining the models is a general attenuation of estimated regression coefficients, which suggests that the models, and by implication, the markets for Treasury bills and consumption goods, are making similar assessments of expected inflation rates. There is, however, more direct evidence on this point. The correlation between the expected inflation rates that come out of the monthly money-demand regression (1) and the Treasury bill rate model (2) in table 6 is .91. The correlations between the expected inflation rates from the corresponding quarterly models (6) and (7) and the annual models (11) and (12) are .90 and .92. More impressive, the correlation between the residuals or unexpected inflation rates of the monthly money-demand and Treasury bill rate models (1) and (2) is .90, while the correlation between the residuals of the corresponding quarterly regressions (6) and (7) is .70.

The closer correlation between the residuals of the monthly inflation models is consistent with the point made above that, in setting the ex post monthly inflation rate, goods markets have only a month of information about future real activity not available to the Treasury bill market when it sets interest rates at the beginning of the month, whereas the ending prices built into the quarterly inflation rate have the benefit of 3 months of additional information. Since the ending prices built into the annual inflation rate have the benefit of an additional year of information about future real activity not available to the Treasury bill market in setting interest rates at the beginning of the year, it is not surprising that the correlation between the conditional unexpected inflation rates from the annual money-demand model (11) and the unexpected inflation rates from the Treasury bill rate model (12) is only .33.

The strong information advantage given to the conditional expected inflation rates of the annual money-demand model can be measured directly. The residual or unexpected inflation rate from the monthly Treasury bill rate regression (2), like the residual from the money-demand regression (1), is uncorrelated with the following year's industrial production growth rate. In contrast, the residual from the annual interest rate model (12) has correlation $-.61$ with next year's growth rate of industrial production. However, DPR_{t+1} is necessarily uncorrelated with the residual from the annual money-demand regression (11) in which it appears as an explanatory variable. The correlation $-.61$ is a measure of the information about future real activity available to price goods at the end of a year, which is included in the explanatory power of the annual money-demand inflation regression but was not available to the Treasury bill market to set interest rates at the beginning of the year.

It is also well to note that the strong negative correlation between the annual unexpected inflation rate that comes out of the Treasury bill market and next year's rate of growth of real activity is contrary to the positive correlation between unexpected inflation and future output hypothesized in the rational-expectations versions of the Phillips curve (e.g., Lucas 1972; Barro 1978). Given the evidence from the monthly, quarterly, and annual money-demand inflation regressions that expected inflation rates also show consistent negative relations with current and future growth rates of real activity, all versions of the Phillips curve model are difficult to reconcile with the behavior of inflation and real activity during the post-1953 period.

VI. Conclusions and Policy Implications

In a world of efficient markets or rational expectations, interest rates provide the best possible forecasts of inflation. From this viewpoint, the finding that the monthly and quarterly money-demand-quantity-theory regressions replicate the forecasts of inflation extracted from 1- and 3-month interest rates lends credence to the hypothesis that the money-demand model can be viewed as a model for inflation. Indeed, the results suggest that the simple quantity-theory model in which real activity and money are presumed to be exogenous with respect to inflation may be close to the best one can do in modeling the inflation process during the post-1953 period. It is in this aggressive spirit that we now review the results of this paper and their implications.

Monthly, quarterly, and annual data consistently support the money-demand-quantity-theory proposition that, controlling for the variation in nominal money growth rates, there are strong negative relations between real activity growth rates and inflation. The absence of systematic positive correlations between money and real activity growth rates then causes the negative partial correlations between real activity growth rates and inflation to show up as negative simple correlations—the phenomenon of stagflation. When one treats real activity as exogenous, stagflation is a consequence of the fact that most of the variation in real money demand in response to variation in real activity is accommodated through inflation rather than through nominal money growth. For both policy and intellectual purposes, the negative inflation–real activity relations observed so consistently call into question the common belief, founded in the many variants of the Phillips curve, that the trade-offs between inflation and real activity growth rates are positive.

Perhaps the most important result of this paper is the consistent finding that the base is the relevant variable in the inflation process, thoroughly dominating demand deposits or M1. Moreover, as suggested earlier, the dominance of the base has strong theoretical foundations. Patinkin (1961) shows that fixing an equilibrium real value for a nominal unit of account (a dollar) involves (i) fixing the supply of a nominal asset which has a well-defined demand function and for which there is no perfect substitute, and (ii) fixing the interest rate on the asset at less than its free-market value. In the U.S. system, the two main nominal assets on which interest rates are fixed (at zero) and which are supplied directly by the monetary authorities are currency and the reserves banks are forced to hold against various kinds of deposits. Interest rates on demand deposits and some time deposits are also fixed below free-market levels. However, since the split of reserves among various kinds of deposits is determined by demand, the control of the monetary authorities over the supply of deposits is indirect and incomplete.

Currency and the transactions services provided by deposits are substitutes but not perfect substitutes as methods of executing transactions. Thus, currency and reserves have separate demand functions. Patinkin's analysis then implies that the price level can be controlled by controlling the nominal supply of currency alone. The government could follow a passive policy with respect to reserves, allowing banks to exchange securities (but not currency) for reserves on demand. The reserve requirement is then just a proportional tax on deposit returns which does not imply a need to control the level of either reserves or deposits in order to control the price level. Alternatively, since currency and reserves have separate demand functions, the real value of the dollar could be controlled by controlling the nominal quantity of reserves but following a passive policy with respect to currency, that is, allowing banks to exchange currency for ordinary securities (but not reserves) on demand.

In the U.S. system, however, the central bank follows a passive policy with respect to the mix of currency and reserves, allowing banks to exchange currency for reserves on demand. In this case there are no separate supply functions for currency and reserves, and the price level depends on the total of the two, that is, the monetary base. This explains the consistent empirical finding that the base is the relevant monetary aggregate in the inflation process.

While theory and evidence suggest that control of the price level can be achieved through control of the base, this is not the simplest approach to the problem. In the current system, currency and reserves held against both demand and various kinds of time deposits are all involved in the determination of the price level. Controlling the price level is complicated by shifts in the tastes of the public among currency, demand, and time deposits. For example, central bankers must worry about how an open-market operation will eventually work its way into different parts of the system, giving rise to work for an army of economists tinkering with various currency and deposit multipliers.

Managing the price level would be much simplified by focusing the problem on the supply of currency. This could be done by ceasing to allow free convertibility between reserves and currency or, more directly, by dropping reserve requirements. The theoretical arguments in Fama (1980), which are just applications of those in Patinkin (1961) and Tobin (1963), indicate that in such a system the liabilities issued by the banking sector would not be important in price-level determination. There would be no more need to control the quantity of demand deposits (or time deposits, or certificates of deposit, or Eurocurrency deposits) for the purpose of controlling the price level than there is for controlling the amount of securities issued and held by mutual funds and other free-market intermediaries. As long as there is a set of transactions in which currency has a comparative advantage as transactions medium, control of the price level could be obtained by controlling currency.

Moreover, Fama's (1980) analysis indicates that there is no need to be concerned about the disruptive effects of a liberated banking sector on real activity or the way that activity is financed. Competitive banks would be subject to the Modigliani and Miller (1958) theorem; that is, banks would be pure financial intermediaries, in the nature of mutual funds, that bring together demanders and suppliers of portfolio assets and then act as repositories for the securities that are thereby created.

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