FEDERAL RESERVE BANK
OF SAN FRANCISCO

ECONOMIC REVIEW

REACTIONS TO UNCERTAINTY

SUMMER 1977

Savings, Money Demand and the Inflation/Unemployment Tradeoff

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In recent years the rapid rise in the rate of inflation has caused economists to consider what role price expectations play in determining the behavior of the private economy, especially in regard to savings behavior and the demand for money.[1] Both of these questions are analyzed in this paper. In addition, the question of the effect of *unanticipated* (as opposed to *anticipated*) inflation on such variables is considered in relation to the presumed "trade-off" between unemployment and inflation.

This paper argues that the rise in unanticipated inflation in recent years has tended to increase the personal saving rate and to decrease the demand for real money balances. The net effect of these offsetting actions has been a decrease in the rate of growth of economic activity and an increase in the unemployment rate. In other words, the private sector's response to an increase in unanticipated inflation in many cases involves an actual short-run worsening of the unemployment situation. Anticipated inflation, meanwhile, tends to have no long-run impact on savings behavior, money demand, or the unemployment rate.

Our results for the effect of anticipated inflation on the unemployment rate are consistent with the "rational expectations" literature, that price expectations are formed by utilizing knowledge of the structure of the economic system and of the behavior of policymakers. However, our finding of a possible perverse short-run trade-off between unemployment and unanticipated inflation is at variance with previous empirical work in this area.

I. Prices and the Saving Rate

Our saving-rate analysis is based on the argument that aggregate demand is influenced by errors in price forecasts. Surprises with respect to the rate of inflation cause the demand side of the economy to retrench on real spending in favor of increased saving.

One of the most basic propositions of demand theory is that consumer demand is dependent on "relative prices" (e.g., the price of good A "relative" to the price of good B). An absolute price change—for example, a proportionate rise in the prices of all goods and incomes—should in principle leave the demand for any particular good unchanged. However, unexpected changes in inflation create increased difficulties for households in making decisions about relative prices. Indeed, consumers may interpret a sudden increase in inflation as a worsening in their relative prices—the price of their labor versus the prices of various goods. When consumers perceive relative prices worsening because of unexpected variability in the absolute price level (unanticipated inflation), they tend to change their consumption decisions by choosing to save more today. That is, increased variability in the absolute price level leads consumers to perceive increased variability in their real income, which uncertainty in turn leads them to increase their saving rate. This argument, it should be noted, assumes that individuals require greater price stability if they are to maintain a stable relationship of saving to income. The greater the inflation instability, the greater will be the instability in the personal saving rate.

This argument is the demand counterpart to what is observed on the supply side of the economy. In the latter case, it is assumed that suppliers have more accurate price information available for their own products (output and

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labor) than they do for all products in the aggregate. Suppliers interpret a rise in the price of their output as an increase in their "relative prices," so that they tend to increase both output and labor supply in the short-run. In this sense, workers are "fooled" in the short-run, when they see their nominal wages rising, but "smarten up" in the long-run, when they realize that the rise in nominal wages was simply the result of a rise in the aggregate price level. This "rational expectations" argument, developed by Lucas and Sargent and Wallace,[2] assumes that economic agents have a supply response to unanticipated inflation, but not a demand response. In this view, a surprise increase in the rate of inflation can result in a short-run rise in aggregate output.

Nonetheless, ignoring the effects of unanticipated or "surprise" inflation on the demand side of the economy ignores the important intertemporal decision consumers make regarding the proportion saved out of current income. We argue that the increased saving response to surprise inflation may offset any positive supply response to these same inflation surprises.

Thus, unanticipated inflation can increase the perceived variability of real income—even when expected real income remains unchanged—and can thereby result in a rise in the saving rate. This argument, adapted from the work of Jacques Dreze and Franco Modigliani,[3] can be developed as follows. Assume that we have an individual who plans for two periods into the future. In the first period, he knows his income with certainty, and presumably he also knows the rate of interest at which he can invest any first-period income that is not consumed. In the second period, this individual's consumption will be equal to his investment returns plus his second-period income. Algebraically, $c_2 = (y_1 - c_1)(1 + r) + y_2$ where y denotes income, c consumption, r the rate of interest and numerical subscripts denote time periods. Saving in period one is equal to $(y_1 - c_1)$.

Let us assume, however, that this individual does not know with certainty the real purchasing-power value of the next period's income, specifically because of a rise in uncertainty with respect to the rate of inflation. In this situation, the individual's real income in the next period may be either higher *or* lower in real terms than had been anticipated before the introduction of inflation uncertainty. The question thus arises—will he maintain the same level of consumption which he would have done in the absence of any uncertainty with respect to the value of the next period's income? If the individual is a "risk averter"—that is, if he prefers less rather than more variability in the range of possible uncertain events—he would decrease his consumption in period one in the face of uncertainty with respect to period two's real income.

At the same time, an increase in *anticipated* inflation should have little, if any, impact on aggregate saving behavior. In this case, current spending decisions incorporate the gains (for some) and the losses (for others) of the current anticipated rate of inflation. Anticipated inflation has little effect on real spending decisions, to the extent that relative prices are unaffected by any such change. Unanticipated inflation, however, tends to create the impression that relative prices have changed, and thereby generates decisions to alter spending patterns.[4]

To summarize, a rise in unanticipated inflation should increase the saving rate, while a rise in anticipated inflation should have no significant effect on this rate. If unanticipated inflation fails to affect money demand or the supply of real output, the rise in the saving rate would tend to decrease aggregate demand and increase the unemployment rate. There may, however, be an offsetting effect of unanticipated inflation on the monetary side of the economy. A decrease in the demand for real money balances, i.e., an excess nominal money supply, would tend to stimulate aggregate demand, and could offset the decline in aggregate demand resulting from an increased saving rate. Before considering these possibly offsetting forces, we turn to a discussion of money demand and price expectations.

II. Prices and Money Demand

In the traditional textbook formulation, the demand for money is dependent on a measure of aggregate transactions—for example, income (y)—and some measure of the opportunity cost of holding money—typically a short-term interest rate (r). This state of the "desired" real demand for money (m_t^*) can be expressed as

$$m_t^* = \alpha_0 + \alpha_1 y_t + \alpha_2 r_t \quad (1)$$

where subscripts refer to time periods. Since m* is defined in "real" terms, multiplying it by the actual price level yields a "nominal" demand for money, or $M_t^* = m_t^* \times P_t$. In models of short-term demand for money balances, when the period of analysis is less than a year, it is common to assume that individuals reduce the gap between desired and actual money balances by some constant fraction, λ, where λ is positive but less than unity. This "partial adjustment" hypothesis may be stated as

$$M_t - M_{t-1} = \lambda(M_t^* - M_{t-1}) \quad (2)$$

On the basis of this hypothesis, consider how prices and inflation expectations influence the demand for money. First, a one-percent rise in the observed price level may result in a one-percent rise in the desired nominal demand for money, under an assumption of "unitary price elasticity." Secondly, price expectations are already embedded in the desired demand for money, equation (1), to the extent that the interest rate incorporates this price expectation. That is, price expectations are already adequately reflected in the desired demand for money, under the assumption that the nominal rate of interest, r, is composed of both a "real rate of interest," defined as the lending rate in the absence of price inflation or deflation, and an "anticipated rate of inflation" defined over the life of the respective financial asset. Hence in the "Fisher equation,"

$$r_t = r^* + \pi_t^a \quad (3)$$

where r = the nominal market rate of interest, r* the real rate of interest, and π^a the anticipated rate of inflation, r captures expected price inflation over the remaining maturity of the financial asset to which it is related. The assumption in (3) is that the nominal market rate of interest fully incorporates the implicit anticipated rate of inflation.

If we assume that a one-percent rise in anticipated inflation results in a one-percent rise in the desired nominal demand for money—our price-elasticity assumption—there is no reason to add any further estimate of anticipated inflation to the demand for money. However, an argument can be made for including the remaining "unanticipated" (forecast error) component of inflation in the equation. A rise in the price level requires a rise in nominal money balances to finance a given volume of real transactions, but it also entails a tax on real (price-deflated) money balances. Interest-rate effects capture the negative impact of *anticipated* inflation. However, after the fact—after actually observing the rate of inflation—individuals and businesses may attempt to economize further on real cash balances in response to the surprise excise tax imposed by *unanticipated* inflation. That is, an increase in the variance of the "tax" rate (unanticipated inflation) causes individuals to reduce the tax base (their holdings of real money balances).

An unanticipated rise in prices thus creates two partially offsetting effects in the money market. First, for a given nominal money stock, a rise in prices decreases the real (supply) stock of money balances. Secondly, the surprise tax on real money balances induces an *ex post* decline in the real demand for money, which partially offsets the contractionary effect of the decline in the real money stock. On balance, a rise in unanticipated inflation should decrease the demand for real money balances, in contrast to a rise in anticipated inflation, which should have no statistically significant effect on real money demand aside from the effect captured in interest rates.

III. Measuring Anticipated Inflation

In order to conduct statistical tests regarding money demand and saving behavior, we must derive a measure of anticipated inflation. As a first approximation, the Fisher equation, with an additive random-error term, may represent the relationship between the nominal rate of interest and the anticipated rate of inflation.

$$r_t = r_t^* + \delta\pi_t^a + \epsilon_t \quad \delta \geq 0 \qquad (4)$$

Equation (4) is similar to equation (3) except that the real rate of interest is not assumed constant and the nominal rate is also influenced by a random error term, ϵt, which is uncorrelated with r_t^* and π_t^a.

To obtain an estimate of π_t^a, the anticipated rate of inflation, we compare the nominal rate of interest—measured by Standard and Poor's high-grade long-term bond yield—and the real rate of interest, measured by Standard and Poor's dividend-price ratio. Subtracting, we obtain:

$$r_t - r_t^* = \delta\pi_t^a + \epsilon_t = \hat{\pi}_t^a \qquad (5)$$

In view of the inclusion of the measurement error, ϵ_t, our estimate of anticipated inflation, $\hat{\pi}_t^a$, is at best a crude approximation. Nonetheless, we may subtract this estimate of the anticipated rate of inflation from the observed rate of inflation, measured by the consumer-price index, to obtain a rough estimate of the "unanticipated rate of inflation."[5]

As a check, we compared our series with the eight-month inflation forecasts, and forecast errors, obtained by John A. Carlson on the basis of the semi-annual survey of price forecasts conducted by Joseph Livingston of the *Philadelphia Inquirer*.[6] (The Livingston forecast survey is conducted two months before the close of each half year.) The Livingston surveys provide semi-annual forecasts, so we averaged our quarterly average values to obtain similar semi-annual figures. Estimates for the anticipated rate of inflation can then be compared for the Livingston method and what we will call the "Crude Fisher Method" (Table 1).

Table I

Comparison of Inflation Forecasts: Annual Rates of Change (1954 first half to 1976 first half)

	Livingston Forecast	Crude Fisher Forecast
Mean	2.09%	1.95%
Standard Deviation	1.97	1.90
Coefficient of Variation	0.94	0.98
Correlation	0.85	

The two approaches yield similar results, although the Fisher method contains a measurement error, which can be large (Chart 1). Thus, generally speaking, data obtained from financial markets can yield imputed inflation forecasts similar to those obtained from pure survey techniques. Fama's finding[7] that short-term interest yields accurately reflect very short-term inflation expectations may be true for longer-term corporate securities as well. In addition, it is interesting that a long-term bond incorporates, according to the Fisher measure, an anticipated rate of inflation similar to a survey rate with only an eight-month horizon. This suggests that short- and long-run inflation forecasts were not significantly different except for the 1974-75 period. Given these qualifications, the "Crude Fisher" measure seems to provide a reasonable method for estimating the unanticipated rate of inflation.

A further test was obtained by regressing the Livingston forecast (LF) on the contemporaneous Fisher forecast (FF), for the period 1954H1 to 1971H2.

$$LF = 0.54 + 0.63\ FF \qquad (6)$$
$$(2.1) \quad (5.8)$$

$\bar{R}^2 = 0.88$ SER = 0.40 DF = 36

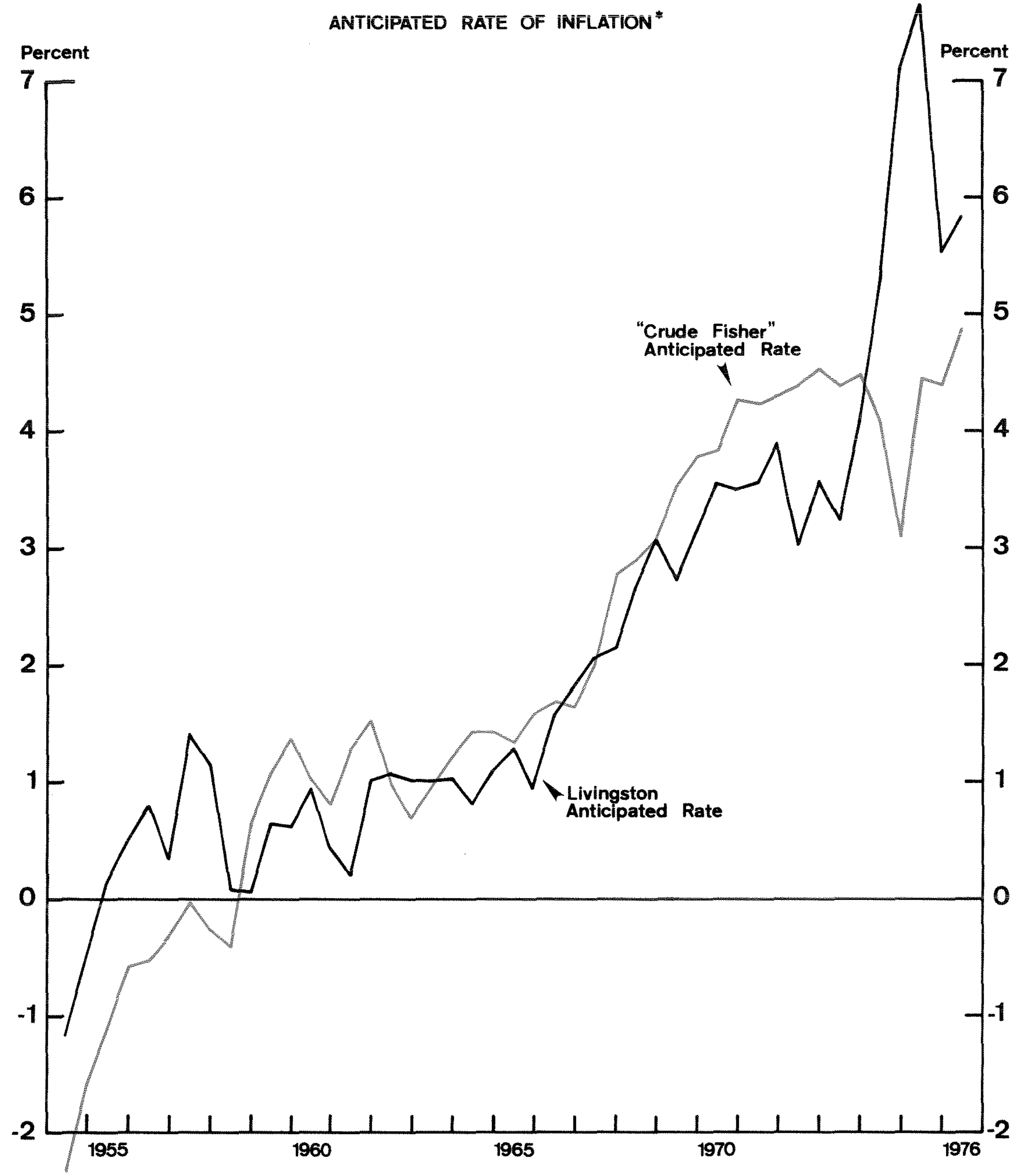
D.W. = 1.91 RHO = 0.61

RHO = estimated first-order serial correlation coefficient;
$\bar{R}^2$ = adjusted R^2, DF = degrees of freedom;
D.W. = Durbin-Watson statistic, and SER = standard

error of the regression; t-statistics in parentheses. Equation (6) reveals a high correlation between the two series, after quasi-first-differencing the two series by the estimated serial correlation coefficient, 0.61. As indicated in Chart 1, inclusion of post-1971 data provided a poorer statistical fit, because the "Fisher approach imputed a high inflation rate over the 1972-1973 period—

Chart 1

ANTICIPATED RATE OF INFLATION*



*Annual change in consumer-price index

the period of price controls—but a lower rate over the late 1974-1975 period—the post-control period.

Next, both approaches yielded very similar rates of unanticipated inflation, or forecast errors (Table II). The Livingston forecast yielded a lower average rate of unanticipated inflation over the period as a whole, but the "Crude Fisher" procedure performed marginally better until the recent experience with price controls.

Table II

Comparison Rates of Unanticipated Inflation: Annual Rates of Change (1954 first half to 1976 first half)

	Livingston Forecast	Crude Fisher Forecast
Mean	1.27%	1.37%
Standard Deviation	1.52	2.05
Coefficient of Variation	1.20	1.50
Correlation	0.86	

The high correlation and the similar average values should not be surprising, since both measures were obtained by subtracting the observed CPI rate of inflation from the anticipated inflation series.

It should be noted that the unanticipated inflation variable may actually be a proxy for another aspect of inflation—the variance of the expected inflation rate (Chart 2). The chart plots the unanticipated inflation rate against the variance in price expectations around the expected mean change in prices, developed from Survey Research Center data.[8] The fact that two survey measures of inflation, Livingston and SRC, parallel the movement of our financial-market determined measure of unanticipated inflation supports the use of the latter variable in our analyses of both personal saving and money demand.

At this point we have developed arguments regarding how unanticipated inflation affects saving behavior and money demand, and have obtained a proxy measure for unanticipated inflation. We now turn to the statistical testing of saving behavior and money demand.

IV. Testing the Saving Rate Hypothesis

The basic formulation of the saving-rate hypothesis for empirical estimation can be stated as

$$PS^* = f(\underset{+}{UR}, \underset{+}{y^T/y}, \underset{+}{UI}) \qquad (7)$$

$$PS_t - PS_{t-1} = \beta(PS^*_t - PS_{t-1}) \quad 0 \leq \beta < 1 \qquad (8)$$

Equation (7) states that the desired personal saving rate (PS*) is positively influenced by employment uncertainty as measured by the unemployment rate (UR), positively related to the ratio of transitory (windfall) to observed income (y^T/y), and positively influenced by the unanticipated rate of inflation (UI). The implicit assumptions are that most transitory income is saved and that anticipated inflation (AI) does not influence the saving decision. We may hypothesize that if the anticipated inflation variable is included in the estimated equation, its coefficient should be statistically insignificant. Also, we may hypothesize that the gap between the desired personal saving rate and the actual saving rate (PS) is closed each quarter by a constant fraction, β, as seen in equation (8).

Equation (7) is intentionally parsimonious. We argue that short-term variations in the saving rate around its trend value result from variables proxying for uncertainty in employment, income and inflation.

The estimated equation for the personal-saving rate is

$$PS_t = \underset{(1.3)}{0.60} + \underset{(10.7)}{.717}\ PS_{t-1} + \underset{(2.8)}{.201}\ UR_t + \underset{(3.7)}{15.93}(y^T/y)_t + \underset{(.8)}{.031}\ AI_t + \underset{(2.7)}{.083}\ UI_t \qquad (9)$$

$\bar{R}^2 = .655$ SER = .63 DF = 79

D.W. = 1.86 RHO = −.25

Sample Period: 1955.1-1976.3

t - statistics appear below the coefficients.

The ratio of "transitory income" (observed less permanent income) to observed income was measured by real per capita disposable personal income. Transitory income was obtained by first estimating "permanent income" as an adaptive trend.[9] Equation (9) supports the argument that a rise in unanticipated inflation increases the saving rate while anticipated inflation has no statistically significant effect. The t-statistic on the unanticipated inflation variable is 2.7, which is statistically significant at the .995 significance level. In addition, both the unemployment rate and the transitory/observed income ratio are positive, as expected, and statistically significant.

To obtain the estimated "adjustment coefficient β," we simply subtract the estimated coefficient on the lagged personal-saving rate from unity. This implies that approximately 30 percent of the gap between the desired and actual saving rate is removed each quarter. During the 1970's, when unanticipated inflation was significantly above its average value of the 1960's, the private sector adjusted its saving rate much more rapidly, completing this adjustment fully within one quarter. For example, the coefficient on the lagged saving rate was found to be near zero when equation (9) was estimated for the 1966-76 period.

Further testing of the inflation-saving hypothesis involves estimating the equation for the *level* of real per capita personal saving. The saving rate could, for example, rise because income has fallen, while the level of saving remains unchanged, so it is necessary to determine whether unanticipated inflation has any effect when income is held constant. As detailed

Chart 2

UNANTICIPATED INFLATION AND VARIANCE OF EXPECTED PRICE CHANGES

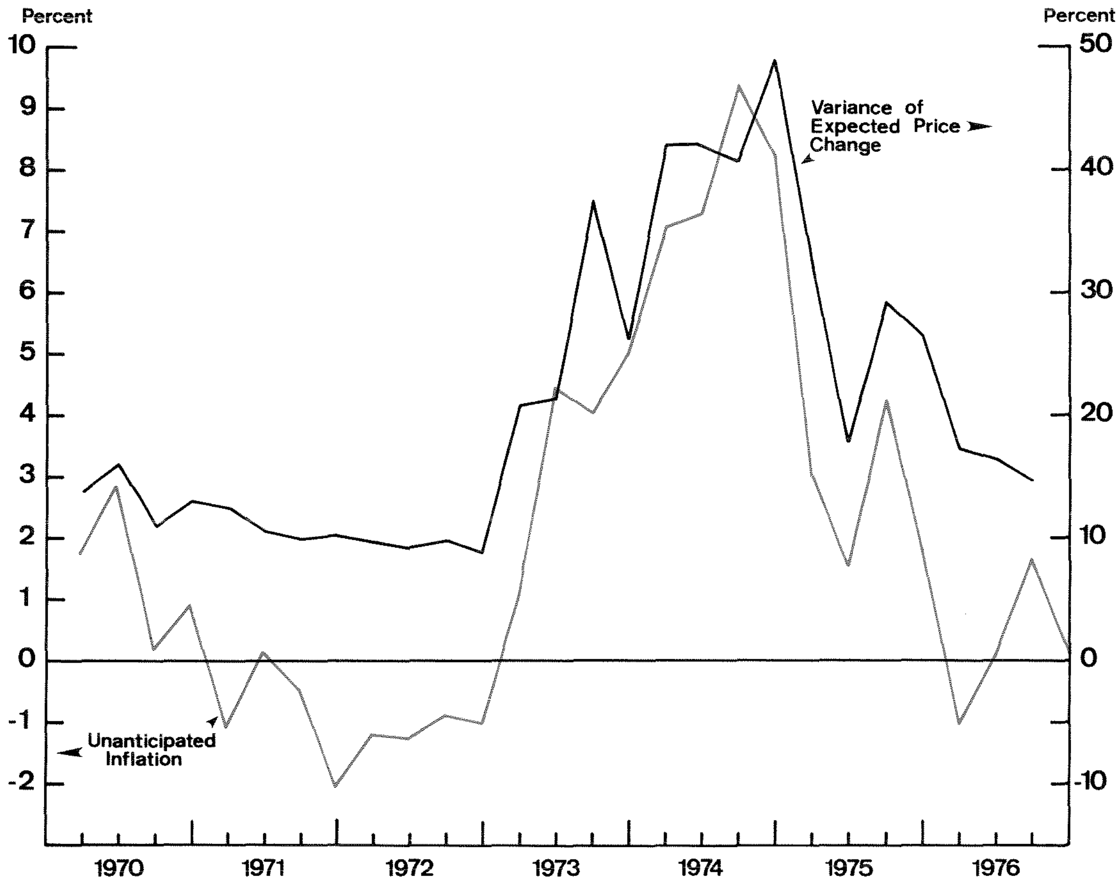


Table III
Personal Saving Rate and Inflation
1960.1-1976.4

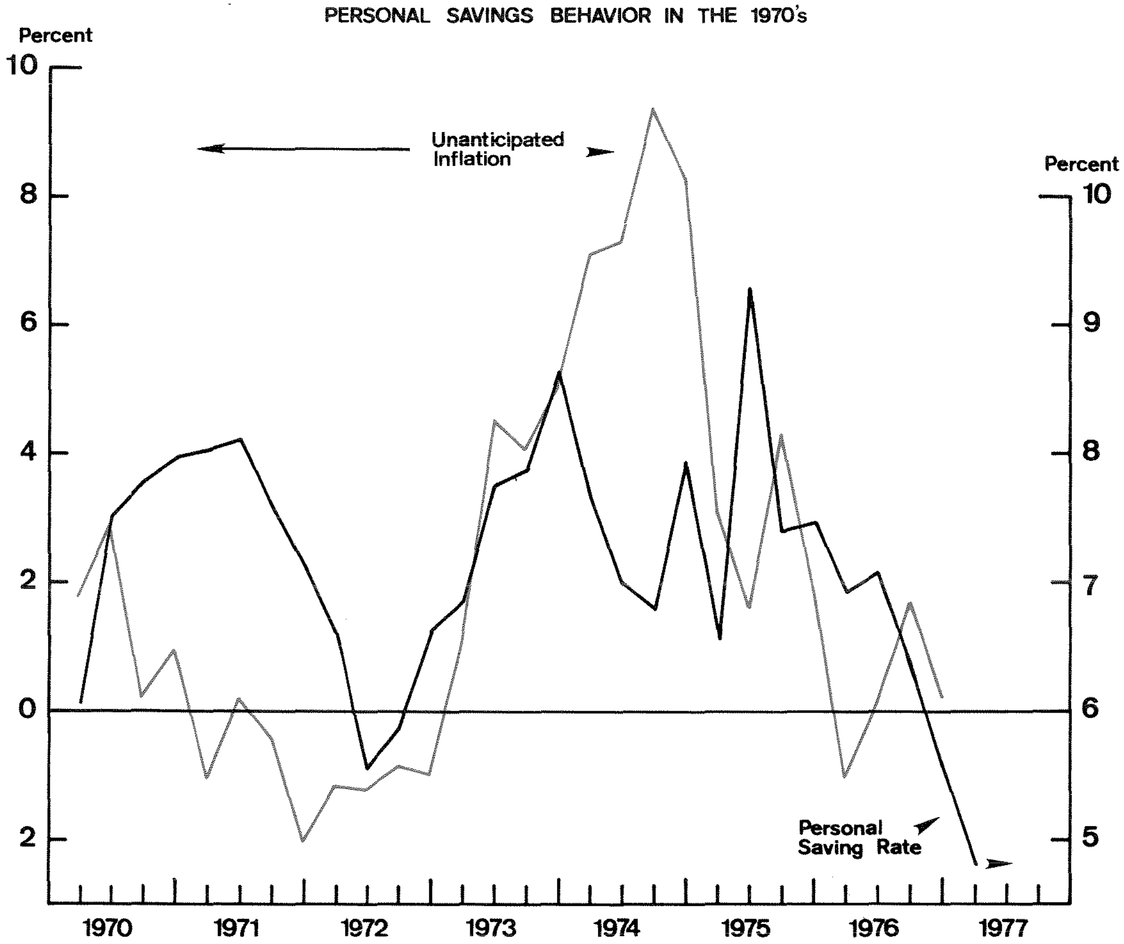
	1960.1-1969.4	1970.1-1976.4
Personal Saving Rate		
Mean	5.9%	7.2%
Standard Deviation	0.96	0.9
Rate of Inflation (CPI)		
Mean	2.4	6.3
Standard Deviation	1.8	2.8
Unanticipated Inflation		
Mean	0.6	2.0
Standard Deviation	1.1	3.1

in Appendix 1, unanticipated inflation affects the level of saving in much the same way as it affects the saving rate.

The rise in unanticipated inflation, from an average 0.6 percent in the 1960's to 2.0 percent in the 1970's, apparently helped to account for the 1.3-percentage point rise in the personal saving rate between these two periods. (Table III and Chart 3).

Chart 3

PERSONAL SAVINGS BEHAVIOR IN THE 1970's



V. Money Demand and Price Expectations

Many analysts have argued recently that the demand for money has declined because of structural changes in the economy.[10] While this phenomenon may reflect certain regulatory changes and financial innovations, we argue that it is also due to the rise in unanticipated inflation. Because the holding of real money balances involves a cost, roughly measured by the observed rate of inflation, and because this cost is not known without error, it would appear that real money balances may respond to that anticipational error, as measured by the rate of unanticipated inflation. Any decline in money demand due to unanticipated inflation could have a potentially stimulative effect on the economy, which could offset the contractionary impact exerted by a rise in the saving rate.

To test the appropriateness of unanticipated inflation in the real money-demand equation, we first estimated a partial-adjustment equation for real M_1 per capita balances. Desired real money demand is defined as dependent on both "permanent" (trend) real disposable personal income (y^P), "transitory" (observed less permanent) real disposable personal income (y^T), a short-term interest rate, defined as the commercial paper rate (CPR), unanticipated inflation (UI) and anticipated inflation (AI). As before, we hypothesize that anticipated inflation should be statistically insignificant but unanticipated inflation should be significant and negative. The estimated equation, in linear form, is given below. All dollar variables are in real per capita terms, with the consumer-price index used as the deflator.

$$
\begin{aligned}
M1_t = \underset{(.6)}{20.62} &+ \underset{(1.8)}{.013}\, y^P_t + \underset{(2.5)}{.038}\, y^T_t + \underset{(34.5)}{.954}\, M1_{t-1} \\
&- \underset{(3.9)}{2.22}\, CPR_t - \underset{(4.8)}{1.833}\, UI_t - \underset{(.1)}{.077}\, AI_t
\end{aligned}
\qquad (10)
$$

$\bar{R}^2 = .987$ SER = 3.60 DF = 71

D.W. = 1.82 RHO = .45

Sample period: 1955.1-1974.4

In this equation, unanticipated inflation (UI) has a statistically significant negative impact on real per capita M_1 balances with a respectable t-statistic of 4.8. Also, the anticipated inflation (AI) variable is statistically insignificant, with a t-statistic of only 0.1[11] As detailed in Appendix 2, the same result with respect to the effect of unanticipated inflation is found when household (rather than total) real money balances are used to estimate the relation.

VI. Implications for Economic Activity

We have argued in this paper that a rise in unanticipated inflation will increase the personal saving rate and decrease the real demand for money. Given those effects, unanticipated inflation could lead to a decline in real output and a rise in the unemployment rate. This conclusion is not theoretically certain, however, because the effects cited are partially offsetting. That is, a rise in unanticipated inflation tends to increase the saving rate, which is contractionary, but also tends to reduce the demand for money, which is expansionary. Depending on the magnitude of these offsetting forces, we may find the unemployment rate either rising or falling.

This argument is an addition to the arguments of Lucas, Sargent and Wallace, who suggest that a *positive supply* response to unanticipated inflation, in the short-run, will decrease the unemployment rate. They implicitly assume that the demand side of the economy is not subject to the same misconceptions about relative prices as is the supply side. Thus, in their models a rise in unanticipated inflation can exert only a beneficial effect on the unemployment rate. Our argument is closer to that of Robert Barro's. In his study, Barro contends that a "surprise" regarding the rate of inflation can also affect the demand side of the economy, creating the possibility of either a beneficial or perverse short-run trade-off between unemployment and unanticipated inflation.[12]

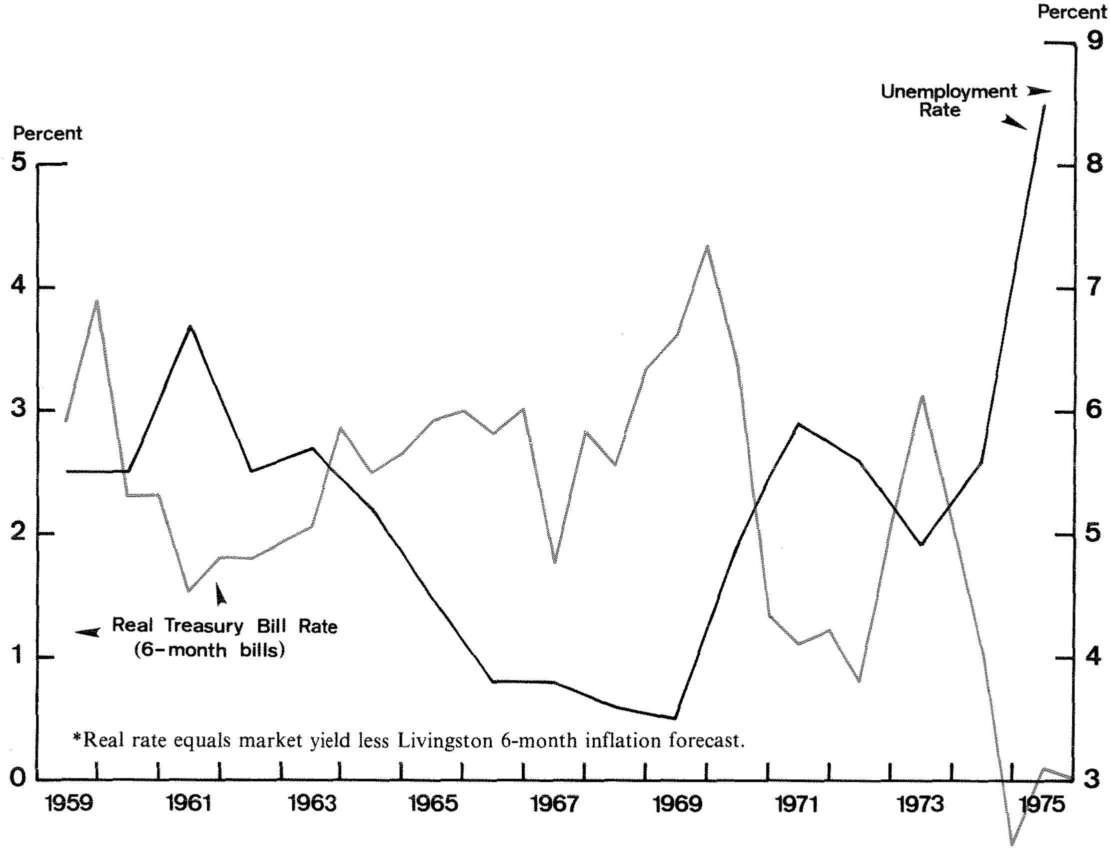
Our analysis assumes that the real rate of interest can be more variable in the short-run, as a result of short-term shifts in saving behavior and real money demand. Errors in price forecasts increase the actual (ex post) variability in the real rate, and this variability is greater the greater the variance in inflation (Chart 4). The chart shows the real rate on 6-month Treasury bills, obtained by subtracting June and December 6-month Livingston inflation forecasts (made two months previous) from the market yield on 6-month bills.

Determination of the real rate can be shown in a graphical analysis (Chart 5), which illustrates the effects of unanticipated inflation on aggregate demand. "Normal full capacity utilization" is assumed to generate a real income level of y^o, associated with which is a "natural rate of unemployment," u^o. The LM curve represents the equilibrium between the supply and demand for real money balances. The LM curve slopes upward, because with a rise in the real rate of interest, the given level of real money balances will be held only at a higher level of income. The IS curve represents the equilibrium between investment and saving. This curve slopes downward, because a lower real rate of interest (with its stimulus to investment) will equilibrate saving and investment only if income increases to generate the necessary saving.

Assume now that prices unexpectedly rise. This price rise will increase the level of saving, which, for a given level of income, can equal investment only if the real rate falls to encourage investment. Hence, the IS curve shifts down and to the left with respect to the money market. The unexpected rise in prices will first decrease the level of the real money supply, shifting the LM curve to the left, say to LM^1—perhaps shifting enough to retain the old real rate of interest r^o. If real money demand declines at the same time, the LM curve will make a partially offsetting move to the right, between points F and G. That new

Chart 4

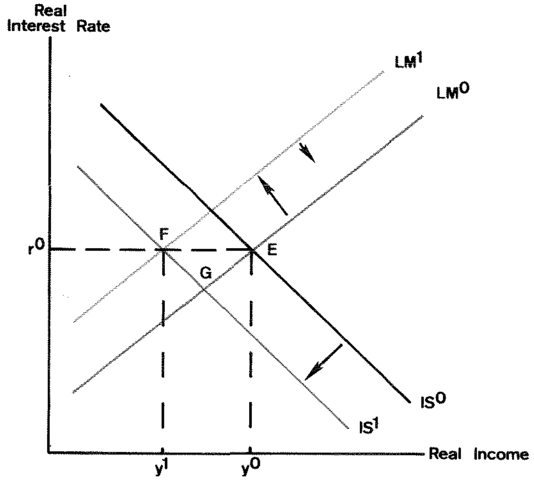
UNEMPLOYMENT RATE AND EX ANTE REAL TREASURY BILL RATE*



*Real rate equals market yield less Livingston 6-month inflation forecast.

Chart 5

REAL INTEREST RATE and REAL INCOME



equilibrium level—where there is equality of real saving and real investment and equality of real money demand and supply—results in a lower real income level (higher unemployment rate) and a lower real rate of interest. Hence, a surprise increase in the rate of inflation can result in higher *nominal* rates of interest but lower *real* rates of interest and a higher unemployment rate. This would also imply an inverse relationship between the unemployment rate and the real rate of interest over the business cycle. This inverse relationship has been especially evident since about 1969, when a fall in the real rate of interest was associated with a rapid rise in the unemployment rate (Chart 4). In particular, the drastic fall in the real rate after 1972 was associated with a proportionately large rise in the unemployment rate.

If unanticipated inflation has a significant impact on the demand side of the economy, the unemployment rate and real output should be statistically related to that variable. To test these propositions, we next present two alternative tests of the hypothesis that a rise in unanticipated inflation has had a negative effect on unemployment, while anticipated employment has had no effect on aggregate output and unemployment. The first test involves the unemployment rate, following a procedure developed by Thomas Sargent, and the second test employs real output.[13]

The first statistical test regresses the unemployment rate on lagged values of itself, and on the rates of anticipated and unanticipated inflation. Under our basic hypothesis, the coefficient on the anticipated inflation should be near zero and insignificant, while the coefficient on the unanticipated inflation variable should be significant. The sign of the coefficient on the latter variable will determine whether a rise in unanticipated inflation tends, in the aggregate, to raise or to lower the unemployment rate. The estimated equation is

$$\underset{}{Un_t} = \underset{(.3)}{.044} + \underset{(19.5)}{1.873}\, Un_{t-1} - \underset{(7.3)}{1.259}\, Un_{t-2}$$

$$+ \underset{(3.8)}{.368}\, Un_{t-3} + \underset{(3.6)}{.046}\, UI_t + \underset{(.2)}{.004}\, AI_t \qquad (11)$$

$\bar{R}^2 = .954$ SER = .285 DF = 80

D.W. = 2.01 RHO = −.20

Sample Period: 1955.1-1976.4

This equation supports the hypothesis that anticipated inflation (AI) has no statistically significant effect on the unemployment rate. It also supports the argument that a rise in unanticipated inflation (UI) will increase the unemployment rate, at least to some small extent. In other words, an adverse effect through the demand side of the economy has, in the past 20 years, been greater than the positive effect through the supply side. On balance, a rise in unanticipated inflation has resulted in an increase in the unemployment rate.

We observe in equation (11) that the quantitative impact of unanticipated inflation on the unemployment rate is small. This is due to the fact that unanticipated inflation gives rise to offsetting influences on the demand and supply sides of the economy, which can be reversed given a different set of circumstances. The important point is that unanticipated inflation's effect on the unemployment rate can be positive or negative. The theoretical argument does not yield a definitive answer, so that empirical estimation must settle the issue.

In a further test, the dependent variable employed was "residual real GNP" (RRGNP), which may be defined as the difference between the observed level of real GNP and its trend value.[14] Because residual real GNP is trendless, we used no lagged values, but instead regressed it on a constant term, anticipated and unanticipated inflation. The estimated equation is

$$RRGNP_t = 1.52 - 1.793\ UI_t + .500\ AI_t \qquad (12)$$
$$\quad (1.0) \quad (4.4) \quad (1.0)$$

$\bar{R}^2 = .171$ SER = 8.49 DF = 85

D.W. = 2.35

Sample Period = 1955.1-1976.4

In this equation, a rise in anticipated inflation has no significant effect on real GNP, while a rise in unanticipated inflation decreases real GNP from its trend value. The coefficient on the latter variable is 4.4, easily passing conventional significance tests. The overall fit of equation (12) is not very large, but this is not surprising since the dependent variable is a sequence of variations in the level of real GNP.

Sub-sample results indicate the lack of any "trade-off" during the 1950's between real GNP and either variety of inflation. During the 1960's, a perverse trade-off developed, with output decreasing with a rise in unanticipated inflation, and this trade-off worsened during the 1970's. The estimated equation for the 1970's, given below, indicates that a rise in unanticipated inflation of one percentage point decreased real GNP by almost $2 billion.

$$RRGNP_t = -5.81 - 1.953\ UI_t + 2.354\ AI_t \qquad (13)$$
$$\quad (.2) \quad (2.0) \quad (.3)$$

$\bar{R}^2 = .197$ SER = 12.13 DF = 25

D.W. = 2.53 Sample Period = 1970.1-1976.4

The equations reported above were reexamined in a variety of ways, utilizing Sargent's test procedures,[15] to determine whether a beneficial trade-off between unemployment and inflation could be discovered. In no case were such results obtained. Indeed, during the period considered, there was an adverse relation between inflation and unemployment. The indicated neutrality of the *anticipated* rate of inflation in relation to real output and employment is entirely consistent with the results obtained in our analysis of the saving rate and the demand for money. Anticipated inflation appears to have had no statistically significant effect on either real output or unemployment.

VII. Conclusion

In his recent Nobel Lecture, Professor Milton Friedman argued that the increased variability of inflation decreases the efficiency of the price system in coordinating economic activity.[16] Prices are means of conveying information on the relative scarcity of goods. However, individuals must extract information about "relative prices" from observations on "absolute prices." The greater the variability in absolute prices, the greater the difficulty in abstracting the informational content regarding relative prices from absolute price-level information. Friedman's argument is relevant to the decisions consumers must make with regard to saving and holding of real money balances. Errors in price forecasts in recent years, as evidenced either in the Livingston survey data or our measure of unanticipated inflation, have tended to raise the saving rate and to decrease the demand for real money balances.

The difficulty of extracting the "signal" from information on absolute prices has increased consumers' uncertainty regarding the value of both their future income and their future wealth. This increased uncertainty in turn has led to a significant rise in the saving rate, and thereby contributed to the severity of the worst postwar recession. The result has been a concurrent rise in inflation and unemployment, contrary to what we would expect from the received wisdom of the 1960's. The evidence considered in this paper forces us to cast a skeptical eye not only on any long-term trade-off between unemployment and *anticipated* inflation, but also on any short-term trade-off between unemployment and *unanticipated* inflation. Economic theory posits an ambiguous relation between unemployment and unanticipated inflation. If supply considerations dominate, the trade-off will be beneficial; if demand considerations dominate, the trade-off will be adverse. Our evidence suggests that the trade-off has been adverse during the last 20 years.

The policy implications of our paper which follow from this apparent lack of any beneficial trade-off support the argument that monetary policy can best stabilize the economy by stabilizing (or reducing) the rate of inflation. Greater instability in the rate of inflation creates the conditions for greater instability in aggregate demand and employment.

Appendix 1

The level of real personal saving is hypothesized to be dependent on permanent real disposable personal income, y^P, transitory real disposable personal income, y^T, unanticipated inflation, anticipated inflation, and the unemployment rate. All dollar magnitudes were deflated by the consumer-price index.

We also introduce into the analysis the effect of real per capita money balances, M1. In line with the "real balance effect," emphasized in the work of A. C. Pigou, Lloyd Metzler and Robert Mundell, we argue that a fall in real money balances should lead to a rise in real saving. Also, we introduce the 3-month Treasury bill rate, TBR, as an additional explanatory variable. The bill rate serves as a proxy for the real rate of interest. Thus, a rise in the nominal interest rate, with the anticipated rate of inflation held constant, would imply a rise in the real rate of interest.

Although additional variables have been added to explain the level of personal saving, the overall results are not significantly changed if the interest rate and money balances are dropped from consideration. These additional variables are added to determine whether our previous conclusions with respect to anticipated and unanticipated inflation continue to hold up when the theoretical model is expanded.

The general form of the equation for the level of personal savings, S, appears below. The signs below the variables indicate the expected signs on the estimated coefficients.

$$S = S(\underset{+}{y^P}, \underset{+}{y^T}, \underset{+}{TBR}, \underset{+}{UI}, \underset{0}{AI}, \underset{+}{UR}, \underset{-}{M1}) \qquad (14)$$

All dollar variables are in real per capita terms. We drop the partial-adjustment hypothesis because this hypothesis does not appear reasonable for the entire sample period. Also, the elimination of the lagged dependent variable improves our statistical results if the equation errors prove serially dependent. The estimated equation is

$$\begin{aligned} S = {} & \underset{(2.5)}{716.1} + \underset{(.6)}{.029}\, y_t^P + \underset{(8.8)}{.68}\, y_t^T + \underset{(.9)}{2.89}\, TBR_t \\ & + \underset{(2.1)}{2.68}\, UI_t + \underset{(1.67)}{10.08}\, AI_t \\ & + \underset{(2.2)}{7.99}\, UR_t - \underset{(3.0)}{.78}\, M1 \end{aligned} \qquad (15)$$

$\bar{R}^2 = .902$ SER = 15.16 DF = 77

D.W. = 2.38 RHO = .90

Sample period = 1955.1-1976.3

The equation indicates that personal saving—even in level form—is influenced by independent effects arising, first, from the level of real money balances, and second, from surprises in inflation, measured by our proxy for unanticipated inflation. Again we see that anticipated inflation does not have a statistically significant effect at conventional significance levels. The real interest rate is positive, as expected, but not significant. We also note that the most significant impact on real personal saving arises from changes in transitory income. The estimated equation implies that 68 percent of an increase in transitory (windfall) income will be saved. These results support the argument that an unanticipated increase in prices will cause the aggregate level of real saving to rise, due to a decline in real wealth and to an increased desire for precautionary saving.

Appendix 2

To further test the appropriateness of inclusion of unanticipated inflation, we incorporated Federal Reserve flow-of-funds data in the real money-demand equations. The new series included "demand deposit and currency" holdings of the household sector M_1H, deflated by consumer prices and by total "households," [A1] giving us a "permanent real per household disposable personal income" variable.[A2] The difference between observed real personal income and the computed "permanent" component was defined as "transitory" income. Here again, unanticipated inflation was statistically significant and anticipated inflation insignificant. However, the inclusion of the anticipated-inflation variable tended to bias downward the adjustment coefficient. The estimated equation, without the inclusion of the anticipated-inflation variable, is reported below. The commercial-bank passbook saving rate (PSR) is used as the interest-rate variable, because it is the best measure of the household sector's opportunity cost of holding money balances.

$$M1H_t = \underset{(.1)}{7.6} + \underset{(2.7)}{.035}\, y_t{}^P + \underset{(4.3)}{.050}\, y_t{}^T + \underset{(17.6)}{.873}\, M1H_{t-1} - \underset{(2.8)}{32.55}\, PSR_t - \underset{(3.3)}{3.58}\, UI_t \qquad (16)$$

$\bar{R}^2 = .921$ SER = 24.6 DF = 79

D.W. = 2.00 RHO = –.31

Sample Period: 1955.1-1976.3

For the household sector as for the more general case, unanticipated inflation exerts a statistically significant negative impact on real cash balances. For the household sector also, the quarterly adjustment speed again is rather low, but it is also much more realistic than in the general case, at 13 percent per quarter.

FOOTNOTES

1. For some recent examples, see F. Thomas Juster and Paul Wachtel, "Inflation and the Consumer," **Brookings Papers on Economic Activity** (1:1972), and Stephen M. Goldfeld, "The Demand for Money Revisited," **Brookings Papers on Economic Activity** (3:1973), pp. 607-613.
2. Robert E. Lucas, Jr., "Some International Evidence on Output—Inflation Trade-Offs," **American Economic Review** (June 1973), and Thomas J. Sargent and Neil Wallace, "'Rational Expectations,' the Optimal Monetary Instrument, and the Optimal Money Supply Rule," **Journal of Political Economy** (2:1975).
3. Jacques H. Dreze and Franco Modigliani, "Consumption Decisions Under Uncertainty," **Journal of Economic Theory** (1972). For a simple graphical illustration that increased income uncertainty will increase saving, see their Appendix D.
4. The inflation-saving hypothesis has been tested by Lester D. Taylor, using data from the "Consumer Anticipations Survey," and by Juster and Wachtel. Our arguments are similar to theirs, but we utilize different measures of anticipated inflation and obtain different results from our statistical tests. Lester D. Taylor, "Price Expectations and Households' Demand for Financial Assets," **Explorations in Economic Research** (Fall 1974). Thomas Juster and Paul Wachtel, "A Note on Inflation and the Saving Rate," **Brookings Papers on Economic Activity** (3:1972).
5. Another argument as to why the spread between the bond rate and the dividend yield provides a reasonable approximation to the expected rate of inflation concerns the assumption that the variability of inflation is positively related to the rate of inflation. If we assume that the return on equities includes an inflation premium but that the real return on equities is statistically independent of the inflation rate, then as the variability of the inflation rate (and the rate of inflation itself) rises, the real yield on bonds must rise relative to the real yield on stocks in order to induce individuals to hold the existing supply of these assets. Equivalently, the spread between the nominal yield on bonds and the real returns on equities (dividend yield) must widen with the rise in the expected rate of inflation. Thus the "expected rate of inflation" we are measuring in the text also includes a premium for inflation variability. Only in the case when the expected rate of inflation is held with certainty (inflation is always perfectly anticipated) will the nominal bond yield perfectly incorporate the expected rate of inflation (i.e., = 1). On the question of bond-equity yield spreads in relation to the variability of inflation, see M. J. Gordon and P. J. Halpern, "Bond Share Yield Spreads Under Uncertain Inflation," **American Economic Review** (September 1976). Gordon and Halpern argue that the real rate of return on bonds is an increasing function of the variability of the inflation rate.
6. Carlson's study, together with the Livingston forecasts, are found in "A Study of Price Forecasts," **Annals of Economic and Social Measurement** (Winter 1977). Note that the reported "6-month forecasts" found in Table 1 for the CPI are, in fact, 8-month forecasts. The reasons are noted in Carlson's text.
7. See Eugene F. Fama. "Short-Term Interest Rates as Predictors of Inflation," **American Economic Review** (June 1975), and Fama's book, **Foundations of Finance,** New York: Basic Books (1976).
8. I am grateful to Mr. Richard T. Curtin, Director of Surveys of Consumer Attitudes, Survey Research Center, University of Michigan, for supplying me with these series. For a discussion of how the "expected price change" survey is conducted, see F. Thomas Juster and Lester D. Taylor, "Towards a Theory of Saving Behavior," **American Economic Review** (May 1975).
9. Real per capita permanent disposable income (deflated by the CPI) was estimated along the lines suggested in Michael Darby, "The Allocation of Transitory Income Among Consumers' Assets," **American Economic Review** (December 1972).
10. "How Velocity Can Fool the Money Watchers," **Business Week,** May 30, 1977.
11. The one unrealistic result was the implied quarterly adjustment speed of .05 per quarter, which was especially evident as the sample period was extended, and which declined even further with the addition of the anticipated-inflation variable.
12. Robert J. Barro, "Rational Expectations and the Role of Monetary Policy," **Journal of Monetary Economics** (January 1976).
13. The Sargent test was first presented in his article, "Rational Expectations, the Real Rate of Interest, and the Natural Rate of Unemployment," **Brookings Papers on Economic Activity** (2:

1973). Additional anaylses of tests of the natural-rate hypothesis can be found in Thomas J. Sargent, "Testing for Neutrality and Rationality," in **Studies in Monetary Economics**, No. 3, Federal Reserve Bank of Minneapolis (June 1976).

14. To obtain these "real GNP residuals," we estimated a Box-Jenkins ARIMA model for the period 1950.I to 1976.IV and used the white noise residuals as the dependent variable for the regression reported in the text. The ARIMA model estimated was a (1, 1, 0) model in the levels of real GNP. That is, our model was

$$(1 - \phi_1 B) \Delta Z_t = \theta_0 + a_t$$

where ΔZ_t is the change in real GNP.

The estimated coefficients and their t-statistics are:

$$\underset{(5.3)}{\phi_1 = .466} \text{ and } \underset{(3.5)}{\theta_0 = 3.78}; \text{ Residual Standard Error} = 8.83$$

The chi-square value for the test of the "white noise" of the residuals was 27.3, with 25 degrees of freedom. The critical chi-square value at the 95-percent significance level is 37.6. Hence the "residual real GNP series" is white noise.

15. Thomas J. Sargent, "Testing for Neutrality and Rationality," op. cit. Because the results obtained here are so dependent on our estimates of anticipated and unanticipated inflation, an alternative procedure was employed, in which the unemployment, CPI inflation and real GNP series were all first estimated by Box-Jenkins time-series models. The residuals from the unemployment ARIMA model and the real GNP model (both level and rate of growth) were cross-correlated with the CPI inflation residuals (both level and rate of growth). The chi-square test proposed by Larry Haugh was then employed to see if there was any "causality" between unemployment, real GNP and price inflation. In no case was any significant relationship revealed. For the test procedure employed in these analyses, see Larry D. Haugh, "Checking the Independence of Two Covariance-Stationary Time Series: A Univariate Residual Cross-Correlation Approach," **Journal of the American Statistical Association** (June 1976). The results of these analyses are available upon request. The Haugh and related tests are discussed in C. W. J. Granger and Paul Newbold, **Forecasting Economic Time Series,** New York: Academic Press (1977).

16. Milton Friedman, "Nobel Lecture: Inflation and Unemployment," **Journal of Political Economy** (3, 1977).

A1. The number of households is available only annually. To obtain a quarterly series we interpolated using the population series as a related variable.

A2. See footnote (9) for the reference on estimating permanent income. In both the per capita and household estimation of real disposable personal income, the quarterly adjustment coefficient was set equal to 0.1.