No. 8905

STOCK RETURNS AND INFLATION: FURTHER TESTS OF THE PROXY AND DEBT-MONETIZATION HYPOTHESES

David Ely*
San Diego State University
and
Kenneth J. Robinson
Federal Reserve Bank of Dallas

March 1989

Research Paper

Federal Reserve Bank of Dallas

No. 8905

STOCK RETURNS AND INFLATION: FURTHER TESTS OF THE PROXY AND DEBT-MONETIZATION HYPOTHESES

David Ely*
San Diego State University
and
Kenneth J. Robinson
Federal Reserve Bank of Dallas

March 1989

* The views expressed in this article are solely those of the authors, and should not be attributed to either San Diego State University, the Federal Reserve Bank of Dallas, or the Federal Reserve System.

STOCK RETURNS AND INFLATION: FURTHER TESTS OF THE PROXY AND DEBT-MONETIZATION HYPOTHESES

by

David Ely

Department of Finance

San Diego State University

and

Kenneth J. Robinson

Federal Reserve Bank of Dallas

Abstract

This study investigates three hypotheses that attempt to explain the anomalous negative relationship between real stock returns and inflation. The first is Fama's (1981) hypothesis that the relationship is spurious because inflation is simply serving as a proxy for expected real activity, the more fundamental determinant of stock returns. Additionally, we investigate the Geske/Roll (1983) and Kaul (1987) hypotheses that the proxy relationship between inflation and expected real output is driven either by the practice of debt monetization and/or countercyclical monetary policy carried out by the central bank. Using a rational-expectations approach to the determination of stock prices, the results do not favor the Fama explanation. Nor do they indicate that debt monetization lies behind the performance of the stock market during inflationary time periods. A countercyclical monetary policy response, though, is indicated.

Stock Returns and Inflation: Further Tests of the Proxy and Debt-Monetization Hypotheses

I. INTRODUCTION

There exists a well-documented tendency for the stock market to perform poorly during inflationary time periods (Bodie 1976, Nelson 1976, and Fama and Schwert 1977). This relationship is considered anomalous because stocks, representing claims to real assets, should prove to be a good hedge against inflation. Moreover, the Fisher (1930) hypothesis suggests that stock returns and measures of expected inflation should be positively correlated, since the return on a nominal asset should equal the sum of a real rate of return plus expected inflation.

Fama and Schwert (1977) find that common-stock returns are negatively correlated with expected inflation and probably negatively related to unexpected inflation and to changes in expected inflation. This is in contrast to their conclusion that other assets, such as private residential real estate and government bonds and bills, are at least partial hedges against expected inflation. Bodie (1976), Jaffe and Mandelker (1976), Nelson (1976), Gultekin (1983) and Kaul (1987) also find evidence conflicting with the Fisher hypothesis for common stocks.

Fama (1981) hypothesizes that the observed inverse relationship between real stock returns and inflation is spurious. Inflation simply acts as a proxy for real-activity variables in models which relate stock returns to inflation. The primary determinant of stock returns is the expected level of real economic activity. However, due to money-demand effects, Fama argues that increases in anticipated real activity are inversely correlated with inflation. This leads to the illusion that higher levels of inflation cause lower stock returns in models which do not explicitly include expected real-activity variables. Using data for the time period 1954-1976, Fama demonstrates the importance of real activity in determining real stock returns. The negative link between stock returns and expected inflation, though, remains in some of his regressions until the growth rate of the monetary base is also added. Fama attributes this to statistical rather than economic factors. Accounting for real activity and the growth rate of the monetary base removes the significance of unexpected inflation when annual data are used but not when monthly or quarterly data are used.

Geske and Roll (1983) also argue that the negative relationship between real stock returns and inflation is spurious. They hypothesize that changes in stock returns signal exogenous shocks in real output. Changes in real output are then followed by similar movements in government revenue. So, a decline in stock returns is followed by a decline in government revenues. Given government spending, the federal deficit increases, as does government debt outstanding. Pressure then exists on the Fed to monetize the debt, which results in greater inflation. Rational people, observing the change in stock returns, immediately revise their inflation expectations and adjust prices and interest rates accordingly. Geske and Roll argue that a "reverse causality" results from this sequence of events [1]. Stock returns "cause", in an econometric sense, inflation, rather than inflation preceding stock returns.

If the observed negative link between inflation and stock returns is driven by Federal Reserve efforts to monetize government debt, the link should break down in time periods when the Federal Reserve is not engaged in debt monetization. Hein (1981) provides evidence that the Federal Reserve was monetizing the debt from 1955 through 1975 but discontinued this practice after

1975. (The study ends with 1980.) Geske and Roll use the time period from 1953 to 1980 with sub-time periods January 1953 through July 1971 and August 1971 through December 1980. Their tests are thus conducted covering a period of time in which Federal reserve behavior might have changed.

Benderly and Zwick (1985) also argue that the stock return/inflation link is spurious, but attribute the link between inflation and expected real activity to a real balance effect at work. After establishing a link between inflation and future output, Benderly and Zwick find that the monetary base variable has a significant positive coefficient and the inflation variable has a significant negative coefficient. The signs of these coefficients are in line with a wealth effect associated with an increase in real money balances. They also note that the positive coefficient on the monetary base variable is inconsistent with the Geske/Roll debt-monetization hypothesis.

Kaul (1987) builds on Fama's and Geske and Roll's work by considering money-supply responses that may not be debt induced. Using a model that relates the growth rate of money to the federal deficit, the unemployment rate, and lags of money growth, Kaul concludes that a deficit-induced counter-cyclical monetary policy, interacting with money demand, gives rise to the inverse relationship between inflation and stock returns in the post-war time period. To further support this result, Kaul shows that during a period of time characterized by pro-cyclical monetary policy, 1926-1940, base growth and future real activity are positively correlated, which eliminates the link between stock returns and inflation.

Finally, Chang and Pinegar (1987) find that the relationship between inflation and stock returns is related to market risk, a result consistent with both the Fama and Geske/Roll-Kaul hypotheses that stock returns and inflation are related because of their more fundamental relationship with expected real output growth.

This paper extends the studies by Fama, Geske/Roll and Kaul by employing a rational expectations model along the lines suggested by Mishkin (1983). This approach allows the Fama, Geske/Roll and Kaul explanations for the negative stock returns-inflation relationship to be incorporated in a single model. Further, the relationship between stock returns and inflation is estimated over different time periods during which Federal Reserve behavior may have changed. The empirical results do not support the Fama (1981) or the Geske-Roll (1983) explanations for the negative stock returns-inflation link. There is evidence, however, of a countercyclical monetary policy along the lines suggested by Kaul (1987). We proceed as follows: In section II, the model is developed. Section III contains a description of the data set. Section IV presents our results, following which Section V contains our conclusions.

II. A Rational Expectations Model of Stock Returns

The rational expectations approach developed by Mishkin (1983) and employed here expresses rates of return on financial assets as a function of unexpected money growth, unexpected output growth and unexpected inflation. Unlike previous research, this approach imposes a theoretical structure--namely market efficiency--on the estimation of the stock returns-inflation relationship. Further, this approach allows the Fama, Geske/Roll and Kaul theories of the anomaly to be nested within a unified model. Fama's proxy-effect hypothesis, and the temporal orderings implied by Geske and Roll are tested using a Mishkin-type model. Also, the possibility that a countercyclical monetary policy is responsible for the negative stock returns-inflation link can be investigated using this approach.

Our model then consists of four equations. One equation defines stock returns as a function of unexpected money growth, output growth and inflation, while the other three equations provide forecasts of these variables. Our first step is to establish the three forecasting equations. It is also important to investigate the stability of the model parameters in the forecasting equations given the likely changes in the structure of Federal Reserve behavior. Next, we simultaneously estimate the four-equation model to impose the cross-equation constraints implied by the rational-expectations approach.

Following Mishkin (1983) we specify a stock-return equation of the form:

$$y_t = \tilde{y} + \beta(X_t - X_t^e) + \varepsilon_t \qquad (1)$$

where y_t = real stock returns

$\tilde{y}$ = "natural" real stock return

β = vector of coefficients

X_t = matrix of predetermined variables

X_t^e = anticipated value of X at time t, conditional on information available at t-1.

ε_t = error term serially uncorrelated and uncorrelated with the right-hand side variables.

and the forecasting equations as:

$$X_t = Z_{t-i}v + u_t \qquad (2)$$

where X_t = money growth, real output growth, or inflation

Z_{t-i} = set of variables used to forecast X_t available at time t-i

v = vector of coefficients

u_t = error term assumed to be uncorrelated with the information set at t-i

Substituting the expectation of equation (2) into (1), we obtain:

$$y_t = \tilde{y} + \beta(X_t - Z_{t-i}v) + \varepsilon_t \quad (3)$$

Our specification for the "natural" stock return level is:

$$\tilde{y} = \alpha(TB - INFL^e) + d$$

where $(TB - INFL^e)$ is the expected risk-free real return, and d is a constant risk premium.[2] Mishkin notes that a simple specification is justifiable as the variation of the "natural" return relative to the variation of the difference between the "natural" return and the actual return is probably small for long-lived assets over short holding periods.[3]

We also note at this point that the method of rational expectations introduces a cross-equation constraint. The parameter "v" appears in both the forecasting and output equations. Thus, estimation of the four equations must be done jointly.

III. DATA

Quarterly data from 1968 through the first quarter of 1987 are used to estimate all equations. The variables used in the empirical section are described below. All data are from the Citibase data base.

B The growth rate of the adjusted monetary base calculated as the first-differenced series of the logs.

S The real rate of return on common stock calculated as the first-differenced series of the log of the ratio of the S&P 500 index (plus dividend yield) in quarter t divided by the GNP deflator in quarter t.

TB The average 90-day Treasury-bill rate.

DG Growth rate of real government debt, calculated as the first difference of logs. The implicit GNP deflator is used to deflate nominal debt.

U Average unemployment rate over the quarter.

GNPG Growth rate of real GNP (first difference of logs).

INFL Inflation rate calculated as the first difference of logs of the GNP deflator.

FCAB Federal cyclically-adjusted budget surplus.

IV. RESULTS

IV.A. Forecasting Equations

An atheoretical approach is used to form the forecasting equations. The sole criteria for including variables in the forecasting model is that they are useful in predicting changes in the target variable of interest. Whether a theoretical relationship can be established is irrelevant. Before the stock-returns equation can be estimated, the forecasting equations must be established, i.e., the variables in the Z matrix in equation (2) must be selected. This process involves not only identifying the variables to include in Z, but also choosing the number of lagged values of these variables to include, testing for the stability of the parameters, and testing that the residuals are white noise. We forecast money growth (defined as the monetary base), real output growth, and inflation with lagged values of the following variables: the growth rate of the monetary base; the rate on 90-day T-bills; inflation; real GNP growth; real stock returns; the cyclically-adjusted budget surplus; the unemployment rate; and the growth rate of real government debt. By including variables in Z that characterize the state of the economy and level of government debt, we may investigate their relationship to money growth and inflation in an attempt to verify the proxy and debt-monetization hypotheses.

Following Mishkin, four lags of all variables are included. Standard F tests are used to identify the variables that are useful in the forecasting equations. A sequence of forecasting equations is estimated with the coefficients on the four lags of one variable (beginning with lags of the variable being forecasted) jointly restricted to zero. Table 1 presents the results of F tests of these restrictions. Past values of the base growth rate, the T-bill rate, and the unemployment rate test significant, at the 5-percent level, in the base forecasting equation. The growth rate of federal debt tests significant at the 10% level and is retained in future analyses to allow for a direct test of the debt-monetization hypothesis. The base growth rate, the unemployment rate, and the inflation rate all test significant in the inflation equation. No variables were found to be significant in the GNP growth equation. However, to proceed, the T-bill rate is selected since it yielded the greatest F statistic. Lags of the growth rate of GNP are also included.

Due to possible instability in the forecasting equations, we test the importance, over four sub-time periods, of the variables that were found to be insignificant over the entire time period. These four sub-time periods are: 1969.II-1974.IV, 1975.I-1979.III, 1979.IV-1982.III, and 1982.IV-1987.I. (Sightly different periods are used for the base growth equation because of the small number of observations in some of these periods). The 1974 date is chosen because of Hein's (1981) evidence of a change in the impact of government debt outstanding on Federal Reserve behavior. The 1979 and 1982 dates are chosen as possible switch points because of changes in the Federal Reserve's operating target (Friedman, 1988). F tests are again used to determine if these variables are useful additions to the forecasting equations in _any_ of the sub-time periods. The results are given in Table 2. The GNP growth rate terms are close to being significant at the 5% level in the base growth equation and are therefore added. The federal cyclically-adjusted budget surplus is significant in the 1975:I-1979:III and 1969:II-1979:III time periods in the GNP growth equation. No additional variables test significant in the inflation equation.

Armed with these results, Chow tests for regime switches in the forecasting equations may be constructed. We test for switches at the end of 1974, after the third quarter in 1979, and after the third quarter in 1982. The results of these tests are presented in Table 3. These tests are conducted using switching regressions estimated with data from 1969:II to 1987:I with a zero/one dummy variable included where all intercept and slope terms are allowed to change. The null hypotheses of no switches in the base-growth and inflation equations in 1979 is rejected. The Chow test, conducted across the sub-time periods 1969.II-1979.III and 1979.IV-1987.I, yields an F statistic of 4.10 for the base growth equation. The Chow test conducted across the sub-time periods 1975:I-1979:III and 1979:IV-1987:I yields an F statistic of 4.26 for the inflation equation. These are significant at the 1% and 5% levels respectively. No test statistics are significant for the other switch points in the base growth and inflation equations nor in the GNP growth forecasting equation.

Values of the explanatory variables past the fourth lag are also considered for inclusion in the forecasting equations. Each forecasting equation was estimated with the fifth lagged value of all the right-hand-side variables included. F tests are then employed to ascertain the usefulness of including these extra lags. Similar tests are also conducted including the fifth through the eighth lags of these explanatory variables. The results of these tests are presented in Table 4. No test statistics are significant, thus only four lags are included in the empirical work in Section IVB.

A final check performed to validate the forecasting equations is to test if their residuals are white noise. The Box-Pierce portmanteau test is employed for this purpose. The Q-statistics, constructed with one, four, and then ten autocorrelations, are presented in Table 5. The null hypothesis is that the residuals are white noise. Under this null hypothesis, the test statistic is asymptotically chi-squared with degrees of freedom equal to the number of autocorrelations used to construct the statistic. No test statistics are significant; thus the hypothesis that the residuals are white noise cannot be rejected.

Based on these results, we specify the model as [4]:

$$S_t = \beta_0 + \beta_1(TB - INFL^e) + \beta_2(B-B^e) + \beta_3(INFL - INFL^e) + \beta_4(GNPG - GNPG^e) + \varepsilon_{1t} \quad (4)$$

$$B_t^e = g_0 + \sum_{i=1}^{4} g_i(B_{t-i}) + \sum_{i=1}^{4} g_{i+4}(TB_{t-i}) + \sum_{i=1}^{4} g_{i+8}(FD_{t-i}) + \sum_{i=1}^{4} g_{i+12}(U_{t-i}) + \sum_{i=1}^{4} g_{i+16}(GNPG_{t-i}) + \varepsilon_{2t} \quad (5)$$

$$INFL_t^e = b_0 + \sum_{i=1}^{4} b_i(INFL_{t-i}) + \sum_{i=1}^{4} b_{i+4}(B_{t-i}) + \sum_{i=1}^{4} g_{i+8}(U_{t-i}) + \varepsilon_{3t} \quad (6)$$

$$GNPG_t^e = c_0 + \sum_{i=1}^{4} c_i(GNPG_{t-i}) + \sum_{i=1}^{4} c_{i+4}(TB_{t-i}) + \sum_{i=1}^{4} c_{i+8}(FCAB_{t-i}) + \varepsilon_{4t} \quad (7)$$

This completes the first step in the study and establishes the forecasting equations. The first result may be stated at this point. Under the Geske/Roll debt-monetization hypothesis, stock returns should be useful in forecasting the growth rate of the monetary base and inflation. The failure of stock returns to be important in forecasting these variables conflicts with the debt-monetization hypothesis.

IVB. Results of Stock-Returns Model

The seemingly unrelated regression (SUR) method is used to estimate the model consisting of equations (4), (5), (6), and (7). This procedure accommodates the need to restrict parameters across equations and improves efficiency by recognizing that the forecast errors may be correlated across equations [5]. The model is estimated using the entire time period with a zero/one dummy variable included to allow all coefficients to switch in 1979 [6]. However, the parameters for the two sub-time periods are shown to best highlight the results.

The results of estimating equation (4) are:

1969:II - 1979:III

$$S = \underset{(0.11)}{-.00187} - \underset{(1.17)}{4.39}(TB-INFL^e) + \underset{(3.46)}{12.0^{**}}(B-B^e) - \underset{(4.03)}{7.71^{**}}(INFL-INFL^e) - \underset{(1.41)}{1.37}(GNPG-GNPG^e) \qquad (8)$$

1979:IV - 1987:I

$$S = \underset{(2.99)}{0.209^{**}} - \underset{(2.46)}{14.4^{**}}(TB-INFL^e) - \underset{(2.86)}{12.8^{**}}(B-B^e) - \underset{(0.09)}{0.357}(INFL-INFL^e) + \underset{(0.43)}{0.713}(GNPG-GNPG^e) \qquad (9)$$

R-Squared = .74 DW = 1.84

** = significant at the one-percent level

The t values are shown below the parameter estimates. The estimates of the forecasting equations are presented in Tables 6a, 6b, and 6c.

Our results do not support Fama's inflation-proxy hypothesis in the earlier period because the negative relationship between unexpected inflation and stock returns remains even after controlling for real output effects. Furthermore, the unexpected inflation term is significant after controlling for unexpected changes in the growth rate of the monetary base, suggesting that the base is not simply a replacement proxy for inflation.

The results of the base-growth forecasting equation in the first time period imply the possibility of countercyclical policy as suggested by Kaul (1987). As shown in Table 6a, the sum of the unemployment rate coefficients is positive and significant in the first period implying that the equilibrium growth rate of base money moves in a countercyclical manner [7].

However, the results of the base growth forecasting equation conflict with the Geske/Roll hypothesis. The sum of the debt coefficients in Table 6a in the first period is negative (-.523) and significant (t value = 4.15). The sum of the debt coefficients in the second period is not significant. Under the debt-monetization hypothesis, a change in the growth rate of debt induces a change in base growth in the same direction. The negative sign in the first period conflicts with the hypothesis and the insignificant coefficient on the debt terms in the second period fails to support the hypothesis. This directly conflicts with the Geske/Roll and Kaul conclusions that government debt is driving countercyclical monetary policy.

Finally, the coefficient on the unexpected base-growth term switches from a positive to a negative value, while the unexpected inflation term is significant in the first period but insignificant in the second period. These results may be consistent with the monetary authorities' increasing focus on monetary aggregates beginning in late 1979. Unexpected movements in the growth of the base may induce an offsetting response by the monetary authorities. An unexpected increase in base growth may lead to a perceived subsequent tightening by the monetary authority, causing a drop in stock prices (Roley, 1983, 1987). Also, if monetary aggregates played a more important role in Fed policy post-1979, agents may have come to view base growth as a replacement proxy for inflation. This may explain why the base growth variable switches sign after 1979 and remains significant, while unexpected inflation becomes insignificant.

V. SUMMARY AND CONCLUSIONS

This study investigates three hypotheses of the anomalous negative relationship between stock returns and inflation. The first is Fama's hypothesis that the relationship is spurious and that inflation is simply serving as a proxy for expected real activity, a more fundamental determinant of stock returns. Additionally, we investigate the Geske/Roll and Kaul hypotheses that the proxy relationship between inflation and real output is driven by policy reactions of the Federal Reserve. A rational-expectations framework is employed in forming a model which expresses stock returns as a function of unexpected base growth, real output, and inflation. This model allows for a test of the impact of inflation on stock returns while controlling for real output effects. We are also able to detect both the impact of debt growth on the growth rate of the monetary base, and the presence of a countercyclical monetary policy.

Our results conflict with both Fama's proxy hypothesis and the debt-monetization hypothesis. We find that unexpected inflation is still important even after accounting for the effect of real-output shocks. While our results suggest that the monetary policy response process is important in causing the negative stock returns - inflation relationship, it is not debt induced. We find that the growth of federal debt is not positively related to the growth of base money as is predicted by the debt-monetization hypothesis. Our results suggest that the opposite is true. This implies that even if the Federal Reserve is monetizing debt, demand-side effects in the money market outweigh the supply-side effects. Thus, an inflation-expected future output relationship is not due to debt monetization, but possibly arises from a countercyclical monetary policy.

ENDNOTES

1. The "reverse causality" model used by Geske and Roll is:

$$RF_t - RF_{t-1} = G_0 + G_1(bRS_t - RF_t) + e_t$$

where RF is the TBILL rate, RS is the stock return, G_1 characterizes the impact of a change in stock returns on the change in rates, and b is a speed-of-adjustment coefficient. The change in the TBILL rate proxies for the change in expected inflation. The tests focus on the parameter b, which under the reverse causality hypothesis, is negative.

2. This is similar to Mishkin's (1983) specification for the equilibrium rate of return for long-term bonds.

3. See Mishkin (1983, p. 23).

4. Caution should be exercised in assigning meaning to the coefficients of the forecasting equations. They are reduced-form equations from unspecified structural models. For example, the base-growth forecasting equation should not be viewed as a Federal Reserve reaction function, but as the combination of a supply function and a demand function for base money.

5. Under rational expectations, the error term in the stock-returns equation is independent of those in the forecasting equations. The largest covariance between the residuals in the stock return equation and forecasting residuals

from the first stage is -1.96×10^{-6}, so no steps were taken to restrict them to zero.

6. The 1979 break is chosen because it corresponds to the instability indicated in the base-growth and inflation forecasting equations.

7. Table 6a also reveals the presence of a countercyclical monetary policy in the later time period as well. The sum of the coefficients on GNP growth is negative and significant. Cozier and Rahman (1988, p. 765) find evidence using Canadian data that the monetary authorities there may respond to the stock market in setting monetary policy.

REFERENCES

1. Benderly, Jason and Burton Zwick. "Inflation, Real Balances, Output, and Real Stock Returns," American Economic Review, 75 (December 1985), 1115-1123.

2. Bodie, Zvie. "Common Stocks as a Hedge Against Inflation," Journal of Finance, 31 (May 1976), 459-70.

3. Chang, Eric C. and J. Michael Pinegar. "Risk and Inflation," Journal of Financial and Quantitative Analysis, 22 (March 1987), 89-99.

4. Cozier, Barry V. and Abdul H. Rahman, "Stock Returns, Inflation, and Real Activity in Canada," Canadian Journal of Economics 21 (November 1988), 759-774.

5. Fama, Eugene F. "Stock Returns, Real Activity, Inflation, and Money," American Economic Review, 71 (September 1981), 545-65.

6. ________ and C. William Schwert. "Asset Returns and Inflation," Journal of Financial Economics, 5 (November 1977), 115-146.

7. Fisher, Irving. The Theory of Interest, (MacMillan, New York), 1930.

8. Friedman, Benjamin M. "Lessons on Monetary Policy from the 1980's," Journal of Economic Perspectives 2 (Summer 1988), 51-72.

9. Geske, Richard and Richard Roll. "The Fiscal and Monetary Linkage between Stock Returns and Inflation," Journal of Finance, 38 (March 1983), 1-32.

10. Gultekin, N. Bulent. "Stock Market Returns and Inflation: Evidence from Other Countries," Journal of Finance, 38 (March 1983), pp. 49-65.

11. Hein, Scott E. "Deficits and Inflation," Review, Federal Reserve Bank of St Louis, (March 1981), 3-10.

12. Jeffe, Jeffrey F. and Gershon Mandelker. "The 'Fisher Effect' for Risky Assets: An Empirical Investigation," Journal of Finance, 31 (May 1976), 447-58.

13. Kaul, Gautam. "Stock Returns and Inflation: The Role of the Monetary Sector," Journal of Financial Economics, 18(June 1987), 253-276.

14. Mishkin, Frederic S. A Rational Expectations Approach to Macroeconometrics, (The University Of Chicago Press: Chicago), 1983.

15. Nelson, Charles R. "Inflation and Rates of Return on Stocks," Journal of Finance, 31 (May 1976), 471-83.

16. Roley, V. Vance, "The Response of Short-term Interest Rates to Weekly Money Supply Announcements," <u>Journal of Money Credit and Banking</u> 15 (1983) 344-354.

17. ________"The Effects of Money Announcements Under Alternative Monetary Control Procedures," <u>Journal of Money Credit and Banking</u> 19 (August 1987) 292-307.

TABLE 1

Selection of Forecasting Equations
1969:II - 1987:I

Variable[a]	F-Statistics for: Base Growth Rate	Inflation Growth Rate	GNP Growth Rate
Base Growth Rate	3.17**	4.52***	0.0415
T-bill Rate	10.05***	2.02	2.03
Gov't Debt Growth Rate	2.36*	1.56	0.250
Unemployment Rate	3.24**	2.81**	1.60
Inflation Rate	0.931	3.65**	0.45
Real Stock Returns	1.63	1.05	1.58
GNP Growth Rate	1.25	0.782	0.97
Fed Cycl-Adj Budget Surplus	1.55	1.93	0.97
R-Squared 0.73	0.82	0.59	
Durbin h[b] -0.82	-0.78	-0.29	

*** - Significant at the 1% level.
** - Significant at the 5% level.
* - Significant at the 10% level.

a - Four lags of each variable are included in all equations.

b - The Durbin-Watson statistic is biased here because of the presence of lagged endogenous variables on the right-hand side of the equations. The residuals from the OLS estimates of the equations are regressed on the right-hand-side variables along with the OLS residual lagged one period.

TABLE 2

Tests for Additional Variables in Forecasting Equations

Initial Base Growth Equation:

$$B^e = g_0 + \sum_{i=1}^{4} g_i(B_{t-1}) + \sum_{i=1}^{4} g_{i+4}(TB_{t-1}) + \sum_{i=1}^{4} g_{i+8}(D_{t-1}) + \sum_{i=1}^{4} g_{i+12}(U_{t-i})$$

VARIABLES ADDED TO INITIAL EQUATION:	F Statistics		
	TIME PERIODS:		
	69:II-74:IV	69:II-79:III	79:IV-87:I
Real Stock Returns	0.80	2.15	3.00
GNP Growth	0.14	1.25	3.53
Inflation Rate	0.97	1.23	1.07
Fed Cycl-Adj Budget Surplus	0.56	0.31	0.22

Initial Inflation Equation:

$$INFL^e = b_0 + \sum_{i=1}^{4} b_i(INFL_{t-1}) + \sum_{i=1}^{4} b_{i+4}(B) + \sum_{i=1}^{4} g_{i+8}(U_{t-i})$$

VARIABLES ADDED TO INITIAL EQUATION	F STATISTICS				
	TIME PERIODS:				
	69:II-74:IV	75:I-79:III	82:IV-87:I	69:II-79:III	79:4-87:I
Real Stock Returns	0.78	2.45	35.45	0.22	1.21
GNP Growth	4.34	0.61	7.02	1.69	1.18
Fed Debt Growth	0.71	1.96	3.41	0.51	1.04
Fed Cycl-Adj Budget Surplus	3.73	0.80	26.88	0.13	1.01
T-bill Rate	1.05	1.71	7.94	1.64	1.93

Table 2 (cont)

Initial GNP Growth Equation:

$$\hat{GNPG} = c_0 + \sum_{i=1}^{4} c_i(GNPG_{t-i}) + \sum_{i=1}^{4} c_{i+4}(TB_{t-1})$$

VARIABLES ADDED TO INITIAL EQUATION:	F STATISTICS				
	TIME PERIODS:				
	69:II-74:IV	75:I-79:III	82:IV-87:I	69:II-79:III	79:IV-87:I
Real Stock Returns	1.69	1.78	2.60	2.32	0.47
Base Growth Rate	0.28	0.12	1.10	0.36	1.67
Fed Debt Growth Rate	0.12	0.57	0.44	2.20	0.25
Inflation Rate	1.14	1.30	0.56	2.17	0.71
Unemployment Rate	1.04	0.30	4.46	2.10	2.54
Fed Cycl-Adj Budget Surplus	0.45	6.75**	1.59	3.79**	0.82

*** - Significant at the 1% level.
** - Significant at the 5% level.

TABLE 3

Forecasting Equations Tests for Switches

Date	F-Statistic		
	Base Growth Rate	Inflation Growth Rate	GNP Growth Rate
1969:2 - 1974:4 / 1975:1 - 1979:3	0.20	1.72	1.45
1975:1 - 1979:3 / 1979:4 - 1982:3	a	4.26**	1.89
1979:4 - 1982:3 / 1982:4 - 1987:1	a	3.39	2.03
1969:1 - 1979:3 / 1979:4 - 1987:1	4.10***	1.02	2.06

*** - Significant at the 1% level
** - Significant at the 5% level.

a - There are too few observations to estimate the base growth equation for these time periods. The Chow test across the periods 1975:1-1979:3 and 1979:4-1987:1 yields a test statistic of 2.28. The Chow test across the periods 1975:1-1982:3 and 1982:4-1987:1 yields a test statistic of 0.88. Neither of these are statistically significant.

TABLE 4

Significance Tests for Addition Lags in Forecasting Equations [a]

EQUATION	F STATISTICS		
	Time Periods:		
	69:II-87:I	69:II-79:III	79:4-87:1
Base Growth Equation:			
Significance test for lag 5	0.40	0.41	2.13
Significance test for lags 5 - 8	0.96	b	b
Inflation Equation:			
Significance test for lag 5	1.35	0.20	0.85
Significance test for lags 5 - 8	0.97	0.49	0.17
GNP Growth Equation:			
Significance test for lag 5	1.01	0.46	0.21
Significance test for lags 5 - 8	1.43	0.36	1.79

[a] The null hypotheses tested is that the fifth lags of all variables in the equation (or lags 5 through 8) are not significant against the alternative that the fifth lags (or lags 5 through 8) are useful in forecasting the dependent variable.

[b] There are too few observations to conduct the test.

TABLE 5

White Noise Tests of Forecasting Equation Residuals

EQUATIONS	Q-STATISTIC [a]		
	1 LAG	4 LAGS	10 LAGS
Base Growth Forecasting Equation	0.0563	4.83	14.1
Inflation Forecasting Equation	0.276	1.69	4.87
GNP Growth Forecasting Equation	0.29	2.79	6.80

[a] Box-Pierce portmanteau test. This statistic is asymptotically chi-squared under the null hypothesis that the residuals are white noise. The degrees of freedom equal the number of autocorrelations used in the calculation of the test statistic.

TABLE 6a

Base Growth Forecasting Equation

VARIABLE	1969:2 - 1979:3 Estimate	t-stat	1979:4 - 1987:1 Estimate	t-stat
Constant	0.0149	0.01	0.0222	1.09
$\sum_{i=1}^{4}$ Base(t-i)	0.240	0.55	0.787	1.12
$\sum_{i=1}^{4}$ T-bill Rate(t-i)	-0.872**	2.32	0.180	0.23
$\sum_{i=1}^{4}$ Debt Growth (t-i)	-0.523***	4.15	0.0158	0.07
$\sum_{i=1}^{4}$ Unemployment Rate(t-i)	0.237**	2.12	-0.245	1.05
$\sum_{i=1}^{4}$ GNP Growth (t-i)	-0.0169	0.08	-0.845**	2.30

R-SQUARED = .63
Durbin h = -0.90

TABLE 6b

Inflation Forecasting Equation

VARIABLE	1969:2 - 1979:3 Estimate	t-stat	1979:4 - 1987:1 Estimate	t-stat
Constant	0.0000387	0.01	0.00409	0.41
$\sum_{i=1}^{4}$ Inflation Rate(t-i)	-0.221	0.69	0.554**	2.94
$\sum_{i=1}^{4}$ Base Growth Rate(t-i)	1.18**	2.65	-0.0210	0.06
$\sum_{i=1}^{4}$ Unemployment Rate(t-i)	-0.0123	0.13	0.0242	0.30

R-Squared = 0.48
Durbin h = 0.47

TABLE 6c

GNP Forecasting Equation

VARIABLE	1969:2 - 1979:3 Estimate	t-stat	1979:4 - 1987:1 Estimate	t-stat
Constant	0.0570***		0.0222	0.93
$\sum_{i=1}^{4}$ GNP Growth Rate(t-i)	-1.11	1.83	0.761	1.71
$\sum_{i=1}^{4}$ T-bill Rate(t-i)	-3.65***	3.69	-0.621	0.86
$\sum_{i=1}^{4}$ Budget Surplus(t-i)	-.000445**	3.04	0.0000621	0.90

R-Squared = 0.57
Durbin h = -0.90

*** - Significant at the 1% level.
** - Significant at the 5% level.

RESEARCH PAPERS OF THE RESEARCH DEPARTMENT
FEDERAL RESERVE BANK OF DALLAS

Available, at no charge, from the Research Department
Federal Reserve Bank of Dallas, Station K
Dallas, Texas 75222

8801 Estimating the Impact of Monetary Policy on Short-Term Interest Rates in a Rational Expectations--Efficient Markets Model: Further Evidence (Kenneth J. Robinson and Eugenie D. Short)

8802 Exchange and Interest Rate Management and the International Transmission of Disturbances (W. Michael Cox and Douglas McTaggart)

8803 Theoretical Macroeconomic Modelling and Qualitative Specifications of the Bond Market (William R. Russell and Joseph H. Haslag)

8804 Augmented Information in a Theory of Ambiguity, Credibility and Inflation (Nathan Balke and Joseph H. Haslag)

8805 Investment and the Nominal Interest Rate The Variable Velocity Case (Evan F. Koenig)

8806 Tax Policy and Texas Economic Development (Stephen P.A. Brown)

8807 Unionization and Unemployment Rates: A Re-Examination of Olson's Labor Cartelization Hypothesis (William C. Gruben)

8808 The Development and Uses of Regional Indexes of Leading Economic Indicators (Keith R. Phillips)

8809 The Contribution of Nonhomothetic Preferences to Trade (Linda Hunter)

8810 Evidence on the Two Monetary Base Measures and Economic Activity (Joseph H. Haslag and Scott E. Hein)

8811 The Incidence of Sanctions Against U.S. Employers of Illegal Aliens (John K. Hill and James E. Pearce)

8901 An Econometric Analysis of U.S. Oil Demand (Stephen P.A. Brown and Keith R. Phillips)

8902 Further Evidence on the Liquidity Effect Using an Efficient-Markets Approach (Kenneth J. Robinson and Eugenie D. Short)

8903 Asymmetric Information and the Role of Fed Watching (Nathan Balke and Joseph H. Haslag)

8904 Federal Reserve System Reserve Requirements: 1959-88--A Note (Joseph H. Haslag and Scott E. Hein)

8905 Stock Returns and Inflation: Further Tests of the Proxy and Debt-Monetization Hypothesis (David Ely and Kenneth J. Robinson)