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STOCK RETURNS AND INFLATION: THE ROLE OF THE MONETARY SECTOR

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STOCK RETURNS AND INFLATION: THE ROLE OF THE MONETARY SECTOR

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Abstract

This paper hypothesizes that stock return-inflation relations are caused by the equilibrium process in the monetary sector. More importantly, these relations vary over time in a systematic manner depending on the influence of money demand and supply factors. Post-war evidence from the U.S., Canada, the U.K., and Germany indicates that the negative stock return-inflation relations are caused by money demand and counter-cyclical money supply effects. On the other hand, pro-cyclical movements in money, inflation, and stock prices during the 1930's lead to relations which are either positive or insignificant.

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1. Introduction

There is international evidence that common stock returns and inflation are negatively related in the post-war period [e.g., Bodie (1976), Jaffe and Mandelker (1976), Nelson (1976), Fama and Schwert (1977), and Gultekin (1983)]. Real stock returns are negatively related to expected, unexpected, and changes in expected inflation. This evidence is surprising in light of the view that common stocks, as claims against real assets, should be a good hedge against inflation.

The main contention of this paper is that stock return-inflation relations are caused by the equilibrium process in the monetary sector. More importantly, these relations vary over time in a systematic manner depending on the influence of money demand and supply factors.

A money-demand-based hypothesis that has held up well in light of post-war empirical evidence is Fama's (1981) proxy hypothesis. Fama uses money demand theory to demonstrate a strong negative relation between expected inflation and anticipated real activity. On the other hand, stock returns are shown to be positively related to future real variables. Consequently, the negative relation between stock returns and expected inflation simply proxies for the positive relation between stock returns and future real variables.

However, Fama assumes that movements in money supply are invariant with respect to real shocks. A complete model of the monetary sector should also take into account the response of the monetary authorities, i.e., the money supply process. Geske and

Roll (1983) consider one type of monetary response which reinforces Fama's prediction of a negative inflation-real activity relation in the post-war period. They argue that the central bank responds counter-cyclically to real activity shocks. Specifically, a drop in real activity leads to increased deficits which, in turn, lead to an increase in money growth (to the extent that debt is monetized). An unanticipated drop in stock prices signals this chain of events, leading to negative relations between stock returns and changes in expected inflation.[1]

Geske-Roll, however, do not analyze the money supply process completely. A counter-cyclical monetary response does reinforce the negative real activity-inflation relations witnessed during the post-war period. However, if central banks follow a procyclical monetary policy [as in the 1930's, see Friedman and Schwartz (1963)], real activity and inflation could be either unrelated or even positively related. This, in turn, would lead to insignificant or positive relations between stock returns and inflation.

We hypothesize that the negative stock return-inflation relations witnessed during the post-war period can be explained by a combination of money demand and counter-cyclical money supply effects. More importantly, we also argue that if money demand

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[1]This negative relation can easily be reconciled with the negative relation between stock returns and unexpected inflation, because the latter is likely to be positively related to changes in expected inflation.

effects are coupled with monetary responses that are pro-cyclical (as in the 1930's) stock return-inflation relations would be either insignificant or even positive. In other words, the relations between stock returns and inflation depend on the equilibrium process in the monetary sector; they could be negative, positive, or insignificant.

To test the robustness of the hypothesis, we first analyze post WW II data of four industrialized countries (the U.S., Canada, the U.K., and Germany). This analysis indicates that negative relations between inflation and real activity, reinforced by counter-cyclical monetary responses by the monetary authorities, explain all three of the negative stock return-inflation relations consistently across all countries. On the other hand, procyclical movements in money, inflation, and stock prices during the 1930's lead to relations which are either positive or insignificant, and are statistically different from the negative post-war relations.

Section 2 develops the monetary sector model which explains the post-war negative stock return-inflation relations, and we present the relevant empirical evidence in Section 3. Section 4 develops and reports the stability tests of these relations across the pre- and post-war periods for the U.S. and Canada. Section 5 contains a brief summary and conclusions.

2. The model

Three aspects of post-war stock return-inflation relations have been identified by empirical research: expected inflation, unexpected inflation, and changes in expected inflation are all negatively related to real stock returns. In this section we develop our hypotheses concerning these relations.[2]

2.1. Stock returns and expected inflation

Perhaps the most anomalous of stock return-inflation relations is the negative relation between expected real stock returns and the level of expected inflation. Since the level of expected inflation is an ex ante variable, regressions of realized stock returns on expected inflation estimate the relation between the ex ante expected component of stock returns and ex ante expected inflation.

Fama (1981) suggests a money-demand-based model to explain this anomalous relation. He uses money demand theory to model (ex post) the expected inflation process. If we assume that money, real activity, and the interest rate are exogenous with respect to the price level, following Fama, we can convert the typical money demand equation into a model for inflation:[3]

$$I_t = \beta_0 + \beta_1 \, DRA_t + \beta_2 \, DR_t + \beta_3 \, DM_t + \varepsilon_t \tag{1}$$

where I_t = inflation rate for period t,

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[2]A number of explanations have been presented for the stock return-inflation relations [e.g., Kessel (1956), Lintner (1975), Modigliani and Cohn (1979), and Summers (1981)]. Nelson (1979) provides a model which has implications similar to the proxy hypothesis. See also French, Ruback, and Schwert (1983).

[3]The exogeneity assumptions used are not necessarily prescribed by money demand theory. Alternate assumptions have been made [e.g., Black (1972) and Mishkin (1982)], but we use our framework because it allows us to model the inflation process.

DRA_t = growth rate of anticipated real activity,

DM_t = growth rate of nominal money,

DR_t = change in the continuously compounded interest rate,

ε_t = random disturbance term,

and $\beta_1 < 0$ and $\beta_2, \beta_3 > 0$.[4]

A positive relation between real money demand and real activity implies a negative relation between real activity and the price level. The important feature of this model, however, is that agents price commodities by incorporating information about anticipated real activity.

On the other hand, stock returns are positively related to anticipated real activity via the capital expenditure process. Specifically, the capital expenditure process may be characterized by the following chain of events: an increase in real activity puts pressure on the existing capital stock, which raises the average return on capital and this, in turn, induces increased investment. A rational stock market anticipates this chain of events and, therefore, current stock prices incorporate information about future real variables.

Hence, when stock returns are regressed on inflation the negative relation proxies for the positive relation between stock returns and real variables. We maintain that the negative stock return-expected inflation relation is spurious, and that the proxy

[4]Changes in the interest rate and the growth rate of money are presumed to have the usual positive relation with inflation.

hypothesis can explain this anomalous relation across countries and over time within a particular country.[5]

2.2. Stock returns and unexpected inflation/changes in expected inflation

The proxy hypothesis assumes that the money supply is determined exogenously, independent of the level of real activity. However, a complete model of the monetary sector should also take into account the response of the monetary authorities, i.e., the money supply process.

Geske and Roll (1983) consider one type of monetary response which reinforces Fama's prediction of a negative relation between inflation and real activity in the post-war period. They argue that the central bank follows a (deficit-induced) counter-cyclical monetary policy which leads to negative relations between unexpected stock returns and changes in expected inflation.

The economic rationale for such negative relations is based on a reverse causality effect. Geske-Roll contend that movements in stock prices cause (in an econometric sense) changes in inflationary expectations. An unanticipated drop in stock prices is a signal for a drop in anticipated economic activity and, therefore, in government revenues. Given largely fixed government expenditures (called

[5]Day (1984), LeRoy (1984), and Stulz (1986) also provide equilibrium models which are consistent with Fama's explanation. For example, Stulz (1986) argues that an increase in expected inflation leads to a fall in the real wealth of households which, in turn, decreases the real interest rate and the expected real rate on the market portfolio.

entitlements) this leads to the expectation that the government will run a deficit and, to the extent that deficits are monetized, there will be a consequent increase in expected inflation. Thus, Geske-Roll conclude that "stock price changes, which are caused by changes in anticipated economic conditions, will be negatively correlated with changes in expected inflation". (p. 6).

This negative relation, in turn, can easily be reconciled with the negative relation between stock returns and unexpected inflation. Following Geske-Roll, consider a simple adaptive expectations model:

$$EI_t = EI_{t-1} + \gamma\ [I_t - EI_{t-1}] + \eta_t \qquad (2)$$

where EI_t = expected inflation over period t to t+1 as of t,

γ = speed of adjustment (>0),

and η_t = disturbance term.

If the true relation is between stock returns and changes in expected inflation, ΔEI_t, the contemporaneous unexpected inflation variable, UI_t, could serve as a proxy.

Geske-Roll, however, do not analyze the reverse causality/money supply link completely: (1) An effect similar to the deficit-money supply link may be created if the monetary authorities simply follow a counter-cyclical monetary policy, irrespective of movements in deficits.[6] A positive response of money growth to unemployment

[6]Barro (1977) argues that a positive response of money growth to unemployment may occur due to two reasons: (1) the central bank could be following a counter-cyclical monetary policy, or (2) "... a decline in real income lowers holdings of real balances, which would reduce the amount of government revenue from money issue for a given value of the money growth rate ... the optimal response to [which] would be an increase in the money growth rate." (p. 104).

will also lead to a negative relation between stock returns and changes in expected inflation (due to a similar reasoning as the Geske-Roll chain of events).[7] (2) More importantly, if the monetary authorities follow a pro-cyclical monetary policy the relations between stock returns and inflation would be either insignificant or positive (see Section 4).

This paper attempts to explain the negative post-war stock return-inflation relations by considering the impact of the equilibrium process in the monetary sector. Specifically, we argue that money demand and counter-cyclical money supply effects lead to negative relations between stock returns and expected, unexpected and changes in expected inflation. However, these negative relations are not necessarily implied by the monetary model. They are generated by the specific characteristics of the equilibrium process in the monetary sector during the post-war period. A different economic scenario, i.e., money demand effects coupled with pro-cyclical monetary responses, would lead to insignificant or even positive relations between stock returns and inflation (see Section 4).

3. Empirical evidence: The post-war experience

In this section, we analyze post WW II data from the U.S. (1953-1983), Canada (1951-1983), the U.K. (1957-1983), and Germany

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[7]Direct evidence in favor of the reverse causality argument is provided by James, Koreisha, and Partch (1985) who use a VARMA model to identify relationships between stock prices, real activity, inflation, and money supply. See also Cooper (1974), Rozeff (1974), and Rogalski and Vinso (1977).

(1957-1983) to test the robustness of our hypothesis. These four countries are selected because: (1) they have industrialized economies with well-developed capital markets, and (2) the relevant data are available for most of the post-war period.

3.1. Data description

Most U.S. data are obtained from the Survey of Current Business (Business Statistics 1982) and its various annual supplements. The revised monetary variables, in particular the adjusted monetary base series, were provided by the Federal Reserve Bank of St. Louis. Stock return (NYSE value-weighted index) and treasury bill rate data were made available by the Center for Research in Security Prices (CRSP).

All of the Canadian data are obtained from the annual supplements of the Statistical Review and various issues of the Survey of Current Business. The German and U.K. data are accessed from the International Financial Statistics (IFS) tapes.[8]

All of the data, with the exception of the industrial production series for Germany and the U.K., are seasonally unadjusted.

3.2. Expected inflation forecasts

To test the hypothesis of this paper we need to obtain reliable estimates of expected inflation and the implied estimates of

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[8]The stock return data exhibit first order serial correlation because the price series are averages of daily figures. Moreover, monthly data for the U.K. and Germany are not available for our sample period.

unexpected inflation and changes in expected inflation. We use the methodology of Fama and Gibbons (1984) which extracts inflation forecasts, EI_{t-1}, from treasury bill rates assuming that expected real returns follow a random walk.[9,10]

The expected inflation series generally possess good properties as proxies for expected inflation. Specifically, in regressions of inflation rates on the expected inflation estimates, the inflation forecasts exhibit: (1) conditional unbiasedness, i.e., an intercept close to zero and a slope coefficient close to one, (2) serially uncorrelated residuals, and (3) low residual standard errors.[11]

3.3. Stock returns and inflation

Monthly, quarterly, and annual post-war evidence on stock return-inflation relations for the different countries is shown in Table 1, regression (a):

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[9] There is evidence that expected real returns follow a random walk in the post-war period [e.g., Hess and Bicksler (1975), Nelson and Schwert (1977), Garbade and Watchel (1978), and Fama (1981)]. Based on this assumption, we model ex post real returns as an IMA (1,1) process.

[10] Since interest rate data are not available for Germany (quarterly) and Canada (monthly) we forecast expected inflation by fitting IMA(1,1) models to the actual inflation series.

[11] In the absence of yearly treasury bill rates, we obtain annual expected inflation estimates by multiplying EI_{t-1} for the first quarter (month) of each year by four (twelve). This procedure is valid since shorter term expected inflation estimates are close to a random walk (the levels are highly autocorrelated, whereas first differences behave like white noise). The German evidence is the only exception to this general finding.

(1) Real stock returns are negatively related to both the inflation variables (EI_{t-1} and ΔEI_t) in all four countries.[12] Thus, it seems that these anomalous relations, witnessed in the post-war period, are not peculiar to the U.S.

To account for potential correlation in the errors of the regressions across countries, we re-estimate the regressions using Zellner's (1962) "seemingly unrelated regression" method (SURM).[13] As far as the signficiant negative stock return-inflation relations are concerned the OLS and SURM techniques yield very similar results.

(2) The conjecture that unexpected inflation is simply proxying for changes in expected inflation appears to have empirical support in all countries (results not reported). There is a high correlation between ΔEI_t and UI_t (the sample correlations vary between 0.50 and 0.90),[14] they play similar roles in stock return

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[12]However, unlike the monthly and quarterly regressions, these relations are not always significant in the annual results. This finding is probably a result of the smaller sample size in the annual regressions.

[13]Specifically, we allow the errors of the different stock return-inflation regressions to have different variances and correlations between countries while following standard (OLS) assumptions within each country.

[14]In the case of Canada (monthly) and Germany (quarterly), UI_t is perfectly correlated with ΔEI_t. This follows because we fit an IMA(1,1) model to the inflation series, and for such a time series process the two variables are identical up to a multiplicative constant.

regressions, and when pitted against each other ΔEI_t (usually) statistically dominates UI_t.[15]

3.4. Stock returns, expected inflation, and the proxy hypothesis

The proxy hypothesis relies on two major links: (1) the positive relation between stock returns and future real activity, and (2) the negative relation between inflation and real activity.[16]

3.4.1. Stock returns and real activity

The hypothesis regarding stock return-real activity relations is that, given efficient capital markets, these relations should be found in all countries. The post-war regressions shown in Table 2 support this hypothesis. The relation between real stock returns and future real activity is positive (and significant) in all countries in the monthly, quarterly, and annual regressions.

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[15]Fama and Schwert (1977) also find that use of ΔEI_t in their regressions does (usually) cause the UI_t measure to become insignificant.

[16]Only if these two relations are witnessed in the post-war period in all four countries will the proxy hypothesis be a robust explanation for the negative stock return-expected inflation relation.

3.4.2. Inflation and real activity

We present post-war estimates of the money-demand-based inflation model in Table 3[17]:

(1) In each country inflation has a positive relation with current money growth rates. In the case of Germany, however, although this relation is positive it is not significant at conventional levels.[18]

(2) More importantly, there is a significant negative relation between inflation and current and future real activity variables in all countries in the post-war monthly, quarterly, and annual regressions.[19]

A shortcoming of the empirical tests is that we use actual growth rates of future real activity (measured by index of industrial production or real GNP) in lieu of anticipated growth rates.

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[17] Quarterly and monthly monetary and real variables exhibit very strong seasonals, while inflation rates generally do not. We use annual growth rates of the explanatory variables in an attempt to overcome the seasonality problem. Except in some cases where maximum likelihood estimation is used to correct for first order residual autocorrelation, the transformed variables appear to provide a good explanation of short-term inflation.

[18] Fama (1981) suggests that the role of the Fed implies that the adjusted monetary base is the relevant monetary aggregate for the U.S. However, for the other countries we use M1 because the published monetary base data are not adjusted for reserve requirements. When we use both the unadjusted base and the M1 variables simultaneously in the inflation regressions, the coefficient of the former is always insignificant.

[19] The inflation regressions reveal partial negative correlations between real activity and inflation. However, even the simple correlations between both actual and expected inflation measures and real activity are significantly negative.

A macro model to determine anticipated real activity is beyond the scope of this paper and, given low autocorrelation in real activity growth rates, a time series model would be uninformative.[20]

3.4.3. Stock returns, expected inflation, and real variables

A direct test of the proxy hypothesis is to regress stock returns on both inflation and real variables. The relevant regressions are shown in Table 1, regression (b):

(1) The proxy hypothesis appears to be the basis of the spurious negative relation between stock returns and ex ante expected inflation witnessed in the post-war period. Inclusion of future real activity variables eliminates this negative relation consistently in all countries.

(2) Fama (1981) uses U.S. data for the period 1954-1976 and finds that the complete elimination of the expected inflation effect requires inclusion of the base growth rate. Since the base growth rate and the expected inflation variables are strongly related, this could imply that one proxy for expected inflation has simply replaced another. An important aspect of our results is that

[20] Since stock returns signal future changes in real activity, we attempt to forecast real activity a year ahead by using current and past stock returns. Specifically, we regress real activity changes on contemporaneous and lagged stock returns. However, even though the real activity forecasts derived from such a regression are significant when used in the inflation regressions, inclusion of actual future real ativity growth rates always causes them to become insignificant.

mere inclusion of real activity variables is sufficient to eliminate the expected inflation effect consistently across all countries.[21]

(3) However, inclusion of real variables does not reduce the explanatory power of the change in expected inflation variable, ΔEI_t, in the monthly and quarterly regressions. This finding is consistent with Fama's results.

A possible explanation for these results is the measurement error in the real activity growth rates. To overcome the seasonality problem we use overlapping annual growth rates which, in turn, may preclude us from capturing new information about future real activity on a monthly or quarterly basis.[22]

3.5. Stock returns, changes in expected inflation, and the money supply process

There also is evidence of a strong negative relation between real stock returns and changes in expected inflation in all four countries in the post-war period. We hypothesize that a countercyclical monetary response could explain this relation.

We formalize the deficit/unemployment-money supply link in terms of a money supply reaction function:

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[21]In the U.S. regressions, the base growth rate does help further reduce the expected inflation effect. However, in the case of the U.K., Canada, and Germany, inclusion of the monetary variable does not alter the results.

[22]This explanation seems consistent with the evidence. The annual regressions witness attenuation in the ΔEI_t effect apparently because the non-overlapping real activity growth rates measure new information more precisely.

$$DM_t = \beta_0 + \beta_{1i}DM_{t-i} + \beta_2 DEF_t + \beta_3 U_t + \varepsilon_t \qquad (3)$$

where DM_t = money growth over period t-1 to t,

DEF_t = federal deficit during period t,

U_t = unemployment rate during period t,

ε_t = random disturbance term,

and $\beta_2, \beta_3 > 0$.

The federal deficit, DEF_t, is used to capture the deficit-monetization link, and we expect $\beta_2 > 0$. The unemployment rate, U_t, is used to indicate the general state of the economy. Finally, lagged values of money growth, DM_{t-i}, are used to pick up elements of serial correlation in money growth that are not captured by the other independent variables. Table 4 contains estimates of the money supply reaction function:

(1) In all four countries there is a significant positive relation between deficits and the money growth rates [regression (a)]. This finding supports the existence of a (deficit-induced) counter-cyclical monetary policy during the post-war period.[23]

(2) We include the unemployment rate in equation (3) to differentiate the deficit-money supply link from a counter-cyclical monetary response. Though the unemployment rate has a positive coefficient [regression (b)] it does not lead to significant attenuation in the deficit effect (except in the case of Germany). Deficits

[23] We measure the deficit variable by nominal federal deficit as per the National Income Accounts deflated by [(GNP deflator) x (trend value of real GNP)]. The statistical significance of the money-deficit relation is apparently not a seasonal phenomenon because deseasonalized deficit data yield similar results. Hamburger and Zwick (1981) also find a significant money-deficit relation in the U.S. in the post-war period.

appear to exert an independent pressure on money growth in the post-war period. Nevertheless, the eventual effect of deficits is to produce counter-cyclical movements in money supply.[24]

Hence, a negative inflation-real activity relation, reinforced by a counter-cyclical monetary policy, explains the negative stock return-inflation relations witnessed during the post-war period in all four countries.

4. The stability of stock return-inflation relations: The experience of the thirties

In this section we argue that stock return-inflation relations vary over time in a systematic manner. These relations depend on two factors: (1) the positive relation between stock returns and real activity, and (2) the inflation-real activity relation. Our contention is that varying combinations of these factors lead to systematic changes in the relations between stock returns and inflation over time.

Specifically, the positive stock return-real activity relation is likely to be stable over time and across countries with well-developed capital markets. On the other hand, the relation between inflation and real activity depends on the equilibrium process in the monetary sector. In the post-war period, the money-demand-based negative inflation-real activity relation is reinforced by counter-cyclical monetary responses. However, if the monetary authorities were to follow a pro-cyclical policy real activity and inflation could be unrelated or even positively related. Consequently, the

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[24]We expect (and find) the unemployment and deficit variables to be positively correlated.

relations between stock returns and inflation would be either insignificant or positive.

4.1. The thirties

To test our hypothesis we select the depression period. Friedman and Schwartz (1963) argue that failure of the Fed to prevent bank failures and the decline in money growth was largely responsible for the intensity of the depression. Their analysis leads us to believe that the 1930's were a period during which the Fed seemed to follow, or at least allow, a pro-cyclical monetary response.

This conjecture seems to be borne out by the facts: between 1929 and 1933, gross national product (GNP) fell by nearly 30 percent and unemployment rose from 3 to 25 percent, while both money supply and prices fell by about 25 percent. Futhermore, after 1933 real GNP, money supply, and prices tended to rise together.

If monetary policy was indeed pro-cyclical and real activity and prices generally moved together, we should not witness negative stock return-inflation relations during the thirties.

4.2. Evidence

We present estimates of the relevant relations for the U.S. and Canada in Tables 5-9.[25] The expected inflation forecasts

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[25] I would like to thank Merton Miller for suggesting the depression period to test my hypothesis. The 1926-1940 period, in particular, is selected because we are interested in a regime which apparently witnessed pro-cyclical movements in money, prices, and stock returns. The sample is limited to the U.S. and Canada because published data are available in annual supplements of the Survey of Current Business.

are extracted from time series models for the inflation series. For both countries the cost of living index is used as a measure of the price level, and IMA (1,1) models provide expected inflation forecasts that exhibit good statistical properties, i.e., unbiasedness, low residual standard errors, and serial independence of the residuals.

4.2.1. Stock returns and inflation

Table 5 contains estimates of the stock return-inflation relations for the 1926-1940 period. These results can be compared with the post-war evidence in Table 1.

Perhaps the most interesting feature of Table 5 is the consistently positive coefficients of both the expected inflation and changes in expected inflation variables in the U.S. and Canadian regressions. Though these coefficients are usually statistically insignificant, they are not significantly negative as in the post-war period.

For example, in the U.S. monthly regressions the coefficients of EI_{t-1} and ΔEI_t are -2.630 and -10.520 respectively during the post-war period, whereas they are 0.042 and 0.934 in the 1926-1940 period. This comparison is representative of the monthly, quarterly, and annual estimates for both the U.S. and Canada. In fact, ΔEI_t has a significantly positive coefficient in the annual regressions.

Monthly, quarterly, and annual dummy variable regressions (not reported) for both the U.S. and Canada show a statistically significant difference in the coefficients of both EI_{t-1} and ΔEI_t between the pre- and post-war periods.[26]

4.2.2. The proxy hypothesis links

Evidence on the two links of the proxy hypothesis is shown in Tables 6 and 7:

(1) We hypothesize that the stock return-real activity link is expected to be stable across the pre- and post-war periods. The evidence in Table 6 supports this conjecture. Real stock returns are significantly positively correlated with anticipated real activity in the U.S. and Canada.[27]

(2) The second link in the proxy hypothesis is the inflation-real activity relation. Table 7 shows the estimates of the money-demand-based inflation model for the U.S.[28]

In comparison to the post-war evidence, the inflation-real activity relation is very different during the 1926-1940 period. The relation between inflation and the current real activity variable is consistently positive and significant, whereas future real

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[26]The only exceptions are the coefficient estimates of EI_{t-1} in the quarterly regressions which are not statistically different at conventional levels of significance. All tests took account of the heteroskedasticity problem across regimes.

[27]However, in the quarterly U.S. regression, although both the current and future real activity variables have positive coefficients, the latter is not statistically significant.

[28]The money supply series used is the M1 series constructed by Friedman and Schwartz (1963) because data for adjusted base are not available for the entire period. Preliminary regressions using the two alternate series, however, yield similar results. Since money supply data for Canada are not available, we report estimates of the U.S. inflation model alone.

activity has a coefficient which is either indistinguishable from zero (monthly and quarterly data) or significantly positive (annual estimate).

The positive inflation-real activity relation combined with the positive relation between stock returns and real activity is reflected in the positive/non-negative relation between real stock returns and expected inflation (Table 5).

4.2.3. The money-real activity relation

Table 8 presents annual correlations for the 1926-1940 period. The correlations between money growth, DM_t, and lagged, current, and future real activity variables are positive.[29] This positive correlation gives us an idea of the pro-cyclical nature of money growth during this period, which is explicitly documented in the estimated quarterly money response function (Table 9). The coefficient of the real activity growth rate is positive and significant.[30] This pro-cyclical monetary response, in turn, is reflected in the positive inflation-real activity relation in both the inflation regressions and in Table 9.

Given the pro-cyclical monetary response during the 1926-1940 period, it is not surprising that the relation between stock returns

[29] In fact this strong positive correlation leads to a negative coefficient of DM_t in the annual inflation regression (Table 7), even though there is a positive simple correlation between money growth and inflation.

[30] Due to unavailability of deficit and unemployment data, we use the quarterly industrial production growth rate as a proxy for the cyclical indicators.

and changes in expected inflation is positive (unlike the post-war evidence).

Hence, pro-cyclical movements in money, inflation, and stock prices during the 1930's lead to stock return-inflation relations which are either insignificant or positive, and are statistically different from the negative post-war relations.[31]

5. Summary and conclusions

The main hypothesis of this paper is that the post-war negative real stock return-inflation relations can be explained by the equilibrium process in the monetary sector. More importantly, these relations vary over time in a systematic manner depending on the influence of money demand and supply factors.

The analysis of data from four industrialized countries (the U.S., Canada, the U.K., and Germany) indicates that negative inflation-real activity relations, reinforced by counter-cyclical monetary responses, explain the negative relations between stock returns and inflation witnessed in the post-war period.

On the other hand, evidence from the 1930's reveals significantly different stock return-inflation relations as a consequence

[31]A possible interpretation of these results is that regimes during which monetary policy is stable, as in most of the post-war period, we would witness negative inflation-real activity relations. However, during unstable monetary regimes variations in monetary policy will tend to dominate changes in the inflation rate. A significant drop in money supply will lead to a decline in real activity, inflation, and stock returns. Such pro-cyclical movements in these variables during the 1930's appear to lead to stock return-inflation relations which are either positive or insignificant. See also Kaul (1986).

of pro-cyclical movements in money, prices, and stock returns. Specifically, stock returns either have no relation or are positively related to the inflation variables.

Hence, this paper attempts to provide a consistent empirical explanation for stock return-inflation relations across different countries with apparently similar economies. We also present evidence to show that these relations are dependent on the equilibrium process in the monetary sector, and that they vary if the underlying money demand and supply factors undergo a systematic change.

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Table 1

Estimates of regressions of real stock returns on inflation and real variables for the post-war period.

$$RRS_t = \alpha + \beta_1 EI_{t-1} + \beta_2 \Delta EI_t + \beta_3 DRA_{t+1} + \eta_t.^{a}$$

Country and time period		α	β_1	β_2	β_3	$\bar{R}^2$ [b]	$\hat{\rho}_1$ [c]	$\hat{\rho}_2$	$\hat{\rho}_3$	$\hat{\rho}_4$	$\hat{\rho}_s$
(I) United States (1953-1983)											
(1) Monthly	(a)	0.014 (4.28)	-2.630 (-3.83)	-10.520 (-3.85)	-	0.06	0.05	-0.01	0.03	0.08	0.07
	(b)	0.003 (0.81)	-1.110 (-1.49)	-9.472 (-3.54)	0.162 (4.54)	0.11	-0.01	-0.07	-0.02	0.05	0.11
(2) Quarterly	(a)	0.039 (3.43)	-2.272 (-2.98)	-6.201 (-3.63)	-	0.12	0.11	-0.12	-0.06	0.00	-0.11
	(b)	0.003 (0.20)	-0.641 (-0.78)	-4.392 (-2.65)	0.501 (4.18)	0.23	0.01	-0.20	-0.08	0.05	-0.04
(3) Annual	(a)	0.150 (2.71)	-2.243 (-2.11)	-2.235 (-1.50)	-	0.10	-0.14	-0.35	0.06	0.35	-0.01
	(b)	-0.018 (-1.53)	-0.135 (-0.14)	-0.898 (-0.77)	5.407 (4.52)	0.48	0.28	-0.02	0.16	0.26	-0.09
(II) Canada (1952-1983)											
(1) Monthly	(a)	0.007 (2.09)	-1.791 (-2.40)	-6.901 (-2.03)	-	0.02	0.06	-0.06	0.06	0.02	0.07
	(b)	-0.007 (-1.37)	-0.133 (-0.16)	-5.091 (-1.51)	0.192 (4.09)	0.06	0.02	-0.12	0.02	0.00	0.10
(2) Quarterly	(a)	0.023 (2.11)	-1.955 (-2.55)	-4.972 (-2.39)	-	0.06	0.13	-0.04	0.03	-0.04	-0.11
	(b)	-0.014 (-0.96)	-0.498 (-0.60)	-3.117 (-1.52)	0.496 (3.60)	0.15	0.05	-0.11	-0.02	0.01	-0.08
(3) Annual	(a)	0.084 (1.62)	-1.600 (-1.69)	-1.053 (-0.79)	-	0.03	-0.05	-0.37	0.05	0.15	-0.11
	(b)	-0.103 (-1.22)	-0.322 (-0.34)	-0.062 (-0.05)	3.231 (2.87)	0.23	0.19	-0.15	0.14	0.04	-0.13

Table 1 - Page 2: Real stock returns, inflation, and real variables.

Country and time period		α	β_1	β_2	β_3	$\bar{R}^2$	$\hat{\rho}_1$	$\hat{\rho}_2$	$\hat{\rho}_3$	$\hat{\rho}_4$	$\hat{\rho}_s$
(III) United Kingdom (1958-1983)											
(1) Quarterly	(a)	0.027 (1.70)	-1.372 (-2.05)	-4.479 (-1.91)	-	0.05	0.30	-0.03	0.11	-0.14	-0.04
	(b)	-0.007 (-0.38)	-0.385 (-0.56)	-3.225 (-1.44)	0.744 (3.59)	0.15	0.19	-0.11	0.10	-0.18	-0.08
(2) Annual	(a)	0.086 (0.79)	-1.051 (-0.95)	-2.669 (-1.46)	-	0.01	-0.32	-0.14	-0.10	0.21	0.05
	(b)	-0.076 (-0.70)	-0.033 (-0.03)	-0.293 (-0.17)	4.205 (2.96)	0.28	-0.27	0.18	-0.17	0.12	-0.15
(IV) Germany (1958-1983)											
(1) Quarterly	(a)	0.047 (2.79)	-5.023 (-3.01)	-6.144 (-3.04)	-	0.10	0.30	0.05	0.20	0.16	-0.29
	(b)	-0.012 (-0.52)	-0.787 (-0.40)	-3.448 (-1.70)	0.646 (3.69)	0.21	0.16	-0.08	0.22	0.15	-0.17
(2) Annual	(a)	0.233 (2.28)	-4.769 (-2.40)	-8.547 (-3.32)	-	0.30	-0.06	-0.31	-0.03	0.27	-0.13
	(b)	0.105 (0.84)	-3.128 (-1.45)	-6.396 (-2.28)	1.583 (1.64)	0.36	0.01	-0.22	-0.13	0.19	-0.11

[a] RRS_t = real stock returns (continuously compounded) for period t; EI_{t-1} = expected inflation at t-1 for period t; ΔEI_t = change in expected inflation from t-1 to t; DRA_{t+1} = annual growth rate ofindustrial production or real GNP for period t+1. T-statistics are in parentheses.

[b] $\bar{R}^2$ = (adjusted) coefficient of determination.

[c] $\hat{\rho}_k$ = residual autocorrelation at lag k; $\hat{\rho}_s$ indicates autocorrelation at lag s=12 for monthly, s=8 for quarterly, and s=5 for annual regressions, respectively.

Table 2
Estimates of regressions of real stock returns on real variables for the post-war period.

$$RRS_t = \alpha + \beta_1 DRA_{t+1} + \eta_t.^a$$

Country and time period	α	β_1	$\bar{R}^{2\,b}$	$\hat{\rho}_1$	$\hat{\rho}_2$	$\hat{\rho}_3$	$\hat{\rho}_4$	$\hat{\rho}_s$
(I) United States (1953-1983)								
(1) Monthly	-0.002	0.191	0.08	0.01	-0.10	0.01	0.05	0.11
	(-0.74)	(5.76)						
(2) Quarterly	-0.007	0.580	0.20	-0.01	-0.21	-0.04	0.07	-0.03
	(-0.95)	(5.47)						
(3) Annual	-0.118	5.527	0.51	0.32	0.00	0.19	0.24	-0.08
	(-2.75)	(5.48)						
(II) Canada (1952-1983)								
(1) Monthly	-0.008	0.200	0.06	0.02	-0.12	0.02	0.00	0.11
	(-2.67)	(4.87)						
(2) Quarterly	-0.022	0.560	0.15	0.04	-0.13	0.00	0.02	-0.05
	(-2.67)	(4.68)						
(3) Annual	-0.124	3.398	0.28	0.19	-0.14	0.12	0.02	-0.11
	(-2.69)	(3.54)						
(III) United Kingdom (1958-1983)								
(1) Quarterly	-0.016	0.811	0.15	0.18	-0.10	0.11	-0.18	0.16
	(1.68)	(4.29)						
(2) Annual	-0.081	4.303	0.34	-0.26	0.20	-0.17	0.10	-0.14
	(-1.50)	(3.57)						
(IV) Germany (1958-1983)								
(1) Quarterly	-0.021	0.706	0.20	0.15	-0.08	0.22	0.15	-0.10
	(-2.35)	(4.98)						
(2) Annual	-0.082	2.653	0.26	0.15	-0.36	-0.17	0.08	-0.01
	(-1.77)	(3.02)						

[a] RRS_t = real stock returns (continuously compounded) for period t; DRA_{t-1} = annual growth rate of industrial production or real GNP for period t+1. T-statistics are in parentheses.

[b] $\bar{R}^2$ = (adjusted) coefficient of determination.

[c] $\hat{\rho}_k$ = residual autocorrelation at lag k; $\hat{\rho}_s$ indicates autocorrelation at lag s=12 for monthly, s=8 for quarterly, and s=5 for annual regressions, respectively.

Table 3
Estimates of inflation regressions for the post-war period.

$$I_t = \alpha + \beta_1 DM_t + \beta_2 DRA_t + \beta_3 DRA_{t+1} + \beta_4 DR_t + \eta_t.^{a}$$

Country and time period	α	β_1	β_2	β_3	β_4	$\bar{R}^2$ [b]	$\hat{\rho}_1$ [c]	$\hat{\rho}_2$	$\hat{\rho}_3$	$\hat{\rho}_4$	$\hat{\rho}_s$
(I) United States (1953-1983)											
(1) Monthly	0.010	0.078	-0.012	-0.023	0.142						
	(2.68)	(12.67)	(-4.63)	(-8.98)	(0.80)	0.41	-0.04	0.15	0.01	0.04	0.14
(2) Quarterly	0.003	0.229	-0.042	-0.067	0.433						
	(2.57)	(10.82)	(-4.88)	(-7.66)	(3.15)	0.63	0.00	-0.04	0.07	0.28	-0.02
(3) Annual	0.025	0.877	-0.257	-0.609	0.622						
	(3.87)	(11.32)	(-3.85)	(-5.16)	(3.56)	0.90	0.30	0.17	0.16	0.26	0.00
(II) Canada (1952-1983)											
(1) Monthly	0.005	0.024	-0.026	-0.033	- [d]						
	(10.62)	(4.77)	(-5.43)	(-7.31)		0.17	-0.05	0.13	0.05	0.15	0.29
(2) Quarterly	0.014	0.036	-0.059	-0.077	-						
	(7.17)	(1.98)	(-3.04)	(-4.12)		0.12	-0.12	-0.04	0.24	0.28	0.36
(3) Annual	0.564	0.135	-0.157	-0.464	-						
	(2.40)	(2.76)	(-1.66)	(-3.98)		0.24	0.00	-0.30	-0.03	-0.22	-0.05
(III) United Kingdom (1958-1983)											
(1) Quarterly	0.015	0.131	-0.112	-0.182	-						
	(6.95)	(6.05)	(-3.98)	(-6.37)		0.45	0.14	0.04	0.05	0.31	0.27
(2) Annual	0.060	0.531	-0.730	-0.487	-						
	(5.31)	(4.88)	(-4.67)	(-2.98)		0.66	0.23	0.03	-0.04	0.12	-0.26
(IV) Germany (1958-1983)											
(1) Quarterly	0.010	0.025	-0.032	-0.059	-						
	(6.90)	(1.27)	(-2.62)	(-3.98)		0.21	0.15	-0.40	0.19	0.51	0.49
(2) Annual	0.043	0.100	-0.151	-0.270	-						
	(7.69)	(1.34)	(-2.81)	(-3.69)		0.54	0.29	-0.06	-0.07	0.15	-0.06

[a] I_t = inflation rate for period t; DM_t = annual growth rate of money (adjusted base for the U.S., M1 for others) for period t; DRA_t = annual growth rate of industrial production or real GNP for period t; DR_t = change in continuously compounded treasury bill rate for period t. T-statistics are in parentheses.

[b] $\bar{R}^2$ = (adjusted) coefficient of determination.

[c] $\hat{\rho}_k$ = residual autocorrelation at lag k; $\hat{\rho}_s$ indicates autocorrelation at lag s=12 for monthly, s=8 for quarterly, and s=5 for annual regressions, respectively.

[d] Except for the U.S., DR_t has insignificant coefficients throughout.

Table 4
Estimates of quarterly money supply reaction functions for the post-war period.

$$DM_t = \beta_0 + \beta_{1i} DM_{t-i} + \beta_2 DEF_t + \beta_3 U_t + \eta_t .^{a}$$

Country and time period		β_0	β_{11}	β_{12}	β_{13}	β_{14}	β_{15}	β_2	β_3	$\bar{R}^{2}$ [b]	$\hat{\rho}_1$ [c]	$\hat{\rho}_2$	$\hat{\rho}_3$	$\hat{\rho}_4$	$\hat{\rho}_8$
(I) United States (1954-1983)															
	(a)	0.002	-0.104	0.009	-0.007	0.857	– [d]	1.057	–	0.90	0.02	0.06	0.03	-0.32	0.02
		(1.89)	(-2.39)	(0.27)	(-0.19)	(22.14).		(3.09)							
	(b)	-0.001	-0.033	-0.006	-0.043	0.917	–	–	0.0006	0.90	0.03	0.06	0.01	-0.33	0.00
		(-0.30)	(-0.92)	(0.15)	(1.20)	(26.95)			(1.51)						
	(c)	0.004	-0.114	-0.021	0.008	0.844	–	1.327	-0.0004	0.90	0.08	0.00	-0.05	-0.28	0.01
		(1.50)	(-2.51)	(-0.56)	(0.21)	(19.92)		(2.77)	(-0.76)						
(II) Canada (1954-1983)															
	(a)	0.049	–	–	–	–	–	0.876	–	0.09	0.01	0.21	0.26	0.04	-0.01
		(3.99)						(1.95)							
	(b)	0.038	–	–	–	–	–	–	0.0046	0.00	-0.01	0.04	0.16	0.26	0.08
		(1.22)							(0.97)						
	(c)	0.131	–	–	–	–	–	2.506	-0.018	0.15	-0.01	0.18	0.21	-0.10	-0.08
		(2.79)						(2.49)	(-1.79)						
(III) United Kingdom (1960-1983)															
	(a)	0.010	-0.071	0.101	-0.003	0.155	–	2.700	–	0.33	-0.05	0.03	0.15	0.00	0.18
		(2.11)	(-0.80)	(1.16)	(-0.03)	(1.47)		(4.25)							
	(b)	0.007	-0.209	0.044	0.021	0.368	–	–	0.0020	0.21	-0.02	0.06	0.10	-0.01	0.19
		(1.37)	(-2.15)	(0.44)	(0.22)	(3.84)			(1.87)						
	(c)	0.006	-0.113	0.057	-0.042	0.131	–	2.600	0.0015	0.33	-0.06	0.03	0.14	0.00	0.18
		(1.20)	(-1.22)	(0.62)	(-0.45)	(1.24)		(4.17)	(1.52)						
(IV) Germany (1960-1983)															
	(a)	0.012	0.108	-0.059	-0.105	0.638	-0.376	1.245	–	0.82	-0.01	0.09	0.24	-0.13	0.01
		(2.44)	(1.41)	(-0.05)	(-1.45)	(9.30)	(-3.93)	(2.17)							
	(b)	0.017	0.139	-0.076	-0.168	0.648	-0.385	–	-0.0004	0.81	-0.09	0.04	0.23	-0.15	-0.06
		(3.16)	(1.40)	(-1.08)	(-2.41)	(8.79)	(-3.87)		(-0.44)						
	(c)	0.016	0.112	-0.059	-0.097	0.581	-0.418	2.080	-0.0021	0.82	-0.02	0.10	0.22	-0.19	0.01
		(3.17)	(1.18)	(-0.88)	(-1.37)	(8.00)	(-4.36)	(3.02)	(-2.11)						

[a] DM_t = growth rate of money (adjusted base for the U.S., and M1 for the others) for quarter t; DEF_t = nominal federal deficit/[(GNP deflator) x (trend value of real GNP)] for quarter t; U_t = unemployment rate for quarter t. T-statistics are in parentheses.

[b] $\bar{R}^2$ = (adjusted) coefficient of determination.

[c] $\hat{\rho}_k$ = residual autocorrelation at lag k.

[d] All dashes indicate insignificant coefficients.

Table 5
Estimates of regressions of real stock returns on inflation variables for the United States and Canada for the period 1926-1940.

$$RRS_t = \alpha + \beta_1 EI_{t-1} + \beta_2 \Delta EI_t + \eta_t .^{a}$$

Country and time period	α	β_1	β_2	$\bar{R}^2$ [b]	$\hat{\rho}_1$ [c]	$\hat{\rho}_2$	$\hat{\rho}_3$	$\hat{\rho}_4$	$\hat{\rho}_s$
(I) United States									
(1) Monthly	0.004	0.042	0.934	0.00	0.09	0.00	-0.22	0.07	-0.01
	(0.53)	(0.03)	(0.51)						
(2) Quarterly	0.013	1.170	4.511	0.00	-0.26	0.07	0.25	-0.30	0.01
	(0.54)	(0.29)	(1.31)						
(3) Annual	0.073	2.216	4.306	0.16	-0.27	-0.12	0.15	-0.22	-0.06
	(1.02)	(1.21)	(2.15)						
(II) Canada									
(1) Monthly	0.001	1.241	9.447	0.01	0.29	-0.09	-0.23	-0.04	0.04
	(0.15)	(0.91)	(1.90)						
(2) Quarterly	0.002	0.913	2.848	0.00	-0.26	0.13	0.20	0.05	-0.04
	(0.09)	(0.50)	(0.74)						
(3) Annual	0.030	2.110	3.931	0.23	-0.10	0.11	-0.20	-0.45	-0.01
	(0.51)	(1.25)	(2.42)						

[a] RRS_t = real stock returns (continuously compounded) for period t; EI_{t-1} = expected inflation at t-1 for period t; ΔEI_t = change in expected inflation from t-1 to t. T-statistics are in parentheses.

[b] $\bar{R}^2$ = (adjusted) coefficient of determination.

[c] $\hat{\rho}_k$ = residual autocorrelation at lag k; $\hat{\rho}_s$ indicates autocorrelation at lag s=12 for monthly, s=8 for quarterly, and s=5 for annual, respectively.

Table 6
Estimates of regressions of real stock returns on real variables for the United States and Canada for the period 1926-1940.

$$RRS_t = \alpha + \beta_1 DRA_t + \beta_2 DRA_{t+1} + \eta_t.$$ [a]

Country and time period	α	β_1	β_2	$\bar{R}^2$ [b]	$\hat{\rho}_1$ [c]	$\hat{\rho}_2$	$\hat{\rho}_3$	$\hat{\rho}_4$	$\hat{\rho}_s$
(I) United States									
(1) Monthly	0.000 (0.05)	– [d]	0.122 (3.63)	0.06	0.05	-0.05	-0.24	-0.01	-0.00
(2) Quarterly	-0.001 (-0.03)	0.289 (2.43)	0.152 (1.33)	0.09	-0.30	-0.02	0.17	0.30	0.00
(3) Annual	-0.004 (-0.08)	–	2.187 (3.39)	0.43	0.05	-0.06	0.32	-0.27	0.06
(II) Canada									
(1) Monthly	-0.004 (-0.90)	–	0.115 (3.71)	0.07	0.25	-0.14	-0.29	-0.05	0.03
(2) Quarterly	-0.009 (-0.49)	–	0.238 (1.86)	0.04	-0.31	0.08	0.20	0.04	-0.05
(3) Annual	-0.035 (-0.72)	–	2.168 (3.77)	0.52	0.25	0.13	-0.10	-0.32	0.08

[a] RRS_t = real stock returns (continuously compounded) for period t; DRA_t = annual growth rate of industrial production or real GNP for period t. T-statistics are in parentheses.

[b] $\bar{R}^2$ = (adjusted) coefficient of determination.

[c] $\hat{\rho}_k$ = residual autocorrelation at lag k; $\hat{\rho}_s$ indicates autocorrelation at lag s=12 for monthly, s=8 for quarterly, and s=5 for annual regressions, respectively.

[d] Except for the quarterly U.S. regression, the coefficient of DRA_t is insignificant throughout.

Table 7
Estimates of inflation regressions for the United States for the period 1926-1940.

$$I_t = \alpha + \beta_1 DM_t + \beta_2 DRA_t + \beta_2 DRA_{t+1} + \eta_t.^a$$

Country and time period	α	β_1	β_2	β_3	$\bar{R}^{2\,b}$	$\hat{\rho}_1{}^c$	$\hat{\rho}_2$	$\hat{\rho}_3$	$\hat{\rho}_4$	$\hat{\rho}_s$
(1) Monthly	-0.017 (-2.53)	0.057 (0.60)	0.220 (4.96)	-0.007 (-0.19)	0.20	0.01	0.04	-0.16	-0.02	0.19
(2) Quarterly	-0.006 (-2.85)	0.038 (1.35)	0.053 (3.93)	-0.004 (-0.41)	0.41	-0.08	-0.12	0.03	0.31	0.12
(3) Annual	-0.021 (-3.45)	-0.276 (-1.87)	0.557 (5.33)	0.341 (2.77)	0.80	0.10	-0.23	-0.14	0.13	0.11

[a] I_t = inflation rate for period t; DM_t = annual growth rate of M1 for period t; DRA_t = annual growth rate of industrial production or real GNP for period t. T-statistics are in parentheses.

[b] $\bar{R}^2$ = (adjusted) coefficient of determination.

[c] $\hat{\rho}_k$ = residual autocorrelation at lag k; $\hat{\rho}_s$ indicates autocorrelation at lag s=12 for monthly, s=8 for quarterly, and s=5 for annual regressions, respectively.

Table 8

Estimates of annual correlations for the United States for the period 1926-1940.

Variables[a]	DM_t	DRA_{t-1}	DRA_t	DRA_{t+1}	I_t	EI_{t-1}
DM_t	1.00					
DRA_{t-1}	0.38	1.00				
DRA_t	0.75	0.43	1.00			
DRA_{t+1}	0.83	0.14	0.49	1.00		
I_t	0.66	0.34	0.87	0.62	1.00	
EI_{t-1}	0.59	0.87	0.66	0.27	0.53	1.00

[a] DM_t = growth rate of M1 for year t; DRA_t = growth rate of real GNP for year t; I_t = inflation rate for year t; EI_{t-1} = expected inflation at year t-1 for year t.

Table 9

Estimates of quarterly money supply reaction function for the United States for the period 1926-1940.

$$DM_t = \alpha + \beta_{11} DM_{t-1} + \beta_2 DRA_t + \eta_t .^a$$

Time period	α	β_{11}	β_{12}	β_2	$\bar{R}^2$ [b]	$\hat{\rho}_1$ [c]	$\hat{\rho}_2$	$\hat{\rho}_3$	$\hat{\rho}_4$	$\hat{\rho}_8$
Quarterly	0.003 (0.96)	0.344 (3.02)	0.307 (2.61)	0.084 (3.04)	0.45	-0.03	-0.14	0.04	0.03	-0.16

[a] DM_t = growth rate of M1 for period t; DRA_t = growth rate of real GNP for period t. T-statistics are in parentheses.

[b] $\bar{R}^2$ = (adjusted) coefficient of determination.

[c] $\hat{\rho}_k$ = residual autocorrelation at lag k.