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Source: *The Journal of Finance*, Vol. 47, No. 4 (Sep., 1992), pp. 1591-1603
Published by: Wiley for the American Finance Association
Stable URL: http://www.jstor.org/stable/2328955
Accessed: 19-03-2015 01:10 UTC

THE JOURNAL OF FINANCE • VOL. XLVII, NO. 4 • SEPTEMBER 1992

Causal Relations Among Stock Returns, Interest Rates, Real Activity, and Inflation

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ABSTRACT

Using a multivariate vector-autoregression (VAR) approach, this paper investigates causal relations and dynamic interactions among asset returns, real activity, and inflation in the postwar United States. Major findings are (1) stock returns appear Granger-causally prior and help explain real activity, (2) with interest rates in the VAR, stock returns explain little variation in inflation, although interest rates explain a substantial fraction of the variation in inflation, and (3) inflation explains little variation in real activity. These findings seem more compatible with Fama (1981) than with Geske and Roll (1983) or with Ram and Spencer (1983).

VARIOUS THEORETICAL FRAMEWORKS HAVE been developed to explain the negative correlations observed between inflation and real asset returns in the postwar period. In light of the Fisher hypothesis, and of the commonly held view that stocks and bonds should be a hedge against inflation, these relations are indeed puzzling. Fama (1981), Geske and Roll (1983), Ram and Spencer (1983), James, Koreisha, and Partch (1985), Stulz (1986), and Kaul (1987) all attempt to explain the negative association between stock returns and inflation; and Fama and Gibbons (1982) attempt to explain the negative association between inflation and real interest rates.

Fama (1981) hypothesizes that the negative correlation between stock returns and inflation is not a causal relation but that it is proxying for a positive relation between stock returns and real activity and is induced by a negative relation between real activity and inflation. Geske and Roll (1983) argue that stock returns cause (or signal) changes in inflationary expectations because of a chain of macroeconomic events. When stock prices decline in response to anticipated changes in economic conditions, the government, given largely fixed expenditures, will tend to run a deficit. To the extent that the deficit is monetized, expected inflation will rise. Ram and Spencer (1983), however, find evidence of unidirectional causality from inflation to stock returns. Using a vector autoregressive-moving average (VARMA) model, James, Koreisha, and Partch (1985) examine simultaneously the causal links between stock returns, real activity, money supply, and inflation. They find evidence that stock returns signal both changes in real activity and changes in the monetary base, which suggests a link between money supply and real

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activity that is consistent with the money supply explanation offered by Geske and Roll.

All of these studies recognize the importance of causal relations and discuss them in one way or another. However, two potential drawbacks remain. First, as Mehra (1978) and Sims (1980b) point out, the causal relations observed based on a bivariate causal test may not be robust when other relevant variables are introduced into the vector autoregressive (VAR) system. Thus, Geske and Roll's (1983) and Ram and Spencer's (1983) findings, both of which are based on a bivariate causal test, may not be robust in a larger system of variables.[1] In this respect, James, Koreisha, and Partch's test of causality based on a VARMA model seems more appropriate than others, even though interest rates are not well represented in their system because, although the first difference in interest rates is used as a proxy for the change in expected inflation, a separate role of interest rates is not allowed for.

Second, although the James, Koreisha, and Partch analysis is based on a VARMA (or VAR) model, a simple statistical test of rejection or non-rejection of hypotheses about causal relations may not provide a complete description and analysis of the data. An equally important, and probably more interesting, issue may be to obtain empirical regularities by investigating the extent to which a variable helps explain other variables and how a variable responds to shocks in other variables in the system. That is, it may be more informative and revealing to discuss a causal relation in the context of informative (or predictive) content and of dynamic interactions.

The purpose of this paper is, therefore, (1) to investigate, by using a multivariate VAR approach, the causal relations and dynamic interactions among stock returns, interest rates, real activity, and inflation in the postwar United States, and (2) to examine the validity of models explaining the observed negative relations between asset returns and inflation. The paper is organized as follows. Section I briefly describes the VAR analysis based on innovation accounting. Section II describes the variables and data used in the VAR system. Section III interprets the results of the VAR analysis (error decompositions and impulse responses) in the context of asset returns and inflation relations and compares these results with those of previous studies. Section IV concludes the paper.

I. Causality and Vector Autoregression (VAR) Analysis

A. Innovation Accounting

VAR analysis works with unrestricted reduced forms treating all variables as endogenous and imposing no restrictions based on supposed a priori knowl-

[1] Moreover, Geske and Roll's argument, which is based on the transitivity (chain) of bivariate causal ordering, may not necessarily lead to a valid causal relation in a multivariate system (see Section I.*B*).

edge (or theory). In this section, we briefly discuss innovation accounting which provides a basis for the VAR analysis. For a more rigorous discussion, see Sims (1980a, 1980b).

Suppose that z_t, an m by 1 vector for $m \geq 2$, is a linearly indeterministic (or regular) covariance stationary process having a vector moving average representation by the Wold theorem:

$$z_t = B(L)e_t = \sum_{s=0}^{\infty} B(s)e_{t-s}, \tag{1}$$

where $e_t = z_t - E[z_t | z_{t-s}, s \geq 1]$ and E is a linear projection operator. The variable e_t is called the innovation in z_t and is a one-step-ahead linear least squares forecasting error in predicting z_t as a linear function of z_{t-1}, $z_{t-2}, \ldots,$ and is serially uncorrelated by construction. $b_{ij}(s)$, the (i, j)th component of $B(s)$, represents the dynamic response of each endogenous variable z_i to a shock, $e_j(t-s)$, after s periods.

Even though e_t is serially uncorrelated, the components of e_t may be contemporaneously correlated such that a simulation of a shock to $z_j(0)$, holding all other components of z at zero, may not be what occurred historically. To solve this problem, and decompose unambiguously the forecast error variances in the variables into components attributable to each innovation, an orthogonalizing transformation to e_t is performed. As a result, the transformed innovation, u_t, has the identity covariance matrix, without any contemporaneous correlation between components.

Let var $e_t = \Sigma$. Since Σ is a symmetric positive definite matrix, Σ^{-1} is also a symmetric positive definite matrix; and there is a nonsingular matrix G such that $\Sigma^{-1} = G'G$. Now we define a transformed innovation, u_t, such that

$$u_t = Ge_t,$$

so that

$$\text{var } u_t = \text{var}(Ge_t) = G\Sigma G' = G(G'G)^{-1}G' = I_m,$$

where I_m is an identity matrix of rank m. There are several possible ways of transforming e_t. If G is taken to be a lower triangular matrix, however, $u_j(s)$ is the normalized error in forecasting $z_j(s)$ from the past values of the z vector and from the current values of $z_i(s)$ for $i < j$. Because each u_j affects variables lower in the ordering, the ordering of the variables chosen for the transformation may matter when the innovations have a strong contemporaneous correlation. From (1), z_t can be written as

$$z_t = \sum_{s=0}^{\infty} B(s)G^{-1}Ge(t-s) = \sum_{s=0}^{\infty} B(s)G^{-1}u(t-s) = \sum_{s=0}^{\infty} C(s)u(t-s).$$

The coefficients of $C(s)$ represent "responses to shocks (or innovations)" in particular variables, and we can allocate the variance of each element in z to sources in elements of u because u is serially and contemporaneously uncorrelated. This orthogonalization also provides

$$\sum_{s=0}^{t-1} c_{ij}(s)^2 \Big/ \sum_{j=1}^{m} \sum_{s=0}^{t-1} c_{ij}(s)^2,$$

which is the component of error variance in the t-step-ahead forecast of z_i, which is accounted for by innovations in z_j.[2]

B. Intransitivity of the Causal Ordering

Suppose that $z_t = [z_{1t}, z_{2t}, z_{3t}]'$ is a trivariate linearly indeterministic (regular) covariance stationary process with the VAR representation

$$z_t \equiv \begin{bmatrix} z_{1t} \\ z_{2t} \\ z_{3t} \end{bmatrix} = \begin{bmatrix} a_{11}(L) & a_{12}(L) & a_{13}(L) \\ a_{21}(L) & a_{22}(L) & a_{23}(L) \\ a_{31}(L) & a_{32}(L) & a_{33}(L) \end{bmatrix} \begin{bmatrix} z_{1t-1} \\ z_{2t-1} \\ z_{3t-1} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \end{bmatrix},$$

where $a_{ij}(L) = \Sigma_{s=0}^{m} a_{ij}(s)L^s$, for $1 \le m < \infty$ and $e_t = [e_{1t}, e_{2t}, e_{3t}]' = z_t - E[z_t | z_{t-s}, s = 1, 2, ..m]$, i.e., e_t is the innovation in z_t in predicting z_t as a linear combination of $z_{t-1}, z_{t-2}, \ldots z_{t-m}$. In this VAR representation, Granger (1969) causality runs from z_1 to z_2 if $a_{12}(L) = 0$, and causality runs from z_2 to z_3 if $a_{23}(L) = 0$. Causality runs from z_1 to z_3, however, if $a_{13}(L) = 0$, which does not depend upon either $a_{12}(L) = 0$ or $a_{23}(L) = 0$. This shows that, in general, transitivity of causal ordering does not hold, so that if z_1 causes z_2 and z_2 in turn causes z_3, it does not necessarily imply that z_1 causes z_3. To investigate the causal ordering between z_1 and z_3, we have to

[2] From $z_t = \Sigma_{s=0}^{\infty} C(s) u_{t-s}$, the t-step-ahead forecast of z_t based on $z_0, z_{-1}, z_{-2}, \ldots$ is given by $E[z_t | z_0, z_{-1}, z_{-2}, \ldots] = \Sigma_{s=t}^{\infty} C(s)\, u_{t-s}$.
The t-step-ahead forecast error, say w_t, is given by

$$w_t \equiv z_t - E[z_t | z_0, z_{-1}, z_{-2}, \ldots] = \sum_{s=0}^{t-1} C(s) u_{t-s}.$$

Thus, t-step-ahead forecast error variance is given by

$$E[w_t w_t'] = E\left[\sum_{s=0}^{t-1} C(s) u_{t-s}\right]\left[\sum_{s=0}^{t-1} C(s) u_{t-s}\right] = \sum_{s=0}^{t-1} \text{trace}\, C(s)C(s)'.$$

Then, t-step-ahead forecast error variance in z_i, which is accounted for by innovations in z_j, is

$$\sum_{s=0}^{t-1} c_{ij}(s)^2 \Big/ \sum_{j=1}^{m} \sum_{s=0}^{t-1} c_{ij}(s)^2.$$

examine directly whether in fact $a_{13}(L) = 0$ (see Sims (1972, 1980b) and Mehra (1978)).

II. Variables in the System and the Data

I employ a four-variable VAR system—real stock returns (SRE), real interest rates (IRE), growth in industrial production (IPG), and rate of inflation (INF)—with a constant and six lags. Since the paper focuses on asset returns and inflation, stock returns, interest rates, and INF are included in the system, and IPG is added as a measure of the general economic activity. Real returns (SRE and IRE) are computed as nominal returns (SR and IR, respectively) less the expected inflation rate (INFE), which is obtained by taking a one-step-ahead forecast based on the four variable VAR with a constant and six lags and consisting of SR, IR, IPG, and INF (i.e., SRE = SR − INFE, and IRE = IR − INFE).[3]

James, Koreisha, and Partch employed a four-variable system of (nominal) stock returns (RS), changes in expected inflation (ΔRF), anticipated real activity (CIP), and monetary base growth rate (∇MB). The monetary base growth rates are, however, very closely correlated with both the rate of inflation and the interest rate—to the extent that one is almost redundant in the system. The relation between inflation and interest rates and the relation between interest rates and stock returns have been important issues in Geske and Roll (1983) and in Breen, Glosten, and Jagannathan (1989). Therefore, we include interest rates, rather than changes in monetary base, in the VAR system.[4] For the purpose of comparison, however, we also report in Table II the result of the VAR analysis using the same variables as the ones used by James, Koreisha, and Partch (RS_t, $\Delta\mathrm{RF}_t$, CIP_t, and $\nabla\mathrm{MB}_t$).

The sample period for this study is from January 1947 to December 1987. The (nominal) common stock returns (SR) are the returns on the New York Stock Exchange (NYSE) value-weighted stock index obtained from the Center for Research in Security Prices (CRSP). The (nominal) interest rates (IR) are the returns on one-month Treasury bills obtained from the CRSP U.S. Government bond file. The rate of inflation series (INF) is computed by using the monthly Consumer Price Index (CPI) series obtained from the Citibase data file [i.e., $\mathrm{INF}_t = (\mathrm{CPI}_t - \mathrm{CPI}_{t-1})/\mathrm{CPI}_{t-1}$]. The industrial production series (IP) is obtained from the Citibase data file, and the growth rate in industrial production (IPG) is computed $\mathrm{IPG}_t = (\mathrm{IP}_t - \mathrm{IP}_{t-1})/\mathrm{IP}_{t-1}$. The mon-

[3] That is, expected inflation is computed as

$$E_t[\mathrm{INF}_{t+1}] \equiv \mathrm{INFE}_t = E[\mathrm{INF}_{t+1} \mid \mathrm{SR}_{t-s}, \mathrm{IR}_{t-s}, \mathrm{IPG}_{t-s}, \mathrm{INF}_{t-s}, \text{for } s = 0, 1, 2, \dots 5],$$

by using a simple Kalman filter (updating) method.

[4] The fact that James, Koreisha, and Partch use the change in nominal interest rates as a proxy for the change in expected inflation indicates that they implicitly assume a constant real interest rate. Hence, there is no room for an independent role of real interest rates in their analysis.

etary base series (MB) is also obtained from the Citibase data file. The data of IP, INF, and MB are seasonally adjusted.

III. Empirical Results

A. Crosscorrelations

Before we move on to the VAR analysis, we briefly summarize empirical relations based on crosscorrelations for the period January 1947 to December 1987.

1. Contrary to the Fisher hypothesis, nominal stock returns and inflation are weakly negatively correlated, and real stock returns and inflation are mildly negatively correlated for all leads and lags.
2. Nominal interest rates and inflation are strongly positively associated for all lags and leads, as expected from the Fisher hypothesis. Real interest rates and inflation are negatively associated, however, which agrees with the findings of Fama and Gibbons (1982).
3. Stock returns are positively correlated with growth in industrial production, which seems to support the claim that an increase in real stock returns anticipates upward movements in growth in industrial production.
4. Inflation is negatively associated with, in particular, subsequent growth in industrial production. Nominal interest rates and growth in industrial production are also negatively associated, which suggests that when the nominal interest rate rises because of inflationary expectations, it will likely be associated with a lower growth in industrial production.
5. Real interest rates, however, like real stock returns, are positively associated with subsequent growth in industrial production. This observation casts doubt on Mundell's (1963) argument that real returns on financial assets are negatively related to real activity.

B. Empirical Regularities Using the VAR Analysis[5]

B.1. Stock Returns and Real Activity

In Table I, real stock returns (SRE) seem Granger-causally prior in the sense that most (92.67%) of the 24-month forecast error variance is accounted for by their own innovations in the four-variable system. Between real stock returns (SRE) and growth in industrial production (IPG), SRE seem to explain a substantial fraction (10.61%) of variance in IPG. Figure 1 shows that the response of IPG to shocks in SRE is strongly positive up to the first 12 months and after that the effect is quite negligible. This observation is

[5] Some preliminary unit root tests show that, except for ΔMB, all other variables are stationary. Therefore, only ΔMB is differenced in the VAR system.

Table I

Percentage of 24-Month Forecast Error Variance Explained by Innovations in Each Variable Based on Four-Variable Innovation Accounting Using Real Stock Returns (SRE), Real Interest Rates (IRE), Growth in Industrial Production (IPG), and Inflation Rate (INF)

The forecast error variance is computed using the four-variable VAR system z_t with a constant and six lags. The table shows percentage of 24-month forecast error variance in variable i explained by innovations in variable j,

$$\left[\sum_{s=0}^{23} c_{ij}(s)^2 \bigg/ \sum_{j=1}^{4} \sum_{s=0}^{23} c_{ij}(s)^2 \right] \times 100$$

where $c_{ij}(s)$ is obtained from the orthogonalized moving average representation of z_t:

$$z_t = \sum_{s=0}^{\infty} c(s)u(t-s),$$

with z_t being a 4 by 1 vector consisting of SRE, IRE, IPG, and INF. For example, 92.67% of 24-month forecast error variance in real stock returns (SRE) is explained by its own innovations, and 10.61% of 24-month forecast error variance in the growth in industrial production (IPG) is explained by innovations in real stock return (SRE).

The sample period is from January 1947 to December 1987.

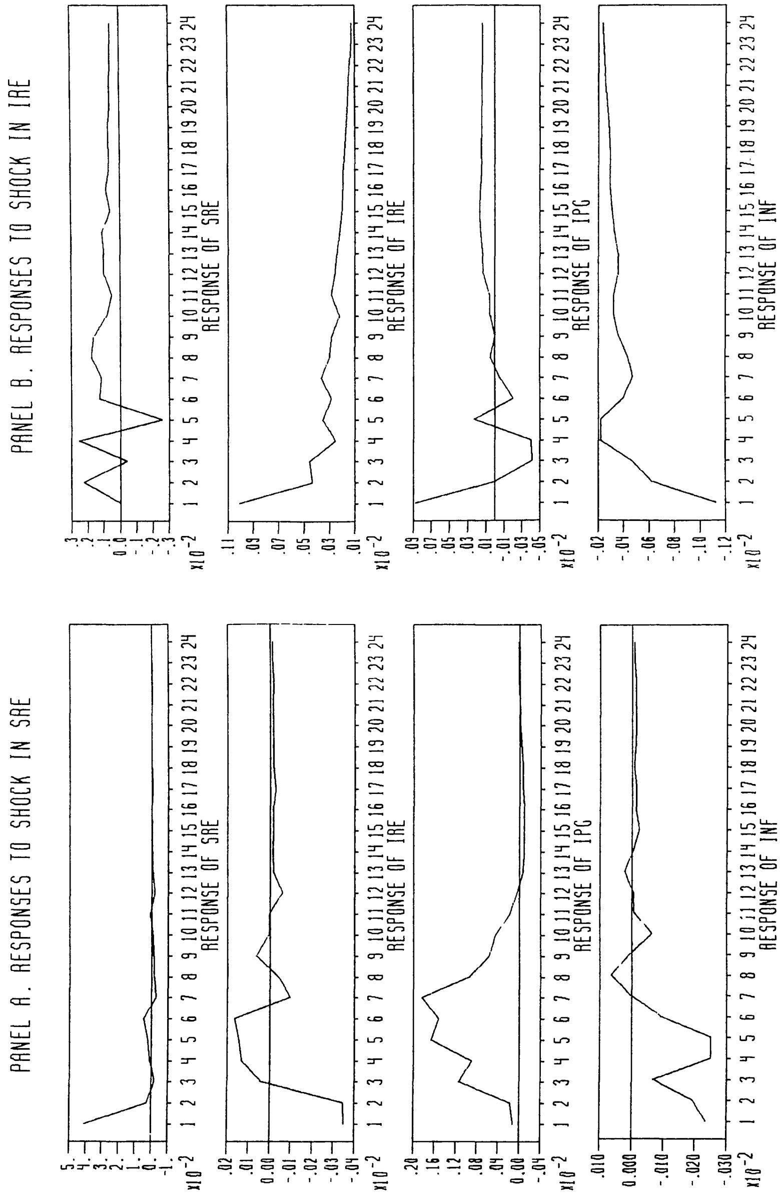
SRE = real stock return measured by SR (nominal stock return) − INFE (expected inflation), where INFE is computed as a one-step-ahead prediction based on a VAR system consisting of SR, IR, IPG, and INF; IRE = real interest rate measured by IR (nominal interest rate) − INFE; IPG = the growth rate of industrial production (IP) measured by $[(\mathrm{IP}_t - \mathrm{IP}_{t-1})/\mathrm{IP}_{t-1}] \times 100$; and INF = the rate of inflation measured by $[(\mathrm{CPI}_t - \mathrm{CPI}_{t-1})/\mathrm{CPI}_{t-1}] \times 100$.

Variables Explained	By Innovations in			
	SRE	IRE	IPG	INF
	(%)	(%)	(%)	(%)
SRE	92.67	1.90	2.27	3.16
IRE	10.06	77.73	6.31	5.89
IPG	10.61	1.30	84.73	3.35
INF	2.37	38.78	4.31	54.53

consistent with the view that the stock market rationally signals (or leads) changes in real activity, and that the relation between stock returns and real activity is positive (see Fama (1981) and Geske and Roll (1983)).

B.2. Stock Returns and Inflation

Table I indicates that inflation (INF) does not appear to be explained by real stock returns (SRE). In the presence of real interest rates (IRE) in the VAR system, only 2.37% of the 24-month forecast error variance of INF is explained by innovations in SRE. On the other hand, a substantial fraction (38.78%) of the variance in INF is explained by IRE. This finding is compatible with Fama's and Geske and Roll's view that the negative observed


PANEL A. RESPONSES TO SHOCK IN SRE
RESPONSE OF SRE
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PANEL B. RESPONSES TO SHOCK IN IRE
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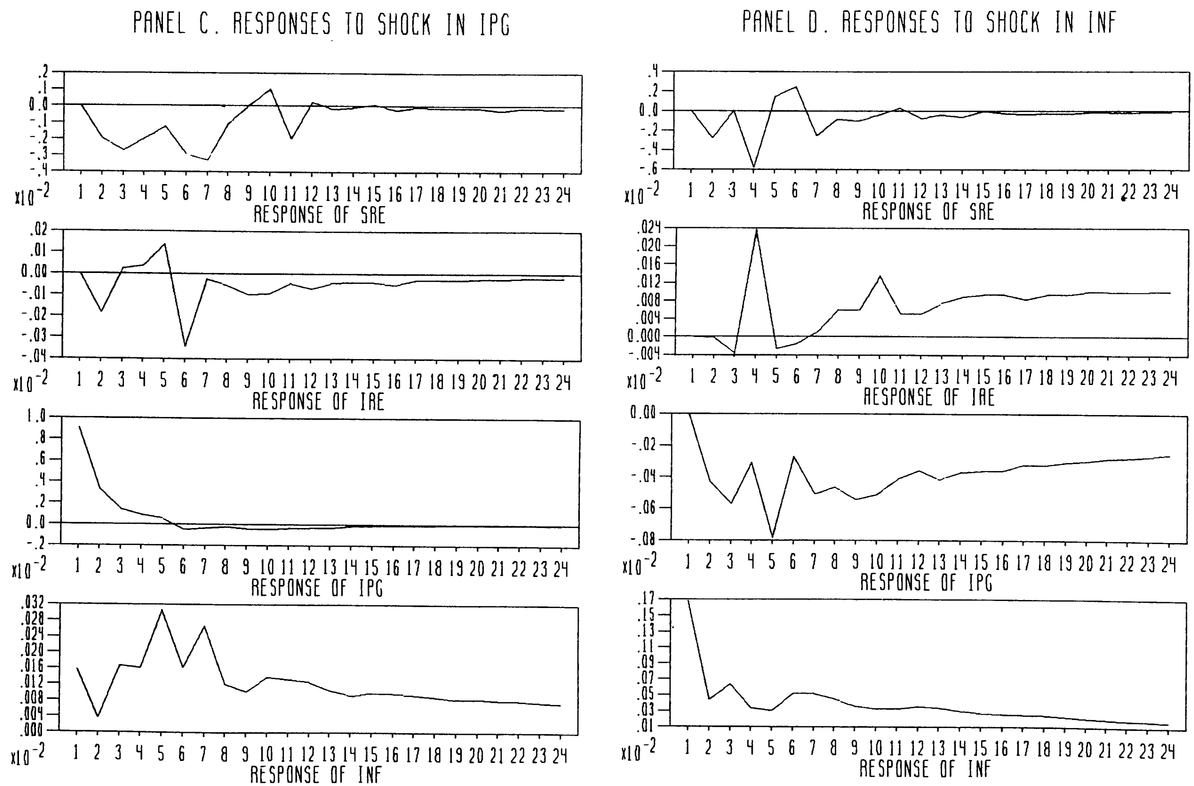

Figure 1. Simulated dynamic (impulse) responses of real stock returns (SRE), real interest rates (IRE), growth in industrial production (IPG), and inflation (INF) to shocks in each variable. Figures plot simulated dynamic (impulse) responses of variable i for 24-months to shocks in variable j, which is represented by c_{ij} in the orthogonalized moving average representation of z_t:

$$z_t = \sum_{s=0}^{\infty} c(s)u(t-s),$$

where z_t is a 4 by 1 vector consisting of SRE, IRE, IPG, and INF. The sample period is from January 1947 to December 1987. SRE = real stock return measured by SR (nominal stock return) − INFE (expected inflation), where INFE is computed as a one-step-ahead prediction based on a VAR system consisting of SR, IR, IPG, and INF; IRE = real interest rate measured by IR (nominal interest rate) − INFE; IPG = the growth rate of industrial production (IP) measured by $[(\mathrm{IP}_t - \mathrm{IP}_{t-1})/\mathrm{IP}_{t-1}] \times 100$; and INF = the rate of inflation measured by $[(\mathrm{CPI}_t - \mathrm{CPI}_{t-1})/\mathrm{CPI}_{t-1}] \times 100$.

relations between stock returns and inflation are proxying for other, possibly more fundamental, economic relations—positive relations between stock returns and real activity. This observation, however, suggests pitfalls in the argument of Geske and Roll. Although they found several causal chains of events connecting stock returns and inflation, because of intransitivity of the causal ordering (see Section I.*B*), their argument does not necessarily point to a causal relation between stock returns and inflation.[6] This finding also does not corroborate the results in Ram and Spencer (1983), who found the unidirectional causation from inflation to stock returns based on a bivariate causal test.

James, Koreisha, and Partch interpret Geske and Roll as suggesting that nominal stock returns (RS) signal changes in expected inflation (ΔRF), which are measured as the change in the return of one-month Treasury bills. By using the variables James, Koreisha, and Partch use, Table II reinterprets James, Koreisha, and Partch's results in a four-variable VAR system. It shows some evidence for James, Koreisha, and Partch's argument in that RS explains 3.96% of the 24-month forecast error variance in ΔRF whereas ΔRF explains 1.96% of the variance in RS. Nevertheless, I have doubts about the validity of their argument. First, 3.96% is too small a fraction to provide a basis for the causation from RS to ΔRF. Second, this fraction is obtained without interest rates in the VAR system. As we observe from Table I, once we include interest rates in the VAR system, the explanatory power of RS for ΔRF is eliminated. In short, I fail to find strong evidence based on the VAR analysis for their interpretation of Geske and Roll's claim that stock returns signal changes in expected inflation.

In addition to this inability to find a unidirectional causality between stock returns and inflation, I fail to find either a consistent negative response of inflation to shocks in stock returns or a consistent negative response of stock returns to shocks in inflation (see Figure 1).

B.3. Interest Rates and Inflation

As mentioned earlier, real interest rates (IRE) rather than real stock returns (SRE) appear to explain a substantial fraction of the forecast error variance in inflation (see Table I). Figure 1 shows that, in response to shocks in IRE, INF declines initially and then recovers quickly, but still its effect remains negative.[7]

B.4. Inflation and Real Activity

Fama (1981) and Fama and Gibbons (1982) have emphasized the negative relation between inflation and real activity as the key determinant of the negative relations between stock returns (or interest rates) and inflation in

[6] In addition to the intransitivity of the causal ordering problem, several studies document that there is little evidence that the growth of monetary base is related to the government deficit (e.g., Blinder (1984) and Joines (1985). See also Geske and Roll, pp. 19–21).

[7] It is also observed, however, that in response to shocks in nominal interest rates, INF increases considerably for the first few months and the positive effect then declines gradually.

Table II

Percentage of 24-Month Forecast Error Variance Explained by Innovations in Each Variable Based on Four-Variable Innovation Accounting Using Anticipated Real Activity (CIP), Nominal Stock Returns (RS), Changes in Expected Inflation (ΔRF), and Monetary Base Growth Rate (∇MB)

The forecast error variance is computed using the four-variable VAR system z_t with a constant and six lags. The table shows percentage of 24-month forecast error variance in variable i explained by innovations in variable j,

$$\left[\sum_{s=0}^{23} c_{ij}(s)^2 \Big/ \sum_{j=1}^{4} \sum_{s=0}^{23} c_{ij}(s)^2\right] \times 100$$

where $c_{ij}(s)$ is obtained from the orthogonalized moving average representation of z_t:

$$z_t = \sum_{s=0}^{\infty} c(s)u(t-s),$$

with z_t being a 4 by 1 vector consisting of CIP, RS, ΔRF, and ∇MB. For example, 93.07% of 24-month forecast error variance in nominal stock returns (RS) is explained by its own innovations, and 3.96% of 24-month forecast error variance in the change in expected inflation (ΔRF) is explained by innovations in nominal stock return (RS).

The sample period is from January 1947 to December 1987.

CIP = the change in industrial production (IP) for the year beginning in month t, i.e., the first differences in $[(\mathrm{IP}_{t+12} - \mathrm{IP}_t)/\mathrm{IP}_t] \times 100$; RS = nominal stock return measured by NYSE value-weighted stock index; ΔRF = the change in expected inflation measured by the first difference in the Treasury bill rate, $\mathrm{IR}_t - \mathrm{IR}_{t-1}$; and ∇MB = the first difference of the annual rate of change for monetary base (MB) for the year ending in month t, i.e., the first difference in $\Delta\mathrm{MB} \equiv [(\mathrm{MB}_t - \mathrm{MB}_{t-12})/\mathrm{MB}_{t-12}] \times 100$.

Variables Explained	By Innovations in			
	CIP	RS	ΔRF	∇MB
	(%)	(%)	(%)	(%)
CIP	98.25	1.31	0.23	0.21
RS	4.39	93.07	1.96	0.58
ΔRF	2.42	3.96	91.96	1.66
∇MB	3.51	2.79	3.13	90.57

the postwar sample period. By using mainly the growth rate in industrial production, Fama (1981) found a negative relation between inflation and real activity, whereas, by using mainly the employment to population ratio as a measure of real economic activity, Ram and Spencer failed to find the negative relation.

Tables I and II show that inflation does not have significant explanatory power for growth in industrial production in the presence of stock returns and interest rates: with SRE and IRE, inflation explains 3.35% of the variance of IPG (Table I), with nominal stock returns (RS), inflation (ΔRF) explains 0.23% of the variance of growth in industrial production (CIP), and monetary base (∇MB) explains 0.21% of the variance of CIP (Table II). These findings are broadly consistent with Sims's (1980b) findings and are at odds with the rational-expectations monetarist view.[8]

IV. Concluding Remarks

Using postwar U.S. data, I conduct an investigation (based on a VAR analysis) of causal relations and dynamic interactions among stock returns, interest rates, real activity, and inflation. Compared to previous studies, this VAR analysis, based on innovation accounting, provides a rigorous study of the dynamic relations among the variables without imposing a priori restrictions.

My major findings are

1. Stock returns appear Granger-causally prior and help explain a substantial fraction of the variance in real activity, which responds positively to shocks in stock returns.
2. With interest rates in the VAR system, unlike James, Koreisha, and Partch, stock returns explain little variation in inflation. However, interest rates explain a substantial fraction of the variation in inflation, with inflation responding negatively to shocks in real interest rates.
3. Inflation explains little variation in real activity, which responds negatively to shocks in inflation for the postwar period.

The findings in this paper, unlike James, Koreisha, and Partch's, seem more compatible with Fama's explanation for the negative stock return–inflation relation, than with the explanations of Geske and Roll or Ram and Spencer. There is no causal linkage between stock returns and money supply growth and, hence, no causal relation between stock returns and inflation. One of the practical implications of these findings is that the negative correlation between stock returns and inflation observed for the postwar period may not be a reliable (that is, causal) relation for purposes of prediction.

[8] Based on a VAR analysis, Sims (1980b) found that money no longer has significant explanatory power for income once interest rates are included in the system.

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