Stock Returns, Real Activity, Inflation, and Money

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There is much evidence that common stock returns and inflation have been negatively related during the post-1953 period. Zvi Body, Jeffrey Jaffe and Gershon Mandelker, Charles Nelson, and my article with G. William Schwert document negative relations between stock returns and both the expected and unexpected components of inflation. These results are puzzling given the previously accepted wisdom that common stock, representing ownership of the income generated by real assets, should be a hedge against inflation.

This paper attempts to explain these anomalous stock return-inflation relations. The data are consistent with the hypothesis that the negative relations between stock returns and inflation are proxying for positive relations between stock returns and real variables which are more fundamental determinants of equity values. The negative stock return-inflation relations are induced by negative relations between inflation and real activity which in turn are explained by a combination of money demand theory and the quantity theory of money. As predicted by the proxy effect hypothesis, the more anomalous of the stock return-inflation relations disappear when both real variables and measures of expected and unexpected inflation are used to explain stock returns.

The first step in the development of this story is to document the negative relations between inflation and real activity. Controlling for the other arguments in the money demand function, especially the nominal money supply, a simple rational expectations version of the quantity theory of money predicts that higher anticipated growth rates of real activity are associated with lower current inflation rates. These predicted negative partial correlations between inflation and real activity are observed consistently in monthly, quarterly, and annual data for the post-1953 period. The negative simple correlation between inflation and real activity, the so-called phenomenon of stagflation, is then traced to the fact that the other important variable in the money demand model for inflation, the nominal quantity of money, does not vary sufficiently with real activity to offset the negative partial correlation between real activity and inflation.

The next step is to study the relations among the real variables presumed to be the fundamental determinants of stock returns. In the theory of finance, the quantity of investments available to firms with expected rates of return in excess of costs of capital is central in the determination of equity values. I study empirically a simple model of the capital expenditures process, similar in spirit to the "flexible accelerator" models summarized by Dale Jorgenson, in which increases in output raise average real rates of return on capital, which in turn induce increased capital expenditures. The tests substantiate that output leads the average real rate of return on capital and that both of these variables lead capital expenditures.

The last set of tests involve relating real common stock returns first to other real variables, then to inflation measures, and finally to combinations of real variables and inflation measures. Real common stock returns are positively related to real variables like capital expenditures, the real rate of return on capital, and output. More interesting, stock returns lead all of the real variables, which suggests that the market makes rational forecasts of the real sector. As in the earlier studies referenced above, stock returns also show strong negative simple corre-

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lations with measures of expected and unexpected inflation. However, in multiple regressions of stock returns on real variables and inflation measures, the most anomalous of the stock return-inflation relations, that between the *ex post* stock return and the *ex ante* expected inflation rate, always disappears. In the annual data, the unexpected component of inflation also has no marginal explanatory power.

In sum, the story proposed is a union of rational expectations models for the monetary and real sectors. The model of the monetary sector says that in setting prices for goods and services, markets for goods make rational assessments of the current nominal money supply and future real activity. The economics of the monetary sector—a combination of money demand theory with an observation on the properties of the money supply process—then implies that the relations between inflation and future rates of growth of real activity are negative. Within the real sector, much of the task of a rational stock market also involves forecasting the values of the real variables that determine equity prices. However, the economics of the real sector implies that the resulting relations between stock returns and anticipated growth rates of real activity are positive. The positive relations between stock returns and real activity that come out of the real sector combine with the negative relations between inflation and real activity that come out of the monetary sector to induce spurious negative relations between stock returns and inflation.

I. Expected and Unexpected Inflation

Two types of models for expected inflation are estimated and compared. One is based on decomposition of interest rates into expected inflation rates and expected real returns. Since the interest rates are observed at the beginning of the time intervals of interest, this approach estimates the *ex ante* expected inflation rates which eventually allow us to document the negative relations between *ex ante* expected stock returns and expected inflation rates. The second approach, based on money demand theory and the quantity theory of money, estimates conditional expected inflation rates as functions of money and real activity growth rates. Since measures of current money and current and future real activity growth rates are major explanatory variables, these conditional expected inflation rates are not *ex ante* measures. However, the money demand-quantity theory models of inflation provide the empirical economic story which explains why the *ex ante* expected inflation rates extracted from interest rates are also strongly related to current and future real activity.

A. *Interest Rates and Expected Inflation Rates*

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

$$(1) \qquad TB_{t-1} = ER_{t-1} + EI_{t-1}$$

or

$$(2) \qquad EI_{t-1} = -ER_{t-1} + TB_{t-1}$$

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

$$(3) \qquad I_t = -ER_{t-1} + TB_{t-1} + \eta_t$$

where η_t is unexpected inflation.

Given a model of bond market equilibrium that renders the expected real return ER_{t-1} observable and a bond market that makes rational assessments of expected inflation, (3) can be used to divide an *ex post* inflation rate into expected and unexpected components. My 1975 article hypothesizes a rational bond market in which the equilibrium expected real return is constant through time. I found that this hypothesis stands up well in data for one- to six-month inflation and interest rates for the 1953–71 period. However, Patrick Hess and James Bicksler, my 1976a article, Charles Nelson and G. William Schwert, and Kenneth Garbade and Paul Wachtel document a small amount of variation in expected real returns

TABLE 1—COMPARISONS OF MONEY DEMAND AND TREASURY BILL RATE MODELS OF INFLATION[a]

Model	Estimated Regression	R^2	$s(\eta)$	ρ_1	ρ_2	ρ_3	ρ_4	ρ_8	ρ_{12}
	Monthly Models								
(1)	$I_t = \underset{(5.78)}{.0016} + \underset{(12.77)}{.058}\,BG_t - \underset{(-6.37)}{.013}\,DPR_t$								
	$- \underset{(-10.41)}{.022}\,DPR_{t+12} + \eta_t$	.50	.0021	.05	.12	−.03	−.02	−.01	.12
(2)	$I_t = \alpha_{t-1} + TB_{t-1} + \eta_t$	.56	.0020	−.01	.07	−.07	−.11	−.05	.12
	Quarterly Models								
(3)	$I_t = \underset{(5.97)}{.0050} + \underset{(12.12)}{.173}\,BG_t - \underset{(-6.81)}{.042}\,DPR_t$								
	$- \underset{(-10.04)}{.067}\,DPR_{t+12} + \eta_t$	.74	.0038	.00	.07	−.07	.13	−.19	.01
(4)	$I_t = \alpha_{t-1} + TB_{t-1} + \eta_t$	.76	.0037	−.11	−.12	.03	.12	−.19	.05
	Annual Models								
(5)	$I_t = \underset{(6.00)}{.0255} + \underset{(3.68)}{.38}\,BG_t + \underset{(3.18)}{.33}\,BG_{t-1}$								
	$- \underset{(-9.02)}{.28}\,DPR_t - \underset{(-6.24)}{.21}\,DPR_{t+1}$								
	$- \underset{(-2.86)}{.10}\,DPR_{t-1} + \eta_t$	.91	.0083	.06	−.08	−.01			
(6)	$I_t = \underset{(-.40)}{-.0014} + \underset{(12.17)}{1.04}\,EITB_{t-1} + \eta_t$	.86	.0106	.10	−.54	−.30			
Summary Statistics for Inflation Rates									
	Monthly		.0030	.55	.57	.51	.50	.48	.46
	Quarterly		.0076	.74	.72	.69	.61	.32	.32
	Annual		.0282	.72	.41	.37			

[a] I_t is the inflation rate for month, quarter, or year t, and TB_{t-1} is the Treasury bill rate observed at the beginning of the month or quarter. BG_t and DPR_t are annual growth rates of the base and industrial production. $EITB_{t-1}$ in regression (6) is the annualized quarterly expected inflation rate from regression (4). R^2 is the coefficient of determination and $s(\eta)$ is the residual standard error, both adjusted for degrees of freedom. The numbers in parentheses below estimated regression coefficients are t-statistics. ρ_τ is the residual autocorrelation at lag τ. Under the hypothesis that the true autocorrelations are zero, the standard errors of the estimated autocorrelations are about .06 for the monthly residuals, about .10 for the quarterly residuals, and about .19 for the annual residuals. Regressions (2), (4), and (6) and the summary statistics for the inflation rates cover the 1953–77 period. Regressions (1), (3), and (5) cover the 1954–76 period.

on bills during the 1953–71 period. Their tests suggest an alternative model in which expected real returns behave like slow moving random walks.

Following up on this evidence, my paper with Michael Gibbons estimates inflation-interest rate regressions

$$I_t = \alpha_{t-1} + \beta TB_{t-1} + \eta_t \tag{4}$$

with a procedure, developed by Craig Ansley, which presumes that the regression intercept α_{t-1}—the negative of the expected real return ER_{t-1} in (3)—follows a random walk. Leaving detailed discussion of the approach to my paper with Gibbons, suffice it to say that this model succeeds in the sense that, consistent with the hypotheses implied by (3), it yields estimates of β that are close to 1.0 (indeed constraining β to equal 1.0 yields models with smaller residual standard errors than when the regressions are allowed to determine β), and it transforms the highly autocorrelated inflation rates into residuals (unexpected inflation rates) which are indistinguishable from white noise.

The "wandering intercept" regressions estimated from monthly and quarterly inflation and interest rates and with interest rate coefficients constrained to equal 1.0 are shown as models (2) and (4) in Table 1. The inflation rates are calculated from the U.S. Consumer Price Index. The interest rates, taken from the quote sheets of Salomon Brothers and described in more detail in my 1976b book, ch. 6, are those for one- and three-month Treasury bills observed at the end of the month or quarter preceding the inflation rates with which they are paired. Inflation and interest rates are continuously compounded, and the data are for successive nonoverlapping months or quarters. The fitted values from (2) and (4), i.e., $\alpha_{t-1}+TB_{t-1}$, are henceforth labeled $EITB_{t-1}$ and are my estimates of *ex ante* monthly and quarterly expected inflation rates. The regression residuals η_t are henceforth labeled $UITB_t$ to indicate that they are estimates of the unexpected components of monthly and quarterly inflation.[1]

Obtaining an annual expected inflation rate is less straightforward. One year Treasury bills were not issued regularly prior to 1964, and, in any case, the wandering intercept regression approach is of dubious value with the restricted sample sizes available from post-1953 annual data. My paper with Gibbons argues, however, that shorter period expected inflation rates are close to random walks so that annual expected inflation rates can be obtained by annualizing the beginning of year monthly or quarterly expected inflation rates. An example of this approach is model (6) in Table 1 which shows the regression of the *ex post* annual inflation rate for year t on $EITB_{t-1}$, the annualized, quarterly expected inflation rate. This annual $EITB_{t-1}$ is just four times the quarterly expected inflation rate $EITB_{t-1}=\alpha_{t-1}+TB_{t-1}$ for the first quarter of the year obtained from model (4) of Table 1. Regression (6) indicates that this annualized $EITB_{t-1}$ has good properties as an estimate of the annual *ex ante* expected rate, and we henceforth use it as such. Its estimated regression coefficient is close to 1.0, and it absorbs about 86 percent of the sample variance of the annual inflation rate. The only shortcoming of the regression is a substantial negative second order residual autocorrelation.

B. *Real Activity and Inflation*

I next document the relations between inflation and the measures of current and future real activity which my model presumes are important in the determination of stock market returns. The theoretical basis for the study of inflation-real activity relations is a "rational expectations" combination of money demand theory and a simple version of the quantity theory of money of Fisher (1911). The theory and empirical results are abstracted from my 1980 paper. I present just enough of the theory and evidence to document the inflation-real activity relations of interest.

In brief, for empirical purposes the demand for money function is represented, in differenced form, as

$$(5)\quad \Delta\, ln\, m_t=\Delta\, ln\, M_t-\Delta\, ln\, P_t$$
$$=b_0+b_1\Delta\, ln\, A_t+b_2\Delta\, ln\, R_t+\varepsilon_t$$

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

The theory postulates that $b_2<0.0$, that is, the demand for money at time t is negatively related to the rate of interest set at t since the

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

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

To specify the endogenous and exogenous variables in (5), I adopt a simple rational expectations version of the Fisherian quantity theory of money. Thus, real activity is assumed to be determined outside of the monetary sector. Within the monetary sector, the price level is the major endogenous variable while money is exogenous or causal with respect to prices. Finally, without going into the details, which in any case turn out to be empirically irrelevant, my 1980 paper argues that, in a fully rational bond market, the interest rate set at time t is "largely" exogenous with respect to the price level set at t. With real activity, money and the interest rate exogenous, the money demand equation becomes a model for inflation. From (5) we obtain

$$(6)\quad \Delta \ln P_t = -b_0 - b_1 \Delta \ln A_t - b_2 \Delta \ln R_t + b_3 \Delta \ln M_t + \eta_t$$

where $\eta_t = -\varepsilon_t$, $b_3 = 1.0$, and the other parameters are as in (5).

Money demand theory, interpreted from the viewpoint of the quantity theory of money described above, says that, for given values of the interest rate and anticipated real activity, the demand for real money is unaffected by changes in nominal money so the latter must be accommodated by proportionate changes in the price level; that is, b_3 in (6) is equal to 1.0. Likewise, controlling for variation in nominal money and anticipated real activity, a negative relation between real money demanded and the interest rate ($b_2 < 0.0$ in (5)) implies a positive relation in (6) between the inflation rate and the change in the interest rate. Finally, and most interesting for our purposes, money demand theory says that a fall in anticipated real activity lowers the demand for real money, which, given nominal money and the rate of interest, is accommodated by a rise in the price level. In other words, controlling for variation in other variables, a positive relation between money and anticipated real activity in the money demand equation ($b_1 > 0$ in (5)) implies a negative relation between the inflation rate and the anticipated growth rate of real activity in (6). The major hypothesis of this paper is that this negative relation between inflation and real activity, with real activity assumed to cause inflation, is the key to the spurious negative relations between stock returns and inflation observed during the post-1953 period.

Estimates of (6) for monthly, quarterly, and annual inflation rates are shown as regressions (1), (3) and (5) in Table 1. In the annual regression (5), the real activity measures are current, future, and past annual growth rates of industrial production, DPR_t, DPR_{t+1}, and DPR_{t-1}. Money growth is measured by base (currency plus reserves held against deposits) growth rates BG_t, since these always have more power in explaining inflation than other monetary measures like demand deposit growth rates or $M1$ (currency plus demand deposits) growth rates—a finding discussed and interpreted at length in my 1980 paper, where the data are also discussed in detail. In the annual regression (5), both the current base growth rate BG_t and the lagged growth rate BG_{t-1} are included as explanatory variables. None of the inflation regressions, (1), (3), and (5) of Table 1 contain the change in the interest rate as an explanatory variable, reflecting the finding in my 1980 paper that interest changes never have reliable marginal explanatory power. This corresponds, of course, to the general finding in the money demand literature that the interest rate is the weakest variable in empirical money demand equations.

The explanatory variables in the monthly and quarterly regressions (1) and (3) are annual growth rates of the base and industrial production. BG_t and DPR_t are the annual growth rates of the base and industrial production for the year ending with month or quarter t, and DPR_{t+12} is the growth rate of industrial production for the year following month or quarter t. Without going into the details of the discussion provided in my 1980 paper, the choice of annual growth rates as explanatory variables is a response to problems that arise from the fact that short-term real activity and money growth rates are highly seasonal whereas inflation rates are not. Annual growth rates of the base and industrial production are, in effect, deseasonalized variables that seem to produce good descriptions of short-term inflation.

The inflation regressions (1), (3), and (5) are statistically well specified in the sense that they absorb substantial fractions of the variation in monthly, quarterly, and annual inflation rates, and they transform the highly autocorrelated inflation rates into well-behaved residuals. As predicted by money demand theory, all estimated coefficients of real activity growth rates are reliably negative, while the estimated coefficients of base growth rates are reliably positive. The coefficients in the monthly and quarterly regressions (1) and (3) are much smaller than those in the annual regression (5). This is due to the fact that the monthly and quarterly inflation rates are explained in terms of annual growth rates of the base and industrial production. In the monthly and quarterly regressions, the estimated regression coefficients must be multiplied by twelve and four to estimate the elasticities of the monthly and quarterly inflation rates with respect to the average monthly and quarterly growth rates of money and real activity. When this is done, the elasticities from the monthly, quarterly, and annual regressions are quite similar.

There are several respects in which the results from the estimated money demand inflation regressions are countertheoretical. My 1980 paper explains that, in a fully rational market for goods, only the contemporaneous money growth rate should appear in the inflation regression, and its coefficient should be 1.0. The estimated annual regression (5), for example, also contains a lagged base growth rate, and the estimated combined elasticity of inflation, I_t, with respect to BG_t and BG_{t-1} is only .71. My 1980 paper explains these countertheoretical results in part in terms of the effects of errors in the measured values of the base growth rates.

Another important shortcoming of the estimated money demand inflation regression is the use of actual growth rates of real activity as explanatory variables instead of the anticipated growth rates called for by a forward-looking rational expectations version of the money demand model. My 1980 paper argues that it is best to regard the past and future growth rates of output that appear as explanatory variables in the inflation regressions as together proxying for the relations between inflation and anticipations of real activity. The implied measurement error problems prevent us from putting much emphasis on the specific estimated values of the real activity coefficients. However, for our purposes, the important result is the uniform evidence that the inflation-real activity relations have the negative sign which is the key to the story I later propose for the negative relations between stock returns and inflation.

C. *Stagflation*

The negative relations between inflation and real activity predicted by the money demand-quantity theory model and observed consistently in the regressions are negative partial correlations. However, the cross correlations in Table 2 show that measures of current and future real activity have negative simple correlations both with the annual inflation rate I_t observed for year t and with the estimated *ex ante* annual expected inflation rate $EITB_{t-1}$ extracted from the interest rate observed at the beginning of the year.

Table 2 also provides evidence on why the negative partial correlations between inflation and real activity predicted by the money demand model turn into the post-1953 phenomenon of stagflation, that is, negative simple correlations between inflation and real activity. In the money demand inflation regressions (1), (3), and (5) of Table 1, the important explanatory variable, in addition to real activity growth rates, is the growth rate of the monetary base which always shows strong positive relations with inflation. In

TABLE 2—CROSS CORRELATIONS: 1953–77[a]

X_t	$Y_{t+\tau}$	τ −1	0	+1
I_t	$DRGNP_{t+\tau}$	.14	−.26	−.45
	$DPR_{t+\tau}$	.09	−.38	−.33
	$DCX/NS_{t+\tau}$	−.13	−.34	−.36
	$DROC_{t+\tau}$	−.05	−.40	−.48
$EITB_{t-1}$	$DRGNP_{t+\tau}$	−.04	−.38	−.26
	$DPR_{t+\tau}$	−.09	−.40	−.14
	$DCX/NS_{t+\tau}$	−.13	−.34	−.36
	$DROC_{t+\tau}$	−.22	−.51	−.34
BG_t	$DRGNP_{t+\tau}$	.03	.05	.17
	$DPR_{t+\tau}$	−.04	.20	−.03
	$DCX/NS_{t+\tau}$	−.06	−.14	.11
	$DROC_{t+\tau}$	−.10	−.07	.01

[a]The table shows cross correlations between the value of the variable X for year t and the value of the variable Y for year $t+\tau$. I_t is the inflation rate for year t, BG_t is the base growth rate, and $EITB_{t-1}$ is the expected inflation rate for year t from the Treasury bill rate model (6) of Table 1. DPR_t is the rate of growth of industrial production for year t, and $DRGNP_t$ is the rate of growth of real GNP. The variable DCX/NS_t is the change in the rate of capital expenditures of nonfinancial corporations for year t, and $DROC_t$ is the change in the after tax average real rate of return on their capital stock. See fn. 2 for more precise definitions of DCX/NS_t and $DROC_t$.

terms of these regressions, transforming the observed negative partial correlations between inflation and real activity into positive simple correlations would require strong positive correlations between the base and real activity growth rates. Table 2 indicates, however, that the actual correlations are small and not even systematically positive.

Explanation of the absence of positive simple relations between money supply and real activity growth rates during the post-1953 period is an interesting topic for future research. This is especially so since the monetary measure used, the growth rate of the base, is the one most under the control of the monetary authorities.

II. The Primrose Path

At this point it is well to outline where we have been and where we must go to complete the story. The results above establish that inflation for month, quarter, or year t is related to the growth rate of real activity for the following year. Taking the simple quantity theory viewpoint that real activity is exogenous with respect to inflation, these results imply that markets for goods make forecasts of real activity which are used in setting current prices of goods. The hypothesis studied next is that forecasts of real activity are also the important determinants of common stock returns. The final step is then to test the key hypothesis that the negative stock return-inflation relations of the post-1953 period are induced by the combination of positive stock return-real activity relations and negative real activity-inflation relations.

III. The Capital Expenditures Process and Common Stock Returns

In the theory of finance, the process generating capital investments with expected rates of return in excess of costs of capital, equivalently, investment projects whose market values exceed costs of acquisition, is central in the determination of stock returns. Estimation of a full-blown investment model would be a formidable project. The more limited goal here is to study the relations proposed by a bare-bones model of investments in order to identify real variables which are potentially important in the determination of stock returns. These real variables can then be put against measures of expected and unexpected inflation in stock return regressions.

A. *Capital Expenditures and Inflation*

The simple model proposed for the capital expenditures process captures the spirit of the "flexible accelerator" models summarized by Jorgenson. In brief, an increase in the general level of real activity puts pressure on the existing capital stock, raising the average return on the existing stock and thus inducing increased capital expenditures.

Estimates of this proposed chain of relations on annual data are shown in Table 3. The measure of general real activity used is the rate of change of industrial production, DPR_t. The rate of change of real GNP yields similar results. The dependent variables in the regressions are the change in the rate of capital expenditures of nonfinancial corporations, DCX/NS_t, and the change in the after tax average real rate of return on their capital stock, $DROC_t$.[2] I work with the differences of the variables because of evidence from preliminary regressions that the high autocorrelations of the levels (Table 4) generally show up in regression residuals. The differences of the variables are less autocorrelated and residual autocorrelation does not seem to be a problem in regressions based on the differences. Moreover, in a rational expectations world, one would presume (and preliminary tests confirmed) that stock market returns respond to new information from the investment process. The less autocorrelated differences DCX/NS_t and $DROC_t$, along with DPR_t, come closer to representing new information about the variables in the capital expenditures process than the highly autocorrelated levels CX/NS_t and ROC_t.

The results in Table 3 are consistent with the simple description of the investment process proposed above. Regressions (1) to (3) show that capital expenditures are led by both the average real rate of return on capital and industrial production, while the average real rate of return on capital is led by industrial production. Other preliminary tests always yielded a pattern of relations similar to that observed in regressions (1) to (5). Industrial production is always the leading variable in the investment process, and capital investment is the lagging variable.

In a world of rational expectations, desired capital expenditures adjust to anticipated changes in future real activity and the average real rate of return on capital. As a consequence, DCX/NS_t could lead DPR_t and $DROC_t$. The fact that DCX/NS_t is a lagging variable suggests one of the common models in which there are costs in adjusting the capital stock rapidly to new equilibrium levels. See, for example, the summary of these models given by Jorgenson.

Regressions (6) and (7) in Table 3 describe DCX/NS_t and $DROC_t$ in terms of measures of expected and unexpected inflation as well as the real variables that appear in regressions (3) and (5). The measure of the annual *ex ante* expected inflation rate is $EITB_{t-1}$ from the annual inflation-interest rate regression (6) of Table 1 and the unexpected inflation rate $UITB_t$ is just the difference between the *ex post* inflation rate for year t and $EITB_{t-1}$. Table 2 shows that there are negative simple correlations between DCX/NS_t or $DROC_t$ and current and past inflation and expected inflation rates. However, regressions (6) and (7) of Table 3 show that although the intercorrelation of the inflation measures and the real variables leads to some attenuation of t-statistics, the real variables nevertheless dominate the inflation measures, and the latter have no marginal power in the description of DCX/NS_t and $DROC_t$. Thus, measures of expected and unexpected

[2] CX/NS_t is the ratio of capital expenditures (equipment, structures, and residential capital, although the latter is always a small fraction of the total) by nonfinancial corporations during year t to a current cost measure of their net capital stock at the end of the year. The latter is net of straight-line depreciation at assumed asset lives which are 85 percent of those used in the guidelines provided by the U.S. Treasury Internal Revenue Service Bulletin F. The data are updated and revised versions of those in *Fixed Nonresidential Business and Residential Capital in the United States, 1925-75*, provided by John C. Musgrave of the BEA.

ROC_t is an estimate of the average real rate of return on capital for the nonfinancial corporate sector during year t. The denominator is the end of year net capital stock in the denominator of CX/NS_t, plus the BEA's estimate of the current value of end of year inventories. The numerator is the before-tax cash flow to nonfinancial corporations (the sum of (1) profits before taxes, (2) depreciation taken for tax purposes, and (3) monetary net interest paid), less the BEA's estimate of replacement cost depreciation (called "capital consumption allowances with capital consumption adjustments" in the National Income and Product Accounts), and less federal, state, and local corporate profits tax liabilities. Since the items in the denominator of ROC_t are estimated in terms of prices for the same year as those in the numerator, the resulting ratio is an average real rate of return on capital after taxes and after an estimate of the current service value of the capital stock, that is, net of a replacement cost measure of depreciation. It is, however, an income or accounting rate of return in that real capital gains or losses on the capital stock are not included. The data for the numerator of ROC_t are from *The National Income and Products Accounts of the United States, 1929-74; Statistical Tables*, as updated in the July 1977 and July 1978 issues of the *Survey of Current Business*. Monetary interest figures are from Table 8.2 of these publications. Profits before taxes, profits tax liability, and capital consumption allowances are those for all corporations in Tables 8.5 and 8.7, less the corresponding numbers for the finance, insurance, and real estate sector in Tables 6.19, 6.20, and 6.24.

Finally, DCX/NS_t and $DROC_t$ are the first differences of CX/NS_t and ROC_t.

TABLE 3—CAPITAL EXPENDITURES AND REAL RATE OF RETURN ON CAPITAL REGRESSIONS: 1954–77[a]

Model	Estimated Regression	R^2	$s(\varepsilon)$	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5
(1)	$DCX/NS_t = \underset{(-.86)}{-.0011} + \underset{(3.62)}{.56}\ DROC_t$							
	$+ \underset{(2.55)}{.39}\ DROC_{t-1} + \varepsilon_t$	.47	.00648	−.05	−.48	.04	.19	−.00
(2)	$DCX/NS_t = \underset{(-4.04)}{-.0066} + \underset{(2.33)}{.048}\ DPR_t$							
	$+ \underset{(5.67)}{.112}\ DPR_{t-1} + \varepsilon_t$	.59	.00569	−.02	−.29	.09	.03	−.00
(3)	$DROC_t = \underset{(-2.73)}{-.0053} + \underset{(3.94)}{.096}\ DPR_t$							
	$+ \underset{(2.30)}{.053}\ DPR_{t-1} + \varepsilon_t$	.43	.00671	.00	.16	−.01	−.29	−.08
(4)	$DCX/NS_t = \underset{(-2.35)}{-.0043} + \underset{(2.17)}{.38}\ DROC_t$							
	$+ \underset{(.66)}{.10}\ DROC_{t-1} + \underset{(.43)}{.011}\ DPR_t$							
	$+ \underset{(3.37)}{.083}\ DPR_{t-1} + \varepsilon_t$	.64	.00533	−.07	−.53	−.01	.27	.03
(5)	$DCX/NS_t = \underset{(-3.25)}{-.0040} + \underset{(3.33)}{.42}\ DROC_t$							
	$+ \underset{(4.72)}{.088}\ DPR_{t-1} + \varepsilon_t$	.66	.00516	−.06	−.53	−.01	.31	.04
(6)	$DCX/NS_t = \underset{(-1.76)}{-.0042} + \underset{(1.37)}{.26}\ DROC_t$							
	$+ \underset{(3.52)}{.127}\ DPR_{t-1} - \underset{(-1.08)}{.25}\ EITB_{t-1}$							
	$+ \underset{(.08)}{.01}\ UITB_t + \underset{(1.08)}{.23}\ EITB_{t-2}$							
	$+ \underset{(.40)}{.09}\ UITB_{t-1} + \varepsilon_t$	.64	.00536	−.10	−.61	.01	.37	.11
(7)	$DROC_t = \underset{(.07)}{.0003} + \underset{(1.04)}{.040}\ DPR_t$							
	$+ \underset{(2.07)}{.084}\ DPR_{t-1} - \underset{(-1.67)}{.49}\ EITB_{t-1}$							
	$+ \underset{(1.14)}{.21}\ UITB_t + \underset{(1.43)}{.39}\ EITB_{t-2}$							
	$+ \underset{(.76)}{.21}\ UITB_{t-1} + \varepsilon_t$	.43	.00671	.04	.05	−.22	−.22	−.07

[a] DCX/NS_t is the change in the rate of capital expenditures of nonfinancial corporations from year $t-1$ to year t, and $DROC_t$ is the change in the average real rate of return on their capital stock. DPR_t is the rate of change of industrial production. $EITB_{t-1}$ and $UITB_t$ are expected and unexpected inflation rates for year t from the annual Treasury bill rate model. R^2 is the coefficient of determination and $s(\varepsilon)$ is the residual standard error, both adjusted for degrees of freedom. The numbers in parentheses below estimated regression coefficients are t-statistics. ρ_τ is the residual autocorrelation at lag τ. Under the hypothesis that the true autocorrelations are zero, the standard errors of the residual autocorrelations are approximately .19.

inflation do not seem to be direct determinants of either capital expenditures or the average real rate of return on capital.

It is appropriate to recall, however, that the money demand models of inflation in Table 1 document strong relations between inflation and industrial production, and the latter is the leading variable in the capital expenditures process. Moreover, there are many papers in the macroeconomic literature, for example, those by Robert Mundell, James Tobin, Milton Friedman (1977), Robert Lucas, and Robert Barro, which propose lines of causation from inflation (and money) to real activity. However, all the popular stories are variants of the "Phillips curve" in which the proposed inflation-output relations are positive. The negative

TABLE 4—SUMMARY STATISTICS FOR ANNUAL VARIABLES: 1953–77[a]

Variable (x)	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	$\bar{x}$	$s(x)$
I_t	.72	.41	.37	.36	.28	.03377	.02823
BG_t	.73	.67	.59	.46	.33	.04598	.03055
CX/NS_t	.71	.36	.22	.07	−.14	.12720	.01177
ROC_t	.75	.44	.26	.09	−.09	.07035	.01323
DCX/NS_t	.03	−.36	.09	.16	−.13	−.00033	.00883
$DROC_t$	.14	−.11	−.12	−.03	−.25	.00059	.00870
$DRGNP_t$	−.03	−.24	−.07	.26	−.06	.03201	.02512
DPR_t	−.09	−.42	.13	.20	−.15	.03692	.05933
RS_t	−.04	−.35	.10	.34	.06	.05562	.19791

[a] I_t is the inflation rate for year t; $DRGNP_t$ and DPR_t are the rates of growth of industrial production and real GNP for year t; BG_t is the rate of growth of the monetary base; RS_t is the real rate of return on common stocks; ROC_t is the after-tax average real rate of return on the capital stock of nonfinancial corporations for year t and CX/NS_t is the ratio of their capital expenditures to their net capital stock; $DROC_t$ and DCX/NS_t are the differences of ROC_t and CX/NS_t; $\bar{x}$ and $s(\bar{x})$ are the mean and standard deviation of the variable and ρ_τ is its autocorrelation at lag τ. Under the hypothesis that the true autocorrelations are equal to zero, the standard errors of the estimated autocorrelations are about .19.

relations between inflation and real activity documented in Tables 1 and 2 seem more consistent with a simple money demand-quantity theory world in which anticipated increases in real activity cause increases in real money demanded which, empirically, are not satisfied by nominal money growth and so must be accommodated by opposite movements in inflation.

Finally, since ROC_t is a measure of the after-tax average real rate of return on the capital stock of nonfinancial corporations, the absence of any marginal effect of expected or unexpected inflation in the $DROC_t$ regression (7) is evidence against the popular hypothesis that negative stock return-inflation relations are the consequence of overtaxation of corporate profits during inflation. (See, for example, the paper by John Lintner.) To check that the regressions are not masking tax effects that might occur during the last few high inflation years, the residuals from regression (3) of $DROC_t$ on DPR_t and DPR_{t-1} were examined. The tax effects hypothesis would predict negative residuals during the high inflation years 1971–74, but the residuals are in fact positive.[3]

B. *Stock Returns and the Real Variables*

Table 5 documents strong positive relations between a measure of annual real common stock returns, RS_t, and the real variables from the capital investment process.[4] For example, next year's change in the capital expenditures ratio, DCX/NS_{t+1}, alone explains 54 percent of the sample variance of the current real stock market return, and next year's change in the real rate of return on capital, $DROC_{t+1}$, explains 40 percent of the sample variance of RS_t. Preliminary tests showed that the stock return is never led by any of the real variables, and as indicated by

[3]An earlier version of this paper, which included an explicit analysis of income taxes paid by nonfinancial corporations, concluded that the average rate of taxation of pretax cash flows declined during most of the post-1953 period and showed no tendency to increase during the later high inflation years. The offsets to the higher taxation of corporate profits during inflation that follow from historical cost expensing of depreciation and inventories seemed to come from (i) interest deductions that vary directly with inflation when interest rates reflect assessments of expected inflation, (ii) liberalized tax rules with respect to asset lives and accelerated depreciation, and (iii) investment tax credits and other tax rules with respect to additional first-year depreciation of assets. I intend to present an expanded version of these results in a separate paper. See also the paper by Nicholas Gonedes.

[4]The real stock return RS_t is the annual continuously compounded nominal return on a value weighted portfolio of all New York Stock Exchange common stocks less the annual continuously compounded inflation rate calculated from the U.S. Consumer Price Index. The nominal stock return is from the Center for Research in Security Prices of the University of Chicago. The monthly and quarterly versions of RS_t used in later sections are defined similarly.

TABLE 5—REGRESSIONS OF ANNUAL REAL STOCK RETURNS ON CURRENT AND FUTURE MEASURES OF REAL ACTIVITY: 1954–76[a]

Model	Estimated Regression	R^2	$s(\varepsilon)$	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5
(1)	$RS_t = \underset{(2.42)}{.070} + \underset{(5.14)}{16.94}\, DCX/NS_{t+1} + \varepsilon_t$	.54	.138	.11	−.07	.13	.06	−.19
(2)	$RS_t = \underset{(1.77)}{.058} + \underset{(3.94)}{14.56}\, DROC_{t+1} + \varepsilon_t$	.40	.157	.27	−.10	−.05	.08	−.22
(3)	$RS_t = \underset{(-2.12)}{-.088} + \underset{(4.44)}{2.22}\, DPR_t + \underset{(3.19)}{1.59}\, DPR_{t+1} + \varepsilon_t$	.54	.138	.14	.28	.06	−.01	−.02
(4)	$RS_t = \underset{(-4.10)}{-.169} + \underset{(6.96)}{6.97}\, DRGNP_{t+1} + \varepsilon_t$	.68	.114	.41	.23	.09	.16	−.07
(5)	$RS_t = \underset{(-1.99)}{-.110} + \underset{(3.58)}{5.26}\, DRGNP_{t+1} + \underset{(1.55)}{6.18}\, DCX/NS_{t+1} + \varepsilon_t$	.70	.111	.46	.36	.13	−.01	−.26

[a] RS_t is the real stock return for year t; DCX/NS_t is the change in the rate of capital expenditures of nonfinancial corporations from year $t-1$ to year t, and $DROC_t$ is the change in the average real rate of return on their capital stock; DPR_t and $DRGNP_t$ are the rates of change of industrial production and real GNP; R^2 is the coefficient of determination and $s(\varepsilon)$ is the residual standard error, both adjusted for degrees of freedom. The numbers in parentheses below estimated regression coefficients are t-statistics. ρ_τ is the residual autocorrelation at lag τ. Under the hypothesis that the true autocorrelations are zero, the standard errors of the estimated autocorrelations are about .19.

the choice of explanatory variables in regressions (1) to (4), the growth rate of industrial production is the only real variable that shows a strong contemporaneous relation with the stock return. Since DPR_t is also the overall leading variable in the capital expenditures process, the evidence in Table 5 suggests a "rational expectations" or "efficient markets" view in which the stock market is concerned with the capital investment process and uses the earliest information from the process to forecast its evolution.

Regression (4) indicates that next year's rate of change in real GNP, $DRGNP_{t+1}$, explains slightly more of the variation of the current stock return than the future change in the capital expenditures ratio DCX/NS_{t+1}, and this impression is reinforced in regression (5). However, the attenuation of regression coefficients and t-statistics observed in regression (5) when compared to regressions (1) and (4) suggests that $DRGNP_{t+1}$ and DCX/NS_{t+1} contain similar information about the real stock market return. Additional tests indicated that DCX/NS_{t+1} is the only real variable with even a bit of marginal explanatory power in annual stock return regressions that also include $DRGNP_{t+1}$ as an explanatory variable.

The fact that $DRGNP_{t+1}$ captures most of the information in the other real variables is fortuitous since it allows a simplified strategy for presentation of the tests that follow in which we try to explain monthly, quarterly, and annual real stock returns in terms of real activity, money growth, and measures of expected and unexpected inflation. The real variables used are current and future rates of change of output (industrial production and real GNP). This choice is dictated by data availability for the monthly and quarterly tests. A wider range of real variables, for example, capital expenditures and the real rate of return on capital, were tried in preliminary annual tests with results similar to those shown below in which rates of change of real GNP are used to summarize annual real activity.

Finally, a shortcoming of the real stock return regressions, both those in Table 5 and those presented below, is the use of actual growth rates of future real activity instead of anticipated growth rates. Under the presumption that the anticipations of future real activity on which the current stock return is based are fully rational, what we would like are the conditional expected values of future real activity measures from the "true" structural model of the business cycle. This "holy grail" of macroeconomics is more than a bit beyond the scope of this paper. Moreover, given the evidence in Table 4 that the annual growth rates of the various measures of real activity are close to white noise, time-series models for the expected future growth rates are not viable alternatives.

Since the point has been raised by many readers, it is also well to note that if we had a candidate structural model for the real sector, we could test the proposition of this section that the current real stock return is caused by anticipations of future real activity while future real activity is not caused by the current stock return—in short, that real activity is exogenous with respect to the stock return. We could also test the proposition of the money demand-quantity theory model that real activity is exogenous with respect to inflation. In the framework suggested by Christopher Sims and John Geweke, the implication of the exogeneity proposition is that expected future rates of change of real activity are a function only of current and past values of real variables which are not caused by either stock returns or inflation. Thus, when rates of change of future real activity are regressed on current and past values of these exogenous real variables and on current and past inflation rates or stock returns, the latter should have no marginal explanatory power.

Unfortunately, the model is likely to flunk these exogeneity tests when in fact it is true and when markets are characterized by rational expectations. Since we are not likely to find the exact form of the true structural model or all of the exogenous variables which are relevant in explaining the growth rates of real activity, current and past inflation rates or stock returns set by rational markets are likely to have marginal explanatory power in the Sims-Geweke tests; that is, the tests are likely to lead to the false conclusion that future real activity is caused by past inflation rates and stock returns.

IV. Stock Returns, Real Activity, and Expected and Unexpected Inflation

The results presented above establish the two major separate pieces of our story. Measures of inflation and expected inflation are strongly related to future real activity (Tables 1 and 2), and real stock returns are also strongly related to future real activity (Table 5). It is time to deliver the punchline, that is, to test whether the stock return-inflation relations observed during the post-1953 period proxy for more fundamental relations between stock returns and real activity.

The tests—three sets of similar regressions on monthly, quarterly and annual stock returns—are in Table 6. The first model in each section is the estimated regression of the real stock return (monthly, quarterly, or annual) on the expected and unexpected inflation rates, $EITB_{t-1}$ and $UITB_t$, from the Treasury bill rate models of inflation (regressions (2), (4) and (6) of Table 1). The second regression in each section is the regression of the real stock return on the conditional expected and unexpected inflation rates, $EIMD_t$ and $UIMD_t$, from the money demand inflation models. $EIMD_t$ is the fitted value from

TABLE 6—MONTHLY, QUARTERLY AND ANNUAL REAL STOCK RETURN REGRESSIONS: 1954–76[a]

Model	Estimated Regression	R^2	$s(\varepsilon)$	ρ_1	ρ_2	ρ_3	ρ_4	ρ_8	ρ_{12}
($M1$)	$RS_t = \underset{(4.70)}{.018} - \underset{(-4.16)}{4.58}\, EITB_{t-1} - \underset{(-2.93)}{3.53}\, UITB_t + \varepsilon_t$	.084	.0392	.04	−.03	.02	.09	−.03	.08
($M2$)	$RS_t = \underset{(5.00)}{.020} - \underset{(-4.52)}{5.03}\, EIMD_t - \underset{(-2.80)}{3.15}\, UIMD_t + \varepsilon_t$	.087	.0391	.04	−.04	.02	.09	−.03	.08
($M3$)	$RS_t = \underset{(1.20)}{.006} - \underset{(-.51)}{.018}\, DPR_t + \underset{(5.30)}{.20}\, DPR_{t+12} - \underset{(-2.18)}{.18}\, BG_t - \underset{(-2.87)}{3.15}\, UIMD_t + \varepsilon_t$	.131	.0382	−.02	−.09	−.03	.05	−.04	.10

Model	Estimated Regression	R^2	$s(\varepsilon)$	ρ_1	ρ_2	ρ_3	ρ_4	ρ_8	ρ_{12}
($M4$)	$RS_t = \underset{(.64)}{.004} + \underset{(3.61)}{.23} DPR_{t+12} - \underset{(-1.49)}{.27} BG_t + \underset{(.51)}{1.45} EIMD_t - \underset{(-2.87)}{3.15} UIMD_t + \varepsilon_t$	.131	.0382	−.02	−.09	−.03	.05	−.04	.10
($M5$)	$RS_t = \underset{(1.13)}{.006} + \underset{(3.80)}{.19} DPR_{t+12} - \underset{(-1.17)}{.18} BG_t - \underset{(-.11)}{.24} EITB_{t-1} - \underset{(-2.75)}{3.24} UITB_t + \varepsilon_t$	.128	.0383	−.02	−.10	−.03	.05	−.04	.10
($M6$)	$RS_t = \underset{(1.05)}{.005} + \underset{(3.79)}{.16} DPR_{t+12} - \underset{(-1.95)}{2.38} EITB_{t-1} - \underset{(-2.71)}{3.20} UITB_t + \varepsilon_t$	.127	.0383	−.01	−.09	−.02	.05	−.03	.10
($M7$)	$RS_t = \underset{(1.19)}{.006} + \underset{(5.32)}{.20} DPR_{t+12} - \underset{(-2.27)}{.19} BG_t - \underset{(-2.76)}{3.25} UITB_t + \varepsilon_t$	.131	.0382	−.02	−.10	−.03	.05	−.04	.10
($Q1$)	$RS_t = \underset{(3.80)}{.050} - \underset{(-3.26)}{4.08} EITB_{t-1} - \underset{(-3.94)}{8.90} UITB_t + \varepsilon_t$	.220	.0761	−.02	−.13	−.08	−.03	−.11	.10
($Q2$)	$RS_t = \underset{(4.37)}{.058} - \underset{(-3.95)}{4.97} EIMD_t - \underset{(-2.86)}{6.16} UIMD_t + \varepsilon_t$	.193	.0774	.02	−.14	−.03	.02	−.09	.11
($Q3$)	$RS_t = \underset{(.58)}{.009} - \underset{(-.14)}{.02} DPR_t + \underset{(5.40)}{.66} DPR_{t+12} - \underset{(-1.67)}{.45} BG_t - \underset{(-3.08)}{6.16} UIMD_t + \varepsilon_t$	.306	.0718	−.09	−.19	−.04	.07	−.05	.08
($Q4$)	$RS_t = \underset{(.41)}{.007} + \underset{(3.57)}{.69} DPR_{t+12} - \underset{(-.98)}{.51} BG_t + \underset{(.14)}{.38} EIMD_t - \underset{(-3.08)}{6.16} UIMD_t + \varepsilon_t$	.306	.0718	−.09	−.19	−.04	.07	−.05	.08
($Q5$)	$RS_t = \underset{(.79)}{.013} + \underset{(3.60)}{.56} DPR_{t+12} - \underset{(-.82)}{.37} BG_t - \underset{(-.22)}{.50} EITB_{t-1} - \underset{(-3.28)}{7.13} UITB_t + \varepsilon_t$	.315	.0713	−.11	−.22	−.11	−.00	−.06	.12
($Q6$)	$RS_t = \underset{(.71)}{.012} + \underset{(3.70)}{.50} DPR_{t+12} - \underset{(-1.51)}{1.97} EITB_{t-1} - \underset{(-3.34)}{7.23} UITB_t + \varepsilon_t$	.317	.0712	−.10	−.20	−.08	.02	−.06	.12

(Continued)

TABLE 6—*Continued*

Model	Estimated Regression	R^2	$s(\varepsilon)$	ρ_1	ρ_2	ρ_3	ρ_4	ρ_8	ρ_{12}
($Q7$)	$RS_t = \underset{(.77)}{.012} + \underset{(4.84)}{.58}\, DPR_{t+12} - \underset{(-1.71)}{.45}\, BG_t - \underset{(-3.29)}{7.10}\, UITB_t + \varepsilon_t$	.322	.0709	−.11	−.22	−.11	−.01	−.06	.12
($A1$)	$RS_t = \underset{(3.72)}{.183} - \underset{(-3.16)}{3.65}\, EITB_{t-1} - \underset{(-4.01)}{11.25}\, UITB_t + \varepsilon_t$	.54	.138	−.22	−.03	.03	.11		
($A2$)	$RS_t = \underset{(4.41)}{.233} - \underset{(-4.03)}{4.98}\, EIMD_t - \underset{(-.66)}{3.03}\, UIMD_t + \varepsilon_t$	.40	.157	−.10	−.16	.05	.19		
($A3$)	$RS_t = \underset{(-1.55)}{-.088} - \underset{(-.37)}{.32}\, DRGNP_t + \underset{(7.70)}{7.35}\, DRGNP_{t+1} - \underset{(-2.41)}{1.84}\, BG_t + \underset{(.80)}{2.53}\, UIMD_t + \varepsilon_t$	.73	.105	.06	.05	−.07	.13		
($A4$)	$RS_t = \underset{(-1.29)}{-.097} + \underset{(4.24)}{7.35}\, DRGNP_{t+1} - \underset{(-1.24)}{1.83}\, BG_t - \underset{(-.01)}{.02}\, EIMD_t + \underset{(.76)}{2.57}\, UIMD_t + \varepsilon_t$	.73	.106	.10	.10	−.06	.09		
($A5$)	$RS_t = \underset{(-1.25)}{-.109} + \underset{(3.25)}{7.67}\, DRGNP_{t+1} - \underset{(-1.32)}{2.18}\, BG_t + \underset{(.23)}{.48}\, EITB_{t-1} + \underset{(.20)}{.89}\, UITB_t + \varepsilon_t$	.72	.108	.10	.05	−.02	.09		
($A6$)	$RS_t = \underset{(-.62)}{-.047} + \underset{(3.57)}{5.20}\, DRGNP_{t+1} - \underset{(-1.84)}{1.91}\, EITB_{t-1} - \underset{(-1.12)}{3.50}\, UITB_t + \varepsilon_t$	.71	.110	.24	.15	−.00	.07		
($A7$)	$RS_t = \underset{(-1.78)}{-.093} + \underset{(5.67)}{7.22}\, DRGNP_{t+1} - \underset{(-2.34)}{1.84}\, BG_t + \underset{(.04)}{.11}\, UITB_t + \varepsilon_t$	.73	.105	.12	.07	−.01	.08		
($A8$)	$RS_t = \underset{(-1.92)}{-.092} + \underset{(7.97)}{7.18}\, DRGNP_{t+1} - \underset{(-2.49)}{1.83}\, BG_t + \varepsilon_t$	.75	.102	.12	.07	−.01	.09		
($A9$)	$RS_t = \underset{(-4.10)}{-.169} + \underset{(6.96)}{6.97}\, DRGNP_{t+1} + \varepsilon_t$	.68	.114	.41	.23	.09	.16		

[a] RS_t is the monthly, quarterly, or annual real stock market return. $EITB_{t-1}$ and $UITB_t$ are the monthly, quarterly or annual expected and unexpected inflation rates from the Treasury bill rate models of inflation, while $EIMD_t$ and $UIMD_t$ are conditional expected and unexpected inflation rates from the money demand models. BG_t, DPR_t, and $DRGNP_t$ are annual growth rates of the monetary base, industrial production and real GNP for year t (in the annual stock return regressions) or for the year ending in month or quarter t (in the monthly and quarterly stock return regressions). R^2 is the coefficient of determination and $s(\varepsilon)$ is the residual standard error, both adjusted for degrees of freedom. The numbers in parentheses below estimated regression coefficients are t-statistics. ρ_τ is the residual autocorrelation at lag τ. Under the hypothesis that the true autocorrelations are zero, the standard errors of the estimated autocorrelations are approximately .06, .10, and .19 in the monthly, quarterly and annual data.

the inflation regression (1), (3), or (5) of Table 1, and $UIMD_t$ is the regression residual. The remaining regressions in each section are concerned with how measures of real activity and money growth compete with the measures of expected and unexpected inflation in the description of real common stock returns.

A. *Stock Returns and Inflation*

The first two regressions of each section of Table 6 document statistically reliable negative relations between real stock returns and measures of expected and unexpected inflation similar to those reported by Bodie, Jaffe and Mandelker, Nelson, and Schwert and myself. However, even these results contain suggestive evidence that the stock market is concerned with inflation for the information it contains about future real activity.

Thus, in setting the end-of-period prices of goods built into the *ex post* inflation rate I_t for month, quarter, or year t, markets for goods have the benefit of increasing amounts (specifically, a month, quarter, or year) of information about future real activity which was not available to the Treasury bill market in assessing *ex ante* expected inflation rates, $EITB_{t-1}$, at the beginning of the period. However, these increasing increments of information about future real activity are built into the monthly, quarterly, and annual *conditional* expected inflation rates $EIMD_t$, estimated from the money demand models of inflation since the latter explain the *ex post* inflation rate in part in terms of future real activity. If, in going from the monthly to the annual data, $EIMD_t$ gains information about future real activity relative to $EITB_{t-1}$, then it follows that $UIMD_t = I_t - EIMD_t$, the conditional unexpected inflation rate from the money demand model, loses information relative to $UITB_t = I_t - EITB_{t-1}$, the unexpected inflation rate from the Treasury bill rate model. Consistent with the hypothesis that expected and unexpected inflation just proxy for future real activity in the stock return regressions, we then observe that in going from the monthly stock return regressions ($M1$) and ($M2$) to the annual regressions ($A1$) and ($A2$), $EIMD_t$ gains explanatory power relative to $EITB_{t-1}$, while $UIMD_t$ loses explanatory power relative to $UITB_t$. For example, the t-statistics for the estimated coefficient of $UITB_t$ go from -2.93 in the monthly regression ($M1$) to -4.01 in the annual regression ($A1$), whereas those for the estimated coefficients of $UIMD_t$ go from -2.80 in the monthly regression ($M2$) to $-.66$ in the corresponding annual regression ($A2$).

We can document more directly that the larger relative importance of $UITB_t$ in the annual data is due to a larger amount of information about future real activity in *ex post* annual unexpected inflation rates. In the monthly data, the correlation between $UIMD_t$ and $UITB_t$ is .90 (implying that the money demand and Treasury bill rate models make similar assessments of the one-month expected inflation rate), and both $UIMD_t$ and $UITB_t$ are uncorrelated with measures of future real activity. However, in the annual data, the correlation between $UITB_t$ and $UIMD_t$ is only .33, and $UIMD_t$, which is a conditional unexpected inflation rate net of the information in the future industrial production growth rate DPR_{t+1}, is uncorrelated with future real activity. On the other hand, $UITB_t$, which estimates a true annual unexpected inflation rate, has correlation $-.61$ with next year's industrial production growth rate DPR_{t+1}. The correlation $-.61$ is a measure of the information about future real activity available to price goods at the end of the year, and thus incorporated into $UITB_t$, which was not available to the Treasury bill market in assessing the expected inflation rate $EITB_{t-1}$ at the beginning of the year.

B. *Stock Returns and Expected Inflation*

Comparing the second and third regressions in the monthly and quarterly sections of Table 6 shows that replacing the conditional expected inflation rates $EIMD_t$ with individual explanatory variables (the annual growth rates of real activity and the monetary base) from the monthly and quarterly money demand inflation models produces large increases in the fraction of the sample variance of the real stock return which is explained. The increase in explanatory power is even more substantial in the comparable annual regressions ($A2$) and ($A3$). Moreover, the growth rates of real activity and the base enter the real stock return regressions with much different relative importance than in the inflation regressions of Table 1. Current and past real activity are always important in the inflation regressions, but never have marginal explanatory power in the stock return regressions. Base growth rates are at least as important as future real activity growth rates in the inflation regressions, but future real activity growth rates dominate base growth rates in the stock return regressions. All of this suggests that expected inflation rates enter stock return regressions primarily because they happen to be functions of future real activity growth rates which are of more direct concern to the stock market.

Better evidence for this conclusion is, however, provided by the fourth and fifth regressions of each section of Table 6 which show that expected inflation rates never have marginal explanatory power in stock return regressions that also include base and future real activity growth rates as explanatory variables. In the case of $EITB_{t-1}$, these results imply that the most anomalous of the negative stock return-inflation relations, that between *ex post* real stock returns and *ex ante* expected inflation rates, has apparently been explained. However, we have more to say about stock return-expected inflation relations when we later consider the role of the base growth rate in the stock return regressions.

C. *Stock Returns and Unexpected Inflation*

The evidence in Table 6 on the relations between real common stock returns and unexpected inflation is less consistent. In the annual data, the explanatory power of the annual unexpected inflation rate $UITB_t$, observed in regression ($A1$), disappears when placed in competition with base and future real activity growth rates in regressions ($A5$) to ($A7$). On the other hand, the reliable negative relations between monthly and quarterly real stock returns and unexpected inflation observed in regressions ($M1$) and ($Q1$) are undisturbed, in terms of magnitudes of estimated regression coefficients and t-statistics, in the regressions ($M5$) to ($M7$) and ($Q5$) to ($Q7$) which also include BG_t and DPR_{t+12} as explanatory variables.

These negative relations between monthly and quarterly stock returns and unexpected inflation rates may reflect shortcomings of the real activity measures used in the monthly and quarterly inflation and real stock return regressions. The money demand inflation regressions produce consistently strong evidence for negative relations between inflation and real activity. However, what the monthly and quarterly inflation regressions call unexpected inflation may also be a response by the markets for goods to information about current and future real activity which is not captured by the specific measures of real activity used. If the stock market makes similar assessments of these omitted real variables, but with the predictable opposite price response, then negative proxy relations between stock returns and unexpected inflation can arise.

The measure of future real activity used both in the monthly and quarterly stock return regressions and in the monthly and quarterly inflation regressions is DPR_{t+12}, next year's rate of growth of industrial production. This choice is a somewhat *ad hoc* solution to problems caused by strong seasonals in real activity which show up neither in inflation rates nor in real stock returns. However, calculation of the annual growth rate of industrial production from one month or quarter to the next involves dropping the growth rate for the most recent month or quarter and adding that for the corresponding month or quarter one year ahead. These largely overlapping growth rates of industrial production may not do well in capturing the new information about future real activity which is used by the stock market and markets for goods in setting prices from one month or quarter to the next. In contrast, the nonoverlapping and largely serially uncorrelated annual growth rates of real output used in the annual stock return and inflation regressions may come closer to representing the new information about future real activity used in setting prices on an annual basis. As a consequence, the annual growth rates of real output may leave less information about future real activity to be explained by unexpected inflation in the annual stock return regressions.

The monthly, quarterly, and annual regressions ($M7$), ($Q7$), and ($A7$) provide suggestive evidence on this point. If the explanatory variables in these regressions (the current unexpected inflation rate, the growth rate of the base, and the future growth rate of real activity), have roughly similar roles, the residual standard error $s(\varepsilon)$ in the quarterly regression ($Q7$) should be about $\sqrt{3}=1.73$ times that of the monthly regression ($M7$), while the residual standard error for the annual regression ($A7$) should be about $\sqrt{12}=3.46$ and $\sqrt{4}=2$ times those of the monthly and quarterly regressions. These projections stand up well in the monthly and quarterly data: $s(\varepsilon)=.071$ in ($Q7$) as compared to the value $.066=1.73(.038)$ projected on the basis of the residual standard error, $s(\varepsilon)=.038$, in regression ($M7$). However, the residual standard error, $s(\varepsilon)=.105$, in the annual regression ($A7$) is much lower than the residual standard errors, $.038(3.46)=.132$ and $.071(2)=.142$, predicted on the basis of the monthly and quarterly regressions ($M7$) and ($Q7$). This power of the annual regression occurs in spite of the fact that the monthly and quarterly regressions ($M7$) and ($Q7$) get substantial assistance from the unexpected inflation rate, $UITB_t$, whereas the future growth of real GNP, $DRGNP_{t+1}$, deprives $UITB_t$ of any marginal explanatory power in the annual regression ($A7$).

Since the direct results with respect to the unexpected inflation rate are mixed, it is well to take note of the somewhat different explanation of the relations between stock returns and unexpected inflation which is offered by Franco Modigliani and Richard Cohn. Their hypothesis is that the stock market is irrational. Nominal discount rates that vary directly with expected inflation are used by the market to price the real payoffs generated by equities. As a consequence, positive unexpected inflation, which implies higher future expected inflation in a world where expected inflation is approximately a random walk, produces a decline in stock prices and a negative relation between stock returns and unexpected inflation. However, a more direct implication of the particular market irrationality hypothesized by Modigliani and Cohn is that expected real stock returns should be positively related to the expected inflation rate. The stock return-expected inflation regressions reported here and elsewhere indicate uniformly that during the post-1953 period, the relations between expected stock returns and expected inflation rates are negative.[5]

D. *Stock Returns and Money Growth*

The results in Table 6 show that using base and future real activity growth rates to explain real stock returns kills the explanatory power of expected inflation rates. However, the fact that the variation in expected stock returns cannot be attributed to expected inflation does not erase the implication of regressions ($M1$), ($Q1$), and ($A1$) that the two variables move in opposite directions during the post-1953 period; in short, that expected real stock returns are reliably lower later in the period.

Moreover, although the first and sixth regressions in each section of Table 6 indicate that future real activity growth rates alone cut the coefficients of the *ex ante* expected inflation rates in half, regressions (5) to (7) of each section show that elimination of the expected inflation effect requires inclusion of the base growth rate in the regressions. These regressions also indicate that although the base growth rate seems to dominate the expected inflation rate, the two variables have a similar role. For example, the estimated coefficients of $EITB_{t-1}$ and BG_t in regressions ($M6$) and ($M7$), ($Q6$) and ($Q7$), or ($A6$) and ($A7$) have similar t-statistics, and substitution of BG_t for $EITB_{t-1}$ has little

[5]Since the expected inflation rate $EITB_{t-1}$ is an *ex ante* variable with respect to the real stock return RS_t, the regression of RS_t on $EITB_{t-1}$ estimates the relation between the *ex ante* expected component of the real stock return and the *ex ante* expected inflation rate.

effect on explanatory power. These results are not surprising in light of the strong relations between base growth rates and expected inflation rates implied by the money demand models of inflation in Table 1. Like expected inflation rates, base growth rates are highly autocorrelated (Table 4) and wander slowly from lower levels to higher levels during the post-1953 period.

There are, of course, models which propose causal relations between money growth and stock returns. For example, Robert Mundell and James Tobin propose models in which there are negative relations between expected real stock returns and either expected inflation rates or money growth rates. They hypothesize that the higher expected inflation rates caused by higher growth rates of money cause shifts from non-interest-bearing money to financial assets like common stocks, which lower the expected real returns on such assets. However, the hypothesized consequence of the lower expected real returns (costs of capital) caused by higher expected inflation rates is a boom in capital investment and real activity. This prediction is refuted by the consistent negative relations between real activity and expected inflation rates documented in Tables 1 and 2.

One could search for other economic interpretations of the stock return-expected inflation or base growth rate relations, but close examination of a few key regressions in Table 6 leads me to suggest a less profound explanation, in particular, that the relations are spurious. Thus, a time-series plot of the real stock return RS_t for the post-1953 period would show that real stock returns were on average higher during the 1950's than during the 1970's. Examination of the residuals from the regression ($A9$) of RS_t on $DRGNP_{t+1}$ would then show that although $DRGNP_{t+1}$ absorbs a substantial proportion (.68) of the variance of RS_t, it leaves some of the downward pattern of returns unexplained. Inclusion of the slowly wandering base growth rate BG_t in the regression ($A8$), however, has the effect of "twisting" the regression residuals toward lower values in the early years and higher values in the later years, thus producing residuals that are better scattered about zero than those from regression ($A9$). The plots are too cumbersome to show in a journal article, but the reader can observe in Table 6 that the residuals from regression ($A9$) are autocorrelated, whereas the residuals from regression ($A8$) show little autocorrelation.

While inclusion of BG_t in the real stock return regression twists the residuals so that they are better scattered about zero, the residuals from regression ($A8$) otherwise behave quite similarly to those from regression ($A9$) in which $DRGNP_{t+1}$ is the only explanatory variable. The reason BG_t has little effect on the residuals from the real stock return regressions is that, unlike the real stock return, the base growth rate is a highly autocorrelated variable (Table 4) that wanders rather smoothly from lower to higher values during the post-1953 period. Another variable of the same sort is the expected inflation rate $EITB_{t-1}$, which has a similar role in the inflation regressions. In fact, any variable that wanders slowly from lower to higher levels (or vice versa) would do a similar job in capturing the nonstationarity of expected stock returns which is left unexplained by measures of future real activity. For example, diagnostic checks showed that functions of time (time and time squared) replicate the effects of BG_t or $EITB_{t-1}$ in the stock return regressions.

Thus, the fact that BG_t dominates $EITB_{t-1}$ in the stock return regressions may not imply that there is a monetary rather than an expected inflation effect to be explained. The appropriate conclusion may be that the relations between real stock returns and either BG_t or $EITB_{t-1}$ are examples of spurious correlations of the sort first analyzed by G. Udney Yule. Specifically, there is nonstationarity in expected real stock returns which can be tracked by BG_t or $EITB_{t-1}$ but which is not caused by these variables. However, even a full guarantee that this viewpoint is correct would leave us with the uncomfortable fact that there is downward drift in expected real stock returns during the post-1953 period which is not fully explained by our story about real activity, or at least by the particular real variables used to test the story.

V. Conclusions

The hypothesis of this paper is that the negative relations between real stock returns and inflation observed during the post-1953 period are the consequence of proxy effects. Stock returns are determined by forecasts of more relevant real variables, and negative stock return-inflation relations are induced by negative relations between inflation and real activity.

In many respects, the empirical tests of this model are successful. There is evidence that real stock returns are positively related to measures of real activity like capital expenditures, the average real rate of return on capital and output which we hypothesize reflect variation in the quantity of capital investment with expected rates of return in excess of costs of capital. There is also consistent evidence of negative relations between inflation and real activity which we interpret in the context of money demand theory and the quantity theory of money. Moreover, stock returns and inflation rates are most strongly related (though with opposite signs) to measures of future real activity. This is consistent with a rational expectations view in which markets for goods and securities set current prices on the basis of forecasts of relevant real variables.

The proxy effect hypothesis implies that measures of real activity should dominate measures of inflation when both are used as explanatory variables in real stock return regressions. In monthly, quarterly, and annual data, growth rates of money and real activity eliminate the negative relations between real stock returns and expected inflation rates. In the annual stock return regressions unexpected inflation also loses its explanatory power when placed in competition with future real activity.

There are other respects in which the empirical results are less supportive. In the monthly and quarterly data, future real activity does not explain the negative relations between real stock returns and unexpected inflation. There is suggestive evidence that this is due to the deficiencies of overlapping annual growth rates of real activity as measures of the new monthly or quarterly information used by the stock market to set prices. However, the evidence for this explanation is indirect, and the ritual call for further research is appropriate.

Perhaps most disappointing, although the anomalous negative relations between real stock returns and expected inflation rates largely disappear in the face of competition from measures of future real activity, complete explanation of the expected inflation effect occurs only when the base growth rate, a variable highly correlated with the expected inflation rate, is also included in the stock return regressions. Detailed examination of these regressions suggests that the relations between real stock returns and either the base growth rate or the expected inflation rate are spurious. However, this conclusion leaves us without an economic explanation for part of the documented decline in expected real stock returns during the post-1953 period.

Finally, the story told here about real stock returns is similar to that offered by Michael Gibbons and me for the behavior of the expected real returns on Treasury bills estimated from the wandering intercept inflation-interest rate regressions (2) and (4) of Table 1. As in the case of common stock returns, Gibbons and I found that expected real returns on bills vary negatively with expected inflation rates during the post-1953 period. However, contrary to the explanation for this phenomenon offered by Mundell and Tobin, Gibbons and I found that, as for common stocks, expected real returns on bills vary positively with measures of future real activity like output, capital expenditures and the average real rate of return on the capital stock. We conclude that equilibrium expected real returns on financial assets, like bills and common stocks, vary directly with desired capital expenditures in order to induce equilibrium allocations of resources between consumption and investment.

In short, the hypothesis for both common stocks and bonds is that expected real returns are determined in the real sector. Spurious negative relations between inflation and expected real returns are then induced by a somewhat unexpected characteristic of the money supply process during the post-1953 period, in particular, the fact that most of the variation in real money demanded in response to variation in real activity has been accommodated through offsetting variation in inflation rather than through nominal money growth.

REFERENCES

C. F. Ansley, "Signal Extraction in Finite Series and the Estimation of Stochastic Regression Coefficients," Proceedings of the American Statistical Association, Business and Economic Statistics Section, 1980.

R. J. Barro, "Unanticipated Money, Output, and the Price Level in the United States," *J. Polit. Econ.*, Aug. 1978, *86*, 549–80.

Z. Body, "Common Stocks as a Hedge Against Inflation," *J. Finance*, May 1976, *31*, 459–70.

E. F. Fama, "Short-Term Interest Rates as Predictors of Inflation," *Amer. Econ. Rev.*, June 1975, *65*, 269–82.

______, (1976a) "Inflation Uncertainty and Expected Returns on Treasury Bills," *J. Polit. Econ.*, June 1976, *84*, 427–48.

______, (1976b) *Foundations of Finance*, New York 1976.

______, "Inflation, Output and Money," working paper no. 39, Center for Research in Security Prices, Graduate School of Business, Univ. Chicago, rev. Dec. 1980.

______ **and M. R. Gibbons,** "Inflation, Real Returns, and Capital Investment," working paper no. 41, Center for Research in Security Prices, Graduate School of Business, Univ. Chicago, rev. Dec. 1980.

______ **and G. W. Schwert,** "Asset Returns and Inflation," *J. Finan. Econ.*, Nov. 1977, *5*, 115–46.

Irving Fisher, *The Purchasing Power of Money*, New York 1911.

______, *The Theory of Interest*, New York 1930.

M. Friedman, "A Theoretical Framework for Monetary Analysis," *J. Polit. Econ.*, Mar./Apr. 1970, *78*, 193–238.

______, "Nobel Lecture: Inflation and Unemployment," *J. Polit. Econ.*, June 1977, *85*, 451–72.

K. Garbade and P. Wachtel, "Time Variation in the Relationship between Inflation and Interest Rates," *J. Monetary Econ.*, Nov. 1978, *4*, 755–65.

J. Geweke, "Testing the Exogeneity Specification in the Complete, Dynamic, Simultaneous Equation Model," *J. Econometrics*, Apr. 1978, *7*, 163–85.

N. Gonedes, "Evidence on the 'Tax Effects' of Inflation under Historical Cost Accounting Methods," *J. Business*, Apr. 1981, *54*, 227–70.

P. J. Hess and J. L. Bicksler, "Capital Asset Prices versus Time Series Models as Predictors of Inflation: The Expected Real Rate of Interest and Market Efficiency," *J. Finan. Econ.*, Dec. 1975, *2*, 341–60.

J. Jaffe and G. Mandelker, "The 'Fisher Effect' for Risky Assets: An Empirical Investigation," *J. Finance*, May 1976, *31*, 447–58.

D. W. Jorgenson, "Econometric Studies of Investment Behavior: A Survey," *J. Econ. Lit.*, Dec. 1971, *9*, 1111–47.

J. Lintner, "Inflation and Security Returns," *J. Finance*, May 1975, *80*, 259–80.

R. E. Lucas, Jr., "Expectations and the Neutrality of Money," *J. Econ. Theory*, Apr. 1972, *4*, 103–24.

F. Modigliani and R. A. Cohn, "Inflation, Rational Valuation and the Market," *Financial Analysts J.*, Mar./Apr. 1979, 24–44.

R. Mundell, "Inflation and Real Interest," *J. Polit. Econ.*, June 1963, *71*, 280–83.

C. R. Nelson, "Inflation and Rates of Return on Common Stocks," *J. Finance*, May 1976, *31*, 471–83.

______ **and G. W. Schwert,** "Short-Term Interest Rates as Predictors of Inflation: On Testing the Hypothesis that the Real Rate of Interest Is Constant," *Amer. Econ. Rev.*, June 1977, *67*, 478–86.

C. A. Sims, "Money, Income and Causality," *Amer. Econ. Rev.*, Sept. 1972, *62*, 540–52.

J. Tobin, "Money and Economic Growth," *Econometrica*, Oct. 1965, *33*, 671–84.

G. U. Yule, "Why Do We Sometimes Get Nonsense Correlations between Time Series?—A Study in Sampling and the Nature of Time Series," *J. Royal Statist.*

Soc., Part 1, Jan. 1926, *89*, 1–69.

U.S. Department of Commerce, Bureau of Economic Analysis, *Fixed Nonresidential Business and Residential Capital in the United States, 1925–75*, June 1976.

______, *The National Income and Product Accounts of the United States, 1929–74; Statistical Tables.*

______, *Survey of Current Business*, July 1977, *57*.

______, *Survey of Current Business*, July 1978, *58*.