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The Relation between Stock Prices and Inflationary Expectations: The International Evidence

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ABSTRACT

This paper provides empirical evidence on the relation between stock returns and inflationary expectations for nine countries over the period 1971–80. The Fisherian assumption that real returns are independent of inflationary expectations is soundly rejected for each major stock market of the world. Using interest rates as a proxy for expected inflation, our data provide consistent support for the Geske and Roll model whose basic hypothesis is that stock price movements signal (negative) revisions in inflationary expectations. Finally, a weak real interest rate effect was found for some of these countries.

THE PAST DECADE HAS witnessed an increased preoccupation with monetary variables such as exchange rates and inflation. The average level and volatility of inflation has greatly increased in every country, prompting more theoretical and empirical research on the relation between asset prices and monetary variables such as inflation.

A negative relation between stock prices and inflation has been consistently observed in U.S. data. In a comprehensive study, Fama and Schwert [5] showed that stock returns were negatively related to expected inflation, unanticipated inflation, and changes in expected inflation. The failure of the Fisherian model to explain the observed relation between stock prices and inflation has led to the development of alternative macro-economic theories. Recently, Geske and Roll [7] have argued that the basic underlying relation is between stock returns and changes in inflationary expectations. Prior to Geske and Roll (hereafter G-R), the conventional view has been that changes in inflationary expectations was the causative influence.

While empirical studies on the U.S. capital market abound, few tests have been performed on other countries. The disruption of the international monetary system in 1971, and the resulting introduction of flexible exchange rates has permitted independence of national monetary policies and divergent national inflation rates; this means that different inflationary processes may be observed in different countries whereas this was theoretically not possible under the previous system of fixed exchange rates. Indeed, the same theoretical model

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needs not apply to every country if it is a model such as G-R, which relies on the behavior of the domestic fiscal and monetary authorities.

The purpose of this paper is to present tests of the relationship between inflationary expectations and asset prices for the major stock markets. Contrary to the previous research of Firth [6] and Gultekin [8], we find that the same structural relation existed for all major countries over the past 10 years of flexible exchange rates, and that previous results are caused by model misspecification.

Section I reviews the empirical and theoretical literature while the empirical results are presented in Section II.

I. Review of the Literature

Early empirical work on U.S. data indicates a significant negative relation between inflation and stock prices (Lintner [12], Body [1]), Jaffe and Mandelker [11], Nelson [13], and Fama and Schwert [5] found a negative relation between stock returns and expected inflation as well as unanticipated inflation. According to most financial theories, expected inflation should be the basic underlying (inflation) influence in asset pricing since it might affect both the expected cashflows and the discount rate. In the most comprehensive published paper, Fama and Schwert used expected and unanticipated inflation as well as changes in expectations as explanatory variables. They found a consistent negative relation between stock returns and each of these three variables.

Geske and Roll [7] argue that unanticipated inflation, $I_t - \hat{I}_t$, is simply a proxy, with error in the variable, for changes in expectations $\hat{I}_{t+1} - \hat{I}_t$. They point out that in the Fama and Schwert regressions, unexpected inflation becomes statistically insignificant when changes in inflationary expectations are introduced; furthermore, the R^2 greatly improves and this last variable is by far the most significant of the three inflation linked measures[1]. The symbols used are described in Table I.

Empirical investigation for foreign markets has been sparse. Firth [6] regressed nominal monthly stock returns on current and past realized inflation rates in Britain from 1955 to 1976. The coefficient for current inflation was always positive and often significant, which seems in sharp contrast with U.S. results. However, no formal test of the relation between stock returns and *expected* inflation was proposed; furthermore, when lagged inflation rates are introduced in the regres-

[1] As a matter of fact, the two variables, $\hat{I}_t - I_t$ and $\hat{I}_{t+1} - \hat{I}_t$ would be identical (up to a multiplicative constant) if the inflationary process was exactly of the IMA (1.1) form; i.e.:

$$\tilde{I}_{t+1} - I_t = \tilde{\mu}_{t+1} - \theta u_t$$

or

$$\hat{I}_{t+1} = \hat{I}_t + \theta\,(I_t - \hat{I}_t)$$

This process was found to be the most reasonable ARIMA proxy for the U.S. (Nelson and Schwert [14], Hess and Bicksler [9]) as well as for other countries but not all (Hillion and Solnik [10]).

In a Fisherian framework, there is no reason to include unanticipated inflation, while both levels and changes in inflation expectations should be considered to test the real rate independence assumption.

Table I

Notation

I_t	The inflation rate over period t
$\hat{I}_t = E(\tilde{I}_t \mid \phi_{t-1})$	The expectation of inflation for period t formulated at the end of period $t-1$
R_t	The nominal return on the asset over period t
r_t	The ex post real return on the asset ($r_t = R_t - I_t$)
RF_{t-1}	The risk free interest rate quoted at the end of period $t-1$
ρ_t	The ex post real interest rate ($\hat{\rho}_t = RF_t - I_t$); its expected value is $_{\rho t} = RF_t - \hat{I}_t$, since the risk free rate is known with certainty at the start of the period
U_t	The noise or innovation in any time series X ($U_t = X_t - \hat{X}_t$)

sion, they usually take negative coefficients. In an unpublished paper, Gultekin [8] ran simple regressions between contemporaneous nominal stock returns and inflation rates for a large number of countries.[2] Six of the seventeen countries have a positive coefficient; it is significantly positive for Germany and Britain (even significantly greater than 1, its Fisherian value) and significantly negative for Spain, Denmark, and the U.S.A. No systematic relationship seems to appear across countries, but again this cannot be regarded as a test of the relation between stock return and inflationary *expectations* as claimed by the various theories.

The basic theoretical framework of all these papers was Fisherian. Fisher hypothesized that expected real returns are determined solely by real factors and therefore expected real returns are independent of inflationary expectations (both levels and variations). This hypothesis can be tested by a regression model of the form:

$$r_t = \alpha + \beta_1 \hat{I}_t + \beta_2 (\hat{I}_{t+1} - \hat{I}_t) + \epsilon_t \tag{1}$$

where β_1 and β_2, the coefficients for inflationary expectations and revisions in expectations, are equal to zero under the null hypothesis. Given this Fisherian model, it would seem preferable to work on real asset returns rather than nominal returns as was done in the mentioned studies (with the exception of Fama [3]). This further allows a more direct comparison between countries with different inflation processes.

Recently, two types of macroeconomic approaches have been suggested to account for this negative relation between inflationary expectations and stock prices. Fama [3] documents evidence of a negative relation between realized inflation and economic activity (the stagflation scenario) in the past twenty years. Since stock returns are shown to be related to future economic activity, the negative relation between stock return and inflation is the expression of a more general phenomenon. As G-R point out, the inclusion of money growth in the regression makes the expected inflation insignificant which might be interpreted as replacing one inflationary expectation proxy by another; furthermore, the change in expectations stays significant (except in one case).

[2] Part of the study used IMF stock indices which are well-known poor indices of monthly averages; monthly results are also reported for the period 1/1969–5/1978 and various subperiods, using Capital International indices for 17 countries.

Geske and Roll [7] proposed a "reverse causality" model in which government policy plays a central role. They argue that movements in stock prices cause (in an econometric sense) changes in inflationary expectations. The reasoning is conducted as follows: a drop in stock prices is a signal for a drop in economic activity, and therefore in government revenues. This leads to expectations that the government will run a budget deficit and will have to take inflationary measures to finance the deficit. In other words, a movement in stock prices implies a negative revision of inflationary expectations. This is a money supply counter part of the money demand justification provided by Fama. A simple adaptive expectation model of inflation leads to the following testable relation:

$$\hat{I}_{t+1} - \hat{I}_t = \gamma\,[bR_{t+1} - \hat{I}_t] + \epsilon_t \tag{2}$$

where G-R expect γ positive, b negative, and both small. They further argue that because government will borrow to finance the deficit, the real interest rate might increase (assuming partial debt monetization). In the other words, a decrease in stock prices would be associated with an increase in Treasury Bill interest rates because both the real interest rate and the anticipated inflation rate increase. They provide strong empirical evidence of their inflationary expectation revision model but find little support for the real effect. This effect might be much stronger for countries attempting to demonetize their budget deficit.

II. Tests

A. *The data*

Direct tests on the relation between inflationary expectations and asset prices have not been performed for non-U.S. markets, partly because of the problems involved in estimating expected inflation. Assuming a constant real interest rate, the Treasury Bill rate has been used by most U.S. researcher as a proxy for expected inflation (Jaffee and Mandelker [11], Fama and Schwert [5], Schwert [15]). Fama [4] and Schwert [15] conclude that inflation ARIMA models (optimal time series predictors), even when estimated over the *same* data on which the tests were conducted, did not significantly outperform interest rates as predictors of inflation. Somewhat similar conclusions are reached by Hillion and Solnik [10] for major foreign countries. However, in some countries, the variability of monthly inflation rates is very large because of index construction (infrequent sampling of some items . . .) inducing a strong seasonal pattern;[3] while interest rates ignore this "spurious" seasonality in the inflation rate (and probably rightly so), it is detected by seasonal ARIMA models which achieve a greater predictability of the realized inflation rate. This technical seasonality of reported monthly inflation, which is probably absent of the true underlying inflationary process, is of little interest to our purpose. Following Schwert's [15] and Fama's [4] conclusion that the interest rate remains the best single prediction of the inflation rate, we shall use interest rates as proxies for expectations of inflation. However, in a later

[3] In Japan, the inflation rate standard deviation is three times its American equivalent. Negative monthly rates are frequent even in period of large average inflation and these are not data errors.

part of the paper, we shall check that the results are not induced by changes in the real interest rate rather than revisions of inflationary expectations, when interest rates are used as a proxy.

Few countries have a free market for short term interest rates. In most cases the rates are set, or at least heavily controlled, by governments. While market forces must dominate in the medium or long run, the quality of the monthly data on domestic interest rates is not sufficient for our purpose. However, in the past decade, the Eurocurrency market has developed into an efficient international money market, free of government control.[4] When free domestic markets exit, the Eurorates rates are closely linked to the domestic rates as in the U.S.A.; banks intervene heavily in this market and would arbitrage away discrepancies. When no domestic equivalent exists, the Eurorate is undoubtedly the best measure of a true market rate. Even for the U.S., the Eurodollar rate might be a better measure of expected inflation than the T-bill rate since the Federal Reserve had a policy of T-bill rate manipulation before October 1979.

One-month rates were collected from the Bank for International Settlements and Banque de France for nine active currencies. The data are the 30 days interbank rate on the last day of the month reported by a major London Bank at a fixed hour.[5] These data were checked with the figures reported in World Financial Markets (Morgan Guaranty): discrepancies existed for minor currencies (the Belgian franc, Dutch guilder, and even the French franc and Japanese yen). The period chosen was January 1971 to December 1980. Prior to 1971, there was no active market for some of the currencies.

The stock market data are end-of-the-month Capital International Indices cum dividend. Consumer Price Indices taken from the I.M.F. tape have been used to measure inflation rates. A detailed description of the time series properties of inflation and interest rates can be found in Hillion and Solnik [10]. Together, the nine stock markets represent about 90% of the world capitalization.

All monthly rates of return are multiplied by 1200. In other words, all returns are expressed in percents per year.

The two equations discussed in Section I will be successively tested for the nine major markets. Although they rely on somewhat different theories, the variable used are similar.

B. *The Results*

The Fisherian "direct causality" Equation (1) will be tested using the regression model for real stock returns:

$$r_t = \alpha + \beta_1\, RF_{t-1} + \beta_2\,(RF_t - RF_{t-1}) + \epsilon_t \tag{3}$$

where RF_{t-1} is used as a proxy for $\hat{I}_t$. Remember that RF_{t-1} is known at the end of the period $t-1$, so that RF_t is known at the same time as r_t and might be considered as the inflation expectation for period $t+1$. Table II reports the

[4] Governments of the D.M. zone (Germany, the Netherlands, and Switzerland) sometimes resorted to regulations on their banking system as well as to fiscal measures to attempt a control on the volume of this market in their own currency. This might affect the results for those countries.

[5] The bank as well as the time changed over the period and was deemed confidential by our sources.

Table II

Stock Returns and Inflationary Expectations 1/1971–12/1980 monthly data

$r_t = \alpha + \beta_1 RF_{t-1} + \beta_2 (RF_t - RF_{t-1})$

	β_1	β_2	$\bar{R}^2$	F-test	Durbin-Watson
U.S.A.	− 1.86 (1.20)	− 14.5 (3.48)	0.92	6.4	2.02
JAPAN	− 4.35 (2.36)	−16.0 (1.56)	.052	3.7	1.73
U.K.	− 2.04 (0.94)	−28.6 (5.23)	.184	13.7	1.68
SWITZERLAND	− 4.36 (2.36)	− 22.1 (4.26)	.145	10.4	2.07
FRANCE	− 1.97 (1.10)	− 13.2 (3.12)	.071	4.9	1.87
GERMANY	− 0.98 (0.60)	− 16.96 (3.92)	.109	7.7	2.26
NETHERLANDS	− 2.31 (1.38)	− 7.20 (1.94)	.031	2.6	1.78
BELGIUM	− 3.23 (2.65)	− 16.6 (4.35)	.160	11.6	2.05
CANADA	1.50 (0.69)	− 33.4 (3.96)	.118	8.3	2.02

(t-ratios in parentheses)

results for the ten year period, 1971–80. The results for the U.S.A. confirm the previous findings of a significant negative relation between asset returns and inflationary expectations; moreover, the same conclusion holds for every other country. The F-test is always significant at the 5% level. As found in U.S. studies, β_2, the coefficient of expectation changes, is negative, large in magnitude, and statistically significant for every country but Japan (t-ratio of −1.56). The coefficient of expected inflation is negative for all countries except Canada and is significantly different from zero for Japan, Switzerland, and Belgium. The average R^2 is above 10%.

To test whether these results could be due to the use of *real* stock returns, Table III reports the results using nominal stock returns for comparison purposes. The substance of the conclusion[6] is unaltered and is consistent with the earlier findings of Fama and Schwert [5], and Geske and Roll [7] for different periods as reported in Table III. The use of Eurodollar instead of T-bill rates does not seem to significantly alter the results, although a detailed comparison is impossible because of different time periods. However, the higher R^2 found in this study for U.S. data might be an indication that the Eurodollar rate is a better measure of expected inflation than the T-bill rate as discussed above.

The results seem in contradiction with earlier findings by Firth [6] and Gultekin [8]. However, they tested a different model. They performed regressions between

[6] Interest rates are close to a random walk in their first differences (except for Japan), so that there is little or no correlation between the explanatory variables.

stock returns and *realized* inflation rates; this has little to say about the relation between stock returns and *expected* inflation, or revisions in expectations, which is the variable called for by the above mentioned theories. To illustrate this point on British data, the correlation of nominal stock returns with current inflation is + 0.26 while the correlation with the expected inflation level is only + 0.04, and the correlation with changes in inflationary expectations is very negative and equal to −0.44. In other words, the important underlying structure is the negative reaction of stock prices to increases in inflationary expectations.

The high magnitude of β_2 is disturbing if one were to interpret Equation (3) as a causal economic relation, in the sense that revisions in inflationary expectations induce movements in stock prices. This observation, made by Geske and Roll for the U.S. results, applies equally to all the other major stock exchanges.

As mentioned in Section I, G-R developed a model with "reverse (temporal) causality" in which a movement in stock prices induces a revision of inflationary expectations with elasticity of $1/\beta_2$. Using interest rates, their final model is of the form

$$RF_t - RF_{t-1} = \gamma\,[bR_t - RF_{t-1}] + \epsilon_t \tag{4}$$

Table III

Nominal Stock Returns and Inflationary Expectations, monthly data 1/1971–12/1980

$$R_t = \alpha + \beta_1\, RF_{t-1} + \beta_2\,(RF_t - RF_{t-1})$$

	β_1	β_2	R^2	F-test	D.W.
U.S.A.	− 0.99	− 14.1	.085	5.9	2.01
	(0.65)	(3.42)			
JAPAN	− 3.24	− 13.4	.031	2.4	1.83
	(1.80)	(1.35)			
U.K.	− 1.14	− 29.2	.187	13.9	1.65
	(0.51)	(5.23)			
SWITZERLAND	− 3.71	− 21.2	.131	9.3	2.07
	(2.01)	(4.11)			
FRANCE	− 1.43	− 13.1	.068	4.8	1.87
	(0.78)	(3.09)			
GERMANY	− 0.80	− 16.6	.104	7.3	2.27
	(0.47)	(3.81)			
NETHERLANDS	− 2.30	− 7.69	.030	2.4	1.82
	(1.40)	(1.87)			
BELGIUM	− 2.88	− 16.5	.153	11.1	2.13
	(2.38)	(4.36)			
CANADA	1.95	− 32.7	.118	8.3	2.02
	(0.90)	(3.89)			
U.S.A.					
Geske-Roll	−2.81	− 7.56	.014	1.8	n.a.
8/71–12/80	(1.33)	(1.55)			
Fama-Schwert[a]	− 6.03	− 17.7	.050	n.a.	n.a.
1/53–7/71	(3.28)	(2.38)			

(t-ratios in parentheses)

[a] Their regression included unanticipated inflation as a variable whose coefficient was insignificant.

Table IV

Reverse Causality between Inflationary Expectations and Stock Return, 1/71–12/80

$RF_t - RF_{t-1} = \alpha + \gamma_1 RF_{t-1} + \gamma_2 R_t$

Countries	γ_1	γ_2	R^2	F-test	D.W.
U.S.A.	−.038 (1.15)	−.006 (3.42)	.092	6.4	1.75
JAPAN	−.018 (1.06)	−.001 (1.35)	.013	1.3	1.16
U.K.	−.073 (2.25)	−.007 (5.25)	.219	16.9	2.24
SWITZERLAND	−.077 (2.50)	−.006 (4.11)	.146	10.5	1.88
FRANCE	−.097 (2.59)	−.006 (3.09)	.115	8.1	1.93
GERMANY	−.062 (1.87)	−.007 (3.81)	.128	9.1	2.19
NETHERLANDS	−.085 (2.35)	−.004 (1.87)	.058	4.1	1.63
BELGIUM	−.064 (2.31)	−.009 (4.36)	.151	10.9	1.90
CANADA	−.010 (0.45)	−.004 (3.89)	.113	7.9	1.79
U.S.A. (Geske-Roll)	−.078 (1.91)	−.003 (1.55)	.031	2.8	n.a.
8/71–12/80 1/53–12/80	−.023 (1.58)	−.002 (2.45)	.017	3.8	n.a.

(t-ratios in parentheses)

where they expect γ positive, b negative, and both small. They used nonlinear maximum likelihood and OLS estimation techniques. Since the technique used makes almost no difference to their results, their model is tested here using OLS estimation of the form:

$$RF_t - RF_{t-1} = \alpha + \gamma_1 RF_{t-1} + \gamma_2 R_t + \epsilon_t \tag{5}$$

where both γ_1 and γ_2 are expected to be negative. The results reported in Table IV indicate the coefficient signs are negative for every country, including Canada, the deviant in the previous regressions. γ_2 is statistically significant for every country except Japan where the residual are autocorrelated because of serial dependence in changes in interest rates.[7] The coefficient of expected inflation γ_1 is statistically significant in 6 out of 9 countries, but not the U.S. The American results are consistent with those of G-R over 1/53 to 12/80. Again the (adjusted) R^2 are larger than those found previously.

The results are unexpectedly good in their consistency across countries in so far as magnitude, signs, and significance of the coefficients are concerned. There seems to exist a fundamental structural process in every country between stock

[7] A Cochrane-Orcutt transformation to eliminate autocorrelation did not improve the significance level of the Japanese regression.

returns and changes in inflationary expectations. A possible explanation might be dependent observations caused by international correlation between national stock markets and Euro interest rates. The country pairwise correlation for stock market movements and changes in interest rates are reported on Table V. The average R^2 is 23.0% for stocks and 4.8% for interest rates; these figures are probably too low to fully support such an explanation.

However, this interdependence is likely to create some problems if one wishes to run a joint test over all countries. A stacked regression on all observations displays serious positive correlation for contemporaneous residuals in all countries and heteroscedasticity.[8] To remedy this autocorrelation and difference in residual variance across countries, we used Zellner "seemingly unrelated regression" technique where the regression coefficients are constrained to be the same in each country. In other words, the coefficients are estimated over all observations, while the error terms are allowed to have different variance and correlation *between* countries but follow the traditional assumption *within* a country. This is a maximum likelihood estimation where the t-ratios can be interpreted in the usual way. The results of the G-R model are

$$RF_t - RF_{t-1} = 0.316 - \underset{(4.01)}{0.0341}\, RF_{t-1} - \underset{(7.26)}{0.0034}\, R_t$$

The coefficients have the expected negative sign and are significantly different from zero. The *t*-ratios given in parentheses are much larger (in absolute value) than for individual countries regressions indicating a very significant relation, valid worldwide. A nonlinear maximum likelihood estimation as suggested by Equation (4) was also performed on the total set of countries, combined with the Zellner technique. The parameters estimates are equal to the previous one to the third significant digit.

A final word of caution is in order in interpreting these results. Changes in interest rates will equal changes in inflationary expectation if the ex ante real interest rate stays constant. If this is not the case, our results should be interpreted as the joint effect of changes in inflation expectations *and* ex ante real rates on stock return (or vice versa).

If the ex ante real rate could be measured, it would be easy to build a test to differentiate between the two effects, but remember that we resorted to interest rates as a proxy for expected inflation because expectations could not be measured directly. A poor alternative would be to compute the ex post real rate ($\rho_t = RF_t - I_t$) and run a check on the model through regression:

$$\rho_t - \rho_{t-1} = \alpha + \beta R_t \tag{6}$$

This test is subject to the problem that $\rho_t - \rho_{t-1}$ will tend to follow a MA (1) process since $RF_t - RF_{t-1}$ tends to follow a random walk and $I_t - I_{t-1}$ is a MA

[8] The results of the stacked regression for the G-R model are (*t*-ratios in parentheses):

$$RF_t - RF_{t-1} = 0.376 - \underset{(4.63)}{0.0399}\, RF_{t-1} - \underset{(10.47)}{0.0055}\, R_t \quad R^2 = 0.106$$

but the residuals covariance matrix deviates from the identity matrix multiplied by a constant.

Table V

Correlation (R-square) of national stock returns (top-right) and changes in interest rates (bottom-left)

	Germany	France	Netherlands	United Kingdom	Switzerland	Japan	Canada	USA	Belgium
GERMANY	*****	.191	.346	.107	.282	.120	.092	.099	.230
FRANCE	.002	*****	.307	.244	.255	.076	.276	.190	.345
NETHERLANDS	.023	.001	*****	.317	.383	.143	.269	.316	.395
UNITED KINGDOM	.004	.120	.006	*****	.262	.074	.233	.254	.257
SWITZERLAND	.207	.172	.006	.115	*****	.150	.206	.289	.404
JAPAN	.000	.047	.037	.025	.017	*****	.063	.115	.099
CANADA	.009	.019	.007	.014	.035	.000	*****	.479	.198
U.S.A.	.015	.050	.007	.047	.119	.006	.233	*****	.222
BELGIUM	.024	.021	.166	.030	.021	.013	.022	.065	*****

(1) process. This will create an autocorrelation in the residuals which is not of the autoregressive type that can easily be accommodated by Cochrane-Orcutt type of corrections. Run on our data, Equation (6) showed an average D.W. of 2.79 with limited second order autocorrelation. Another alternative is to construct an ARIMA estimator of expected inflation, use it to compute an estimate of the ex ante real rate, and run the regression (6). Since inflation, interest rate, and stock prices are three separate sets of data, this two-step procedure should not introduce any biases. However, the most efficient method is a joint procedure in which the expected real rate and the coefficient β are determined jointly via an ARIMA transfer function model, a method followed by Geske and Roll. The model determines an optimal estimator of the expected real rate conditional on past inflation and interest rates as well as on stock returns. Given our knowledge of the process and (6), the model to be fitted is

$$\rho_t - \rho_{t-1} = \omega_0 R_t + N_t \tag{7}$$

where N_t, the noise model of random shocks μ_t is a first-order moving average process with trend MA (1):

$$N_t = \theta_0 - \theta_1 \mu_{t-1} + \mu_t$$

Equation (7), generates the expectation model for ex ante real rates.[9]

$$\hat{\rho}_t = \hat{\rho}_{t-1} + \omega_0 R_{t-1} + \theta_0 + (1 - \theta_1) \mu_{t-1} \tag{8}$$

Depending on the value of the coefficients ω_0 and θ_s', conclusions might be drawn on the constancy of the real interest rate $\hat{\rho}_t$.

Table VI reports the coefficients and their standard deviations as well as residual standard errors (RSE) for (7), the MA (1) model without transfer-function, and for the original series of changes in ex post real interest rates. The results differ across countries. The coefficient ω_0 is statistically significant and negative as expected in four cases (Japan, U.K., France, and Switzerland). The moving average term is highly significant for all countries and close to one except for the U.S.A. (.88) and Belgium (.77). The trends are small (real rates are

[9] The ex ante real rate $\hat{\rho}_t$ for period t is derived from (7) by taking the conditional expected value at the end of period $t - 1$:

$$\hat{\rho}_t - \rho_{t-1} = \omega_0 \hat{R}_t + \theta_0 - \theta_1 \mu_{t-1} \tag{7a}$$

To simplify notations, assume that stock returns follow a random walk with stationary mean ($\hat{R}_t = \hat{R}$) and substract (7a) from (7):

$$\rho_t - \hat{\rho}_t = \omega_0 (R_t - \hat{R}) + \mu_t \tag{7b}$$

Using Equation (7b) to derive $\hat{\rho}_{t-1}$ and replacing in (7) yields

$$\hat{\rho}_t = \hat{\rho}_{t-1} + \omega_0 R_{t-1} + \theta_0 + (1 - \theta_1) \mu_{t-1} \tag{8}$$

Also note that (7b) implies that

$$\mu_t = (RF_t - I_t) - (RF_t - \hat{I}_t) - \omega_0 (R_t - \hat{R})$$

$$\mu_t = \hat{I}_t - I_t + \omega_0 (\hat{R} - R_t) \tag{7c}$$

when $\omega_0 = 0$, the shock or "innovation" in ex post real rate reduces to the innovation in inflation with a minus sign.

Table VI

Influence of the stock returns on expected real rates: Transfer function and comparison with Residual Standard Errors of simpler models

	$\rho_t - \rho_{t-1} = \omega_0 R_t + \theta_0 - \theta_1 \mu_{t-1} + \mu_t$				MA(1)	$\rho_t - \rho_{t-1}$
	ω_0 (S.D.)*	θ_0 (S.D.)	θ_1 (S.D.)†	RSE	RSE	RSE
U.S.A.	− .002 (.003)	− .029 (.047)	.877 (.059)†	3.279	3.270	4.116
JAPAN	− .019 (.003)*	.067 (.116)	1.043 (.002)†	10.704	11.384	14.343
U.K.	.003 (.003)	− .152 (.049)*	1.041 (.004)	8.915	9.193	11.041
GERMANY	− .014 (.003)*	.093 (.024)*	1.018 (.011)	3.614	3.842	4.176
FRANCE	− .004 (.001)*	.044 (.024)	.954 (.031)	3.538	3.612	3.944
NETHERLANDS	− .002 (.003)	− .075 (.043)	.951 (.030)	6.153	6.256	7.492
BELGIUM	− .002 (.004)	− .018 (.094)	.765 (.060)	3.783	3.771	4.499
SWITZERLAND	− .011 (.003)*	.046 (.025)	1.032 (.136)	5.348	5.656	7.008
CANADA	.002 (.002)	− .064 (.038)	.962 (.028)	4.394	4.390	5.516

N.B.: Standard deviation and not t-statistics are given in parentheses to allow a comparison with 1 on θ_1

* and † Coefficients statistically different from 0 or 1 at the 1% level.

measured in percent per year) and insignificant except for U.K. and Germany. The introduction of the stock market variable in the transfer-function brings a significant although small reduction in the residual standard error for the four mentioned countries. While the influence of stock movements on changes in interest rates was quite weak for Japan, this is the country with the strongest influence of stock returns on changes in real rates.

Some more specific comments should be made. The size of the ω_0 is always small. Even for Japan, a 10% drop in the stock market will induce an increase in the real rate of less than 0.2% (0.04% for France). If stock returns indicate general economic conditions, the real rate elasticity would seem to be quite small. Special attention should also be devoted to the value of θ_1. The fact that the moving average coefficient is significantly less than one for the U.S. should be stressed. With a nonsignificant trend and stock market coefficients, Equation (8) for the U.S. reduces to

$$\hat{\rho}_t = \hat{\rho}_{t-1} + .12\ (\hat{I}_{t-1} - I_{t-1})$$

In other words, a higher than expected inflation rate in period $t - 1$ implies a corresponding reduction in the expected real rate at the end of the period. Since both rates are annualized, an unexpected increase of 1% will reduce the real rate by 0.13%: this is a "permanent" effect which will only be offset by future unanticipated low inflation rate. This negative impact of inflation on real interest rate seems to exist only for the U.S. and Belgium, but not for the other countries. For the other countries, the real rate seems to follow a random walk ($\theta_1 = 1$ for the first differences in real rates), once the effect of the stock market is removed. More definite conclusions would require a detailed analysis of the model specification and diagnostic checks (seasonality, cross-correlation) well beyond the scope of this paper.

III. Summary and Conclusions

The Fisherian assumption that real returns are independent of inflationary expectations is soundly rejected for each major stock market of the world. Using interest rates as a proxy for expected inflation, our data provide support for the Geske and Roll [7] model whose basic hypothesis is that stock price movements signal (negative) revisions in inflationary expectations. This relation between stock returns and inflationary expectations appears to be a structural phenomenon, at least in the recent times of floating exchange rates, since it was present for every country.

To check that the results were not caused partly by the use of interest rates as a proxy for expected inflation, a real-interest-rate-effect was tested. The negative relation between stock returns and nominal interest rates would be compounded if ex ante real rates were to increase during a drop of the stock market, as it is claimed by some theories. The impact of stock returns on the real interest rate was found to be always small, but significant for four countries out of nine. The real rate results are significant for precisely those countries, Japan, Germany, Switzerland, and France, whose monetary authorities are less inclined to monetize a deficit (actually France's coefficient is much smaller as one would expect). This suggests at least a minor international difference due to the national attitude towards debt monetization.[10]

To summarize, these results are surprisingly good in their consistency across countries. Without deciding on the "causality" direction, the link between inflation and stock returns appears to be through inflationary expectations and more specifically revisions in expectations.

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