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Fama's Hypotheses of the Relationship Between Inflation and Nominal Interest Rates: An International Comparison

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ABSTRACT

The relationship between inflation and nominal interest rates was extensively researched by Fama (1975, 1977) and others. Fama concluded that expected real returns were constant and that capital markets are efficient in setting nominal t-bill rates. Inflation is predicted by nominal rates.

This paper extends the Fama relationship to international data. Several t-tests and Chow tests resulted in rejection of Fama's conclusions, except for several instances.

I. Introduction

Irving Fisher pointed out that the one-period nominal rate of interest is the equilibrium real return plus the fully anticipated rate of inflation. With imperfect formulation and significant uncertainty the nominal rate of interest can be thought of as the sum of the equilibrium expected real return and the market's view of the expected inflation rate.

Empirical research in this area has to date been largely restricted to United States data. Fama (1975) tested the relationship between nominal interest rates on default-free bonds and price level changes. As such he was the first to test the relationship on an ex ante basis. His conclusions were that:

1) Expected real returns on Treasury Bills were constant during the testing period, and

2) The capital markets are efficient in setting the price of the bills since the nominal rates summarize all the information about future rates of inflation that is in the time series of past rates.

These conclusions have drawn some criticism. Carlson (1977) used survey data on inflation expectations to discount assumption number one. He found that the short-term expected real rate fell during recessions. Further, he found that interest rates were not efficient predictions of inflation. Information about inflation was also provided by an additional variable, the ratio of employment to population. Joines (1977) rejected Fama's results as supportive of his hypothesis. Using an information set broader than the past history of the CPI he concludes that the market is concerned about forecasting a more general index of inflation. Further, the lack of monthly

sampling of all items in the CPI is a deficiency in the data. In setting nominal rates an efficient market should incorporate the effects of any true seasonal pattern in the rate of inflation.

Nelson and Schwert (1977) showed that the autocorrelation function of the ex post real rate of interest may be quite close to zero at all lags, even if the ex ante real rate varies substantially and is highly autocorrelated. They showed that, using the time-series properties of the rate of inflation to construct a univariate ARIMA model, the coefficient of the predictor is large and significant in a composite prediction regression equation which includes the market interest rate. This only occurs if the market were inefficient in assimilating information contained in past inflation rates. By making more efficient use of the information about future inflation contained in past rates, Nelson and Schwert rejected Fama's joint hypothesis.

Hess and Bicksler (1975) also concluded that the behavior of nominal interest rates on Treasury Bills is not consistent with the joint market efficiency and real rate constancy hypotheses. Furthermore, the failure to confirm market efficiency appeared to be the result of naive estimates of the expected real rate. The authors felt this was due to failure to incorporate a more robust model, like ARIMA, in place of simple linear regression.

Fama (1977) countered that all these challenges do not imply rejection of the joint hypotheses over the 1953-71 period for the Treasury Bill market. He found that the interest rate remained the best (if not the sole) single predictor of the inflation rate. Though not an exact description of the actual markets, the specific

deviations were mostly manifestations of measurement errors in the estimates of the different rates.

The purpose of this paper is to test the basic Fama equation on a new, updated data set in an international setting. The basic issue is to see if Fama's hypotheses are valid for monetary and economic systems besides the USA.

II. The Model

Following Fama (1975, 1977) we have the basic Fisher relationship

$$(1) \qquad R_t = \tilde{r}_t + \tilde{\Delta}_t,$$

where $\tilde{r}_t$ and $\tilde{\Delta}_t$ are random variables with $\tilde{r}_t$ = real return in month t, $\tilde{\Delta}_t$ = inflation rate at end of month t-1, and R_t = nominal interest rate quoted at end of month t-1 on a Treasury Bill that matures at the end of month t.

The market's expectation about inflation will depend on the difference between the nominal rate and the market's expectation about the real return, or

$$(2) \qquad E_m(\tilde{\Delta}_t | \phi^m_{t-1}) = R_t - E_m(\tilde{r}_t | \phi^m_{t-1}, R_t)$$

$$= R_t - E(\tilde{r}_t),$$

where $E_m(\tilde{\Delta}_t | \phi^m_{t-1})$ = market's expected inflation rate based on prior information set used by the market, $E_m(\tilde{r}_t | \phi^m_{t-1}, R_t)$ = market's expected real return, based on prior information and current nominal rate, and $E(\tilde{r}_t)$ = expected value of the real return on the bill for the month. This becomes a testable hypothesis via the linear equation

(3) $$\Delta_t = \alpha_0 + \alpha_1 R_t + e_t.$$

If Fama's hypotheses are correct the intercept term should be negative and significantly different from zero ($\alpha_0 = -E(\tilde{r}_t) < 0$) and the slope should be insignificantly different from unity (α_1=1.0). Fama himself found these estimates to be $\alpha_0 = -.00068$ (t = -2.27) and $\alpha_1 = .978$ (t=9.59) from his 1953-71 data.

III. The Data and the Subperiods

The monthly Main Economic Indicators manual, published by the OECD, was our primary source of interest rates and inflation rates. Data for each of seven countries--USA, West Germany, France, Netherlands, Japan, United Kingdom, and Canada--was collected for the period 1965 (first quarter) to 1983 (first quarter). The OECD source lists only the monthly nominal Treasury Bill rates for a three month maturity period for the USA, United Kingdom and Canada. Nominal Call money rates are listed for West Germany, France, Netherlands and Japan. Since the CPI is only reported on a monthly basis the tests are limited to intervals that cover an integral number of months. Specifically in this study, the interval from t-1 to t is three months; R_t is the three-month nominal rate of interest from t-1 to t on a bill with three months to maturity at t-1; the real return $\tilde{r}_t$ and the inflation rate $\tilde{\Delta}_t$ are likewise measured for nonoverlapping three-month intervals. Inflation was defined as the annualized natural log of the ratio of consecutive end-of-quarter CPI values, or $\Delta_t = \ell n(\frac{CPI_t}{CPI_{t-1}}) \cdot 4$, where t = each quarter's third month.

The period of our study includes the transition period in the early 1970s from a worldwide fixed exchange rate regime to a floating system. The period of this transition cannot be pinpointed exactly, but it is credited to have started in August, 1971 with President Nixon's decision to take the USA off the gold standard. The culmination may have been the acceptance of fluctuating international money rates by the major European central bankers in March, 1973.

In our empirical tests we subdivided our data into three segments: (1) the period of fixed exchange rates, 1965-1 through 1971-2, (2) the transition period 1971-3 through 1973-1, and (3) the fluctuating exchange rate period, 1973-2 through 1983-1.

In addition, the period of the late seventies and early eighties saw a marked increase in the rate of inflation almost worldwide. In order to screen out any possible distortions resulting from this marked increase, several empirical results excluded the period 1979-1 through 1983-1.

IV. Empirical Results

The tables on the following pages list the ordinary least squares and seemingly-unrelated regression (OLS and SUR) results for all seven countries during different subperiods. Since the FAMA equation includes "level" (not "change") values of interest rates and inflation, the OLS runs indicated significant autocorrelation difficulties. These difficulties were alleviated by use of the Cochrane-Orcutt iterative technique. These latter results are the ones listed for OLS.

The tests for significance of slope and intercept coefficients use the t-statistic, a ratio of each coefficient value to its standard

error. Thus $t(\alpha_0) = \frac{\hat{\alpha}_0}{S.E.(\hat{\alpha}_0)}$ and $t(\alpha_1) = \frac{\hat{\alpha}_1}{S.E.(\hat{\alpha}_1)}$ test for the intercept and slope, respectively. Meanwhile, the test for Fama's assertion of a slope value of unity uses the ratio $t(\alpha_1-1) = \frac{\hat{\alpha}_1-1}{SE(\hat{\alpha}_1)}$. These three t values are reported in each of the following tables.

The appendices show the residual correlation matrices of the seven country's equations. Since the SUR technique is used when contemporaneous correlation of residuals across equations is presumed, a statistically significant residual correlation would be evidence of its need.

a) The Entire Period, 1965-1 to 1983-1

A total of 73 quarters comprise the entire sample period. Table 1 shows corrected OLS results for all seven countries. The slope coefficient is significantly different from zero for all countries except Netherlands. But for only three countries (USA, Japan and United Kingdom), $\hat{\alpha}_1$ is insignificantly different from unity, as Fama prescribes. Furthermore, as a harbinger of a pattern to continue, the constant term $\hat{\alpha}_0$ is insignificant in our instances and has the wrong sign when it is significant. The fairly strong residual correlations shown in Appendix A imply some plausibility in running the SUR technique for each country. The results (shown in Table 1) do not differ much from OLS. Only two equations have $\hat{\alpha}_1$ insignificantly different from 1.0, while all $\hat{\alpha}_0$ values go against the Fama hypothesis. Even Japan has a positive $\hat{\alpha}_0$ under SUR, after its negative value in OLS approached Fama's assertion of constant expected real rate of return.

Table 1: SUR and OLS[a] Results for Fama Equation $\Delta_t = \alpha_0 + \alpha_1 R_t$
For Period 1965(1) - 83(1)
(n=73 quarters)

Country	Method	R^2	α_0	$t(\alpha_0)$	α_1	$t(\alpha_1)$	$t(\alpha_1-1)$
USA	OLS	.19	.013	0.92	.698	4.00**	-1.73
	SUR	--	.014	1.74	.704	7.02**	-2.95**
Germany	OLS	.14	.017	2.04*	.415	3.44**	-4.85**
	SUR	--	.019	2.55**	.381	3.58	-5.82**
France	OLS	.32	.016	1.32	.725	5.78**	-2.19*
	SUR	--	.015	1.84	.737	8.88**	-3.17**
Netherlands	OLS	.005	.065	7.13**	-.078	-0.60	-8.29**
	SUR	--	.062	8.07**	-.030	-0.27	-9.27**
Japan	OLS	.17	-.024	-0.94	1.228	3.72**	0.69
	SUR	--	.008	0.41	.796	3.13**	-0.80
United Kingdom	OLS	.11	.014	0.48	.887	2.89**	-0.37
	SUR	--	.024	1.31	.791	4.19**	-1.11
Canada	OLS	.21	.027	2.47**	.517	4.26**	-3.98**
	SUR	--	.025	3.54**	.537	6.72**	-5.79**

[a]Corrected for Autocorrelation

*5% level of significance

**1% level of significance

Source: OECD, Main Economic Indicators, 1965-1983

b) Fixed Exchange Rate Period, 1965-1 to 1971-2

The 18-year period of the entire sample includes numerous developments and changes in the world economy and in each country's specific economy. In an effort to disaggregate these developments, regressions were run over various subsample periods. The earliest period occurred during the fixed exchange rate regime. This dovetails over a good deal of Fama's time period of study. The results are listed in Table 2.

The most successful OLS results occurred in the USA and Japan. Both equations had negative (though not significant) $\hat{\alpha}_0$ values, and $\hat{\alpha}_1$ estimates not insignificantly different from unity. The $\hat{\alpha}_1$ value for the USA was also significantly different from zero, making this equation the best evidence for Fama's hypotheses.

Unfortunately the hypotheses do not seem to prevail in other countries. Besides the USA, only Japan and the United Kingdom had $\hat{\alpha}_1$ values close to 1.0, while five countries had intercept values of the wrong sign. The SUR results were no better for most equations, and was worse for the case of Japan. The relatively low correlations in Appendix B seem to imply that OLS results are fairly reliable.

c) Floating Exchange Rate Period, 1973-2 to 1983-1

Tables 3 lists the results from the period of floating exchange rates in the world economy. The OLS results contradict the Fama hypotheses in all cases except Japan. The Japanese equation has the only negative (though insignificant) $\hat{\alpha}_0$ value, and had $\hat{\alpha}_1$ close to 1.0. Only the United Kingdom's $\hat{\alpha}_1$ value is also close to unity. The SUR results are no better for most countries, and worse for Japan and

Table 2: SUR and OLS[a] Results for Fama Equation $\Delta_t = \alpha_0 + \alpha_1 R_t$ For Period 1965(1) - 1972(2), Fixed Exchange Rate System (n=26 quarters)

Country	Method	R^2	$\hat{\alpha}_0$	$t(\hat{\alpha}_0)$	$\hat{\alpha}_1$	$t(\hat{\alpha}_1)$	$t(\hat{\alpha}_1-1)$
USA	OLS	.63	-.017	-1.76	1.100	6.22**	0.57
	SUR	--	-.016	-1.64	1.084	6.08**	0.47
Germany	OLS	.06	.012	0.70	.374	1.26	-2.11*
	SUR	--	.016	0.95	.306	1.09	-2.47*
France	OLS	.29	.007	0.59	.557	3.05**	-2.43*
	SUR	--	.012	0.95	.491	2.72**	-2.82**
Netherlands	OLS	.02	.069	2.55*	-.386	-0.69	-2.48*
	SUR	--	.067	2.56*	-.341	-0.64	-2.52*
Japan	OLS	.06	-.009	-0.19	.866	1.24	-0.19
	SUR	--	.034	0.47	.261	0.26	-0.74
United Kingdom	OLS	.03	.006	0.11	.713	0.85	-0.34
	SUR	--	.010	0.23	.641	0.99	-0.55
Canada	OLS	.02	.025	1.67	.196	0.74	-3.04**
	SUR	--	.032	2.12*	.052	0.19	-3.46**

[a]Corrected for Autocorrelation

*5% level of significance

**1% level of significance

Source: OECD, Main Economic Indicators, 1965-1983

Table 3: SUR and OLS[a] Results for Fama Equation $\Delta_t = \alpha_0 + \alpha_1 R_t$
For Period 1973(2) - 1983(1), Floating Exchange Rate System
(n=40 quarters)

Country	Method	R^2	$\hat{\alpha}_0$	$t(\hat{\alpha}_0)$	$\hat{\alpha}_1$	$t(\hat{\alpha}_1)$	$t(\hat{\alpha}_1-1)$
USA	OLS	.09	.039	1.65	.478	1.88	-2.05*
	SUR	--	.040	2.91**	.481	3.25**	-3.51**
Germany	OLS	.17	.019	1.78	.405	2.76**	-4.05**
	SUR	--	.020	2.11*	.402	3.28**	-4.88**
France	OLS	.16	.064	3.86**	.390	2.66**	-4.16**
	SUR	--	.057	4.56**	.456	4.19**	-5.00**
Netherlands	OLS	.02	.075	5.80**	-.141	-0.94	-7.61**
	SUR	--	.064	6.63**	.001	0.01	-9.99**
Japan	OLS	.17	-.025	-0.64	1.291	2.79**	0.63
	SUR	--	.006	0.27	.888	3.29**	-0.41
United Kingdom	OLS	.01	.094	1.52	.302	0.56	-1.29
	SUR	--	.105	2.60**	.214	0.61	-2.24*
Canada	OLS	.06	.071	4.84**	.201	1.49	-5.92**
	SUR	--	.070	5.91**	.213	1.97*	-7.28**

[a]Corrected for Autocorrelation

*5% level of significance

**1% level of significance

Source: OECD, Main Economic Indicators, 1965-1983

the U.K. than OLS. The residual correlation matrix associated with Table 4 is listed in Appendix C.

d) Floating Exchange Rate Period with Moderate Inflation, 1973-2 through 1978-4

The soaring inflation rates which started in 1979 had, by 1981-82, resulted in a significant gap between nominal rates and inflation. This seeming increase in the real rate would distort the Fama equation. To test the hypotheses without this distortion we ran OLS and SUR for 23 quarters of moderate inflation throughout the mid-to-late 1970s. Table 4 has these results.

The $\hat{\alpha}_1$ values were improved for most OLS results. Five countries had slope values statistically close to one. However, only the Japanese equation showed a negative $\hat{\alpha}_0$ value. Meanwhile, the SUR results did not improve the results for any country, but worsened them for Germany, France and Japan. The residual matrix in Appendix D seems to imply little contemporaneous correlation between countries.

e) The Entire Period During Moderate Inflation, 1965-1 to 1978-4

Combining both exchange rate periods during moderate cost of living increases generated the results shown in Table 5. Compared to the results in Table 1's OLS, the Fama hypotheses seem to fit the USA, France, Japan and the United Kingdom. All of these (as well as Canada) have $\hat{\alpha}_1$ values close to one; but all negative α_0 values are not much different from zero. The use of SUR (justified by the large correlations in Appendix E) resulted in a worsening in France and Canada. But the USA, Japan and the United Kingdom maintained the correct signs and (for $\hat{\alpha}_1$) the correct t values with regards to Fama's

Table 4: SUR and OLS[a] Results for Fama Equation $\Delta_t = \alpha_0 + \alpha_1 R_t$ For Period 1973(2) - 1978(4), Floating Exchange Rate System (n=23 quarters)

Country	Method	R^2	$\hat{\alpha}_0$	$t(\hat{\alpha}_0)$	$\hat{\alpha}_1$	$t(\hat{\alpha}_1)$	$t(\hat{\alpha}_1-1)$
USA	OLS	.24	.011	0.40	1.040	2.49*	0.10
	SUR	--	.031	1.61	0.727	2.47*	-0.93
Germany	OLS	.26	.011	0.80	.610	2.65**	-1.69
	SUR	--	.013	1.12	.577	3.10**	-2.27*
France	OLS	.37	.025	1.07	.822	3.39**	-0.73
	SUR	--	.053	2.57*	.511	2.35*	-2.25*
Netherlands	OLS	.08	.086	5.89**	-.236	-1.31	-6.86**
	SUR	--	.075	6.58**	-.041	-0.28	-7.11**
Japan	OLS	.31	-.018	-0.43	1.471	2.97**	0.95
	SUR	--	.013	0.47	1.090	3.58**	0.30
United Kingdom	OLS	.02	.094	1.20	.466	0.60	-0.69
	SUR	--	.087	1.66	.557	1.08	-0.86
Canada	OLS	.08	.134	3.73**	-.583	-1.29	-3.50**
	SUR	--	.137	4.64**	-.625	-1.68	-4.37**

[a]Corrected for Autocorrelation

*5% level of significance

**1% level of significance

Source: OECD, Main Economic Indicators, 1965-1983

Table 5: SUR and OLS[a] Results for Fama Equation $\Delta_t = \alpha_0 + \alpha_1 R_t$ For Period 1965(1) - 1978(4), Both Exchange Rate Systems During Moderate Inflation (n=56 quarters)

Country	Method	R^2	$\hat{\alpha}_0$	$t(\hat{\alpha}_0)$	$\hat{\alpha}_1$	$t(\hat{\alpha}_1)$	$t(\hat{\alpha}_1-1)$
USA	OLS	.42	-.025	-1.87	1.427	6.21**	1.86
	SUR	--	-.016	-1.67	1.270	7.86**	1.67
Germany	OLS	.14	.015	1.51	.471	2.98**	-3.35**
	SUR	--	.019	2.15*	.400	2.91**	-4.36**
France	OLS	.34	-.003	-0.18	.957	5.25**	-0.24
	SUR	--	.013	1.27	.745	5.76**	-1.97
Netherlands	OLS	.01	.069	6.48**	-.133	-0.75	-6.39**
	SUR	--	.068	7.61**	-.098	-0.67	-7.51**
Japan	OLS	.23	-.029	-1.06	1.408	3.96**	1.15
	SUR	--	-.005	-0.23	1.090	3.62**	0.30
United Kingdom	OLS	.15	-.008	-0.23	1.238	3.08**	0.59
	SUR	--	-.008	-0.34	1.254	4.60**	0.93
Canada	OLS	.10	.014	0.73	.725	2.48**	-0.94
	SUR	--	.025	2.14*	.548	3.04**	-2.51*

[a]Corrected for Autocorrelation

*5% level of significance

**1% level of significance

Source: OECD, Main Economic Indicators, 1965-1983

assertions. It appears that the uncharacteristic 1979-83 period served to distort the Fisher relationship.

f) Combined Exchange Rate Periods Excluding the Transition Period, 1965-1 to 1971-2 and 1973-2 to 1983-1

Finally, the transition period of 1971-73 was excluded from the entire sample period. The results in Table 6 show a similar pattern to most prior evidence. Only Japan's equation exhibited the dual conditions of $\hat{\alpha}_1$ close to 1.0 and $\hat{\alpha}_0 < 0$. The inclusion of the 1979-83 distortion period here undoubtedly had a deleterious effect on the coefficients. The residual correlation coefficient matrix is listed in Appendix F.

V. Chow Tests on All Time Periods

a) Lump Sum Comparisons

In order to test for the constancy of the intercept and slope coefficients across all seven countries' regressions an F-test was constructed. The null and alternative hypotheses are as follows:

$$H_0: \quad \alpha_0^A = \alpha_0^G = \alpha_0^F = \alpha_0^N = \alpha_0^J = \alpha_0^K = \alpha_0^C; \; \alpha_1^A = \alpha_1^G = \alpha_1^F = \alpha_1^N = \alpha_1^J = \alpha_1^K = \alpha_1^C$$

$$H_a: \quad H_0 \text{ is not true,}$$

where the superscripts A, G, F, N, J, K, and C refer, respectively, to the USA, Germany, France, Netherlands, Japan, United Kingdom, and Canada.

The pooled regression of all seven countries' data for each respective time period (as shown in Tables 1, 2, 3, 4, 5 and 6) was

Table 6: SUR and OLS[a] Results for Fama Equation $\Delta_t = \alpha_0 + \alpha_1 R_t$
For Period 1965(1) - 1971(2) and 1973(2)-1983(1),
Both Exchange Rate Systems Without Transition Period
(n=66 quarters)

Country	Method	R^2	$\hat{\alpha}_0$	$t(\hat{\alpha}_0)$	$\hat{\alpha}_1$	$t(\hat{\alpha}_1)$	$t(\hat{\alpha}_1-1)$
USA	OLS	.17	.015	1.00	.675	3.64**	-1.75
	SUR	--	.018	2.08*	.658	6.22**	-3.23**
Germany	OLS	.14	.014	1.55	.435	3.27**	-4.25**
	SUR.	--	.017	2.03*	.387	3.20**	-5.07**
France	OLS	.32	.013	0.99	.749	5.47**	-1.83
	SUR	--	.012	1.42	.760	8.72**	-2.75**
Netherlands	OLS	.02	.060	5.67**	-.018	-0.12	-6.79**
	SUR	--	.059	6.42**	.007	0.05	-7.09**
Japan	OLS	.20	-.037	-1.37	1.360	4.03**	1.07
	SUR	--	-.004	-0.18	.934	3.47**	-0.25
United	OLS	.09	.015	0.44	.879	2.57**	-0.35
Kingdom	SUR	--	.027	1.28	.770	3.68**	-1.10
Canada	OLS	.20	.025	2.00*	.531	3.96**	-3.50**
	SUR	--	.023	2.85**	.556	6.38**	-5.09**

[a]Corrected for Autocorrelation

*5% level of significance

**1% level of significance

Source: OECD, Main Economic Indicators, 1965-1983

estimated. The sum of the squared errors (SSE^{TOT}) from this regression was used, together with the SSE values from the seven separate autocorrelation--corrected OLS runs. In line with Zellner (1962), Bower and Bower (1969) and Chung (1974), the following F-statistic was set up, for (M-1)(P-q) degrees of freedom in the numerator and (m•n - m•p) degrees of freedom in the denominator:

$$F = \frac{(SSETOT-SSEA-SSEG-SSEF-SSEN-SSEJ-SSEK-SSEC)/(M-1)(P-q)}{(SSE^{A}+SSE^{G}+SSE^{F}+SSE^{N}+SSE^{J}+SSE^{K}+SSE^{C})/(M\cdot n-M\cdot P)},$$

where M = number of individual regressions (7), P = number of variables employed (2), q = number of variables excluded (0), and n = number of observations per regression.

Table 7 lists the F value and degrees of freedom for each of the six time periods discussed in Section IV. In all cases, the value is significant at the 1 percent level. Thus the null hypothesis of coefficient constancy across all models must be rejected. There is significant variability from model to model.

b) Comparing Individual Country Equations to the USA Equation

Besides considering the overall constancy of coefficients, it is of interest to see how the six foreign regressions of Fama's model compare to the United State's results. F values of these "one-to-one" relationships were calculated across all six time periods, and are listed in Table 8.

Looking across all time periods, the USA-French relationship showed the largest amount of constancy of coefficients. Five of six F-values were insignificant. The USA-Japanese situation was also similar, with four of six F values being low. Interestingly, the F-value was low for the overall period (1965-83) but significantly

Table 7: F-Values for "Lump-Sum" Comparisons of Fama Equation for Different Time Periods (OLS Method Only)

Period	F-Value	D.F. (Num., Denom.)
1965(1)-83(1)	7.949**	(12,497)
1965(1)-71(2)	2.768**	(12,168)
1973(2)-83(1)	8.192**	(12,266)
1973(2)-78(4)	5.893**	(12,147)
1965(1)-78(4)	7.379**	(12,378)
1965(1)-71(2) and 1973(2)-83(1)	7.116**	(12,448)

*5% level of significance

**1% level of significance

Source: Same as Table 1

Table 8: F-Values for Individual Country Comparisons to USA Equation for Different Time Periods (OLS Method Only)

Other Country	1965-83 F-Value	1965-71 F-Value	1973-83 F-Value	1973-78 F-Value	1965-78 F-Value	1965-71 73-83 F-Value
Germany	17.814**	2.000	15.049**	5.585**	11.822**	17.416**
France	1.031	1.846	4.082*	0.265	2.659	-0.787
Netherlands	21.211**	3.260*	12.718**	5.948**	13.283**	16.085**
Japan	-0.215	7.549**	3.320*	1.262	-0.701	0.000
UK	9.897**	1.670	8.718**	4.810*	9.625**	8.999**
Canada	5.046**	4.688*	4.313*	-0.520	-0.809	3.801*
DF(Num, Denom)	(2,142)	(2,48)	(2,76)	(2,42)	(2,108)	(2,128)

*5% level of significance

**1% level of significance

Source: Same as Table 1.

higher for each of the two separate exchange rate periods (1965-1971 and 1973-83). The relationship between the USA models and each of the three other European countries was more distant. Only two of the 15 F-values associated with Germany, Netherlands, and the UK were insignificant. There is very little similarity in the coefficient results between the USA and these countries. Finally, even the USA-Canadian relationship is fairly weak. Only two of five F-values (for the periods 1973-78 and 1965-78) indicate acceptance of the null hypothesis of α_0 and α_1 constancy between the two countries.

VI. Conclusions

The results of these tables show that the Fama hypotheses of a constant real rate and complete summarization of future inflation from past nominal rates, as tested via linear regression, seems to hold in only isolated cases. The United States and Japanese equations seem to behave well in certain subsample periods. The equations behave poorly in most other countries, and the nominal rate seems to be inversely related to inflation in the Netherlands.

The results of the Chow tests for coefficient constancy across different countries' equations show a great amount of discrepancy. All pooled results were different from the disaggregated regressions; and the USA-other country individual comparisons for the most part led to the rejection of the null hypothesis.

Perhaps it is not a coincidence that the Fisher relationship seems to be most closely reflected in the two most affluent capitalistic economies in the world. The statistical comparisons between the USA and Japan showed much similarity in structure.

Apparently there is also a relation between stability of the coefficients and volatility of the inflation rate. Perhaps the OLS method of testing the hypotheses is sensitive to the fluctuating values of the dependent variable. Certainly the results were more in line with Fama before the 1979-83 increased volatility period. The use of alternative testing techniques, such as univariate and multivariate ARIMA, may reduce this distortion problem.

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Appendix A: Residual Correlation Matrix
From Results for 1965(1)-83(1)
(n=73 quarters)

Country	USA	Germany	France	Netherlands	Japan	U.K.	Canada
USA	1	.242*	.496*	.234*	.420**	.509**	.398**
Germany		1	.293*	.296*	.109	.396**	.225
France			1	.382**	.265*	.361**	.454**
Netherlands				1	.332**	.274*	.246*
Japan					1	.168	.198
U.K.						1	.385**
Canada							1

*5% level of significance

**1% level of significance

Source: OLS regressions over 1965(1)-83(1) period

Appendix B: Residual Correlation Matrix
From Results for 1965(1)-71(2)
(n=25 quarters)

Country	USA	Germany	France	Netherlands	Japan	U.K.	Canada
USA	1	.205	.438*	.226	.257	.425**	.401**
Germany		1	.389*	.274	-.045	.244	.089
France			1	.316	.217	.320	.276
Netherlands				1	.161	.086	-.024
Japan					1	-.025	-.166
U.K.						1	-.008
Canada							1

*5% level of significance

**1% level of significance

Source: OLS regressions over 1965(1)-71(2) period

Appendix C: Residual Correlation Matrix
From Results for 1973(2)-83(1),
Floating Exchange Rate System
(n=40 quarters)

Country	USA	Germany	France	Netherlands	Japan	U.K.	Canada
USA	1	.328*	.502*	.274	.424**	.475**	.311
Germany		1	.119	.219	.184	.528**	.195
France			1	.485**	.272	.269	.250
Netherlands				1	.411**	.402	.288
Japan					1	.166	.068
U.K.						1	.230
Canada							1

*5% level of significance

**1% level of significance

Source: OLS regressions over 1973(2)-83(1) period

Appendix D: Residual Correlation Matrix
From Results for 1973(2)-78(4),
Floating Exchange Rate System
During Moderate Inflation Period
(n=23 quarters)

Country	USA	Germany	France	Netherlands	Japan	U.K.	Canada
USA	1	-.020	.316	.301	.336	.215	.438*
Germany		1	-.143	.125	-.042	.483*	-.088
France			1	.392	.363	.101	.073
Netherlands				1	.372	.366	.010
Japan					1	-.217	-.084
U.K.						1	.234
Canada							1

*5% level of significance

**1% level of significance

Source: OLS regressions over 1973(2)-78(4) period

Appendix E: Residual Correlation Matrix
From Results for 1965(1)-78(4),
Both Exchange Rate Systems
During Moderate Inflation Period
(n=56 quarters)

Country	USA	Germany	France	Netherlands	Japan	U.K.	Canada
USA	1	.206	.396**	.330*	.344**	.341*	.519**
Germany		1	.281*	.308*	.045	.356**	.245
France			1	.358**	.294*	.278*	.380**
Netherlands				1	.318*	.230	.217
Japan					1	-.054	.200
U.K.						1	.416*
Canada							1

*5% level of significance

**1% level of significance

Source: OLS regressions over 1965(1)-78(4) period

Appendix F: Residual Correlation Matrix
From Results for 1965(1)-72(2) and 1973(2)-83(1)
Both Exchange Rate Systems Without Transition Period
(n=66 quarters)

Country	USA	Germany	France	Netherlands	Japan	U.K.	Canada
USA	1	.265*	.542**	.240	.424**	.516**	.416**
Germany		1	.293*	.277*	.091	.412**	.222
France			1	.408**	.312*	.358**	.448**
Netherlands				1	.300*	.290*	.265*
Japan					1	.176	.188
U.K.						1	.402**
Canada							1

*5% level of significance

**1% level of significance

Source: OLS regressions over 1965(1)-71(2) and (1973(2)-83(1) combined period.