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Inflation, Taxation, and the Rate of Interest--  
A Study of Eight Industrial Countries, 1961-82

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I. Introduction

Persistently high interest rates in recent years have renewed the interest in the theories of interest rate determination and in the relationship between inflation and interest rates. Questions have arisen as to the impact of differential tax treatment of interest income and expenses in different countries on the rate of interest. This study investigates the relationship between interest rates and inflation, and the effects of taxation on this relationship for a sample of eight industrial countries during the period 1961-82.

The classical theories of the determination of interest rates, Ricardo's theory of value, Wicksell and the Austrian school's natural rate, and the Fisherian theory on the interaction between time preference of individuals and the marginal productivity of capital were all theories of the determination of real interest rates. With the introduction of money into the analysis, the loanable funds (Fisher) approach and the liquidity preference (Keynes) or portfolio approach were developed. Periods of inflation necessitated that a distinction be drawn between the money rate and the real rate of interest.

The "Fisher effect," which had first been introduced by Thornton (1802) and subsequently formalized by Fisher (1896; 1930), suggests that as individuals anticipate higher rates of inflation they would expect nominal rates of interest to reflect this increase. <sup>1/</sup> However, Fisher (1930, p. 43) observed ". . . when prices are rising, the rate of interest tends to be high but not so high as it should be to compensate for the rise; and when prices are falling, the rate of interest tends to be low, but not so low as it should be to compensate for the fall." Employing a

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<sup>1/</sup> See Ben-Zion (1982) for a survey of the literature on the Fisher effect.

loanable funds framework, Fisher expected the anticipated inflation coefficient to be unity, and upon observing a smaller coefficient, he noted that the erratic behavior of real interest rates is evidently a trick played on the money market by "money illusion" and he went on arguing that it was also due to "the instability of money."

Analysis of the effect of a change in anticipated inflation on the real rate of interest was introduced by Mundell (1963) and Tobin (1965). Mundell demonstrated that a rise in expected inflation would result in a decrease in the real rate of interest, the rationale being that a rise in anticipated inflation depresses equilibrium real balances, thus causing an increase in saving to compensate for the real balance effect. Equilibrium is restored by means of a lower real interest rate, which raises the level of investment until it is equal to the higher level of savings. The "Tobin effect" is a portfolio effect noting that a rise in anticipated inflation causes a shift out of money balances and into real capital, thereby depressing the marginal product of capital and the equilibrium real rate. Thus, according to Mundell the Fisher equation,

$$(1) \quad i = r + \pi^e$$

where  $i$  is the nominal rate of interest,  $r$  is the real rate of interest, and  $\pi^e$  is the anticipated rate of inflation would imply that  $dr/d\pi^e < 0$  and  $di/d\pi^e < 1$  and not  $di/d\pi^e = 1$  as Fisher would have expected.

More recently, economists have realized that the relationship between changes in anticipated inflation and interest rates ought to be adjusted for the tax effect. This "tax effect" was developed independently by Darby (1975), Tanzi (1976), and Feldstein (1976), who noted that if the pretax Fisher effect, e.g., the coefficient of  $\pi^e$  (equation 1) were unitary, then the tax-adjusted Fisher effect should be  $(1/1-\tau)$  where  $\tau$  is the effective tax rate applied to interest income. Since  $1 > \tau > 0$ ,  $1/1-\tau > 1$ , the combined Fisher effect and tax effect would result in a coefficient greater than unity. If a capital gains tax ( $\theta$ ) is introduced, the modified Fisher and tax effects would be  $\frac{1-\theta}{1-\tau}$ , which could still be greater than one but less than  $1/1-\tau$  since  $\tau$ , is normally greater than  $\theta$ .

Since the Fisher equation reflects only partial equilibrium, a number of attempts have been made to develop more comprehensive models incorporating macroeconomic effects as well as tax effects. Levi and Makin (1978) constructed a macroeconomic model wherein  $di/d\pi^e$  was derived; it was shown to depend on income, liquidity, and employment effects as well as interest income tax and capital gains tax. A more detailed model was constructed by Summers (1982), while Nielsen (1981) developed a general-equilibrium framework based on microeconomic optimizing behavior by both households and firms. He incorporated personal income tax, company income tax, and capital gains tax into the model, but his conclusions were similar to the ones derived earlier in that the nominal interest rate would increase by more than the pure Fisher effect but by less than required to keep consumers' real after-tax rate of return constant.

Empirical studies on the relationship between interest rates and inflation with or without taxes have tended to focus on the United States, while little work has been done with regard to other countries. This paper investigates to what extent interest rates respond differently to changes in expected and actual inflation rates in different countries with different rates of inflation, given different tax treatments of interest income or capital gains; it also investigates to what extent response coefficients have changed over time as the world economy has moved from lower to high rates of inflation and to what extent, if any, changes in the instruments of monetary policy have affected these response coefficients.

This study is divided into three parts. The first part tests the relationship between short-term and long-term interest rates, on the one hand, and actual and expected inflation, on the other hand. The second part deals with the impact of acceleration in the rate of inflation that occurred in the 1970s and the response of interest rates to inflation; it also studies the possible effects of the October 1979 change in technique of monetary policy on this relationship. The third part studies the impact of taxation on the response of interest rates to inflation.

This study introduces to the literature on the Fisher effect a new technique developed by Frankel (1982) to derive a time series of expected inflation from the term structure of interest rate. The results of the tests show that the Fisher effect based on expected inflation was generally not significantly different from unity; the response coefficient of interest rates to actual inflation was significantly less than one for all eight countries during the period 1961-81. The results also indicate that the acceleration of inflation during the 1970s was accompanied by increases in these response coefficients; a slight increase was also observed following the October 1979 change by the U.S. conduct of monetary policy. The Fisher effect, adjusted for interest income tax and capital gains tax, was found to be broadly consistent with the estimated response coefficients of nominal interest rates to expected inflation.

In interpreting these results, it ought to be noted that in most of the sample countries interest rates have been an instrument of monetary policy and in some of the countries varying degrees of credit rationing have been pursued, while in other countries a liberal approach to capital flows, or the existence of offshore banking, tended to "exogenize" interest rates. Thus, the response of interest rates to inflation would reflect the adjustment of interest rates by the monetary authorities to inflation in countries that have pursued monetary or interest rates controls, and external factors in countries that have pursued policies of free capital flows.

## II. The Study

In studying the Fisher effect, one ought to recognize that the Fisher equation relating interest rates to expected inflation is an ex post identity, while ex ante it is nothing but a partial equilibrium; it is not a theory of interest rate determination as such and does not include all the variables that determine interest rates. A major theoretical issue, recognized in the literature, is in the treatment of the effect of expected inflation on the expected real interest rate. In addition, two methodological obstacles that an empirical study of the Fisher effect encounters are the determination or measurement of expected inflation, and the measurement of the interaction between the expected real rate and expected inflation. The first obstacle was bypassed in a number of studies on the United States and the United Kingdom by using the Livingston series on expected inflation, or by using actual inflation or distributed lags thereof; as for the second obstacle, attempts have been made to use proxy variables, such as capacity utilization, but these have raised additional methodological problems.

In this study, a number of formulations for inflation are used; these include actual inflation, distributed lags of present and past inflation, inflationary expectations formed by distributed lags of past inflation and monetary growth, and inflationary expectations derived from the term structure of interest rates based on the new Frankel technique.

Regarding the effect of expected inflation on the real interest rate, a number of tests are conducted where the computed ex post real interest rate is subtracted from the nominal rate of interest so that the nominal rate of interest less the ex post real rate is regressed on actual or expected inflation rates. This is designed, in part, to take account of the effect of expected inflation on the real interest rate.

### 1. Inflation and the interest rate

As a first approximation the actual rate of inflation is employed, the rationale being twofold. First, actual inflation can be thought of as representing a form of rational expectations (with perfect foresight), 1/ and second, such a test could indicate the extent of an ex post response of interest to inflation. Thus, the equation estimated was

$$(2) \quad i_t = \beta_0 + \beta_1 \pi_t + u_t$$

where  $i_t$  is the short-term interest rate, and  $\pi_t$  the rate of inflation. Using quarterly data for the period 1961-81 and adjusting for serial correlation in the error term, the results indicate that the estimated coefficient of  $\pi_t$  is significant with a probability of 98 per cent for seven of the eight countries--the exception being the United Kingdom

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1/ See Summers (1982, Appendix, pp. 52-57).

(Table 1). Among the other seven countries  $\beta_1$  is significantly less than one; the highest was found for the United States (0.671) and France (0.637), while Italy, Canada, and the Federal Republic of Germany recorded coefficients of about one half; Japan and the Netherlands were well below, with 0.228 and 0.147, respectively.

Since  $di/d\pi < 1$ , the intercept cannot be regarded as the real interest rate. Table 5 (in the Appendix) provides a summary of average short-term interest rates, average rates of inflation, and average ex post real rates of interest for the full period 1961-81 and for the two subperiods. With the exception of the United Kingdom, which had negative real interest for the period as a whole, all other countries experienced positive average real interest rates. As for the breakdown of the period into two subperiods, the more than doubling of average inflation rates was accompanied by a decline in average real interest rates for all countries. These computations, however, are in no way an analytical proof of the Mundell-Tobin effect, but as a casual observation it is interesting to note that along with the rise in inflation rates, ex post real interest rates tend to be lower.

Thus, a second test is designed to establish the "true" coefficient of response of interest to inflation by superimposing the ex post average real interest rate on the regression as the intercept,  $\beta_0$ . The estimated equation was

$$(3) \quad i_t - \bar{r} = \beta_1 \pi_t + u_t$$

where  $\bar{r}$  is the average real interest rate for the period 1961Q1-1981Q4

defined as  $\bar{r} = \bar{i} - \bar{\pi}$ , and  $\bar{i}$  and  $\bar{\pi}$  are average interest and inflation rates, respectively. The motivation behind this formulation is that  $\beta_1$  reflects the response of the interest rate to changes in expected inflation most accurately when the intercept  $\beta_0$  is equal to the real rate of interest. Also, by computing the average ex post real rate, account is being taken of the fact that  $dr/d\pi^e \neq 0$ . Thus, the results of the estimation, which are summarized in Table 2, are theoretically more defensible than the results of the previous test. These results show that for the period as a whole, the response coefficients are the highest for France (0.888) and the United States (0.876), in the range of 0.5 for the Federal Republic of Germany, Italy, and Canada, and 0.213 for the Netherlands; Japan and the United Kingdom did not record significant coefficients.

To assess the cumulative effect of inflation on interest rates, two alternative schemes of distributed lags were employed, both using the Almon lag technique with polynomials of degree 3 corrected for autocorrelation. In the first,

$$(4) \quad i_t = \alpha + \sum_{l=0}^8 \beta_l \pi_{t-l} + u_t$$

Table 1. Eight Industrial Countries: Regression of Short-Term Interest Rates on Inflation, 1961Q<sub>1</sub> - 1981Q<sub>4</sub> <sup>1/</sup>

$$(i_t = \beta_0 + \beta_1 \pi_t + u_t)$$

Country	$\beta_0$	$\beta_1$	$\bar{R}^2$	$\bar{DW}$
Canada	4.373 (2.922)	0.491 (3.055)	0.923	1.718 <sup>b</sup>
France	2.854 (3.595)	0.637 (6.854)	0.919	1.823 <sup>b</sup>
Germany, Fed. Rep.	4.824 (3.237)	0.482 (2.485)	0.846	1.470 <sup>a</sup>
Italy <sup>2/</sup>	5.104 (2.281)	0.533 (4.444)	0.900	1.922 <sup>b</sup>
Japan	5.799 (7.669)	0.228 (4.257)	0.835	1.355 <sup>a</sup>
Netherlands	6.667 (8.765)	0.147 (2.790)	0.861	1.687 <sup>b</sup>
United Kingdom	8.559 (4.833)	0.061 (0.818)	0.899	1.899 <sup>b</sup>
United States	2.303 (3.499)	0.671 (7.248)	0.914	1.786 <sup>b</sup>

<sup>1/</sup> Inflation is defined as  $\pi_t = [(P_t/P_{t-4}) - 1] \cdot 100$ ; (a) and (b) represent one-lag and two-lag autoregressive error terms, respectively, adjusted by the Cochrane-Orcutt procedure. T-values are in parentheses.

<sup>2/</sup> Data on short-term interest rates are available only from 1971Q<sub>1</sub> to 1981Q<sub>4</sub>.

Table 2. Eight Industrial Countries: Response of Short-Term Interest Rates to Inflation, 1961Q1 - 1981Q4 <sup>1/</sup>

$$(i_t - \bar{r} = \beta_1 \pi_t + u_t)$$

Country	Years	$\bar{r}$	$\beta_1$	$\bar{R}^2$	$\bar{DW}$
Canada	1961-81	1.035	0.425 (2.450)	0.921	1.669 <sup>b</sup>
	1961-71	1.993	0.936 (11.005)	0.888	1.881 <sup>a</sup>
	1971-81	0.165	0.879 (6.221)	0.885	1.756 <sup>b</sup>
France	1961-81	0.260	0.888 (15.660)	0.910	1.303 <sup>b</sup>
	1961-71	1.315	0.417 (2.129)	0.938	1.427 <sup>a</sup>
	1971-81	-0.699	0.973 (25.407)	0.866	1.796 <sup>b</sup>
Germany, Fed. Rep.	1961-81	2.273	0.548 (3.051)	0.843	1.516 <sup>a</sup>
	1961-71	2.425	0.170 (0.870)	0.745	2.024 <sup>a</sup>
	1971-81	2.135	1.050 (6.910)	0.884	1.930 <sup>b</sup>
Italy	1971-81	-2.220	0.505 (4.425)	0.893	1.895 <sup>b</sup>
Japan	1961-81	0.134	-0.009 (-0.048)	0.591	1.933 <sup>a</sup>
	1961-71	0.871	0.073 (1.113)	0.915	1.983 <sup>a</sup>
	1971-81	-0.538	0.818 (3.106)	0.409	1.979 <sup>b</sup>
Netherlands	1961-81	0.527	0.213 (3.837)	0.822	1.404 <sup>a</sup>
	1961-71	2.473	0.039 (0.365)	0.664	1.501 <sup>a</sup>
	1971-81	-1.242	0.283 (4.565)	0.888	1.524 <sup>a</sup>
United Kingdom	1961-81	-1.102	0.062 (0.913)	0.893	1.383 <sup>a</sup>
	1961-71	1.645	0.087 (0.786)	0.815	1.583 <sup>a</sup>
	1971-81	-3.599	0.061 (0.651)	0.809	1.346 <sup>a</sup>
United States	1961-81	0.439	0.867 (12.280)	0.908	1.785 <sup>b</sup>
	1961-71	1.586	0.683 (5.481)	0.941	1.697 <sup>b</sup>
	1971-81	-0.603	0.968 (14.384)	0.868	1.831 <sup>b</sup>

<sup>1/</sup> Table 1, footnote 1, gives definitions.

Short-term interest rates are regressed on present and past inflation rates with eight quarterly lags. In the second,

$$(5) \quad i_t = \alpha + \sum_{i=1}^8 \beta_i \pi_{t-i} + u_t$$

Short-term rates are regressed on the past eight quarterly lags. The formulation of equation (4) is a form of rational expectations with actual inflation at time  $t$ ,  $\pi_t$  representing expected inflation at time  $t$ , and  $\pi_{t-1}$ , instrumental variables. Equation (5), on the other hand, represents an adaptive/distributive scheme of inflationary expectations. As could be expected,  $\sum \beta_i$  in the rational scheme are somewhat higher than those in the adaptive/distributive one, but in both, the sums of the coefficients are less than unity (not recorded).

As remarked above, a major estimation difficulty is that of the formulation of price expectations. Papers by Lahiri (1976), Tanzi (1980), and others have introduced a number of schemes or hypotheses on the formation of expectations. These include distributed, adaptive, and extrapolative schemes that were then used along with the Livingston series of price expectations to generate a modified price expectations series. This last was in turn used to test the Fisher effect. In the absence of a Livingston series for countries other than the United States and the United Kingdom, this study employs variations of the above schemes, some of which have been recorded earlier. All those schemes were estimated using ordinary least squares with the possible deficiency that error terms were correlated with the explanatory variables, thus resulting in inconsistent estimates. In the following test, a two-stage least-squares estimation is carried out:

$$(6') \quad \pi_t = \alpha + \sum_{i=1}^n \delta_i \pi_{t-i} + \sum_{j=1}^m \gamma_j \mu_{t-j} + \varepsilon_t$$

$$(6'') \quad i_t = \beta_0 + \beta_1 \pi_t + u_t$$

Where distributed lags of past inflation and money growth,  $\mu$ , are employed as instrumental variables, both distributed lags of the Almon type with polynomials of degree 3 corrected for autocorrelation. <sup>1/</sup> The results, which are summarized in Table 6 (in the Appendix), are not as robust as the ones derived above using simpler techniques. Another method using the Fama approach of short-term interest rates as predictors of inflation did not yield any significant results (not recorded).

A new technique for extracting a measure of expected inflation from the term structure of interest rates developed by Frankel (1982) is applied

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<sup>1/</sup> See Carlino (1982).



in the following section. Proxies used as measures of expected inflation include either actual present or lagged values of inflation, or survey data. The first do not incorporate all the pieces of information that enter into the formation of expectations, while the latter, such as the Livingston series, have been shown to have deficiencies.

The Frankel method is based on the notion that long-term interest rates reflect expected future short-term rates, and that long-term rates reflect the expected inflation rate more fully than do short-term rates. It is thus assumed that there exists a commonly held expectation ( $\pi^e$ ) as to what the long-run inflation rate is and that in the absence of future disturbances, the real rate of interest will converge to a constant in the long run. The gap is expected to be closed at some rate  $\delta$

$$(7) \quad di_t/dt = -\delta(i_t - \pi_0^e - \bar{r})$$

where  $i_t$  is the short-term interest rate;  $\pi_0^e$  is the long-run inflation rate expected at time 0; and  $\bar{r}$  is the long-run real interest rate.

The speed of adjustment is measured in the following way:

$$(8) \quad (i_t^{\tau 2} - i_t^{\tau 1}) = \alpha + \beta(i_{t-1}^{\tau 2} - i_{t-1}^{\tau 1}) + u_t$$

where  $i_t^{\tau 2}$  is the interest rate on  $\tau 2$  (long-term) maturity bond issued at time  $t$ ,  $i_t^{\tau 1}$  is the interest rate on  $\tau 1$  (short-term) maturity bond issued at time  $t$ , and  $\delta = -12 \log \beta$ . Upon estimation of the above regression,  $\beta$  can be used to compute the weights of the linear combination of  $i_t^{\tau 2}$  and  $i_t^{\tau 1}$  such that

$$(9) \quad \pi_t^e + \bar{r} = \frac{W_{\tau 1} i_t^{\tau 2} - W_{\tau 2} i_t^{\tau 1}}{W_{\tau 1} - W_{\tau 2}}$$

$$\text{and } W_{\tau 1} = -\frac{1 - \beta^{\tau 1}}{\tau 1 \log \beta} \quad \text{and } W_{\tau 2} = -\frac{1 - \beta^{\tau 2}}{\tau 2 \log \beta}$$

Thus, from equation (9), a time series of expected inflation (plus a constant term) can be obtained.

The above technique is employed in the estimation of a time series of expected inflation for six industrial countries using Eurocurrency deposit rates for one month and 12 months. The results of the estimation of equation (8) are presented in Table 7 (in the Appendix) while the

estimated coefficients were used to generate  $\pi_t^e + \bar{r}$  as shown in equation (9). It is assumed that one and 12-month Eurodeposit rates

belong to the same risk class, for otherwise  $\pi_t^e + r_t$  will contain some risk factor. <sup>1/</sup>

Once a time series of expected inflation was obtained, two tests on the impact of inflationary expectations were conducted: in the first, short-term interest rates were regressed on expected inflation and in the second, short-term rates minus the ex post real rate were regressed on expected inflation. The results of the first test (Table 8 in the Appendix) indicate  $\beta$  coefficients significantly greater than unity for all six countries, ranging from about 1.15 for the Federal Republic of Germany and the United States through 1.2 in the United Kingdom and the Netherlands and 1.48 for France and Japan, while the results of the second test (Table 3) show coefficients of response to inflation not significantly different from unity for all but Japan, which recorded a coefficient of 1.16.

Before completing this section, one should mention that a number of tests on the relationships between inflation and long-term interest rates were conducted. In the first test, long-term interest rates were regressed on actual inflation resulting in low coefficients 0.10-0.25 for Canada, France, the Netherlands, the United States, and Italy and insignificant ones for the Federal Republic of Germany, Japan, and the United Kingdom (Table 9 in the Appendix). In the second test, long-term interest rates were regressed on expected inflation as derived by the Frankel method. The results indicate a high but less than unitary response coefficient of interest rate of expected inflation for the United States (0.93) and 0.58 for France, while for all other countries in the sample the response coefficient fell within the range 0.11-0.18 (Table 10 in the Appendix).

## 2. Changes in Fisher effect, over time

This section deals with tests related to changes in the Fisher effect following the acceleration of inflation as the 1970s experienced higher inflation rates than did the 1960s; it also deals with possible changes in the Fisher effect following the October 1979 change in technique of monetary policy in the United States, which resulted in increased variability of interest rates. <sup>2/</sup>

In the first test, the period 1961-81 was divided into two subperiods--1961-70 and 1971-81. The main objective of this test was to observe whether, during periods of higher inflation, interest rates respond more fully to inflation, that is the  $\beta$  was higher during the 1970s. The result (Table 11 in the Appendix) tends to indicate that the coefficient of response

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<sup>1/</sup> Ideally, one would use short-term and long-term government bonds of fixed maturities, but these could not be obtained for all countries in the sample.

<sup>2/</sup> Makin and Tanzi (1982).

CHART 1  
EIGHT INDUSTRIAL COUNTRIES:  
INFLATION AND INTEREST RATES

(In per cent)

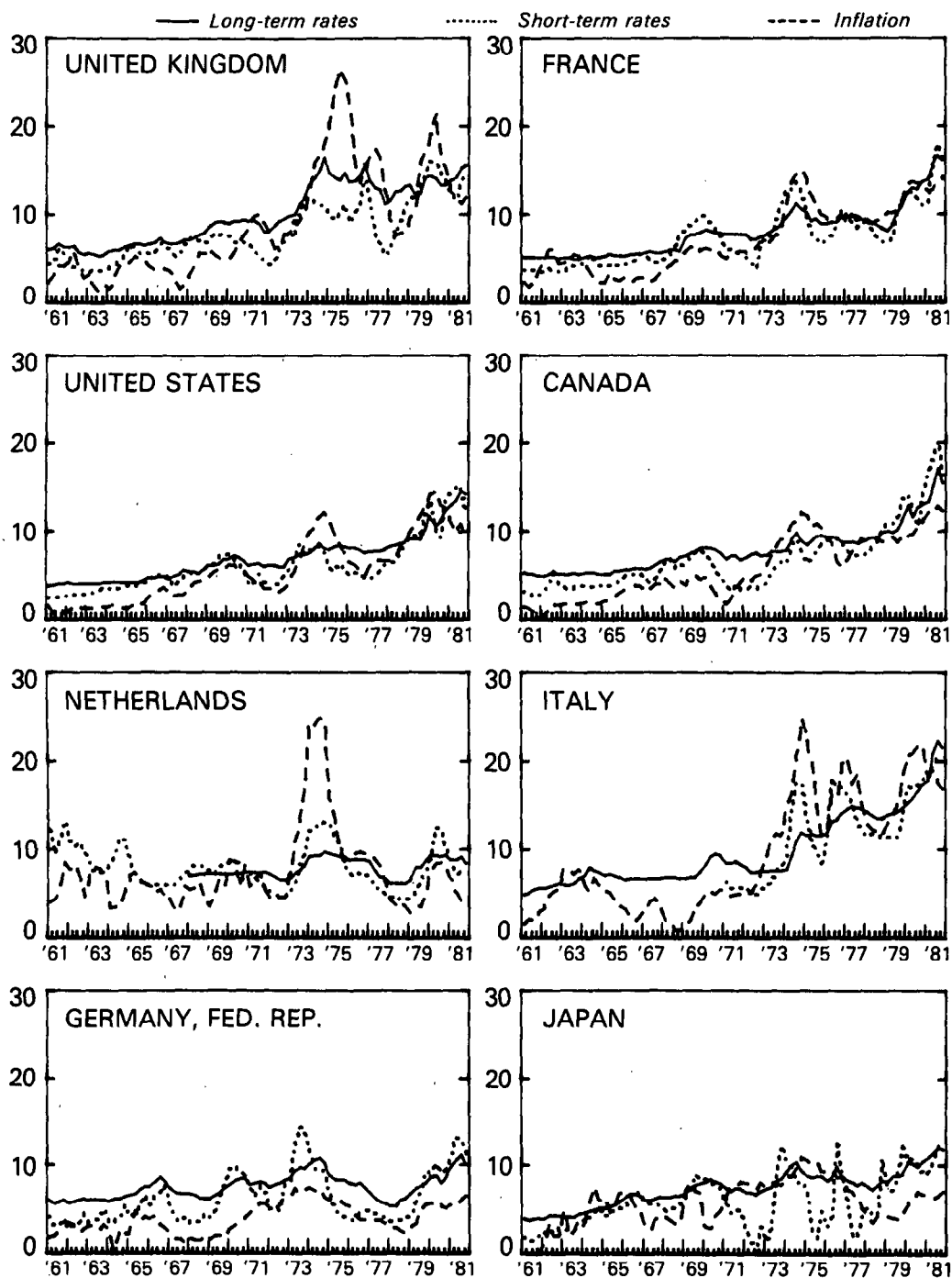


Table 3. Eight Industrial Countries: Response of Short-Term Interest Rates to Expected Inflation, September 1973-July 1982 1/

$$(i_t - \bar{r} = \beta \pi_t^e + u_t)$$

Country	$\beta$	$\bar{R}^2$	$\bar{DW}$	$\bar{r}$
Canada	0.991 (0.026)	0.969	1.530	0.908
France	1.022 (0.034)	0.754	2.042	1.252
Germany, Fed. Rep.	0.991 (0.036)	0.927	1.933	1.715
Italy	1.030 (0.025)	0.779	1.970	1.019
Japan <u>2/</u>	1.162 (0.097)	0.905	2.432	-0.279
Netherlands	0.984 (0.040)	0.881	1.802	0.953
United Kingdom	0.997 (0.021)	0.814	2.120	-1.927
United States	0.993 (0.032)	0.961	2.028	1.027

1/ The variable  $\pi^e$  is derived by the Frankel procedure from the term structure of interest rates. One-lag autoregressive error term adjusted by the Cochrane-Orcutt procedure; estimated standard errors are in parentheses.

2/ November 1975-March 1982.

was higher in the 1970s (it is possible, however, that  $\pi$  was a better measure of  $\pi^e$  in the 1970s). With the exception of the United Kingdom (with insignificant coefficients during both decades) and Canada (with a significant coefficient in the 1960s and insignificant coefficients in the 1970s) all other countries recorded noticeably higher  $\beta$ 's during the second subperiod. The most significant change occurred in the Federal Republic of Germany, as  $\beta$  rises from 0.176 to 1.303 and in France with a rise from 0.15 to 0.788; in the United States, the increase is more modest-- from 0.622 to 0.808.

In conducting the above test, there is a possibility that changes in the intercept might have affected the outcome. Although the intercept declined in most countries during the second period, the likelihood that intercept variability might somewhat obscure the outcome suggests a test in which changes in the intercept would not affect the response coefficients. To deal with this potential problem, a third test is constructed in which the intercept is held constant for the two subperiods so that the change in  $di/d\pi$  will fully reflect the change in the response of interest rates to inflation. Thus, equation (10) is estimated (Table 12 in the Appendix).

$$(10) \quad i_t = \beta_0 + \beta_1 \pi_{t1} D + \beta_2 \pi_{t2} (1-D) + u_t$$

Where  $D$  is a dummy;  $D = 1$  for  $t1 = 1961Q1-1970Q4$  and  $D = 0$  for  $t2 = 1971Q1-1981Q4$ . This test is designed to answer the question of whether  $\beta_2$  is higher than  $\beta_1$ , given the fact that inflation was higher during the second period. The results indicate a general increase in response, as  $\beta_2$  exceeds  $\beta_1$  for France, the Federal Republic of Germany, the Netherlands, and Canada, which had insignificant coefficients in the previous test; the United States records a decline with  $\beta_1 = 0.772$  and  $\beta_2 = 0.680$  (the difference is slightly less than one standard error of the coefficients). Japan and the United Kingdom recorded insignificant coefficients during both subperiods. The results of this test seem to reinforce those of the previous test in indicating that as a result of higher rates of inflation, the response of interest rates to inflation tends to be higher.

As inflation rates accelerated during the 1970s, there was a decline in the ex post average real rate for the eight countries in the sample (Chart 1). Moreover, during 1971-81, negative average real rates were experienced by France, Italy, Japan, the Netherlands, the United Kingdom, and the United States, while the Federal Republic of Germany's average real rate was 2.135 and Canada's was marginally positive (Table 5 in the Appendix).

In applying different ex post real rates for the two subperiods for all countries, a comparison between the 1960s and 1970s shows that the response coefficient is significantly higher during the latter period for France, the Federal Republic of Germany, Japan, the Netherlands, and the United States; no significant change is recorded for Canada, whereas for the United Kingdom, the coefficient is not significant (Table 2). It is

interesting to note that during the period 1971-81,  $\beta_1$  for the Federal Republic of Germany is slightly greater than unity and those for France and the United States are not significantly different from unity.

As of October 1979, the U.S. Federal Reserve Board changed its instruments of monetary policy from that which combined the use of interest rates and money growth targets to one that set monetary growth targets. Changes in a similar direction occurred in the United Kingdom and in Japan, although in a considerably less pronounced manner. As a result, short-term interest rates have become more market determined while fluctuations of rates have become more pronounced. This section tests whether these changes in the technique of monetary policy have affected the degree of response of interest rates to inflation.

Two tests similar to the ones conducted above are being used with monthly data. The first is as follows:

$$(11) \quad i_t = \beta_0 + \beta_1 \pi_{1t} D + \beta_2 \pi_{2t} (1-D) + u_t$$

Where  $D = 1$  for the period  $t1 = \text{January 1971-September 1979}$  and  $D = 0$  for the period  $t2 = \text{October 1979-March 1982}$ . The results of the estimation (Table 13 in the Appendix) indicate an increase in the response of interest rates to inflation in four of the eight countries in the sample: France, the Federal Republic of Germany, Italy, and the United States. Only the United States, however, recorded a significant increase ( $\beta_2$  is greater than  $\beta_1$  by one standard deviation of the mean coefficient). The second

test for the period October 1979-March 1982 using monthly data, where  $\bar{r}$  is the average ex post real interest rate for the period, resulted in response coefficients that are not significantly different from unity for five of the countries: Canada, France, the Federal Republic of Germany, Japan, and the United States (Table 14 in the Appendix). These results indicate somewhat higher coefficients than those obtained for the full period 1971-81 with quarterly data.

### 3. Impact of taxation on Fisher effect

This section estimates the impact of taxation on the response of interest rates to inflation. The incorporation of tax consideration into the Fisher effect was done independently by Darby (1975), and Tanzi (1976); assuming that borrowers and lenders are concerned with the real after-tax interest, the formulation of the Fisher equation was modified to

$$(12) \quad 1 = r + \pi/(1-\tau)$$

Where  $\tau$  is the effective personal tax rate applied to interest income. Feldstein (1976) and later Gandolfi (1982), in two different analytical frameworks, introduced the corporate sector as a borrower and investor in the capital market, whose effective capital gains tax rate ( $\theta$ ) resulted in a further modification of the Fisher equation

$$(13) \quad i = r + \frac{(1-\theta)\pi}{1-\tau}$$

The expression derived by Levi and Makin (1978) from their macroeconomic framework was:

$$(14) \quad \frac{di}{d\pi^e} = \frac{1}{(1-\tau)/(1-\theta) + L}$$

here  $L$  is a term incorporating liquidity, income, and employment effects. Computing the magnitude of  $di/d\pi^e$  for the United States (assuming  $\tau = 0.5$ ), they found a range of 0.750-1.285, depending on the parameters in  $L$ . Neilsen's (1981) general-equilibrium model based on micro-optimization behavior of households and firms incorporated (in addition to personal income tax and capital gains tax) company income tax,  $\tau_1$ . Neilsen derived an expression for  $di/d\pi$  that was shown as a range, depending on the relative magnitudes of all three tax rates

$$(15) \quad \frac{1-\theta}{1-\tau_1} < \frac{di}{d\pi} \leq \frac{1}{1-\tau_1}$$

The tax treatment of interest income and interest expenditure on the part of the household sector, on the one hand, and corporate taxation on the other hand, varies quite substantially from country to country. <sup>1/</sup> Preferential treatment of interest income of the household sector differs from country to country and is most generous in Japan, where interest income of the equivalent of US\$56,000 per taxpayer is tax exempt; it is estimated that average tax payments on interest income during the 1970s were about 7 per cent. Interest incomes are incorporated into total individual income and treated as part of global income in Canada, the Federal Republic of Germany, the United Kingdom, and the United States, while France, Italy, and Japan permit the nominal withholding taxes on them to become final taxes.

Deductibility of interest payments is most liberal in the Netherlands and in the United States, as it extends to general consumer credit and mortgages. Steuerle (1982) suggests that only 30 per cent of income from capital in the United States is subject to individual income taxation; he estimated that about 80 per cent of the assets held by individuals has been in forms for which there has been a tax preference arising from capital gains tax rates, exclusions, or some other means of nontaxation of some or all of the income from the assets. Interest payments on home mortgages are also deductible in Canada, France, and the United Kingdom, while in the Federal Republic of Germany and Japan, less generous schemes apply. In the Federal Republic of Germany, there are taxes on the imputed income of owner-occupied housing. While many industrial countries tax

<sup>1/</sup> See Modi (1983) for a survey of tax treatment of investment income and expenditure in industrial countries.

long-term capital gains of individuals, either under a separate tax (e.g., the United Kingdom) or under the regular income tax after exempting a certain proportion of the gains (e.g., Canada and the United States), most industrial countries apply lower rates of taxes on long-term capital gains than on ordinary incomes. Regarding corporate taxation, double taxation exists in the United States at shareholder levels. In the Federal Republic of Germany, shareholders receive full credit for the tax paid by the corporation on dividends distributed; in other countries, there are partial imputations.

Acknowledging the difficulties in quantifying effective tax rates on interest income, company income tax, and capital gains tax for the countries in the sample, the author presents in Table 15 (in the Appendix) an estimate of average effective rates of interest income of individuals and corporations during the period 1971-81. Tax rates on interest income of individuals for Canada, the Federal Republic of Germany, the Netherlands, the United Kingdom, and the United States represent the percentage ratio of tax paid to taxed income of "representative" taxpayers defined as individuals whose assessable incomes constitute about one third of the total taxed income in the highest income brackets. For France and Italy, the rates are final withholding tax rates; for Japan, the rate represents the average ratio of interest income tax receipts to interest income. <sup>1/</sup> Regarding capital gains tax rates, owing to difficulties in obtaining effective rates, statutory rates have been chosen; effective capital gains tax rates would be somewhat lower, thus the computed  $(1-\theta)/(1-\tau)$  could be biased downward somewhat.

On the basis of these tax rate computations, the Fisher effect adjusted to interest income tax alone shows coefficients ranging from 1.075 for Japan, 1.299 for the United States to about 1.5 for France and the Federal Republic of Germany (Table 4). If both individual interest income tax and capital gains tax are taken into account, the tax-adjusted Fisher effect is less than unity for all but France (1.124) and Italy (1.072); it ranges between 0.847 for the Netherlands and 0.964 for the Federal Republic of Germany. However, since the capital gains tax rates employed are the statutory rates, these tax-adjusted Fisher effects would be somewhat higher. If these are compared with the  $\beta$ 's obtained for expected inflation, the two sets tend to be fairly consistent for France, the Federal Republic of Germany, the Netherlands, the United Kingdom, and the United States. For Japan, the tax ratio is less than unity while the response coefficient is significantly greater than unity. If the response coefficient of interest rates to actual inflation in Japan is compared with the tax ratio, the two will be of similar orders of magnitude--0.818 and 0.857, respectively.

The application of the Neilsen range shows that only in the United Kingdom  $di/d\pi^e$  was between  $1/(1-\tau)$  and  $(1-\theta)/(1-\tau_1)$ ; in all the other countries, both  $di/d\pi$  and  $di/d\pi^e$  were smaller than the lower bound of the range.

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<sup>1/</sup> For a discussion on the employment of average rates versus marginal rates, see Tanzi (1982).



Table 4. Eight Industrial Countries: Impact of Taxation  
on Adjustment of Interest Rates to Inflation, 1971-81

Country	$\frac{1}{1-\tau}$	$\frac{1-\theta}{1-\tau_1}$	$\frac{1-\theta}{1-\tau}$	$\beta_1(\text{of } \pi^e)$	$\beta_1(\text{of } \pi)$
Canada	1.176	1.069	0.906	0.991	0.879
France	1.493	1.136	1.120	1.022	0.973
Germany, Fed. Rep.	1.515	1.067	0.970	0.991	1.050
Italy	1.429	1.000	1.072	1.030	0.505
Japan	1.075	0.988	0.860	1.162	0.818
Netherlands	1.299	--	--	0.984	0.283
United Kingdom	1.316	0.795	0.921	0.997	0.061
United States	1.299	1.061	0.909	0.993	0.968

Source: Tax rates are based on those of Table 15 (in the Appendix);  $\beta_1(\text{of } \pi)$  and  $\beta_1(\text{of } \pi^e)$  are regression coefficients of Tables 2 and 3, respectively.

In sum, when only personal interest income tax is used, the Fisher effect is expected to be greater than one. Empirical results that tend to support a response coefficient of interest rates to expected inflation of greater than one were obtained when a regression of the type  $i_t = \beta_0 + \beta_1 \pi_t^e + u_t$  was used without correcting for the effects of expected inflation on the real rate of interest. When both types of tax (interest income tax and capital gains tax) are taken into consideration, the tax-adjusted Fisher effect can be greater or less than unity. In fact, it was found to be greater than unity for France and Italy and less than one for all other countries. These tax-adjusted Fisher effect coefficients were found to be consistent with the estimated response coefficients of nominal interest rates to expected inflation for France, the Federal Republic of Germany, the Netherlands, the United Kingdom, and the United States; they were found to be consistent with  $\beta_1$ 's of actual inflation for Canada, the Federal Republic of Germany, Japan, and the United States.

### III. Conclusion

The results of the tests conducted above can be summarized in three parts:

1. The response coefficients of nominal short-term interest rates to expected inflation derived from the term structure of interest rates and based on a new technique that had been developed by Frankel (1982) was significantly greater than unity in Japan (1.16) but not significantly different than unity for all other countries. The same test without adjusting for real interest rates resulted in response coefficients significantly greater than one for all sample countries; these were about 1.15 for the United States and the Federal Republic of Germany, about 1.20 for the Netherlands and the United Kingdom, and about 1.50 for France and Japan.

The results indicate that the response of nominal short-term interest rates to actual inflation for the period 1961-81 was significantly less than unity for all eight countries; France and the United States recorded coefficients of about 0.90, Germany, Italy, and Canada about 0.40-0.50, and the Netherlands 0.21, while Japan and the United Kingdom had insignificant coefficients.

As for long-term interest rates, the response coefficient to expected inflation was high for the United States (0.93), and France (0.58) and in the range of 0.10-0.20 for the Federal Republic of Germany, Japan, the Netherlands, and the United Kingdom; the response coefficient of long-term interest rates to actual inflation was found to be 0.10-0.25 for Canada, France, Italy, the Netherlands, and the United States, and insignificant for the Federal Republic of Germany, Japan, and the United Kingdom.

2. The acceleration of inflation from the 1960s to the 1970s was generally accompanied by increases in the response coefficient of short-term interest rates to inflation; the change of instruments of monetary policy that occurred in October 1979 in the United States was accompanied by some increase in the Fisher coefficient to actual inflation, especially in the United States, Canada, and the Federal Republic of Germany.

3. The Fisher effect adjusted for interest income tax and capital gains tax can be greater or less than unity; it was found to be greater than unity for France and Italy and less than unity for all the other countries in the sample. These tax-adjusted Fisher effects were found to be consistent with the estimated response coefficients of nominal interest rates to expected inflation for France, the Federal Republic of Germany, the Netherlands, the United Kingdom, and the United States; they were found to be consistent with the response coefficient of short-term interest rates to actual inflation for Canada, the Federal Republic of Germany, Japan, and the United States.

In interpreting these results, one should note that monetary policies of most countries have been pursued with interest rates as a major instrument, while in other countries free capital flows or the existence of "offshore banking" tended to make the determination of interest rates exogenous. Consequently, the response of interest rates to actual or expected inflation could reflect adjustments by the monetary authorities to inflation, on the one hand, or adjustments stemming from external factors, on the other hand.

Table 5. Eight Industrial Countries: Mean Inflation and Short-Term Nominal and Real Interest Rates, 1961Q<sub>1</sub> - 1981Q<sub>4</sub> 1/

Country	Years	$\bar{i}$	$\bar{\pi}$	$\bar{r}$
Canada	1961-81	6.768	5.733	1.035
	1961-71	4.724	2.731	1.993
	1971-81	8.626	8.461	0.165
France	1961-81	7.422	7.162	0.260
	1961-71	5.354	4.039	1.315
	1971-81	9.302	10.001	-0.699
Germany, Fed. Rep.	1961-81	6.216	3.943	2.273
	1961-71	5.012	2.587	2.425
	1971-81	7.310	5.175	2.135
Italy	1961-81	N.A.	9.377	---
	1961-71	N.A.	---	---
	1971-81	12.081	14.301	-2.220
Japan	1961-81	5.878	5.744	0.134
	1961-71	4.913	4.042	0.871
	1971-81	6.754	7.292	-0.538
Netherlands	1961-81	7.863	7.336	0.527
	1961-71	8.238	5.765	2.473
	1971-81	7.523	8.765	-1.242
United Kingdom	1961-81	7.977	9.079	-1.102
	1961-71	5.709	4.064	1.645
	1971-81	10.040	13.639	-3.599
United States	1961-81	5.992	5.553	0.439
	1961-71	4.350	2.764	1.586
	1971-81	7.485	8.088	-0.603

1/ The variables  $\bar{i}$ ,  $\bar{\pi}$ , and  $\bar{r}$  denote average nominal short-term interest rate, average inflation, and average real interest rate, respectively.

Inflation is measured as  $\pi_t = [(P_t/P_{t-4}) - 1] \cdot 100$ , where  $P_t$  is the quarterly average consumer price index.

Table 6. Eight Industrial Countries: Two-Stage Least-Squares  
Estimation of Impact of Inflation on Short-Term Interest Rates,  
1961Q1 - 1981Q4 1/

$$(1) \pi_t = \alpha + \sum_{i=1}^8 \delta_i \pi_{t-i} + \sum_{j=1}^8 \gamma_j \mu_{t-j} + \varepsilon_t$$

$$(2) i_t = \beta_0 + \beta_1 \pi_t + u_t$$

Country	$\sum_{i=1}^8 \delta_i$	$\sum_{i=1}^8 \gamma_i$	$\beta_0$	$\beta_1$	$\bar{R}^2$	DW
Canada	0.913 (10.143)	0.001 (0.293)	9.681 (3.316)	-0.068 (-0.987)	0.913	1.648 <sup>b</sup>
France	0.917 (11.615)	0.040 (0.583)	1.477 (1.526)	0.799 (6.847)	0.662	1.871 <sup>b</sup>
Germany, Fed. Rep.	0.844 (8.636)	-0.002 (-0.040)	7.029 (6.306)	-0.079 (-2.283)	0.848	2.052 <sup>b</sup>
Italy	0.890 (9.761)	0.325 (2.299)	13.443 (5.677)	0.022 (0.508)	0.870	1.857 <sup>b</sup>
Japan	0.660 (3.015)	-0.041 (-0.326)	6.772 (6.061)	-0.051 (-1.133)	0.624	1.828 <sup>a</sup>
Netherlands	0.771 (7.216)	0.116 (1.920)	7.961 (10.136)	-0.023 (-1.196)	0.835	1.706 <sup>b</sup>
United Kingdom	0.468 (2.361)	0.430 (2.050)	9.482 (4.927)	-0.009 (-0.465)	0.899	1.901 <sup>b</sup>
United States	0.738 (10.720)	0.331 (3.535)	6.908 (3.757)	0.101 (1.118)	0.906	1.795 <sup>b</sup>

1/ The two instrumental variables are  $\sum_{i=1}^8 \pi_{t-i}$  and  $\sum_{j=1}^8 \mu_{t-j}$ , where the latter is the rate of growth of  $M_1$ ; the t-values are in parentheses. The error term is autoregressive with one and two lags (a) and (b), respectively.

Table 7. Eight Industrial Countries: Estimation of Speed of Adjustment, September 1973 - July 1982 1/

$$[(i_t^{\tau 2} - i_t^{\tau 1}) = \alpha + \beta(i_{t-1}^{\tau 2} - i_{t-1}^{\tau 1}) + u_t]$$

Country	$\alpha$	$\beta$	$\bar{R}^2$	$\bar{DW}$	$\delta$ <u>2/</u>
Canada	0.030 (0.064)	0.766 (0.064)	0.582	1.530	3.200
France	0.150 (0.248)	0.387 (0.090)	0.141	2.033	4.948
Germany, Fed. Rep.	0.125 (0.085)	0.600 (0.077)	0.357	1.910	2.658
Italy	-0.181 (0.269)	0.369 (0.095)	0.121	0.950	11.900
Japan <u>3/</u>	0.205 (0.133)	0.694 (0.083)	0.478	2.262	1.906
Netherlands	0.132 (0.109)	0.672 (0.072)	0.450	1.804	2.071
United Kingdom	0.096 (0.139)	0.547 (0.078)	0.311	2.047	3.148
United States	0.102 (0.083)	0.757 (0.064)	0.564	2.033	1.453

1/ The variables  $i_t^{\tau 1}$  and  $i_t^{\tau 2}$  represent one-month and 12-month Euro-currency deposit rates, respectively. Estimated standard errors are in parentheses; the technique of estimation is ordinary least squares.

2/ The speed of adjustment is  $\delta = -12 \log \beta$ .

3/ November 1975-March 1982.

Table 8. Six Industrial Countries: Response of Short-Term Interest Rates to Expected Inflation, September 1973 - July 1982 1/

$$(i_t = \beta_0 + \beta_1 \pi_t^e + u_t)$$

Country	$\beta_0$	$\beta_1$	$\bar{R}^2$	$\bar{D}W$
France	-4.636 (1.152)	1.481 (0.094)	0.798	1.983
Germany, Fed. Rep.	0.615 (0.389)	1.143 (0.063)	0.931	1.881
Japan <u>2/</u>	-4.290 (0.566)	1.477 (0.077)	0.930	1.937
Netherlands	-1.237 (0.725)	1.232 (0.090)	0.889	1.821
United Kingdom	-5.076 (1.521)	1.197 (0.099)	0.819	2.055
United States	-0.876 (0.571)	1.154 (0.054)	0.964	1.990

1/ The variable  $\pi^e$  is derived by the Frankel procedure from term structure of interest rates. One-lag autoregressive error term is adjusted by the Cochrane-Orcutt procedure; estimated standard errors are in parentheses.

2/ November 1975-March 1982.

Table 9. Eight Industrial Countries: Inflation and Long-Term Interest Rates, 1961Q1 - 1981Q4 <sup>1/</sup>

$$(i_t = \beta_0 + \beta_1 \pi_t + u_t)$$

Country/Years	$\beta_0$	$\beta_1$	$\bar{R}^2$	DW
Canada				
1961-81	27.43 (2.30)	0.172 (1.84)	0.951	1.90
1961-70	3.58 (4.35)	0.250 (4.22)	0.969	1.87
1971-81	30.41 (2.10)	0.103 (0.691)	0.900	1.89
France				
1961-81	20.63 (2.12)	0.225 (3.47)	0.977	1.97
1961-70	11.51 (2.85)	0.35 (0.476)	0.929	1.98
1971-81	11.90 (2.16)	0.324 (3.33)	0.953	1.94
Germany, Fed. Rep.				
1961-81	7.78 (13.33)	0.023 (0.37)	0.912	1.78
1961-70	7.30 (16.25)	-0.045 (-1.08)	0.903	1.80
1971-81	6.65 (6.61)	0.229 (1.76)	0.887	1.80
Netherlands				
1968-81	7.36 (15.72)	0.062 (2.70)	0.900	2.05
1968-70	8.04 (18.57)	-0.0008 (-0.83)	0.980	1.54
1971-81	7.36 (13.20)	0.077 (2.71)	0.892	2.04
Japan				
1961-81	10.64 (5.13)	0.012 (0.308)	0.959	1.93
1961-70	8.21 (6.06)	0.012 (0.59)	0.978	1.89
1971-81	9.62 (5.79)	0.094 (0.706)	0.841	1.94
United Kingdom				
1961-81	15.25 (3.54)	0.037 (0.840)	0.960	1.96
1961-70	9.286 (3.66)	0.132 (2.42)	0.951	1.77
1971-81	13.28 (8.36)	0.036 (0.565)	0.839	1.99
United States				
1961-81	3.61 (4.18)	0.136 (2.55)	0.976	1.98
1961-70	3.43 (31.24)	0.528 (16.45)	0.953	2.03
1971-81	33.35 (2.61)	0.133 (1.55)	0.939	1.95
Italy				
1961-81	34.58 (2.26)	0.100 (2.82)	0.983	1.76
1961-70	7.33 (13.88)	-0.069 (-1.49)	0.920	1.88
1971-81	31.05 (2.22)	0.121 (2.53)	0.972	1.74

<sup>1/</sup> The t-values are in parentheses. The Durbin-Watson statistics are adjusted for serial correlation by the Cochrane-Orcutt procedure.



Table 10. Six Industrial Countries: Expected Inflation and Long-Term Interest Rates, 1973Q4 - 1982Q2 1/

$$(i_t = \beta_0 + \beta_1 \pi_t^e + u_t).$$

Country	$\beta_0$	$\beta_1$	$\bar{R}^2$	DW
France	14.45 (3.09)	0.58 (3.59)	0.957	2.17
Germany, Fed. Rep.	5.178 (8.44)	0.177 (8.72)	0.960	1.90
Japan <u>2/</u>	4.92 (10.70)	0.141 (6.82)	0.888	1.97
Netherlands	6.90 (14.57)	0.112 (9.09)	0.947	1.97
United Kingdom	8.184 (6.88)	0.126 (4.84)	0.658	1.99
United States	13.13 (3.33)	0.925 (8.39)	0.978	1.76

1/ The t-values are in parentheses; the Durbin-Watson statistics are adjusted for serial correlation.

2/ 1976Q1-1982Q1.

Table 11. Eight Industrial Countries: Regression of Short-Term Interest Rates on Inflation, 1961Q1 - 1970Q4 and 1971Q1 - 1981Q4 <sup>1/</sup>

$$(i_t = \beta_0 + \beta_1 \pi_t + u_t)$$

Country	Years	$\beta_0$	$\beta_1$	$\bar{R}^2$	$\bar{DW}$
Canada	1961-70	3.017 (5.876)	0.653 (4.452)	0.892	1.970 <sup>b</sup>
	1971-81	8.124 (2.018)	0.270 (0.877)	0.893	1.638 <sup>b</sup>
France	1961-70	7.401 (2.786)	0.150 (1.134)	0.933	1.325 <sup>a</sup>
	1971-81	1.315 (0.865)	0.788 (5.492)	0.868	1.823 <sup>b</sup>
Germany, Fed. Rep.	1961-70	5.806 (3.516)	0.176 (0.877)	0.724	2.030 <sup>b</sup>
	1971-81	0.711 (0.286)	1.303 (3.407)	0.859	1.248 <sup>a</sup>
Italy	1971-81	5.104 (2.281)	0.533 (4.444)	0.900	1.922 <sup>b</sup>
Japan	1961-70	7.011 (4.501)	0.050 (0.737)	0.917	2.038 <sup>b</sup>
	1971-81	4.961 (4.239)	0.292 (4.797)	0.892	1.461 <sup>a</sup>
Netherlands	1961-70	7.270 (3.672)	0.064 (0.945)	0.918	1.956 <sup>a</sup>
	1971-81	6.192 (5.947)	0.159 (2.420)	0.906	2.286 <sup>b</sup>
United Kingdom	1961-70	5.744 (5.631)	0.099 (0.887)	0.822	1.530 <sup>a</sup>
	1971-81	11.262 (3.911)	0.060 (0.625)	0.813	1.284 <sup>a</sup>
United States	1961-70	2.754 (6.119)	0.622 (4.708)	0.940	1.776 <sup>b</sup>
	1971-81	0.949 (0.602)	0.808 (4.634)	0.868	1.800 <sup>b</sup>

<sup>1/</sup> Inflation is defined as  $\pi_t = [(P_t/P_{t-4}) - 1] \cdot 100$ ; (a) and (b) represent one-lag and two-lag autoregressive error structures, respectively, adjusted by the Cochrane-Orcutt procedure; the t-values are in parentheses.

Table 12. Seven Industrial Countries: Regression of Short-Term Interest Rates on Inflation for Two Subperiods, 1961Q1 - 1981Q4 <sup>1/</sup>

$$(i_t = \beta_0 + \beta_1 \pi_{t1} D + \beta_2 \pi_{t2} (1-D) + u_t)$$

Country	$\beta_0$	$\beta_1$	$\beta_2$	$\bar{R}^2$	DW <sup>2/</sup>
Canada	4.278 (2.977)	0.440 (1.552)	0.512 (3.158)	0.922	1.720 <sup>b</sup>
France	3.001 (3.328)	0.589 (3.431)	0.627 (6.455)	0.918	1.824 <sup>b</sup>
Germany, Fed. Rep.	4.613 (3.167)	0.450 (2.064)	0.544 (2.381)	0.844	1.455 <sup>a</sup>
Japan	6.822 (3.941)	0.018 (0.084)	-0.091 (-0.386)	0.618	1.806 <sup>a</sup>
Netherlands	6.621 (8.398)	-0.119 (1.690)	0.169 (2.769)	0.860	1.675 <sup>b</sup>
United Kingdom	8.432 (5.131)	0.008 (0.065)	0.071 (0.946)	0.899	1.899 <sup>b</sup>
United States	2.127 (3.110)	0.772 (4.758)	0.680 (7.406)	0.913	1.794 <sup>b</sup>

<sup>1/</sup> Inflation is defined as  $\pi_t = [(P_t/P_{t-4}) - 1] \cdot 100$ ; D denotes dummy variable  $D = 1$  for  $t_2 = 1971Q_1$  to 1981Q4; the t-values are in parentheses.

<sup>2/</sup> The one-lag and two-lag autoregressive error structures are represented by (a) and (b), both adjusted by the Cochrane-Orcutt procedure.

Table 13. Eight Industrial Countries: Regression of Short-Term Interest Rates on Inflation for Two Subperiods, January 1961 - September 1979 and October 1979 - March 1982 <sup>1/</sup>

$$(i_t = \beta_0 + \beta_1 \pi_{t1} D + \beta_2 \pi_{t2} (1-D) + u_t)$$

Country	$\beta_0$	$\beta_1$	$\beta_2$	$\bar{R}^2$	$\bar{DW}$
Canada	10.189	-0.055 (0.121)	0.142 (0.139)	0.979	1.886 <sup>b</sup>
France	4.508	0.512 (0.184)	0.551 (0.179)	0.952	1.948 <sup>b</sup>
Germany, Fed. Rep.	5.416	0.408 (0.184)	0.552 (0.196)	0.964	1.231 <sup>a</sup>
Italy	9.885	0.270 (0.092)	0.302 (0.093)	0.975	1.989 <sup>b</sup>
Japan	7.105	-0.010 (0.024)	-0.044 (0.061)	0.745	1.980 <sup>b</sup>
Netherlands	7.472	-0.001 (0.002)	-0.006 (0.005)	0.973	2.099 <sup>b</sup>
United Kingdom	10.293	0.040 (0.065)	0.014 (0.069)	0.960	1.956 <sup>b</sup>
United States	4.618	0.367 (0.150)	0.515 (0.149)	0.939	1.858 <sup>b</sup>

<sup>1/</sup> Monthly data are used. The standard error of coefficients is in parentheses. For the period t2 = October 1979-March 1982, D = 1. Standard errors are in parentheses; (a) and (b) represent one lag and two lags of the autocorrelated error term, respectively, adjusted by the Cochrane-Orcutt procedure.

Table 14. Eight Industrial Countries: Response of Short-Term Interest Rates to Inflation, October 1979 - March 1982 1/

$$(i_t - \bar{r} = \beta_1 \pi_t + u_t)$$

Country	$\bar{r}$	$\beta_1$	$\bar{R}^2$	$\bar{DW}$
Canada	3.876	0.992 (0.069) <sup>c</sup> (14.280) <sup>d</sup>	0.843	1.993 <sup>b</sup>
France	0.273	0.997 (0.099) (10.099)	0.810	1.834 <sup>b</sup>
Germany, Fed. Rep.	4.913	0.974 (1.150) (6.497)	0.758	1.594 <sup>a</sup>
Italy	-0.954	0.244 (0.120) (2.032)	0.894	1.904 <sup>a</sup>
Japan	4.139	0.917 (0.130) (7.071)	0.134	1.850 <sup>a</sup>
Netherlands	2.763	0.649 (0.148) (4.387)	0.867	1.680 <sup>a</sup>
United Kingdom	-0.744	0.239 (0.125) (1.913)	0.784	1.493 <sup>a</sup>
United States	1.153	1.004 (0.176) (5.705)	0.558	1.722 <sup>b</sup>

1/ Monthly data are used; (a) and (b) represent one lag and two lags of the autocorrelated error term, respectively; (c) and (d) represent standard error of coefficients and t-values, respectively.

Table 15. Eight Industrial Countries: Statutory and Estimated Effective Tax Rates, 1971-81

(In per cent)

Country	Personal Income	Corporate Income	Capital Gains
	Tax <u>1/</u> ( $\tau$ )	Tax <u>2/</u> ( $\tau_1$ )	Tax <u>3/</u> ( $\theta$ )
Canada	15	28	23
France	33	34	25
Germany, Fed. Rep.	34	40	36
Italy	30	25	25
Japan	7 <u>4/</u>	29	20
Netherlands	23	...	...
United Kingdom	24	18	30
United States	23	34	30

Sources: For personal income tax, reports from the income tax departments of individual countries; for corporate income tax, Thomas Horst, Income Taxation and Competitiveness in France, Germany, Japan, United Kingdom, and the United States, National Planning Association (Washington, D.C., 1977); for Canada, Corporation Taxation Statistics 1977, Statistics Canada (Ottawa, March 1980).

1/ Tax rates for countries other than France and Italy represent the percentage ratio of tax paid to taxed/assessable income of "representative" taxpayers, defined as individuals whose taxable/assessable incomes constitute, say, about one third of the total taxed/assessed income in the highest income brackets. For France and Italy, the rates are final withholding tax rates.

2/ For countries other than Canada, Italy, and the Netherlands, effective tax rates are those calculated by Thomas Horst on the basis of differences in corporate income tax rates, depreciation allowances, and tax credits. For Canada, effective tax rates represent the percentage ratio of corporate income tax assessed to taxable corporate profits, and for Italy, the statutory rate.

3/ Statutory rates.

4/ Average ratio of interest income tax receipt to interest income.

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