THE CROSS-COUNTRY RELATIONSHIP BETWEEN INTEREST RATES AND INFLATION OVER THREE DECADES

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ABSTRACT

This paper looks at the relationship between inflation and interest rates across a number of industrialised countries over the past three decades. The paper is in three parts. It begins by splitting the whole period up into a number of smaller periods and looking at the inflation/interest rate relationship across countries within these periods. The most interesting conclusion of this section is that while there was a negative relationship between inflation and real short-term interest rates in the 1970s (i.e. high inflation countries had lower real short-term interest rates), in the 1980s there was a positive relationship between real short-term interest rates and inflation. The paper then discusses some explanations for this observation - why might we expect to see higher real interest rates in high inflation countries and why has this only occurred in the 1980s. Finally the paper uses a simple test to attempt to distinguish between competing explanations of the positive inflation/real interest rate relationship. Unfortunately, the test cannot distinguish conclusively between the competing hypotheses.

TABLE OF CONTENTS

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1. INTRODUCTION

Casual observation of data on interest rates and inflation suggests that countries with high inflation rates also tend to have high nominal interest rates. This is not a remarkable conclusion. Fisher (1930) put forward the hypothesis that over the longer term, movements in the nominal interest rate will reflect movements in the rate of inflation one-for-one. The implication is that a country will have higher nominal interest rates if inflation (more precisely, expected inflation) is high than if it is low. Translated into predictions for interest rates across countries, a logical conclusion is that nominal interest rates will tend to be higher in countries with higher inflation.

An alternative reason why nominal interest rates might be expected to be higher in high inflation countries is to do with policy reactions. In this scenario, countries with high inflation are attempting to reduce inflation and will consequently run tighter monetary policy than low inflation countries. This implies that, over the period they are running tighter monetary policies, they will have higher real interest rates. Hence, the higher interest rates are due to a higher real component in the interest rate.

This paper takes a very simple look at the relationship between inflation and interest rates for a number of OECD countries over three decades. Unlike many previous studies in this area, there is no attempt to estimate Fisher equations for each of the countries. The paper simply presents some data and puts forward some possible explanations for the relationships found. There is no attempt to test these competing hypotheses formally. Nor does the paper intend to highlight the positions of individual countries in relation to one another. The analysis focuses exclusively on the generalised cross-country relationship.

The paper is organised as follows. First, the data are presented in graphical form and uses simple regression analysis to illustrate relationships. In this section some simple relationships are drawn out. Second, possible explanations for the observed relationships are put forward and an attempt is made to distinguish between the alternative hypotheses on the basis of the data. Finally, the conclusions are summarised.

2. NOMINAL INTEREST RATES AND INFLATION : 1961-1989

(a) Data

As a first step in analysing the data, the 1961 to 1989 period is broken down into a number of sub-periods. Although partly arbitrary, it is an attempt to group years of similar economic experience:

1961-1969: a period of low world inflation and high output growth;

1970-1972: pre-first oil shock;

1973-1979: a period characterised by high and variable inflation and lower output growth after the first oil shock. This is broken down into two shorter periods; 1973-1974 and 1975-1979. Monetary targeting commenced around 1975 for most countries in the sample;

1980-1983: after the second oil shock inflation increased again throughout the OECD and then fell later in the period;

1984-1989: a period of relatively low inflation for many countries and strong output growth. Many countries had either deregulated or were in the process of deregulating their financial systems by this time.

For each period and each country, an average inflation rate and an average interest rate (both nominal and real) are calculated[1]. These points are then

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1 The data are calculated as follows:

plotted on a graph with inflation on the horizontal scale and interest rates on the vertical scale. In addition, the line of best fit is estimated using OLS:

$$i\,(r) = a + b.\pi \qquad (1)$$

where i (r) is the average nominal (real) interest rate for a country in the relevant sub-period and π is the average inflation rate. The regression results are reported in tables in Appendix 2[2] and the slope coefficients from those regressions are also reported on the graphs (a * indicates that the coefficient is significantly different from zero at the 5 per cent level). No causation is implied by these regressions.

The number of countries included in each sample period varies, depending on the availability of a consistent time series for interest rates. For short-term interest rates, the sample for 1961-69 includes Belgium, Canada, France, Italy, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom, the United States and West Germany. In the 1970-72 period,

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(a) Average inflation rate: Quarterly data on consumer price indices (CPI) are used to calculate four-quarter ended percentage changes in consumer prices - the inflation rate. For most countries in the sample, the CPI is a monthly series so a quarterly CPI is calculated by averaging the indices over the three months of the quarter. For each period, the average inflation rate is the average of the quarterly data on the four-quarter ended percentage changes in the CPI.

(b) Average nominal interest rate: For each period an average of monthly data on interest rates is calculated.

(c) Average real interest rate: The average inflation rate for a period is subtracted from the average nominal interest rate for the same period. This is the same as calculating a real interest rate for each quarter and then averaging the real interest rate over the period.

Looking at real interest rates over a period of time as is done in this note should reduce the problem of how real rates are measured and make the results less dependent on the measure used. However, in periods of variable inflation, there may be some difficulties as noted in footnote 4.

[2] Since the level of real interest rates will also impact on the rate of inflation, π is strictly endogenous. As a result, the coefficient estimates will be asymptotically biased. It can be shown that if $b>0$, the coefficient estimate of b will be biased downwards. If $b<0$ the bias could be positive or negative, depending on how large an effect real interest rates have on inflation. If changes in real interest rates have a large impact on inflation then the estimate of b will be biased upwards. In what follows, the sign of b is not obvious. If $b>0$ in the 1980s (as the following sections suggest), then the OLS estimate of b will understate the positive association between real interest rates and inflation.

Australia, Austria and Ireland are added; Norway and Denmark are added from 1973. New Zealand and Spain are added from 1975 to bring the country total to 18. For long-term interest rates, all countries except Austria, Japan and Spain are in the sample from 1961; Austria and Japan are added in 1970 while Spain is added in 1980. Interest rates are market determined wherever possible. Details on the specific interest rates used, the measures of inflation and the sources are contained in Appendix 1.

(b) Short-Term Interest Rates and Inflation

(i) Nominal Short-Term Interest Rates

Graphs 1 to 6 show the relationship between average inflation rates and average nominal interest rates for each of the periods listed above.[3]

Graph 1 shows that over the 1960s, inflation rates and nominal short-term interest rates were both fairly low. The slope coefficient of 1.07 indicates that on average, the relationship was one-for-one; for every percentage point that inflation was higher, nominal interest rates were on average one percentage point higher.

By 1970-1972 inflation throughout the OECD had risen. As Graph 2 shows, the cluster of countries shifted up the 45 degree line as nominal interest rates rose. There is no obvious relationship; the slope coefficient of 0.24 suggests that on average there is a positive relationship but it is insignificantly different from zero.

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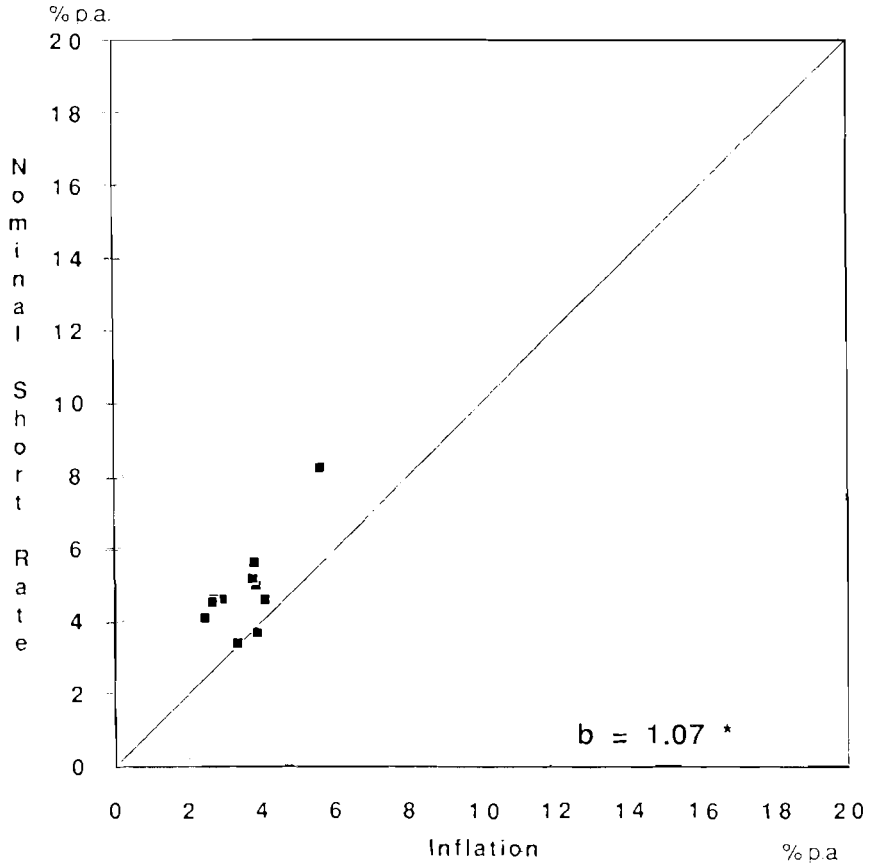
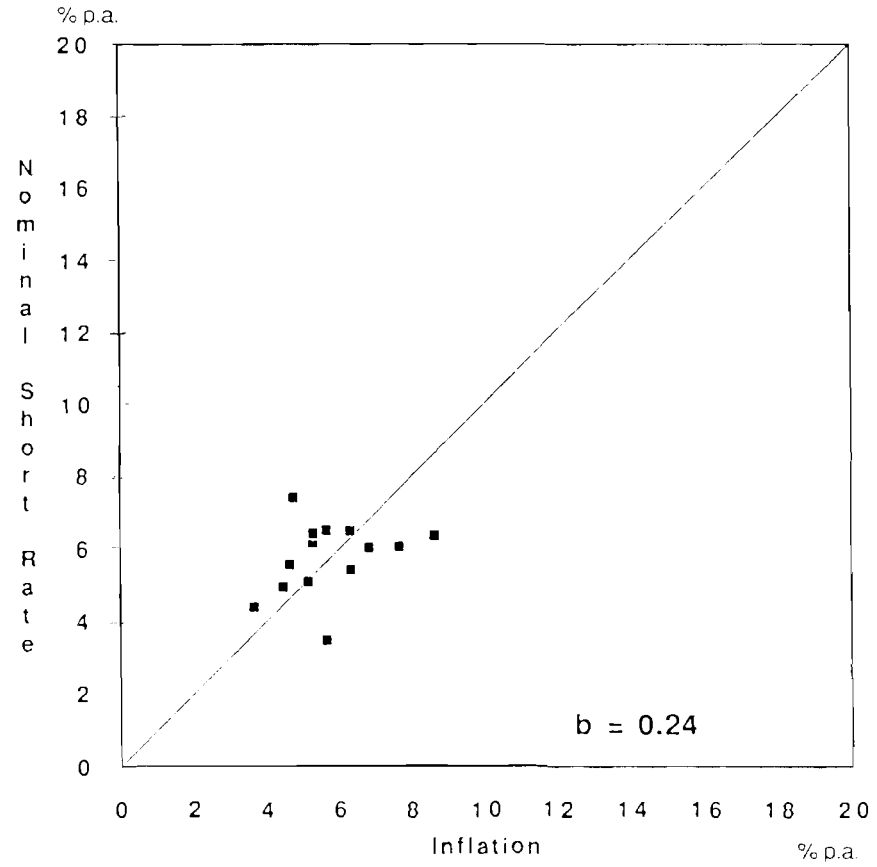
[3] A 45 degree line is drawn to help in assessing the graphs. Points on the line imply zero average real interest rates. Above the line represents positive real rates and below the line negative. Problems with this interpretation are noted below. The graphs do not identify individual countries because, as noted in the introduction, the paper is attempting to identify more general relationships.

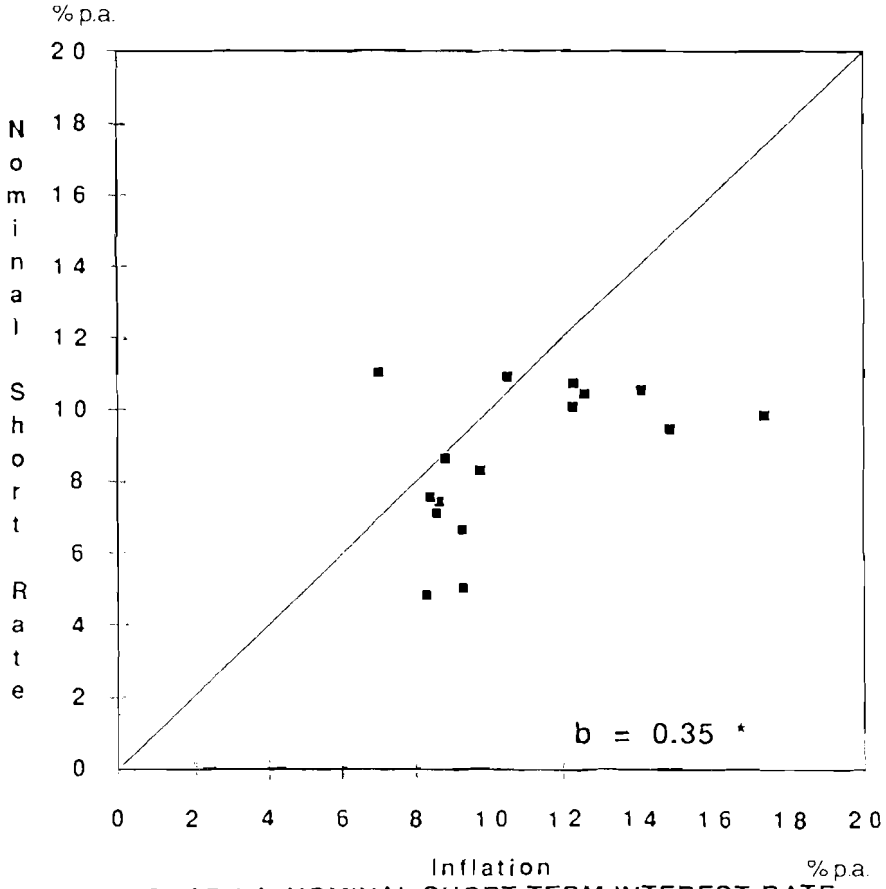
GRAPH 1: NOMINAL SHORT-TERM INTEREST RATE AND INFLATION,1961-69



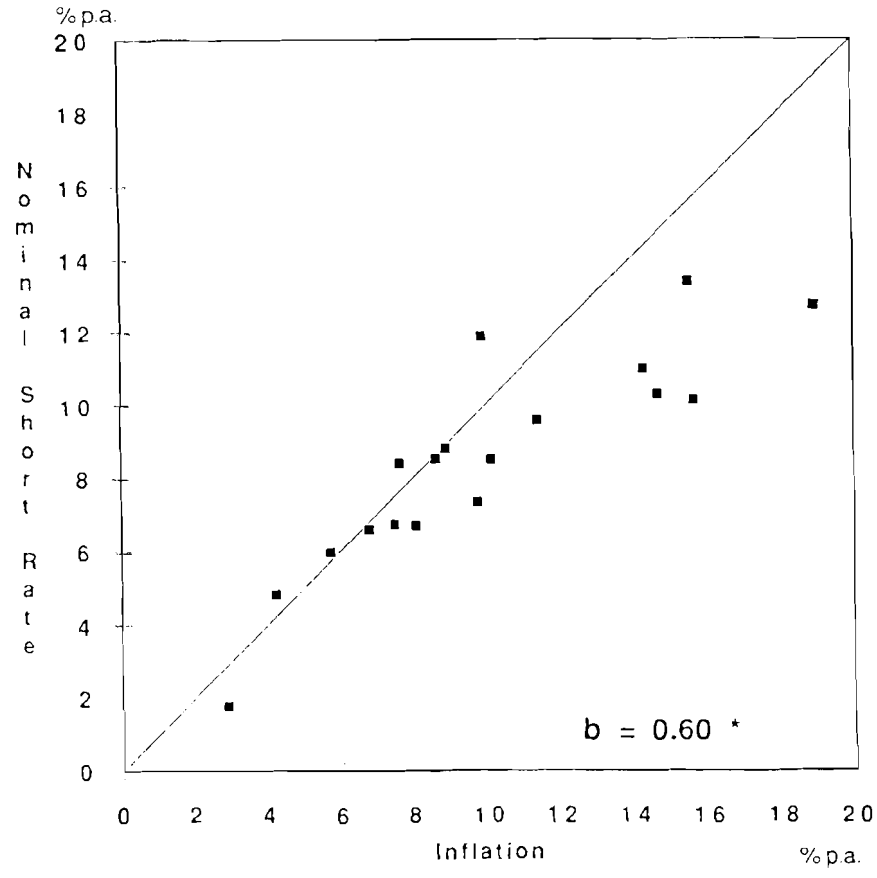
GRAPH 2: NOMINAL SHORT-TERM INTEREST RATE AND INFLATION,1970-72



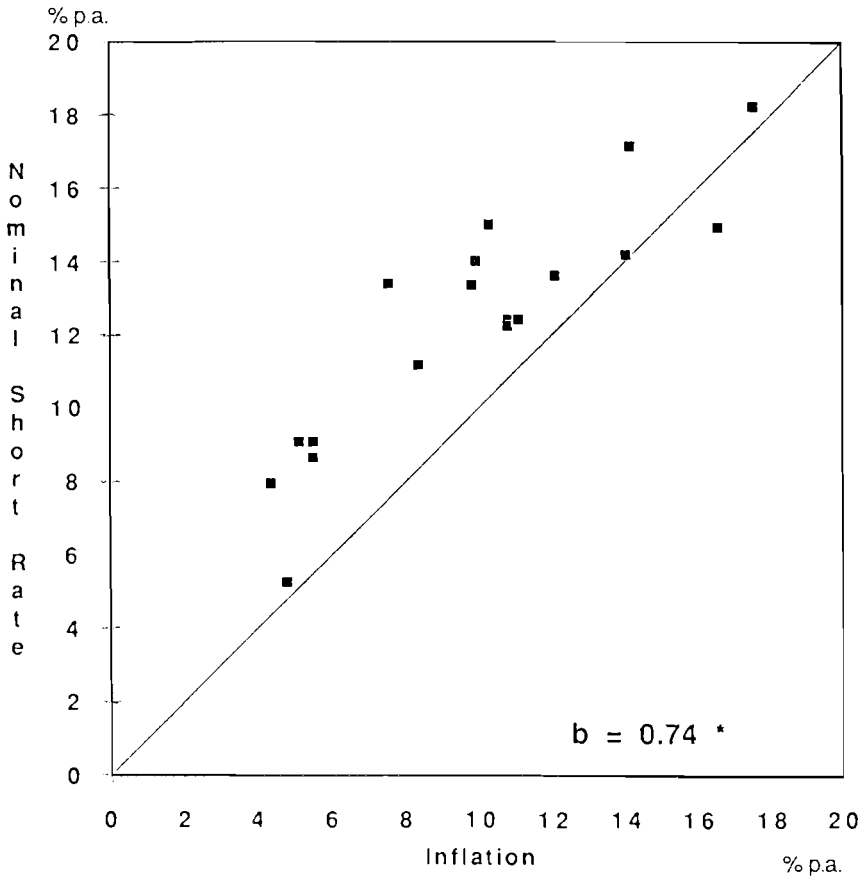
GRAPH 3: NOMINAL SHORT-TERM INTEREST RATE AND INFLATION,1973-74



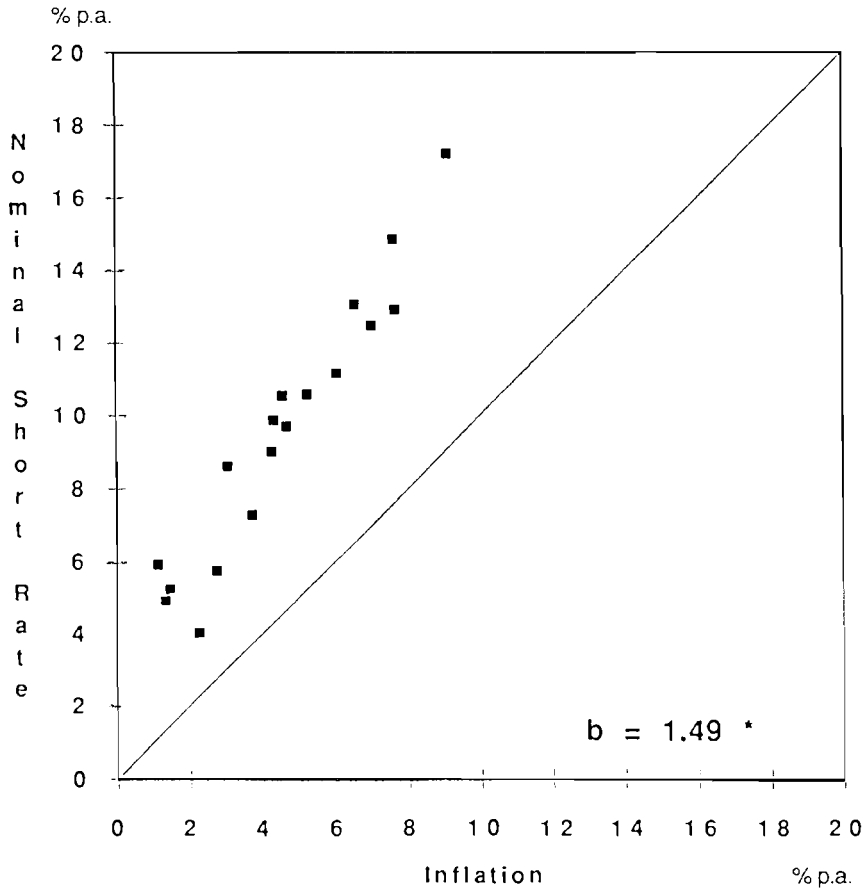
GRAPH 4: NOMINAL SHORT-TERM INTEREST RATE AND INFLATION,1975-79



GRAPH 5: NOMINAL SHORT-TERM INTEREST RATE AND INFLATION,1980-83



GRAPH 6: NOMINAL SHORT-TERM INTEREST RATE AND INFLATION,1984-89



In the 1973-1979 period inflation rose strongly in nearly all the major OECD economies. Graphs 3 and 4 show this in two sub-periods: 1973-74 and 1975-79. In the 1973-74 period the slope coefficient was positive and significantly different from zero. Over the 1975-79 period, the relationship between nominal interest rates and inflation strengthened. The slope coefficient rose but remained less than one.

In 1980-1983 the cluster of outcomes shifted to lie above the 45 degree line, but the points remained fairly dispersed. This suggests a tightening in monetary policies throughout the OECD during this period. By the 1984-1989 period, the cluster had shifted to lie even more significantly above the 45 degree line. More interesting though is that the slope coefficient in this period is significantly greater than unity. This observation is consistent with a couple of hypotheses which will be discussed below.

(ii) Real Short-Term Interest Rates

In the previous section, the relationship between real short-term interest rates and inflation could be determined with reference to a 45 degree line. The following graphs present this information in a more direct way. For each period, the graphs show the relationship between real short-term interest rates and inflation across countries. Regression coefficients are reported on the graphs and in Appendix 2.

During the 1960s there is no obvious relationship between real short-term interest rates and inflation (see Graph 7). This is supported by the slope coefficient which is small (0.07) and insignificant. But from 1970 through to 1979, there were many cases of negative real interest rates.[4] More importantly, the relationship between inflation and real short-term interest rates had become negative (Graphs 8,9 and 10). For 1970-1972 and 1973-74, the slope coefficient is around -0.7 and significant. The relationship weakens in the second half of the 1970s but remains negative.

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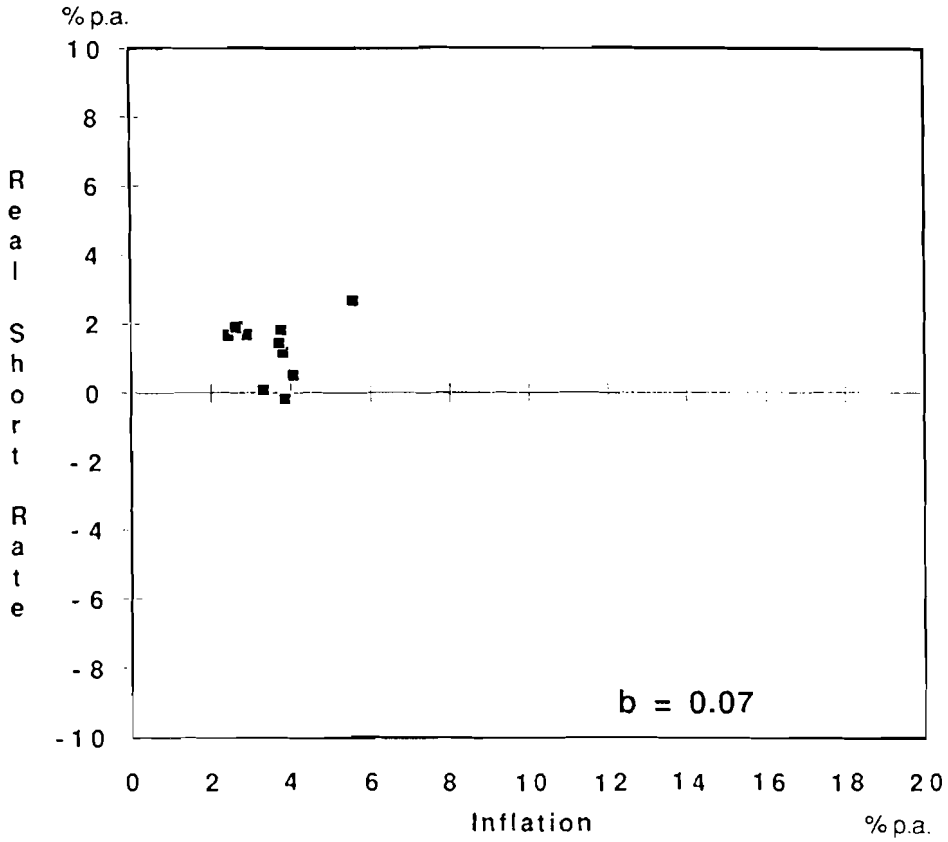
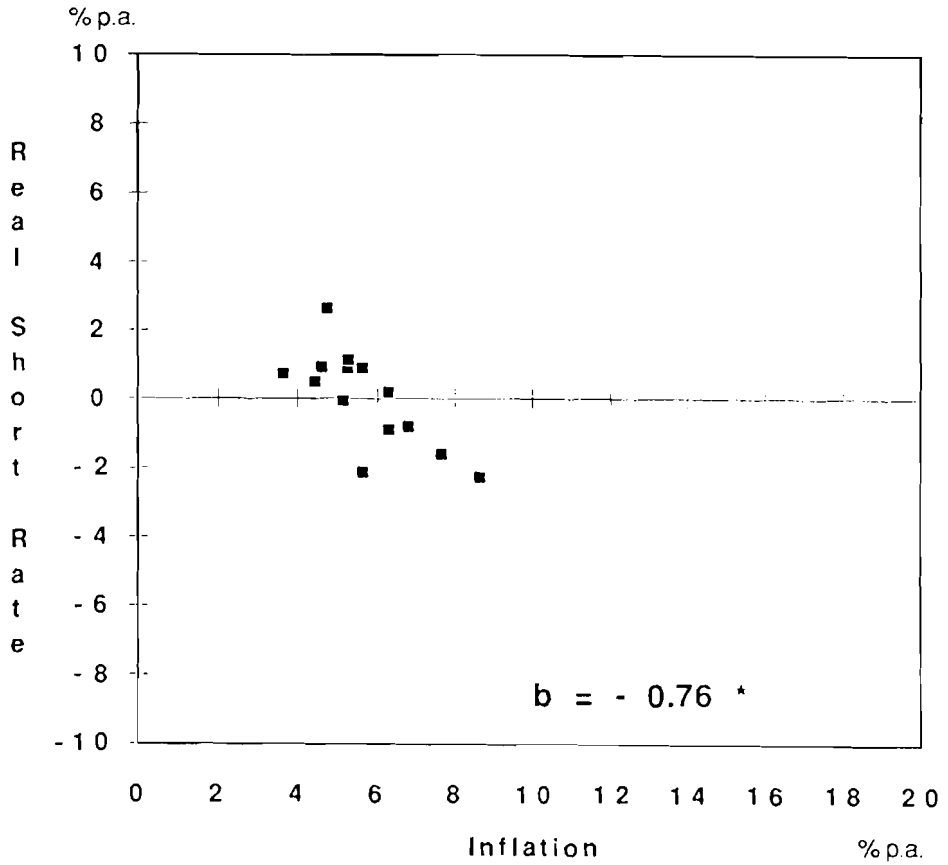
[4] Note that in this instance, the proxy used for real interest rates may be misleading. Since the rates of inflation experienced during this period were outside most people's experience, inflationary expectations may have been vastly different from the actual inflation rate, probably lower. Hence it is possible that expected real interest rates were not as negative as indicated by the measure used here.

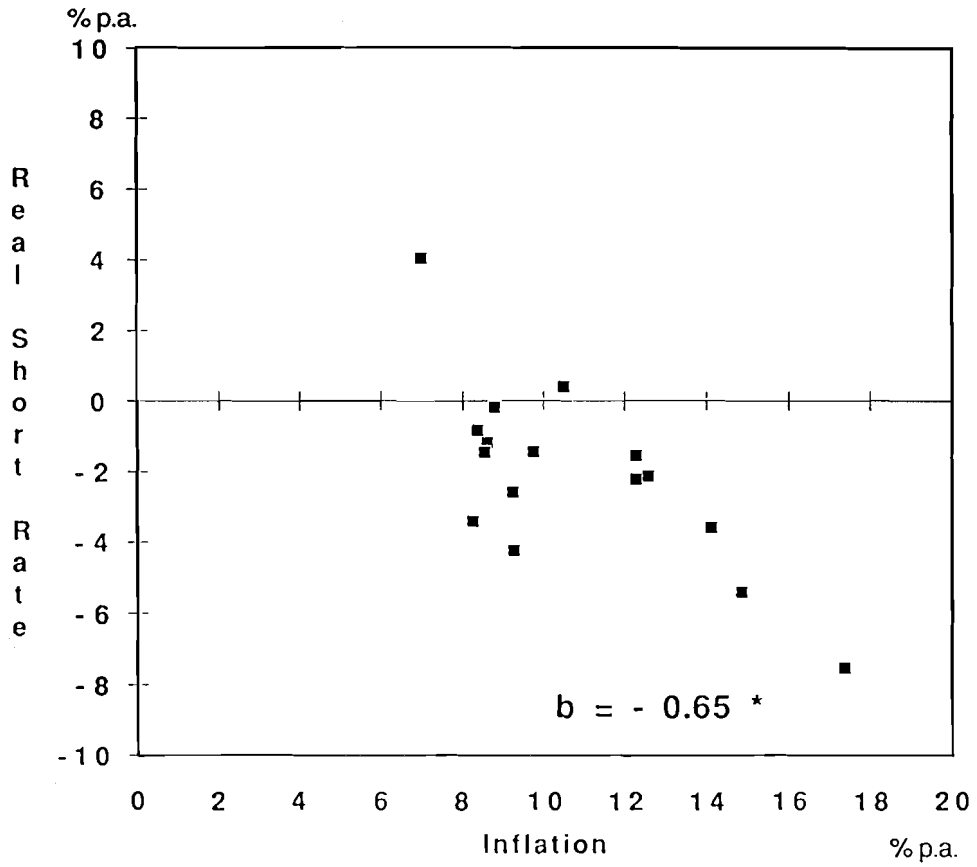
GRAPH 7: REAL SHORT-TERM INTEREST RATE AND INFLATION,1961-69



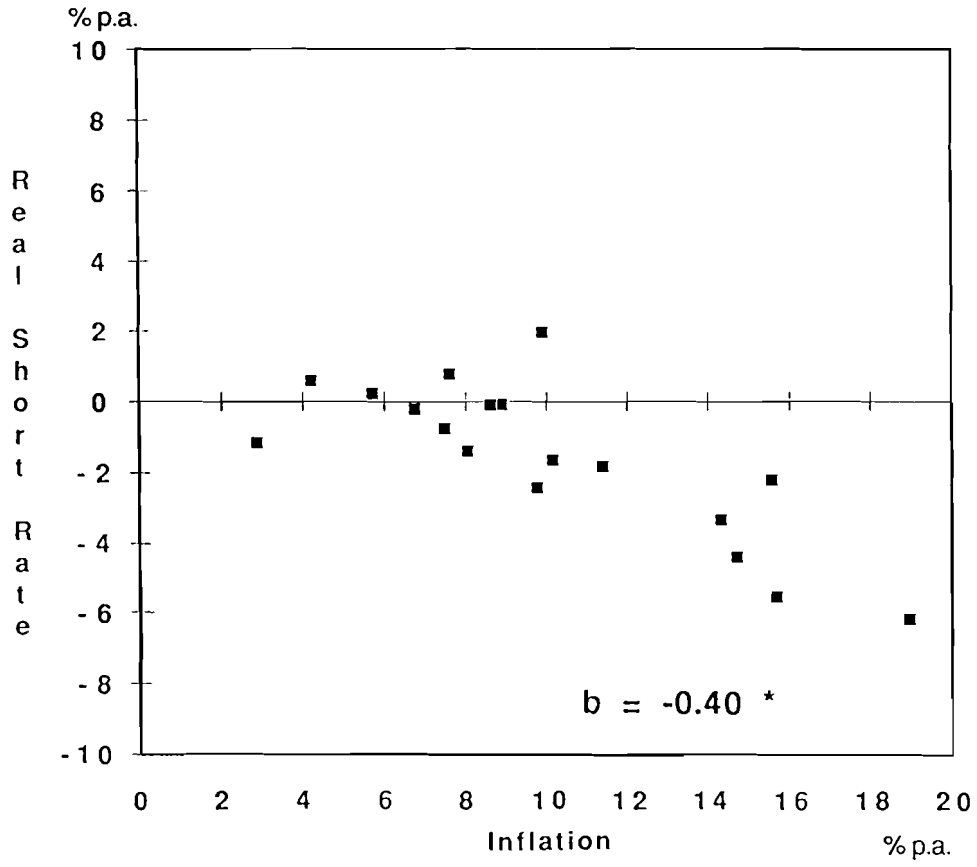
GRAPH 8: REAL SHORT-TERM INTEREST RATE AND INFLATION, 1970-72



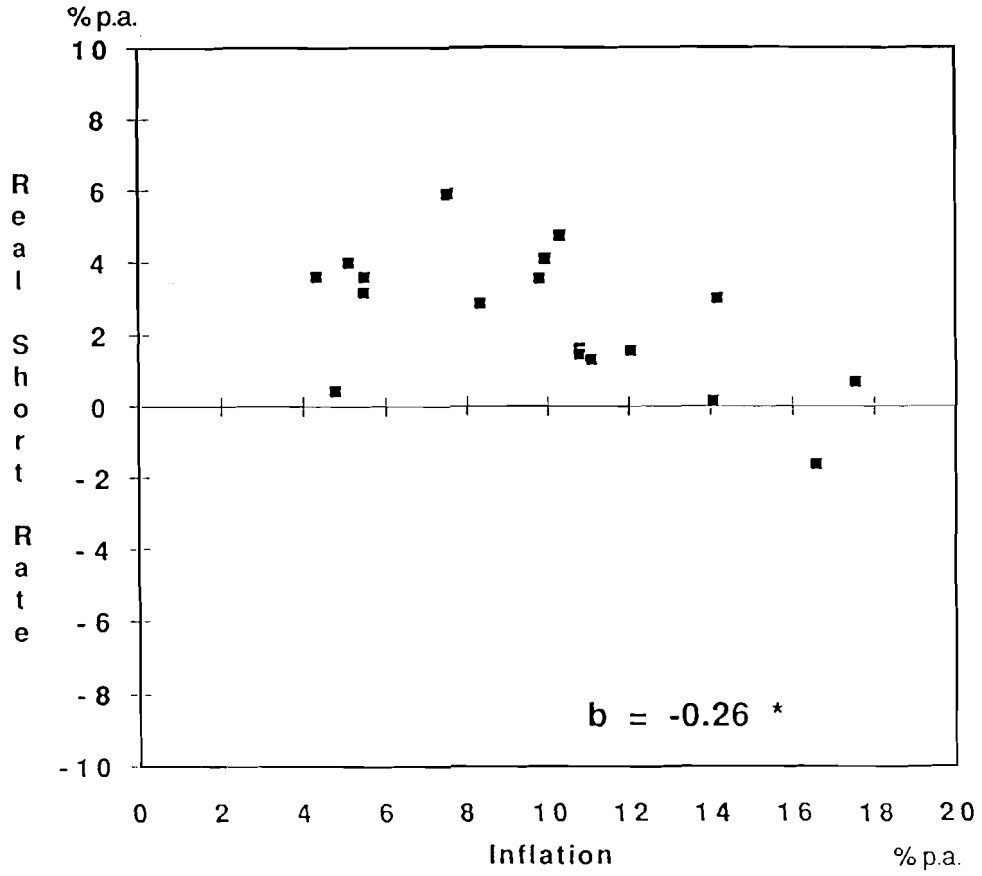
GRAPH 9: REAL SHORT-TERM INTEREST RATE AND INFLATION,1973-74



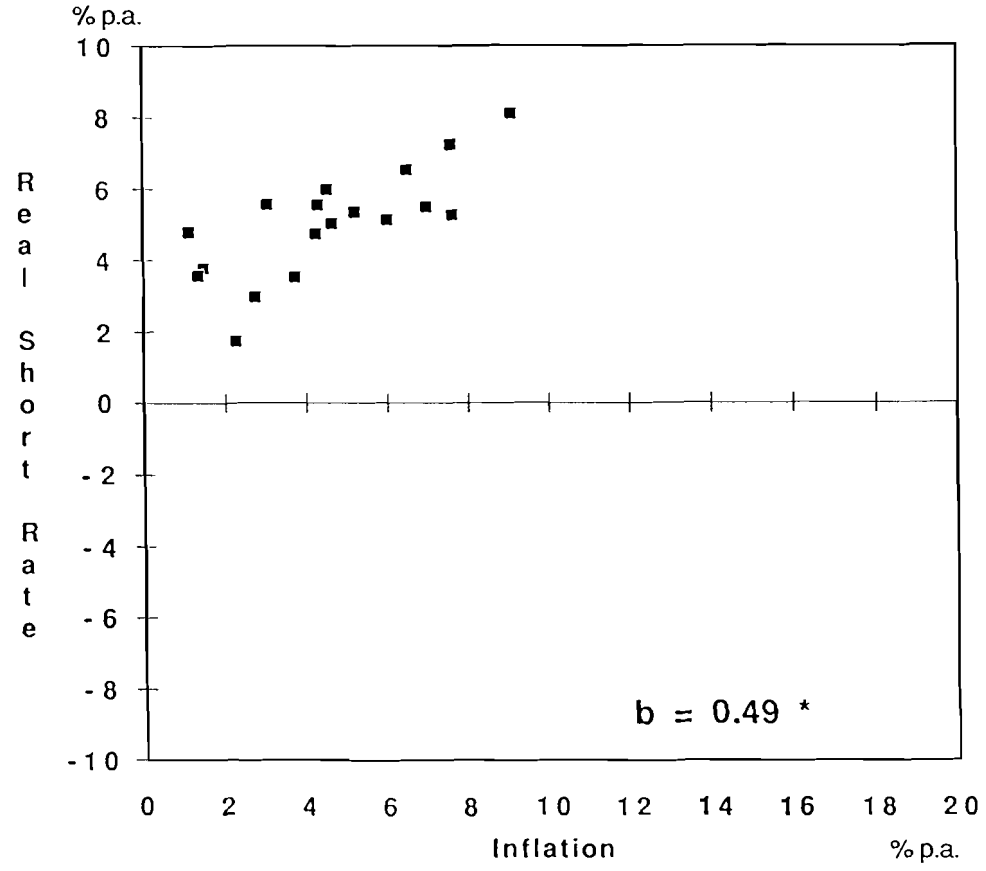
GRAPH 10: REAL SHORT-TERM INTEREST RATE AND INFLATION,1975-79



GRAPH 11: REAL SHORT-TERM INTEREST RATE AND INFLATION,1980-83



GRAPH 12: REAL SHORT-TERM INTEREST RATE AND INFLATION,1984-1989



By the 1980-1983 period however, the relationship between inflation and real short-term interest rates had shifted upwards (see Graph 11). Most countries had at least zero if not positive real short-term interest rates. Furthermore, the negative relationship which was quite strong in the early 1970s had weakened further. Countries such as Australia and Japan had a similar level of real short-term interest rates but Japan's average inflation rate was about 6 percentage points lower than Australia's.

A relationship re-emerged in the 1984-1989 period but it was the opposite to that in the 1970s (see Graph 12)[5]. In this period, there is a positive relationship between inflation and real short-term interest rates; the slope coefficient is 0.49 and significant. *Countries with higher inflation tended to have higher real short-term interest rates.*

As is obvious from a glance at Appendix 1, the data on short-term interest rates is a mixture of rates on short-term government securities and private sector rates, the mixture being dictated by data availability. But private sector assets such as bank bills will have a risk premium on government securities of similar maturity. Since the relationship between real short-term interest rates and inflation in the second half of the 1980s is so striking, it is worth confirming that the relationship is not a product of the mixture of data.

It was not possible to obtain interest rates on short-term government securities for all 18 countries in the sample. Ten countries had a three month government security yield while two more countries had a rate on a security of unknown maturity. A scatter plot of all twelve countries confirms the relationship observed above (see Graph 13). Real short-term interest rates are higher in high inflation countries. The OLS estimate of

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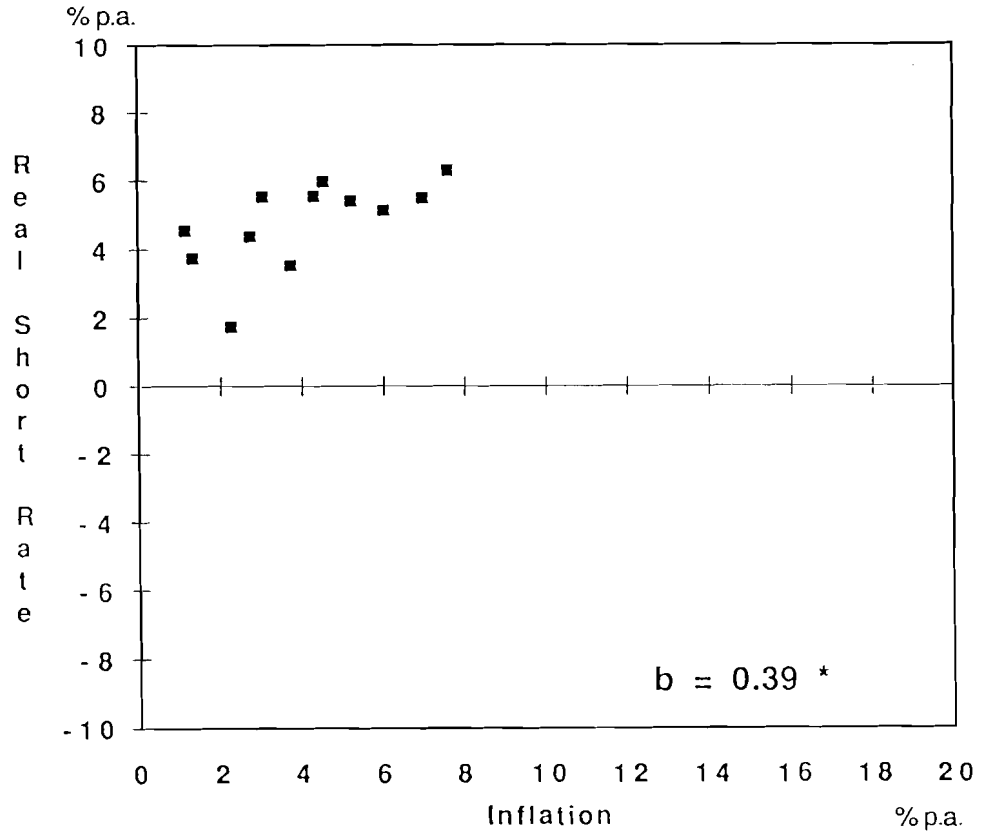
5 In the 1984-89 period a goods and services tax (GST) was introduced in New Zealand. As a result, the measured consumer price inflation rate was pushed up sharply. In 1987, the 12 month ended change in the CPI was sometimes $7\frac{1}{2}$ percentage points higher than it would have been with the impact of the GST removed. In the graph and regressions, the New Zealand inflation rate is measured excluding the GST. There are some other countries in which CPIs were affected by consumption taxes or value added taxes but compared with the New Zealand case, the impact was relatively minor so no adjustments have been made. In the case of Australia, adjustments have been made to take into account the effect on measured inflation of Medibank and Medicare.

the slope coefficient is 0.39; smaller than the coefficient found in the sample of 18 countries but nevertheless significantly different from zero. So the relationship does not appear to be the result of different risk characteristics of assets.[6]

GRAPH 13: REAL SHORT-TERM INTEREST RATE AND INFLATION,1984-89



To summarise the important observations on short-term interest rates:

. through most of the 1970s and 1980s, there was a positive relationship between inflation and nominal short-term interest rates;

. through most of the 1970s there was a negative relationship between inflation and real short-term interest rates; and

. in the second half of the 1980s, there was a positive relationship between inflation and real short-term interest rates.

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6 Note that New Zealand had very high real interest rates during this period but is not included in graph 13. Market determined rates for New Zealand Treasury bills are available from 1986. When graph 13 is reproduced for the period 1986-1989 to include New Zealand (and France can then be included as well), the conclusion is strengthened.

(c) Long-Term Interest Rates and Inflation[7]

Graphs 14 to 19 show that, as for short-term interest rates, there tends to be a positive relationship between nominal long-term interest rates and inflation, although it is not very strong in some of the early periods. For real long-term interest rates, the regressions indicate a negative relationship in the 1960s and early 1970s (Graphs 14 and 15).

The relationship appeared to change from the mid 1970s. Graphs 16 and 17 show that the observations are much more dispersed (essentially due to more dispersed inflation rates) than in earlier periods and that there is a positive relationship between nominal long-term interest rates and inflation. Furthermore, the slope is less than one which implies that there is a negative relationship between real long-term interest rates and inflation from 1973 to 1979. This is precisely what was observed for short-term rates.

In 1984-89 there appeared to be a further change in the relationship between inflation and real interest rates. There is a significant positive relationship between nominal long-term interest rates and inflation - approximately one-for-one (see Graph 19). In other words, long-term real interest rates tend to be equalised across countries. The regression coefficient, b_r, is insignificantly different from zero supporting the conclusion that real long-term interest rates are equalised across countries for this period. This is in contrast to earlier periods and in contrast to real short-term rates.

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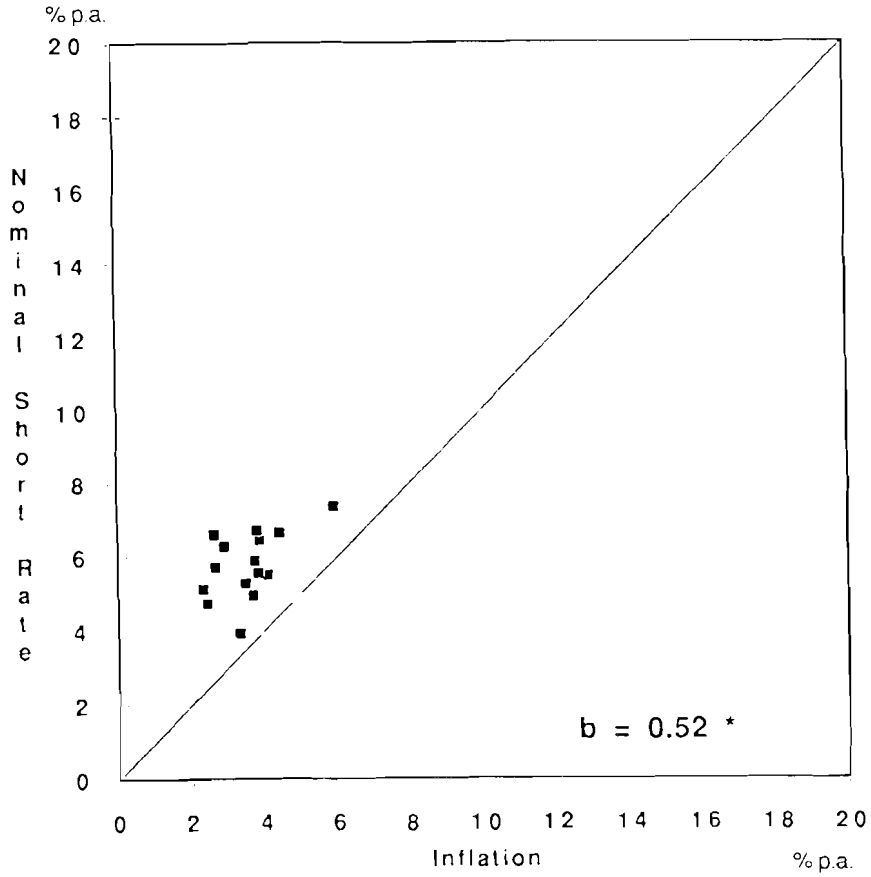
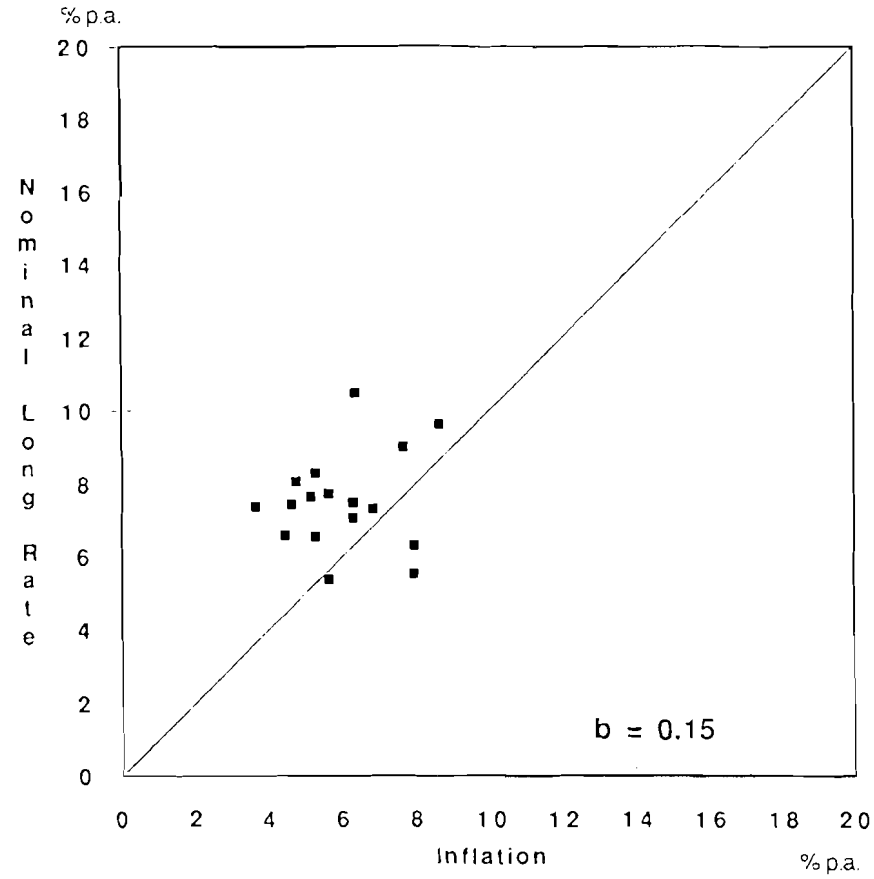
[7] Only graphs of the relationship between nominal long-term interest rates and inflation are shown. The real interest rates/inflation relationship is discussed with reference to the 45 degree line. Regression results are reported on the graphs (noting that $b_r = 1-b_n$) and in Appendix 2.

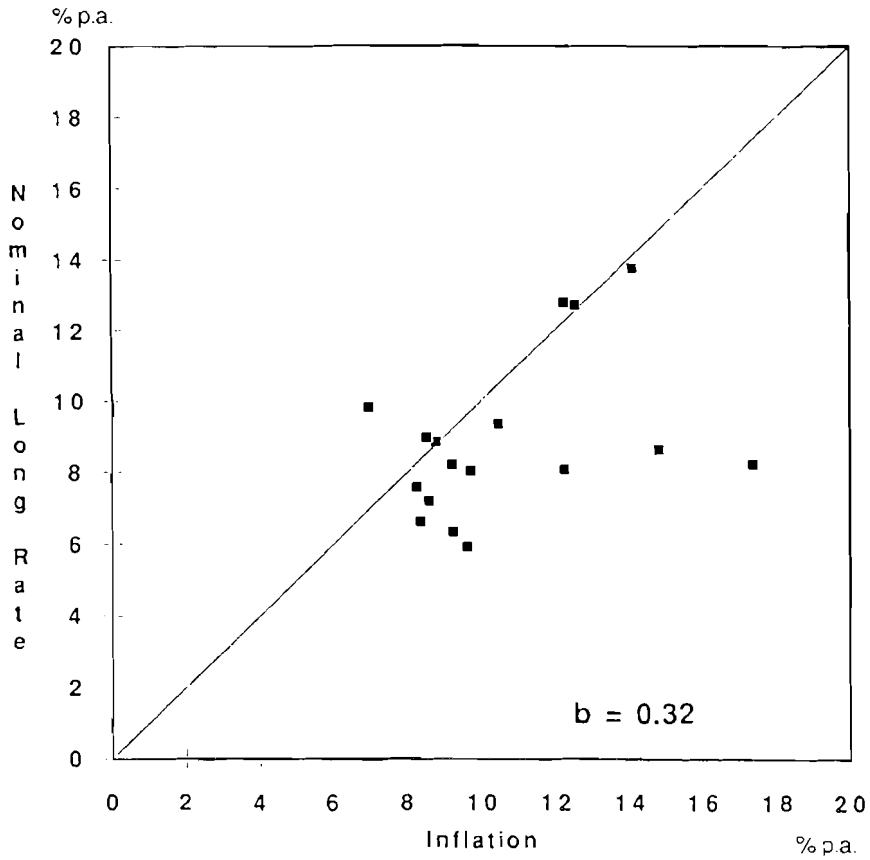
GRAPH 14: NOMINAL LONG-TERM INTEREST RATE AND INFLATION,1961-69



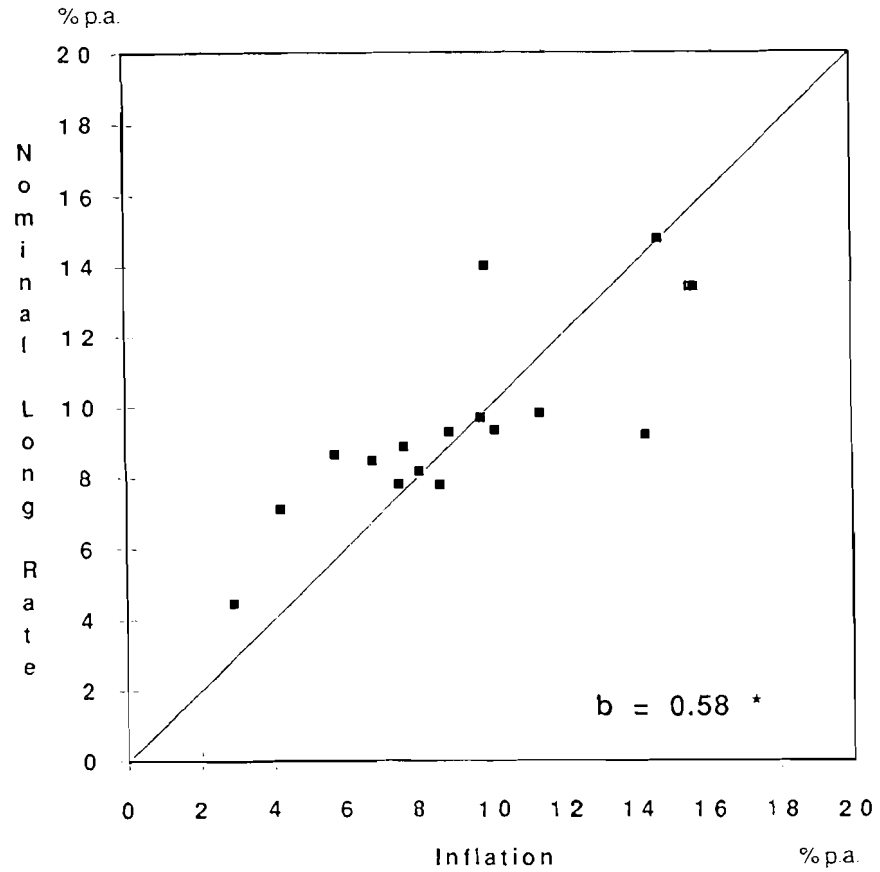
GRAPH 15: NOMINAL LONG-TERM INTEREST RATE AND INFLATION,1970-72



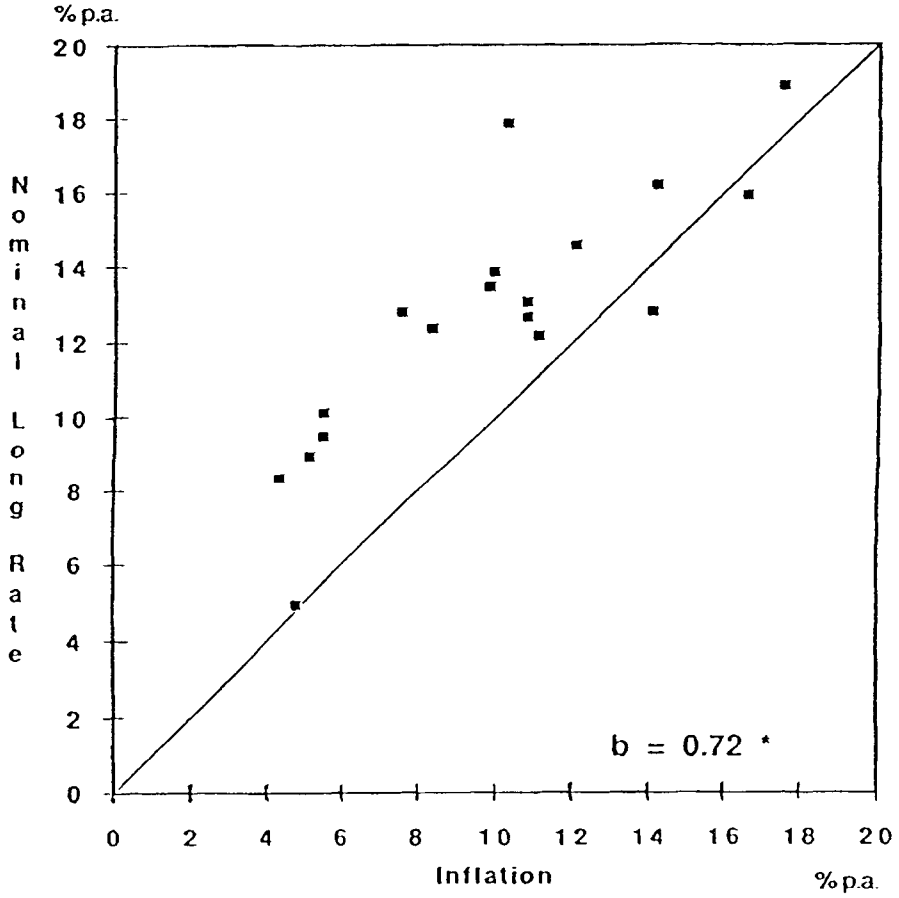
GRAPH 16: NOMINAL LONG-TERM INTEREST RATE AND INFLATION,1973-74



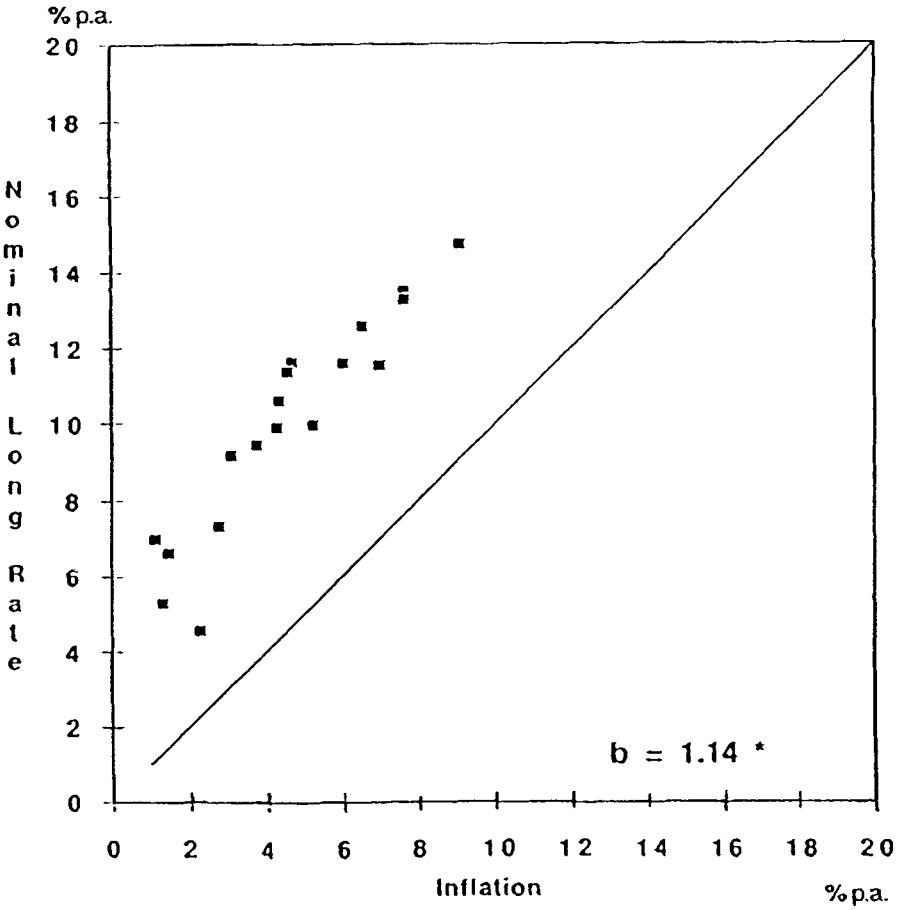
GRAPH 17: NOMINAL LONG-TERM INTEREST RATE AND INFLATION,1975-79



GRAPH 18: NOMINAL LONG-TERM INTEREST RATE AND INFLATION,1980-83



GRAPH 19: NOMINAL LONG-TERM INTEREST RATE AND INFLATION,1984-1989



3. SOME HYPOTHESES

In this section, an attempt is made to explain the empirical regularities observed in section 2b. How can the positive relationship between real short-term interest rates and inflation in the second half of the 1980s be explained? And how can the break with previous periods be justified? Before discussing these issues though, it is worth highlighting some simple hypotheses upon which much of the literature of inflation/interest rate relationships is built.

(a) The Fisher Hypothesis

Theory on the relationship between inflation and interest rates for closed economies has revolved around the Fisher hypothesis and variants on this. Fisher (1930) decomposed the nominal interest rate (i_t) into two parts: a real component (r_t) and inflationary expectations (π^e_t).[8]

$$i_t = r_t + \pi^e_t \qquad (2)$$

Fisher argued that over the longer term, the real rate of interest is determined mainly by individual time preference and will be approximately constant. Nominal interest rates will hence reflect movements in inflationary expectations one-for-one.

This simple analysis neglects taxes which are now recognised (beginning with the contribution of Darby (1975)) as having an important influence on interest rates. When taxes are taken into account, the simple Fisher hypothesis alters. Assuming a proportional income tax, taxable nominal interest receipts and deductible nominal interest payments,

$$r^a_t = i_t - \tau i_t - \pi^e_t \qquad (3)$$

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[8] Continuous compounding is assumed. This allows equation 2 to be written without the cross-product term, $r_t.p^e_t$.

where r^a_t is the real after-tax interest rate, and τ is the (proportional) tax rate. Therefore, if the real after-tax rate of return is constant in the long run, the nominal rate of interest is given by

$$i_t = (r^a_t + \pi^e_t)/(1 - \tau) \qquad (4)$$

So if π^e_t rises by one percentage point, the nominal interest rate rises by $1/(1-\tau) > 1$ percentage points. That is, the nominal interest rate must rise not only by enough to cover the higher inflation rate but also by enough to cover the increased taxation burden. Note also what this implies for the real pre-tax interest rate: it increases with the expected inflation rate and the nominal interest rate. Assuming the real after-tax interest rate is constant, equation 3 implies

$$dr_t = \tau/(1-\tau).d\pi^e_t \qquad (5)$$

where r_t is defined in equation 2. The real pre-tax interest rate will rise proportionately with the expected inflation rate, the proportional tax rate determining the size of the response.

The discussion above proceeded on the basis of a closed economy and said nothing about the relationship between interest rates in different countries. If we assume uncovered interest parity (UIP) and an ex-ante version of purchasing power parity (EAPPP), real pre-tax interest rates will be equalised across countries[9]. Applying the Fisher equation, it is easy to see that high inflation countries will have higher nominal interest rates than low inflation countries.

It appears relatively easy then to reconcile the relationship between nominal interest rates and inflation across countries. But the simple model

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[9] To see this:

(F1) $i_{t+k} - i^*_{t+k} = s^e_{t+k} - s_t$ (UIP)

(F2) $p^e_{t+k} - p^{e*}_{t+k} = s^e_{t+k} - s_t$ (EAPPP)

where i_t and p_t are defined as in the text, s_t is the log of the spot exchange rate and * refers to a foreign variable. Subtracting (F2) from (F1),

$$0 = (i_{t+k} - p^e_{t+k}) - (i^*_{t+k} - p^{e*}_{t+k})$$

That is, ex-ante real interest rates will be equalised across countries.

above suggested that pre-tax real interest rates would be equalised across countries. The data presented in section 2b are not entirely consistent with this prediction: prior to the 1980s, real pre-tax interest rates were not equal across countries at either the short end or the long end. Furthermore, in the 1980s, there was an apparent change in the relationship between inflation and real short and long-term interest rates. Although real long-term interest rates appeared to be equalised across countries in this period, real short-term interest rates were not. The following section discusses possible explanations for these observations.

(b) Short-Term Interest Rates

A simple explanation for the inequality of short-term real interest rates is that prior to the 1980s, countries with high inflation rates were experiencing their inflation because of loose monetary policies (represented by relatively low or negative real short-term interest rates). In the 1980s, central banks around the world became more conscious of reducing inflation. As a consequence, countries with high inflation ran tight monetary policies (high real short-term interest rates) in an attempt to reduce inflation.

Why were these real interest differentials not arbitraged away? In the context of a Dornbusch(1976) overshooting model, real interest rates may differ across countries in the short run if the authorities have adjusted monetary policy. In such a model, the price level is assumed to be sticky and the exchange rate adjusts quickly. If a country loosens monetary policy, at the initial level of prices, the domestic interest rate will fall. The exchange rate will depreciate but it overshoots so that the expected appreciation in the exchange rate offsets the interest differential between home and abroad. As the domestic price level adjusts upward, the domestic interest rate will rise and the exchange rate will appreciate to its long run equilibrium. In long-run equilibrium, the price level and exchange rate will be at their new equilibrium levels and the (real) interest rate will once again be equal to the foreign (real) interest rate[10].

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[10] In the original Dornbusch model, nominal interest rates would also be equalised across countries because there is no money growth and no inflation in the long-run equilibrium.

In this model then, some countries can run lower real interest rates than the rest of the world in the short run. Likewise, if a country tightens monetary policy, it can keep its real interest rates above those in the rest of the world in the short run. In terms of the relationships we observed in section IIb, countries with high inflation were loosening monetary policy in the 1970s and tightening monetary policy in the 1980s.

An alternative explanation is that a country with high inflation must run a higher pre-tax real interest rate than a country with no inflation simply to keep inflation from accelerating. Equation 5 showed that in a closed economy, if the real after-tax interest rate is to remain constant in an environment of rising inflationary expectations, the real pre-tax interest rate will have to rise. If the real pre-tax interest rate does not rise, the real after-tax interest rate will fall. Since saving and investment decisions in the domestic economy are made on the basis of real after-tax interest rates, a fall in the real after-tax interest rate will encourage investment and discourage saving (or, equivalently, encourage consumption). If the authorities want the real after-tax interest rate to remain constant in the face of rising inflation, they will have to run higher pre-tax real interest rates. This is a product of the non-neutrality of the tax system.

Thus, the non-neutrality of the tax system implies that higher inflation countries will have to run high pre-tax real interest rates simply to maintain a given stance of monetary policy. This is consistent with the real short-term interest differentials observed in section 2b. But why are these differentials not arbitraged away as is predicted in the standard open economy model? Gruen (1991) introduces some uncertainty into the standard model. Without going into details, the result is that real interest rates are higher in a high inflation country simply to keep inflation steady.[11] Furthermore, these differentials are not arbitraged away.

Note that unlike the Dornbusch model, this is a longer-run equilibrium position. It explains why high inflation countries may have high real interest rates even if they are not attempting to reduce inflation. But the Gruen model only explains the positive relationship between real short-term interest rates and inflation observed in the second half of the 1980s. As

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[11] An accompanying result is that the exchange rate is overvalued.

will be discussed below, the model does not fit the world of the 1960s and 1970s.

(c) Long-Term Interest Rates

The previous section focussed on the relationship between short-term interest rates and inflation. But it was noted in section 2c that real long-term interest rates are not necessarily equal across countries either. The relationship between real long-term interest rates and inflation tended to be negative over the 1970s. By the 1980s though there was no relationship between real long-term interest rates and inflation. Can this be explained in the context of the hypotheses put forward in the previous section?

In the Dornbusch model, there is no distinction between short and long-term interest rates. But Gruen's model makes this distinction so it is possible to make some predictions about long-term interest differentials. The relationship between domestic and foreign real long-term interest rates is not as clear cut as for real short-term interest rates. Under some assumptions high inflation countries could be expected to have a higher long-term real interest rate than low inflation countries. Under other assumptions, the real long-term interest rate in the high inflation country might be lower than the rate in low inflation countries. But the Gruen model consistently predicts that real long-term interest rates will not be as high as real short-term interest rates in the high inflation country.

The data in section 2c are consistent with the model's prediction of a downward sloping yield curve in high inflation countries. The relationship between real long-term interest rates and inflation over the second half of the 1980s is much weaker than that for real short-term interest rates and inflation over the same period.

(d) Why the Change in the Relationship?

In the previous sections, some hypotheses were offered as to why there is a positive relationship between real interest rates and inflation over the second half of the 1980s. But in the 1960s and 1970s it was observed that

pre-tax real interest rates were either equal across countries or exhibited a negative relationship with inflation. Why did the predicted relationship show up in the data only in the 1980s?

In the Dornbusch overshooting framework, there is no difficulty explaining this change. In this model, real interest differentials are only a short run phenomena induced by changes in monetary policy. A negative relationship between inflation and real interest rates is consistent with this model, as is no relationship.

In Gruen's model, the explanation could be the difference in regulatory regimes between the periods. Through the 1960s and 1970s, monetary policy in most countries operated in a regulated environment. Policy operated through direct controls on the amount and direction of lending, controls on interest rates and a variety of reserve requirements. Although what market determined rates there were would have risen as policy was tightened, this was not the principal channel through which policy had its impact. Furthermore, capital was not nearly as mobile as it is these days. Many countries had fixed or managed exchange rates and capital controls. These restrictions impeded the flows of capital which would tend to arbitrage away interest differentials.

But in the 1980s, most countries undertook substantial deregulation of their financial systems. Monetary policy came to operate increasingly through the markets and changes in interest rates. Capital controls were progressively abolished, allowing increasingly free movement of capital across national borders. Furthermore, communication improvements and financial innovation encouraged global capital flows.

The Gruen model is imbedded in the deregulated environment. In this model, short-term interest rates respond to changes in the stance of monetary policy and exchange rates float. The impact of monetary policy on the economy comes through the interest rate channel and the associated exchange rate channel. Capital is mobile and flows to equalise expected returns between countries. It is not surprising then that the predictions from this model are inconsistent with the data for the regulated period.

In addition, the tax-adjusted Fisher effect might only be expected to show up in a deregulated environment. Carmichael and Stebbing (1983) argued that provided there is some degree of regulation of interest rates and a relatively high degree of substitution between money and financial assets, the Fisher hypothesis may be completely inverted (i.e. the after-tax nominal interest rate is approximately constant while the after-tax real rate moves inversely one-for-one with the rate of inflation). The implication is that the tax-adjusted Fisher effect may only begin to show up in the deregulated period, that is, the 1980s.

A more general explanation for the change in the relationship between the 1970s and the 1980s relates to the adaptive nature of investors expectations. As argued in footnote 4, the inflation rates experienced in the 1970s were well outside the experience of most investors. Investors were probably expecting much lower rates of inflation during this period. But their expectations turned out to be very wrong. As shown in Graphs 9, 10, 16 and 17, the ex-post returns to investors at both the long end and the short end turned out to be negative in many cases over the 1970s. Furthermore, returns tended to be more negative in the higher inflation countries as shown by the negative relationship between inflation and real interest rates. This suggests that the higher the inflation rate, the larger the "mistake" on inflation expectations.

Eventually, investors adapted their expectations to this higher inflation climate. Not wanting to be caught out as they were in the 1970s, investors demanded higher nominal returns in the 1980s. The higher the inflation rate, the more the adjustment since the worst errors in the 1970s had been made in the high inflation cases. This resulted in higher ex-post returns across the board. The graphs showed that in contrast to the 1970s, ex-post real returns tended to be positive in the 1980s. In effect, investors expectations "caught up" with the change in the inflation environment and this produced a change in the relationship between ex-post returns and inflation.

4. A SIMPLE TEST

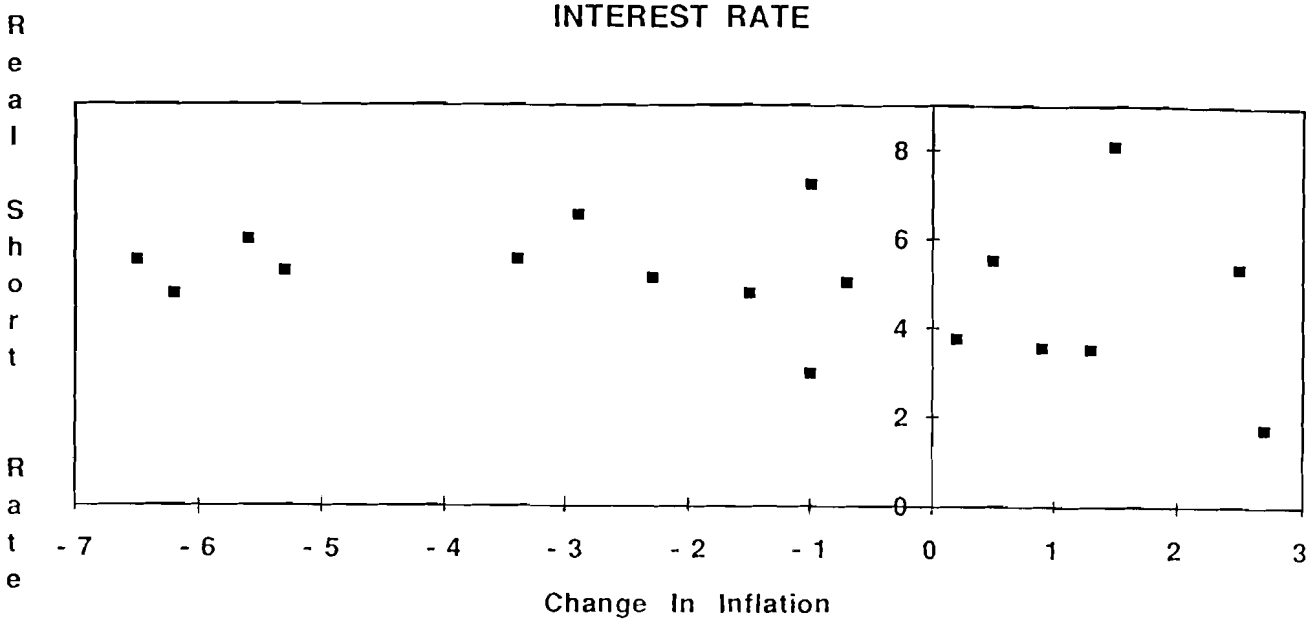
This section attempts to determine whether the high short-term real interest rates in high inflation countries represent an attempt to decrease inflation or whether they are simply keeping inflation steady. Table 1 and Graph 20 look at this. If it is the case that high inflation countries were running tighter monetary policies, we might expect the observations in Graph 20 to lie approximately in a downward sloping line: countries with high real interest rates having made the most progress on inflation.

Table 1: Average Real Short-Term Interest Rate and Change in Inflation, 1984-1989

	Interest Rate(%pa)	Change in inflation*
New Zealand	8.1	1.5
Australia	7.2	-1.0
Norway	6.5	-2.9
Ireland	6.0	-5.6
Italy	5.5	-6.5
Canada	5.5	0.5
Belgium	5.5	-3.4
United Kingdom	5.4	2.5
Spain	5.3	-5.3
Sweden	5.1	-2.3
Denmark	5.0	-0.7
The Netherlands	4.8	-1.5
France	4.7	-6.2
Germany	3.8	0.2
Japan	3.6	0.9
United States	3.5	1.3
Austria	3.0	-1.0
Switzerland	1.7	2.7

* Four-quarter-ended percentage change in the CPI in December 1989 less the four-quarter-ended percentage change in the CPI in December 1983. A positive (negative) number implies an increase (decrease) in inflation.

GRAPH 20: CHANGE IN INFLATION AND AVERAGE REAL INTEREST RATE



There is some evidence of a negative relationship. An OLS regression through these points yields a slope coefficient of -0.52 but it is insignificantly different from zero. Australia, New Zealand[12] and the United Kingdom all had high real short-term interest rates on average over this period but inflation only fell slightly in Australia and rose in the other two countries. On the other hand, Italy, Ireland and France all had average real interest rates around the same level as the United Kingdom but they achieved large reductions in inflation. It is interesting to note that these three countries were all EMS members over this period. The large reductions in inflation with the same level of real interest rates as the UK may be evidence of "credibility" achieved by participation in the exchange rate mechanism.

Table 1 indicates that of the five countries with the highest real interest rates over the period all achieved declines in inflation except for New Zealand. Given the distortions in the New Zealand inflation data, it would not seem unreasonable to exclude New Zealand from the comparisons. Excluding New Zealand from the regression between the change in inflation and the average real interest rate yields a coefficient of -1.04 and it is significantly different from zero. This is evidence in favour of the hypothesis that the high real interest rates in high inflation countries are fighting inflation.

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[12] Price controls early in the period distort the picture.

On the other hand, some of the observations for individual countries support the idea that the high real interest rates were simply stopping inflation from accelerating. If we take the world real interest rate to be the average of those for the US, Germany and Japan (which are all around $3\frac{1}{2}$ per cent per annum) Australia, Canada and Denmark all ran real pre-tax interest rates above the world real interest rate and had close to no progress on inflation. The smaller European countries have generally run their interest rates above the world rate and achieved varying progress on inflation. New Zealand and the UK have experienced a rise in inflation, despite running pre-tax real interest rates above the world rate.

So the simple test used here cannot determine which of the two hypotheses might be correct. The problem is that it is difficult to establish whether the real interest rate in a country is higher than, equal to or less than the real interest rate which would keep inflation steady (the "steady inflation " interest rate). It is this differential which determines whether policy is "tight" or not, rather than the absolute level of the real interest rate.

A further note of caution; there could also be problems with the lags between interest rates and inflation. Real interest rates may be high on average because of a very tight policy toward the end of the period. In this case, the impact on inflation may not have shown up within the period. For example, in 1990 inflation eventually fell in Australia, the UK and New Zealand. If Table 1 and Graph 20 were extended to include another year, these countries would show more progress on inflation for their high real interest rates.

5. CONCLUSION

Although it is relatively well known that nominal interest rates tend to be higher in high inflation countries, it is less well known that in recent years, such countries have also tended to have higher short-term real interest rates. This paper used graphs and some simple regressions to establish the positive relationship between short-term real interest rates and inflation over the second half of the 1980s. It then attempted to explain why this has been the case.

The paper suggested two reasons why real short-term interest rates might be higher in high inflation countries and attempted to determine which of these two hypotheses might be correct. Unfortunately, the simple test used was unable to lend support to either hypothesis.

The graphical analysis also established that the relationship between real interest rates and inflation across countries has changed since the 1970s. The positive relationship referred to above only began to show up in the 1980s. Deregulation was advanced as one reason why the relationship between short-term real interest rates and inflation altered in the 1980s. But another explanation was simply that inflationary expectations adjusted slowly to the high inflation environment of the 1970s. The paper came to no conclusion on which of these explanations is more likely to be correct.

APPENDIX 1
DATA SOURCES*

1. Interest Rate Data

(a) Short-term interest rates

Australia	1970-1989: 90 day bank bill rate (RBA).
Austria	1970-1989: Rate on one day interbank loans among banks in Vienna (IFS).
Belgium	1961-1989: Rate on 3 month Treasury certificates (MEI).
Canada	1961-1969: 3 month Treasury bill rate (MEI).
Denmark	1973-1989: Interbank deposit rate (IFS).
France	1961-1989: Rate on day-to-day loans against private bills (IFS).
Germany	1961-1989: Rate on 3 month loans (Frankfurt) (MEI).
Ireland	1970-1989: Rate on 3 month Treasury bill (MEI).
Italy	1961-1973: 12 month Treasury bill rate (MEI/OECD Financial Statistics). 1974-1989: 6 month Treasury bill rate (MEI).
Japan	1961-1989: Lending rate for unconditional loans in the Tokyo call money market (IFS).
Netherlands	1961-1989: Rate on 3 month loans to local authorities (MEI).

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* The data are available from the authors on request.

New Zealand	1974-June 1987: 90 day commercial bill rate (RBNZ). July 1987-1989: 90 day bank bill rate (RBNZ).
Norway	1973-1989: Money market rate (IFS).
Spain	1975-1989: One day interbank rate (IFS).
Sweden	1961-1989: Rate on 3 month Treasury discount notes (IFS and OP8A).
Switzerland	1961-1989: Rate on 3 month deposits (MEI).
United Kingdom	1961-1989: 3 month Treasury bill rate (MEI).
United States	1961-1989: 3 month Treasury bill rate (MEI).
Sources:	IFS: International Financial Statistics, International Monetary Fund. MEI: Main Economic Indicators, OECD. RBA: Reserve Bank of Australia Bulletin. RBNZ: Reserve Bank of New Zealand Bulletin. OP8A: Occasional Paper No. 8A, Reserve Bank of Australia.

(b) Government security yields

Australia	13 week Treasury note rate (RBA).
Austria	Rate on Treasury bill of unknown maturity (MEI).
Belgium	As above.
Canada	As above.
Ireland	As above.
Italy	Three month Treasury bill rate (IFS).

Japan	Three month Gensaki rate (MEI).
Netherlands	Three month Treasury bill rate (IFS).
Sweden	As above.
Switzerland	Rate on Treasury bill of unknown maturity (IFS).
United Kingdom	As above.
United States	As above.

(c) Long-term interest rates

All data is from the International Financial Statistics (IMF), Item 61 - Long-Term Government Bond Yield except where noted.

Austria	1970 - 1989: Yield on all government bonds issued and not yet redeemed.
Australia	1961-May 1981: Yield on 20 year bond (theoretical yield). June 81- 1989: Yield on 15 year bond (secondary market).
Belgium	1961 - 1989: Yield on bonds with maturity of 5 years or over (weighted average yield to maturity).
Canada	1961-1989: Yield on issues with original maturity of 10 years or over.
Denmark	1961-1989: Yield of 3.5 per cent perpetual bond of 1886.
France	1961-1989: Average yield to maturity of National Equipment bonds of 1965, 1966, 1967.

Germany	1961-Jan 1977: Yield on bonds with remaining life of more than 4 years (weighted average yield to maturity). Feb 1977-1989: Yield on bonds with remaining life of more than 3 years (weighted average yield to maturity).
Ireland	1961-1989: Yield on typical government bond.
Italy	1961-1989: Yield on 15-20 year bonds (average yield to redemption).
Japan*	1970-1989: Yield on 7 year bonds (arithmetic average yield to maturity).
Netherlands	1961-1989: Yield on central government bonds.
New Zealand	1961-1989: Yield on government bonds of 10 years or more.
Norway	1961- 1989 : Yield to maturity of the 5 per cent bond of 1961, callable. Beginning 1986, data relate to yield on bonds with 17 years to maturity.
Spain	1980-1989: Simple monthly average of daily yields of bonds with maturity over 2 years.
Sweden*	1961-1989: Yield on 5 year government bond.
Switzerland	1961-1989: Yield on bonds of 5 years or more (weighted average).
United Kingdom	1961 - 1989: Yield on 20 year bonds (theoretical gross redemption yields).
United States	1961-1989: Yield on 10 year constant maturity bonds.

* Data from OECD Main Economic Indicators.

2. Inflation

All data on inflation are derived from consumer price indexes for the individual countries. All CPI data are from the OECD Main Economic Indicators except for Australia and New Zealand. Australian data are adjusted for Medibank and Medicare effects (source: Reserve Bank of Australia Bulletin). New Zealand CPI data exclude the effects of the goods and services tax (source: Reserve Bank of New Zealand).

APPENDIX 2
REGRESSION EQUATIONS[a]

1. Short-Term Interest Rates

Period	Dependent Variable	a	b	R^2
1961-1969	Nominal	1.08	1.07*	0.55
	Real	1.08	0.07	0.01
		(1.17)	(0.32)	
1970-1972	Nominal	4.37*	0.24	0.10
	Real	4.37*	-0.76*	0.53
		(1.22)	(0.21)	
1973-1974	Nominal	4.89*	0.35*	0.24
	Real	4.89*	-0.65*	0.53
		(1.83)	(0.17)	
1975-1979	Nominal	2.51*	0.60*	0.79
	Real	2.51*	-0.40*	0.63
		(0.85)	(0.08)	
1973-1979	Nominal	2.30*	0.62*	0.72
	Real	2.30*	-0.38*	0.50
		(1.04)	(0.10)	
1980-1983	Nominal	5.03*	0.74*	0.79
	Real	5.03*	-0.26*	0.32
		(1.01)	(0.10)	

[a] Numbers in brackets are standard errors. A * indicates that the coefficient is significant at the 5 per cent level.

1984-1989[b]	Nominal	2.75*	1.49*	0.93
	Real	2.75*	0.49*	0.59
		(0.53)	(0.10)	

Government security yields (12 countries only)

1984-1989	Nominal	3.18*	1.39*	0.90
	Real	3.18*	0.39*	0.41
		(0.67)	(0.15)	

2. Long-Term Interest Rates

Period	Dependent Variable	a	b	R^2
1961-1969	Nominal	3.96*	0.52*	0.27
	Real	3.96*	-0.48*	0.24
		(0.87)	(0.24)	
1970-1972	Nominal	6.62*	0.15	0.02
	Real	6.62*	-0.85*	0.45
		(1.50)	(0.24)	
1973-1974	Nominal	5.50*	0.32	0.16
	Real	5.50*	-0.68*	0.46
		(2.11)	(0.19)	
1975-1979	Nominal	4.13*	0.58*	0.66
	Real	4.13*	-0.42*	0.51
		(1.09)	(0.11)	
1973-1979	Nominal	3.71*	0.58*	0.57
	Real	3.71*	-0.42*	0.41
		(1.34)	(0.13)	

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[b] New Zealand data on inflation (and hence the real interest rate) is adjusted for the GST in this period.

1980-1983	Nominal	5.53*	0.72*	0.70
	Real	5.53*	-0.28*	0.26
		(1.26)	(0.12)	
1984-1989[b]	Nominal	4.75*	1.14*	0.87
	Real	4.75*	0.14	0.09
		(0.57)	(0.11)	

3. Change in Inflation and Real Interest Rates

Period	Dependent Variable	a	b	R^2
Including New Zealand				
1984-1989	Change in inflation	1.11	-0.52	0.07
		(2.45)	(0.47)	
Excluding New Zealand				
1984-1989	Change in Inflation	3.37	-1.04*	0.23
		(2.45)	(0.49)	

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