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The Determinants of Real Long-Term Interest Rates: 17 Country Pooled-Time-Series Evidence

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THE DETERMINANTS OF REAL LONG-TERM INTEREST RATES: 17 COUNTRY POOLED-TIME-SERIES EVIDENCE

by
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ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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THE DETERMINANTS OF REAL LONG-TERM INTEREST RATES:
17 country pooled-time-series evidence

In this paper a model is presented and estimated that explains real long-term interest rates in terms of developments in low-frequency and high-frequency economic factors in a multi-country framework, using a data set covering 17 OECD countries since the early-1980s. A simultaneous estimation procedure is adopted (using instrumental variables), with an error correction framework for each country separating the low-frequency fundamental influences on real rates from the higher-frequency short-term dynamics. Parameters of the low-frequency variables are constrained to be equal across countries, which imposes the requirement that they have consistent effects both on behaviour through time and in explaining cross-country interest differentials. The results indicate that the low-frequency component of real rates is determined by fundamentals such as the rate of return on business capital, portfolio risk, inflation uncertainty, and indicators of future saving and investment balances. Influences on the high-frequency component include monetary policy actions and shocks to inflation.

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Cet article présente un modèle international où les taux d'intérêt à long terme évoluent en fonction des déterminants économiques de long terme et des dynamiques de court terme. Ce modèle a été estimé pour 17 pays, à partir de données remontant au début des années 80. Une procédure d'estimation à équations simultanées est utilisée (à l'aide de variables instrumentales) dans le cadre d'un modèle à correction d'erreur qui, pour chaque pays, distingue l'influence des variables fondamentales tendancielles sur les taux réels de la dynamique de court terme. Les paramètres des variables tendancielles sont contraints à être égaux entre les pays. Cette restriction impose des effets cohérents à la fois sur leurs comportements dans le temps et sur leurs capacités à expliquer les différentiels de taux d'intérêt entre pays. Les résultats indiquent que la composante tendancielle des taux réels est déterminée par des données fondamentales de l'économie tels que le taux de rendement sur le capital des entreprises, les risques associés aux portefeuilles, les incertitudes liés à l'inflation et les indicateurs de l'équilibre épargne-investissement dans le futur. La composante dynamique de court terme est influencée entre autres par le jeu de la politique monétaire et par les chocs associés à l'inflation.

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Table of Contents

Introduction 4

I. Measuring Real Long-term Interest Rates 4

II. Real Long-term Interest Rate Trends and Possible Determinants 6

Low-frequency influences on real rates 6
High-frequency influences on real rates 8
Summary 8

III. A Multi-Country Model of Real Long-term Interest Rates 9

IV. Empirical Results 11

The low-frequency determinants 11
The high-frequency determinants 13

V. Conclusions 14

Notes 16

Tables and Figures 20

Annex 1. Data Sources and Definitions 37

Annex 2. Real Long-term Interest Rate Equation Estimated from 1975 39

Bibliography 40

THE DETERMINANTS OF REAL LONG-TERM INTEREST RATES: 17 Country Pooled-time-series Evidence

Adrian Orr, Malcolm Edey and Michael Kennedy[1]

Introduction

Real long-term interest rates are key determinants of longer-term saving and investment decisions, while their influence on business spending, housing investment and the consumption of durables play a key role in the business cycle and transmission of macroeconomic policies. Given their prominence, it is important for policymakers to be able to identify the determinants of the level of real rates both over time and *vis-à-vis* other countries. Real long-term interest rates rose substantially in most OECD countries during the course of 1994, despite few obvious developments which would explain such a change. The rise in real rates was also surprisingly synchronised, despite the quite different cyclical positions and short-term monetary policy responses across countries. One plausible explanation for the rise could be that the longer-term prospect for the supply of global saving deteriorated, implying a key role for expectational shifts in explaining recent developments. The global integration of capital markets also appears to play an important role in the transmission of long-term interest rate movements, with developments in large countries -- for example the monetary policy tightening in the United States during 1994 -- having a significant influence on the level of world real interest rates.

This paper explains real long-term interest rates in terms of developments in low-frequency and high-frequency economic factors in a multi-country framework, using a data set covering 17 OECD countries since the early-1980s[2]. A simultaneous estimation procedure (using instrumental variables) is adopted, with an error correction framework for each country separating the low-frequency fundamental influences on real rates from the higher-frequency short-term dynamics. Parameters of the low-frequency variables are constrained to be equal across countries, which imposes the requirement that they have consistent effects both on behaviour through time and in explaining cross-country interest differentials. The paper is organised in five parts covering, respectively: measurement issues, the longer-run trends and possible determinants of real rates, the theoretical rationale and details of the empirical model, the estimation results, and concluding remarks.

I. Measuring Real Long-term Interest Rates

Before any discussion regarding the recent trends and possible determinants of real long-term interest rates is possible, a decision must be made as to which nominal interest rates are most relevant to economic agents, as well as how best to transform these into real (and possibly after-tax) magnitudes. In an effort to introduce some standardisation across countries, the analysis uses representative low-risk long-term government bonds, generally public sector bonds with a maturity of about 10 years (see Annex 1). However, it is acknowledged that this simplification ignores differences between rates available to different agents, cross-country differences in the relative importance of long-term and short-term financing, and different risk premia facing similar categories of borrowers.

With regard to taxation, the taxation of returns on saving and the tax-deductibility of interest payments for investors, create a wedge between conventionally measured real interest rates and effective

(after-tax) rates. Furthermore, the influence of taxation is complicated in the sense that, since longer-run saving and investment decisions determine after-tax real rates, any change in the tax wedge will influence observed pre-tax rates. Such distortions are, however, difficult to quantify, typically varying according to factors as diverse as the type of investment, the method of financing, and the status of the investor[3]. In addition, tax treatment has changed over time, affecting the interpretation of long-term trends.

In respect of the empirical analysis presented below, such tax distortions may have been reduced over our selected sample period, i.e. from 1981Q2 to 1994Q2. First, widespread tax reforms in the 1980s -- with efforts to broaden tax bases and reduce marginal rates -- have led to a decline in effective marginal tax rates relative to the previous two decades[4]. Second, since tax distortions tend to be exacerbated by interactions with inflation, and with inflation having generally fallen in the 1980s, the wedge between pre- and post-tax real interest rates is likely to have declined.

The effects of financial regulation also significantly distort interest rate trends and complicate any analysis of their determinants. Financial regulations can alter adjustments in nominal interest rates to ongoing economic developments[5], as well as the saving and investment propensity of households. Again, however, any possible regulation-bias in the following empirical analysis is limited by the fact that the sample period commences in the early-1980s, predominantly a post-regulation era. The general trend of financial liberalisation in the 1970s and 1980s has subsequently provided markets with a much greater role in the allocation of credit, both widening the access to credit and possibly raising the measured (as opposed to actual) mean and variance of the cost of capital[6].

A remaining measurement problem is how best to move from nominal to real interest rates, given that *ex ante* real rates are of most economic importance although inflation expectations are largely unobservable. The difference between the yield on non-indexed and index-linked government bonds provides one measure, although factors other than inflation expectations may also be captured. These include differences in tax treatment, inflation uncertainty, and liquidity premia[7]. At a more practical level, the existence of index-linked bonds is relatively recent and confined to a few countries[8].

In practice, long-term inflation expectations are usually proxied by some estimate of trend inflation projected from current, past, and/or future inflation rates. Accordingly, some alternative measures of real interest rates are presented for the three largest OECD economies in Figure 1. They proxy expected inflation at a given point in time by, respectively, actual inflation over the current and previous two years, realised inflation over the current and subsequent two years, and trend inflation as estimated by the low-frequency component of the GDP deflator from a Hodrick-Prescott filter[9]. The comparisons suggest that medium-term trends in real interest rate are unlikely to be substantially affected by the exact choice of an expected inflation proxy, although the timing of turning points can sometimes differ significantly in periods where inflation is highly variable. Again, however, the latter concern is less of a problem over our selected sample period, given the generally lower rate of inflation.

In sum, the real long-term interest rate referred to in the remainder of this paper is the yield on representative public sector bonds (with maturity generally about 10 years) adjusted for trend inflation generated using the Hodrick-Prescott filter (see the Data Annex for a detailed description). The latter is selected as intuitively plausible because it incorporates both forward and backward elements of the inflation process.

II. Real Long-term Interest Rate Trends and Possible Determinants

Real long-term interest rates across a range of OECD countries are presented in Figure 2. Several features are worth noting. First, since the early 1980s real interest rates have been considerably higher than during the previous two decades. Second, there appears to have been an increasing international convergence[10]. Third, average real rates in most countries were significantly lower in the early 1990s than their levels reached over much of the previous decade. Fourth, in most countries there was a marked, albeit temporary, decline in long-term interest rates in 1992-93. Finally, both real and nominal long-term rates rose steeply during 1994 in a relatively synchronised manner, although they remain within the range of experience of the past 10-15 years.

When attempting to explain these developments, it is perhaps useful to separate short-run (i.e. high-frequency) influences -- such as monetary policy developments -- from longer-run (i.e. low-frequency) influences -- such as structural shifts in the rate of return on capital. The low-frequency component of real rates can then be thought of as that price which *ex ante* equilibrates saving and investment, incorporating the influence of expected future developments.

The importance of these anticipatory influences can perhaps be illustrated by the rise in real rates during 1994. The magnitude and timing of this rise was very difficult to explain in many countries by any specific event. However, it is plausible that the longer-term prospects for saving and investment balances may have changed significantly, prompting adjustments in real rates. One possible culprit was the absence of fiscal consolidation in several countries despite improved economic conditions, signalling possible future domestic saving pressures. On a more positive note, several countries may have good reason to expect higher future returns on investment, following significant structural adjustment policies and, to some extent, higher real interest rates might reflect increases in expected future profitability. Consistent with globally integrated capital markets, the transmission of real rate movements from larger to smaller countries -- for example, responses to the monetary policy tightening in the United States -- also played a significant role.

In sum, given that real interest rates are determined so as to equilibrate *ex ante* saving and investment, for estimation purposes it is useful to separate their determinants into low-frequency and high-frequency components. Low-frequency determinants can be thought of as the fundamentals that influence saving and investment trends, while high-frequency determinants are those which proxy the movements in expectations about these fundamental factors. In this framework, it is plausible that the low-frequency fundamentals operate consistently in all countries (i.e. they have equal coefficients across countries), while expectation's formation varies across countries, given that agents are anticipating country-specific developments.

Low-frequency influences on real rates

Saving and investment developments

In order to explain the low-frequency (trend) component of real interest rates it is necessary to identify the exogenous factors which influence saving and investment behaviour. An explanation for rising real rates, for example, would require a net balance of factors working in the direction of reducing *ex ante* savings relative to investment. With respect to their recent trends -- acknowledging significant measurement problems[11] -- estimates of saving and investment expenditure (relative to GDP) indicate that both have declined appreciably in the OECD area from their peak in the early 1970s (Figure 3). With

regard to saving, much of the decline is due to falling government saving. There has also been a substantial shift in the composition of private saving in several countries, with declines in household saving being partly offset by increased business sector savings. The reverse is true with respect to investment, with most of the decline in nominal investment expenditure (relative to GDP) having arisen in the private sector.

The aggregate decline in saving ratios can be linked to several possible influences, including: financial liberalisation, which may have reduced saving propensities by removing liquidity constraints; lower inflation, which may have reduced the need for precautionary savings; and longer-term demographic factors[12]. The main demographic factor likely to be affecting saving is the ageing of populations in most OECD countries, raising dependency ratios (i.e. the ratio of the non-working-age to working-age population) and lowering national saving. However, the net influence of ageing populations on aggregate saving behaviour varies across countries[13] and is very complex. Some hypotheses, for example, suggest that savings should actually rise in anticipation of the rise in dependency rates, although it is generally agreed that the demand on public sector savings will increase given the growing demand for public services and income support. In sum, it is possible that anticipation of future events may give rise to expectations of savings shortages, placing upward pressure on real interest rates well before any actual shortage occurs.

With regard to investment, factors putting upward pressure on returns to business investment translate into higher real interest rates. Consistent with this hypothesis is a trend increase in the rate of return on capital in the business sector since the early 1980s (Figure 4)[14]. Possible factors responsible for this rise include structural economic reforms, trade liberalisation, lower inflation, and the elimination of restrictions on foreign direct investment. The direction of causation between rising real interest rates and the return on capital is unclear, however, although two pieces of evidence suggest that the 1980s causation ran more strongly from higher returns to higher real interest rates. First, the observed rise in price-earnings ratios would be incompatible with high real interest rates unless at least partly driven by expectations of higher business profitability. Second, if higher real interest rates were the driving force, one would expect to observe a shift away from capital (in favour of labour) in the production process -- with little evidence of this having occurred amongst the major OECD economies[15].

Rising demands for investment funds in non-OECD countries also represent a potential source of upward pressure on interest rates. In particular it is conjectured that economic policy reforms in central and eastern Europe, and in Latin America, may place those economies on a faster growth path and induce substantial rises in investment demand. What is not known is the extent to which faster growth will give rise to increases in savings, making the process largely endogenous, as has tended to be the case in the fast-growing Asian economies[16].

Country-specific influences

In general, global financial integration is leading to a degree of convergence in real interest rates,[17] especially at the longer end of the maturity structure, although significant real interest rate differentials persist across countries. The most common explanation for these differentials is the existence of financial risk premia which vary across countries. These risk premia can be broadly defined as the additional returns required by savers to compensate for uncertainty with respect to such factors as default risk, market volatility and inflation variability. Such risk premia are hard to identify empirically or to distinguish from the inflation premium included in nominal yields[18].

Several interrelated factors are likely to influence the size of the premia, including the expected sustainability of government fiscal positions and perceived degrees of commitment to monetary discipline.

With respect to fiscal positions, although government debt tended to rise in all OECD countries over the 1980s, these developments differed significantly across countries. In extreme cases, high public debt may have created perceptions that it will become harder to avoid inflation or higher taxes some time in the future[19]. Past records of inflation control and exchange rate stability may also be important indicators of monetary policy commitment to low inflation. Finally, current-account or external debt positions, where these imply unsustainable imbalances between savings and investment, may also have led to anticipations of future exchange rate movements, again influencing the risk premia on real rates. While the relative importance of these factors is hard to quantify, cross-country experiences summarised in Figures 5a to 5d suggest that a number of them may be related to international differences in real interest rates.

High-frequency influences on real rates

Cyclical developments, and related monetary and fiscal policy developments, are probably the most important transitory influences on real long-term interest rates. This influence is exacerbated by the integration of global financial markets, which can to some degree override the influence of other country-specific developments. With regard to monetary policy, the most recent business cycle indicated a clear tendency for long-term interest rates to react to both observed and expected changes in policy-controlled short-term rates (Figure 6). In part, this could be explained by the effect of short-term interest rates on the holding cost of long-term securities. However, the signalling effects of changes in official rates are also important. That is, recent shifts in official rates have tended to be linked to broader shifts in growth and inflation prospects, both of which are relevant to the determination of long-term bond yields.

The influence of fiscal policy developments on long real rates is less easy to detect, with the expected relationship likely to be weakened in the short-term by general business cycle developments. For example, during an economic downturn, although government borrowing is likely to increase in line with deteriorating budget positions, private sector investment demands and future inflation expectations are also likely to decrease. Nonetheless, in countries where fiscal problems are extreme (for example, Italy and Sweden), even cyclical fiscal deteriorations appear to have had a major effect on bond markets if they are perceived to threaten fiscal sustainability.

Summary

From the above discussion, it appears that an empirical analysis of the determinants of real long-term interest rates ideally should:

-- identify the fundamentals which determine the low-frequency developments in real rates;

-- allow actual market rates to diverge from the low-frequency real rate for considerable periods, through the influence of short-run factors influencing expectations;

-- identify the process by which real rates move together internationally, albeit allowing for persistent cross-country differentials; and

-- capture the influence of real rate developments in large countries on smaller countries.

The remainder of this paper develops a theoretical and empirical framework aimed at satisfying requirements, before outlining some general policy conclusions.

III. A Multi-Country Model of Real Long-term Interest Rates

The following model of real long-term interest rates is based on the analytics of international interest rate linkages in a flexible real exchange rate environment. The basic premise is that investors shift capital between countries in search of the highest risk-adjusted return, and in so doing, exert pressure on interest rates to converge across all countries to the extent that their fundamentals converge. However, cross-country differentials in real interest rates can persist and vary over time, reflecting factors such as: uncertainty regarding expected real exchange rate changes; factors which may differentiate foreign from domestic assets, including liquidity, credit risk and tax treatment; and differences in government policies and/or institutions which impede financial flows across borders[20].

The low-frequency component of the real interest rate in each country is modelled as a function of the observable slower moving fundamentals, which indicate saving and investment developments, as well as indicators of any risk premium required by investors. This relationship is specified as:

$$\hat{r}_{it} = \delta_1 \rho_{it} + \delta_2 gd_{it} + \delta_3 \beta_{it} + \delta_4 \bar{ca}_{it} + \delta_5 (\bar{\pi} - \pi^e)_{it} \qquad [1]$$

where: $\hat{r}$ is the low frequency long-term real interest rate,

ρ is the rate of return on capital,

gd is the government deficit relative to GDP (defined so that a deficit is a positive number),

β is a measure of the domestic portfolio risk of holding bonds, (for the precise definition, see Annex 1),

ca is the current account balance relative to GDP, (defined so that a positive number represents a surplus), measured as an average over the preceding 5 years,

$\bar{\pi}$ is a long-term (10-year) average of past inflation,

π^e is the Hodrick-Prescott measure of expected future inflation, and the subscripts i and t represent country and time respectively.

The first term in equation [1], the rate of return on capital, proxies the opportunity cost of holding a bond. This can be thought of as the minimum return required on bonds before an investor would consider the purchase of bonds versus some other asset. Given that this is not the long-run equilibrium, the domestic rate of return on capital is included rather than some proxy of the world rate. As economic fundamentals converge in the long-run, however, so do the rates of return on capital and consequently real long-term interest rates. Undiversifiable domestic portfolio risk captures the risk of holding bonds versus equities in a particular country. The government deficit is an indicator of exogenous influences on net saving

trends. A persistent deficit, for example, might suggest some *ex-ante* shortage of domestic saving relative to investment, necessitating higher current real interest rates.

The remaining variables in equation [1] can be thought of as the risk premium component of the low frequency real interest rate associated with exchange rate risk. A history of persistent current account (ca) deficits, for example, may lead to expectations of a depreciation of the real exchange rate. In an international market, this would necessitate a risk premium on domestic rates to attract investors. The final term captures the risk premium related to inflation credibility. If the long-run historical performance on inflation (π) relative to existing expectations (π^e) is poor, some additional yield on bonds may be required by investors over and above the market's average inflation expectation. In an international financial market, low inflation credibility would be embodied in the expectation of a real exchange rate depreciation[21].

In a world of mobile capital, it is intuitively sensible to treat developments in these low frequency variables consistently across countries. International investors form views about the required real yield on a country's long-term bond by comparing developments in the country's fundamentals both over time and relative to other countries. Arbitrage activity by investors in the world bond market thus ensures that profit opportunities -- where real yields in one market are persistently higher than another after having accounted for differences in their fundamentals -- are limited. This suggests that it is sensible to think of equation [1] as applying with the same parameters to all countries, so that risk factors are consistently priced both over time and across countries. This assumption has two appealing properties. First, any pair of equations can be subtracted to imply an equation in the same form for the real interest rate differential as a function of differences in fundamentals. Second, the equations, in principle, can be aggregated to arrive at a model for a world average real rate in the same form. In this aggregate equation, current account positions would sum to zero (if taken over a large enough group of countries), so this factor would drop out as an explanation for the world real rate.

When estimating real long-term interest rate developments, it must be recognised that high-frequency influences also exist. As discussed above, these may lead to further cross-country variation in real rates, as well as lead actual rates to diverge temporarily from their low-frequency components. This has led to an error-correction estimation framework being used, specified in equation [2], whereby actual real rates move toward their low-frequency (trend) level with a speed of adjustment (λ). The high-frequency factors which enable actual rates to deviate from trend are included in the z variables in equation [2]. Also included in the z variables are developments in the G3 countries (i.e. the United States, Germany and Japan) real long-term interest rates, recognising that large country developments influence real rates in smaller countries. This necessitates the use of a simultaneous estimation procedure, where instrumental variables are used for the first differences in G3 real rates.

$$\Delta r_{it} = \lambda \ (\hat{r}_{it-1} - r_{it-1}) + \Upsilon_i \Delta z_{it} \qquad [2]$$

In sum, equation [2] represents the basic model which is estimated simultaneously, using instrumental variables, for 17 OECD countries. The equation is augmented by the inclusion of the real interest rate of a G3 country (with the US rate chosen for Canada and Australia, the German rate for the remaining non-G3 countries, and both foreign G3 rates for each G3 countries). The low frequency real rate appears in the error-correction component, with the coefficients constrained to be equal across countries. The coefficients on the high-frequency variables are unconstrained across countries, reflecting the fact that these are proxying unobservable expectations regarding country-specific developments. In such a situation,

developments in similar variables across countries, for example short-term interest rates, can imply significantly different outcomes for real long-term rates.

IV. Empirical Results

The empirical results are largely summarised in Tables 1 and 2 below. A general-to-specific approach was followed, which involved sequentially dropping the least significant variable from each equation until only those statistically significant at the 95 per cent level remained. This procedure led to variation across countries as to the final specification of the short-term dynamics, although all variables are consistently signed across countries and according to our priors.

From Figures 7a-q it can be seen that the estimated real rates track the actuals quite well, while the low-frequency components appear plausible (i.e. the estimated rates deviate only temporarily). It is noteworthy that real rates in those countries which either liberalised their financial markets during this period (e.g. New Zealand in 1984) and/or provided a commitment to a hard currency (e.g. Spain and Ireland in 1987) immediately converged toward their estimated low-frequency rate. The diagrams also enable an interpretation of the 1994 rise in real rates across the OECD, which appears to be a correction toward their low-frequency component, after having declined in 1993 on a cyclical basis. Several countries also experienced a rise in their low-frequency (trend) rate. This can be viewed either as a positive development if driven by a rise in the rate of return on capital (e.g. the United States), or a detrimental outcome due to a deterioration in relative fundamentals (e.g. a decline in Germany's relative current account position).

The low-frequency determinants

As discussed above, the coefficients on the fundamentals -- the low-frequency determinants -- are constrained to be equal across the 17 countries and hence displayed only once (see Table 1)[22]. Each of the coefficients proved statistically significant and with the expected signs.

As mentioned above, the level of a foreign G3 real rate (r^*) was also included in each country equation[23], although the coefficient was not constrained to be equal across countries. A significant positive coefficient implies that a country pays a premium on its own real long-term rate above that suggested by its fundamentals -- to the extent that these are fully captured. Some possible explanations for an additional risk premium could include: domestic and foreign assets not being perfect substitutes, leading to home country preferences on the part of large-country investors; the relative depth of financial markets, with larger countries perhaps offering more variety in terms of the types of assets available; and, greater concern over a smaller country's policy stability, given their greater exposure to exogenous external shocks. The possibility of a temporary risk premia was also accommodated through the inclusion of the foreign real rate divided by a time trend (r*/t) as an additional regressor[24]. A positive(negative) coefficient implying that the risk premium was declining(rising) over the sample period.

The estimation results in Table 1a (continued) suggest that a number of countries which have followed a fairly hard-currency option (i.e. France, Austria, Belgium, and Denmark) or are highly integrated with a major capital market (i.e. Australia and Sweden) have had an additional risk premium on their real rate related to the level of the foreign real rate[25]. Only Canada has a declining risk premia (*vis-à-vis* the United States), while Belgium, Spain and Switzerland have experienced an increase in their premia (*vis-à-vis* Germany) over the sample period. The negative premium on the Italian real rate is

difficult to justify and may be more indicative of measurement concerns than any fundamentals[26]. It should be noted, however, that the empirical results are not substantially altered in the absence of a G3 real rate level in each equation. The constrained coefficients on the fundamentals remain significant and deviate little from the values in Table 1.

Inflation uncertainty or mismeasurement?

The significance of past inflation (relative to current expectations) in a real interest rate model can be interpreted in two ways. First, it can be viewed as a proxy of the monetary authorities inflation-credibility, with investors demanding a risk premium on the real rate of return in proportion to their past inflation. The fact that this variable is a 10-year moving average of past inflation implies that real rates will adjust only slowly to an improved inflation track record,[27] implying credibility is slow to establish. Nonetheless, the coefficient on past inflation suggests that gaining credibility (which is captured in the model by holding actual inflation at a low level for several years) could lead to a decline in real rates by as much as 1/3 of a percentage point.

The second rationale for the significance of past inflation is that it is a correction for any mismeasurement of inflation expectations. This is consistent with the view that *ex ante* real interest rates vary considerably from their ex-post approximations, possibly given the slow adjustment of inflation expectations[28]. In order to assess the validity of the inflation expectations hypothesis, the final specification outlined in Tables 1 and 2 was re-estimated as a nominal interest rate model. That is, the inflation expectations series -- generated using the Hodrick prescott filter -- was treated as an explanatory variable, in addition to the current and 10-year moving average of actual inflation. The coefficients on these variables were again constrained to be equal across countries. The coefficient on inflation expectations was found to be insignificantly different from 1.0, with the remaining inflation variables statistically insignificant and their coefficients summing near to zero -- implying a long-run pass through of inflation into nominal rates. In sum, it appears reasonable to interpret the results in Table 1 as a real rate specification, with some risk premium attached to monetary policy credibility.

The rate of return on capital

The rate of return on business capital, despite significant measurement difficulties, is a statistically important determinant of the level of real long-term interest rates. This variable can be viewed as a proxy for the opportunity cost of holding bonds and is a substitute to equity price indices sometimes used in time-series analysis of interest rates[29]. The estimated long-term coefficient suggests that the rise in the rate of return on capital from the early-1980s to 1994 (from a G7 weighted average of 13 per cent in the first half of the 1980s to 16 per cent in 1994) accounts for around 3/4's of a percentage point of the total rise in real long-term interest rates.

More generally, the time path and cross-country comparison of rates of return on capital appear to provide a credible story of economic "catch-up" across the OECD countries, which fits well with the longer-run properties of the empirical model. That is, real long-term interest rates converge to their domestic rate of return on capital in the medium-term, with real rates converging internationally only in the longer run as factor returns equalise. It is important to note, however, that the other explanatory variables remain relatively robust even when the rate of return on capital is replaced either with a single constant or some weighted average of the G3 real rates (i.e. imposing some stricter form of convergence).

Future saving and investment imbalances

The estimation results indicate that current account balances and government deficits are important determinants of movements of real rates both as a group and relative to one another. The statistical significance of these two variables is possibly indicative of several related factors. As noted earlier, a persistent current account imbalance will raise the probability of a future correction, leading to uncertainty about the future value of the exchange rate. Persistence current account imbalances also reflect a structural domestic saving-investment imbalance, possibly due to a persistent government deficit. In the case of persistent external and/or government deficits, real long-term rates will come under upward pressure, both compensating foreign investors for any exchange rate risk and acting to correct any domestic saving-investment imbalance[30].

The estimated coefficients suggest that a rise in a country's public deficit by one per cent of GDP could raise real interest rates by around 1/6 of a percentage point, if financed exclusively by the domestic private sector. If, however, the deficit results in an equivalent current account deterioration (i.e. the deficit is financed entirely from abroad), the corresponding rise in real rates is likely to be doubled over time. These results appear consistent with casual empiricism. For example, those countries which have experienced high government deficits but fairly balanced current account positions (e.g. Belgium and the Netherlands) have had relatively low real rates over the past 15 years. In contrast, Australia has had a history of relatively balanced government finances but a persistent current account deficit, resulting in higher real rates. Finally, Canada has a history of both higher-than-average current account and public deficits, and relatively high real rates. A policy virtuous-circle is evident; reduced government deficits, especially those which positively influence the current account balance, will lead to lower real long-term interest rates over time.

The high-frequency determinants

From Figures 7a-q it is noticeable that developments in the longer-run fundamentals explain very little of the shorter-term movements in real rates. That is, significant divergences of actual from trend real rates are evident. Instead, most of the explanatory power of the model is derived from the short-run dynamics, more specifically, the interactions between G3 and non-G3 countries' real rates and domestic monetary policy.

The initial set of high-frequency (i.e. short-run) explanatory variables included first differences in all of the above low-frequency determinants, in addition to a lagged dependent variable, quarterly inflation changes and proxies of the stance of monetary and fiscal policy (Table 2). The latter two variables were respectively proxied by the first differences of the real short-term interest rate and the structural budget balance (as a ratio to GDP). The first difference in a G3 country's real rate was also included contemporaneously (necessitating estimation using instrumental variables), allowing for the simultaneous determination of real rates globally. Again, details of these variables are given in Annex 1.

Movements in real short-term interest rates were significant in all countries, consistent with the view that monetary policy actions -- in response to cyclical price developments -- lead actual real rates to deviate from their low-frequency component. In addition, the short-term influence of G3 monetary policy actions are transmitted across all of the countries, given the significance of G3 long-term rate developments in the dynamics. The most recent example of international monetary policy transmission is the United States' policy tightening in 1994, leading to a more general rise in real long-term rates. As mentioned

above, the positive coefficient on real short rates appears consistent with both their effect on the holding cost of longer-term securities, as well as in part, a signalling effect of changes in official rates: movements in official rates may tend to be linked to broader shifts in perceptions about prospects for growth and inflation, both factors which are relevant to the determination of longer-term bond yields.

Fiscal policy developments, as proxied by changes in the structural budget balance, only appear significant in two countries (Austria and Ireland). The general insignificance of this variable is not surprising for two reasons. First, cyclical developments reduce the influence that fiscal policy is likely to exert on real rates in the short term (as discussed in Section II). In addition, fiscal policy decisions are generally taken on an infrequent basis (often only annually with the Budget process) complicating any dynamic analysis. Annual fiscal statements in many countries also necessitates the interpolation of this series. The inclusion of further proxies of fiscal developments may be an area of future research.

Finally, as a means of testing the logic of the estimation technique, the final model structure outlined in Tables 1 and 2 was re-estimated over the sample period 1975Q1 to 1994Q2, which incorporates a considerable rise in real rates across all countries. Figures 8a-g graph the actual, estimated and low-frequency real rates resulting from this exercise, with Annex 2 containing the estimated coefficients on the low-frequency determinants. The specification remained relatively robust with all coefficients signed according to our priors. The rate of return on capital, past inflation and the partial-adjustment term remained statistically significant. However, the coefficient on the error-correction term was almost halved, leading to prolonged deviations in real rates from their low-frequency component. Importantly, the fundamentals in part captured the rise in real rates in the early-1980s. To the extent that this rise is not fully explained by inflation expectations inertia and the rise in the rate of return on capital, the residual most probably reflects financial liberalisation, a phenomenon which is not accounted for in our specification.

V. Conclusions

Pooled-time-series analysis suggests that the rate of return on capital, a country's past history of inflation, current account balances and government deficits are all important determinants of trend real long-term interest rates -- both as a group and relative to one another. However, developments in these fundamentals explain very little of the shorter-run movements in real rates, with significant divergences of actual from trend real rates evident. Nonetheless, these features appear consistent with an integrated global capital market, where actual real rates can be strongly influenced by both domestic and foreign short-term policy developments. Meanwhile, longer-run pressures exist for real interest rates to converge, driven by a reduction in the cross-country divergence of economic fundamentals.

A general conclusion drawn from the analysis is that policies designed to lower real long-term interest rates must recognise the interactions between the differing determinants. For example, attempts to lower a current account deficit through exchange rate manipulation may simply lead to inflation pressure, leaving real rates unchanged. Other specific policy conclusions include, first, that maintaining low and stable inflation will result in lower real interest rates. However, the rewards come after a considerable period of time, with policy credibility slow to establish. Second, public deficits have a significant influence on the level of real rates. Maintaining a relatively balanced budget over the business cycle will result in lower real interest rates, and possibly set in motion a virtuous circle -- given the lower future cost of servicing any public debt. Third, to the extent that reduced government dissaving raises national saving (that is, improves the current account balance), further real rate declines can be anticipated over time.

Finally, an additional risk premium on real long-term rates can possibly be expected in cases where a hard-currency commitment is made but economic fundamentals have not fully converged to those of the anchor country.

NOTES

1. The authors would like to thank Jorgen Elmeskov, Andrew Gurney, Peter Hoeller, Ketil Hviding, Giuseppe Nicoletti, Pete Richardson and Dave Turner of the OECD Economics Department; seminar participants at the Bank of England; John Murray, David Longworth and Agatha Côté of the Bank of Canada; Paul Masson and Edward Gardner of the IMF; David Archer of the Reserve Bank of New Zealand; and Joseph Gagnon of the U.S. Department of the Treasury for helpful comments. Thanks also to Laure Meuro for statistical assistance and to Paula Simonin and Andrea Prowse for their secretarial skills. The views expressed in this paper are those of the authors and are not necessarily shared by the OECD.

2. The 17 countries include the United States, Japan, Germany, France, Italy, the United Kingdom, Canada, Australia, Austria, Belgium, Denmark, Ireland, the Netherlands, New Zealand, Spain, Sweden and Switzerland.

3. OECD (1990a) reviews the significant differences in the taxation of various assets and sources of finance both within and across countries.

4. See, for example, OECD (1990a); Dean *et al.* (1990); and Fukao and Hanazaki (1987), for a discussion of issues relating to the effects of taxation on interest rates.

5. This may be evidenced by prolonged periods of negative real rates in many OECD countries in the 1970s. For an empirical investigation of the issue see Mishkin (1984) and Browne and Fischer (1991). See also OECD (1991a), Blundell-Wignall and Browne (1991), and Blundell-Wignall *et al.* (1991).

6. To some extent such rises are likely to overstate true increases in the cost of capital, since standard interest rate series do not capture the costs to businesses associated with non-price rationing. See, for example, Atkinson and Chouraqui (1985).

7. See Deacon and Derry (1994) and Duenwald (1994). The inflation risk premium may arise if agents are willing to pay more (that is, accept a lower real yield) for an asset where the real yield is guaranteed. In addition, the inflation expectations of financial markets may not be those of the public at large (i.e. ordinary savers or borrowers), implying saving and investment decisions are influenced by different "real" yields. The market for index-linked bonds also differs in the degree of liquidity across countries, implying some variation in the liquidity premium.

8. Within the OECD-region, index-linked bonds have existed since 1981 in the United Kingdom, 1985 in Australia, and 1991 in Canada.

9. This method of trend estimation is described in King and Rebelo (1989).

10. See Throop (1994) and OECD (1994) for empirical evidence of convergence.

11. Trends in saving and investment aggregates are affected by a number of measurement problems. In broad terms these affect the measurement of total income, the exact classification of expenditures between consumption and investment, and the measurement of the sectoral allocation of these aggregates between household, business and government sectors. Empirical efforts have

been made to adjust saving ratios (as calculated in an SNA framework) for several specific measurement concerns within these broad areas (see Elmeskov *et al.*, 1991). Some of these adjustments do have significant effects on measured levels of saving and investment, for example differing the deflators, although most do not affect the overall balance between saving and investment at an aggregate level.

12. For a review of these issues, see Dean *et al.* (1990) and Sturm (1983).

13. Dependency ratios have trended upwards since the 1950s in the United States, Japan and Europe. However, this effect has to some extent been offset by rising labour force participation rates, particularly in the United States. In the United States, the support ratio (ratio of the labour force to total population) has been increasing since the 1960s and is not expected to peak until around the year 2010. In Japan and Europe the projections show the peak having been reached in 1990. See Cutler, Poterba, Sheiner and Summers 1990), Auerbach *et al.* (1989) and Hagemann and Nicoletti (1989).

14. The gross rates of return on business capital are subject to measurement errors, especially with regard to the absence of a deflator for the total capital stock. This has necessitated using a gross business investment deflator, which, since the relative price of these goods has been declining, may bias downward the rate of growth of the value of the capital stock. This in turn would imply overstatement of the increase in the rate of return on capital. See Keese *et al.* (1991).

15. See Tease *et al.* (1991).

16. Herd (1989) provides an illustrative calculation of the impact of increased financing requirements by the central and eastern European countries. Assuming that these countries ran increased current account deficits of the order of 3 to 4 per cent of their GDP, this would still represent an additional financing requirement of less than 1/4 of 1 per cent of OECD-GDP. His estimates suggest that a permanent increase in demand for funds from the non-OECD area of this order of magnitude would be unlikely to have a large effect on real interest rates. See also Blanchard and Summers (1984).

17. It is important to remember that the convergence of real long-term interest rates on government debt still leaves open significant opportunity for other rates to differ, for example, those to business and households, based on their credit-worthiness, tax position and investment opportunities.

18. This is well exampled by the recent widening of the gap between nominal and indexed-linked bond yields, which may be due to a combination of both increased inflation expectations and a perceived increase in risk.

19. It could be argued that more recently the extent to which countries are able to inflate their debt away has declined, with the low-inflation objectives of central banks becoming more transparent. This is also often in association with some form of increased independence from government decision-making (as, for example in Spain, Italy, France, Mexico and New Zealand) providing increased institutional resistance to the ability to inflate.

20. The analysis could be derived from the Mundell (1968) and Fleming (1962) model which ensures interest rates converge across all countries when domestic and foreign assets are perfect substitutes and real exchange rate expectations are constant. Throop (1994) shows why interest rates diverge across countries once the stricter assumptions of the Mundell-Fleming model are relaxed. Kasman and Pigott (1988) also provide a general discussion of persistent interest rate differentials.

21. In this situation a drop in expected inflation relative to past experience will lead to an initial depreciation of the real exchange rate. This can be related to the low initial inflation credibility. It is only over time, once the country's performance on inflation catches up with expectations, that the real exchange rate will return to its initial point of equilibrium.

22. The validity of the cross-equation restrictions were assessed relative to an unrestricted simultaneous regression. The chi-squared (1) test statistic and marginal significance level for restricting each variable is, respectively: error correction 7.51 (0.01); return on capital 0.015 (0.9); risk 0.76 (0.38); past minus expected inflation 8.26 (0.005); current account 3.92 (0.05); and government deficit 0.40 (0.52). Only the error-correction and past inflation coefficients failed the 17-country restrictions at the 5 per cent level. With regard to the former, a lagged dependent variable in the model enables differing speeds of adjustment.

23. In selecting the G3 rate to include in each equation, the German real rate was chosen for the European countries, excluding the United Kingdom, and the United States real rate for the remainder. Within the G3, the initial specification included both foreign G3 rates. Although this is not optimal and may partially explain why the foreign rate is insignificant in some countries, it appears sufficient as a first proxy. Future empirical refinement could focus on designing some weighted-average of foreign country real rates for each country.

24. The time trend commenced in 1981Q2, the same as the data sample. This may not be optimal, however, with several countries undergoing regime shifts during the sample period. For example, Spain, Ireland, and the United Kingdom made relatively late commitments to the ERM, while several countries shifted into a deregulated financial environment. Future empirical refinements could include varying the commencement of the time trend to coincide with these country-specific dates.

25. The Netherlands is a surprising exclusion given its strong commitment to the ERM. It is possible, however, that their integration with the German economy is at such an advanced stage that only divergences in the fundamentals explain any real rate differentials.

26. The level of Italian real rates are probably understated given the relatively short maturity of Italian government debt, especially in the early part of the sample.

27. Several moving averages of past inflation were assessed in the initial specification (e.g. 3, 5, 8 and 10-year periods) with the 10-year average consistently the most statistically significant.

28. Such an explanation could significantly reduce the measured gap between real rates in the 1970s and 1980s, with inflation consistently above expectations in the 1970s and below expectations in the 1980s.

29. See for example, Barro and Martin (1990).

30. In this regard, it is quite feasible for a country to maintain an external deficit/surplus as a longer-run equilibrium position. It should also be mentioned that the following variables proved statistically insignificant in our modelling: the structural budget balance as a ratio to GDP; both total and net public debt as ratios of GDP; and the past performance (a 5-year moving average) of the annual change in the effective exchange rate.

Table 1a. **Real long-term interest rate equation** (a)
17 country simultaneous estimation

Dependent variable: first difference of real long-term interest rates
Quarterly data from 1981Q2 to 1994Q2

Variable	ECM coefficient	t-statistic	Implied long-run coefficient
	Constrained low-frequency coefficients		
Error correction	-0.079	-8.42	
Return on capital	0.019	5.06	0.24
Risk	0.122	4.44	1.54
Past minus expected inflation	0.027	3.31	0.34
Current account	-0.012	-2.31	-0.15
Government deficit	0.012	2.32	0.15

a) See data sources and definitions in Annex 1.

Table 1a. **Real long-term interest rate equation** (a) (continued)
17 country simultaneous estimation

Dependent variable: first difference of real long-term interest rates
Quarterly data from 1981Q2 to 1994Q2

	Unconstrained coefficients: foreign rates (b)				
	Foreign rate	t-statistic	Foreign rate/time	t-statistic	Long-run coefficient
United States					
Japan					
Germany					
France	0.027	3.06			0.33
Italy	-0.048	-2.98	0.25	3.85	-0.60
United Kingdom					
Canada			0.16	5.23	
Australia	0.023	2.00			0.28
Austria	0.011	2.38			0.14
Belgium	0.024	2.31	-0.11	-3.28	0.30
Denmark	0.029	1.69			0.36
Ireland					
Netherlands					
New Zealand					
Spain			-0.16	-2.03	
Sweden	0.019	1.52			0.24
Switzerland			-0.07	-2.41	

a) See data sources and definitions in Annex 1.

b) For the G3 countries, both foreign G3 rates were included. For the smaller countries, the foreign rate is Germany, for the United Kingdom, Canada and Australia for which it is the United States rate.

Table 2a. **Real long-term interest rate equation: unconstrained coefficients** (a)

17 country simultaneous estimation (t-statistics in parentheses)

Dependent variable: first difference of real long-term interest rates

Quarterly data from 1981Q2 to 1994Q2

Variables	United States	Japan	Germany	France	Italy	United Kingdom	Canada
Lagged dependent	0.17 (1.85)	-0.27 (-3.65)	0.10 (1.94)	0.17 (3.00)	0.11 (1.49)		
Δ foreign rate: i) United States			0.19 (4.81)			0.42 (5.54)	0.69 (13.06)
ii) Japan			0.27 (6.49)				
iii) Germany	0.72 (3.49)	0.87 (6.31)		0.72 (6.16)	0.32 (1.98)		
Δ short rate	0.30 (3.69)	0.29 (3.06)	0.19 (5.52)	0.19 (6.06)	0.32 (6.88)	0.34 (8.86)	0.15 (6.37)
Δ inflation	0.36 (2.81)	0.23 (2.04)	0.11 (2.32)	0.08 (1.77)	0.40 (4.66)	0.24 (4.53)	0.12 (2.59)
Δ return on capital			0.41 (2.63)				
Δ risk							
Δ current account balance							
Δ structural deficit							
Δ exchange rate					-0.03 (-1.68)	-0.02 (-1.98)	
$\bar{R}^2$	0.35	0.43	0.65	0.58	0.51	0.63	0.86
Standard error of estimated equation	0.53	0.44	0.23	0.37	0.54	0.45	0.26
LM (b)	1.84	2.10	3.74	1.71	0.47	2.07	1.48
ADF (c)	-23.7	-11.8	-12.4	-15.4	-8.6	-17.8	-23.3

For notes, see following page.

Table 2a (continued). **Real long-term interest rate equation: unconstrained coefficient** (a)

Dependent variable: first difference of real long-term interest rates

Quarterly data from 1981Q2 to 1994Q2

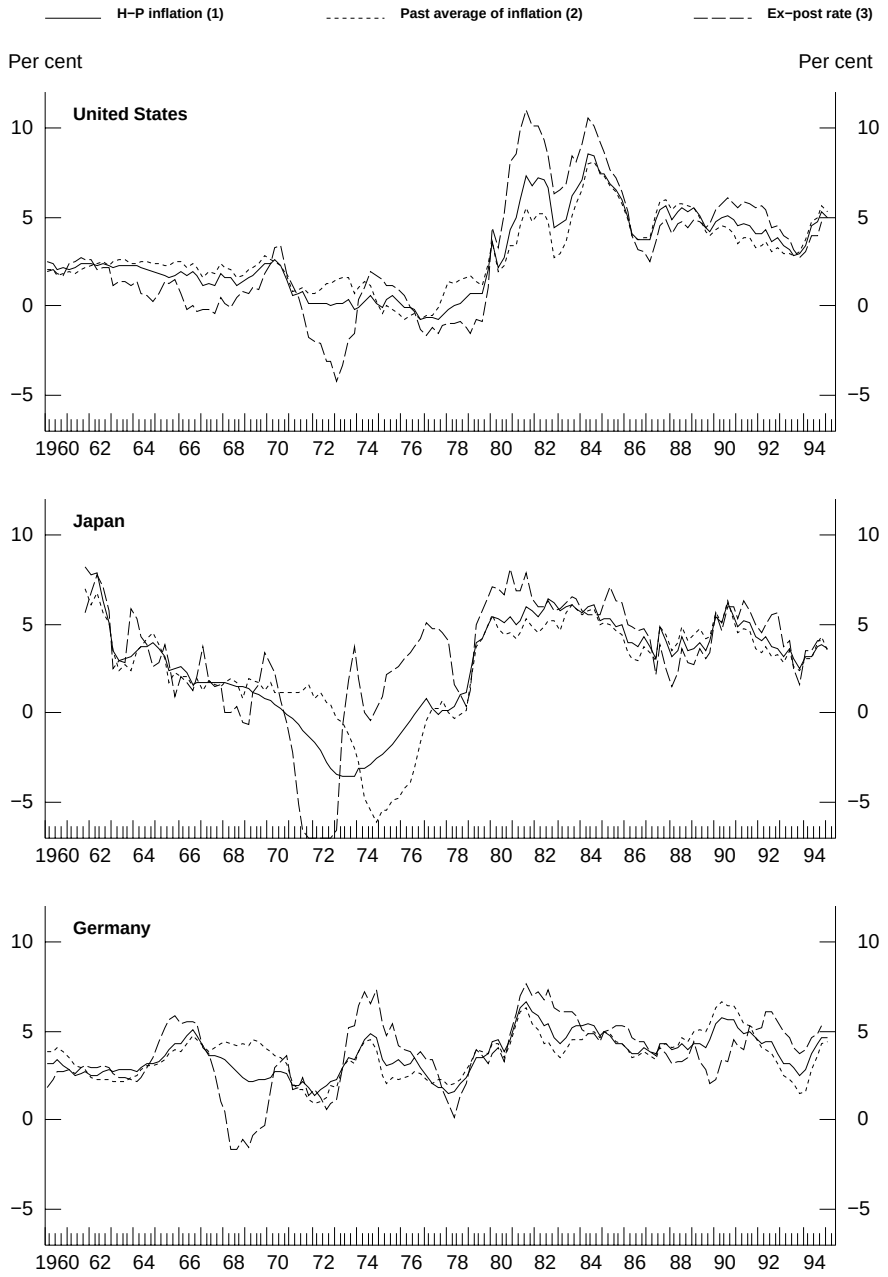
Variables	Australia	Austria	Belgium	Denmark	Ireland	Netherlands	Spain	Sweden	New Zealand	Switzerland
Lagged dependent		0.38 (7.16)	0.10 (1.62)	0.21 (2.71)			0.30 (3.64)	0.33 (4.48)	.. ..	0.18 (1.98)
Δ foreign rate:										
i) United States	0.54 (5.33)								-0.14 (0.85)	
ii) Germany		0.53 (9.05)	0.50 (5.44)	0.90 (4.13)	0.85 (3.84)	0.59 (7.45)	0.48 (2.25)	0.43 (2.73)		0.28 (3.33)
Δ short rate	0.23 (5.58)	0.08 (3.25)	0.16 (5.74)	0.24 (6.63)	0.13 (4.87)	0.31 (9.10)	0.26 (5.76)	0.24 (6.45)	0.19 (3.76)	0.13 (4.03)
Δ inflation	0.22 (3.11)	0.06 (2.62)	0.23 (4.29)	0.45 (5.85)	0.11 (1.24)	0.37 (9.75)	0.45 (5.19)	0.24 (4.59)	0.19 (3.55)	0.16 (4.30)
Δ return on capital			0.31 (2.53)							0.09 (1.08)
Δ risk	1.43 (3.97)			1.12 (2.18)						
Δ current account		-0.55 (-2.97)	-0.55 (-3.45)							
Δ structural deficit		0.11 (1.45)			0.29 (2.24)					
Δ exchange rate	-0.02 (-2.23)								-0.07 (-4.54)	
$\bar{R}^2$	0.45	0.72	0.54	0.42	0.36	0.82	0.39	0.49	0.25	0.46
Standard error of estimate	0.55	0.18	0.29	0.71	0.71	0.21	0.69	0.49	0.93	0.23
LM (b)	2.58	3.13	0.79	3.69	2.66	7.10	2.75	2.18	5.36	2.58
ADF (c)	-11.5	-14.6	-15.9	-18.8	-36.1	-18.7	-18.1	-19.4	-27.4	-19.2

a) See data sources and definitions in Annex 1.

b) LM is the F-form of the Lagrange multiplier test for up to 4th order residual autocorrelation, with a 5 per cent (1 per cent) critical value of 2.69 (4.02).

c) Augmented Dickey-Fuller statistic for stationarity of the cointegrating vector from the low-frequency component, with a likelihood ratio critical value of -5.13.

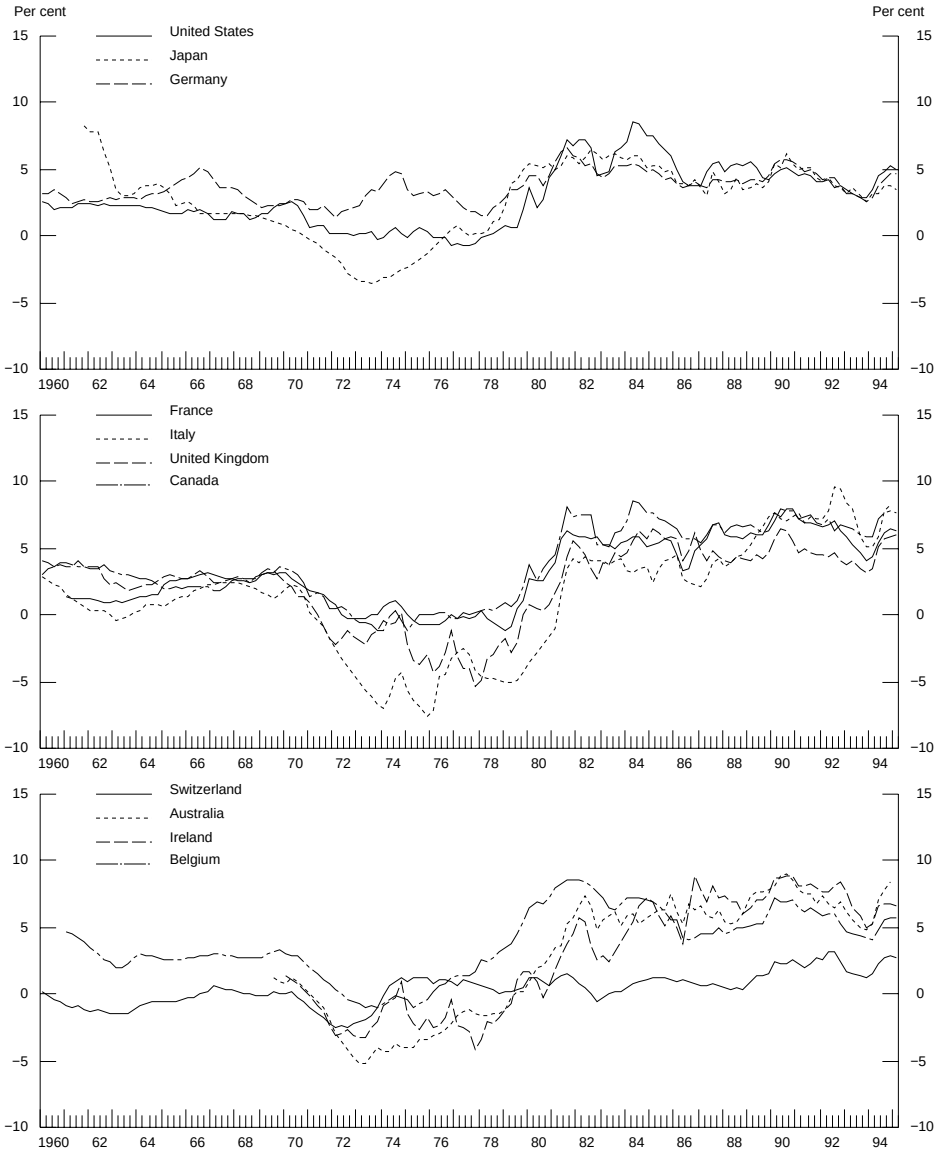
Figure 1. **Real long−term interest rates: comparison of alternative estimates**



1. Inflation expectations generated using the low frequency component of GDP deflator using a Hodrick−Prescott filter.
2. Inflation expectations equal an average inflation rate of the previous two years.
3. Inflation expectations generated using inflation realised over the following two years.

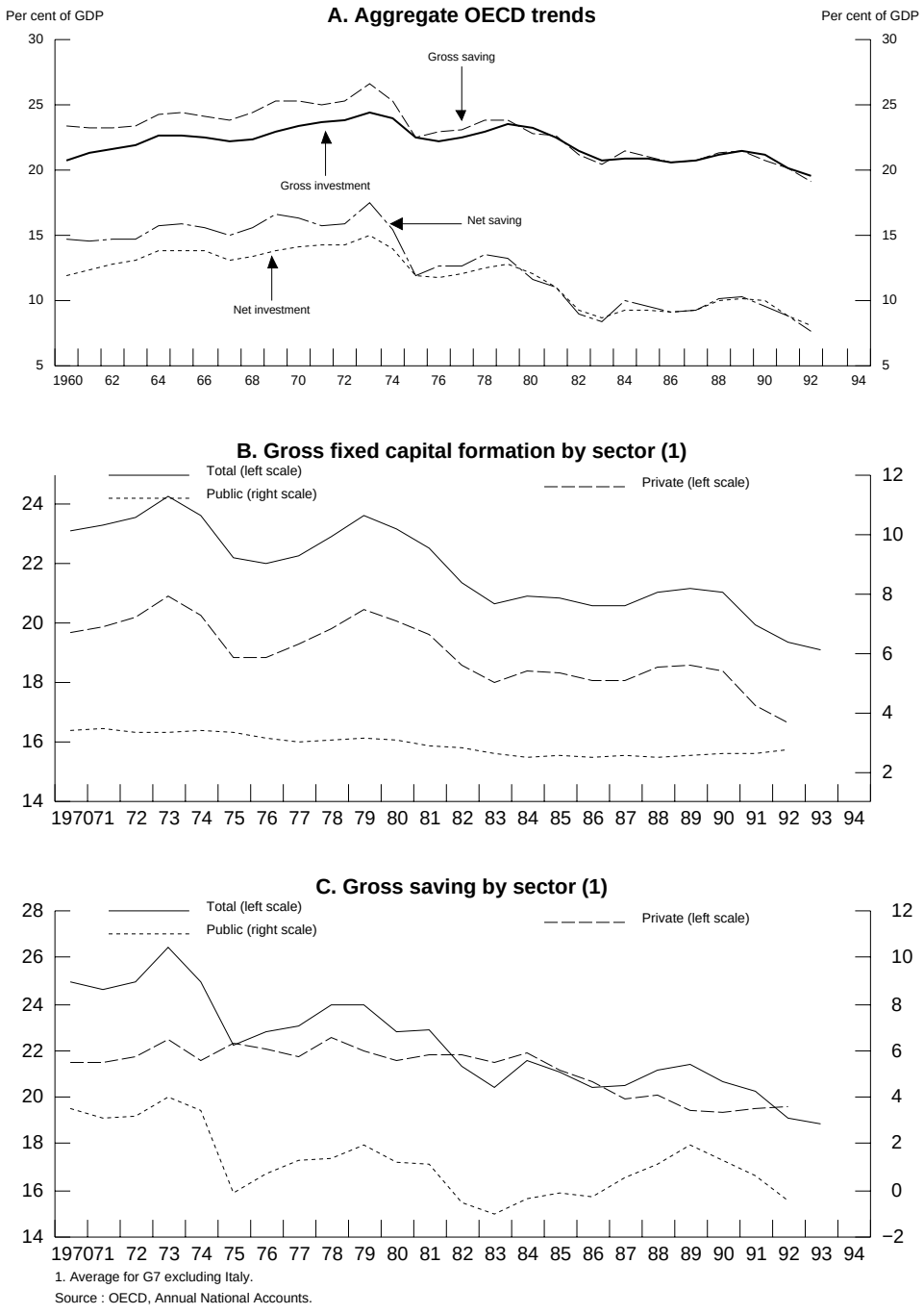
Source: OECD Secretariat; see Annex I for details.

Figure 2. **Real long−term interest rates**
H−P inflation definition (1)



1. Inflation expectations generated from the low frequency component of GDP deflator using the Hodrick−Prescott filter.
Source: OECD Secretariat; see Annex I for details.

Figure 3. **OECD saving and investment trends**

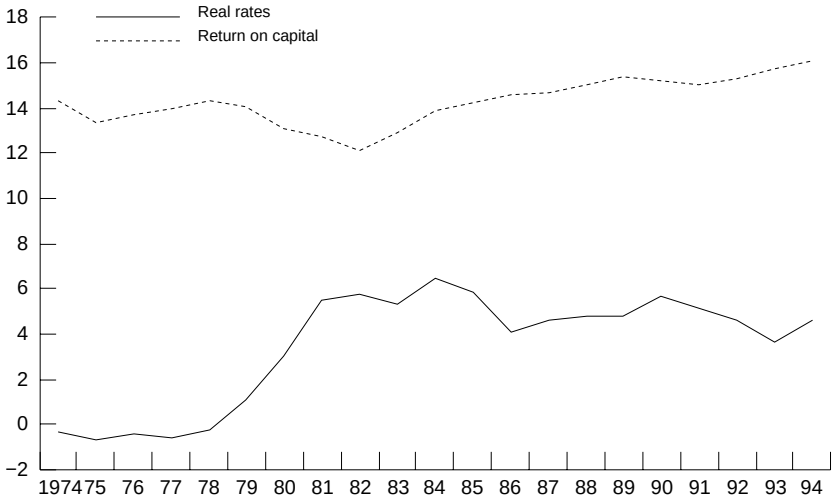


1. Average for G7 excluding Italy.

Source : OECD, Annual National Accounts.

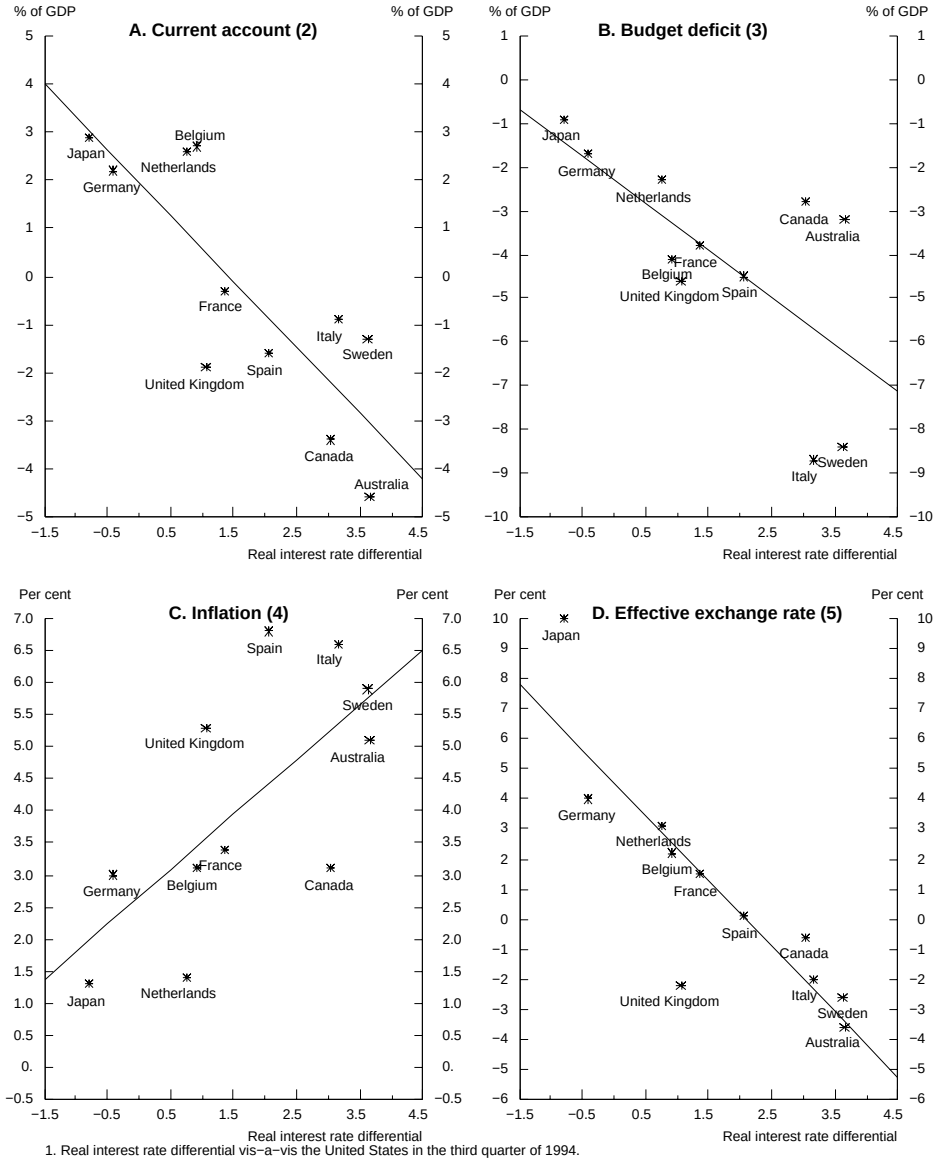
Figure 4. **Real long−term interest rates and the rate of return on business capital**

G7 GDP−weighted average



Source: OECD Secretariat; see Annex I for details.

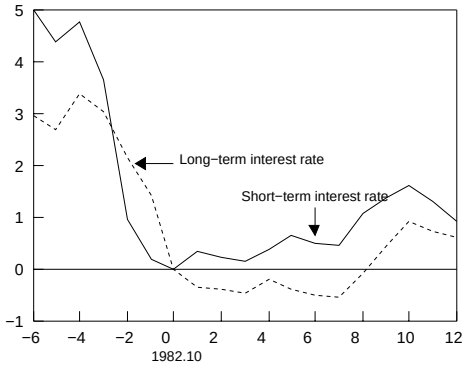
Figure 5. **Real interest rate differential vis−a−vis the United States (1)**

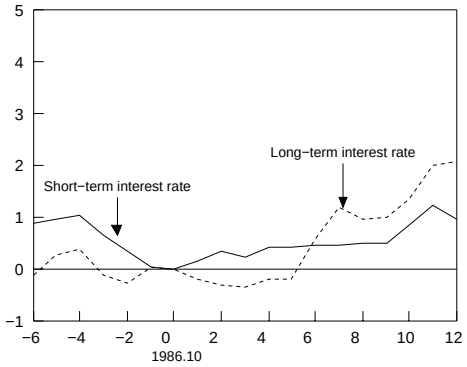


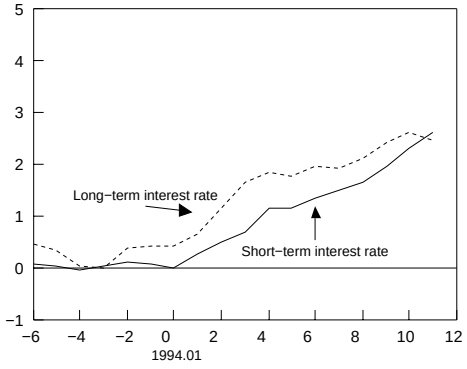
1. Real interest rate differential vis−a−vis the United States in the third quarter of 1994.
2. Annual average 1985−93.
3. 1994; structural estimate.
4. Average annual rate of change in the GDP deflator 1985−93.
5. Average annual rate of change in the effective exchange rate, 1985−93.

Source: OECD Secretariat; see Annex I for details.

Figure 6. **Monthly short−term and long−term nominal interest rates in the United States over the past three episodes of monetary tightening**

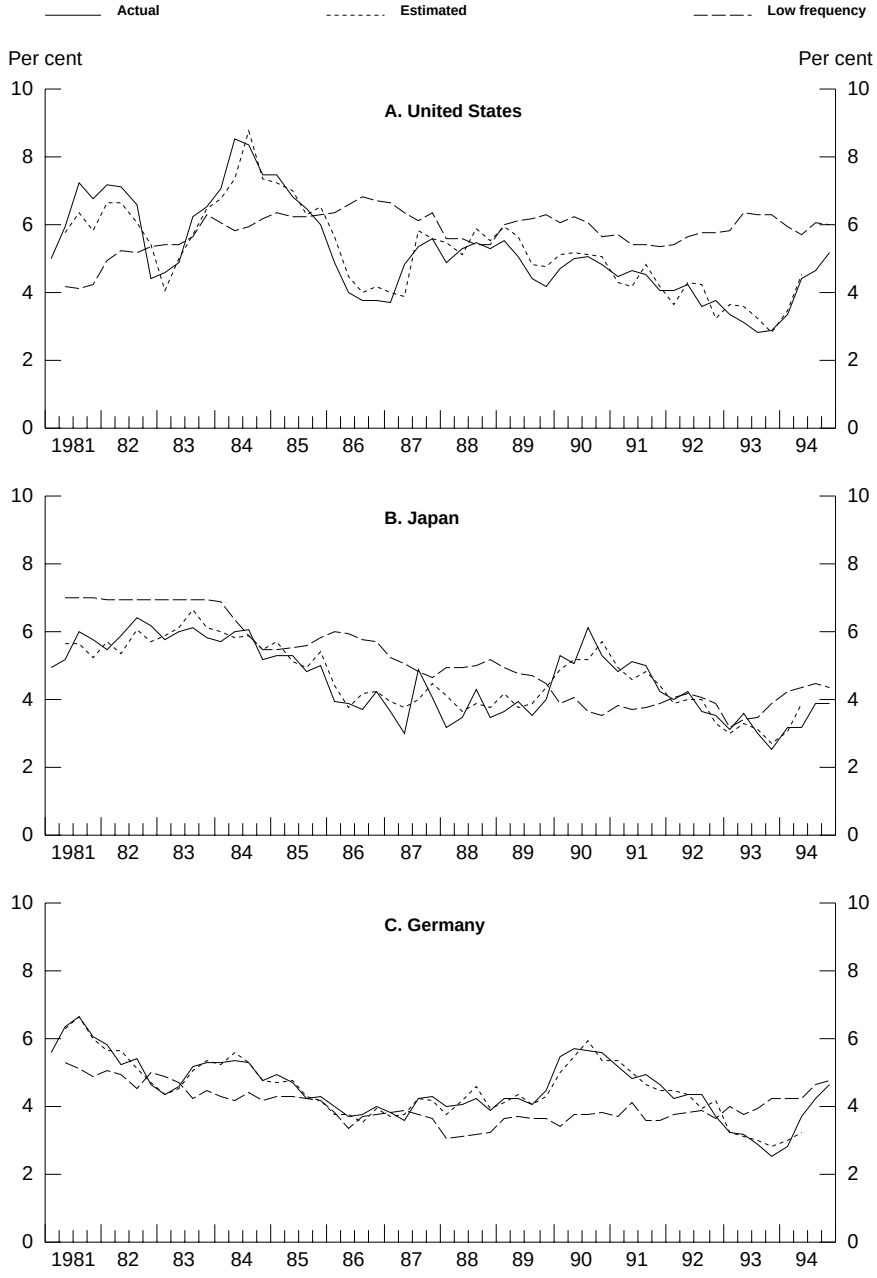






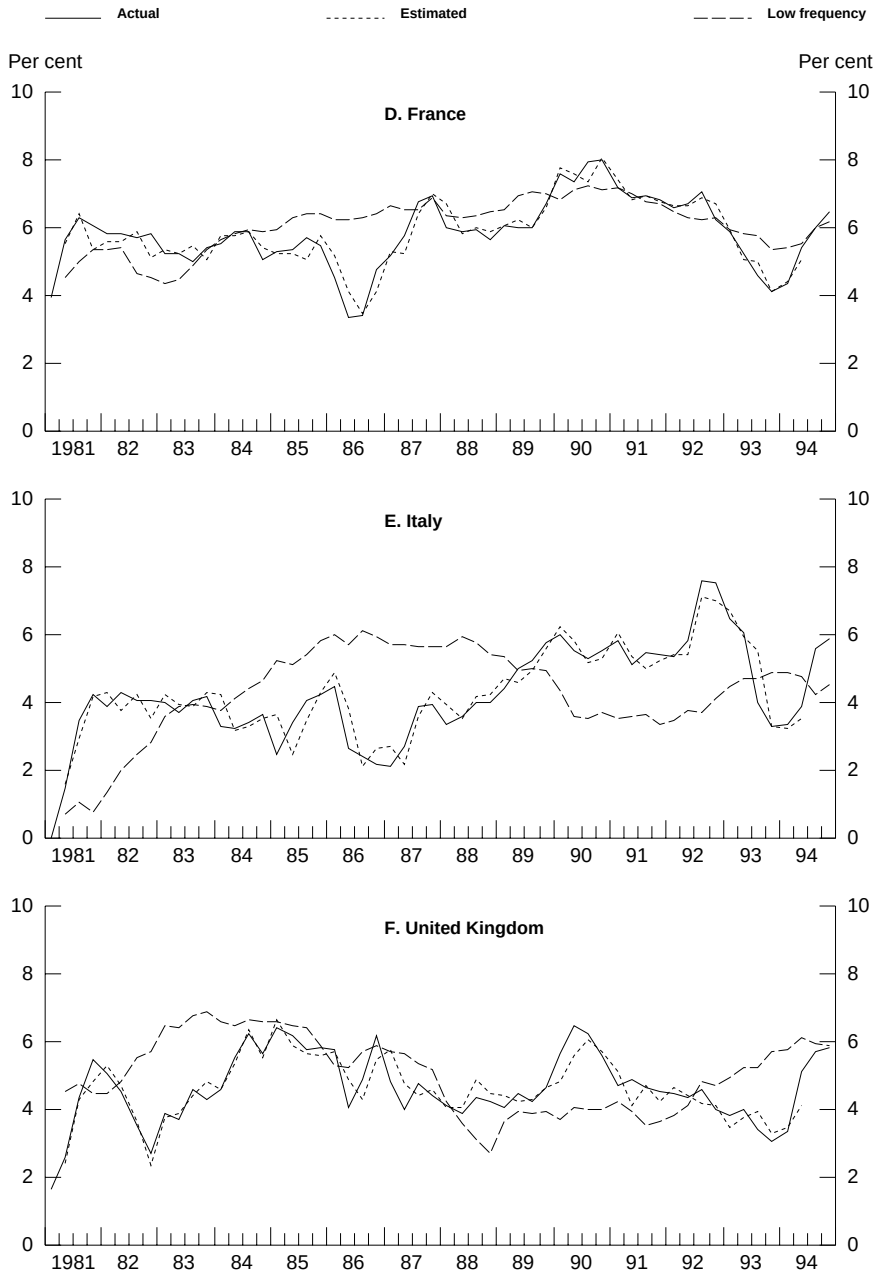
Source: OECD Secretariat.

Figure 7. **Real long−term interest rates:**
Actual, estimated and low−frequency component. (1)



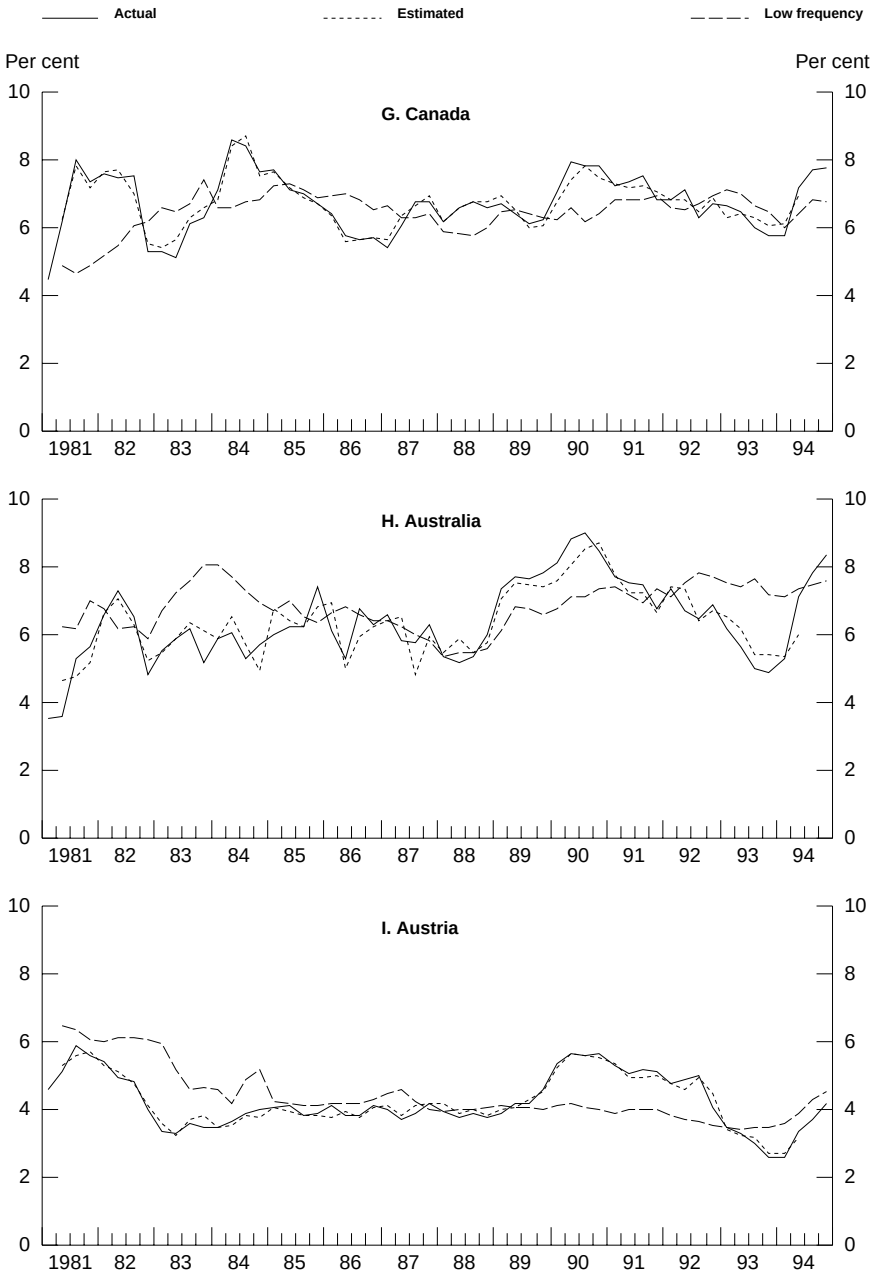
1. The low−frequency figures for the fourth quarter of 1994 are estimates.

Figure 7 continued. **Real long−term interest rates:**
Actual, estimated and low−frequency component. (1)



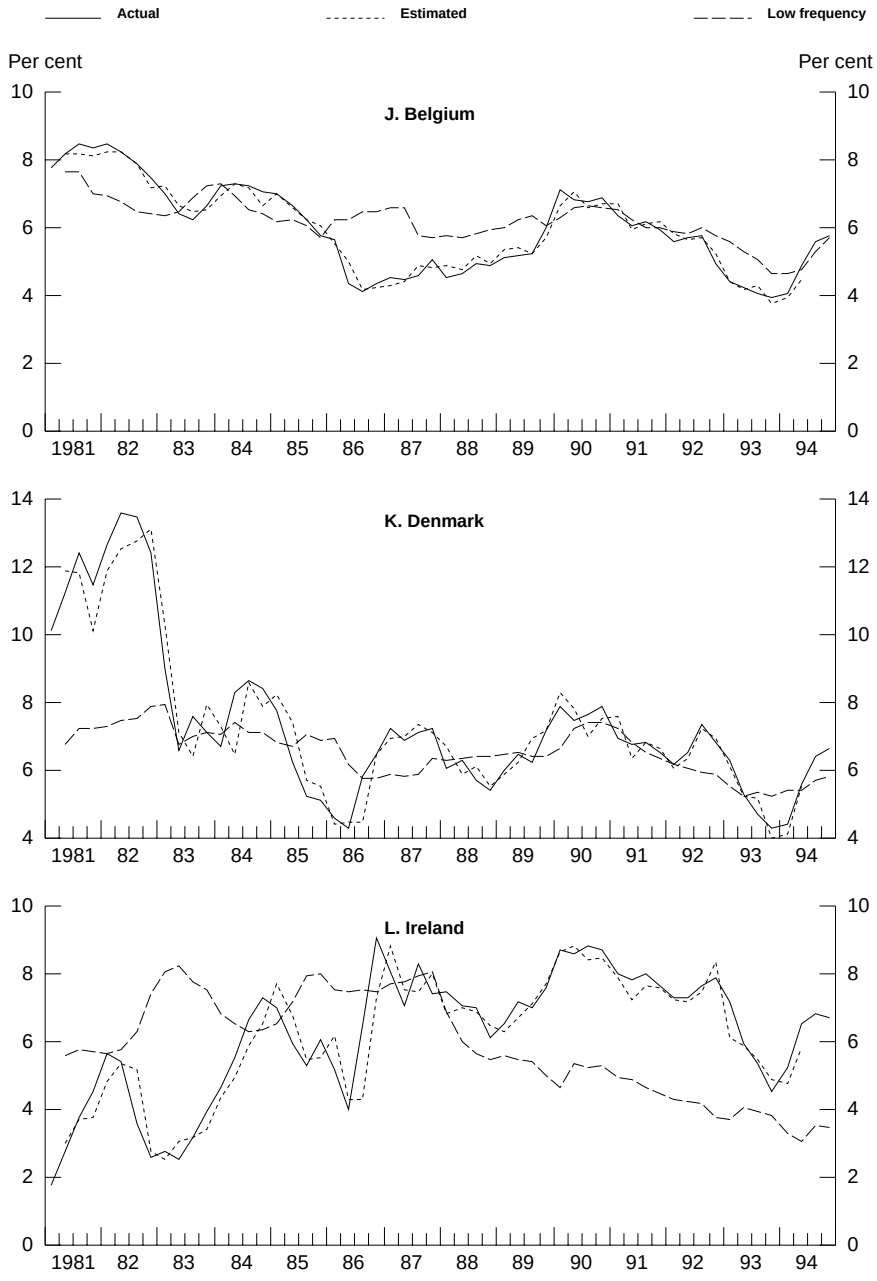
1. The low−frequency figures for the fourth quarter of 1994 are estimates.

Figure 7 continued. **Real long−term interest rates:**
Actual, estimated and low−frequency component. (1)



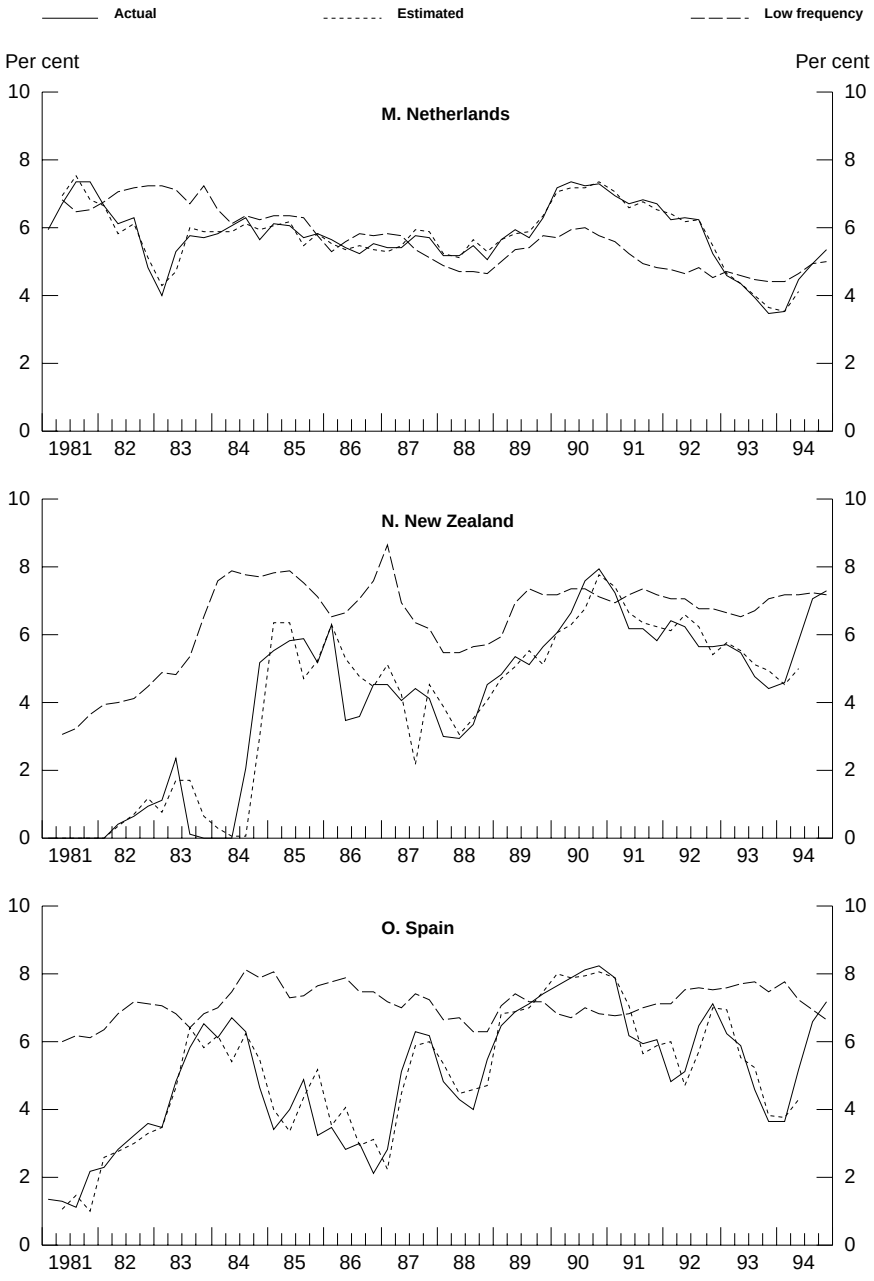
1. The low−frequency figures for the fourth quarter of 1994 are estimates.

Figure 7 continued. **Real long−term interest rates:**
Actual, estimated and low−frequency component. (1)



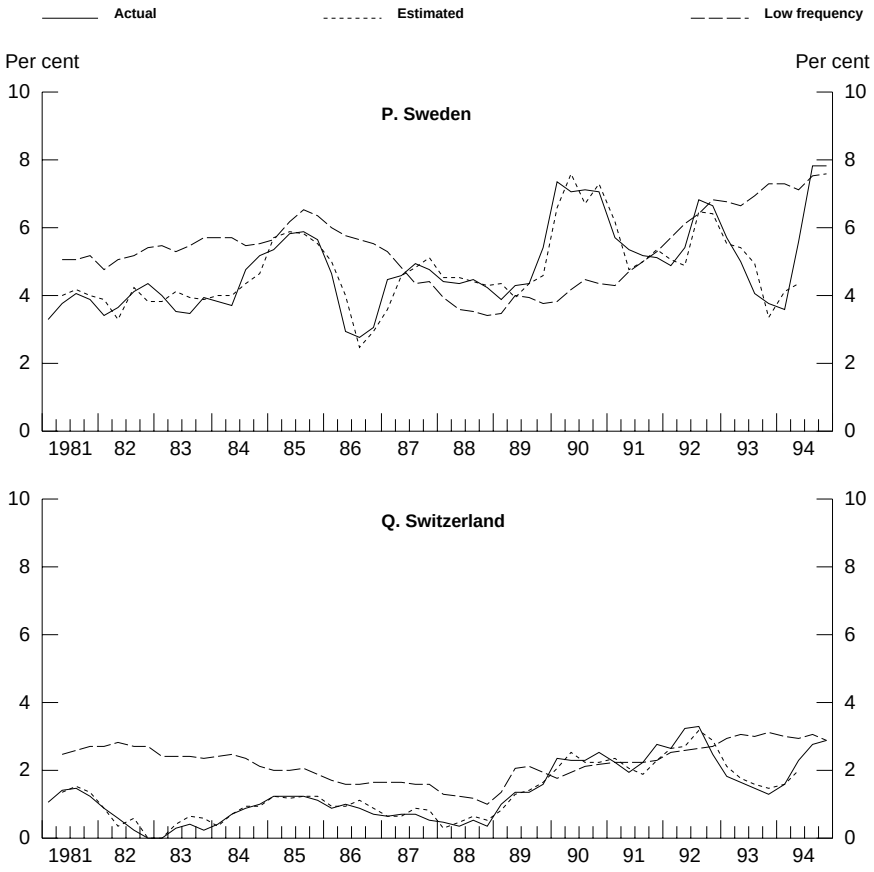
1. The low−frequency figures for the fourth quarter of 1994 are estimates.

Figure 7 continued. **Real long−term interest rates:**
Actual, estimated and low−frequency component. (1)



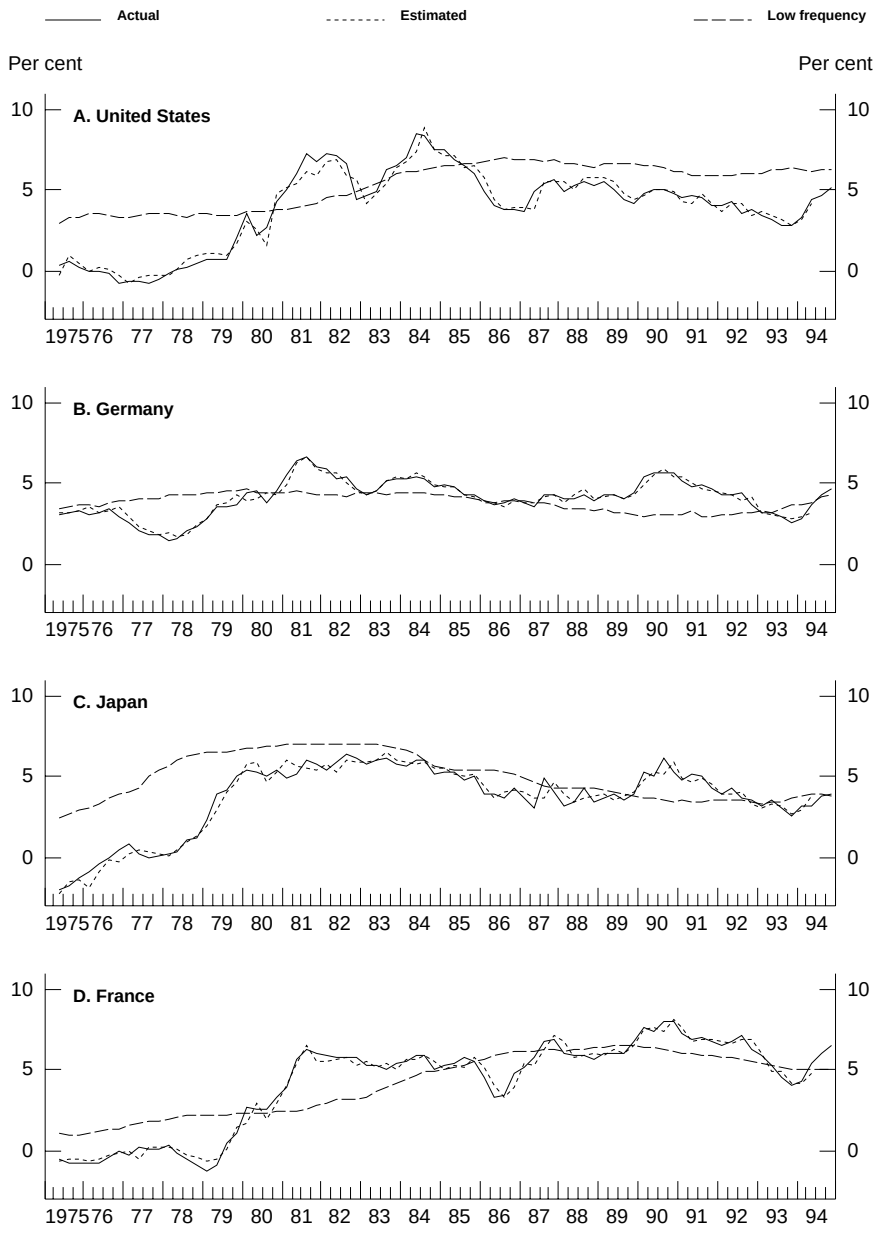
1. The low−frequency figures for the fourth quarter of 1994 are estimates.

Figure 7 continued. **Real long−term interest rates:**
Actual, estimated and low−frequency component. (1)



1. The low−frequency figures for the fourth quarter of 1994 are estimates.

Figure 8. **Real long−term interest rates since 1975:**
Actual, estimated and low−frequency component.



ANNEX 1: DATA SOURCES AND DEFINITIONS

Real long-term interest rates (r): are defined as the nominal long-term interest rate minus expected inflation.

Nominal long-term interest rates: are the yields on benchmark public sector bonds of around 10 years maturity. For the United States, Japan, the United Kingdom, Denmark, Australia and New Zealand: 10-year government bonds; Germany: 7-15 year public sector bonds; France: 10-year public and semi-public sector bonds; Italy: 10-year net Treasury bonds; Canada: over 10-year long-term federal government bonds; Austria.: public sector bonds; Belgium: central government bonds (more than 5-years); Ireland: 15-year government bonds; Netherlands: 5-8 year central government bonds; Spain: government bonds (more than 2 years); Sweden: 5-year long-term government bonds; Switzerland: 10-year private sector bonds. *Source*: OECD Analytical Database.

Inflation expectations (π^e): are generated using the low-frequency component of the annual percentage change in the GDP deflator using a Hodrick-Prescott filter. A lambda value of 1600 is used in the filtering process. *Source*: OECD Secretariat.

Past inflation ($\bar{\pi}$): is a 10-year moving average of the annual percentage change in the GDP deflator. *Source*: OECD Secretariat.

Inflation: is the annual percentage change in the GDP deflator index. *Source*: OECD Analytical Database.

Real short-term interest rates: are benchmark 3-month yields minus annual inflation. The benchmark 3-month yields are: for the United States: 3-month Treasury bills; Japan: 3-6 month CD; Germany, France, Italy, United Kingdom, Denmark, Spain: 3-month interbank rate; Canada: 90-day commercial paper; Austria: day-to-day money; Belgium: 3-month Treasury certificates; Ireland: 91-day Exchequer bills until 1983, 3-month interbank rate from 1984; Netherlands: 3-month Aibor; Sweden: 3-month Treasury discount notes; Switzerland: 3-month deposit rate; Australia, New Zealand: 90-day bank bills. *Source*: OECD Analytical Database.

The return on capital (ρ): is calculated as gross operating surplus of the enterprise sector divided by the enterprise sector's capital stock. See Keese *et al.* (1991) for a full description of the sources and methods used to calculate the capital stock data. *Source*: OECD Analytical Database.

Risk is the beta coefficient β: defined as a 12 month moving average of the covariance between the *ex post* bond yield and the return on a domestic portfolio, divided by the variance of the *ex post* return on the domestic portfolio. The domestic portfolio includes domestic bonds and equities, weighted by their respective proportion of the total value of domestic bonds and equities. In calculating the capital gains on domestic bonds, an average effective duration of 6 1/2 years is assumed. *Source*: OECD *Financial Accounts*, Part 2; UK Central Statistical Office, Financial Statistics; Salomon Brothers, Economic and Market Analysis Bulletin.

The current account balance (ca): is a 5-year moving average of the current account balance as a proportion of GDP. *Source*: OECD Secretariat.

The government deficit (gd): is the general government financial balance as a proportion of GDP. *Source*: OECD Secretariat.

Structural budget balance: is the cyclically adjusted general government financial balance as a proportion of GDP. *Source*: OECD Secretariat.

Exchange rate: is the annual percentage change in the nominal effective exchange rate. *Source*: OECD Analytical Database.

ANNEX 2

Real long-term interest rate equation estimated from 1975 (a)
17 country simultaneous estimation

Dependent variable: first difference of real long-term interest rates
Quarterly data from 1975Q2 to 1994Q2

Variable	ECM coefficient	t-statistic	Implied long-run coefficient
	Constrained long-run coefficients		
Error correction	-0.044	6.71	
Return on capital	0.012	4.63	0.27
Risk	0.021	0.77	0.48
Past minus expected inflation	0.022	3.21	0.50
Current account	-0.010	-2.22	-0.23
Government deficit	0.004	0.81	0.09

a) See data sources and definitions in Annex 1.

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