Determinants of Long-Term Interest Rates: An Empirical Study of Several Industrial Countries

by Howard Howe and Charles Pigott

Real interest rates on long-term financial assets play a central role in linking financial markets to the economy at large. Long-term real interest rates are a key determinant of business and housing investment as well as household spending on automobiles and other durables. As such, the rates are an important influence on the business cycle and on capital formation and a key link in the transmission of macroeconomic policies. The extensive debate over the reasons for and implications of the apparently high level of real long-term rates worldwide during much of the 1980s attests to their practical economic significance—and the importance of trying to improve understanding of their behavior.

This article examines the principal influences on long-term real interest rates over the last fifteen years in the United States and four major foreign countries: Japan, Germany, the United Kingdom, and France. Our goal is to identify the macroeconomic and other factors that have shaped the broader movements of the real rates over the period as well as their shorter term fluctuations.[1]

We begin by examining several important features of the behavior of long-term real interest rates since the mid-1970s. This analysis yields two key findings: first, the countries' real rates have shown a persistent rise since the mid-1970s, reaching levels in the 1980s that seem unusually high by historical standards; second, the movements in the real rates appear to reflect, at least in part, shifts in their long-run, or "equilibrium," levels. This second finding suggests that any adequate explanation of the evolution of the real rates must allow for determinants with relatively lasting effects as well as factors leading mainly to short- and medium-term fluctuations in those rates. We apply such a framework in evaluating the empirical importance of several potential influences, including macroeconomic policies, the rate of return to capital, and the effects of risk and other factors arising in part from changes in financial structure and regulation.

Overall, the evidence developed here suggests two important if very tentative conclusions. The first, and probably firmer, is that much, perhaps the dominant portion, of the observed movement in long-term real interest rates reflects relatively permanent changes in their long-run equilibria. In particular, the increase in real rates from the 1970s to the 1980s, which occurred to some degree in all the countries (and for short-term rates as well), appears to stem largely from such a change in equilibria. There is also some evidence, although mixed and highly tentative, that rising debt levels relative to GNP along with increases in the return to physical capital are at least partly responsible for the increase in real rates.

Our second conclusion is that macroeconomic policies have been an important, but clearly not exclusive, influence on the evolution of the long real rates over the last fifteen years. In particular, monetary policy appears

[1] Our approach complements that of most studies on long-term interest rates over the last decade, which have focused on more specific and technical issues such as the degree to which long-term rates are determined by expectations of future short rates. Our analysis is similar in spirit to two earlier studies of real interest rates that attempted to explain the evolution of real rates over time: Robert J. Barro and Xavier Sala i Martin, "World Real Interest Rates," National Bureau of Economic Research, Working Paper no. 3317, April 1990, and Olivier J. Blanchard and Lawrence H. Summers, "Perspectives on High World Real Interest Rates," Brookings Papers on Economic Activity, 2: 1984.

to have contributed significantly to the rise in real rates abroad at the end of 1970s and to the increase in U.S. real rates in the early 1980s. On the whole, however, monetary policy was not responsible for *persistently* high real rates during the last decade. Likewise, changes in government budget deficits appear to have affected real rate movements in certain periods, but to a degree (apart from their effect on debt levels) that is fairly modest compared with the overall trend in the real rates. On balance, the two conclusions suggest that macro policies have affected real long-term interest rates but, given the importance of other influences, have not exercised a high degree of "control" over those rates in any economically meaningful sense.

The evolution of long-term real interest rates

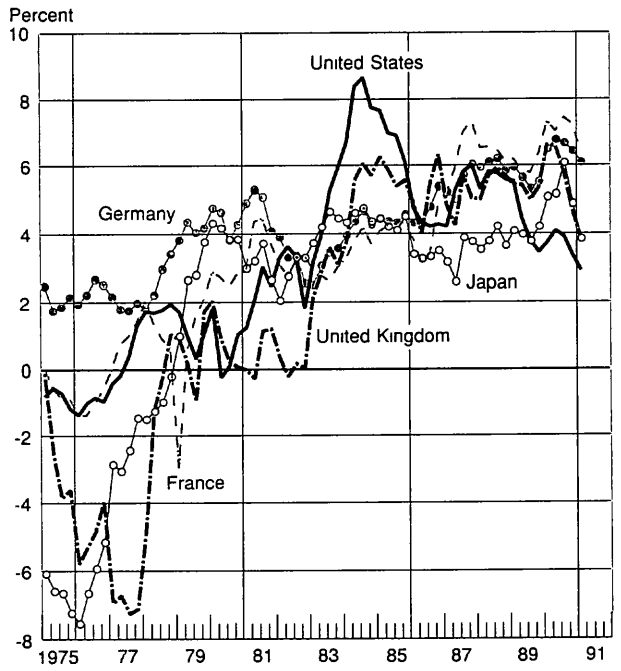
Conceptually, the real interest rate on a financial asset is equal to its nominal yield minus the inflation that a typical investor expects to prevail over the holding period. Because the anticipated inflation rate cannot be directly measured, any empirical measure of real interest rates inevitably is only a rough proxy.[2] In this study, we approximate the long-term real interest rate as the nominal rate minus the average of consumer price inflation over the past three years (For the nominal rates we use the yields to maturity on government bonds, since these bonds are the primary fixed income instruments in the countries we are considering[3]) Our real rate measure is very rough and not necessarily the best that might be constructed But given the considerable evidence that inflation expectations tend to be strongly influenced by past trends, the measure should reasonably reflect the broad movements in actual real rates over time that are our main concern here[4]

Chart 1 shows the movements in the real long-term interest rate proxies since the mid-1970s, and Table 1 presents the corresponding averages Movements in nominal long-term rates appear in Chart 2. Three features of these movements are noteworthy First, long-term real rates have varied considerably over time, indeed, by nearly as much as their nominal counterparts This observation implies that nominal rates have not varied just to offset movements in inflation, as a simplified Fisherian model of interest rate determination

Chart 1

Real Long-Term Interest Rates

Nominal Yields less Inflation of Past Three Years



Sources Board of Governors of the Federal Reserve System (U S data), Bank for International Settlements (data for all other countries)

Notes Nominal yields are for ten-year government bonds except in the case of Germany, where the term is four years or longer Inflation is measured by the consumer price index Quarterly figures are averages of monthly data

[2]There are, of course, other significant measurement problems—for example, the accounting for taxation of bond returns

[3]Maturities on the instruments considered are ten years for all countries except Germany, where the term is four years or longer Government bonds are generally the most widely held and actively traded long-term fixed income instruments in all the countries

[4]That is, in some long-run or average sense, the proxy used here should equal the actual real rate, since investor expectations of future inflation should (at least if they are "rational") ultimately coincide with its actual trend

Table 1

Average Real Long-Term Interest Rates

Nominal Yields less Past Three Years' Inflation

	Japan	Germany	France	United Kingdom	United States
1975-90	1 8	4 1	3 2	1 7	3 1
1975-82	−0 5	3 2	1 2	−1 7	0 9
1983-90	4.2	5 0	5 1	5 1	5 4
Memo					
1963-69	2 0†	4 1	2 8	3 2	2 7

†1965-69

would suggest. Moreover, the behavior of the real rates has often been quite different from that of their nominal counterparts; in particular, real rates have tended to rise over time, while the nominal rates, reflecting the general decline in inflation rates from the 1970s to the 1980s, have fallen over the period as a whole.

Second, although the average levels of the real rate have differed significantly across countries, both the overall trend in real rates and their behavior from the late 1970s to the early 1980s and again at the end of the 1980s have been remarkably similar across countries The coincidence of the broad movements in the countries' real rates suggests that their underlying determinants may have behaved in very similar ways.

The third and perhaps most striking feature of the real rate movements is their general rise after 1975 to levels in the 1980s that appear unusually high in comparison with the past [5] Admittedly, the first portion of this rise, in the latter 1970s, represents the recovery of real rates from the exceptionally low, indeed generally negative, levels to which they had fallen during the first half of the decade (in all the countries but Germany) (Because much of the rapid rise in inflation during the mid-1970s was probably unanticipated by markets, our measure may significantly understate the true level of real interest rates during this period) The surge in real rates over 1979-81, to levels somewhat above past averages (except in the United Kingdom), is similar to that seen in several of the countries in 1973-74 The sustained increase in real rates after 1982, however, marks a clear departure from past historical patterns Although real rates abroad, at least during 1982-85, did not rise nearly as much as in the United States, the average level of the rates in all five countries after 1982 was noticeably higher than during the 1960s or the first half of the 1970s Thus, by postwar standards, real long-term interest rates have been quite high *internationally* during the last decade.

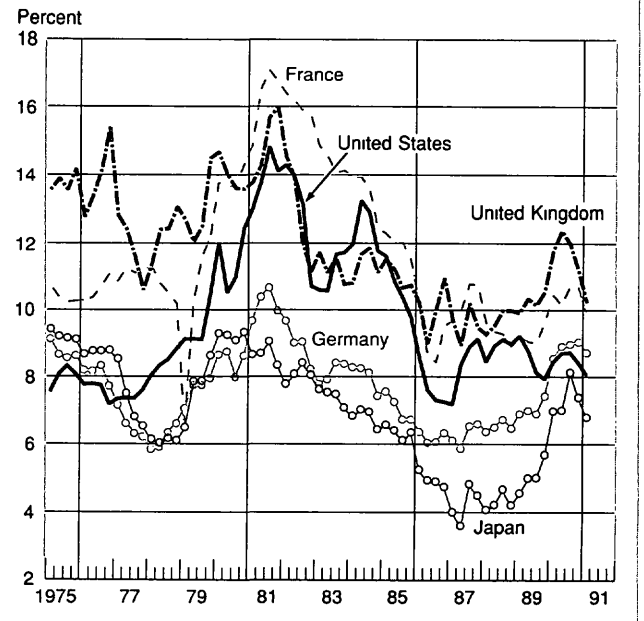
The persistent rise in real long-term interest rates[6]

[5]The persistently high level of both short- and long-term real interest rates during the 1980s has been widely noted and discussed (See in particular Paul Atkinson and Jean-Claude Chouraqui, "The Origins of High Real Interest Rates," Organization for Economic Cooperation and Development, OECD Economic Studies, no 5, Autumn 1985, pp 7-55) Commentators have attributed it to a wide range of factors, including government budget deficits and, more recently, a worldwide "shortage of capital "

[6]This rise is also displayed by several alternative definitions based on other inflation indexes and measures of expected long-term inflation In particular, real rate proxies based on a "forward-looking" measure of anticipated inflation, calculated as the average of inflation rates one year in the future and two years in the past,

Chart 2

Nominal Long-Term Interest Rates



Sources See sources in Chart 1

Note See yield definitions in Chart 1

Table 2

Tests for Varying Equilibrium of Long Rates

	Japan	Germany	France	United Kingdom	United States
Real long rate (1973-III to 1990-IV)	−1 77	−1 06	− 49	−1 79	−1 75
Long-short spread (1973-III to 1990-IV)	−4 00*	−3 21*	−3 92*	−2 09†	−2 45

Notes Figures are augmented Dickey-Fuller test statistics on the coefficient b in the equation

$$x(t) = bx(t-1) + \sum_{i=1}^{4} c_i \Delta x(t-i) + e_x,$$

where four lagged autocorrelation terms are used A significant value indicates that the hypothesis that the equilibrium (long-term or unconditional mean) is changing can be rejected None of the values for tests of constant equilibrium real long rates are statistically significant Tests of constant long-short spread are statistically significant at the 5 percent (*) level for Japan, Germany, and France Critical values for the Dickey-Fuller statistic are obtained from WA Fuller, *Introduction to Statistical Time Series*, 1976, p 373.

†The United Kingdom spread appears to have a negative time trend but to be otherwise stable (that is, around the trend) when a time trend is included, the critical value of the test statistic for significance at the 5 percent level is −3 41

strongly suggests that their long-run (conditional) mean values have changed over time We will refer to such changes as shifts in the "equilibria" of the real interest rates since the means represent the levels to which the real rates will eventually converge in the absence of any further disturbance to their values [7] The supposition that the equilibria have changed periodically is supported by formal statistical tests, reported in Table 2, which evaluate whether the long-term real rate is "stationary" in the sense of having a constant mean value toward which it tends to return As the table indicates, the hypothesis that the long-run mean values of the real rates have varied over time cannot be rejected at any reasonable confidence interval.[8]

The most plausible interpretation of these statistical results is that the equilibrium values of the long-run rates have changed significantly over time rather than that the real rates are simply "unstable" in the sense of having no true equilibrium The implication is that the observed evolution of real long-term rates reflects not only fluctuations about a given equilibrium but also changes in the equilibria themselves. Note too that the average level of real interest rates on short-term financial assets has also increased noticeably (Chart 3)

Footnote 6 continued
also display a considerable rise between the mid-1970s and the 1980s, although somewhat more modest than that shown in Chart 1 The same is true of proxies calculated by discounting considerably (for example, by smoothing over a longer period) the sharp surge in our inflation measure in the mid-1970s and of proxies based on the GNP deflator or the consumer price index excluding food and energy Comparisons of the 1980s with the 1960s are also fairly robust to alternative measures

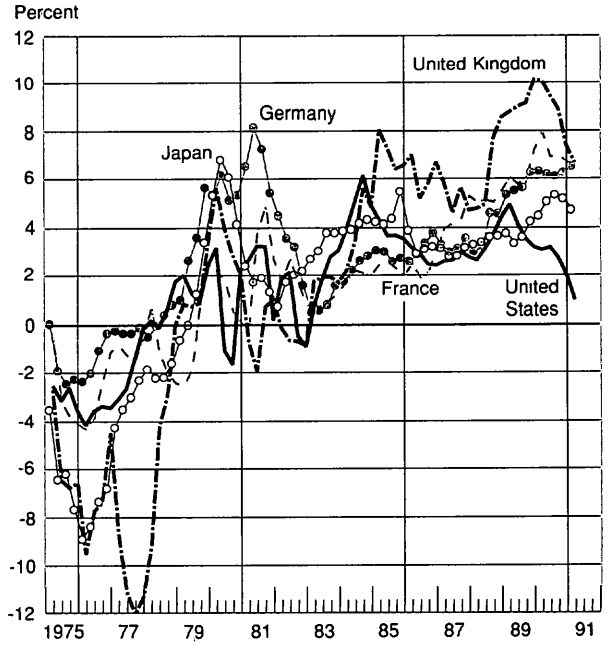
[7]Thus, "equilibrium" as defined here is inherently subject to change over time, in contrast to the very long-run "steady-state" equilibria referred to in classical growth theories and much other literature The economic meaning of the real rate equilibrium is discussed below

[8]Tests over a longer period (beginning in the mid-1960s, or late 1960s for Japan) support this conclusion even more decisively than the tests reported in the table Furthermore, a more general regression relating the long-term nominal rate to inflation (allowing the real rate to vary systematically with inflation) also appears to have an "unstable" mean It is, of course, possible that the shifts in the mean real long rate have occurred at a few discrete points during the period, rather than more or less continuously, as a literal reading of the statistical results underlying Table 2 would imply Nevertheless, the hypothesis that a single mean shift occurred after 1981, or at mid-sample, is effectively rejected by the test statistics (at the 5 percent, and generally the 10 percent level) for all countries but the United States

Chart 3

Real Short-Term Interest Rates

Nominal Yields less Inflation of Past Three Years

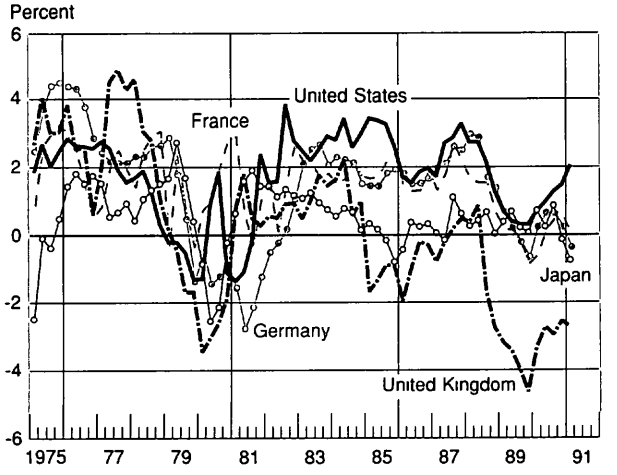


Sources See sources in Chart 1

Notes Nominal yields are for three-month obligations in the money markets Inflation is measured by the consumer price index Quarterly figures are averages of monthly data

Chart 4

Spread between Real Long-Term and Real Short-Term Interest Rates



Sources See sources in Chart 1

Note Real interest rates are those presented and defined in Charts 1 and 3

However, the relation between long- and short-term rates, as measured by the difference in their values, appears to have remained fairly stable over time (Chart 4). This latter observation is supported by statistical tests analogous to those applied to the real long rates; here the tests suggest that the long-short spread does have a constant mean in most cases (Table 2, bottom row).[9] Thus we may also conclude, if equally tentatively, that the rise in equilibrium long-term real rates appears to reflect forces affecting financial instruments generally, not simply forces specific to long-term instruments.

The finding that equilibrium real rates have varied does not itself, of course, cast light on the specific economic factors responsible. Nevertheless, the finding does help us to determine the factors we will consider and the approach we will take in our empirical analysis of the behavior of long-term real rates—the analysis to which we now turn.

Fundamental determinants of long-term real interest rates

In this section we attempt to identify and quantify the importance of the fundamental economic forces behind the evolution of the real long-term interest rates examined above. The evidence presented in the first section implies that any adequate framework for this analysis must consider forces leading to persistent changes in the equilibria of the real rates as well as forces producing fluctuations about those equilibria. Such a framework is provided by the approach to interest rate determination formulated by the Swedish economist Knut Wicksell in the late 19th century.[10] The "Wicksellian" approach is the prototype for much modern theoretical analysis of interest rate determination.

The Wicksellian framework

Fundamental to Wicksellian frameworks is the distinction between the "natural" real rate of interest and the market rate. The first corresponds to what we have called the long-run equilibrium real interest rate: it is the rate toward which actual real rates will eventually tend over time in the absence of any further disturbances. Fundamentally, the equilibrium real rate represents the future return in forgoing current consumption.[11] This equilibrium real rate can, and generally will, change over time as its underlying determinants vary; these changes will be reflected in the broader, longer term movements in actual real rates.

The framework recognizes, however, that actual interest rates generally adjust only gradually to shifts in their underlying equilibria. Asset supplies and demands may respond slowly to altered conditions, and certain forces may temporarily push interest rates away from equilibrium without altering the equilibrium itself. Accordingly, the actual market rate of interest at any given time (which Wicksell called the "financial" rate) will generally differ from its equilibrium. Virtually any of the factors affecting supplies of or demand for financial assets could lead to such deviations, but two are widely believed to be of special importance: monetary policy and fiscal policy.

From this perspective, the evolution of long-term real interest rates over any substantial period reflects both changes in their long-run equilibria and fluctuations about those equilibria. In practice, however, forecasting and other empirical models of real interest rates have tended to focus mainly on the latter, with little or no explicit consideration of changes in real-rate equilibria. The models most often view long-term real interest rates as reflecting actual and expected movements in short-term nominal interest rates and inflation, movements that are largely determined by macroeconomic policies.[12]

In such models, monetary policy induces fluctuations in short- and therefore long-term real interest rates through its effects on the supply and demand for liquidity but does not (to a first approximation) affect the long-run equilibrium real rate.[13] Real interest rate vari-

[9]The spread for the United States is just below the 10 percent critical value that would indicate "acceptance" of the hypothesis of a constant mean. But evidence from earlier work using a longer sample period (for example, Robert F. Engle and C. W. Granger, "Cointegration and Error Correction: Representation, Estimation, and Testing," *Econometrica*, vol. 55, no. 2 [March 1987], pp. 251-76) indicates that the U.S. spread is in fact stationary, and we will so regard it in our statistical analysis.

[10]Wicksell's approach was developed in his treatise, *Interest and Prices* (1898).

[11]The natural rate was originally identified with the real rate level compatible with a constant (nonaccelerating or decelerating) inflation rate. As originally formulated, the Wicksellian framework was meant to apply to the general level of interest rates within a given country, rather than to individual assets or even classes of assets. Risks affecting the general level of rates are most likely to arise from fundamental technological factors, business cycle fluctuations, or other forces affecting all assets. The framework can be applied to particular types of assets, as here, but then it must allow for their individual risks.

[12]Fairly typical in this respect are the interest rate relations embedded in the MPS, DRI, and other large econometric models. These models generally relate long-term nominal interest rates to a distributed lag on past short-term rates; in some cases, the models also relate the long-term rates to inflation and other variables. Short-term (nominal) rates are then usually modeled as a function of some measure of the money stock, the level of prices, and real activity. However, in a reduced-form model, macroeconomic policies tend to be the main *explicit* driving forces of prices and income. In any case, the determination of real interest rates is largely implicit in such models.

[13]For example, expansionary monetary policy initially tends to lower short-term nominal and real interest rates by increasing liquidity.

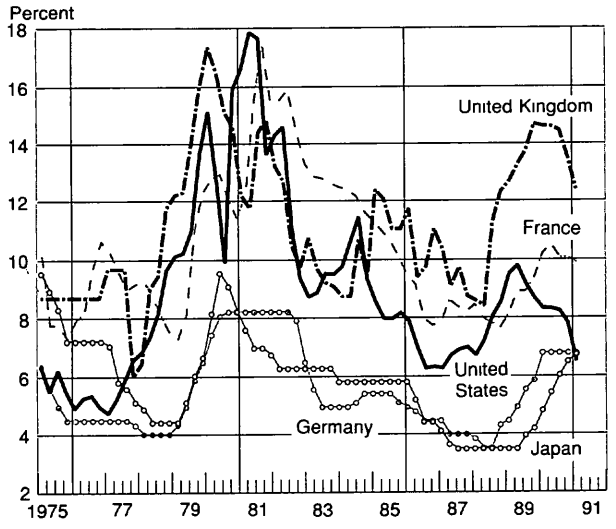
ations about equilibrium can also arise from cyclical fluctuations in real growth caused by fiscal stimulus or contraction. In principle, fiscal policy may alter the real rate equilibrium through its effect on government debt levels (see below) or other channels, but such effects are normally not considered, at least not explicitly, in standard models

Models focusing on changes in interest rates around some equilibrium have proved useful in analyzing interest rate movements over moderate intervals such as the business cycle. But they can be expected to provide only a very incomplete explanation of the movements over longer periods. Here we consider extended intervals for the reason emphasized previously long-term real interest rate movements appear to be too persistent to be attributed simply to business cycle fluctuations caused by macroeconomic policies. Examination of the pattern of monetary and fiscal policies over the last fifteen years further supports this conclusion.

Footnote 13 continued
Long-term rates are thus likely to fall at first, both in nominal terms and relative to prevailing inflation trends (that is, in real terms according to our measure) Over time, however, as the policy increases inflation and stimulates real growth, interest rates will tend to rise, with real rates returning to their original equilibrium Nominal rates, of course, are likely to end up higher than they were originally because of the increased inflation

Chart 5

Money Market Intervention Rates



Sources See sources in Chart 1

Note Money market intervention rates differ among countries for the United States, we use the federal funds rate, for Japan, the call money rate, for Germany, the repurchase rate on short-term Treasury bills, for the United Kingdom, the base rate on sales of commercial and eligible bank bills, and for France, the repurchase rate on short-term private paper

No single measure can fully capture the stance of monetary policy Chart 5 provides one measure of the stance of the five countries' monetary policies, namely, central bank money market intervention rates or interbank rates. The movements in short-term real interest rates and in the spread between long and short rates in Charts 3 and 4 provide additional indicators of the policy stance Collectively, these measures suggest that monetary policy was relatively expansionary during 1975-78, the years following the first oil shock (note especially the sharp declines in the central bank rates), but then tightened fairly markedly beginning around 1979-80, partly in response to the second oil shock. Policy next seems to have relaxed—as early as 1980 in Japan, about 1982 in Germany and the United Kingdom, and somewhat later in the United States—and showed only moderate changes through much of the decade until about 1988, when it began to tighten in most countries. As judged by money market intervention rates, monetary policy eased after 1989 in the United States, relaxed in the United Kingdom a bit later, and in the other three countries either tightened or showed no significant change

These patterns suggest that monetary policies influenced the relatively low level of real long-term interest rates over 1975-79 and contributed significantly to the surge in real rates in the early 1980s.[14] It seems quite unlikely, however, that monetary policy could have been responsible for the persistence of relatively high long-term interest rates after 1982 These rates remained nearly as high as in 1980-81 despite a considerable easing of monetary policy.

Fiscal deficits are widely believed to have been a major contributor to high real interest rates during the 1980s In the United States, the persistence of a high deficit throughout the decade (Chart 6) seems at least consistent with this view In the foreign countries, however, the deficits were highest in the 1970s and early 1980s, and fell substantially thereafter, foreign deficit-to-GNP ratios after 1983 were noticeably lower on average than in the latter half of the 1970s Hence fiscal deficit movements, which appear to have reinforced the effects of monetary easing after 1982, would seem unable to explain the high level of real rates abroad during that period

These observations do not mean, of course, that

[14]Comparison of individual country experiences also supports the conclusion that monetary policy was substantially responsible for the sharp rise in foreign real long-term rates at the beginning of the 1980s The rate increases were greatest in Britain, and most sustained there and in Germany, the two countries that appear to have undergone the most severe and prolonged tightening

macroeconomic policies have had little or no impact on the long-term real interest rates The observations do confirm, however, that analysis of the real rates must account for shifts in equilibria and consider fundamental factors in addition to standard macroeconomic policies

Determinants of the equilibrium real long-term interest rate

The equilibrium level of a country's real interest rates can be viewed as the product of three factors. The first is the rate of return to physical capital, which represents the rate at which current savings are transformed into future output. Chart 7 shows one very crude summary measure of this return, namely the gross profit rate (including depreciation) on business capital as estimated by the Organization for Economic Cooperation and Development Because this measure reflects only the current earnings of capital, it can only indirectly indicate the prospective return to new investment Nonetheless, it is interesting that the gross profit rates have increased over time and were on average 1 to 2 percentage points greater over 1983-89 than during the preceding economic expansion of the latter 1970s (although not generally higher than in the 1960s) [15] To the extent that this increase reflects a fundamental shift in capital productivity or capital's share of output, it may have contributed to the rise in real interest rates on financial assets.[16]

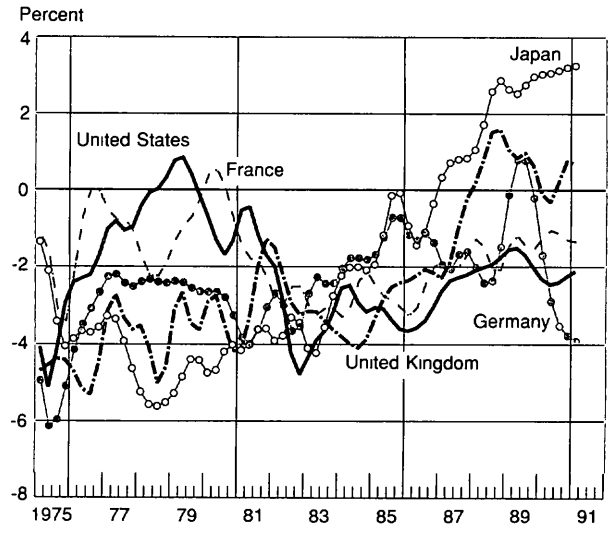
A second factor determining the equilibrium real bond rates is their risk. Conceptually, the interest rate on an asset includes a "risk premium" to compensate for the uncertainty about the future value of wealth entailed in

[15]Of course, the return to capital may be measured in several ways, but all have serious defects For alternative measures and

Footnote 15 continued
discussion of the issues raised, see James Chen-Lee and Helen Sutch, "Profits and Rates of Return in OECD Countries," OECD Working Paper no 20, 1985 One alternative measure is the market return to equities, which was also relatively high during the 1980s, the Barro and Sala i Martin study ("World Real Interest Rates") in fact attributes much of the rise in short-term real rates during the 1980s to this factor

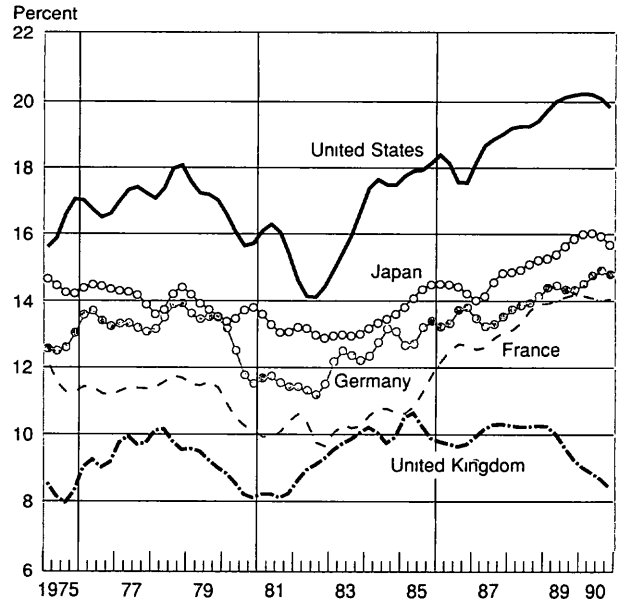
[16]The reasons for the increasing return to capital are unclear, although a general rise in profit shares was apparently one proximate contributor Note, however, that investment was very robust abroad during the latter half of the 1980s and in the United States in the middle portion of the decade This pattern at least suggests that returns to capital improved significantly Blanchard and Summers ("Perspectives") make a similar argument and provide evidence that the shifts may have been manifest by the early 1980s

Chart 6
Government Balances as a Share of GNP



Source Organization for Economic Cooperation and Development
Note Quarterly figures are interpolated from semiannual data

Chart 7
Gross Rate of Return to Capital



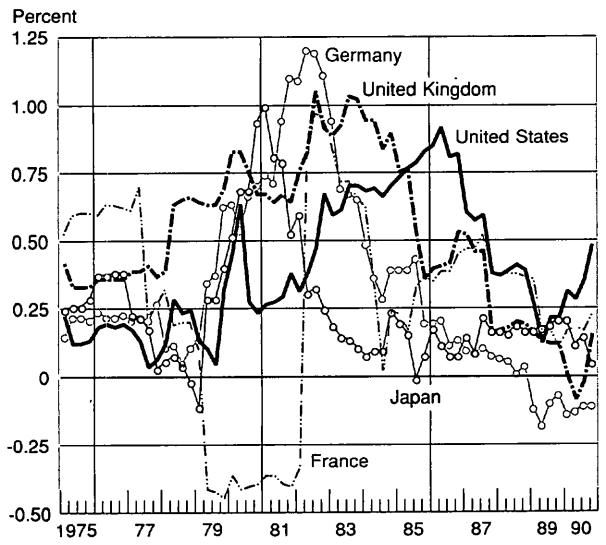
Source Organization for Economic Cooperation and Development
Notes The rate of return to capital is defined as the gross operating surplus of enterprises divided by the nonresidential gross fixed capital stock Quarterly figures are interpolated from semiannual data

holding that asset. Like the return to capital, risk has a number of possible proxies, all of which are imperfect. Chart 8 shows a common measure based on the historical contribution, "beta," of government bonds to the volatility of the overall market portfolio—a portfolio that consists of domestic bonds plus domestic equities. Generally, these measures reached their peaks in the early to mid-1980s; they have fallen considerably since then. Abroad, the risk proxies appear about equal to or lower than those of the latter 1970s, although in the United States they seem to have remained somewhat higher.

An alternative proxy that may better reflect prospective risks than measures based on past performance is the ratio of government debt to GNP. One rationale is that high and rising government debt burdens could undermine the credibility of the government's commitment to contain inflation or could create other economic problems that depress the future value of government debt. As the upper panel of Chart 9 indicates, the public debt ratio in the United States rose throughout the last decade; by contrast, the debt ratio has fallen or leveled off since 1985 in Japan, Germany, and France, and declined continuously in the United Kingdom since the mid-1970s.

Chart 8

Contribution of Bonds to the Volatility of the Domestic Portfolio

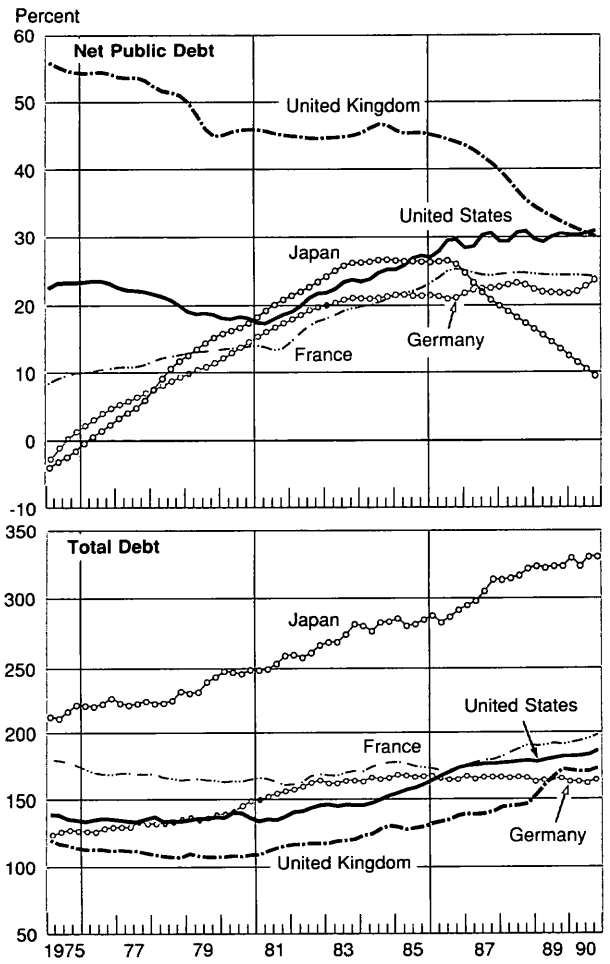


Source: Authors' calculations.

Notes: The risk contribution, or beta (β), of bonds is defined as the covariance between the ex post real bond yield and the real return on the domestic portfolio (bonds plus equities weighted by their respective shares of the total value of domestic bonds and equities) divided by the variance of the ex post real return on the domestic portfolio. The data plotted here and used in the estimation of the model (equation A.1 of the appendix) are three-year moving averages. Since the average maturity of the bonds is not known, the computation assumes an average effective duration of six years in calculating capital gains.

Chart 9

Debt as a Share of Nominal GNP



Sources: Organization for Economic Cooperation and Development (OECD), Bank for International Settlements, U.K. Central Statistical Office, and Board of Governors of the Federal Reserve System.

Notes: Net public debt for all countries and gross public debt for all countries except the United States are interpolated from semiannual data of the OECD. Gross public debt and private nonfinancial sector debt for the United States are available quarterly. Private nonfinancial sector debt (private nonbank debt for the United Kingdom) is interpolated from annual data.

Deregulation and other extensive changes in financial structure represent a third factor thought to have permanently affected real interest rates These changes, which have occurred to varying degrees in all major industrial countries over the last decade, have spurred the exceptionally rapid growth of private sector debt in the 1980s. It is widely believed that this debt growth, along with the great increase in the number and complexity of available financial instruments associated with it, has added to aggregate financial risks by increasing the vulnerability of lenders and borrowers to adverse economic developments [17] Moreover, the factors leading to increased credit availability may well have affected interest rates in other ways—for example, by substantially curtailing credit rationing and other mechanisms that tended to depress rates below market clearing levels.[18] These considerations suggest that the trend in overall debt, private as well as public, better reflects the impact of changes affecting equilibrium returns on financial assets than do historical risk measures or government debt alone. As shown in the lower panel of Chart 9, the overall debt ratios have grown substantially and continuously over the last decade in all the countries except Germany

[17]Bank for International Settlements, *Recent Innovations in International Banking*, Chap 10, April 1986

[18]For an extensive discussion of these financial changes and their effects, see M A Akhtar, "Recent Changes in the Financial System A Perspective on Benefits versus Costs," in D F Fair, ed , *Shifting Frontiers in Financial Markets* (1986)

Estimates of the equilibrium rate

To apply the Wicksellian approach to the analysis of the real rate movements, we have estimated empirical models of interest rate determination for the five countries Each of the country models consists of two basic relations, estimated on quarterly data beginning in 1975 The first describes the determination of the equilibrium real long-term interest rate in terms of the fundamental factors described below The second relation depicts the fluctuations in real rates around those equilibria as the rates adjust to changes in the equilibrium determinants and shifts in macroeconomic policies [19] Details of the models, their estimation, and key properties are given in the appendix. Beginning with the equilibrium relation and then proceeding to the overall "explanation" of the real rate movements provided by the full models, we will focus on the models' main economic implications

Empirical relations between the equilibrium long-term interest rates and the return, risk, and financial change measures are summarized in Tables 3 and 4. We focus

[19]The dynamic model has a fairly traditional form in that movements in long-term real interest rates are effectively related to movements in real short-rates and, in part through the latter, to changes in macroeconomic policies However, following the "error correction" methodology (see, for example, Engle and Granger, "Cointegration"), we include the real rate equilibrium in the dynamic relations, so that long-term real interest rates approach their equilibrium in the absence of further disturbances An equilibrium relation between long and short rates is also included in the model The dynamic relations should be regarded as partial reduced forms, with variables such as real income and oil price shocks essentially reflected in the estimated coefficients on the policy variables

Table 3

Determinants of the Equilibrium Long-Term Interest Rate

Dependent variable is the bond yield less average inflation over the past three years as measured by the consumer price index

	Japan		Germany		France		United Kingdom		United States	
Constant	−20 3	(−8 4)	−12 8	(−7 0)	−7 55	(−6 1)	−38 4	(−9 3)	−11 3	(−5 0)
Return to capital	—		0 57	(4 7)	0 47	(4 8)	0 76	(1 9)	0 44	(1 9)
Beta	3 19	(2 3)	—		—		8 53	(6 6)	7 04	(7 1)
Ratio of debt to GNP	0 08	(9 3)	0 06	(8 8)	0 30	(12 5)	0 22	(11 3)	0 026	(1.3)
Adjusted R-squared	57		62		71		71		64	
Cointegration test ADF	−3 51**		−3 03		−3 45**		−3 01		−3 75*	

Notes The bond yield is the yield to maturity on ten-year government bonds, except in the case of Germany, where the term is four years or longer Return to capital is the ratio of profits (including depreciation) to gross capital stock, The source for these figures is the Organization for Economic Cooperation and Development Beta is the contribution of the government bond to the risk of the overall (bonds and equities) domestic portfolio The ratio of debt to GNP is the total nonfinancial debt ratio, it is calculated as the nominal value of gross government debt plus nonfinancial private debt, divided by nominal GNP (except in France) In France, the public debt ratio is used; it is calculated as the nominal value of net government debt divided by nominal GNP T-statistics are in parentheses. ADF is the augmented Dickey-Fuller test Critical values for the Dickey-Fuller statistic are obtained from P C B Phillips and S Ouliaris, "Asymptotic Properties of Residual-Based Tests for Cointegration," *Econometrica*, vol 58, no 1 (January 1990), pp 165-93

*Significant at the 12 5 percent level

**Significant at the 10 percent level

on the relations using the overall debt measure (except for France) since these appear somewhat superior to those using government debt only.[20] In any case, the empirical relations are intended, first, to provide an estimate of the movements in the equilibrium real rate itself. These movements are important for interpreting the evolution of actual rates and, in particular, for assessing the influence of monetary policy and other primarily cyclical influences. Second, the relations provide some indication of the factors at least associated with, and perhaps even proximately responsible for, changes in the real rate equilibria. We caution, however, that the relations, along with the interpretations given below, cannot be viewed as causal in any meaningful sense. As the discussion above indicates, the return and risk measures may well be related to more fundamental determinants of the real rates, but they probably are in large part proxies for their effects.

As Table 3 shows, the equilibrium long-term real interest rate appears positively and significantly related to the debt ratio[21] in all cases except Japan.[22] The beta risk measure appears to contribute to the real rates of Japan, the United Kingdom, and the United States, although (at least in this particular relation) not to those of Germany or France. The return to capital exerts the most uniform influence across countries. In particular, a rise of 1 percentage point in the return to capital is associated with an increase in the equilibrium rate of roughly one-half of 1 percentage point for Germany, France, and the United States, and about three-quarters of 1 percentage point for the United Kingdom. These magnitudes are consistent with the view that bonds and real capital assets are close but imperfect substitutes. The effects of a change in the debt ratio vary more considerably among countries. A rise in the debt ratio of 1 percentage point is associated with increases of 20 and 30 basis points in the U.K. and French real rates, respectively, but with much smaller increases for Japan and Germany, and a negligible

[20] In general, the equations using total debt come closest to accepting the hypothesis that the residuals have a constant mean (in other words, that the real rate and other variables are "cointegrated")—a key criterion if the relations are to be used to estimate the real rate equilibrium. The augmented Dickey-Fuller (ADF) tests reported in the table support this hypothesis most strongly for Japan, France, and the United States, and at best marginally for Germany and the United Kingdom. The alternative equations using the government debt ratio give quite similar estimates of the equilibrium real rate, although what they imply about its determinants differs importantly in certain respects. In any case, data limitations and other factors seriously constrain the ability to choose among alternative variables, underscoring the need to interpret our results cautiously.

[21] The equilibrium relation was tested with total debt and with (net) government debt. Arguably, total debt is a preferable measure because it provides a more comprehensive notion of risk and captures more fully the pace of financial innovation and deregulation over time. Total debt as a share of GNP provides better results than does government debt for all countries but France. Financial markets in France remained regulated longer than those of other industrial economies, with reforms coming in much later. So, for France, the total debt ratio is not associated with an increasing real rate through much of the sample.

[22] The presence of private debt causes the return to capital to drop out of the equilibrium relation for Japan. When only public debt is used, the return to capital enters significantly with a positive sign.

Table 4

Contributions to Change in the Equilibrium Long-Term Interest Rate

In Percentage Points

	Japan	Germany	France	United Kingdom	United States
Return to capital	—	0.46	0.65	0.64	0.87
Beta	−0.73	—	—	−1.11	2.18
Ratio of debt to GNP	5.16	1.60	3.13	6.46	0.79
Total change in equilibrium real long-term interest rate	4.33	2.06	3.78	5.99	3.84
Actual change in real long-term interest rate	4.61	1.86	3.81	6.87	4.47
Unexplained change	0.28	−0.20	0.03	0.88	0.63

Notes: The entries in the first three lines of the table combine the coefficients of Table 3 with the differences in subsample means of the arguments between the first (1975-I to 1982-IV) and second (1983-I to 1990-IV) halves of the sample period. For example, the mean value of the real long-term interest rate in Japan for the second half was 4.61 percentage points higher than it was for the first half. The average "equilibrium" value of the real long rate increased 4.33 percentage points over the two periods; 5.16 percentage points of this change was attributable to the shift in the mean value of the total debt-to-GNP ratio. The relative riskiness of bonds in the Japanese portfolio declined over the two periods, thereby reducing the equilibrium value of the real long rate by 0.73 percentage points.

change for the United States.[23]

Of course, the overall influence of each factor on the evolution of long-term rates over the sample period depends on the amount by which the determinant varies as well as the size of its respective coefficient. Table 4 presents a simple accounting of the sources of shift in the equilibrium interest rate between the first and second halves of the sample period.

The pattern of relative contributions in the United States differs from that of the other countries. Here, the rise in the relative risk of bonds accounts for about half the increase in the real rate, the increase in the rate of return to capital and the rise in the debt ratio account nearly equally for the remainder of the explained shift in the equilibrium real rate. The shift in the debt ratio contributes less to the rise in the equilibrium long-term interest rate in the United States than it does in the other countries One reason could be that the greatest increase in the debt-to-GNP ratio occurred somewhat later than the steepest rise in the real interest rate. The increase in private and public debt contributes slightly more than three times as much to the rise in the German real long-term rate as does the rise in the return to capital. In France, the rise in the public debt ratio accounts for about three-quarters of the shift in the equilibrium rate over the two halves of the sample

To sum up, the equilibrium component of a Wicksellian model explains between 60 and 70 percent of the variation in real long-term interest rates in the major industrial economies over the period 1975-90. Charts 10 through 14 illustrate how well the equilibrium relation alone explains the major movements of the real long rate in each of the five countries over time. These results are consistent with the case made above for the factors influencing the equilibrium rate. But we caution against too strict a structural interpretation of the equilibrium equations. Debt and the other variables could be picking up the influence of a host of other factors related to real interest rates. All we can claim is that the variables are related in a way that helps to explain the equilibrium shift in the real rate.[24]

[23]The U S and U K debt data for the private nonfinancial sector are consolidated (U S data are from Board of Governors of the Federal Reserve System, *Money, Stock, Liquid Assets, and Debt Measures*, U K data are from Central Statistics Office, *Financial Statistics*, various issues, Table 14 1) By contrast, private debt data for Japan, Germany and France are summed from sector balance sheets and could contain double counting of cross-sectoral holdings (source of data is OECD, *Financial Statistics*, Part 2, Financial Accounts of OECD Countries, various issues, Table 33 B) Where identified, liabilities in the form of equity shares are subtracted Comparisons across countries regarding the influence of private debt would require further data refinement to ensure comparable coverage of the debt aggregate

[24]Because we cannot measure inflation expectations at all precisely, and because a significant portion of the surge in inflation during the mid-1970s was very likely unanticipated, our estimates probably overstate the true increase in equilibrium real rates from the 1970s to the 1980s This overstatement is probably greatest for Japan and the United Kingdom These two countries underwent the largest surge in inflation during the 1970s, and their equilibrium long-term real rates appear by our measure to have increased the most

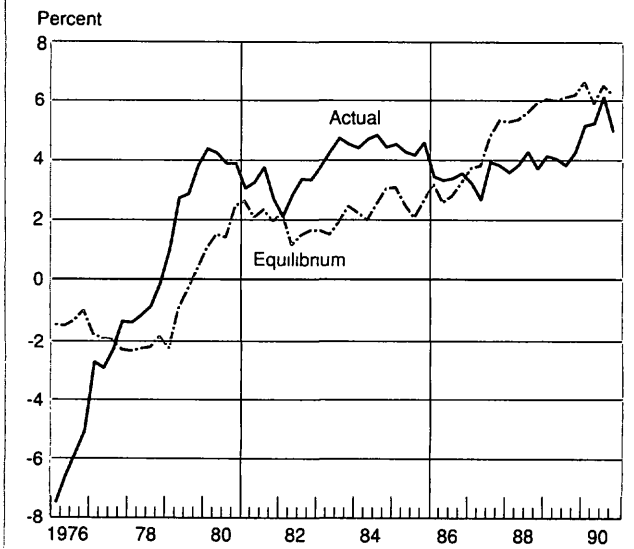
Some 30 to 40 percent of the variation in real long rates remains to be explained by other influences. Fiscal policy, apart from its link to the debt ratio, and monetary policy could drive short-term fluctuations in the real rate. The dynamic equations discussed below will allow monetary and fiscal policy to play a role in the adjustment of the real rate to shifts in the determinants of the equilibrium rate.

Estimates of the short-run fluctuations in real long rates

The second key relationship in the country model explains the fluctuations of the real long rate around its equilibrium value. The dynamic equation explains the change in the real long rate in terms of the difference between the previous period's actual rate and equilibrium rate, current and past changes in interest rates, and shifts in macroeconomic policy Fiscal policy changes are introduced in the form of current and past changes in government deficits or surpluses. Current and past changes in the real central bank intervention

Chart 10

Real Long-Term Interest Rate: Japan



Note The equilibrium path charts the solved values of equation A 1 of the appendix

rate represent shifts in monetary policy[25] The model imposes the condition that the real long rate, if unperturbed by macroeconomic policy changes or random shocks, will converge over time to the equilibrium relation estimated above.

Incorporating the information on monetary and fiscal policies improves the explanation of rate movements over history. Relative to the movements captured by the equilibrium relation, the dynamic model reproduces history with approximately 5 percent (United Kingdom) to 45 percent (France) less error.[26] However, the dynamic model's main application is to assess the relative contributions of the equilibrium long rate and changes in macroeconomic policies to movements in the actual real rate

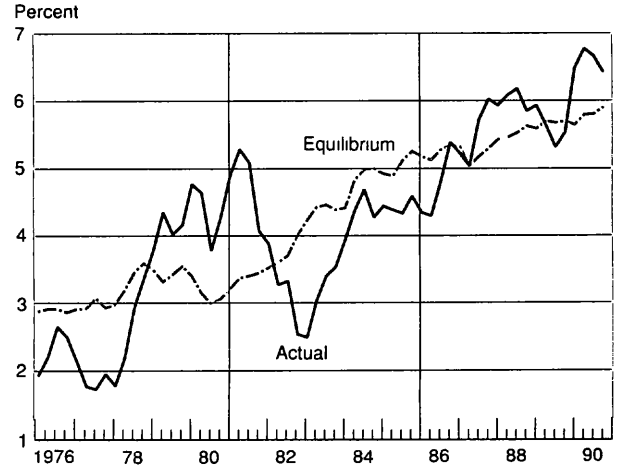
We apply this assessment to episodes of unusual movement in the real rate. For example, between 1978 and 1979 the Bank of Japan raised the intervention rate nearly 6 percentage points. The equilibrium real rate

[25]Tests on earlier versions of the dynamic model (using the ratio of government debt to GNP in the equilibrium relation) indicated that changes in the return to capital and changes in beta did not contribute to the explanatory power of the dynamic relations Although we did not repeat the tests for the models using total debt in the equilibrium equation, the earlier findings led us to exclude changes in these arguments from the dynamic equations

[26]The appendix table assesses the ability of the equilibrium relation and the dynamic model to track history across countries and measures the degree to which each country's dynamic model improves on the explanatory power of the equilibrium relation alone

Chart 11

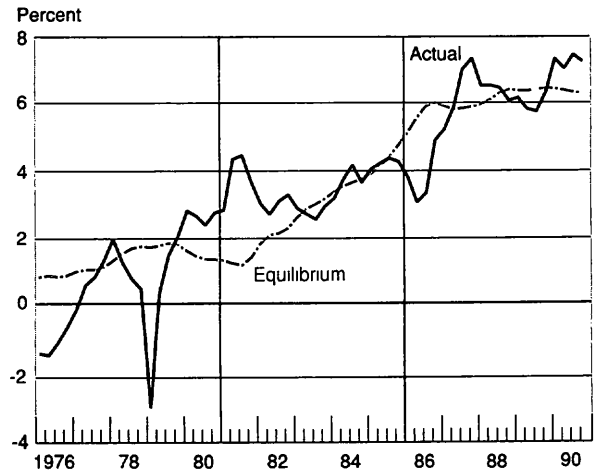
Real Long-Term Interest Rate: Germany



Note The equilibrium path charts the solved values of equation A 1 of the appendix

Chart 12

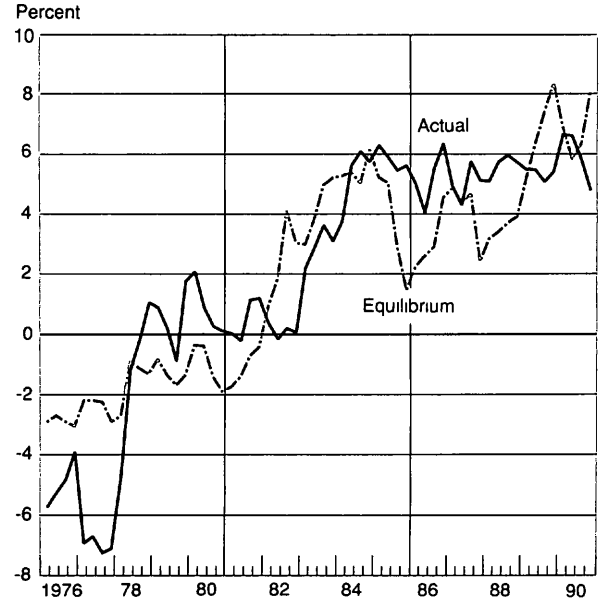
Real Long-Term Interest Rate: France



Note The equilibrium path charts the solved values of equation A 1 of the appendix

Chart 13

Real Long-Term Interest Rate: United Kingdom



Note The equilibrium path charts the solved values of equation A 1 of the appendix

also moved up in 1987 and 1979, but with a two-quarter lag and by 2 percentage points less than the real long rate (Chart 10) The dynamic equation, incorporating policy changes, explains almost the full run-up in the real rate, with at most a one-quarter lag How much of the difference between the actual rate and the equilibrium rate is attributable to monetary policy, how much to fiscal policy, and how much to the adjustment properties of the model?

Two additional sets of calculations, one assuming an alternative history of unchanged monetary policies and the other an alternative history of unchanged fiscal policies, shed light on such a decomposition [27] Table 5 attributes the changes in four countries' real long rate during selected intervals to shifts in the equilibrium relation, changes in monetary policy, and changes in fiscal policy [28]

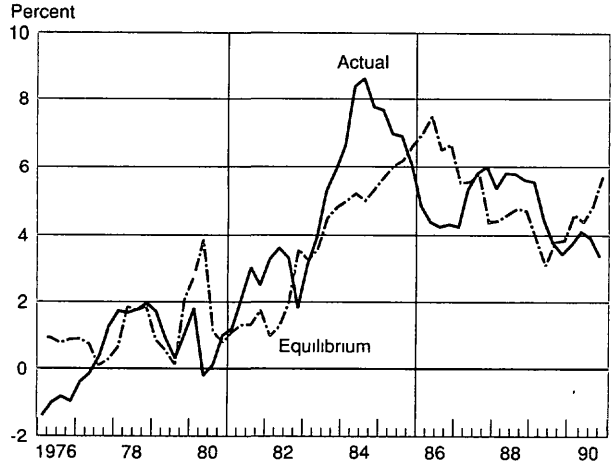
In Japan during 1978-80, the real long rate rose some 5¼ percentage points, and the equilibrium rate rose about 5 percentage points The decomposition of this change suggests that the rise in the central bank rate would have added about 2¾ percentage points to the real long rate, while the increase in the government deficit would have influenced the real rate by much less, an increase of ¼ percentage point This accounting indicates that with changes in the determinants of the equilibrium, a rise in the real central bank rate, and a

[27]Such alternative histories might not represent realistic policy choices, but they can help us to assess the importance of the changes in policy relative to other changes affecting the economic environment These model simulations are described further in the appendix

[28]The intervals are uniform for all countries except Germany, where the real long-term rate reached a trough at the end of 1982 Note that France is omitted from the table

Chart 14

Real Long-Term Interest Rate: United States



Note The equilibrium path charts the solved values of equation A 1 of the appendix

Table 5

Attribution of Real Long Rate Changes in Selected Episodes

In Percentage Points

Japan	1978-80	1981-84	1985-88	1989-90
Equilibrium	5	½	2¾	0
Monetary policy	2¾	−¾	−2¼	½
Fiscal policy	¼	0	¼	0
Total†	7¾	−¼	¾	¾
Actual change in real long-term rate	5¼	1½	−¾	¾
Memo				
Initial gap	1	¼	1½	−2
Germany	1978-80	1981-82‡	1983-88	1989-90
Equilibrium	0	¾	1½	¼
Monetary policy	¾	−1¼	1½	−½
Fiscal policy	¼	−¼	0	1
Total†	1	−¾	3	1
Actual change in real long-term rate	2½	−2¼	3¼	½
Memo				
Initial gap	−1¼	1¾	−1¾	½
United Kingdom	1978-80	1981-84	1985-88	1989-90
Equilibrium	¾	8	−1¼	3
Monetary policy	1½	1½	−1	−1½
Fiscal policy	¼	¼	−2¼	1¼
Total†	2¾	9½	−4½	2¾
Actual change in real long-term rate	4¾	5¾	−½	−¾
Memo				
Initial gap	−2	1¾	1	¼
United States	1978-80	1981-84	1985-88	1989-90
Equilibrium	¼	4¼	−1	1¾
Monetary policy	−1½	1¾	−½	−2
Fiscal policy	1¼	−1	0	¾
Total†	0	5	−1½	½
Actual change in real long-term rate	−¾	6½	−2	−2¼
Memo				
Initial gap	1	0	2	1¾

†Columns may not sum to totals because of rounding
‡Intervals are uniform for all countries except Germany, where the real long-term rate reached a trough at the end of 1982

widening government deficit in these years, the real long rate in Japan would have risen some 7¾ percentage points. Thus it appears that unexplained factors along with the adjustment process itself held the rise to 5¼ points

During 1978-80, monetary policies in all five countries tightened (Chart 5) and real long rates rose by 2½ to 5 percentage points in all countries except the United States In Japan, Germany, and the United Kingdom monetary policy had a positive influence on the real rate, but in the United States it did not The reason for this anomaly might be that during 1980, the *real* central bank intervention rate (the argument of the dynamic equations) in the United States declined sharply.[29] The attributions suggest that during this episode, fiscal policy generated upward pressure on rates of about ¼ to 1¼ percentage points in all countries

The 1981-84 period, if judged by movements in the nominal central bank intervention rates, appears to be a period of monetary easing. But on net, the real central bank rates declined between the beginning and end of the period only for Germany and the United States In Germany (between 1981 and 1982) and Japan, monetary policy negatively influenced the real long rate But the United Kingdom, perhaps owing to the rise in the real central bank rate, experienced tighter monetary policy than the movement in the nominal central bank rate would suggest Germany showed a negative contribution from fiscal policy, consistent with a declining deficit ratio over this interval.

In all countries but the United Kingdom, nominal central bank rates continued to decline between 1985 and 1988 (1983 to 1988 for Germany) In Japan, the real central bank rate also tended to decline, here the effect of monetary policy on the real long rate was negative In Germany, however, the real central bank rate increased despite the decline in the nominal rate; our calculations attribute 1½ percentage points of the rise in the real long rate over the period to monetary policy. The final episode, 1988-90, might also be characterized as a period of tight monetary policies because all four countries experienced increases in their nominal central bank rate (although the rate hikes were comparatively mild in the United States). In addition, real central bank rates rose and fell, but ended higher in the episode. Nevertheless, only in Japan did monetary policy appear to raise the real long rate

Of the three forces—equilibrium shifts, monetary policy, and fiscal policy—equilibrium shifts tended to predominate in explaining real long rates over the three- to five-year intervals. In slightly under half the episodes reported in Table 5 (seven of sixteen), the changes in the real long rate attributable to shifts in the equilibrium rate were as large or larger than the changes attributable to either monetary or fiscal policy Germany poses an interesting exception. here, the equilibrium shifts were no larger than the influences of monetary or fiscal policy in any of the four intervals Recall that in Germany, the real long rate (and therefore the equilibrium rate) varied over a narrower range than in the other countries Equilibrium shifts showed a strong upward drift over the four intervals; in twelve of the sixteen episodes, the equilibrium factor influenced real rates positively By contrast, the influences of monetary and fiscal policy did not show clear upward tendencies. In only six of the sixteen episodes were the contributions of monetary policy to the change in the real long rate positive; in nine episodes, fiscal policy contributions were positive. In all but two cases, the magnitude of fiscal policy influences on the real long rate was smaller than that of monetary policy influences

Conclusions

We have attempted to identify the broad macroeconomic forces shaping the evolution of long-term interest rates in several major industrial countries. Our basic contention is that the movements in these rates reflect persistent and sizable changes in what we have called their "equilibria," as well as fluctuations around those equilibria. More specifically, we argue that the dominant portion of the overall rise in the real long-term rates of the United States and major foreign economies over the last fifteen years is attributable to increases in the rates' equilibrium levels This large shift in the equilibrium also accounts for the apparent similarity of the broad movements in the countries' real rates over the period as a whole Macroeconomic policy as it normally influences rates over the business cycle cannot fully explain the increases in real long-term rates.

Our analysis yields more tentative evidence that the shifts in long-run equilibrium real rates reflect changes in the returns to capital and perceptions of the risks to these returns. In particular, the general rise in the return to capital during the 1980s seems to have been a significant, although not the principal, contributor to the rise in equilibrium real long-term rates of the countries studied Most strongly associated with the rise in equi-

[29]The dynamic model seems to work less well for the United States than for the other countries For some intervals, the results presented in Table 5—suggesting, for example, that fiscal policy had a net negative effect on the real rate over the early 1980s and monetary policy a net negative impact on the rate in the 1985-88 interval—are counterintuitive There are two possible explanations for these anomalies 1) as Chart 15 in the appendix demonstrates, the directions of fiscal and monetary policy effects in the United States are initially correct but short-lived and lead to reversals over subsequent quarters, and 2) these intervals might not be the best for analyzing U S policy shifts because the real central bank rate and the deficit-to-GNP ratio fluctuate inordinately within the interval

librium real rates in the four foreign countries are increasing debt ratios, which appear to reflect higher aggregate financial risk Somewhat surprisingly, the debt ratio seems only weakly associated with the increase in U S real long-term rates.

Finally, our evidence suggests that at certain times, macroeconomic policies did significantly influence the movements in long-term real interest For example, monetary policies and changes in budget deficits were important factors behind the movements in real interest rates in the early 1980s. Nonetheless, it appears that the broader upward movement in the real rate equilibria over the last fifteen years has dominated the business cycle fluctuations induced by the policies. Overall, our analysis suggests that the high levels of real long-term interest rates experienced during the 1980s cannot be explained adequately without taking into account changes in both macroeconomic policies and other economic fundamentals such as rates of return to capital and financial sector risks

Appendix: An Empirical Model of Real Long-Term Interest Rates

This appendix describes the major features of the model used to analyze movements in real long-term interest rates. The model combines the equilibrium long-term rate with two dynamic equations to describe the adjustment paths of the real interest rates toward their equilibria. The model was estimated for each country on quarterly data beginning in 1975.

The equilibrium long-term rate, RL, is related to the return to capital, RK; risk, β; and the total debt-to-GNP ratio, DB In the case of France, however, the ratio of government debt to GNP replaces the total debt-to-GNP ratio [†]

$$(A.1)\quad RL = a_0 + a_1 RK + a_2 \beta + a_3 DB + e_{RL}$$

The dynamic model is based on the well-accepted proposition that long-term interest rates in part reflect movements in short-term rates For each country, changes in short- and long-term real interest rates are jointly-explained in terms of deviations from the real rate equilibrium, changes in monetary policy and in government budget deficits, and the rates' own past changes. The equations have the following form:[‡]

$$(A.2)\quad \Delta RL(t) = b_1 \hat{e}_{RL}(t\text{-}1) + b_2 \hat{e}_{SP}(t\text{-}1) + \sum_{i=1,2,4} b_{3i} \Delta RL(t\text{-}i) + \sum_{i=0,1,2,4} b_{4i} \Delta RS(t\text{-}i) + \sum_{i=0,1,2,4} b_{5i} \Delta DF(t\text{-}i) + \sum_{i=0,1,2,4} b_{6i} \Delta CB(t\text{-}i) + e_{\Delta RL},$$

and

$$(A.3)\quad \Delta RS(t) = c_1 \hat{e}_{RL}(t\text{-}1) + c_2 \hat{e}_{SP}(t\text{-}1) + \sum_{i=1,2,4} c_{3i} \Delta RL(t\text{-}i) + \sum_{i=1,2,4} c_{4i} \Delta RS(t\text{-}i) + \sum_{i=0,1,2,4} c_{5i} \Delta DF(t\text{-}i) + \sum_{i=0,1,2,4} c_{6i} \Delta CB(t\text{-}i) + e_{\Delta RS},$$

where RL and RS are the long-term and short-term real rates, respectively, $\hat{e}_{RL}$ is the residual from the long-term equilibrium equation A.1, $\hat{e}_{SP}$ is the long-short spread less its mean, DF is the ratio of the government deficit to GNP, and CB is the real central bank intervention rate (nominal rate less the past three years' inflation)

The model incorporates the equilibrium real rate relation The equations imply that the actual long (and short) real rates will converge to the equilibrium in the absence of further disturbances, likewise, a constant equilibrium for the spread between long and short rates is imposed [§] We use the real central bank intervention rate to measure the stance of monetary policy, since movements in the nominal rate relative to underlying inflation are the primary influence on the real economy. [‖]

[†]Our estimation procedure initially used the return to capital, beta, and one of two debt-to-GNP ratios as the explanatory variables of the real rate in each country Those arguments with a positive sign were retained, even if only marginally significant In general, the equations using total debt fit better and came closer to a cointegrating relationship than did those using the ratio of net government debt to GNP In the case of Japan, the fit with total debt is poorer than with government debt, but the augmented Dickey-Fuller statistic is larger The final estimation results are summarized in text Table 3

[‡]Note that contemporaneous causation is assumed to run from the short-term interest rate and the policy variables to the long rate (For this reason, current values of these variables are included in equation A 2 but not in equation A 3) In the case of Germany, however, lagged values of the change in the central bank rate are statistically insignificant and therefore omitted

[§]Recall that the evidence in text Table 2 generally supports the proposition that the spread is stationary The United Kingdom is, however, an exception. In the model estimation for this country, we allow the equilibrium spread to follow an estimated time trend

[‖]In effect, the model (that is, its "reduced form") ultimately attributes movements in long-term real rates to a) past

Appendix: An Empirical Model of Real Long-Term Interest Rates *(continued)*

Summary Statistics for Interest Rate Models

	Japan	Germany	France††	United Kingdom	United States
Root mean squared error (percentage points)					
Equilibrium relation	2.06	0.87	1.31	2.20	1.55
Dynamic model	0.55	0.52	0.76	1.65	0.97
Goodness of fit of dynamic equations ($\bar{R}^2$)					
Real long rate	0.56	0.61	0.32	0.59	0.70
Real short rate	0.88	0.43	0.89	0.57	0.88

††The model for France uses net government debt as a share of GNP.

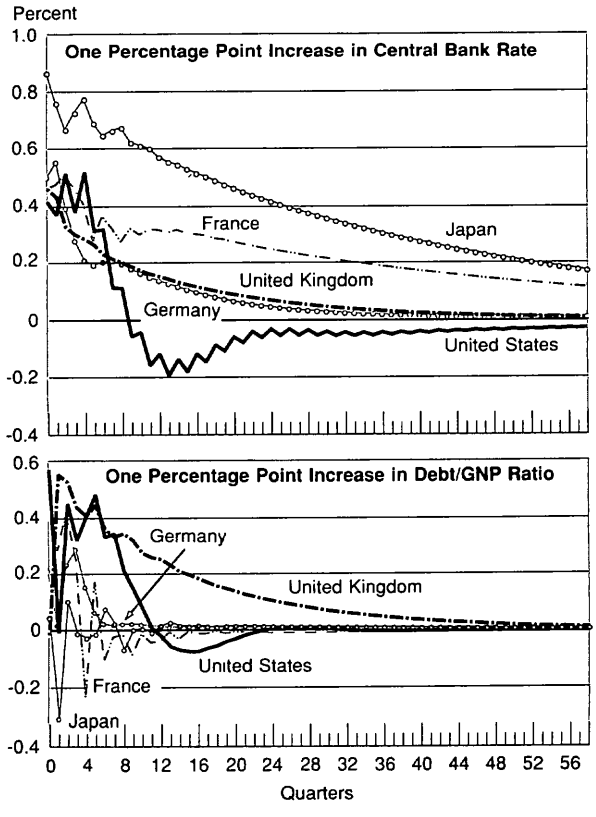
The table above compares the abilities of the equilibrium relationship alone and the dynamic model to explain the actual path of the real long-term rate in the five countries. Statistics on goodness of fit for the dynamic equations are also provided.

We introduce hypothetical changes in macroeconomic policy to illustrate how the initial interest rate responses and the rate changes over time differ for monetary and fiscal policy. The initial responses to a 1 percentage point sustained increase in the central bank rate range from 80 basis points in Japan to 40 to 50 basis points in the other countries (Chart 15, upper panel). Since monetary policy has no permanent effect in the model, the rises in the real long-term rate decay at various rates, although the effects do persist for some time, particularly in Japan and France.

A onetime increase of 1 percentage point in the ratio of the government deficit to GNP generates shorter lived interest rate responses than does a monetary policy shock.‡‡ The deficit surge in the United States, United

Chart 15

Real Long-Term Rate Responses to Shocks



Footnote ‖ continued
changes in the equilibrium real rate; b) past changes in the macroeconomic policy variables; and c) "unexplained" disturbances, in particular to short-term rates, as well as factors such as oil shocks. The impact of macroeconomic policies includes not only direct effects, but also indirect effects on interest rates by way of real income and other variables.

‡‡This experiment is somewhat artificial in assuming that the equilibrium remains unaffected. Since the debt-to-GNP ratio is a component of the total debt ratio (an argument of the equilibrium real rate), a shock to the change in the deficit would have a permanent effect on the long rate. However, because the purpose of this shock is to illustrate the real income effects over the business cycle, the link to the debt ratio is not completed and consequently the equilibrium does not shift. And since the presence of debt in the equilibrium relation acts as a proxy, the link to debt need not be implemented literally. This shock could also be interpreted as

Appendix: An Empirical Model of Real Long-Term Interest Rates *(continued)*

Kingdom, and France increases the real long rate by some 40 to 60 basis points in the first year (Chart 15, lower panel) The deficit shock causes the real long rate to oscillate,[§§] but the adjustment is heavily damped in most countries, with the possible exception of Japan and France The most durable effect occurs in the United Kingdom, where a 20 basis point increase in the real long rate persists as long as four years after the shock

Finally, to identify the contributions of policy changes to movements in the real long rates (text Table 5), the models are simulated assuming unchanged monetary and fiscal policies For example, real long-term rates have trended upward over the past fifteen years and real central bank rates are now higher than they were in the high-inflation environment of the mid-1970s. How would real long rates have moved had the real central bank rates not risen? Comparison of these results with the actual paths over history provides a measure of the contribution of tightened monetary policies to changes in real rates Analogously, the contributions of fiscal policies to the actual movements in real rates are derived from the real rates that would have prevailed had government deficits remained unchanged.[‖‖]

Footnote ‡‡ continued
an assumption that a decrease in private debt offsets the effects of increased public debt on the equilibrium

§§This response stems from sign shifts on the lagged deficit terms in the dynamic equations.

‖‖Again, the effects of alternative fiscal policies on debt are ignored