Real Interest Rates, Saving and Investment

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Abstract

This paper investigates the determinants of real interest rates at world and country level. The starting point is the idea that real interest rates reflect the interaction of desired saving and planned investment, using the framework developed by Barro and Sala-i-Martin (1990) and Barro (1992). The paper updates previous results and extends the analysis to study long real interest rates. We analyse which factors have been responsible for real rate `regime shifts' during 1959 to 1992. We examine the determinants of interest rate differentials across ten major industrialised countries and provide estimates of the extent of capital market integration.

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1. Introduction

The level of real interest rates has once again become the focus of policymakers' concern. Movements in interest rates since early 1994 led to worries that real rates had returned to | or even exceeded | high levels previously experienced during the 1980s. These anxieties prompted a study by the Deputies of the G10 ¯nance ministers and central bank governors (G10 Deputies, 1995). This paper was prepared as background to the G10 Deputies' report.[1]

This paper attempts to identify the economic forces that have driven movements in real interest rates. The theoretical framework is based on the successful model developed by Barro and Sala-i-Martin (1990) and Barro (1992). This paper extends the model to investigate structural determinants of cross-country di®erentials in real interest rates. The paper also updates previous studies to cover the period 1959{92. The use of data for these 33 years permits the identi¯cation of factors that have been, and probably will be, consistently important in determining the level of real interest rates. The analysis is also extended to include long as well as short real rates, in line with the generally held view that the saving and investment decisions of ¯rms and households are more likely to relate to long than to short rates.

Part of this paper investigates the determination of world interest rates. As in previous work, the `world' is regarded as a group of ten major OECD economies, comprising Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, the United Kingdom and the United States. This group is thought of as forming a closed economy with, e®ectively, no capital °ows into or out of the system. The `world' interest rate can be thought of as a `common trend' (or underlying) measure that re°ects `global' factors which determine the average level of interest rates across the `world'.[2]

This paper's closest predecessors are the studies by Barro and Sala-i-Martin (1990)

[1] The G10 Deputies' (1995) report and Bank of England contributions to it are discussed in Jenkinson (1996).

[2] Henceforth, `world' will be written without inverted commas, but it should be understood to refer to the ten-country group.

and Barro (1992). The main focus of Barro and Sala-i-Martin (1990) was an analysis of factors a®ecting world real rates. Over 1959 to 1988, Barro and Sala-i-Martin found that high real rates tended to re°ect both positive shocks to investment demand (such as improvements in the expected pro¯tability of investment) and negative shocks to desired saving (such as temporary reductions in world income). During the 1980s, Barro and Sala-i-Martin argued, real interest rates had been raised by factors operating through the investment side: favourable stock returns (which stimulated investment and raised real rates) and high oil prices (which depressed investment but, it was argued, raised real rates).

Barro (1992) further developed the work by obtaining estimates of structural coef¯cients relating to own-country saving and investment for the period 1959 to 1989{90. In this structural framework, Barro investigated whether country-level real rates have been a®ected by country-level versions of the variables the basic model predicts will a®ect real interest rates in a closed economy (although the analysis was limited to adding one country-speci¯c variable at a time). Barro concluded that the common component of real interest rates was linked especially to developments on world stock and oil markets and secondarily, to world monetary and ¯scal policies. But country-speci¯c components of interest rates were not found to depend on own-country stock market returns or monetary or ¯scal policies.

We con¯rm that the level of world interest rates has been a®ected by factors working through both investment and saving. Higher expected pro¯tability of investment (as captured in stock market price rises) tends to raise real interest rates. Income shocks that temporarily reduce saving | such as oil price shocks | have also been responsible for raising real rates.

A higher global level of public debt is found to have a major in°uence in raising the level of world interest rates, but other aspects of ¯scal stance are not found to be in°uential. Results suggest a possible role for monetary shocks, which are negatively related to real interest rates. There are some indications that the e®ects of monetary shocks might be persistent.

The level of real interest rates has undergone two major `regime shifts' over the last 30 years, declining from moderate to low levels in the early 1970s and rising to high levels at the end of that decade. We ¯nd that variations in world debt{GDP ratios have played by far the largest role in driving these broad movements.

Within our theoretical framework, the relative impact of country and world factors on country real rates can be used to measure the extent of capital market imperfection. According to one measure of long real rates, capital markets have been fully integrated across the ten countries studied. But we identify varying degrees of imperfection across countries using other measures of real rates.

In general, we ¯nd that own-country variables have played a relatively minor part in determining interest rate movements, although results concerning cross-country di®erentials are sensitive to which measure of real rates is used. Even though global government consumption has no e®ect on the level of world real rates, a higher level of public spending in any individual country is associated with higher country short real rates (but there is little e®ect on long rates). Temporary income shocks at country level, proxied by the proportion of income spent on oil, have e®ects on long real rates over and above their e®ect at global level. There are also some indications that idiosyncratic monetary shocks have persistent e®ects driving long real interest rate di®erentials.

The structure of the paper is as follows. Section 2 sets out the theoretical framework, which is based on a closed economy. Section 3 describes the data used, outlining the construction of short and long real interest rate series. Estimation techniques are also outlined in Section 3. Section 4 investigates which factors a®ect the global level of real interest rates. An assessment is made as to what has been responsible for long-run movements in real rates: we calculate which factors were behind the reduction in real rates during the mid-to-late 1970s and their increase to high levels during the 1980s and 1990s. Section 5 extends the model to focus on the determination of country-level real rates. Section 6 concludes.

2. Theoretical framework

A relatively simple supply{demand framework is used to model real interest rates, following Barro and Sala-i-Martin (1990) and Barro (1992). The real interest rate is the price at which the supply of and demand for capital are equated. Capital is supplied via saving, and is demanded for investment. Combining structural saving and investment equations gives rise to a reduced form equation in which real interest rates are determined by factors affecting saving and investment. The empirical work of the paper estimates both reduced form and structural equations. Structural estimates are obtained from the joint estimation of real interest rate and investment equations with the imposition of cross-equation restrictions arising from the structural model.

The rest of this section explains the modelling of the saving and investment ratios and the derivation of the expression for world real interest rates. The theoretical framework is set out at country level; it is at this level that the theoretical model of investment holds. An estimable equation for the world real rate of interest is derived through aggregation of investment and saving equations across countries. Under the assumption that capital markets are perfect, factors affecting the global rate of interest will simply be an average of individual country variables, the weights given to each country's variables reflecting that country's proportion of (the ten-country) world economy.

(i) Saving ratio

The proportion of national income saved in each country i at time t, $(S/Y)_{it}$ is affected by the expected level of world real interest rates r^e_t. The national saving rate is also affected by shocks that result in temporary changes in income: a temporary increase in income will do little to raise consumption, and will therefore raise the saving ratio.[3] Temporary changes in income are proxied by changes in the proportion of income that is spent on oil, $OILCY_{it-1}$.[4] A rise in this proportion represents a temporary fall in income.

We allow for the possibility that monetary growth will influence the national saving rate. In some models, unanticipated monetary growth generates temporarily high income, with a consequent positive impact on the saving rate and negative effect on

[3] Permanent changes in income are assumed to have no effect on the desired saving rate.

[4] This follows Barro (1992). Barro and Sala-i-Martin (1990) used the relative price of oil instead. The interpretation of $OILCY_{t-1}$ as capturing temporary changes in income is supported by its time series properties: an ARMA(1,1) regression of $OILCY_t$ over 1959–71 reveals AR(1) and MA(1) coefficients of 0.377 and -0.279 respectively, revealing some persistence but lack of permanence in the proportion of income spent on oil.

the real interest rate. Keynesian sticky-price models predict that interest rates should decline with an expansionary monetary shock, as nominal interest rates fall faster than prices. In the empirical work, two lags of monetary growth are included (ΔM_{it-1} and ΔM_{it-2}).

Saving might also be affected by government spending and fiscal policy. Government spending consists of purchases of goods and services and transfer payments. Blanchard (1985) showed that both the level and expected changes of government spending might affect aggregate demand. The effect of a change in government purchases depends whether the change is expected to be temporary or permanent. A temporary increase in government spending will tend to lower national saving. In contrast, a permanent rise in government spending will tend to `crowd out' private spending, having little or no overall effect on national saving rates. The empirical work focuses on government non–investment expenditures including military spending, GCY_{it-1}, which will capture temporary expenditures by government, and should therefore be positively related to real interest rates.

As further measures of fiscal stance, the ratios of the stock of government debt and the government deficit to GDP are included — respectively $DBTY_{t-1}$ and $DEFY_{t-1}$ (both debt and deficit are entered as positive numbers). Together with government spending, these make up Blanchard's (1985) `index of fiscal policy'.[5] Debt policy matters if Ricardian equivalence does not hold or if governments do not use lump-sum taxes. Higher government debt or prospective budget deficits may reduce national saving rates if agents are not infinitely-lived or do not make bequests to future generations, as agents will then not reduce consumption to fully compensate for the higher future tax burden. Blanchard (1985) formalises the idea that what matters is the extent to which (an increase in) debt is not counterbalanced by a (higher) expected stream of future surpluses. The initial debt level is captured by $DBTY_{t-1}$ and future debt by $DEFY_{t-1}$. Blanchard's theory predicts that it is the anticipated effect of budget deficits on the level of public debt in the long run that matters, rather than actual budget deficits. We use as our deficit measure the cyclically-adjusted change

[5] No multicollinearity problem arises from including all three fiscal variables, as their correlations are quite low (correlation statistics: GCY-DBTY: -0.023; GCY-DEFY: -0.232; DBTY-DEFY: 0.250).

Regressor	Dependent variable (S/Y)	(I/Y)	r^e
$(S/Y)_{-1}$	+	none	−
$OILCY_{-1}$	−	none	+
ΔM_{-1}, ΔM_{-2}	+	none	−
GCY_{-1}	−	none	+
$DBTY_{-1}$	−	none	+
$DEFY_{-1}$	−	none	+
r^e	+	none	N/A
$(I/Y)_{-1}$	none	+	+
ΔSTK_{-1}	none	+	+
$\Delta OILCY_{-1}$	none	−	−

Table 1: Predicted Effects

Mnemonics are defined in Table A1 in the Appendix. Predicted effects apply to world and country variables.

in real debt: the 'structural', trend, component of deficits is more likely to relate to expectations.

The saving rate for country i at time t is given by the following equation:

$$\begin{aligned}(S/Y)_{it} = \alpha_{0i} + \alpha_1 r^e_t + \alpha_2 OILCY_{it-1} + \alpha_3 \Delta M_{it-1} + \alpha_4 \Delta M_{it-2} \\ +\alpha_5 GCY_{it-1} + \alpha_6 DBTY_{it-1} + \alpha_7 DEFY_{it-1} + \alpha_8 (S/Y)_{it-1} + \varepsilon_{it}\end{aligned} \tag{2.1}$$

The predicted signs of the coefficients are set out in Table 1.

(ii) Investment ratio

The ratio of investment to GDP in country i at time t, $(I/Y)_{it}$, is largely determined by a Tobin's q-type variable:

$$(I/Y)_{it} = \beta_{0i} + \beta_1 \ln q_{it-1} + u_{it}; \tag{2.2}$$

where q_{it-1} is the market valuation per unit of capital at the start of period t, and $\beta_1 > 0$. Investment is also affected by unspecified country-level factors β_{0i}. q_{it} is a measure of the expected profitability of the marginal unit of capital in country i, relative to the real interest rate on risk-free assets (such as Treasury Bills), and a risk premium that is assumed to be country-specific. In this formulation, the real interest rate does not a®ect investment directly, but acts indirectly through its in°u-ence on the market valuation of capital.[6] A reasonable proxy for the growth rate of q_i over the period t ¡ 1 can be found in the real stock market return for the previous year, calculated as the December-to-December change in stock market prices, denoted ¢$STK_{it ¡ 1}$.[7] Correspondingly, the investment equation is speci¯ed in ¯rst-di®erence form. Favourable changes in stock returns will re°ect increased expected pro¯tability, which will stimulate faster investment growth.

It is the ratio of expected pro¯tability to expected real interest rates and risk that relates to the marginal investment which matters for investment. Stock returns will not capture the distinction between marginal and average q_i. One of the main in°uences on the di®erence between marginal and average q_i will be the severity of shocks to income. The more severe the income shock, the faster the expected pro¯tability of new investment (as well as its riskiness) will adjust. It was argued above that the ratio of oil consumption to GDP can capture unexpected, temporary changes in income; the faster this ratio changes, the more severe the income shock. ¢$OILCY_{it ¡ 1}$ can therefore be used to capture di®erences between marginal and average $q_{it ¡ 1}$, as in Barro (1992). ¢$OILCY_{it ¡ 1}$ could also represent changes in the cost of production, which will a®ect investment. The e®ect of ¢$OILCY_{it ¡ 1}$ on changes in the investment ratio is predicted to be negative.[8]

This gives an expression for the rate of change in the investment{GDP ratio:

$$(I=Y)_{it} = ¯_{0i} + ¯_1 ¢STK_{it ¡ 1} + ¯_2 ¢OILCY_{it ¡ 1} + (I=Y)_{it ¡ 1} + u_{it} \qquad (2.3)$$

where coe±cients take the signs set out in Table 1 and u_{it} is white noise.

[6] This is supported empirically by the insigni¯cance of real interest rate measures when included in the investment ratio equations. For example, when added to the investment system reported in column [1] of Table 3 (page 16), the current world real interest rate has coe±cient -0.053 (s.e. 0.041).

[7] The omission of dividends in our measure of stock market returns seems justi¯ed since they are relatively constant over time. Barro and Sala-i-Martin (1990) tested broader measures of stock return for three countries (Canada, the UK and the US), with negligible changes in results.

[8] The inclusion of ¢$OILCY_{t ¡ 1}$ in the investment equation and $OILCY_{t ¡ 1}$ in the saving equation gives rise to the overidentifying restriction that $OILCY_{t ¡ 2}$ does not a®ect saving. This restriction is accepted by the data (the $Â^2_1$ Wald test statistic relating to the two-equation system reported in columns [3] and [4] of Table 3 is 0.57, p-value 0.45).

(iii) Equilibrium world interest rates

Desired world saving and planned world investment are given by summing, respectively, equation (2.1) and equation (2.3) across countries. In equilibrium, desired world saving and planned world investment will be equal:

$$(S/Y)_t = (I/Y)_t \tag{2.4}$$

In other words, the sums across countries of expressions (2.1) and (2.3) can be equated:

$$\begin{aligned} &\alpha_0 + \alpha_1 r^e_t + \alpha_2 OILCY_{t-1} + \alpha_3 \Delta M_{t-1} + \alpha_4 \Delta M_{t-2} \\ &+\alpha_5 GCY_{t-1} + \alpha_6 DBTY_{t-1} + \alpha_7 DEFY_{t-1} + \alpha_8 (S/Y)_{t-1} + \varepsilon_t \\ &= \beta_0 + \beta_1 \Delta STK_{t-1} + \beta_2 \Delta OILCY_{t-1} + (I/Y)_{t-1} + u_t \end{aligned} \tag{2.5}$$

Substituting the lagged investment ratio $(I/Y)_{t-1}$ for the lagged saving ratio $(S/Y)_{t-1}$ and rearranging to get an expression for real interest rates:

$$\begin{aligned} r^e_t = \eta_0 + (1/\alpha_1)\big[&\beta_1 \Delta STK_{t-1} + \beta_2 \Delta OILCY_{t-1} - \alpha_2 OILCY_{t-1} \\ &- \alpha_3 \Delta M_{t-1} - \alpha_4 \Delta M_{t-2} - \alpha_5 GCY_{t-1} \\ &- \alpha_6 DBTY_{t-1} - \alpha_7 DEFY_{t-1} + (1 - \alpha_8)(I/Y)_{t-1}\big] + \nu_t \end{aligned} \tag{2.6}$$

where $\eta_0 = (\beta_0 - \alpha_0)/\alpha_1$ and $\nu_t = (u_t - \varepsilon_t)/\alpha_1$. Higher investment will raise interest rates, whereas increased saving will lower them. α coefficients take the signs predicted for the saving ratio in Table 1 (their effect on real interest rates is the reverse, as they enter negatively in equation (2.6)), whereas β coefficients relate to the investment rate.

Factors that increase investment (higher stock returns ΔSTK_{t-1}) will raise interest rates. Factors that discourage investment (faster increases in the proportion of income spent on oil, captured by $\Delta OILCY_{t-1}$) will reduce interest rates. Rates will increase with variables that have a negative effect on saving (temporary reductions in income, proxied by $OILCY_{t-1}$). Positive influences on saving (temporary increases in income, proxied by higher monetary growth ΔM_{t-1} and ΔM_{t-2}) will lead to lower interest rates, whereas higher government current expenditure GCY_{t-1} will have the opposite effect. The effect of looser fiscal policy, represented by increases in $DBTY_{t-1}$ and $DEFY_{t-1}$, will be to reduce national saving, so their effect on real interest rates should be positive. Note that higher investment will raise interest rates (i.e. the overall coe±cient on $(I=Y)_{t¡1}$ in equation (2.6) will be positive) if persistence in saving is lower than persistence in investment (which requires $®_8 < 1$).

The coe±cient on lagged investment/saving is unidenti¯ed in an unrestricted real interest rate equation | it captures the e®ects of lagged on current investment and lagged on current saving. Simultaneous estimation of interest rate and investment equations allows us to identify the `structural' coe±cients set out in (2.6) relating to saving and investment ratios. This identi¯cation is accomplished by imposing restrictions | requiring that variables which at world level a®ect the world real interest rate and at country level a®ect each country's investment{GDP ratio have the same coe±cients in each of these equations.[9] This accords with our theoretical framework, whereby such variables a®ect real interest rates via their e®ect on desired investment. The unrestricted coe±cients in the real interest rate equation then relate to the structural saving ratio equation.

3. Data and econometrics

Our empirical work employs three di®erent interest rate variables | one short rate and two measures of the expected real long rate. The use of more than one measure enables us to monitor the robustness of results. Expected real short-term interest rates are measured as the short nominal interest rate that is most closely analogous to the three month Treasury Bill rate, less expected in°ation.[10] Short-run in°ation expectations are modelled as a forecast of consumer price in°ation. For greatest possible accuracy, in°ation is forecast using all available data up to the forecast period. An ARMA(1,1) formulation with deterministic seasonals is used. The three-month nominal short interest rate for January is de°ated by the annualised expected increase in the consumer price index from January to April, and so on.

The long nominal interest rate is taken to be the representative rate on long-term

[9] In estimation of the country{level investment equations, variables are restricted to have the same e®ect in each country. The investment equation is estimated at country level as it is at this level that q theory holds. This is because stock markets re°ect the valuation of the assets of those companies that are traded on them, and these are largely domestic.

[10] Detailed information about data sources can be found in Table A1 in the Appendix.

Country	Weight
Belgium	1.2
Canada	4.4
France	7.2
Germany	8.4
Italy	7.1
Japan	15.8
Netherlands	1.8
Sweden	1.2
UK	7.0
US	46.1

Table 2: Country Weights in World Averages, 1988

Weights are calculated from the Penn World Table database (Summers and Heston, 1991) and use PPP GDP (RGDPCH*POP).

government bonds, as de¯ned by IMF International Financial Statistics. Table A2 in the Appendix sets out the maturity of these long rates, which varies from `more than three' years in Germany to 20 years in the UK. The di±culty of obtaining sensible measures of in°ation expectations over the long term is notorious | indeed, it is a major motivation behind the common use of short expected real interest rates in empirical studies. The VAR forecast method used here to construct short-term in°ation forecasts is problematic over the longer term. Survey measures of in°ation expectations are available only for some countries and over certain periods, as are in°ation expectations implied by index-linked bond yield curves. We use two measures of in°ation over longer maturities. The ¯rst is a two-year moving average of actual in°ation centred at the current period. The second measure of long-run in°ation expectations extracts trend in°ation using the Hodrick-Prescott ¯lter. Both representations of expected in°ation seem reasonable compromises between the desire to model in°ation expectations and the limited means of doing so. They are plotted in Figure 3.1 together with short and long, nominal and expected real interest rates.

Interest rate data are available for most countries from 1959, but there are four exceptions. Data on short interest rates for Italy are available only from 1960 and data on long rates are available for Sweden only from 1960, the Netherlands from

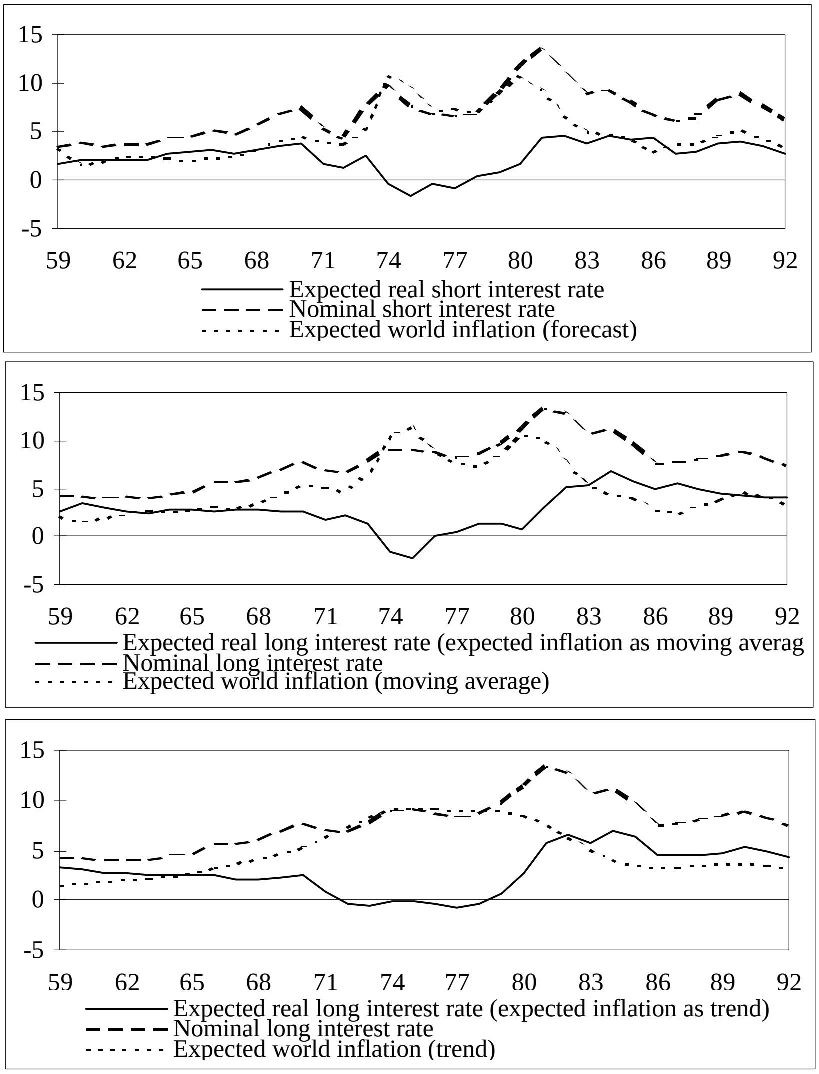

Figure 3.1: World Interest Rates and Expected In°ation

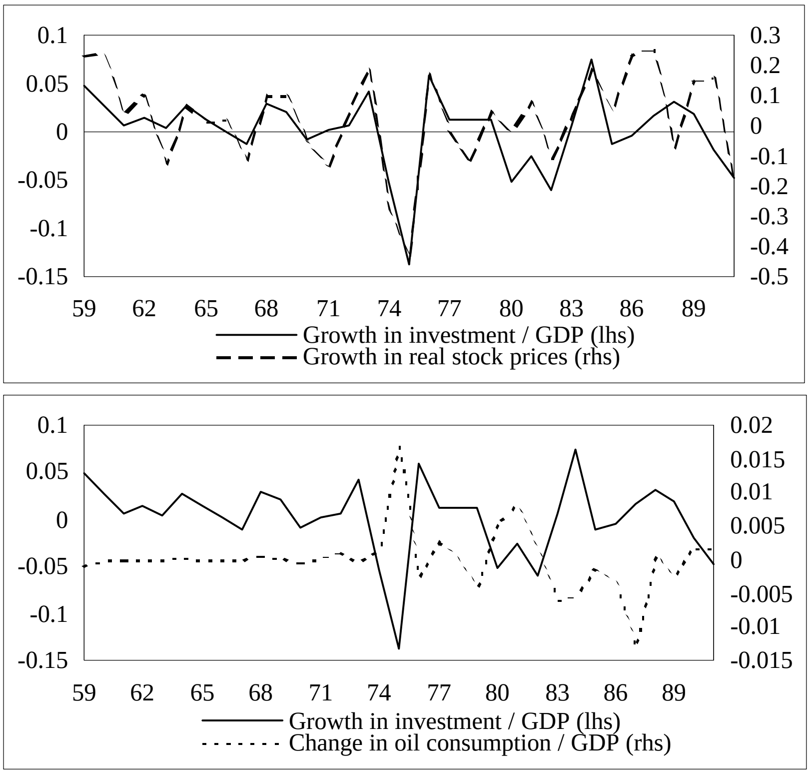

Figure 3.2: World Investment Rate and its Determinants

1964, and Japan from 1966. Calculation of world rates and subsequent estimation are based on all available data, averaging over all available countries.

To calculate world variables, series relating to each country are weighted according to that country's GDP at purchasing power parity relative to ten-country GDP. Table 2 shows country weights for the full ten-country system in 1988. Using GDP series means that each country's weight changes over time — for example, the US weight in the ten-country sample declined from 50% in 1960 to 46% in 1988.

The world investment rate and the factors that are likely to influence it are shown in Figure 3.2. Real stock market returns for country i, ΔSTK_{it-1}, are calculated as the change in equity prices deflated by the consumer price index. (Changes in both equity prices and the CPI are measured from December$_{t-2}$ to December$_{t-1}$ so as to be centred on the relevant year, to match other variables that are annual averages.)

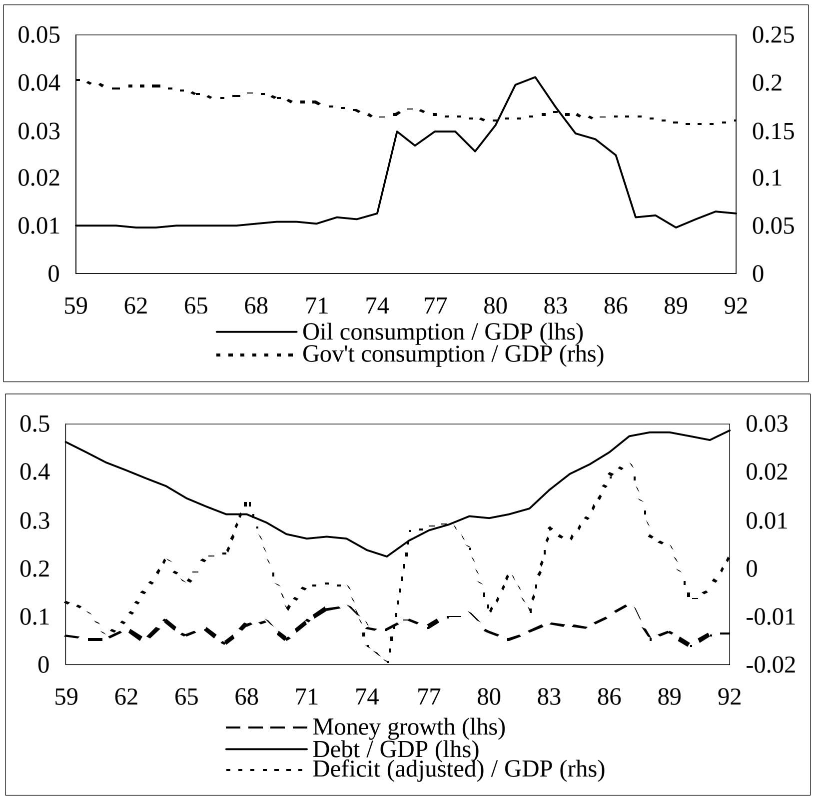

Figure 3.3: Determinants of the World Saving Rate

The world-level determinants of the world saving rate are plotted in Figure 3.3.[11] Monetary growth is measured as the December to December growth in the narrow money supply (M1). Figure 3.3 demonstrates the substantial rise in debt relative to GDP since 1974. Correspondingly, deficits were particularly high in the mid-to-late 1980s. The deficit is measured as the change in real public debt, which is then cyclically adjusted to leave only the 'structural' deficit component. As in Barro (1992), cyclically adjusted data are derived as the residual from the regression of the raw data on a constant, the current value and four annual lags of GDP growth.

All equations are estimated by iterative weighted least squares. Expected real interest rates exhibit persistence, which is modelled as an AR(1) process. Estimation is conducted using EViews.

4. World real interest rates and country-level investment

The results of estimating separate equations for the country-level investment–GDP ratio and the world short-run real interest rate are reported in the first two columns of Table 3. Results for the two measures of world long-run real rates are reported in the first columns of Table 4 and 5.[12] All coefficients are left free to vary in these single-equation regressions.

Turning first to the investment/GDP equation (column [1]), coefficients have the expected signs. Rises in the stock market lead to increases in investment, in line with q theory. This result is consistent with the hypotheses that firms find it easier to raise investment finance during periods of rising share prices, and that rising share prices might embody expectations of future improvements in profitability. The estimated coefficient implies that a 10 percentage point rise in the growth rate of real share prices leads to a 2 percentage point increase in the investment-GDP ratio. The rate of change of oil prices, captured by changes in the ratio of oil consumption to GDP, negatively affects investment. Barro (1992) suggests that the overall effect of an oil shock is likely to be greater than that indicated by the coefficient on $\Delta OILCY_{it-1}$,

[11] The saving rate itself is not shown: in the framework used here, the saving rate is modelled only implicitly.

[12] Obviously, in joint estimation the same investment equation is used with short and long interest rate equations.

Dep. vbl.	$(I/Y)_{it}$	r^e_{St}	$(I/Y)_{it}$	$(S/Y)_t$
	unrestricted, single		restricted, system	
	[1]	[2]	[3]	[4]
$(I/Y)_{it-1}$	0.914 [38.15]		1	
ΔSTK_{it-1}	0.020 [6.23]		0.023 [7.56]	
$\Delta OILCY_{it-1}$	−0.560 [−4.43]		−0.605 [−5.30]	
$(I/Y)_{t-1}$		0.575 [1.62]		
ΔSTK_{t-1}		0.042 [4.41]		
$\Delta OILCY_{t-1}$		−0.629 [−1.37]		
$(S/Y)_{t-1}$				0.531 [3.04]
$OILCY_{t-1}$		1.054 [1.86]		−0.822 [−3.06]
ΔM_{t-1}		−0.174 [−2.32]		0.107 [2.41]
ΔM_{t-2}		−0.101 [−1.66]		0.066 [1.70]
GCY_{t-1}		0.596 [1.16]		−0.438 [−1.52]
$DBTY_{t-1}$		0.171 [2.30]		−0.105 [−2.39]
$DEFY_{t-1}$		−0.252 [−1.03]		0.143 [0.97]
r^e_{St}				0.608 [4.05]
constant	varies	−0.260 [−1.48]	varies	−0.332 [−2.03]
AR(1)		0.742 [7.49]		0.719 [6.70]
R^2	varies	0.815	varies	0.797
s.e.	varies	0.009	varies	0.009
DW	varies	1.80	varies	2.06

Table 3: Investment and World Short Interest Rates

Sample 1959–92. Estimated by iterative weighted least squares. t-statistics in square brackets. s.e.: regression standard error. DW: Durbin–Watson autocorrelation statistic. Intercept and AR(1) estimates in [4] refer to real interest rate. Mnemonics defined in Table A1.

Dep. vbl.	r^e_{Lt} unrestricted, single [5]	$(I/Y)_{it}$ restricted, system [6]	$(S/Y)_t$ restricted, system [7]
$(I/Y)_{it-1}$		1	
ΔSTK_{it-1}		0.020 [6.51]	
$\Delta OILCY_{it-1}$		-0.703 [-5.76]	
$(I/Y)_{t-1}$	0.168 [0.51]		
ΔSTK_{t-1}	0.013 [1.45]		
$\Delta OILCY_{t-1}$	-1.023 [-2.39]		
$(S/Y)_{t-1}$			0.909 [2.89]
$OILCY_{t-1}$	1.123 [2.14]		-0.910 [-2.20]
ΔM_{t-1}	-0.043 [-0.61]		0.047 [0.64]
ΔM_{t-2}	-0.005 [-0.09]		0.013 [0.21]
GCY_{t-1}	0.797 [1.53]		-0.696 [-1.38]
$DBTY_{t-1}$	0.261 [3.75]		-0.243 [-2.35]
$DEFY_{t-1}$	-0.243 [-1.06]		0.229 [0.93]
r^e_{Lt}			1.092 [2.49]
constant	-0.252 [-1.49]	varies	-0.188 [-1.25]
AR(1)	0.752 [8.15]		0.736 [7.62]
R^2	0.898	varies	0.889
$s.e.$	0.008	varies	0.008
DW	1.46	varies	1.44

Table 4: Investment and World Long Real Interest Rates (based on moving average measure of expected inflation)

See notes to Table 3.

Dep. vbl.	r^e_{Lt} unrestricted, single [8]	$(I/Y)_{it}$ restricted, system [9]	$(S/Y)_t$ restricted, system [10]
$(I/Y)_{it-1}$		1	
ΔSTK_{it-1}		0.021 [6.70]	
$\Delta OILCY_{it-1}$		−0.683 [−5.62]	
$(I/Y)_{t-1}$	0.345 [1.04]		
ΔSTK_{t-1}	0.016 [1.87]		
$\Delta OILCY_{t-1}$	−0.942 [−2.22]		
$(S/Y)_{t-1}$			0.740 [2.61]
$OILCY_{t-1}$	1.233 [2.32]		−1.020 [−2.52]
ΔM_{t-1}	−0.198 [−2.88]		0.207 [2.52]
ΔM_{t-2}	−0.118 [−2.08]		0.126 [1.83]
GCY_{t-1}	0.603 [1.09]		−0.527 [−0.98]
$DBTY_{t-1}$	0.227 [3.06]		−0.214 [−2.13]
$DEFY_{t-1}$	−0.646 [−2.80]		0.667 [2.26]
r^e_{Lt}			1.051 [2.68]
constant	−0.226 [−1.32]	varies	−0.174 [−1.09]
AR(1)	0.816 [9.37]		0.826 [9.49]
R^2	0.914	varies	0.912
s.e.	0.008	varies	0.008
DW	1.77	varies	1.73

Table 5: Investment and World Long Real Interest Rates (based on trend measure of expected inflation)

See notes to Table 3.

as the oil consumption ratio is negatively related to stock returns. We con¯rm this: the correlation between the two series is -0.59, and bivariate regressions indicate a signi¯cant relationship.

Although the coe±cient on the lagged investment ratio is close to unity (0.914), a Wald test shows that it is signi¯cantly di®erent from one (the Wald test statistic, distributed $\hat{A}^2_1$, is 13.03, indicating that the hypothesis can be rejected at the 99% con¯dence level).

Results for reduced form short and long real interest rate equations (columns [2], [5] and [8]) indicate that world real rates are a®ected by in°uences on world investment in the predicted direction. Short and long world real rates tend to decline with a faster rate of growth of the proportion of income spent on oil. Short rates are signi¯cantly raised by higher stock market returns. The estimated coe±cient implies that a 10 percentage point rise in the growth rate of real share prices leads to a 4 percentage point increase in real short rates. The coe±cient on in long rate equations is also positive, but is lower and not very well determined.

World interest rates are also a®ected by factors whose in°uence comes from their e®ect on the world saving rate. An increase in the proportion of income spent on oil has a positive e®ect on real rates, consistent with the idea that positive oil price shocks capture temporary downward shocks to income. The estimated coe±cients imply that a 1 percentage point increase in the oil consumption-GDP ratio leads to an increase in real rates of up to 1.1 percentage points.

A faster rate of world monetary growth during the previous year tends to depress world expected short real interest rates, consistent with sticky-price models. It is sometimes suggested that ¯ndings of a signi¯cant e®ect of monetary growth on real interest rates rely on the use of short-term interest rate variables and re°ect policymakers' ability to manipulate short rates. Because policymakers have little in°uence on rates in the long run, it is suggested that results would not carry over to long rates. Contrary to this view, we ¯nd strong e®ects of monetary growth on long rates according to the `trend' measure, of similar magnitude to e®ects on short rates. (However, there are no identi¯able monetary e®ects on long rates according to the `moving average' measure.) The apparent persistence of the e®ect of monetary shocks on interest rates is consistent with so-called `limited participation' models with strong liquidity e®ects (see, for example, Christiano and Eichenbaum, 1992). When only ¯rms (not households) have access to additional ¯nance following a positive monetary shock and when there are small costs associated with the adjustment of the °ow of funds between sectors, positive monetary shocks can generate long-lasting, quantitatively signi¯cant liquidity e®ects, leading to persistently lower interest rates (and also to persistent increases in aggregate economic activity).

Turning to ¯scal policy: a higher ratio of government debt to GDP raises short and long world interest rates, in line with the Blanchard (1985){type hypothesis. The e®ect of debt is discussed further below.

Although higher (cyclically adjusted) budget de¯cits appear to be associated with lower long real rates according to the `trend in°ation' measure (contrary to our expectation), de¯cits have no discernible e®ect on short rates, nor on the `moving average' long rate measure. The insigni¯cance of the budget de¯cit is consistent with results in Barro and Sala-i-Martin (1990) and Barro (1992). Blanchard (1985) showed that the importance of de¯cits declines, the longer the horizon of households (and disappears when agents have in¯nite horizons). So our results are consistent with the behaviour of in¯nitely-lived agents. When agents are ¯nitely-lived, it is the expected sequence of de¯cits that matters for aggregate demand. In that case, current de¯cits matter only to the extent they proxy, or predict, (a weighted sum of) future de¯cits. Barro (1992) found current de¯cits to be very poor predictors of future de¯cits. Our results therefore should be interpreted as con¯rming that it is not helpful to look at current de¯cits in assessing the impact of ¯scal stance on real activity and interest rates | but this does not necessarily mean that expected future de¯cits do not matter.

There are no e®ects from government spending on either short or long real rates. Insigni¯cance might suggest government consumption data capture permanent changes in public spending. As noted by Barro (1992), a major temporary element of government spending is military expenditure, in which there has been relatively little °uctuation for the ten countries studied here during the last 30 years.

The last two columns of Tables 3, 4 and 5 report results of estimating investment ratio and interest rate equations as a two-equation system with cross-equation restrictions. The restricted system consists of equations (2.3) and (2.6). In this restricted system, a unit coefficient is imposed on lagged investment in the investment–GDP ratio equation and influences from factors affecting investment are restricted to take the same coefficients in the investment and real interest rate equations. Note that coefficients in columns [4], [7] and [10] refer to $(S/Y)_{it}$, the implicit dependent variable, so coefficients should be of opposite sign to those in the reduced form interest rate equations.

There are no major differences in results between the restricted systems and the separate investment and real interest rate equations. Estimates for short rates are very similar to those reported in Barro (1992), with the exception of the coefficient on government spending (now -0.44 compared to Barro's 0.04), although its effect remains insignificant. All restrictions, including a common intercept across countries in the investment equation, can be accepted, except the unit restriction on the lagged investment ratio — but this is nevertheless imposed on theoretical grounds.[13] In general, the imposed restrictions improve the degrees of freedom of the regression and reduce standard errors, meaning that effects are measured with somewhat greater precision.

4.1. Influences on long-term movements in interest rates

It is of particular interest to investigate what lies behind broad movements in real interest rates over the longer term. The level of world real rates over the last three decades can be divided into three `regimes': low, medium and high (see Figure 4.1).

[13] For the moving average measure of long rates, the coefficient on real stock market returns appears smaller in the unrestricted reduced-form long rate equation than in the restricted system. This might reflect a significant positive effect from stock market returns on this measure of real rates arising through a positive impact on the saving rate, counteracting the effect acting through investment. Correspondingly, the equality of coefficients on stock market returns in the investment equations of the system and the real interest rate can be rejected (Wald statistic 4.64, p-value 0.03). Nevertheless, the exclusion of stock market returns from the saving equation is supported for the other two interest rate measures. Wald statistics for the other restrictions are as follows (p-values in square brackets). Unit restriction on $(I/Y)_{it-1}$: short: 13.19 [<0.001]; long (moving average): 9.94 [0.002]; long (trend): 12.83 (<0.001). Equality of effect of ΔSTK_{t-1} in investment and interest rate equations: short: 0.26 [0.61]; long (trend): 1.45 [0.23]. Equality of effect of $\Delta OILCY_{t-1}$ in investment and interest rate equations: short: 0.53 [0.47]; long (moving average): 0.64 [0.43]; long (trend): 0.64 [0.43]. Zero intercepts in investment equations: short: 5.78 [0.83]; long (moving average): 5.79 [0.83]; long (trend): 5.78 [0.83].

`Regime'	Average world real interest rate		
	Short	Long (m.a.)	Long (trend)
Medium	2.4	2.5	2.4
Low	-0.3	-0.1	-0.2
High	3.9	5.0	5.5

Table 6: Average Level of World Expected Short and Long Real Interest Rates

Long (m.a.) is long real rate based on moving average measure of expected inflation. Long (trend) is long real rate based on trend measure of expected inflation. Regimes are defined as follows: For short and long (m.a.), Medium is 1959-73; Low is 1974-79; High is 1980-92. For long (trend), Medium is 1959-71; Low is 1972-79; High is 1980-92.

Having averaged 2.4% between 1959 and 1973 (the `medium regime'), short real rates fell, and were on average negative between 1974 and 1979 - the `low regime' (see Table 6). Long rates followed a similar pattern.[14] Since 1980, real interest rates have been at historically high levels.

We can use estimates from the reduced form real interest rate equations (columns [2] of Table 3, [5] of Table 4 and [8] of Table 5) together with changes in average values of explanatory variables (see Table A3 in the Appendix) to detect which factors were responsible for these interest rate shifts.

Broad changes in short rates were driven mainly by changes in the level of world public sector debt and by movements in world equity markets (see Table 7). Inter-regime movements in long rates were also primarily affected by global debt levels (see Tables 8 and 9).

Over 30% of the fall in real rates during the 1970s was due to the reduction in global debt levels from 33% of GDP (1959-73) to 28% (1974-79). The more recent rise in government debt levels to over 40% of GDP contributed more than 60% to the rise in real rates since 1979.

Across the world, share prices rose 5% a year between 1959 and 1973, fell 11% a year between 1974 and 1979, then rose 9% a year between 1980 and 1992. These share

[14] Long real rates fell to low levels earlier (in 1971) according to the measure calculated using trend inflation, so the timing of the medium-to-low regime change differs for this measure. Results are similar if either regime definition is used.

Figure 4.1: Interest Rate Regimes

Contribution of:	`Regime' shift Medium → Low (fall in rates)	Low → High (rise in rates)
Stock market returns		
ΔSTK_{t-1}	0.23	0.20
Oil expenditure		
$\Delta OILCY_{t-1}$	0.05	0.06
$OILCY_{t-1}$	-0.59	-0.04
Monetary growth		
ΔM_{t-1}	0.08	0.05
ΔM_{t-2}	0.09	0.03
Gov't consumption		
GCY_{t-1}	0.47	-0.04
Gov't debt		
$DBTY_{t-1}$	0.31	0.63
Gov't deficit		
$DEFY_{t-1}$	0.03	-0.03
Proportion explained	0.68	0.86

Table 7: Proportionate Contribution of Independent Variables to Shifts in World Short Real Interest Rates

Contributions are based on coefficients reported in Table 3, column [2]. Regimes are defined as follows: Medium 1959-73; Low 1974-79; High 1980-92. Contributions might not sum to proportion explained due to rounding.

Contribution of:	`Regime' shift Medium ! Low (fall in rates)	Low ! High (rise in rates)
Stock market returns		
¢$STK_{t¡1}$	0.07	0.05
Oil expenditure		
¢$OILCY_{t¡1}$	0.09	0.09
$OILCY_{t¡1}$	-0.66	-0.03
Monetary growth		
¢$M_{t¡1}$	0.02	0.01
¢$M_{t¡2}$	0.00	0.00
Gov't consumption		
$GCY_{t¡1}$	0.65	-0.04
Gov't debt		
$DBTY_{t¡1}$	0.50	0.79
Gov't de¯cit		
$DEFY_{t¡1}$	0.03	-0.03
Proportion explained	0.72	0.84

Table 8: Proportionate Contribution of Independent Variables to Shifts in World Long Real Interest Rates
(based on moving average measure of expected in°ation)

Contributions are based on coe±cients reported in Table 4, column [5]. Regimes are de¯ned as follows: Medium 1959-73; Low 1974-79; High 1980-92. Contributions might not sum to proportion explained due to rounding.

Contribution of:	`Regime' shift Medium → Low (fall in rates)	 Low → High (rise in rates)
Stock market returns		
ΔSTK_{t-1}	0.05	0.04
Oil expenditure		
$\Delta OILCY_{t-1}$	0.07	0.06
$OILCY_{t-1}$	-0.56	0.04
Monetary growth		
ΔM_{t-1}	0.21	0.07
ΔM_{t-2}	0.14	0.03
Gov't consumption		
GCY_{t-1}	0.51	-0.05
Gov't debt		
$DBTY_{t-1}$	0.60	0.65
Gov't deficit		
$DEFY_{t-1}$	0.01	-0.09
Proportion explained	1.03	0.76

Table 9: Proportionate Contribution of Independent Variables to Shifts in World Long Real Interest Rates
(based on trend measure of expected inflation)

Contributions are based on coefficients reported in Table 5, column [8]. Regimes are defined as follows: Medium 1959-71; Low 1972-79; High 1980-92. Contributions might not sum to proportion explained due to rounding.

price movements contributed at least 20% to broad changes in short real interest rates during this time. In contrast to their e®ect on short rates, equity market returns had little e®ect on broad movements in long real rates.

The decline in government purchases from 19% of GDP during 1959-73 to 17% during 1974-79 may have played a part in the decline in both short and long real rates between these periods (the contributions of between 47% and 65% reported in Tables 7 to 9 are based on the size of the estimated coe±cients, but although relatively large these are not well determined). This, together with the reduction in public debt, outweighed the e®ect of the rise in the proportion of GDP spent on oil by industrialised countries from 1% before 1973 to 2.6% during the mid to late 1970s | which would have tended to raise interest rates. There has been little change in the world government consumption to GDP ratio since the mid-1970s (see Figure 3.3, page 14), so this factor has had no impact on the later rise in real rates.

Changes in the rate of monetary growth had little e®ect on broad movements in short real rates, but | perhaps surprisingly | faster monetary growth during the mid to late 1970s is estimated to have contributed between 14% and 21% to the decline in the prevailing level of long rates according to the measure based on trend in°ation.

5. Real interest rates at country level

So far, no attempt has been made to account for cross-country real interest rate di®erences. These di®erences are substantial: for example, Table 10 demonstrates that over 1959-92, the average real short interest rate in the Netherlands (1.9%) was less than half that in Belgium (3.9%). Similarly, over the same period the average real long rate varied from under 2% in Japan to over 4% in Germany. The rest of this paper focuses on explanations for these di®erentials. The hypothesis that country{speci¯c factors matter for interest rate determination is ¯rst examined in the most general way possible, by including unobservable country characteristics as factors a®ecting the level of country real interest rates. Then, with the intention of narrowing the range of determinants of observable country interest rate di®erentials, the analysis focuses on country{speci¯c variables that might a®ect the levels of saving and investment in each country.

Country	Short	Long (m.a.)	Long (trend)
Belgium	3.92	3.82	3.75
Canada	3.08	3.59	3.56
France	2.67	2.59	2.64
Germany	3.58	4.16	4.08
Italy	2.92	2.48	2.38
Japan	2.79	1.75	1.85
Netherlands	1.89	3.23	3.34
Sweden	2.69	2.48	2.43
UK	1.92	2.63	2.65
US	2.09	2.86	2.81
World	2.44	2.83	2.80

Table 10: Average Real Interest Rates

Sample for short rates is 1959 to 1992 except for Italy (1972{92). Sample for long rates is 1959 to 1992 except for Switzerland (1960{92), Netherlands (1964{92) and Japan (1966{92). World rates are GDP-weighted averages over countries in sample.

In Section 5.1 we investigate whether country interest rates have been responsive only to worldwide factors, which would be consistent with perfection in capital markets and country real interest rates following the world rate. If, on the other hand, factors speci¯c to each country have been important in determining country expected real interest rates, this could re°ect capital market imperfections, or persistent di®erences in the perceived riskiness of investment or saving across countries. In Section 5.2 we explicitly test whether the country{speci¯c factors that in°uence each country's real interest rate are the same variables that a®ect world real rates, but at country level. A positive ¯nding would constitute evidence that country real interest rate di®erentials have re°ected capital market imperfections, because such a ¯nding would suggest that the levels of saving and investment in each country are important in determining the level of interest rates in that country, re°ecting imperfect capital mobility between countries. There are some observations that would support the idea that the capital market is not perfectly integrated across the ten countries studied. These include evidence that investors have `preferred habitats' | in particular, there is a persistent tendency to invest in own-country assets; imperfect competition in retail ¯nancial markets; the fact that a large share of real assets (for example, equity in self-owned businesses) are not traded; and, finally, high correlations of country saving and investment.

5.1. The extent of cross-country variation: analysis of variation and fixed effects

Initially, following Barro (1992), we assume that country real interest rates deviate from world real rates by some differential which varies across countries but remains constant over time, and is affected by country–specific random variations:

$$r^e_{it} = \gamma_{0i} + r^e_t + \varepsilon_{it} \tag{5.1}$$

where γ_{0i} are fixed effects (permanent deviations from the world rate r^e_t) and ε_{it} is allowed to follow a first-order autoregressive process; the degree of persistence is allowed to vary across countries.

Analysis of variance indicates that, over 1959–1992, variation across countries (`between' variation) accounted for only 7.5% of the total variation of country-level short real interest rates, most variation occurring over time and being captured by movements in the world weighted average r^e_t.

The relative importance of country-specific factors can also be seen from estimation of equation (5.1), which is reported for short and long rates in Table 11. The fixed effects γ_{0i} can be interpreted as country premia over the world real rate. Only four of these country dummies are significantly different from zero in the short rate equation — those for Belgium, Canada, France and Germany (those for Japan and Sweden are significant at the 10% level); two countries have significant fixed effects in the long rate equations. (Results are similar whether or not allowance is made for country–specific autoregressive errors.)

Although these results suggest that world-level events, working through the world interest rate, dominate movements in countries' own rates, we can also see that there are persistent cross-country differentials that require explanation.[15]

To obtain a full model consistent with those reported in Section 4, we can substitute

[15] The joint insignificance of the fixed effects can be clearly rejected (for example, for short rates: $\chi^2_{10} = 79.5$, $p < 0.001$).

Country	Real interest rate premium Fixed effect coefficient ×100 [t-value]		
	Short	Long (m.a.)	Long (trend)
Belgium	1.7 [9.75]	1.3 [1.95]	1.0 [2.77]
Canada	0.8 [4.10]	1.1 [4.32]	0.9 [3.19]
France	0.5 [2.00]	0.4 [0.95]	0.5 [0.58]
Germany	1.4 [5.08]	1.5 [2.53]	0.9 [0.70]
Italy	6.5 [0.44]	0.4 [0.26]	0.3 [0.19]
Japan	0.5 [1.81]	−0.8 [−1.17]	−1.1 [−1.68]
Netherlands	−0.3 [−1.14]	0.9 [1.24]	0.7 [1.23]
Sweden	0.5 [1.88]	−0.04 [−0.11]	−0.3 [−1.09]
UK	−0.2 [−0.61]	0.1 [0.24]	−0.1 [−0.25]
US	−0.2 [−1.49]	0.3 [0.71]	0.01 [0.03]

Table 11: Estimated Fixed Effects from Regression of Country Real Interest Rates on Country Dummies and World Real Interest Rates

Country real interest premium (expressed in percentage points) is $100 \times \gamma_i$, where γ_i are fixed effect coefficients from estimation of equation (5.1). Sample 1959-92 except: Short rate: Italy 1972-1992; Long rates: Switzerland 1960-92; Netherlands 1964-92; Japan 1966-92. Coefficient [t-value] on world interest rate: short: 0.939 [25.00]; long (m.a.): 0.899 [19.80]; long (trend): 0.987 [29.54]. Regressions include country-specific autoregressive terms.

r^e_t in (5.1) with the determinants of r^e_t as shown in equation (2.6).[16] That gives the following restricted equation for country real rates:

$$
\begin{aligned}
r^e_{it} = \eta_{0i} + (1/\alpha_1)\big[\beta_1 \Delta STK_{t-1} + \beta_2 \Delta OILCY_{t-1} - \alpha_2 OILCY_{t-1} \\
- \alpha_3 \Delta M_{t-1} - \alpha_4 \Delta M_{t-2} - \alpha_5 GCY_{t-1} \\
- \alpha_6 DBTY_{t-1} - \alpha_7 DEFY_{t-1} + (1-\alpha_8)(I/Y)_{t-1}\big] + \nu_{it}
\end{aligned}
\qquad (5.2)
$$

where $\eta_{0i} = \eta_0 + \gamma_{0i}$ and $\nu_{it} = \nu_t + \epsilon_{it}$. As before, expected signs of coefficients are given in Table 1. We estimate equation (5.2) jointly with the investment equation (2.3),[17] restricting variables whose effect on interest rates stems from their influence on investment to have the same coefficients in both equations. Country real interest rates are again allowed to show differing degrees of persistence. To summarise this model: the known influences on country real interest rates are restricted to world variables, but unspecified country–specific effects are included in the equation.

The two-equation restricted system of equations (5.2) and (2.3) is reported in Tables 12 (short rates) and 13 (the two measures of long rates). All world variables now appear to have significant influences on short real interest rates at country level.[18] Comparing the 'country' system for short real interest rates with the 'world' single equation, the impact of the global deficit-GDP ratio appears higher in the 'country' system, whereas the effect of oil shocks is somewhat reduced. Differences between 'country' and 'world' estimates for the moving average measure include lower coefficients on the lagged saving and oil consumption-GDP ratios, and an increase in size and significance of last period's narrow money growth. Estimates for the trend long rate measure are largely unchanged.

Differences between long and short rates include that long rates are affected to

---

[16] We repeat equation (2.6) here for convenience:

$$
\begin{aligned}
r^e_t = \eta_0 + (1/\alpha_1)\big[\beta_1 \Delta STK_{t-1} + \beta_2 \Delta OILCY_{t-1} - \alpha_2 OILCY_{t-1} \\
- \alpha_3 \Delta M_{t-1} - \alpha_4 \Delta M_{t-2} - \alpha_5 GCY_{t-1} - \alpha_6 DBTY_{t-1} - \alpha_7 DEFY_{t-1} + (1-\alpha_8)(I/Y)_{t-1}\big] + \nu_t.
\end{aligned}
$$

[17] Equation (2.3) is repeated here for ease of reference:

$$
(I/Y)_{it} = \beta_{0i} + \beta_1 \Delta STK_{it-1} + \beta_2 \Delta OILCY_{it-1} + (I/Y)_{it-1} + u_{it}.
$$

[18] It seems that the greater efficiency of estimation using disaggregated data has enabled effects to be estimated more precisely.

Dep. vbl.	$(I/Y)_{it}$	$(S/Y)_{it}$
	restricted, system	
	[11]	[12]
$(I/Y)_{it-1}$	1	
ΔSTK_{it-1}	0.024 [8.59]	
$\Delta OILCY_{it-1}$	−0.543 [−5.49]	
$(S/Y)_{t-1}$		0.553 [5.07]
$OILCY_{t-1}$		−0.551 [−3.63]
ΔM_{t-1}		0.110 [3.89]
ΔM_{t-2}		0.077 [3.19]
GCY_{t-1}		−0.547 [−4.18]
$DBTY_{t-1}$		−0.097 [−4.17]
$DEFY_{t-1}$		0.312 [3.50]
r^e_{St}		0.604 [6.10]

Table 12: Country-Level Investment, Saving and Short Real Interest Rates

All equations include country–specific constant terms, and real interest rate/saving rate equations include country-specific autoregressive parameters. Country-specific features for short real interest rate/saving rate equations (column [12]) are reported in Table 12a. See also notes to Table 3. Samples as in Table 11.

Country	Fixed effect	AR(1)	R^2 [s.e.]	DW
Belgium	-0.323 [-4.05]	0.775 [8.69]	0.694 [0.013]	1.71
Canada	-0.335 [-4.18]	0.757 [7.63]	0.611 [0.017]	2.30
France	-0.329 [-4.14]	0.792 [9.46]	0.611 [0.016]	1.99
Germany	-0.329 [-4.11]	0.681 [6.09]	0.244 [0.022]	1.74
Italy	-0.318 [-3.73]	0.853 [5.29]	0.757 [0.027]	1.80
Japan	-0.343 [-4.30]	-0.031 [-0.19]	0.646 [0.015]	2.08
Netherlands	-0.341 [-4.26]	0.775 [8.27]	0.462 [0.018]	1.58
Sweden	-0.332 [-4.14]	0.752 [6.72]	0.505 [0.022]	2.24
UK	-0.346 [-4.29]	0.611 [4.78]	0.535 [0.034]	2.09
US	-0.348 [-4.35]	0.754 [7.38]	0.640 [0.015]	2.14

Table 12a: Country–Specific Elements of Short Real Interest Rates

Statistics relate to column [12] of Table 12. Fixed effect and AR(1) coefficients refer to real interest rate. Square brackets under intercept and AR(1) coefficients contain the relevant t-statistics. Square brackets under R^2 contain standard error of regression. DW are Durbin–Watson autocorrelation test statistics.

Dep. vbl.	$(I/Y)_{it}$	$(S/Y)_{it}$	$(I/Y)_{it}$	$(S/Y)_{it}$
	restricted, system (m.a.)		restricted, system (trend)	
	[13]	[14]	[15]	[16]
$(I/Y)_{it-1}$	1		1	
ΔSTK_{it-1}	0.020 $[7.00]$		0.018 $[7.24]$	
$\Delta OILCY_{it-1}$	-0.731 $[-6.70]$		-0.772 $[-7.63]$	
$(S/Y)_{t-1}$		0.591 $[4.32]$		0.640 $[6.10]$
$OILCY_{t-1}$		-0.710 $[-3.54]$		-1.073 $[-6.06]$
ΔM_{t-1}		0.093 $[2.66]$		0.196 $[5.70]$
ΔM_{t-2}		0.002 $[0.08]$		0.100 $[3.98]$
GCY_{t-1}		-0.350 $[-1.78]$		-0.259 $[-1.45]$
$DBTY_{t-1}$		-0.244 $[-4.70]$		-0.215 $[-5.64]$
$DEFY_{t-1}$		0.126 $[1.08]$		0.459 $[4.51]$
r^e_{Lt}		1.042 $[4.83]$		0.927 $[6.03]$

Table 13: Country-Level Investment, Saving and Long Real Interest Rates

See notes to Table 12.

a greater extent by public debt and oil shocks, but are not significantly affected by monetary growth and the ratio of government consumption to GDP. The long real interest rate has an almost one-for-one effect on the saving rate, whereas the effect of the short real interest rate is lower: a one percentage point rise in short rates is on average associated with 0.6 of a percentage point increase in the national saving rate.

Country-specific intercept and autoregressive terms are reported in Table 12a.[19] Cross-country variation is perhaps even lower than would have been expected given results reported earlier in this Section. The intercept term does exhibits any cross-country variation. For long rates, there are no cross-country differences in autoregressive processes. Apparent rejection of equality of autoregressive parameters in the case of short rates is caused by the unusual process followed by the Japanese short rate.[20] Nevertheless, there are significant cross-country differences in the fit of the model, which works least well for Germany on all three interest rate measures, and best for Italy, France or Belgium. The following section tries to pin down the sources of cross-country differences in performance of the model, examining the possibility that these might be due to omitted country-level variables.

5.2. Narrowing the source of variation: country-level variables as indicators of capital market imperfection

A further model of country-level interest rates can be developed that acknowledges that the world capital market might not be perfect, but capital is not completely immobile. Section 2 discussed the (global) structural determinants of the world real interest rate under perfect capital markets. Completely immobile capital would mean that each country's real interest rates were determined by the same structural factors at country level. Allowing explicitly for some imperfection in capital markets means that we can model (at least part of) the fixed effects η_{0i} that are treated as `unobservable' in equation (5.2).

Country real rates deviate (often persistently) from the world rate. The way in which they do so might depend on the extent to which factors affecting saving

[19] For brevity, results for long rates are not reported, but are available on request from the author.

[20] Wald test statistics (p-values) are as follows. Equality of intercepts: short: 9.2 (0.42); long (m.a.): 10.8 (0.29); long (trend): 9.9 (0.36). Equality of AR(1) coefficients: short: 23.3 (0.006); short excluding Japan: 2.4 (0.97); long (m.a.): 6.9 (0.65); long (trend): 4.4 (0.88).

and investment deviate from average world levels. Thus, instead of equation (5.1) ($r^e_{it} - r^e_t = \gamma_{0i} + \varepsilon_{it}$), the deviation of country real interest rates from the world rate can be written:

$$
\begin{aligned}
(r^e_{it} - r^e_t) = {} & \mu_{0i} + \gamma_1(\Delta STK_{it-1} - \Delta STK_{t-1}) \\
& + \gamma_2(\Delta OILCY_{it-1} - \Delta OILCY_{t-1}) \\
& + \gamma_3(OILCY_{it-1} - OILCY_{t-1}) + \gamma_4(\Delta M_{it-1} - \Delta M_{t-1}) \\
& + \gamma_5(\Delta M_{it-2} - \Delta M_{t-2}) + \gamma_6(GCY_{it-1} - GCY_{t-1}) \\
& + \gamma_7(DBTY_{it-1} - DBTY_{t-1}) + \gamma_8(DEFY_{it-1} - DEFY_{t-1}) \\
& + \gamma_9\left((I/Y)_{it-1} - (I/Y)_{t-1}\right) + \upsilon_{it}.
\end{aligned}
\tag{5.3}
$$

The coefficients relating to deviations of country-specific from world variables are expected to have the signs given for the relevant variable in Table 1. We can again allow for fixed effects μ_{0i}.

Combining equation (5.3), specifying the determination of the country–world interest rate differential ($r^e_{it} - r^e_t$), with equation (2.6), specifying the determinants of the world interest rate r^e_t, implies that country real interest rates r^e_{it} are affected by both world and country–specific factors.[21] r^e_t is still determined by world factors — it is still the price that equates desired saving and planned investment at world level.

The question arises whether the response of country real rates to changes in a given world variable will be the same as their response to changes in the own-country component of the world average. We will investigate both possibilities.

First, assume that the effect of a variable at country or world level is the same: the elasticity of r^e_{it} with respect to a given factor is the same, whether that variable is measured at country or world level. Then, if we allow the impact on interest rate differentials of deviations of country from world factors to vary across countries, we can measure the extent to which country real rates are affected by country rather than world variables. This is accomplished by estimating country-specific weighting factors m_i, as shown in the following country real interest rate equation:[22]

[21] Barro (1992) examined only effects on country-specific real rates of country versions of world variables in the saving rate equation. In contrast, the theoretical framework set out here would also recommend the inclusion of country-level variables appearing in the country investment rate equation.

[22] The same notation is used for intercept and error terms as in (5.2), although these are not necessarily identical.

$$
\begin{aligned}
r^e_{it} = \eta_{0i} &+ \beta_1 (m_i \Delta STK_{it-1} + (1 - m_i) \Delta STK_{t-1}) \\
&+ \beta_2 (m_i \Delta OILCY_{it-1} + (1 - m_i) \Delta OILCY_{t-1}) \\
&- \alpha_2 (m_i OILCY_{it-1} + (1 - m_i) OILCY_{t-1}) \\
&- \alpha_3 (m_i \Delta M_{it-1} + (1 - m_i) \Delta M_{t-1}) \\
&- \alpha_4 (m_i \Delta M_{it-2} + (1 - m_i) \Delta M_{t-2}) \\
&- \alpha_5 (m_i GCY_{it-1} + (1 - m_i) GCY_{t-1}) \\
&- \alpha_6 (m_i DBTY_{it-1} + (1 - m_i) DBTY_{t-1}) \\
&- \alpha_7 (m_i DEFY_{it-1} + (1 - m_i) DEFY_{t-1}) \\
&+ (1 - \alpha_8) \left[m_i (I/Y)_{it-1} + (1 - m_i) (I/Y)_{t-1} \right] + \varepsilon_{it}.
\end{aligned}
\tag{5.4}
$$

m_i reflect the extent to which country i's capital market is imperfect. A country whose capital market is fully integrated into the world capital market (i.e. a country characterised by completely free capital flows) would be affected only by variables at world level. In that case, $m_i = 0$ and own-country variables would matter only to the extent that they affect world (weighted) averages. When $m_i = 0$, (5.4) reduces to the fixed-effects formulation (5.2) discussed in Section 5.1.

The extent to which r^e_{it} deviates from r^e_t depends on the extent of capital market imperfection in country i, m_i, and the extent to which own-country factors deviate from world-level variables. This can be seen from a decomposition of (5.4) into world interest rate equation (2.6) and the following expression for the deviation of country from world rates:[23]

$$
\begin{aligned}
(r^e_{it} - r^e_t) = \mu_{0i} + m_i \Big[&\beta_1 (\Delta STK_{it-1} - \Phi \Delta STK_{t-1}) \\
&+ \beta_2 (\Delta OILCY_{it-1} - \Phi \Delta OILCY_{t-1}) \\
&- \alpha_2 (OILCY_{it-1} - \Phi OILCY_{t-1}) - \alpha_3 (\Delta M_{it-1} - \Phi \Delta M_{t-1}) \\
&- \alpha_4 (\Delta M_{it-2} - \Phi \Delta M_{t-2}) - \alpha_5 (GCY_{it-1} - \Phi GCY_{t-1}) \\
&- \alpha_6 (DBTY_{it-1} - \Phi DBTY_{t-1}) - \alpha_7 (DEFY_{it-1} - \Phi DEFY_{t-1}) \\
&+ (1 - \alpha_8) \left[(I/Y)_{it-1} - \Phi (I/Y)_{t-1} \right] \Big] + \upsilon_{it},
\end{aligned}
\tag{5.5}
$$

where $\Phi = (1 + (1 - \alpha_1)/\alpha_1 m_i)$.

We estimate equation (5.4) jointly with investment equation (2.3), as before imposing cross-equation restrictions (these are evident from the coefficients in the equations). Full results are not reported here; they are similar to those reported above.[24]

[23] The same notation is used for intercept and error terms as in (5.3), although these are not necessarily identical.

[24] In general, the significance of coefficients is raised. The only notable difference is in the GCY_{-1} coefficient for short rates, estimated at 0.095 [0.51] compared to -0.547 [-4.18] in Table 12.

The most interesting aspect of these results is our ability to recover estimates of capital market imperfection. Table 14 reports m_i coefficients multiplied by 100, which can be interpreted as an index of capital market imperfection, with 0 (and, arguably, also negative values) representing a completely open capital market, and 100 representing a completely closed capital market. We can interpret negative coefficients as indicating open capital markets, since in these cases the effect of world variables has been sufficiently strong as to counteract movements in own-country variables. We find that Belgium, Canada, France, Sweden, the UK and the US all appear to have had reasonably open capital markets during the period under study. In no case is the estimate of m_i for these countries significantly positive. Germany, Italy, Japan, and the Netherlands seem to have had the least open capital markets, although estimates vary somewhat according to which interest rate measure is used.[25] Interestingly, on the basis of the long rate measure based on trend inflation, all m_i are insignificantly different from zero, implying that capital markets are fully integrated across the ten countries.

We now turn to a less restricted formulation, where we let the elasticity of interest rates with respect to a given factor vary, depending whether that factor is measured at world or country level. Then the country real interest rate equation is:[26]

$$
\begin{gathered}
r^e_{it} = \eta_{0i} + (1/\alpha_1)\,[(\beta_1 - \alpha_1\gamma_1)\,\Delta STK_{t-1} \\
+ (\beta_2 - \alpha_1\gamma_2)\,\Delta OILCY_{t-1} - (\alpha_2 - \alpha_1\gamma_3)\,OILCY_{t-1} \\
- (\alpha_3 - \alpha_1\gamma_4)\,\Delta M_{t-1} - (\alpha_4 - \alpha_1\gamma_5)\,\Delta M_{t-2} \\
- (\alpha_5 - \alpha_1\gamma_6)\,GCY_{t-1} - (\alpha_6 - \alpha_1\gamma_7)\,DBTY_{t-1} \\
- (\alpha_7 - \alpha_1\gamma_8)\,DEFY_{t-1} + (1 - \alpha_8 - \alpha_1\gamma_9)\,(I/Y)_{t-1} \\
+ \gamma_1\Delta STK_{it-1} + \gamma_2\Delta OILCY_{it-1} + \gamma_3 OILCY_{it-1} \\
+ \gamma_4\Delta M_{it-1} + \gamma_5\Delta M_{it-2} + \gamma_6 GCY_{it-1} + \gamma_7 DBTY_{it-1} \\
+ \gamma_8 DEFY_{it-1} + \gamma_9\,(I/Y)_{it-1} + \varepsilon_{it}.
\end{gathered}
\qquad (5.6)
$$

Expression (5.6) can be decomposed into world real rate equation (2.6) and equation (5.3) for the deviation of country from world rates. The α's and β's are struc-

[25] According to the OECD, based on the existence of official controls on interest rates, the ordering from most to least open — if financial liberalisation is a good measure of openness — should be, roughly: Canada, Germany, Italy, Netherlands, Sweden, UK, Belgium, France, US, Japan. (Source: OECD Banks in Crisis (1992), quoted in G10 Deputies (1995)).

[26] The same notation is used for intercept and error terms as in (5.2) and (5.4), although these are not necessarily identical.

Country	Short	Long (m.a.)	Long (trend)
Belgium	¡ 0:4 [¡ 0:02]	1:4 [0:10]	¡ 2:4 [¡ 0:28]
Canada	¡ 35:0 [¡ 2:66]	48:5 [1:52]	¡ 5:3 [¡ 0:63]
France	24:4 [1:22]	¡ 4:9 [¡ 0:22]	0:2 [0:02]
Germany	4:1 [0:15]	67:2 [3:11]	¡ 0:1 [¡ 0:01]
Italy	78:9 [3:79]	¡ 65:9 [¡ 2:29]	2:9 [0:20]
Japan	¡ 32:2 [¡ 3:90]	93:0 [1:79]	13:5 [0:94]
Netherlands	43:5 [1:79]	1:0 [0:04]	10:3 [0:80]
Sweden	23:3 [1:12]	17:7 [1:69]	8:4 [0:86]
UK	20:1 [0:72]	4:4 [0:41]	2:2 [0:27]
US	¡ 5:9 [¡ 0:14]	¡ 7:1 [¡ 0:12]	¡ 32:9 [¡ 1:07]

Table 14: The Extent of Capital Market Imperfection

Index of capital market imperfection is 100 ¤ m_i, where m_i are coe±cients relating to the weight on country-level variables in the system given by equations (2.3) and (5.4). The higher is m_i, the more imperfect is country i's capital market.

tural coe±cients relating to the equations for, respectively, desired world saving and planned world investment. The °'s capture the e®ects on country real interest rates of observable country{level variables over and above their world counterparts. (In the model developed in Section 5.1 (equation (5.2)) these in°uences were captured in the country{speci¯c constant and error terms.) When real interest rate equation (5.6) is estimated jointly with the investment ratio equation (2.3), cross{equation restrictions can again be imposed that enable the identi¯cation of structural coe±cients. In particular, the e®ects of factors a®ecting investment are restricted to be identical in the investment equation (at country level) and the interest rate equation (at world level). In addition, the coe±cient on lagged investment is restricted to be unity (again, at country level in the investment equation and world level in the interest rate equation). The two{equation restricted system (5.6) and (2.3) is reported in Tables 15 (short rates) and 16 (long rates).

The major focus of interest is whether any explicit country-level variables a®ect county-level real interest rates (the e®ects of world variables are very similar to those reported earlier). These results, shown in the lower halves of columns [18], [20] and [22], di®er between short and long rates. The only country-level factor that appears to in°uence short rates, over and above the e®ect of world factors, is the ratio of government consumption to GDP. Barro (1992) also found country-level government spending to be signi¯cant when added as a single country-level variable to a short rate-based system of equations similar to that reported in Table 12.[27]

In contrast, government consumption has only a marginal e®ect on country{world long real rate di®erentials. In the case of the moving average measure, these di®erentials have been driven more by changes in the proportion of income spent on oil and, surprisingly, by di®erences in monetary stance across countries. On the basis of the trend measure, we could conclude (as before) that treating the ten countries as a closed economy | as having perfect capital markets | is valid: no single country-level variable signi¯cantly a®ects long real rates, according to this measure.

A strong conclusion to emerge from these results is that countries' ¯scal policies have very little in°uence on real interest rate di®erentials | neither $\text{DBTY}_{it¡1}$ nor

[27] This result conforms with the instability of the coe±cient reported between Tables 12 and 14.

Dep. vbl.	$(I{=}Y)_{it}$	r^{e}_{Sit} / $(S{=}Y)_{it}$
	restricted, system	
	[17]	[18]
		E®ects on $(S{=}Y)_{it}$
$(S{=}Y)_{t\,¡\,1}$		0:527 [4:58]
$OILCY_{t\,¡\,1}$		¡ 0:586 [¡ 3:61]
$¢M_{t\,¡\,1}$		0:113 [3:89]
$¢M_{t\,¡\,2}$		0:075 [3:04]
$GCY_{t\,¡\,1}$		¡ 0:526 [¡ 3:20]
$DBTY_{t\,¡\,1}$		¡ 0:107 [¡ 4:19]
$DEFY_{t\,¡\,1}$		0:256 [2:93]
r^{e}_{St}		0:607 [5:99]
		Additional e®ects on r^{e}_{Sit}
$(I{=}Y)_{it\,¡\,1}$	1	0:149 [1:80]
$¢STK_{it\,¡\,1}$	0:024 [8:43]	¡ 0:004 [¡ 0:85]
$¢OILCY_{it\,¡\,1}$	¡ 0:558 [¡ 5:53]	0:188 [0:61]
$OILCY_{it\,¡\,1}$		¡ 0:323 [¡ 0:81]
$¢M_{it\,¡\,1}$		0:005 [0:30]
$¢M_{it\,¡\,2}$		0:009 [0:50]
$GCY_{it\,¡\,1}$		0:558 [3:17]
$DBTY_{it\,¡\,1}$		¡ 0:018 [¡ 0:92]
$DEFY_{it\,¡\,1}$		0:045 [0:85]

Table 15: Country-Level Investment, Saving and Short Real Interest Rates

See notes to Table 12.

Dep. vbl.	$(I=Y)_{it}$	r^e_{Lit} / $(S=Y)_{it}$	$(I=Y)_{it}$	r^e_{Lit} / $(S=Y)_{it}$
	restricted, system (m.a.)		restricted, system (trend)	
	[19]	[20]	[21]	[22]
		E®ects on $(S=Y)_{it}$		E®ects on $(S=Y)_{it}$
$(S=Y)_{t\,¡\,1}$		0:549 [4:00]		0:571 [5:30]
$OILCY_{t\,¡\,1}$		¡ 0:676 [¡ 3:45]		¡ 1:082 [¡ 6:13]
$¢M_{t\,¡\,1}$		0:099 [2:83]		0:180 [5:54]
$¢M_{t\,¡\,2}$		¡ 0:008 [¡ 0:26]		0:093 [3:84]
$GCY_{t\,¡\,1}$		¡ 0:396 [¡ 1:80]		¡ 0:372 [¡ 1:80]
$DBTY_{t\,¡\,1}$		¡ 0:242 [¡ 4:74]		¡ 0:228 [¡ 5:74]
$DEFY_{t\,¡\,1}$		0:039 [0:33]		0:468 [4:61]
r^e_{Lt}		1:042 [4:96]		0:917 [6:15]
		Additional e®ects on r^e_{Lit}		Additional e®ects on r^e_{Lit}
$(I=Y)_{it\,¡\,1}$	1	¡ 0:061 [¡ 1:04]	1	0:100 [1:84]
$¢STK_{it\,¡\,1}$	0:020 [7:23]	0:002 [0:70]	0:018 [7:23]	¡ 0:004 [¡ 1:39]
$¢OILCY_{it\,¡\,1}$	¡ 0:705 [¡ 6:50]	0:436 [1:80]	¡ 0:776 [¡ 7:67]	0:096 [0:50]
$OILCY_{it\,¡\,1}$		¡ 0:984 [¡ 2:96]		¡ 0:408 [¡ 1:51]
$¢M_{it\,¡\,1}$		¡ 0:021 [¡ 1:72]		0:001 [0:13]
$¢M_{it\,¡\,2}$		¡ 0:036 [¡ 2:83]		¡ 0:018 [¡ 1:68]
$GCY_{it\,¡\,1}$		0:045 [0:35]		0:164 [1:23]
$DBTY_{it\,¡\,1}$		0:018 [1:22]		0:009 [0:59]
$DEFY_{it\,¡\,1}$		0:029 [0:75]		¡ 0:011 [¡ 0:37]

Table 16: Country-Level Investment, Saving and Long Real Interest Rates

$DEFY_{it-1}$ have signi¯cant e®ects. But global ¯scal policy has a strong e®ect on interest rates across the world. This is in line with the idea that greater integration of capital markets over time has resulted in much of the link between ¯scal policy and real interest rates shifting to the global level. Our results are supported by other recent work: Ford and Laxton (1995) found that a one percentage point rise in the OECD ratio of debt to GDP raises interest rates by around 25 basis points. The policy implication of our results is that only a generalised reduction in de¯cits will lower real interest rates | countries have limited power to alter real rates through their own ¯scal stance.

There is also no evidence that cross-country di®erences in expected returns to investment a®ect expected real interest rate di®erentials, even though world stock market returns have a strong in°uence on the world average level of real rates (coef-¯cients on ΔSTK_{it-1} in country real interest rate equations are insigni¯cant, and the signi¯cant coe±cients on the variable in the investment equation relate to world real rates).

6. Conclusions

This paper has examined the determinants of short and long real interest rates at world and country level. The analysis was conducted on the basis that real interest rates re°ect the interaction of desired saving and planned investment. A model was developed, stage by stage, that extended those of Barro and Sala-i-Martin (1990) and Barro (1992). At each stage models of real interest rate and investment determination were applied to a group of ten major industrialised countries over the period 1959 to 1992. Both long and short real rates were examined.

The level of world real rates has been a®ected by factors working through both investment and saving. Higher expected pro¯tability of investment (as captured in stock market price rises) tends to raise rates. Income shocks that temporarily reduce saving | such as oil price shocks | have also been responsible for raising real rates.

A higher global level of public debt was found to have a major in°uence, reducing national saving rates and raising the level of world interest rates. This is consistent with the idea that households do not fully compensate for higher expected future taxes by raising saving: Ricardian equivalence does not seem to hold. The other components of Blanchard's (1985) index of ¯scal stance were also examined. Government consumption was not found to be in°uential. In general, global public de¯cits were also found to have no signi¯cant impact on world real interest rates | but, surprisingly, they were found to enter with a positive coe±cient. Results also suggested a role for monetary shocks, which are negatively related to real interest rates. There were some indications that the e®ects of monetary shocks might be persistent.

We suggested that the level of real interest rates has undergone two major `regime shifts' over the last 30 years, declining from moderate to low levels in the early 1970s and rising to high levels at the end of that decade. From an analysis of the factors lying behind these broad shifts we conclude that variations in world debt{GDP ratios have played by far the largest role.

Within our theoretical framework, the relative impact of country and world factors on country real rates can be used to measure the extent of capital market imperfection. According to one measure of long real rates, capital markets have been fully integrated across the ten countries studied. But we identi¯ed varying degrees of imperfection across countries using other measures of real rates.

In general, own-country variables seem to have played a relatively minor part in determining interest rate movements, although results concerning cross-country di®erentials are sensitive to which measure of real rates is used. In contrast to our ¯ndings for world real rates, cross-country interest rate di®erences have not been in°uenced by di®erences across countries in either country debt levels or in the expected pro¯tability of investment. Cross-country di®erentials in short real interest rates have been in°uenced by countries' ratios of government current consumption to GDP, whereas di®erentials in long rates over the last 30 years have been mainly driven by di®erent responses to oil shocks.

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Code	Definition, description and source
r^e	Expected real interest rate Quarterly nominal short rate: Treasury Bill (3-month) rate (IFS line 60a) for January, April, July and October (except Japan: money market rate (IFS line 60b)). Rate for January deflated by inflation between January and April, and so on. Inflation is annualised CPI growth (4 times first difference of natural logarithms of CPI (IFS line 64)). Quarterly nominal long rate: rate on government bonds (IFS line 61) for January, April, July and October (see Table A2 for details). For moving average measure: deflated by eight-quarter moving average of inflation, centred at current quarter. For trend measure: deflated by trend inflation extracted inflation extracted using Hodrick-Prescott filter.
ΔSTK	Growth in real stock market prices Difference (December on December) of log of industrial share prices (IFS line 62) less CPI growth over same period.
OILCY	Proportion of GDP spent on oil Imports of petroleum and related products at current prices (BOPS Table 1, line 1A.BX) as a proportion of GDP at current prices (OECD Table 1, panel 1, line 15).

Table A1: Variable Definitions and Sources

BOPS is IMF Balance of Payments Statistics.
IFS is IMF International Financial Statistics.
OECD is OECD National Accounts.

Code	Definition, description and source
ΔM	Growth in narrow money supply Difference (December on December) of log of M1 (IFS line 34).
GCY	Ratio of real government consumption to GDP Government final consumption expenditure at constant prices (OECD Table 1, panel 2, line 1) as a proportion of GDP at constant prices (OECD Table 1, panel 2, line 15).
DBTY	Real government debt/GDP ratio Government debt (end-year) at current prices (Canada, Germany, Italy, Sweden, USA: IFS line 88; Belgium: lines 88a plus 89a; France: lines 88b plus 89b; Sweden: Monthly Digest of Swedish Statistics; UK: CSO) deflated by December CPI, as a proportion of GDP at constant prices (IFS line 99b) (except Japan, which uses GNP at constant prices (IFS line 99a)).
DEFY	Cyclically adjusted real budget deficit/GDP ratio Change in real government debt (defined as for DBTY) as a proportion of GDP at constant prices (also defined as for DBTY). Cyclically adjusted values are residuals from regression on a constant, current and four lags of real GDP growth.
(I/Y)	Real investment/GDP ratio Gross domestic capital formation at constant prices (OECD Table 1, panel 2, line 6) as a proportion of GDP at constant prices (OECD Table 1, panel 2, line 15).
(S/Y)	Real saving/GDP ratio Implicit variable.
weights	Weighting factors Share of ten-country real GDP (RGDPCH multiplied by POP) from Penn World Tables 5.5 (Summers and Heston, 1991).

Table A1 continued

Country	Description
Belgium	Weighted average yield to maturity of all 5 to 8 per cent bonds issued after December 1962 with more than 5 years to maturity.
Canada	Average yield to maturity of issues with original maturity of 10 years and over.
France	Average yield to redemption of public sector bonds with an original maturity of more than 5 years. Monthly yields are based on the weighted average of Friday prices.
Germany	Weighted average of all bonds issued by Federal government, railways, postal system, Lander governments, municipalities and other public associations, with an average remaining life to maturity of more than 3 years (4 years for bonds included before January 1977). The weights refer to the amounts of individual bonds in circulation. Monthly ¯gures are calculated as averages of four bank week return dates including the end-of-month yield of the preceding month.

Table A2: Long Interest Rate De¯nition and Sources

Country	Description
Italy	Average yield to redemption on bonds with original maturity of 15 to 20 years, issued on behalf of the Treasury by the Consortium of Credit for Public Works. (Average yield to maturity of long- and medium-term bonds is about two years.)
Japan	Arithmetic average yield to maturity of all government bonds with 7 years to maturity. Monthly series are compiled from end-of-month prices quoted on the Tokyo stock exchange.
Netherlands	The yield on the most recent 10-year government bond.
Sweden	Until December 1979, average yield to maturity on government bonds maturing in 15 years or more. From January 1980, yield on bonds maturing in 10 years or more. Monthly data are based on prices at the middle of the month.
UK	Theoretical gross redemption bond yields of bonds issued at par with 20 years to maturity.
US	10-year constant maturities.

Table A2 continued

\`Regime'	¢STK$_{t ¡ 1}$	¢OILCY$_{t ¡ 1}$	OILCY$_{t ¡ 1}$
Medium	0.047	0.000	0.010
Low	-0.107	0.002	0.026
High	0.093	-0.002	0.024

\`Regime'	¢M$_{t ¡ 1}$	¢M$_{t ¡ 2}$	GCY$_{t ¡ 1}$	DBTY$_{t ¡ 1}$	DEFY$_{t ¡ 1}$
Medium	0.076	0.069	0.189	0.328	-0.003
Low	0.089	0.092	0.167	0.278	0.000
High	0.077	0.079	0.165	0.433	0.006

Table A3: Average Level of Independent Variables in World Real Interest Rate Equations

Note: \`Regimes' are de¯ned as follows:
Medium: 1959-73; Low: 1974-79; High: 1980-92.