Changes in world real interest rates and inflationary expectations

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Published in:
Weltwirtschaftliches Archiv

Publication date:
1994

Changes in World Real Interest Rates and Inflationary Expectations

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I. Introduction

The rise in real interest rates towards levels of about 5 percent in the early eighties in all industrialized countries and, above all, the tendency of these rates to remain high since that time, has been as much of a puzzle in recent years as the puzzle of the persistently low real rates of interest rates in the seventies used to be.[1]

Two major questions have been raised with respect to the behaviour of real interest rates. First, to what extent and for how long can the domestic real interest rate deviate from rates in other countries, or, in the aggregate, from a world real interest rate (see, for instance, Cumby and Mishkin [1986]; Frankel and MacArthur [1988]; Mark [1985], and Mishkin [1984]). Empirical results are mixed in this respect.

A second issue of analysis concerns the determinants of movements in real interest rates. This has been investigated among others by Blanchard and Summers [1984]; Holland [1984]; Bonser-Neal [1990]; Cecchetti [1986]; Evans [1985] and Barro and Sala-i-Martin [1991].

Barro and Sala-i-Martin (henceforth BS) integrate both issues as they analyze the expected (ex ante) short-term world real interest rate [2] – measured as an average across ten OECD countries – between 1959–88. Using an IS-LM framework, BS link the expected real interest rate to aggregate investment and aggregate desired saving and conclude: "Simulations of the model indicated that fluctuations in world stock returns and oil prices explain a good deal of the time series

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[1] See, for instance, Wilcox [1983] for an explanation of real interest rate behaviour in the seventies.

[2] According to Barro and Sala-i-Martin, deviations of domestic real rates from world interest rate levels are second order, in general.

for the world average of expected real interest rates; specifically why the rates were low in 1974–1979 and high in 1981–1986". This conclusion is debated by Lucas [1991], who attributes changes in real interest rates mainly to misperceptions about expected inflation.

In this paper, we extend and improve [3] the work by BS in a number of ways by investigating both short- and long-term real interest rate behaviour in ten OECD countries for the period 1974–90. BS model the level of the world real interest rate as a function of stationary and nonstationary variables, including a lagged endogenous variable. According to their model, this latter variable theoretically should have a coefficient reflecting the response of the investment ratio to changes in ex ante real interest rates. We explicitly opt for a simple error-correction framework to account for the nonstationarity of real interest rates and to avoid spurious correlation.

We then relate changes in the world real interest rate to changes in the expected world inflation, to unexpected changes in world money growth, world real income growth, the price of oil and world trade growth and to changes in world stock returns. Compared to BS, we include changes in expected inflation as explanatory variable to allow for the fact that nominal interest rates in the short run needn't move one for one with (expected) inflation. That is, the pure Fisher effect is not imposed a priori. Also, we include (shocks in) real GNP growth as an explanatory variable instead of the investment ratio. The latter is more subject to measurement error and is likely to suffer more from simultaneity problems.

Second, we analogously model deviations of domestic real interest rates from world rates as error correction processes and investigate whether country-specific shocks in money growth and real income growth cause short-run or long-run interest rate divergences. Similarly, we analyze whether country-specific responses to common international shocks may lead to interest rate divergences.

The plan of this paper is as follows. Section II contains a description of the data, with some preliminary statistics. In Section III we briefly introduce the explanatory variables, while empirical results are presented in Section IV. Concluding remarks are in Section V.

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[3] See Brainard [1991] and Lucas [1991] for a critical review of the work by Barro and Sala-i-Martin.

II. Data Description

In the empirical analysis we use quarterly data for ten OECD countries Belgium, France, Germany, Italy, the Netherlands, Japan, Sweden, Switzerland, the United Kingdom and the United States from 1974.2 to 1990.4. Data for long-term interest rates, short-term interest rates, nominal stock prices, money supply (M1), gross domestic product (GDP), the GDP-deflator, the oil price and the volume of real world trade from the IFS are used.

In order to compute aggregate world variables, we use a weighting scheme, which is explained in detail in the Appendix. Domestic ex ante real interest rates are constructed by subtracting an ex ante prediction of future inflation from the nominal interest rate. The inflation predictions are constructed using the Multi State Kalman Filter (MSKF) method, which uses recursive, Bayesian learning techniques.[4]

In the remaining part of this section, we summarize the behaviour of domestic and world real interest rates and inflation rates for several sub-periods and graphically show the time path of domestic interest rates compared with the world rates for Germany, Japan, the United Kingdom and the United States. Also some evidence of nonstationarity of real interest rates over the sample is provided.

1. Simple Summary Statistics

Table A1 in the Appendix contains the average value and standard deviation of the ex ante real short-term and long-term interest rates and the realized inflation rate for the periods 1974.2–1990.4, 1974.2–1979.4 and 1980.1–1990.4.[5]

The difference between the two sub-periods is striking. In the first sub-period, 1974–79, the average short- and long-term world real interest rates are −1.61 per cent and −0.24 per cent, respectively, while they average 3.71 per cent and 4.67 per cent in the second period (1980–90). At the same time, the standard deviation of world real interest rates declines from the first to the second sub-period, suggesting the convergence of real interest rates in the eighties. Second, no clear relation between levels of ex ante real interest rates and levels of inflation across countries appears to be present.

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[4] A detailed description of this technique is available from the authors upon request. See also Kool [1989].

[5] The results do not change considerably when the German monetary unification is excluded from the sample. Results over the sub-period 1980.1–1989.3 are available from the authors upon request.

For a graphical analysis of domestic interest rate deviations from the world real interest rate over the sample, the left part of Figure 1 shows the national and world ex ante short-term real interest rates, while the right part presents the corresponding long rates.

The graph shows that even though real interest rates across the countries analyzed have roughly experienced the same swing from low levels in the seventies to high levels in the eighties, sizable and persistent deviations from the average world real interest rate do exist. As is apparent from Figure 1, for example, real interest rates in Germany have been above the world level between 1973 and 1982 and from 1985 onwards, and it shows that U.K. real interest rates have been the most volatile.[6] This warrants further analysis of country-specific interest rate movements.

2. (Non)stationarity of Ex Ante Real Interest Rates

To investigate which statistical procedure is most appropriate for modelling real interest rates, Table 1 contains information about the amount of (non)stationarity of ex ante real interest levels and spreads (national rates minus world rates). The following general regression has been used:

$$\Delta x_t = c_0 + c_1 T + \gamma x_{t-1} + \sum_{j=0}^{12} \beta_j \Delta x_{t-j}, \qquad (1)$$

where x_t is the ex ante real interest rate level or spread under consideration, T is a linear trend and c_0, c_1, γ and β_j, $j=1,\ldots,12$ are fixed coefficients. For each endogenous variable x, equation (1) is estimated in three ways: first without intercept and trend, second only with an intercept included, and third with both intercept and trend included. In Table 1, the significance[7] of the negative coefficient γ is indicated by * (10 per cent), ** (5 per cent) or *** (1 per cent).

Although results have to be interpreted with caution because of the low power of this type of tests in small samples, the results suggest nonstationarity of real interest rate levels – and even of interest rate spreads – over the sample, although there are a few cases where the real interest rate and the interest rate spread appear to be stationary. For this reason, we will use changes in interest rate levels and spreads

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[6] As the referee pointed out to us, this could be due to the specific definition of the CPI in the United Kingdom which includes interest rates. Another reason might be the drastic tax changes affecting inflation and thus also the estimates.

[7] The null hypothesis is that γ equals zero, implying nonstationarity.

Figure 1 – *Ex Ante Real Interest Rates in the World and in Major Countries, 1974–90 (per cent)*

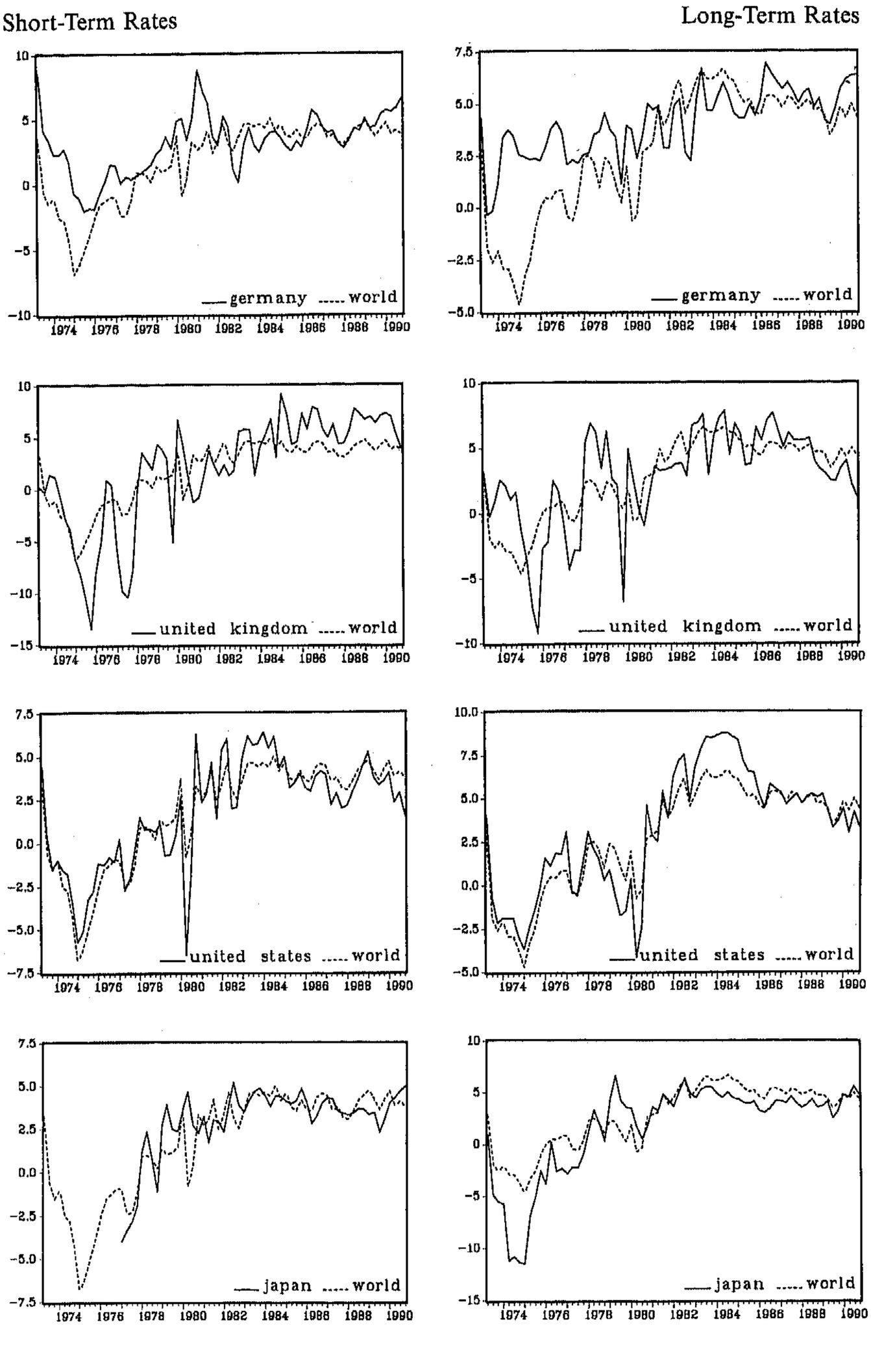

Table 1 – *Unit Root T-Test*

	Ex ante real interest rate level			Ex ante real interest rate spread		
	ADF	ADF +constant	ADF +constant +trend	ADF	ADF +constant	ADF +constant +trend
			Short-term rate			
World		***		n.a.	n.a.	n.a.
Belgium		*		*		
France						
Germany						
Italy						*
Japan				**		**
Netherlands		*		**	*	
Sweden				**		
Switzerland			*			
United Kingdom				**		**
United States				**		
			Long-term rate			
World				n.a.	n.a.	n.a.
Belgium		***	*	*	**	
France						
Germany						
Italy						
Japan		*		*		
Netherlands						
Sweden				***	*	
Switzerland						
United Kingdom		*		***	***	**
United States				*		

Note: * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

as endogenous variables in our empirical research and use an error-correction framework to allow for longer-term mean reversion.

III. Methodology

In the empirical work, we take an agnostic view and use reduced-form estimation. No specific theoretical framework is imposed.[8] The

[8] Note, though, that the resulting reduced form is quite similar to BS [1991], who derive it from a simple IS/LM model. An intertemporal (consumption) asset pricing model with (time-dependent) macroeconomic state variables could lead to the same type of equation, however [see Bomhoff, 1983].

focus is not so much on testing specific restrictions of particular theories but on investigating to what extent a restricted set of a priori chosen exogenous variables is capable of explaining movements in both the world real interest rate and national deviations from that world rate.

Evidence on financial markets, moreover, suggests that financial prices approximately follow a random walk. We, therefore, use a "news" framework and relate changes in interest rates to unexpected components of our hypothesized explanatory variables.

1. The Empirical Specification

As a result, the following equation for the world real interest rate (2) is central to the empirical work:

$$\Delta R^W = \alpha_0 + \alpha_1 R^W_{-1} + \alpha_2 \Delta P^W + \alpha_3 M^W + \alpha_4 Y^W + \alpha_5 TR^W + \alpha_6 P^W_{oil} + \alpha_7 S^W , \quad (2)$$

where R^W is the world real interest, Δ the first difference operator, and where ΔP^W is the change in expected world inflation, M^W, Y^W, TR^W, P^W_{oil} represent unexpected movements in money growth, real income growth, world trade growth, and oil price changes [9] and S^W represents real world stock returns.

For the deviations of domestic real interest rates from the world real interest rates we use a similar framework:

$$\Delta R^D = \alpha_0 + \alpha_1 R^D_{-1} + \alpha_2 \Delta P^D + \alpha_3 M^N + \alpha_4 Y^N + \alpha_5 M^W + \alpha_6 Y^W + \alpha_7 TR^W + \alpha_8 P^W_{oil} + \alpha_9 S^W , \quad (3)$$

where R^D is the spread between the domestic and the world real interest rate, ΔP^D denotes the change in the spread between domestic and world expected inflation and M^N and Y^N stand for unexpected movements in domestic (national) money growth and real income growth respectively. The other symbols have the same interpretation as in (2).

For the choice of explanatory variables, we have drawn upon the existing literature. Below, we briefly discuss the channels through which each of the selected variables may be thought to influence real interest rates.[10]

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[9] All unexpected shocks in the explanatory variables are derived from application of the Multi State Kalman Filter procedure.

[10] Notably missing in the list is a measure of fiscal policy, like for example, the budget deficit. Although we tried to incorporate such variable initially, results were totally insignificant and are, therefore, not reported.

2. Potential Determinants of Real Interest Rates

Expected Inflation

If the pure Fisher effect – as imposed by BS – holds even in the short run, changes in expected inflation will be transmitted proportionally in nominal interest rates, leaving real rates unaffected. If not, real rates may move inversely with expected inflation rates in the short-run.

Money Supply

In the short run, an unexpected increase in the money supply lowers real interest rates by inducing portfolio substitution. An excess supply of money will increase the demand for interest bearing assets, raise their price and, thus, lower interest rates. Besides this short-run liquidity effect, there is also a long-run effect. To the extent that monetary surprises will contain information about permanent changes in expected future inflation, they might even lead to higher nominal interest rates immediately. With actual inflation lagging expected inflation, this could result in higher ex ante real interest rates as well.[11]

Real Income

Several factors could cause a co-movement between income and real interest rates. First, movements in real income could influence both business and consumer confidence.[12] Second, the demand for money rises as income increases, necessitating a rise in real interest rates as well.

Oil Price

The effect of an increase in the oil price can be viewed in two different ways: as a (temporary) fall in income or as a negative supply shock, driving down the marginal utility of capital. In the former case, any forward-looking model of consumer behaviour would predict a fall in the savings rate, since only part of the original fall in income would be allowed to affect current consumption. This would depress the real interest rate, implying a positive relationship between the oil price and real interest rates. Alternatively, Wilcox [1983] suggests that oil or, more generally, energy is considered to be a complement of

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[11] See Bomhoff [1983] for an illustration of this channel.

[12] This cyclical character of income is consistent with the use of the investment ratio by BS [1991] as an indicator of flow of funds disequilibria.

capital in the production process. Rising oil prices would depress the demand for capital, which in turn would lead to a fall in the real rate of interest.

World Trade

The growth in the volume of world trade would seem to be a good approximation of the world business cycle. A rise in world trade therefore may be assumed to raise real interest rates, analogously to the hypothesized positive link between real income and real interest rates.

Stock Prices

Since stock prices reflect discounted future dividends, they are often used as approximations for expected profitability. A rise in expected profitability implies that it will become more attractive to borrow and to invest. As a result, the demand for loanable funds will increase, driving up the real interest rate. Alternatively, portfolio substitution from bonds to stocks may occur, driving up real interest rates as well.

IV. Empirical Results

1. World Real Interest Rates

Table 2 contains the results for the short-term and long-term world real interest rates between 1974.2 and 1990.4. Our results indi-

Table 2 – *Short-Term and Long-Term World Real Interest Rates*

Exogenous variables								Statistics		
c	R^W_{-1}	ΔP^W	M^W	Y^W	TR^W	P^W_{oil}	S^W	R^2	See	LM(4)
Short-term rates										
0.13	−0.05	−0.88	−0.04	0.04	0.04	0.001	–	0.62	0.70	1.24
			2	2						
(1.20)	(1.50)	(7.48)	(1.58)	(1.84)	(3.63)	(1.64)	–			
Long-term rates										
0.21	−0.06	−0.89			0.02	0.001		0.80	0.41	3.32
(2.75)	(3.11)	(13.72)			(2.68)	(2.16)				

Note: Figures on the first lines are coefficients, figures on the second lines are the numbers of lags, figures between parentheses on the third lines are *t*-statistics.

cate that the short-term world real interest rate is nonstationary, as the coefficient on the one-period lagged interest level is insignificant. Second, changes in expected world inflation have an almost one to one negative impact on changes in the short real interest rate.[13] Since changes in expected inflation and changes in real rates appear to be negatively correlated, it follows that persistent overestimation of the level of future inflation would lead to high real interest rates. Third, unexpected movements in world gross domestic product, world trade and the oil price appear to have driven up the real interest rate over the sample period, while unexpected movements in money growth had a negative effect on short-term world real interest rates.

With respect to the long-term world real interest rate the following points stand out. First, in contrast with the short-term real interest rate, the long-term interest rate appears to be stationary. Second, as with the short-term real interest rate, changes in expected inflation have a strong negative effect on long-term real interest rates. Third, unexpected movements in world trade growth and the oil price change appear to have driven up the long-term real interest rate significantly.

Although our results are not strictly comparable with BS [1991], some notable differences exist. First, BS find an autoregressive (mean reversion) coefficient of about 0.5 for the level of the world real interest rate, while we document absence of mean reversion and, thus, nonstationarity for the short rate. For the long rate, not investigated by BS, we find a very slow mean reversion pattern. Various explanations come to mind. First, BS's inclusion of the sixties with relatively stable real interest rate levels may underlie their finding of mean reversion. On the other hand, their set of explanatory variables includes both stationary and nonstationary elements, so that their results may be spurious. Overall, such comparison reveals the sensitivity of this type of regression for the unaccounted presence of nonstationarity.

A second major difference is the set of explanatory variables. In the BS analysis, real factors, specifically stock returns and oil prices appear to be key elements. They note (p. 15): "We think we have partial answers to how world real interest rates have been determined, and more specifically, to why real interest rates were as high as they

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[13] With a coefficient on changes in expected inflation insignificantly different from unity, the results may also be interpreted as a regression of changes in the nominal interest rate on real and monetary factors. A negative coefficient on the lagged real interest rate then suggests that nominal interest rates will decline on average when real rates are high.

were in the 1980s. The key elements in the period 1981–86 appear to be favorable stock returns (which raised real interest rates and stimulated investment) combined with high oil prices (which raised real interest rates, but discouraged investment)".

As opposed to this, we assign a major role to changes in expected inflation[14] in explaining both short-term and long-term real interest rates, which is consistent with the comments of Lucas [1991, p. 73], who notes: "... I would attribute all the remaining differences in nominal rates, and most of the year-to-year variances in these rates, to changes in expected inflation rates. Throughout most of the 1970s, I think people in the OECD countries expected inflation rates to be reduced to earlier levels; throughout most of the 1980s, they expected high inflation to resume. After the fact, these beliefs were proven to be wrong and for many years they were less accurate than extrapolations based on inflation rates in the recent past would have been".

Apart from this, we do find some influence of real factors (oil prices, world trade, and world income growth) for both long and short rates. Money growth only influences the short rate, through a liquidity channel. No effect of stock returns was found. For the long rate, the LM(4) statistic is significant at the 5 per cent level, indicating some serial correlation of the residuals.

2. The Spread Between Domestic and World Real Interest Rates

Until now, we have implicitly assumed the existence of one world capital market and one world real interest rate. In reality, domestic real interest rates may deviate from the world real interest, either because of country-specific shocks or because of country-specific responses to common shocks.

To address this issue, we use equation (3). Note that we do not impose the coefficients of domestic and world money supply shocks and real growth shocks to be the same. The results for short-term and long-term interest rate spreads are in Table 3.

As is apparent from the upper part of Table 3, movements in the spread between domestic and world short-term real interest rates are first and foremost explained by changes in the spread between domestic and world expected inflation. In addition, we find unexpected

[14] To check the sensitivity of our results for the specific way in which inflationary expectations have been formed, we repeated the analysis using realized inflation rates. No major differences arose.

Table 3 – *Regression Results of Real Interest Rate Differentials*

	Exogenous variables										Statistics		
	c	R^D_{-1}	ΔP^D	M^N	Y^N	M^W	Y^W	TR^W	P^W_{oil}	S^W	R^2	See	LM(4)
							Short-term interest rates						
Belgium	0.34	−0.19	−0.74	−0.06	0.03		−0.051				0.60	1.21	0.44
	(1.68)	(3.12)	(5.12)	(3.34)	(2.93)		(1.80)						
France	0.07	−0.16	−0.93					−0.022		−4.27	0.61	0.84	1.05
	(0.64)	(2.85)	(9.08)					(1.71)		(2.96)			
Germany	0.16	−0.11	−1.05	−0.03							0.57	0.89	2.05
	(1.30)	(1.97)	(8.50)	(2.45)									
Italy	−0.14	−0.06	−0.99		0.06		−0.122	0.082	−0.004		0.77	1.24	0.82
	(0.87)	(0.97)	(12.32)		(2.42)		(3.15)	(3.48)	(3.68)				
Japan	0.01	−0.39	−0.61		0.061			−0.07			0.63	0.88	0.52
	(0.09)	(3.48)	(3.52)		(1.75)			(4.09)					
Netherlands	0.11	−0.17	−0.95	−0.05			−0.071				0.53	1.24	1.72
	(0.72)	(2.39)	(6.75)	(3.99)			(2.32)						
Sweden	−0.15	−0.26	−0.85	−0.03			−0.072	−0.061	−0.004		0.70	1.45	1.10
	(0.74)	(3.56)	(7.00)	(2.31)			(2.17)	(3.21)	(2.09)				
Switzerland	−0.04	−0.07	−0.97	−0.02			−0.05				0.74	0.87	2.32
	(0.26)	(1.39)	(11.73)	(2.25)			(1.80)						
UK	0.10	−0.05	−0.97		0.06		−0.09		0.003		0.76	1.37	1.00
	(0.57)	(0.84)	(12.61)		(1.94)		(1.99)		(2.01)				
US	0.003	−0.21	−1.02		0.05			−0.021			0.66	0.75	2.01
	(0.03)	(2.53)	(7.60)		(3.20)			(1.69)					

(Table continued on the next page)

(Table 3 – Continued)

	Exogenous variables										Statistics		
	c	R^D_{-1}	ΔP^D	M^N	Y^N	M^W	Y^W	TR^W	P^W_{oil}	S^W	R^2	See	LM(4)
							Long-term interest rates						
Belgium	0.07	−0.02	−1.00		0.01				0.001		0.91	0.38	1.14
					1				2				
	(1.24)	(0.84)	(24.64)		(2.21)				(1.97)				
France	−0.01	−0.04	−1.07	−0.01			−0.02			−1.45	0.89	0.41	0.57
				2			2						
	(0.11)	(1.21)	(20.54)	(1.74)			(1.85)			(2.23)			
Germany	0.06	−0.06	−1.03					0.01			0.90	0.32	0.95
	(1.41)	(3.12)	(21.97)					(1.80)					
Italy	−0.05	−0.07	−0.98		0.03		−0.03		−0.001		0.91	0.68	1.55
					2		2						
	(0.53)	(1.39)	(21.29)		(2.13)		(2.13)		(2.35)				
Japan	−0.01	−0.03	−0.86		0.02		−0.02		0.001		0.91	0.37	0.84
					1								
	(0.25)	(1.28)	(16.58)		(2.50)		(1.78)		(2.67)				
Netherlands	0.03	−0.03	−1.01	−0.01							0.92	0.34	1.11
	(0.59)	(1.23)	(25.98)	(3.30)									
Sweden	0.07	−0.03	−1.02			0.03		−0.01			0.92	0.51	1.22
	(1.18)	(0.83)	(25.36)			(2.00)		(2.10)					
Switzerland	−0.12	−0.06	−0.97		0.02			−0.02			0.95	0.34	2.26
	(2.35)	(3.62)	(31.37)		(1.74)			(2.90)					
UK	−0.03	−0.001	−0.96				−0.04	0.03			0.93	0.68	1.00
							1	1					
	(0.35)	(0.03)	(24.83)				(1.92)	(2.57)					
US	0.05	−0.02	−1.01		0.03	0.02	−0.04			−1.01	0.84	0.35	0.94
					2	1	2			2			
	(0.97)	(0.62)	(16.78)		(2.40)	(1.62)	(2.03)			(1.72)			

Note: Figures on the first lines are coefficients; figures on the second lines are the numbers of lags; figures between parentheses on the third lines are *t*-statistics.

domestic money growth and real income growth to be significant explanatory variables for a number of countries. For Belgium, Germany, the Netherlands, Sweden and Switzerland, unexpected money growth has a negative effect on domestic real interest rates. Domestic unexpected real growth has a positive significant effect in the case of Belgium, Italy, Japan, the United Kingdom, and the United States.

With respect to the deviations of the long-term domestic real interest rates from the world real interest rate, we find a similar picture. Deviations of domestic inflationary expectations from the world level appear to be the most important explanation for deviations from long-term real interest rates from the world real interest rate. In addition, we find unexpected real income growth to play a significant role in the case of Belgium, Italy, Japan, Switzerland, and the United States.

Unexpected movements in world variables – money growth, income growth, trade growth and oil prices – also affect interest rate spreads in various countries. When significant, world money growth enters with a positive sign and world income growth with a negative sign as hypothesized.[15] Oil price shocks and world trade shocks enter with differing signs, probably reflecting differences in industrial structures across countries. Stock returns enter negatively for the short rate and the long rate in France, and for the long rate in the U.S.

One troublesome aspect of the results in Table 3 is the lack of mean reversion of countries. For the set of industrialized and integrated economies investigated, one would at least in the long term expect real interest rates to converge. A possible explanation is the relatively short sample, which may prevent the long run from taking its effect in the estimation. Another possibility is the presence of significant measurement error in inflationary expectations. This requires further research.

V. Conclusions

In this paper, we have analyzed short-term and long-term real interest rates from 1974 to 1990. The analysis uses a standard error-correction framework and focuses both on world and national real interest rates. With respect to the world short-term real interest rate, we find changes in inflationary expectations, unexpected money growth, unexpected real income growth, unexpected world trade

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[15] This is the counterpart of the domestic impulses.

growth and unexpected oil price movements to be important explanatory variables. With respect to the long-term world real interest rates, changes in inflationary expectations, unexpected world trade growth and unexpected oil price movements are significant explanatory variables. Paramount in the explanation of short-term as well as long-term world real interest rates is the importance of changes in inflationary expectations, which are significantly negatively correlated with movements in real interest rates. This corroborates recent conjectures by Lucas [1991] that misperceptions about future inflation have been a dominant characteristic in both the seventies and eighties.

We have also investigated the extent to which domestic factors cause domestic interest rates to diverge from world real interest rates. For all countries we find changes in inflationary expectations (relative to the world) to be the most important factor through which the domestic real interest rate deviates from the world real interest rate. Unexpected domestic money and real income growth also contribute to the explanation of real interest rate spreads.

Our results imply that measurement of inflationary expectations should be at the top of the research agenda to be able to explain movements in real interest rates. It also suggests that understanding why and under what circumstances the relationship between real interest rate and expected inflation exhibits regime changes is of crucial importance. In future work we intend to investigate the effect of learning about different inflation regimes on real interest rates using regression techniques which explicitly allow for such changes in regime.

Appendix

Construction of world variables

Aggregation of domestic variables has been applied to obtain the following world variables: short- and long-term real interest rates, nominal money supply growth, real income growth and stock returns.[16] This appendix will briefly describe the construction of the aggregate variables.

We have used the OECD National Accounts quarterly series for real income (gross domestic product, GDP), except for Belgium and

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[16] For the oil price, an existing series (UK Brent prices) has been used. For world trade we use the sum of real OECD imports and exports.

Table A1 – *Summary Statistics*

	1974.2–1990.4		1974.2–1979.4		1980.1–1990.4	
	Mean	SD	Mean	SD	Mean	SD
	Short-term real interest rates					
World	1.89	3.05	−1.61	2.47	3.71	1.09
Belgium	4.10	4.05	0.57	4.78	5.94	1.83
France	2.45	3.25	−0.97	2.20	4.23	2.05
Germany	3.05	2.24	0.82	1.61	4.21	1.53
Italy	2.81	4.35	−1.03	4.07	4.82	2.92
Japan[a]	3.11	1.81	0.59	2.50	3.74	0.79
Netherlands	2.43	3.91	−1.10	4.32	4.27	1.94
Sweden	1.94	3.73	−2.32	2.50	4.16	1.85
Switzerland	0.26	2.63	−2.15	2.08	1.52	1.93
United Kingdom	2.02	5.42	−3.39	5.45	4.85	2.46
United States	1.85	3.11	−1.25	1.93	3.47	2.25
	Long-term real interest rates					
World	2.98	2.93	−0.24	2.14	4.67	1.55
Belgium	4.17	3.44	0.56	3.60	6.05	0.94
France	2.99	3.16	−0.71	1.30	4.93	1.81
Germany	4.23	1.39	2.98	0.82	4.89	1.16
Italy	1.99	3.88	−1.37	3.66	3.75	2.66
Japan	1.92	4.39	−2.18	5.35	4.07	1.10
Netherlands	4.23	2.64	1.52	2.34	5.65	1.37
Sweden	2.81	2.91	−0.33	1.97	4.46	1.71
Switzerland	1.08	1.80	0.40	2.12	1.43	1.51
United Kingdom	2.89	3.78	−0.09	4.50	4.46	2.08
United States	3.37	3.48	−0.03	1.92	5.15	2.69
	Inflation rates					
World	6.57	3.41	9.14	2.39	5.23	3.09
Belgium	6.03	3.61	8.45	3.87	4.77	2.75
France	8.27	4.01	10.69	1.82	7.01	4.27
Germany	3.44	2.02	4.50	1.48	2.89	2.05
Italy	12.84	5.88	16.47	3.84	10.94	5.90
Japan	4.96	5.21	9.52	6.28	2.58	2.16
Netherlands	4.34	3.31	7.21	2.68	2.83	2.54
Sweden	8.72	2.82	9.77	2.09	8.17	3.01
Switzerland	3.56	2.38	3.76	3.23	3.46	1.83
United Kingdom	10.46	6.14	15.83	5.51	7.65	4.33
United States	6.55	3.37	8.48	2.39	5.55	3.38

[a] Japan starting at the second quarter of 1977.

Sweden. In these two cases, annual GDP data have been interpolated using quarterly series for industrial production.

National GDP data have been converted into dollar equivalents, by multiplying with their respective 1988 average exchange rate relative to the dollar (IFS series). National weights are then calculated by dividing the national dollar denominated GDP data by the corresponding dollar denominated aggregate. The national weights have in turn been used to calculate the world counterparts of national nominal M1-figures, interest rates and consumer price indices. On the basis of the world consumer price index, a world inflation series has been constructed. Expected world inflation has been constructed using the Multi State Kalman Filter. World real interest rate series have been calculated as the difference between the world nominal interest rate and the expected rate of world inflation.

The national inflation rates have been subtracted from the growth rate of national stock prices, in order to attain a measure for real stock returns. National real stock prices have been aggregated into a world total using GDP weights after which first differences were taken. Since the real stock returns follow a random walk, this procedure should yield an adequate measure for unexpected shocks in stock returns.

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Abstract: Changes in World Real Interest Rates and Inflationary Expectations. – One of the major macroeconomic puzzles has been that the real interest rates were persistently low in the seventies and persistently high in the eighties. The authors use a news framework to investigate the extent to which shocks in real output, money supply, world trade, oil prices, stock prices and expected inflation affect the world and national real interest rates. They find dominant effects on real interest rates from movements in expected inflation rates. This suggests the presence of persistent misperceptions about future inflation and the need of further research into the formation of inflationary expectations. JEL No. E43, G15.

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Zusammenfassung: Veränderungen der realen Zinssätze in der Welt und Inflationserwartungen. – Eines der größeren makroökonomischen Rätsel war die Tatsache, daß die realen Zinssätze in den siebziger Jahren anhaltend niedrig und in den achtziger Jahren anhaltend hoch waren. Die Verfasser benutzen ein Modell, das unerwartete Ereignisse verarbeitet, um zu untersuchen, wie stark Schocks bei Produktion, Geldmenge, Welthandel, Ölpreisen, Aktienkursen und Inflationserwartungen die realen Zinssätze in der Welt insgesamt und in den einzelnen Ländern beeinflussen. Sie finden, daß Veränderungen in den erwarteten Inflationsraten eine dominierende Wirkung auf die realen Zinssätze ausüben. Dies deutet darauf hin, daß es dauerhaft falsche Vorstellungen über die künftige Inflation gibt und daß es notwendig ist, das Entstehen von Inflationserwartungen weiter zu untersuchen.