On the determination of long-term interest rates and exchange rates

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Introduction

Empirical investigations of the behaviour of interest rates are mostly based on a loanable funds theory. Well known examples of this approach are Evans (1987), Hoelscher (1986), Barro and Sala-i-Martin (1991). In these models the real interest rate is determined by the equilibrium between investment demand and desired saving in the economy. Following this approach, expected economic growth or profitability, inflation surprises, public deficits and public consumption are considered to be the main variables explaining the behaviour of interest rates. Especially the impact of public deficits was, however, the subject of contradictory results. Public deficits, by reducing the available funds, were expected to raise real interest rates, except in those cases where private agents would increase their private wealth accumulation to offset future tax liabilities. This last argument illustrates that the loanable funds approach by lacking rigorous microeconomic and intertemporal underpinnings, is not the best possible theoretical model to analyse the behaviour of interest rates.

Another shortcoming of the loanable funds approach, which was partly responsible for the contradictory results, was the absence of a distinction between the determination of the short and long-term interest rates. Most authors who did not find a significant impact of government deficits on interest rates, were actually concentrating on short-term interest rates, while others who found strong influences of deficits were explaining long-term interest rates, including the short-term rate as an explanatory variable in the equation (Hoelscher, 1986, Correira-Nunes and Stemitsiotis, 1995). The empirical investigation should therefore start from a model that incorporates an explanation of the term structure, and distinguishes the determinants of short and long-term rates. Following this reasoning it is important to introduce uncertainty in the model to avoid the simplistic expectations theory and to allow for time varying risk premia in the determination of returns on risk-bearing assets.

The loanable funds approach also led to overemphasising the role of public deficits, and to ignoring the role of the current account balance in the determination of interest rates. This asymmetric treatment of two macroeconomic imbalances is also reflected in the public discussion. Following the loanable funds approach one should expect a surplus on the current account, if determined exogenously by the competitiveness of the economy, to increase the interest rate as the domestic economy is lending to the rest of the world. But the empirical results, which incorporate current account balances, show a negative effect on the real interest rate (OECD 1995). This result was interpreted as reflecting expectations of exchange rate appreciation allowing lower interest rates. Such an argument, however, is more appropriate in a portfolio diversification approach, than in a loanable funds context.

In this paper, we adopt an alternative framework for analysing the determinants of long-term interest rates and exchange rates. The theoretical model is based on optimal intertemporal behaviour of the consumption-saving-portfolio allocation in small open economies and then applied to the explanation of bond yield differentials in a number of European countries the German bond vis-à-vis yield giving special emphasis to the treatment of expectations and uncertainty. The complementary analysis of exchange rate determination is applied to the DEM/BEF exchange rate.

1. Theoretical framework

The representative consumer maximises the expected value of a discounted expected logarithmic utility function which depends on consumption:

$$\underset{t}{Max\,E}\sum_{k=0}^{\infty}\rho^{k}U(C_{t+k}) \tag{1}$$

subject to a budget constraint (here written as in Lee, 1995):

$$\begin{aligned}&\sum_{i=k+1}^{\infty} b_{t+k}^{t+i}\, B_{t+k}^{t+i} + \sum_{i=k+1}^{\infty} f_{t+k}^{t+1}\, s_{t+k}\, F_{t+k}^{t+i} = \\ &B_{t+k-1}^{t+k} + s_{t+k}\, F_{t+k-1}^{t+k} + \sum_{i=k+1}^{\infty} b_{t+k}^{t+i}\, B_{t+k-1}^{t+i} + \sum_{i=k+1}^{\infty} f_{t+k}^{t+i}\, s_{t+k}\, F_{t+k-1}^{t+i} + Y_{t+k} - C_{t+k}\end{aligned} \tag{2}$$

where $\underset{t}{E}(\cdot)$ is the mathematical expectation conditioned on information available at time t, ρ = the subjective discount factor, U is the utility function, C is consumption, b_t^{t+i} = time t price of a domestic discount bond which pays one unit of domestic currency at time $t+i$, B_t^{t+i} = the number of i period domestic discount bonds held by the household at time t, f_t^{t+i} = time t price of a foreign discount bond which pays one unit of foreign currency at time $t+i$, s = the price of one unit of foreign currency in domestic currency, F_t^{t+i} = the number of i period foreign discount bonds held by the household at time t, and Y = income.

The dynamic Lagrangean to be maximised is[1]:

$$L_t = \underset{t}{Max\,E}\sum_{k=0}^{\infty}\rho^{k}\left(\begin{aligned}&U(C_{t+k}) + \lambda_t(Y_{1+k} - C_{t+k} + B_{t+k-1}^{t+k} + s_{t+k}\, F_{t+k-1}^{t+k} + \sum_{i=k+1}^{\infty} b_{t+k-1}^{t+i}\, B_{t+k-1}^{t+i} \\ &+ \sum_{i=k+1}^{\infty} f_{t+k}^{t+i}\, s_{t+k}\, F_{t+k-1}^{t+i} - \sum_{i=k+1}^{\infty} b_{t+k}^{t+i}\, B_{t+k}^{t+i} - \sum_{i=k+1}^{\infty} f_{t+k}^{t+i}\, s_{t+k}\, F_{t+k}^{t+i})\end{aligned}\right) \tag{3}$$

In period t, the first order conditions w. r. t. the five decision variables are:

$$\frac{\delta L_t}{\delta C_t} = \underset{t}{E}\left[U'(C_t) - \lambda_t\right] = 0 \tag{4}$$

$$\frac{\delta L_t}{\delta B_t^{t+1}} = \underset{t}{E}\left[-\lambda_t b_t^{t+1} + \rho\lambda_{t+1}\right] = 0 \tag{5}$$

$$\frac{\delta L_t}{\delta B_t^{t+2}} = \underset{t}{E}\left[-\lambda_t b_t^{t+2} + \rho\lambda_{t+1} b_{t+1}^{t+2}\right] = 0 \tag{6}$$

1 The transversality conditions accompanying this maximisation problem are not discussed here. For an infinite horizon model and no uncertainty, these conditions would imply that the present value of future public and current account surpluses would equate current deficits. However under the assumption of imperfect substitution between different assets (and liabilities), supply and wealth effects will still influence the consumption and allocation decision.

$$\frac{\delta L_t}{\delta F_t^{t+1}} = \underset{t}{E}\left[-\lambda_t f_t^{t+1} s_t + \rho\lambda_{t+1} s_t\right] = 0 \tag{7}$$

$$\frac{\delta L_t}{\delta F_t^{t+2}} = \underset{t}{E}\left[-\lambda_t f_t^{t+2} s_t + \rho\lambda_{t+1} f_{t+1}^{t+2} s_{t+1}\right] = 0 \tag{8}$$

1.1 The holding return on domestic bonds

Because period t-values are known with certainty in period t, it follows from equation (6) and

$$\rho \underset{t}{E}\left[\frac{\lambda_{t+1} b_{t+1}^{t+2}}{\lambda_t b_t^{t+2}}\right] = 1 \tag{9}$$

Assuming that $\left(\frac{\lambda_{t+1}}{\lambda_t}\right)$ and $\left(\frac{b_{t+1}^{t+2}}{b_t^{t+2}}\right)$ are jointly lognormally distributed, then (9) can be solved as:

$$\begin{aligned}&\ln\rho + \underset{t}{E}\left[\ln\left(\frac{\lambda_{t+1}}{\lambda_t}\right)\right] + \frac{1}{2}\operatorname{var}\left[\ln\left(\frac{\lambda_{t+1}}{\lambda_t}\right)\right] + \underset{t}{E}\left[\ln\left(\frac{b_{t+1}^{t+2}}{b_t^{t+2}}\right)\right] + \frac{1}{2}\operatorname{var}\left[\ln\left(\frac{b_{t+1}^{t+2}}{b_t^{t+2}}\right)\right]\\ &+\operatorname{cov}\left[\ln\left(\frac{\lambda_{t+1}}{\lambda_t}\right)\right]\cdot\ln\left(\frac{b_{t+1}^{t+2}}{b_t^{t+2}}\right) = 0\end{aligned} \tag{10}$$

Using similar assumptions, (5) can be written as:

$$\begin{aligned}&\ln\rho + \underset{t}{E}\left[\ln\left(\frac{\lambda_{t+1}}{\lambda_t}\right)\right] + \frac{1}{2}\operatorname{var}\left[\ln\left(\frac{\lambda_{t+1}}{\lambda_t}\right)\right] + \underset{t}{E}\left[\ln\left(\frac{1}{b_t^{t+1}}\right)\right] + \frac{1}{2}\operatorname{var}\left[\ln\left(\frac{1}{b_t^{t+1}}\right)\right]\\ &+\operatorname{cov}\left[\ln\left(\frac{\lambda_{t+1}}{\lambda_t}\right)\right]\cdot\ln\left(\frac{1}{b_t^{t+1}}\right) = 0\end{aligned} \tag{11}$$

Eq. (4) implies:

$$\lambda_t = U'(C_t)$$

and hence:

$$\lambda_{t+1} = U'(C_{t+1})$$

In case of a logarithmic utility function, the marginal rate of substitution equals the negative of the growth rate of consumption, so that:

$$\ln\left[\frac{\lambda_{t+1}}{\lambda_t}\right] = \ln\left[\frac{U'(C_{t+1})}{U'(C_t)}\right] = -g_C \tag{12}$$

For a discount bond, the expected one period holding return (H) should correspond to its expected price change over the corresponding period:

$$\underset{t}{E}\left(H_t^{t+1}\right)=\underset{t}{E}\left(\ln\frac{b_{t+1}^{t+2}}{b_t^{t+1}}\right) \tag{13}$$

where the price of such a bond depends on the one period rate of interest (i):

$$\ln b_t^{t+1}=-i_t^{t+1} \tag{14}$$

From (10) and (11) and making use of (12), (13) and (14):

$$\underset{t}{E}\left(H_t^{t+1}\right)=i_t^{t+1}-\frac{1}{2}\operatorname{var}\left(H_t^{t+1}\right)+\frac{1}{2}\operatorname{var}\left(i_t^{t+1}\right)+\operatorname{cov}\left(g_C,H_t^{t+1}-i_t^{t+1}\right) \tag{15}$$

For a logarithmic utility function, the growth rate of consumption equals the growth of wealth $\left(g_w\right)$. However, wealth itself grows with the one period total return on the wealth portfolio (T) and the savings ratio:

$$g_W=T_t^{t+1}+\left(\frac{Y-C}{W}\right)_t$$

Total portfolio return can be expressed as the weighted sum of holding returns on riskbearing assets (having maturity longer than one period) and the one period interest rate (the remuneration on the one period asset, assumed to be the riskless asset in the absence of price risk):

$$T_t^{t+1}=\tilde{s}'\left(\tilde{H}_t^{t+1}-\mathrm{I}i_t^{t+1}\right)+i_t^{t+1}$$

where: $\tilde{s}'=$vector of shares of riskbearing assets in the total portfolio and

$\tilde{H}_t^{t+1}-\mathrm{I}i_t^{t+1}=$vector of one period risk premia on riskbearing assets (I being the identity nature).

Therefore:

$$g_W=s'\left(\tilde{H}_t^{t+1}-\mathrm{I}\cdot i_t^{t+1}\right)+i_t^{t+1}+\left(\frac{Y-C}{W}\right)_t \tag{16}$$

By substituting (16) into (15), neglecting the risk premia in terms of variances and considering the savings rate and the one period interest rate to be non-stochastic, the following expression for the expected holding period return on the two period domestic discount bond is obtained:

$$\underset{t}{E}\left(H_t^{t+1}\right)=i_t^{t+1}+\operatorname{cov}\left[\tilde{s}'\left(\tilde{H}_t^{t+1}-\mathrm{I}i_t^{t+1}\right),\left(H_t^{t+1}-i_t^{t+1}\right)\right]$$

which can be written as:

$$\underset{t}{E}\left(H_t^{t+1}\right)=i_t^{t+1}+\tilde{V}_t'\tilde{s}_t \tag{17}$$

where: $\tilde{V}'=$variance-covariance nature of expected risk premia.

Equation (17), shows that the expected holding period rate of return on domestic bonds equals the sum of the one period rate of interest with unitary coefficient and a risk premium that depends on the shares of domestic and foreign bonds in the total portfolio, premultiplied with the variance-covariance nature of expected returns on these assets.

This interpretation of the intertemporal CAPM stresses the importance of the supply and wealth effects in the risk premia. A more general model would include additional risk components, such as the variance of inflation and the covariance of the latter with expected returns. If then the rate of inflation is correlated with its volatility, this would suggest a positive relation between the past realised inflation rates and expected real returns on bonds.

1.2 The exchange rate

From eq. (7) follows:

$$\rho \underset{t}{E}\left(\frac{\lambda_{t+1}}{\lambda_t} \frac{s_{t+1}}{s_t \cdot f_t^{t+1}} \right) = 1$$

Assuming lognormal distributions, this equation can be rewritten as:

$$\begin{aligned} &\ln \rho + \underset{t}{E}\left(\ln \frac{\lambda_{t+1}}{\lambda_t} \right) + \frac{1}{2} \operatorname{var}\left(\ln \frac{\lambda_{t+1}}{\lambda_t} \right) + \underset{t}{E}\left(\ln \frac{s_{t+1}}{s_t f_t^{t+1}} \right) + \frac{1}{2} \operatorname{var}\left(\ln \frac{s_{t+1}}{s_t f_t^{t+1}} \right) \\ &+ \operatorname{cov}\left(\ln \frac{\lambda_{t+1}}{\lambda_t} \cdot \ln \frac{s_{t+1}}{s_t f_t^{t+1}} \right) = 0 \end{aligned} \tag{18}$$

From (18) and (11) and neglecting risk premia in terms of variances, the following exchange rate equation is obtained:

$$\ln s_t = \underset{t}{E} \ln(s_{t+1}) + i*_t^{t+1} - i_t^{t+1} - \tilde{W}_t' \tilde{s}_t \tag{19}$$

where $i*$ denotes the foreign short term interest rate, and

$\tilde{W}'$ is the variance-covariance nature of expected returns.

Equation (19) implies that the exchange rate depends on the expected future exchange rate, the short-term interest rate differential and a risk premium that depends on the shares of domestic and foreign bonds in the total portfolio, premultiplied with the covariance-variance vector of expected returns on these assets.

2. Empirical application

2.1 Bond yields

2.1.1 From holding period returns to bond yields

The theoretical derivation in Section 1.1 resulted in an expression for the expected holding period return on domestic bonds. In the empirical application, we want to explain the bond yield. Therefore the link between holding return and yield has to be clarified. Furthermore, for estimation purposes, we necessarily have to focus exclusively on a discrete time approach.

The return, R, on a perpetuity paying a coupon of one unit of domestic currency, depends inversely on its price, P:

$$R_t = \frac{1}{P_t}$$

In discrete time the expected holding return on such a bond can be approximated as:

$$\underset{t}{E}\left(H_t^{t+1}\right) = R_t - \frac{\underset{t}{E}(R_{t+1}) - R_t}{\overline{R}} \tag{20}$$

where $\overline{R}$ is interpreted as an average return (see e.g. Mankiw, 1986, and Mankiw and Summers, 1984). Substituting (20) into (17), assuming rational expectations and applying recursive forward solution:

$$R_t = (1-\gamma)\sum_{k=0}^{\infty}\gamma^k \underset{t}{E}\left[i_{t+k} + \left(\tilde{V}'\tilde{s}'\right)_{t+k}\right] \tag{21}$$

where $\gamma = \frac{1}{1+\overline{R}}$

Equation (21) can be rewritten as:

$$R_t = (1-\gamma)\sum_{k=0}^{\infty}\gamma^k \underset{t}{E}\left(i_{t+k}^*\right) + (1-\gamma)\sum_{k=0}^{\infty}\gamma^k \underset{t}{E}(i-i*)_{t+k} + (1-\gamma)\sum_{k=0}^{\infty}\gamma^k \underset{t}{E}\left[\left(\tilde{V}'\tilde{s}'\right)_{t+k}\right]$$

where i^* is the German short-term interest rate.

Taking the same expression as (21) for German interest rates, but assuming absence of a risk premium in the German long-term bond yield, results in the following domestic bond yield equation:

$$R_t = R_t^* + (1-\gamma)\sum_{k=0}^{\infty}\gamma^k \underset{t}{E}(i-i*)_{t+k} + (1-\gamma)\sum_{k=0}^{\infty}\gamma^k \underset{t}{E}\left[\left(\tilde{V}'\tilde{s}'\right)_{t+k}\right] \tag{22}$$

where $R*$ is the German long term bond yield.

In the presence of transaction costs, the bond yield will not instantaneously react to its new equilibrium level $\left(R^e\right)$. Therefore we assume a partial adjustment mechanism:

$$R_t = (1-\varepsilon)R_t^e + \varepsilon R_{t-1}$$

such that eq. (22) can be rewritten as:

$$R_t = (1-\varepsilon)\left\{R_t^t + (1-\gamma)\sum_{k=0}^{\infty}\gamma^k \underset{t}{E}(i-i*)_{t+k} + (1-\gamma)\sum_{k=0}^{\infty}\gamma^k \underset{t}{E}\left[\left(\tilde{V}'\tilde{s}'\right)_{t+k}\right]\right\} + \varepsilon R_{t-1} \tag{23}$$

Eq. (23) can easily be reparameterised as a forward looking error correction model:

$$\begin{aligned}\Delta R_t &= -(1-\varepsilon)\left(R - R* - i + i* - \tilde{V}'\tilde{s}\right)_{t-1} \\ &+ (1-\varepsilon)\left\{\sum_{k=0}^{\infty}\gamma^k \underset{t}{E}\,\Delta(i-i*)_{t+k} + \sum_{k=0}^{\infty}\gamma^k \underset{t}{E}\,\Delta\left[\left(\tilde{V}'\tilde{s}'\right)_{t+k}\right] + \Delta R_t^*\right\}\end{aligned} \tag{24}$$

Equations (4) and (5) clearly show that the short-term nominal interest rate differential must be related to differential growth rates in nominal consumption expenditures, or to inflation and real growth differentials taken separately. We will split expected future nominal interest rate differentials into expected future real interest rate differentials (which should be related to growth prospects) and expected future inflation differentials.

Furthermore, in the presence of transaction costs, portfolio reallocations will occur at the margin through the allocation of new savings. Therefore, the risk premia can be restated as a function of the public deficit (instead of the public debt) and in terms of the current balance of payments (instead of net foreign assets). Another reason for substituting the deficit and current account variables for the stock variables, is the forward looking character of the flow concepts. The future development of the debt ratio or the net foreign asset position is crucially dependent on the actual and expected future deficit and current account balances. It is precisely this information on the future evolution of the asset composition that is relevant for the financial markets (see also Blanchard and Fisher, 1989).

Under these conditions, eq. (24) can be rewritten as:

$$\Delta R_t = -(1-\varepsilon)\left\{\begin{array}{l}\left[R - R* - a(r-r*) - b(I-I*) - cB - dA\right]_{t-1} \\ -\sum_{k=0}^{\infty}\gamma^k \underset{t}{E}\,\Delta\left[a(r-r*) + b(I-I*) + cB + dA\right]_{t+k}\end{array} - \Delta R_t^*\right\} \tag{25}$$

where: r = real short term interest rate

I = inflation rate

B = government budget deficit (revenues - outlays) as a percentage of GDP

A = current account balance (revenues - outlays) as a percentage of GDP

Equation (25) explains the domestic nominal government bond yield in terms of:

- the German long term interest rate;
- actual and expected future inflation differentials;
- actual and expected future real short-term interest rate differentials (or growth differentials);
- actual and expected future course of domestic government budget deficit;
- actual and expected future course of the domestic current account balance;
- variances and covariances of expected returns, which are mainly related to uncertainty.

2.1.2 Estimation results

Table 1 contains the results of unit root tests for the variables that enter into the long-term part of equation (25). Dickey-Fuller and augmented Dickey-Fuller tests show that the null hypothesis that the series contain a unit root cannot be rejected, whereas the null that their first differences contain a unit root is rejected, except for the Dutch-German short-term interest and inflation differentials. Also all growth differentials seem to be stationary.

Table 1

Dickey–Fuller (DF) and Augmented Dickey Fuller (ADF) tests for unit roots

Sample 1980 I – 1995 II

Variable	**Levels**		**First differences**	
	DF	**ADF**	**DF**	**ADF**
Long–term interest difference				
ITL–DEM	–1.36	–1.45	–7.20 *	–4.15 *
DKK–DEM	–1.18	–1.35	–6.53 *	–5.10 *
FRF–DEM	–1.02	–0.86	–7.00 *	–4.42 *
BEF–DEM	–1.02	–0.68	–9.13 *	–5.22 *
NLG–DEM	–2.17	–1.32	–9.89 *	–6.44 *
Short–term interest difference				
ITL–DEM	–2.03	–1.58	–11.61 *	–6.82 *
DKK–DEM	–2.74	–2.46	–10.71 *	–4.94 *
FRF–DEM	–2.61	–1.54	–12.46 *	–5.30 *
BEF–DEM	–1.89	–1.22	–10.22 *	–6.34 *
NLG–DEM	–3.59 *	–2.66	–9.88 *	–7.07 *
Inflation difference				
ITL–DEM	–0.99	–1.22	–8.26 *	–3.31 *
DKK–DEM	–1.33	–1.58	–9.67 *	–4.30 *
FRF–DEM	–1.21	–0.92	–7.47 *	–4.92 *
BEF–DEM	–1.31	–1.41	–8.28 *	–3.55 *
NLG–DEM	–3.81 *	–2.61	–9.76 *	–4.44 *
GDP growth difference				
ITL–DEM	–8.41 *	–3.61 *		
DKK–DEM	–7.33 *	–3.72 *		
FRF–DEM	–8.73 *	–4.03 *		
BEF–DEM	–27.76 *	–10.57 *		
NLG–DEM	–8.47 *	–6.97 *		
Public deficit/GDP ratio				
ITL		–2.69	–2.87	–3.29 *
DKK		–2.67	–2.08	–3.21 *
FRF		–2.71	–2.59	–2.91 *
BEF		–1.43	–2.93 *	–3.55 *
NLG		–2.55	–3.38 *	–4.05 *
DEM		–2.83	–3.16 *	–3.77 *
Current account/GDP ratio				
ITL		–2.76	–3.91 *	–3.91 *
DKK		–0.76	–4.04 *	–3.82 *
FRF		–1.72	–4.59 *	–3.49 *
BEF		–0.73	–6.55 *	–3.53 *
NLG		–2.82	–4.98 *	–3.66 *
DEM		–1.84	–3.16 *	–2.84

* Indicates significant at 95 per cent. The 95 per cent critical value for the DF and the ADF–test is –2.91.

We first estimated the long-term part of eq. (25) for a number of EMS currencies: Belgium, Denmark, France, Italy and the Netherlands. The results of these time series regressions are summarised in Table 2. All coefficients have the correct sign. The null hypothesis of no cointegration is rejected.

Table 2
OLS estimation of the static equations
Sample 1979 IV – 1995 II

Dependent variable	**Nominal long–term interest rate differential RL - RLDEM**				
	ITL-DEM*	**DKK-DEM**	**FRF-DEM**	**BEF-DEM**	**NLG-DEM**
RRS differential	0.36	0.31	0.16	0.19	0.05
INF differential	0.66	0.70	0.62	0.42	0.24
CURACC / GDP	–0.47	–0.38	–0.53	–0.15	–0.26
PUBDEF / GDP	–0.32	–0.49	–0.15	–0.13	–0.16
DF–test	–4.81	–4.75	–5.86	–5.04	–3.88
ADF–test	–3.05	–4.35	–4.25	–3.11	–2.45
SER	1.14	1.12	0.53	0.42	0.38

RL	long–term interest rates
RRS	real short–term interest rates
INF	consumer price inflation
CURACC	current account of the balance of payments
PUBDEF	public deficit
GDP	gross domestic product.

The 95 per cent critical values are –4.7 for the DF–test and –4.15 for the ADF–test.
(The hypothesis of cointegration is acceptable for NLG–DEM as not all explanatory variables are I(1).)

* Including a dummy from 1991 I to account for the discontinuity in the long–term interest rate series.

Test for equality of the risk premium coefficients over equations:

CURACC/GDP	–0.25	$\chi^2(4)=17.86$	$p = 0.00$
PUBDEF/GDP	–0.20	$\chi^2(4)=49.82$	$p = 0.00$

Test for equality of the risk premium coefficients over equations after multiplication with the standard error of the equation:

CURACC/GDP	–0.43 * SER	$\chi^2(4)=5.39$	$p = 0.25$
PUBDEF/GDP	–0.34 * SER	$\chi^2(4)=8.22$	$p = 0.08$

Theory suggests that the impact of the current account and the public deficit ratio on the risk premium in the long-term rate should depend on the degree of uncertainty about the expected returns. Therefore, it is interesting to compare the impact of these variables between countries and over different time periods.

The hypothesis of cross-country equality of coefficients of the current account ratio and the public deficit ratios is not accepted. This result possibly indicates differences in market participants' conditional degree of uncertainty across countries. If these ratios are multiplied with the standard error of the country-specific equation, as a measure of the differences in uncertainty across countries, the same hypothesis is (just) accepted.

Table 3 shows the joint-estimation results of the long-term equations after imposing equality of all coefficients across all countries and also imposing equal effects of both public deficits and current account balances (to prevent a possible multicollinearity problem). It provides information on an **average EMS response** of long term interest rate differentials to all explanatory variables. These results indicate that in the long run, nominal domestic bond yield differentials w.r.t. the German bond yield depend on:

- the real short term interest rate differential which, in principle, reflects differences in expected growth rates. A positive real short term interest rate differential of one percentage point increases the bond yield differentials by 22 basis points;
- the inflation differential. A positive inflation differential by one percentage point increases the bond yield differential by 61 basis points;
- the government budget deficit. Lower budget deficits, with constant current account balance, reduce the supply of bonds and, therefore, tend to lower interest rates. The impact is different across countries as it depends on the standard error of the equations. Each one percent deficit reduction in terms of GDP reduces the bond yield differential by 33 basis points multiplied by the standard error of the regression;
- the current account balance. Increasing current account balances, with constant budget deficits, augments liquidity in domestic financial markets and tends to lower domestic interest rates. Each one percent improvement of the current account balance in terms of GDP reduces the bond yield differential by 33 basis points multiplied by the standard error. This means that countries, like Belgium, where lower budget deficits are accompanied by higher current account surpluses, would tend to experience a fast narrowing of the bond yield differential.

Table 3

Restricted joint-estimation (SUR) of the static equations for different sub-periods

Dependent variable	**Nominal long-term interest rate differential RL-RLDEM**			
	79 IV - 95 II	**79 IV - 85 IV**	**86 I - 92 II**	**92 III- 95 II**
RRS differential	0.22	0.20	0.31	0.28
INF differential	0.61	0.53	0.52	0.42
SER* (CURACC+PUBDEF)/GDP	–0.33	–0.50	–0.03	–0.21
Mean volatility for five currencies for the				
Nominal long-term interest rate differentials		0.73	0.41	0.39
Exchange rate w.r.t. DEM		1.06	0.47	1.21

Although the static relations passed the cointegration test, it is interesting to consider the pooled regression results over different sub-periods. The long-run equation was estimated over three sub-sample periods. Table 3 compares the estimation results over the period 1986 I to 1992 II, which was characterised by relative exchange rate stability within the EMS, with those for the periods 1979 IV to 1985 IV and 1992 III to 1995 II. These results indicate that the coefficients of the risk premia (current account and public deficit) have been markedly different in those periods. These coefficients are related to market participants' uncertainty concerning the expected returns on domestic and foreign bonds. In a stable environment as to interest and exchange rates, these risk premia would tend to disappear. The ultimate case of stable exchange rates would occur in a monetary union. In such a world returns would, therefore, converge. During the middle period, credibility in the EMS was relatively high up to the point where some authors raised the question: "The European Monetary System: Credible at Last?" (Frankel, Phillips, 1992). Since mid-1992 uncertainty in the EMS re-emerged and the influence of risk premia led to divergences among bond yield differentials especially in those countries with relatively poor performance in terms of government budget and current account balances.

Charts 1 and 2 illustrate the relation between uncertainty and the influence of risk premia for a sample of European countries, including Belgium (B), Netherlands (N), France (F), Denmark (DK), United Kingdom (UK), Italy (IT), Spain (E), Portugal (P), Ireland (IR), Austria (A) and Sweden (S). During the period 1980 - 1994, the differentials of long-term interest rates in these countries w.r.t. Germany are strongly correlated with the aggregate risk premium. This correlation is much weaker in the relatively calm period 1986 - 1991.

Chart 1

European long term interest rate differentials and sum of public and current balances 1980 - 1994

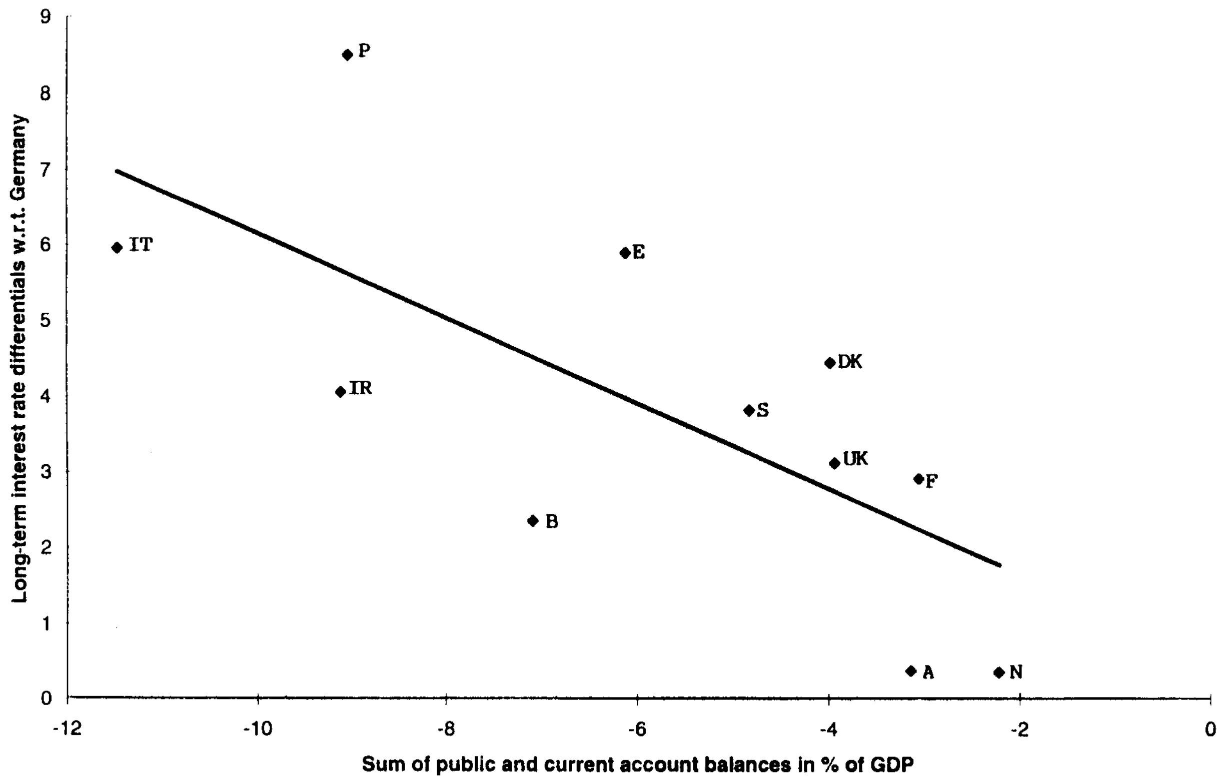
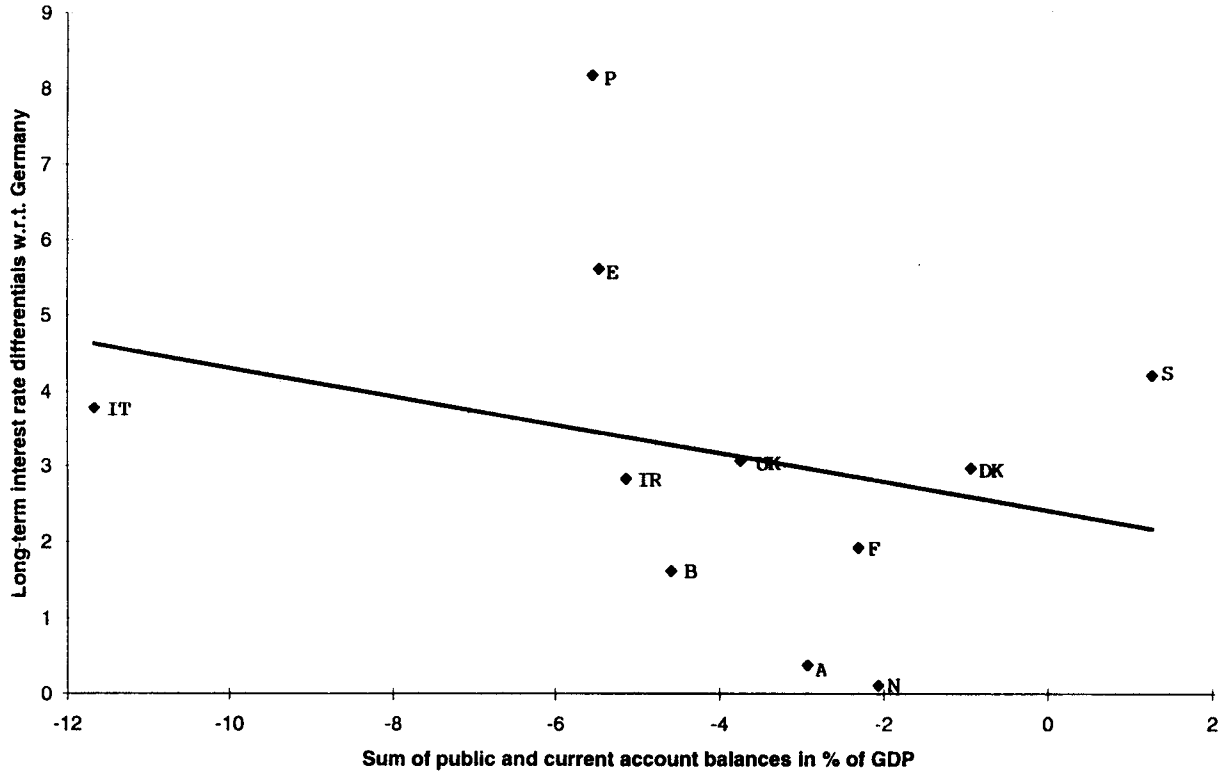


Chart 2

European long-term interest rate differentials and sum of public and current account balance 1986 - 1991



Of course, eq. (25) illustrates that short term variations in bond yields are not only related to actual values of these long-term determinants, but equally so to market participants' expectations concerning their future evolution. The question then arises as to how these expectations are formed. In this context we should pay extra attention to stability over the different periods distinguished above. Different formulations of the expectations can probably solve the instability problem.

We investigated two major alternative assumptions in this respect: the use of an autoregressive forecasting rule, on the one hand and of a forward looking device, on the other hand.

If expectations on short-term real interest rates, inflation rates, government budget deficit ratio's and current account balance ratio's are each based on a second order autoregressive scheme containing a unit root, then eq. (25) reduces to a traditional error correction mechanism (eq. (26)). The latter can then be interpreted as a reduced form of a structural forward looking model with rational expectations and autoregressive processes generating the expectations. This formulation would be sensitive to the Lucas critique, but the real issue in this respect is the stability of the autoregressive processes, which can be tested for.

$$\begin{aligned} \Delta R_t = & -\mu\left[R - R* - a(r - r*) - b(I - I*) - cB - dA\right]_{t-1} \\ & + \tau_1 \Delta(r - r*)_t + + \tau_2 \Delta(I - I*)_t + \tau_3 \Delta B_t + \tau_4 \Delta A_t + \tau_5 \Delta R_t^* \end{aligned} \qquad (26)$$

The estimation results for this equation are shown in Table 4. The diagnostic statistics are acceptable, except for the stability test: three countries show a significant structural break after 1986 I. However, the most recent period does not form a special problem for the relations.

Table 4

Error correction model (two-step estimation)

Sample 1980 I - 1995 II

Dependent variable	**Change in the nominal long-term interest rate**				
	ITL	**DKK**	**FRF**	**BEF**	**NLG**
Constant	–0.01	–0.01	–0.04	0.00	–0.01
	(.09)	(.09)	(.05)	(.04)	(.03)
ECM-coefficient	–0.26	–0.58	–0.54	–0.46	–0.37
	(.10)	(.10)	(.11)	(.11)	(.11)
Δ RLDEM	0.88	0.33	0.88	0.66	0.99
	(.17)	(.16)	(.10)	(.08)	(0.07)
Δ RRS-RRSDEM	0.13	0.15	0.12	0.18	0.11
	(.03)	(.05)	(.02)	(.04)	(.05)
Δ INF-INFDEM	0.37	0.15	0.19	0.33	0.20
	(.10)	(.11)	(.08)	(.08)	(.08)
Δ CURACC/GDP	–0.23	–0.52	–0.74	–0.15	–0.04
	(.24)	(.27)	(.21)	(.08)	(.07)
Δ DEFPUB/GDP	–0.20	–0.78	–0.11	–0.21	–0.09
	(.12)	(.20)	(.23)	(.12)	(.12)
Δ RL{–1}	0.16	0.38			
	(.10)	(.10)			
Δ RLDEM{–1}	0.43				
	(.16)				
Dummy 1991 I	2.30				
	(.64)				
Statistics					
R2	0.66	0.53	0.74	0.65	0.82
SER	0.62	0.67	0.39	0.32	0.27
DW	1.90	2.06	1.88	1.66	2.12
AR(1) : $\chi 2(1)$	2.97	1.77	0.51	3.81	5.42
probability value	(.08)	(.18)	(.48)	(.05)	(.02)
Ljung-Box : $\chi 2(15)$	7.73	13.20	10.25	18.56	18.50
probability value	(.93)	(.59)	(.80)	(.23)	(.24)
ARCH(2) : $\chi 2(2)$	0.63	1.60	1.22	4.58	2.11
probability value	(.73)	(.44)	(.54)	(.10)	(35)
Norm test : $\chi 2(2)$	0.15	3.43	0.18	4.86	7.71
probability value	(.93)	(.18)	(.91)	(.09)	(.02)
CHOW test 86:1*	3.59	2.54	1.46	3.74	0.74
probability value	(.00)	(.02)	(.20)	(.00)	(.63)
CHOW test 92:3*	1.13	0.68	0.46	0.81	0.81
probability value	(.36)	(.70)	(.86)	(.58)	(.58)

* Based on F-test, with critical values determined by F(c,n-2c), with c = number of coefficients and n = number of observations.

To give some indication of the origin of the stability problem, the dynamic equations were jointly estimated with equal coefficients over equations. The results are summarised in Table 5. Four remarks are obvious :

Table 5

Restricted joint-estimation (SUR) of the Error Correction Model (two-step estimation)

Dependent variable	**Change in the long-term interest rate**			
	80 I - 95 II	**80 I - 85 IV**	**86 I - 92 II**	**92 III - 95 II**
ECM-coefficient	–0.38	–0.47	–0.31	–0.51
	(.04)	(.06)	(.05)	(.09)
Δ RLDEM	0.80	0.69	0.98	0.98
	(.04)	(.05)	(.08)	(.05)
Δ RRS-RRSDEM	0.15	0.11	0.27	0.18
	(.01)	(.01)	(.03)	(.02)
Δ INF-INFDEM	0.21	0.20	0.43	0.35
	(.03)	(.04)	(.05)	(.06)
Δ SER*[CURACC/GDP+DEFPUB/GDP]	–0.24	–0.38	–0.06	–0.22
	(.06)	(.07)	(.08)	(.12)

- the short-term impact of the DEM long rate on the other countries' long rates increased substantially and was not significantly different from one after 1986 I. This result reflects the increasing capital mobility between countries;
- the short-term interest differentials and the inflation differentials did have a stronger short-term impact on the long-term interest rates during the period of relative stability;
- the direct impacts of changes in the deficit and current account ratios were less important during the second period, but regained their impact during the most recent period;
- the adjustment speed toward the long run equilibrium was lower during the second period; this may reflect the smaller importance of the fundamental determinants of the risk premium during this period. After 1992 II, the adjustment speed increased again.

The alternative to the ECM is to estimate eq. (25) with forward looking expectations directly (using all restrictions on the coefficients) with non - linear instrumental variables. It seems that the explanatory power of the equations incorporating the forward looking expectations assumption drops dramatically, in comparison with the alternative hypothesis which retains all the dynamic restrictions included in equation (25). Therefore, the short-term coefficient for the German long rate was estimated freely (instead of estimating changes in interest differentials), and the lagged dependent variables were included to prevent a possible autocorrelation problem. Table 6 contains the results. There remains a stability problem for the long BEF-rate (Table 7). The results for DKK and ITL also indicate that at least the short-term coefficient for the DEM rate still poses a problem for stability.

We did not make any formal discriminatory test between the two assumptions concerning expectation formation. Nonetheless, it seems to us that the results in Tables 3, 4 and 6 largely support the same conclusions. The stability problem for the risk premium coefficients suggests the introduction of time-varying second moments in the equations (the absence of *ARCH* and the use of quarterly data prevent us from applying a *GARCH-M* specification).

Table 6

Estimation with forward-looking expectations (non-linear instrumental variables)*

Sample 1980 IV - 1994 III

Dependent variable	**Change in the nominal long-term interest rate**				
	ITL	**DKK**	**FRF**	**BEF**	**NLG**
Constant	–1.41	0.05	0.18	0.24	0.01
	(.72)	(.25)	(.19)	(.48)	(.17)
γ discount factor (imposed)	0.96	0.96	0.96	0.96	0.96
ε RL-RLDEM	0.49	0.49	0.5	0.57	0.26
	(.07)	(.08)	(.08)	(.11)	(.11)
a RRS-RRSDEM	0.3	0.46	0.18	0.33	0.14
	(.07)	(.18)	(.06)	(.09)	(.25)
b INF-INFDEM	0.84	0.49	0.64	0.44	0.17
	(.07)	(.26)	(.04)	(.06)	(.29)
c CURACC/GDP	–0.53	–0.63	–0.47	–0.14	–0.09
	(.18)	(.22)	(.21)	(.07)	(.12)
d DEFPUB/GDP	–0.18	–0.54	–0.13	–0.21	–0.09
	(.12)	(.07)	(.11)	(.10)	(.09)
ℓ1 Δ RLDEM	0.68	0.33	0.8	0.75	0.91
	(.23)	(.22)	(.13)	(.11)	(.10)
ℓ2 Δ RL{–1}	0.16	0.24	0.09		0.3
	(.10)	(.10)	(.08)		(.18)
Dummy 1991 I	3.16				
	(.45)				
Statistics					
R2	0.64	0.60	0.71	0.61	0.76
SER	1.00	0.63	0.39	0.33	0.28
DW	1.93	2.27	2.26	1.65	2.12
CHOW test 86 I**	1.07	1.86	1.07	6.67	1.08

* Instruments: 4 lags of all variables. Truncation after two leads.

** Based on F-test, with critical values determined by F(c,n-2c), with c = number of coefficients and n = number of observations.

Table 7

Restricted joint-estimation with forward-looking expectations

Dependent variable	**Change in the long-term interest rate**			
	80 I - 95 II	**80 I - 85 IV**	**86 I - 92 II**	**92 III - 95 II**
γ discount factor (imposed)	0.96	0.96	0.96	0.96
ε RL-RLDEM	0.31	0.43	0.50	0.47
	(.03)	(.04)	(.06)	(.06)
a RRS-RRSDEM	0.25	0.15	0.23	0.25
	(.04)	(.03)	(.05)	(.02)
b INF-INFDEM	0.66	0.57	0.48	0.40
	(.04)	(.07)	(.05)	(.02)
c SER*[CURACC/GDP+DEFPUB/GDP]	–0.32	–0.59	–0.16	–0.48
	(.04)	(.05)	(.07)	(.02)
ℓ1 Δ RLDEM	0.85	0.62	0.97	0.96
	(.05)	(.04)	(.08)	(.03)

Chart 3

European long-term interest rate differentials and current account balances 1980-1984

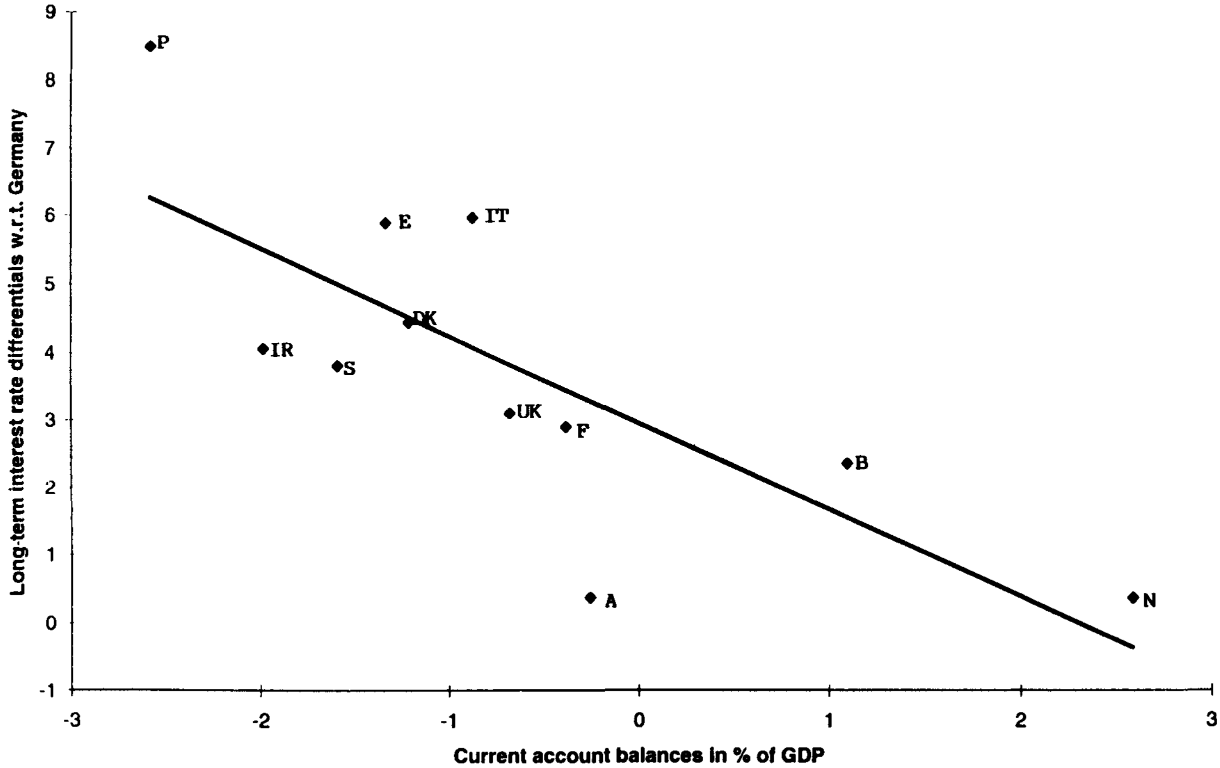
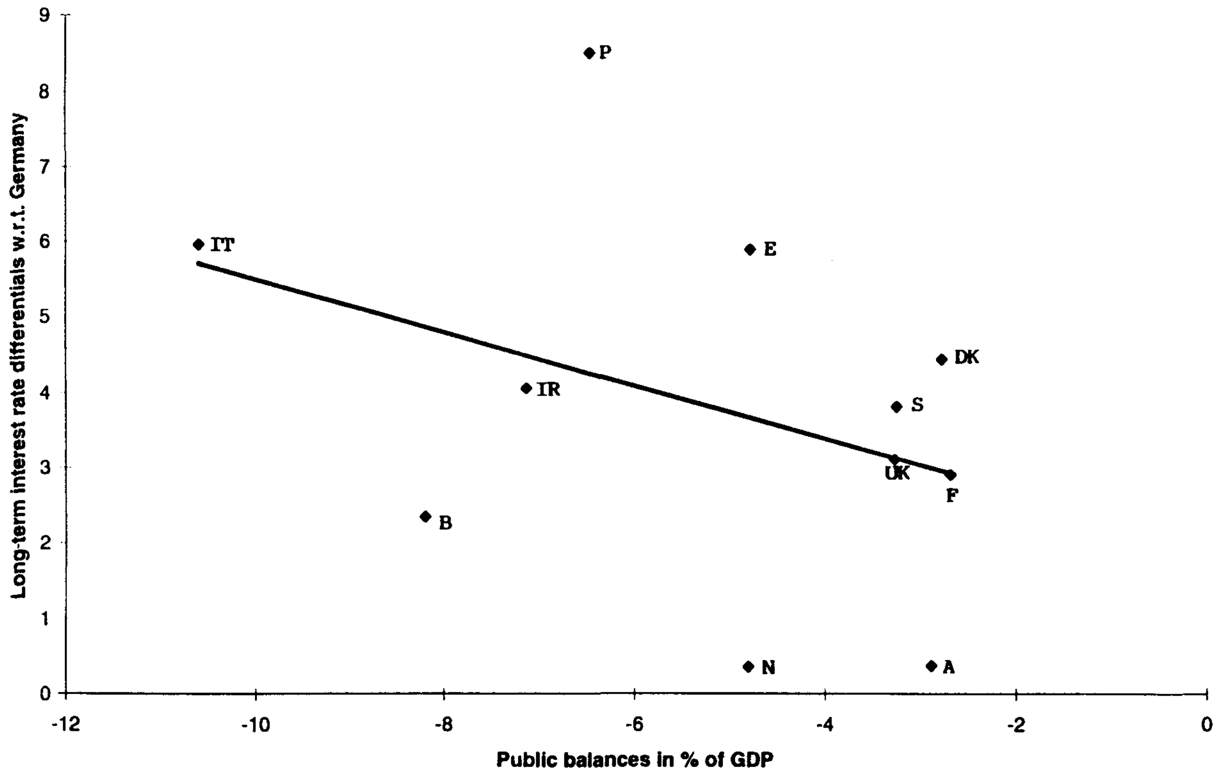


Chart 4

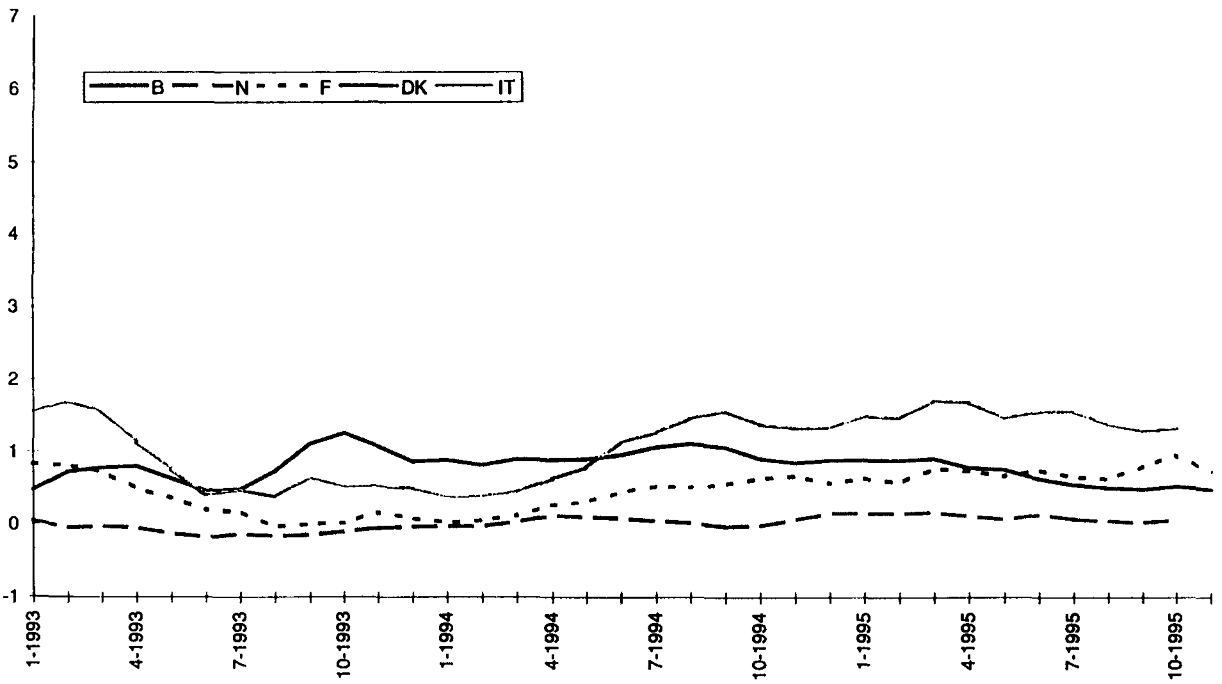
European long-term interest rate differentials and public balances 1980-1994



Charts 3 and 4 confirm our estimation results in Table 6 by showing for some countries a weaker relationship between long-term interest rate differentials and public balances in comparison with the correlation with current account balances.

Chart 5 contains the most recent evolution of long-term interest rate differentials. In 1994 interest differentials were up again, especially in France, Denmark and Italy, but not in Belgium. Even more so, the long-term interest differential BEF/DEM declined dramatically since early 1995, in contrast to most of the other countries under review. An explanation may be advanced in terms of expectations. The Belgian strategy of linking its exchange rate to the DEM kept inflation expectations low, while its increasing current account surplus and lower public deficit led to a considerable reduction of the risk premium on Belgian bonds.

Chart 5
Long-term bond yield differentials w.r.t Germany
Benchmark data



2.2 The exchange rate

The DEM/BEF exchange rate equation in the Quarterly model of the NBB, is based on eq. (19). The explanatory variables are the expected exchange rate, the short-term interest rate differential and one risk premium: net foreign assets, approximated by the cumulated current account balance (*CCA*) and the cumulated official interventions in the exchange market (*CINT*), multiplied by a variable conditional variance (*H*). The latter was constructed in a rather ad hoc way. It depends on the probability, as perceived by market participants, that the monetary authority is of the hard currency type. The longer the time span since the last devaluation against the DEM, the higher this probability and therefore, the lower *H*. The same type of reasoning applies to the modelling of the expected exchange rate. Before 1990 I the expected exchange rate is determined by the slowly increasing probability of the Belgian monetary authorities evolving towards a strong currency policy, from time to time interrupted by a devaluation against the DEM. Thereafter, the expected exchange rate is affected by the official announcement of the DEM-link, such that the expected exchange rate gradually converged towards the DEM-EMS parity rate.

The long-run exchange rate equation is estimated as follows:

$$\ln s_t = \underset{t}{E}(s_{t+1}) + 0.36(i_r^* - i_t) + 2.59 H_t CCA_t - 1.05 H_t CINT_t + \mu_t$$

Conclusion

Starting from an intertemporal optimal consumption - saving - portfolio allocation model, it was shown that the holding period return on domestic and foreign bonds depends on the short term risk free rate of interest (which is risk free because it does not contain any price risk) and on risk premia. These risk premia depend on the degree of uncertainty with which market participants hold their expectations concerning future returns; or, more generally, on the volatility in the financial markets. These premia also depend on the shares of domestic and foreign bonds in the total portfolio.

This analysis was applied to the explanation of bond yield differentials w.r.t. German yields (in the perspective of an application to EMS currencies). When allowing for transaction costs, it was shown that these differentials depend on actual and expected future inflation differentials, actual and expected future real short-term interest rate differentials, which are theoretically related to growth differentials, the actual and expected future course of government budget ratio's and of current account balance ratio's and finally on the degree of uncertainty or financial market volatility.

We estimated the average long run EMS responses of long-term interest rate differentials to all of these explanatory variables. The estimation results seemed to accord with theory. One result indicated that the average EMS response of bond yield differentials to the public balance and current account balance ratio's were about equal across countries after multiplication of these coefficients by the standard error of the equations. The influence of the risk premium, however, disappears in periods of low exchange rate and interest rate volatility, such as from 1986 to mid 1992. In such period the inflation differential was found to be the most important factor of bond yield differentials.

As far as expectation formation is concerned, we investigated two alternative assumptions. The first one assumes that market participants base their forecasts of the determining variables on autoregressive processes. A traditional ECM mechanism then describes the dynamic adjustment of bond yields. The alternative assumption relies on forward looking expectations and a dynamic equation in terms of forecasts was estimated with non-linear instrumental variables. We did not perform rigorous discriminatory tests between the two assumptions, but they both lead to the same conclusions.

The theoretical analysis concerning exchange rate determination revealed dependence of the exchange rate on the expected future exchange rate, short-term interest rate differentials, and the same type of risk premium as was found for holding period returns on domestic bonds. Estimation of the DEM/BEF exchange rate confirms the importance of the short-term interest rate differential as well as important effects of the current account balance and financial market volatility.

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Comments on paper by M. Dombrecht & R. Wouters by Frank Smets (BIS)

In this paper the authors examine both theoretically and empirically the main determinants of bond yield differentials in Belgium, the Netherlands, Denmark, France and Italy vis-a-vis Germany. The most interesting result in the empirical work is that both the public deficit and the current account are important determinants of bond yield differentials, in particular in periods of higher uncertainty. While similar results have been found previously, the robustness across countries is striking. In my comments I will first discuss the adequacy of the theoretical framework the authors present to motivate their estimated equations. I will then propose a different framework to think about the parameter estimates and discuss within that framework the results with respect to the effects on bond yield differentials of the current account, inflation differentials and the government budget deficit. Finally, I will say a few words about the importance of credit or default risk.

A. The authors motivate the inclusion of the current account in their estimated equations in terms of a portfolio balance model in which the risk premium is a function of the variance-covariance matrix of the excess returns on the various risky assets and the shares in the total portfolio of each of the risky assets.

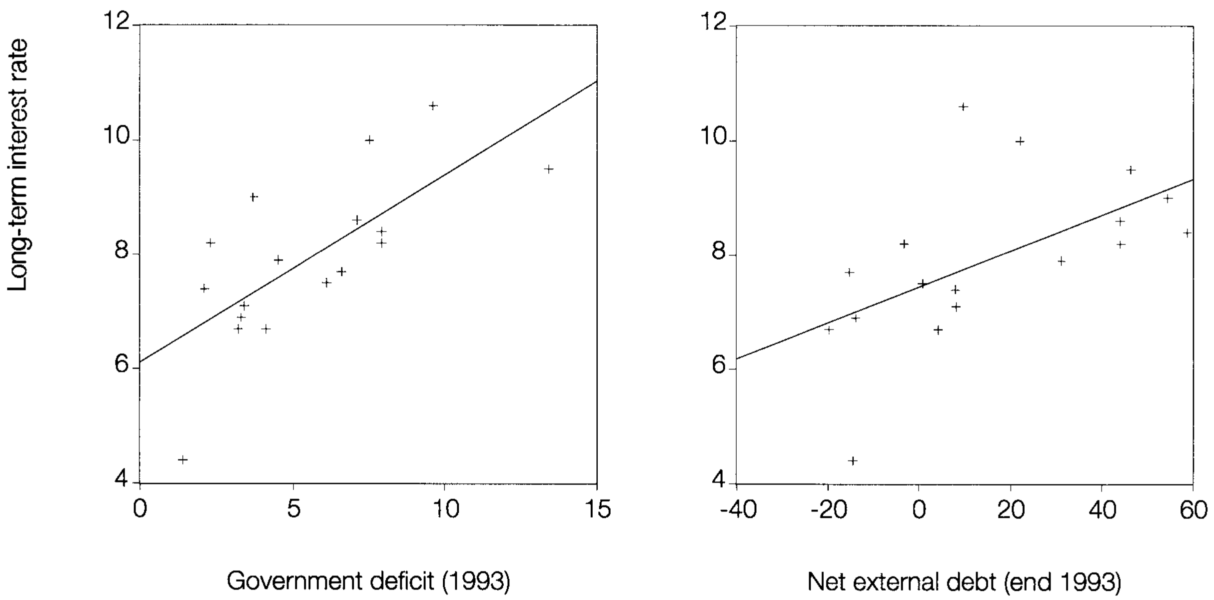
I have doubts on whether this is the appropriate theoretical framework to motivate the estimated equation for bond differentials for two reasons. First, we know from more direct tests of the international CAPM model that it is hard to make it work. A recent survey by Charles Engel on the foreign exchange risk premium, for example, lists six or seven studies which test the implications of this model and find very poor results. The fit is terrible and sign errors are everywhere. Second, while the asset pricing equations are rigorously derived from an intertemporal saving and portfolio allocation model, a partial adjustment argument is necessary to derive the estimated equation. Given the efficiency of international asset markets it seems to me that the assumption of a relatively slow adjustment of asset prices is rather implausible. In the alternative framework which I discuss below a dynamic adjustment model, as considered in the paper, may be justified when credibility is imperfect and there is learning about the true type of the government.

B. This brings me to the second major point. I find it a bit strange that in the theoretical framework that the authors present there is almost no mention of the role of the exchange rate regime. Given that all the countries analysed in the paper were members of the ERM and attempted to fix the exchange rate with respect to the DM, I would expect that most of the variations in the long-term interest rate differential are determined by changes in the credibility of the respective exchange rate parity. Thus, a more appropriate theoretical framework would try to model such devaluation expectations. My interpretation of the empirical results the authors present is that each of the variables that enter the bond yield differential equation have their primary effects because they affect devaluation expectations. This can also explain why the significance of the effects varies across periods when the overall credibility of the fixed parities in the ERM differs. If the fixed exchange rate is fully credible, then the interest rate differential should be close to zero (primarily reflecting a default premium) and all the parameters should be insignificant. In what follows we elaborate on how the current account, the inflation differential and fiscal variables may affect devaluation expectations.

1. The current account

The current account and the size of the net external debt are important factors in the determination of devaluation expectations. The link between bond yields and net external indebtedness is illustrated in the following graph. The main reason for such a link is clear. If a country has an external sustainability problem, one of the easiest ways of solving this is to devalue the exchange rate which, if the pass-through in domestic prices is imperfect would improve the trade balance and stop the accumulation of external debt. That this is not just a theoretical possibility was visible in 1994 when there was a clear positive correlation between the degree of exchange rate overvaluation (as measured by deviations from purchasing power parity) and the current account balance.

Debt, deficits and long-term interest rates
17 industrial countries



2. The inflation differential

One would expect that in a floating exchange rate regime and with a long enough sample the coefficient on both the real interest rate difference and the inflation difference would be insignificantly different from one. However, in a fixed exchange rate regime, this is not necessarily the case. There can be temporary factors that drive a wedge between inflation rates in the two countries (e.g. the German reunification boom). However, if the fixed exchange rate parity is credible, this should not lead to an interest rate differential. For example, Halikias (1993) finds that over the period 1982-1992 the inflation differential is significant in Belgium (with a coefficient of 0.45), but insignificant in the Netherlands and Austria where the credibility of the fixed exchange rate parity was higher. He also shows that Belgium has been moving towards this strong version of credibility during the period under consideration, as the inflation differential becomes insignificant towards the latter part of the period. Finally, Halikias (1993) also shows that it is really competitiveness that explains the significance of the inflation differential, which again indicates the appropriateness of the devaluation expectations hypothesis.

3. The importance of fiscal variables

Although the time series data do not give a lot of evidence in favour of a clear link between deficits and bond yield differentials, there is quite a lot of cross-country evidence that government deficits matter as e.g. illustrated by the above graph. For the evidence on Belgium I would again like to refer to the study by Halikias (1993) who finds that both the relative debt and the relative primary deficit turn out to be a statistically significant determinant of the bond yield differential with Germany. Moreover, he shows that this effect remains, even if one controls for its impact on inflationary expectations and hence expected exchange rate movements.

C. This brings me to a last point which concerns the presence of default risk. Several pieces of evidence suggest that fiscal variables have an impact on the bond yield differential beyond their impact on inflation or exchange rate devaluation expectations. Next to the evidence presented above under B.3., it appears that it is total government debt, and not necessarily local currency denominated debt that matters for long-term interest rate differentials. Second, high-debt countries typically face higher interest rates on foreign currency bonds than e.g. comparable bonds issued by the World Bank. While the authors interpret this premium as a portfolio balance premium, I would prefer to call this a credit or default risk premium. Some evidence in favour of the latter interpretation is that one can find a positive correlation between measures of such a premium, debt variables and indicators of political stability.