Oslo
December 31, 2004

Working Paper

Research Department

Who was in the driving seat in Europe during the nineties, International financial markets or the BUBA?

by

Roger Hammersland

NB NORGES BANK

Working papers fra Norges Bank kan bestilles over e-post:
posten@norges-bank.no
eller ved henvendelse til:
Norges Bank, Abonnementsservice
Postboks 1179 Sentrum
0107 Oslo
Telefon 22 31 63 83, Telefaks 22 41 31 05

Fra 1999 og senere er publikasjonene tilgjengelige som pdf-filer
på www.norges-bank.no, under "Publikasjoner".

Working papers inneholder forskningsarbeider
og utredninger som vanligvis
ikke har fått sin endelige form.
Hensikten er blant annet at forfatteren
kan motta kommentarer fra kolleger
og andre interesserte.

Synspunkter og konklusjoner i arbeidene
står for forfatternes regning.

Working papers from Norges Bank can be ordered by e-mail:
posten@norges-bank.no
or from Norges Bank, Subscription service,
P.O.Box. 1179 Sentrum
N-0107Oslo, Norway.
Tel. +47 22 31 63 83, Fax. +47 22 41 31 05

Working papers from 1999 onwards are available as pdf-files on the bank's
web site: www.norges-bank.no, under "Publications".

Norges Bank's working papers present
research projects and reports
(not usually in their final form)
and are intended inter alia to enable
the author to benefit from the comments
of colleagues and other interested parties.

Views and conclusions expressed in working papers are
the responsibility of the authors alone.

ISSN 0801-2504 (printed) 1502-8143 (online)

ISBN 82-7553-278-7 (printed), 82-7553-279-5 (online)

Who was in the driving seat in Europe during the nineties, International financial markets or the BUBA? *†‡

Roger Hammersland
Research Department
Norges Bank §

December 31, 2004

Abstract

The purpose of this paper is to reexamine empirically the relationship between long-term interest rates in well integrated financial markets. The analysis focuses on long-term interest rates in the US and Germany and has been carried out within the framework of a five dimensional VAR for the simultaneous determination of short- and long-term interest rates in the US and Germany and the rate of exchange rate depreciation. The results strongly support the existence of a long-run relationship between the long-term German and the long-term US interest rate and imply a full pass-through of changes in the long-term US rate into the corresponding German rate. The analysis

*I am grateful for comments by Søren Johansen, Grayham Mizon and participants at the first year student forum at the EUI, Florence. I also want to extend a particular word of thanks to Birger Vikøren whith whom I wrote the forerunner of this paper.

†This paper forms part of my PhD thesis at the European University Institute, Florence. However, the paper is based on research undertaken in Norges Bank.

‡The analyses of this paper have been undertaken by using PcFiml 9.20 (Doornik and Hendry (1999)) and the acronym BUBA stands for the Bundesbank.

§E-mail: roger.hammersland@norges-bank.no

also substantiates that the direction of causality goes from the long-term US to the long-term German interest rate. With regard to the possibility of controlling the long end of the market on the part of the Bundesbank, the paper apparently takes on a rather pessimistic view, as there is nothing to indicate a long-run relationship between short- and long-term German interest rates. However, the strong influence that short-term German interest rates exhibit on German long-term interest rates in the very short run according to the structural model of this paper, might be taken to indicate that the opposite is the case, as effects originating from expectations of future short-term interest rates might totally neutralize an unequivocally positive short-run portfolio effect in the long run. If this is the case, there is nothing strange to the fact that one is unable to identify a long-run relationship between short- and long-term German interest rates. On the contrary, it is exactly what to be expected if the monetary transmission mechanism works appropriately.

Keywords: Cointegration, Simultaneous Equation Models, International Interest Rate Linkages, Transmission Mechanism,

JEL: C32 ,E43,E52, E58

1 Introduction

In the last decade, there has been some focus on what impact increased capital mobility could have on the determination of long-term interest rates (e.g. Borio and McCauley (1996) and OECD (1996)). These studies have been initiated by the striking co-movements of long-term interest rates in US and Europe in the 1990s (Figure 1). Two types of explanations, one macroeconomic and one microeconomic, have been suggested as reasons for this strong co-movements in long-term interest rates.[1]

A typical macroeconomic explanation for the correlation between nominal long-term interest rates across countries assumes that these rates are

[1] It is important to realize that these explanations are all based on time series being stationary and that a high degree of correlation may be spurious as a consequence of non-stationarity. When analyzing the actual data, it is therefore extremely important to use a methodology that is capable of identifying the fundamental factors behind the correlation patterns observed. This is the main reason why I pursue a reduced rank VAR analysis in this paper.

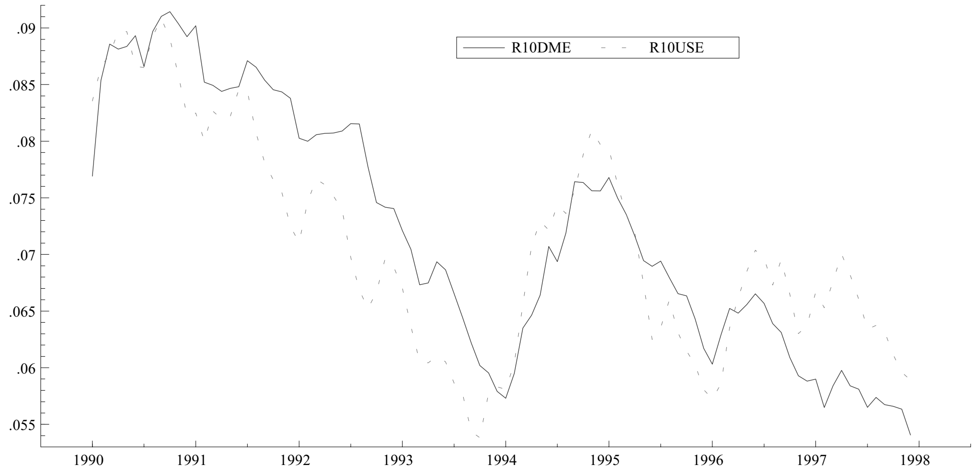

Figure 1: Long-term interest rates in Germany (R10DME) and the US (R10USE).

roughly equal to the sum of real long-term interest rates and inflation expectations. Disregarding for a moment the problem commented on above with regard to spurious correlation when dealing with non-stationary data, correlation between nominal interest rates must therefore entail that there is a correlation between real interest rates and/or a correlation between inflation expectations. The joint hypothesis of uncovered interest rate parity (UIP) and ex ante Purchasing Power Parity (PPP) leads to real interest rate parity (RIP). Although it is a widely held view that RIP does not hold in the short run, King (1992) argues that RIP is more likely to hold in the long run. In this case, real long-term interest rates will be highly correlated between countries. There might also be a correlation between inflation expectations in different countries due to either significant changes in commodity prices or to synchronized changes in the assessment of the business cycles in various countries.

A microeconomic explanation looks at the trading strategies of large institutional investors. For instance, the increase in bond rates in the US and Europe during 1994 has been explained by the observation that the fall in bond prices in the US prompted highly leveraged investors to sell US as well as European bonds. This explanation is supported by Borio and McCauley (1996) who examine the rise in long-term interest rates in 1994 and conclude that markets' own dynamics seem to provide a stronger explanation than market participants' apprehensions about economic fundamentals.

So far, I have focused on the relationship between foreign long-term interest rates across countries. However, the expectations theory of the term structure entails that there should also be a relationship between short-term and long-term interest rates in each country. According to this theory, the long-term interest rate is equal to a weighted average of the current and expected future short-term interest rate (see Schiller (1979)). Thus, the impact on the long-term interest rate from a change in the current short-term interest rate depends on how expected future short-term interest rates are affected. A rise in the current short-term interest rate that is regarded as permanent will lead to a full pass-through from short-term to long-term interest rates. On the other hand, if an increase in the current short-term interest rate leads to a significant reduction in inflation expectations, long-term interest rates may even decline.

The discussion above shows that both domestic short-term interest rates and foreign long-term interest rates could have an impact on domestic long-term interest rates. Goodhart (1995) recognizes this and argues that increased capital mobility has led to a greater tension between international pressure (e.g. foreign long-term interest rates) and domestic factors (e.g. the expected time-path of future short rates) in the determination of long-term interest rates. However, uncovered interest parity and relative purchasing power parity, used to explain the correlation between long-term interest rates, also suggest effects from differences in inflation rates or the expected rate of depreciation, and a unified treatment of all these possibilities may be given within the framework of a loanable funds equilibrium approach where interest rates are determined by the demand and supply of funds (Branson (1977)).

In Figure 2 I plot the spreads between long-term interest rates in Germany and the US and between domestic long- and short-term German interest rates, respectively. Graphical inspection indicates a possible long-run relationship between German and US long-term interest rates, although extended periods are observed in which the long-run relationship does not seem to hold. However, a similar relationship between German short and long-term interest rates does not seem to exist.

A study of these relationships undertaken some years ago (Hammersland and Vikøren (1997)) substantiates the high degree of correlation between US and German long-term interest rates and suggests that long-term German in-

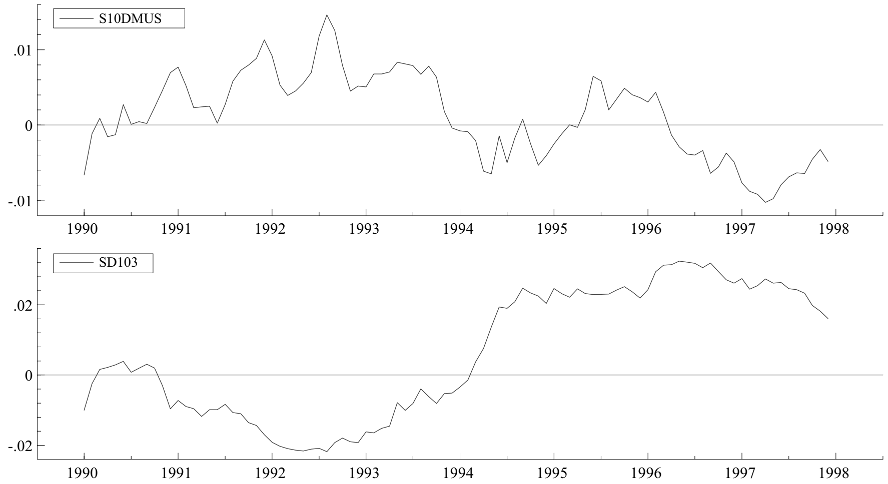

Figure 2: Interest spreads between long-term interest rates in the US and Germany (S10DMUS) and between domestic long-and short-term German interest rates (SD103).

terest rates are determined by a linear combination of domestic short-and US long-term interest rates in the long run. The direction of causality between the two long-term interest rates is in addition identified to be unidirectional, going from the US to the German economy. However, the model developed in this paper is a one-equation conditional model for the long-term German interest rate and is thus implicitly based on the potential fallacy of errouneously treating other variables as exogenous for estimation of the conditional model's parameters. Furthermore, the model does not really seem to explain the events of 1997 when the two interest rates start to diverge and there are problems related to the interpretation of the model's long-run relationship. To improve upon these obvious deficiencies this paper seeks to throw new light on the structure governing international and national interest rate linkages by undertaking a fully simultaneous analysis of all the variables in an extended information set. This information set comprises of nominal short- and long-term interest rates in Germany, (i^{GL} and i^{GS}), and the US, (i^{UL} and i^{US}), and the actual rate of depreciation in the bilateral German marks per US dollar exchange rate, Dv. The empirical proxies for long-term interest rates have been effective interest rates on government bonds with ten years to maturity while short-term interest rates are represented by the corresponding three months money market interest rates.[2] The rationale for including the rate of exchange rate depreciation was alluded to in the above and comes from the arbitrage condition of uncovered interest rate parity, saying that in a steady state the return of investing one unit of domestic currency at home or abroad should be equal. Thus, the domestic interest rate, i^D, should be equal to the foreign interest rate, i^F, plus the expected percentage increase in the value of the foreign currency relative to the domestic currency, that is the expected depreciation of the bilateral domestic exchange rate, over the horizon we are looking at.[3] The analysis has been undertaken using monthly data for the period 1990 (1) to 1997 (12) and has been carried out within the framework of a five dimensional VAR model for the simultaneous determination of the four interest rates and the rate of depreciation. To be able to test the Fisher hypothesis and to build a model of inflation, information sets including inflation rates and indicators of domestic activity have been tried out prior to the empirical analysis of this paper. However, these attempts have so far not succeeded and belong to the field of unexplored ground. Compared to a study undertaken on a data set comprising only the four interest rates, it turns out that the widening of the information set to also include the bilateral exchange rate revises results significantly and makes it possible to identify an interpretable long-run relationship. The model's forecastability

[2]The concept effective interest rates refers to the fact that one has taken into account the compound interest rate effect. In the general case with a deposit with a term to maturity less than one year this might be given the following representation:

$$i = \left(\left(1 + \frac{\frac{r_{nom}}{100}}{n} \right)^n - 1 \right) 100$$

where: i is the effective interest rate, r the nominal coupon interest rate and n the number of periods per year. The implicit assumption in the above example is that the principal amount and the accrued interest rate are re-invested at the same nominal rate of interest rate throughout the period. In the case of bonds with fixed coupon dividends the formulas become slightly more elaborate and the interested reader is referred to The Norwegian Society of Financial Analysts (2001)

[3]In the paper I have used the monthly change in the logarithm of the bilateral exchange rate, being aware of the fact that it would have been more correct from a theoretical perspective to use the change over three months. However, one may argue that investors operating in the markets are using the monthly change as an indicator because it is a more updated proxy for what it after all seeks to capture, namely the expected rate of depreciation.

is also improved compared to a model of interest rates only.

The rest of this paper is organized as follows. Section 2 examines cointegration and exogeneity. Section 3 then presents the outcome of a structural reinterpretation of the reduced form analysis. Section 4 contains concluding remarks.

2 Integration, Cointegration and Weak Exogeneity

This section presents statistics for testing stationarity of the individual time series in the information set. Johansen's maximum likelihood procedure (Johansen (1988)) is applied to test for cointegration and the direction of causality among the short-and long-term interest rates in Germany and the US.

Prior to modelling, it is useful to determine the orders of integration of the variables in the information set. Below, I therefore first present the results of using ordinary univariate augmented Dickey-Fuller (ADF) tests for unit roots in individual time series (Dickey and Fuller (1981)). However, I also present the results of using the Johansen method to test for stationarity in a multivariate framework. These two approaches for testing stationarity differ in two important respects. First, when using the Johansen approach the null-hypothesis is that the individual time series is stationary, while Dickey-Fuller tests have non-stationarity as their null-hypothesis. Second, the multivariate test statistics are conditional on the number of cointegrating vectors in the information set.

Table 2.1 lists augmented Dickey-Fuller test statistics for the long- and short-term interest rates in Germany and the US. The last column also gives the tests for the rate of depreciation. The absolute value of the deviation from unity of the estimated largest root appears in parentheses below each Dickey-Fuller statistic: this deviation should be approximately zero if the series has a unit root. Unit root tests are given for the variables in levels and for their first differences. This permits testing whether a given series is I(0), I(1) or I(2), albeit in a pairwise fashion for adjacent orders of integration.[4] According to the unit root tests all variables except the rate of depreciation

[4]For identification of the cointegration indices using the two-step procedure of Johansen (1995), the reader is referred to the international interest rate analysis in Hammersland (2004).

appear to be integrated of order one.[5] The rate of depreciation on the other hand seems to be a stationary variable.

Table 2.2 reports values of a multivariate statistic for testing the time series properties of a given variable. Specifically, these LR-test statistics test the hypothesis that one of the cointegrating vectors contains all zeros except for the coefficients corresponding to the variable under consideration and a non-restricted constant term, where the test as alluded to above, is conditional on the number of cointegrating vectors. For instance, the null hypothesis of a stationary long-term German interest rate implies that one of the cointegrating vectors is $\begin{pmatrix} 1 & 0 & 0 & 0 & 0 & \beta \end{pmatrix}'$, where I have implicitly assumed that long-term German interest rates and the constant are the first and last variable of the variable vector, respectively. In Table 2, the statistics quoted are conditional on there being two cointegrating vectors and refer to the same VAR model that is used later to identify the long-run relationships. Empirically, all the stationarity tests, except for the depreciation rate, reject with p-values less than one per cent. These rejections of stationarity are consistent with the inability to reject the null hypothesis of a unit root in all the interest rates when using the Dickey Fuller test statistic. Thus, all four interest rates are treated below as if they are I(1). The rate of depreciation, however, seems to be stationary and will be treated likewise.

The methodology developed by S. Johansen (Johansen (1988), (1992) and Johansen and Juselius (1990)) is used to identify the long-run relationships and to test whether some variables may be considered as exogenous with regard to estimation of the parameters of the long-run relationships. The results of the analysis are given in Table 3. However, the order of the VAR is not known a priori, hence some testing of lag order may be beneficial in order to ensure reasonable power in the Johansen procedure. Beginning with a fifth-order VAR in i^{GL}, i^{UL}, i^{GS}, i^{US} and Dv that includes a restricted constant term, we show in Appendix A, Table 8, that it is statistically acceptable to simplify to a second-order VAR. Further reduction to a first-order VAR is rejected. The empirical cointegration analysis is therefore made on a 5 dimensional VAR of order two.

Table 3 shows the results of Johansen's maximum likelihood procedure. Looking first at Table 4 which gives the diagnostics of the individual equa-

[5] The diagnostics of the fourth order autoregressive model of the German long-term interest rate reveal problems with heteroscedasticity and autocorrelation as well as non-normality. Strictly speaking therefore, the results of the Dickey Fuller test for this variable is not valid. However, with regard to the other variables all diagnostics are fine.

Table 1:
ADF(4) Statistics for Testing for a unit Root.
Estimates of $\left|\left(\hat{\rho}\right)-1\right|$ in parenthesis[1),2)]

	Variable				
H_0	i^{GL}	i^{UL}	i^{GS}	i^{US}	Dv
$I(1)$	-1.1465 (0.0217)	-1.5053 (0.036)	-0.9477 (0.0074)	-1.9276 (0.0231)	-5.072** (0.859)
$I(2)$	-3.5098** [3)] (0.5419)	-4.5702** (0.747)	-3.1376** (0.469)	-2.7768** (0.3662)	-7.3708 (2.5954)

[1] For any variable x and a null hypothesis of I(1), the ADF statistics are testing a null hypothesis of a unit root in x against an alternative of a stationary root. For a null hypothesis of I(2), the statistics are testing a null hypothesis of an unit root in Δx against the alternative of a stationary root in Δx.

[2] For a given variable and the null hypotheses of I(1) and I(2), two values are reported. The 4'th-order augmented Dickey-Fuller (1981) statistics, denoted ADF(4) and (in parentheses) the absolute value of the estimated coefficient on the lagged variable, where that coefficient should be equal to zero under the null. A constant-term is included in all regressions. The effective sample is 1990(1)-1997(12).

[3] Here and elsewhere in the paper, asterisks * and ** denote rejection of the null hypotheses at the 5% and 1% significance level, respectively. The critical values for the ADF statistics are -2.892 at a level of 5% and -3.499 at a level of 1 %(MacKinnon (1991))

Table 2:
Multivariate test statistics for testing for stationarity
Two cointegrating vectors and constant in CI-space[1),2)]

	Variables				
	i^{GL}	i^{UL}	i^{GS}	i^{US}	Dv
$X^2(3)$	17.556**	10.387*	18.814**	12.095**	4.1717
	[0.0005]	[0.0155]	[0.0003]	[0.0071]	[0.2435]

[1]The test statistics are the LR-tests of restrictions on the cointegration space within the Johansen framework. Specifically, these statistics test the restriction that one of the cointegrating vectors contains all zeros except for a unity corresponding to the coefficient of the variable we are testing whether is stationary and a non-restricted constant coefficient. In Table 2, the statistics quoted are conditional on there being two CI-vectors and refer to the same VAR model that later is used to identify the long-run relationships. The figures in brackets under each test statistics are the tests' significance probabilities and * and ** denote rejection at 5% and 1% critical levels, respectively.

Table 3: Johansens cointegration tests

System: i^{GL}, i^{UL}, i^{GS}, i^{US}, Dv.
Deterministic part: Restricted constant[1)]
VAR order: 2. Sample period: 1990 (1)-1997 (12).

Eigenvalues of Π: 0.4508 0.2551 0.2064 0.1219 0.0520

Max Eigenvalue Tests[2)]				Trace Eigenvalue Tests			
Null	Alt.	Statistics	95%	Null	Alt.	Statistics	95%
r=0	r≤1	57.53**	34.4	r=0	r≤5	125.6**	76.1
r≤1	r≤2	28.27*	28.1	r≤1	r≤5	68.08**	53.1
r≤2	r≤3	22.2	22.0	r≤2	r≤5	39.8*	34.9
r≤3	r≤4	12.48	15.7	r≤3	r≤5	17.61	20.0
r≤4	r≤5	5.13	9.2	r≤4	r≤5	5.13	9.2

1) The constant is restricted to lie in the space spanned by the columns of α
2) The 5 per cent critical values shown in brackets are taken from Osterwald Lenum (1992). An asterisk indicates that a test is significant to a level of five per cent, while two asterisks indicate that the test is significant to a level of one per cent.

tions as well as for the system, it is worth noting that all diagnostics are fine except for a five per cent rejection of normality for the residuals in the long-term US interest rate equation and a marginal rejection of the corresponding vector test statistic. Table 3 supports the existence of three cointegrating vectors at a significance level of five per cent, but only two using a test level of one per cent. However, we know that the rate of depreciation is stationary, so if we accept that there are only two cointegrating vectors, we only have to identify the second.[6] The unrestricted estimated cointegrating linear combinations and the loading matrix in case of only two cointegrating vectors are given in Table 5 below. The following table, Table 6, quotes tests of different hypotheses with regard to the cointegration space and the space spanned by the α's. As already noted when tested for stationarity the test of the restrictions identifying the rate of depreciation as the first cointegrating vector is fine. Also, the tests do not reject a homogenous linear combination of the long-term interest rates and the short-term German to be the second cointegrating vector. However, the spread between the two long-term interests rates is nor rejected. Anticipating the outcome of the tests for Granger non-causality and exogeneity, this suggests that the German short rate is superfluous and that there is a full pass through of changes in the US rate into the German rate in the long run. This agrees with the former graphical inspection of the spreads made in the introduction.

A simple test of weak exogeneity, proposed by Johansen (1992a, 1992b) (see also Urbain (1992)), is simply to test zero restrictions on a subset of the weights in the loading matrix, α. The results of these tests give support to treating the long-term US interest rate as exogenous with respect to estimation of the long-run parameters of the two restricted cointegrating vectors. With regard to the short-term US interest rate the status is more uncertain as the individual test conditional on the two identified cointegrating relationships and no error correction in the equation of long-term American interest rates, is significant to a level of five per cent (p-value equal to 0.0246). However, the same test when not conditioning on long-term American interest rates as exogenous has a p-value that is only marginally below five per cent which is also the case with regard to the test of considering both US rates as jointly exogenous. This implies that we probably are not

[6] The analysis of this paper is based on the existence of only two cointegrating long-run relationships. For an elaboration of the alternative of three cointegating vectors the reader is referred to Hammersland (2004).

making too big a mistake by restricting the two cointegrating vectors to enter only the equations of the long- and short-term German interest rate and the equation for the rate of exchange rate depreciation. If so, the two US interest rates can be considered as being exogenous with regard to estimation of the long-run parameters and inference with regard to these would be possible to conduct from a three dimensional model where we condition on US interest rates without a significant loss of information. However, to take the additional step of justifying on this basis the simpler modelling strategy implied by a three dimensional conditional system analysis when building a dynamic structural model necessitates further investigation as to whether the two American interest rates might also be considered as weakly exogenous with regard to estimation of the dynamic short-run parameters. A test of strict exogeneity with regard to the two American interest rates related to the structural model developed in the next section, does however not reject.[7] This is indicative of both US interest rates also being weakly exogenous with regard to the dynamic coefficients and together with their status of being exogenous with regard to estimation of the long-run parameters legitimate the sort of conditional analysis pursued in the next section to come. That is a three dimensional structural dynamic analysis of the system consisting of German short- and long-term interest rates and the actual rate of depreciation conditional on the two US interest rates.[8]

The two identified cointegrating relationships together with the restricted loading matrix, are given in Table 7 below. The test of the restrictions is also quoted and does not reject to a level of five per cent. The long-run relationship implies that a 100 basis points change in the long-term US interest rate leads to the same change in the German long-term interest rate in the long run. Thus there is a full pass-through of changes in US long-term interest rates into the corresponding German rates. The recursively estimated

[7]The test of strict exogeneity has been undertaken by plugging the residuals of the structural model of Section 3 into the autoregressive marginal processes of order one of the two US interest rates and restricting their coefficients to zero. The joint test of restricting all residual coefficients to zero is $\chi^2(6)$ and gave a test statistic equal to 6.25826 [0.3949], where the number in parenthesis is the respective test's significance probability.

[8]The outcome of an unconditional analysis does not significantly change the outcome of our analysis as the restrictions implied by both US interest rates being univariate autoregressive processes of order one constitute valid restrictions on the full dynamic structure. However, there is some indication of a simultaneous dynamic effect of changes in long-term US interest rates on changes in the corresponding short-term interest rates. For a discussion of this possibility the reader is referred to Hammersland (2002).

Table 4:
Individual equation and system diagnostics of the unrestricted VAR[1)]

Equation/Tests	AR 1-6 F[6,79]	ARCH 6 F[6,73]	Normality χ^2 (2)
Δi^{GL}	0.6045[0.7260]	0.5329[0.7815]	4.510[0.1049]
Δi^{UL}	1.2169[0.3065]	0.8787[0.5149]	9.128[0.0104]*
Δi^{GS}	1.3716[0.2364]	0.6138[0.7185]	1.933[0.3804]
Δi^{US}	2.0817[0.0646]	1.9673[0.0814]	0.759[0.6842]
ΔDv	0.6376[0.6998]	0.2909[0.9394]	1.631[0.4424]

System tests:	AR 1-5[150,257]	VNormality $\chi^2(10)$	VX^2 F[300,646]
Statistics:	1.2128[0.0886]	14.707[0.1431]	1.1967[0.0324]*

[1]The Values shown in brackets are the individual test's significance probability. * and ** denote as usual rejection of the corresponding null at levels of 5 and 1 per cent, respectively. VNormality and VX^2 denote the Vector tests of normality and heteroscedaticity. For an explanation of the various test statistics the reader is referred to Chapter 14 of the PcFiml manual (Doornik and Hendry (1999)).

Table 5: The unrestricted cointegrating linear combinations and the loading matrix

$$\widehat{\beta}' \begin{pmatrix} i^{GL} & i^{UL} & i^{GS} & i^{US} & Dv & 1 \end{pmatrix}'$$

$$=$$

$$\widehat{\beta}_{11} i^{GL} + \widehat{\beta}_{21} i^{UL} + \widehat{\beta}_{31} i^{GS} + \widehat{\beta}_{41} i^{US} + \widehat{\beta}_{51} Dv + \widehat{\beta}_{61}$$

$$\widehat{\beta}_{12} i^{GL} + \widehat{\beta}_{22} i^{UL} + \widehat{\beta}_{32} i^{GS} + \widehat{\beta}_{42} i^{US} + \widehat{\beta}_{52} Dv + \widehat{\beta}_{62}$$

$$=$$

$$i^{GL} - 0.28 i^{UL} - 0.21 i^{GS} - 0.23 i^{US} + 0.64 Dv - 0.025$$

$$-0.79 i^{GL} + i^{UL} - 0.06 i^{GS} - 0.071 i^{US} + 0.014 Dv - 0.016$$

Equation				Loading matrix[1]	
Δi^{GL}	$\widehat{\alpha}_{11}$	$\widehat{\alpha}_{12}$		$-$ 0.025 [0.0136]	0.143 [0.0527]
Δi^{UL}	$\widehat{\alpha}_{21}$	$\widehat{\alpha}_{22}$		$-$ 0.010 [0.0170]	$-$ 0.101 [0.0656]
Δi^{GS}	$\widehat{\alpha}_{31}$	$\widehat{\alpha}_{32}$	=	$-$ 0.016 [0.0149]	0.201 [0.0575]
Δi^{US}	$\widehat{\alpha}_{41}$	$\widehat{\alpha}_{42}$		$-$ 0.017 [0.0143]	0.022 [0.0552]
ΔDv	$\widehat{\alpha}_{51}$	$\widehat{\alpha}_{52}$		$-$ 1.340 [0.1777]	$-$ 1.468 [0.6836]

[1]The values shown in brackets to the right of the estimated loading coefficients are the respective coefficients' standard error.

eigenvalues of Figure 3 in the appendix show signs of instability. However, taking the scale on the vertical axes into consideration, this instability seems mainly to be a graphical illusion.

3 A conditional error correction model for the long- and short-term German interest rate.

Based on the results of the vector autoregressive analysis above, I started by specifying a three-dimensional conditional structural error correction model incorporating only one lag of differences and the two error correction mechanisms given by the rate of depreciation and the long-term interest spread lagged one period.[9] The structure identified was informed by theory and the desire to explain the correlation pattern of the reduced form residuals as the result of a solved data generating simultaneous equation model. From preliminary data analysis we know that the regression model is balanced, i.e. that the model includes only variables with consistent temporal properties. The error correction specification makes it easy to distinguish between short- and long-run effects. The short-run effects are represented by the differenced variables, while the long-run effects are associated with the level variables. In order to find a parsimonious representation, I then imposed restrictions on the short-term coefficients of the model. The restrictions, like the identification- scheme, were informed by theory and the desire to explain the correlation pattern of the reduced form.

The structural model below shows the regression result when using Full Information Maximum Likelihood (FIML) on monthly data for the period January 1990 to December 1997. Looking at the diagnostics quoted below the identified structural model, the LR test for over-identifying restrictions implies that the structure imposed constitutes a valid reduction of a just-identified structure. Also, I cannot reject a joint test of imposing dynamic contemporaneous linear homogeneity in the equation for long-term German interest rates, together with a linear restriction identifying the first difference of the long-term interest spread as an explanatory variable in the equation determining the bilateral exchange rate. The negative impact from the first

[9] Note that one lag of a difference includes the second lag of the level, matching the order of the VAR in Section 2.

Table 6: Test of Hypotheses related to the parameterisation of Table 5

Hypotheses		LR-test, Rank =2
1):	$\beta_{11} = \beta_{21} = \beta_{31} = \beta_{41} = \beta_{61} = 0, \beta_{51} = 1$	$\chi^2(4) = 4.18\,[0.383]$
2):	$\beta_{11} = \beta_{21} = \beta_{31} = \beta_{41} = \beta_{61} = 0, \beta_{51} = 1$ $\beta_{42} = \beta_{52} = \beta_{62} = 0, \beta_{12} = 1 = -(\beta_{22} + \beta_{32})$	$\chi^2(7) = 8.46\,[0.294]$
3):	$\beta_{11} = \beta_{21} = \beta_{31} = \beta_{41} = \beta_{61} = 0, \beta_{51} = 1$ $\beta_{32} = \beta_{42} = \beta_{52} = \beta_{62} = 0, \beta_{12} = 1 = -\beta_{22}$	$\chi^2(8) = 13.65\,[0.091]$
4):	$\beta_{11} = \beta_{21} = \beta_{31} = \beta_{41} = \beta_{61} = 0, \beta_{51} = 1$ $\beta_{32} = \beta_{42} = \beta_{52} = \beta_{62} = 0, \beta_{12} = 1 = -\beta_{22}$ $\alpha_{21} = \alpha_{22} = 0$	$\chi^2(10) = 13.78\,[0.183]$
5):	$\beta_{11} = \beta_{21} = \beta_{31} = \beta_{41} = \beta_{61} = 0, \beta_{51} = 1$ $\beta_{32} = \beta_{42} = \beta_{52} = \beta_{62} = 0, \beta_{12} = 1 = -\beta_{22}$ $\alpha_{41} = \alpha_{42} = 0$	$\chi^2(10) = 18.75\,[0.044]^*$
6):	$\beta_{11} = \beta_{21} = \beta_{31} = \beta_{41} = \beta_{61} = 0, \beta_{51} = 1$ $\beta_{32} = \beta_{42} = \beta_{52} = \beta_{62} = 0, \beta_{12} = 1 = -\beta_{22}$ $\alpha_{21} = \alpha_{22} = 0, \alpha_{41} = \alpha_{42} = 0$	$\chi^2(12) = 21.06\,[0.05]^*$

[1] The value shown in brackets after each individual LR-test is the test's significance probability. One star, *, behind a test statistic means as before that the test is significant to a level below five per cent.

Table 7: The restricted cointegrating linear combinations and the restricted loading matrix

Restricted cointegrating linear combinations[1]

$$\beta' \left(i^{GL}, i^{UL}, i^{GS}, i^{US}, Dv, 1\right)' = \begin{bmatrix} Dv_t \\ \left(i^{GL} - i^{UL}\right)_t \end{bmatrix}$$

Equation:				Restricted estimated loading matrix	
Δi^{GL}	$\widehat{\alpha}_{11}$	$\widehat{\alpha}_{12}$	=	−0.0112 [0.0078]	−0.1067 [0.0324]
Δi^{UL}	$\widehat{\alpha}_{21}$	$\widehat{\alpha}_{22}$	=	0.0000	0.0000
Δi^{GS}	$\widehat{\alpha}_{31}$	$\widehat{\alpha}_{32}$	=	−0.0094 [0.0096]	−0.1021 [0.0409]
Δi^{US}	$\widehat{\alpha}_{41}$	$\widehat{\alpha}_{42}$	=	0.0000	0.0000
ΔDv	$\widehat{\alpha}_{51}$	$\widehat{\alpha}_{52}$	=	−0.8302 [0.1097]	0.0000

$$\chi^2 (13) = 21.08\,[0.0714]$$

[1]The values in brackets to the right of the estimated loading coefficients are the respective coefficients' standard error

difference of the spread on the first difference of the depreciation rate is consistent with an overshooting effect in case of changes to long-term interest rates. That is, to generate increased depreciation expectations in the wake of long-term interest hikes the depreciation rate will have to decrease.[10] From the identified structure we note that the two variables i^{GS} and i^{UL} both seem to explain the German long-term interest rate in the short run, but only the latter in the long run. The coefficient on Δi_t^{UL} shows the impact (after one month) on the German long-term interest rate of a change in the US long-term rate. The estimate of this coefficient is 0.40, implying that a 100 basis point change in US long-term interest rates leads to a 40 basis points change in the German long-term interest rate after one month. Moreover, we note that this effect is considerably weaker than the short-run impact from a 100 basis points change in the short-term German interest rate which changes the German long-term interest rate by as much as 60 basis points. As the long-run effect of a change in short rates on long-term interest rates is neutral this suggests that the strong short-run effect is neutralized in the long run through affecting expectations of future short-term interest rates.

The long run relationship is derived by setting all the differenced variables in the reduced form of the structure equal to zero and implies as commented on before, that there is a complete pass-through into German long-term interest rates of a change in the US long-term interest rate. Thus, a 100 basis points change in the long-term US interest rate leads in the long run to an equal change in the German long-term rate. Hence, US long-term interest rates have a considerably stronger impact on German long-term interest rates in the long run than in the short run.

[10] To facilitate the interpretation of the exchange rate equation one may convert $\Delta^2 v_t = -\gamma\Delta(i^{GL} - i^{UL})$ to $v_t = v_{t-1} + \Delta v_{t-1} - \gamma\Delta(i^{GL} - i^{UL})$. Assuming a particular form of adaptive expectations implying next period's expected nominal exchange rate level is equal to the realised exchange rate level of last period, $v_{t+1}^e = v_{t-1}$, then implies that $\Delta^2 v_{t+1}^e = \gamma\Delta(i^{GL} - i^{UL})$. This equation says that an increase in the German US interest rate spread leads to an instant increase in the depreciation expectation bigger than the one predicted by UIP ($\gamma > 1$). The corresponding negativ relationship between the interest rate spread and the change in the change of the actual spot exchange rate then says nothing else than this is accomplished through an instantaneous appreciation of the spot exchange rate.

The Identified Structural model

$$\begin{aligned}
\Delta i_t^{GL} &= \underset{(0.0803)}{0.156}\ \Delta i_{t-1}^{GL} + \underset{(0.066)}{0.398}\ \Delta i_t^{UL} + \underset{(0.066)}{0.602}\ \Delta i_t^{GS} + \widehat{\varepsilon}_{1t} \\
\widehat{\sigma}_1 &= 0.001756
\end{aligned}$$

$$\begin{aligned}
\Delta i_t^{GS} &= \underset{(0.0854)}{0.234}\ \Delta i_{t-1}^{GS} + \underset{(0.0094)}{0.0151}\ \Delta Dv_t - \underset{(0.0316)}{0.114}\ \left\{ i^{GL} - i^{UL} \right\}_{t-1} + \widehat{\varepsilon}_{2t} \\
\widehat{\sigma}_2 &= 0.00201395
\end{aligned}$$

$$\begin{aligned}
\Delta Dv_t &= \underset{(0.0856)}{0.173}\ \Delta Dv_{t-1} - \underset{(1.107)}{3.819}\ \Delta \left\{ i^{GL} - i^{UL} \right\}_{t-1} - \underset{(0.107)}{0.834}\ Dv_{t-1} \\
&\quad + \underset{(1.142)}{2.517}\ \Delta i_t^{US} - \underset{(1.18)}{3.742}\ \Delta i_{t-1}^{US} + \widehat{\varepsilon}_{3t} \\
\widehat{\sigma}_3 &= 0.022361
\end{aligned}$$

Some Diagnostics of The Structural model

T=96 (1990(1)-1997(12))	LR: $\chi^2(17) = 14.4772\,[0.6331]$
LR: $\chi^2(2) = 0.4298\,[0.807]$	
VAR 1-6 $F(54, 218)$	VNorm $\chi^2(6) = 12.12\,[0.0594]$
$\chi^2(36) = 21.346\,[0.9749]$	$F(36, 80) = 0.59294\,[0.9583]$
$\chi^2(36) = 20.947\,[0.9786]$	$F(36, 80) = 0.58186\,[0.9634]$

In Section 2 I found that I could estimate the long-run parameters conditionally on both US interest rates, without having to pay attention to their marginal distributions. This suggests that the direction of causality goes from the US to the German economy. To further substantiate this claim, however, one has to test against lagged effects of German long- and short-term interest rates as well as of the rate of depreciation on both US interest rates. However, a test for Granger non-causality (Granger (1969)) does not reject the null of no lagged effects on US interest rates of these variables.[11] Thus, there is evidence of a one-way causality between US and German interest rates, the direction of causality going from the US economy to the German economy.

The system diagnostics for serial correlation, non-normality and parameter constancy are all fine. However, both tests for vector heteroscedasticity reject to a level of one per cent.[12] Also, by formulating a structural model we were unable to get rid of the residual correlations across equations in the unrestricted reduced form of the system, the correlation between the residuals of the two German interest rates in fact increasing instead of decreasing.[13] These facts both indicate some sort of misspesification; the two obvious candidates are wrongly imposed structural restrictions and a too small information set. However, as mentioned in the introduction, I have so far not been able to find an adequate understanding of the structure underlying alternative information sets and will therefore leave the ground open for further research. With regard to whether the structural representation might represent wrongly imposed identifying as well as over identifying restrictions the reader is again referred to Hammersland (2002).[14] The forecast

[11]The test of Granger non-causality is made on an error correction model for US long- and short-term interest rates where we together with the lagged error correction terms and lagged changes in US long- and short-term interest rates, have regressed on lagged changes of German long- and short-term interest rates and lagged changes in the rate of depreciation. When incorporating only two lags of differences, the joint reduction of all lagged effects from these model endogenous variables and error correction terms in the marginal models of the two American interest rates gives a test statistic with a significance probability of 0.09.

[12]The vector χ^2 and vector $X_i * X_j$ tests are respectively F(108,402)=1.63[0.0004]** and F(324, 206)=1.58[0.0002]**.

[13]The correlation matrix of the simultaneous equation model is $\begin{bmatrix} 1 & -0.42 & -0.15 \\ -0.42 & 1 & -0.27 \\ -0.15 & -0.27 & 1 \end{bmatrix}$ while the corresponding matrix of the restricted reduced form is $\begin{bmatrix} 1 & 0.22 & -0.24 \\ 0.22 & 1 & -0.10 \\ -0.24 & -0.10 & 1 \end{bmatrix}$.

[14]Particularly interesting in this respect is the fact that to get rid of the worst instances of high and unexplained residual correlations across equations in the simultaneous equation model of this paper the model in Hammersland (2002) reverses the direction of causality between short and long-term interest rates, implying that short-term interest rates are explained by long-term interest rates and not vice versa. This might be indicative of short-term interest rates being set in accordance with a policy rule informed by movements in

statistics together with Figures 5 to 7 in the Tables and Graphs part of the paper, which show static(one step ahead) and dynamic ex ante forecasts for the rate of depreciation and the German long- and short-term interest rate for 1997, indicate that our model seems to make fairly good forecasts inside as well as outside the sample period though the error bands are wide and the ex ante forecasts for the German long-term interest rate systematically overpredicts the actual development.[15] However, a great deal of the systematic forecast failure of the German long-term interest rate is due to the forecast error of 1997 (2) and correcting for this would bring the forecast path considerably closer to the path of the actual series. Figure 4 shows some graphical test statistics for parameter stability. These graphs do not indicate a serious problem with unstable parameters during the sample period and are in line with the formal tests given under the structural model above.

4 Summary and conclusions

The purpose of this paper has been to reexamine empirically the relationship between long-term interest rates in well integrated financial markets. The analysis has been carried out within the framework of a five dimensional VAR for the simultaneous determination of short- and long-term interest rates in the US and Germany, and the rate of depreciation. An important motivation for using this framework has been to carefully examine cointegration and exogeneity. Interestingly, my results indicate that both US interest rates are exogenous with regard to estimation of the long-run coefficients in a three dimensional regression model for German long- and short-term interest rates and the rate of depreciation. Also, German long-term interest rates do not seem to Granger cause US interest rates. Thus, the direction of causality seems to be unidirectional, namely from the US to the German economy. This could have important macroeconomic consequences in Germany since much of the debt to households and firms is linked to long-term interest rates.[16] Moreover, I find that short-term German and long-term US interests rates both have a significant impact on long-term German rates in the short

the domestic long-term interest rates.

[15] All these forecasts have been undertaken by a model estimated on data only for the period 1990 (1) to 1996 (12) and thus are ex ante forecasts in the sense that they are made for the period after the estimation period.

[16] As illustrated by Borio(1995), the share of outstanding debt bearing interest rates which were either predominantly fixed or indexed to long-term interest rates for six of

run. However, domestic interest rates do not seem to enter the long-run relationship. In addition to implying that there is a full pass-through of long-term US interest rates into the corresponding German rate in the long run, this suggests that monetary policy could be effective through affecting expectations with regard to future short-term interest rates in a way that neutralizes a short-run effect that short-term domestic interest rates have on long-term German interest rates in the long run. The forecastability of the model is improved compared to a model where one excludes the bilateral exchange rate in the information set, and does give decent forecasts even for 1997. This suggests that the widening of the German US interest rate spread in late 1996 early 1997 might have been due to increased depreciation expectations as a consequence of overvaluation of the dollar. The subsequent narrowing of the spread in the second half of 1997 might then likewise be ascribed to increased appreciation expectations as a consequence of different growth patterns in the US and Germany and the fact that the dollar by then was perceived to be overvalued.

References

[1] Borio, C.E.V. (1995), *The structure of credit to the non-government sector and the transmission mechanism of monetary policy:* A cross-country comparison, in BIS (1995).

[2] Borio, C.E.V. and McCauley, R.N. (1996), *The Economics of recent Bond Yield Volatility*, BIS Economic Papers No. 45. Basle: Bank for International Settlements.

[3] Branson, W.H. (1977), *Asset Markets and relative prices in exchange rate determination*, Sozialwissenschaftliche Annalen, 1: 69-89.

[4] de Brouwer G. and Ericsson, N.R. (1995), *Modelling Inflation in Australia*, International Finance Discussion Papers No. 530. Washington, Board of Governors of the Federal Reserve System.

---

the seven largest European economies, amounted in 1993 to more than 55% . The only country among the seven with a significantly lower share at that time was Italy. Recent evidence shows however that things have changed dramatically in Italy since then and that the share of mortgages at fixed long-term interest rates has increased from 25 per cent in 1993 to more than 50 per cent in 1997 (European Mortgage Federation (1998)).

[5] Doornik, J.A. and Hansen, H. (1994), *A practical test of multivariate normality*, Unpublished paper, Nuffield College.

[6] Doornik, J.A. and Hendry D.F. (1999): *PcFiml 9.20 for Windows: A module for empirical econometric modelling of dynamic systems.,* London, International Thomson Publishing.

[7] Dickey, D.A. and Fuller, W.A. (1981), *Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root*, Econometrica 49, 1057-1072.

[8] Eitrheim, Ø. (1995), *Robustness of rank tests for cointegration in misspecified model: Some Monte Carlo evidence*, Unpublished paper. Oslo: Norges Bank.

[9] Engle, R.F. (1982), *Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation*, Econometrica 50, 987-1008.

[10] Frankel, J.A. (1989), *Quantifying International Capital Mobility in the 1980s*, NBER Working Paper No. 2856. Boston: National Bureau of Economic Research.

[11] EMF, European Mortgage Federation (1998): *Hypostat 1987-97.*

[12] Goodhart, C.A.E. (1995), *Financial Globalisation, Derivatives, Volatility and the Challenge for the Policies of Central Banks*, Special Papers No. 74. London: London School of Economics.

[13] Granger, C.W.J. (1969), *Investigating causal relations by econometric models and cross-spectral methods*, Econometrica 37, 424-438.

[14] Hammersland, R. and Vikøren, B. (1997), *Long-term interest rates in the US and Germany*, Arbeidsnotat 1997/10 , Oslo: Norges Bank.

[15] Hammersland,R. (2002): "*We are arrogant because we are good". A critical appraisal of Central Banking in accomplishing the community wide convergence of the eighties and the nineties*", In: L.Magnusson and B.Strath(eds), From the Werner Plan to the EMU: A In Search of a political Economy for Europe. Brussels: Peter Lang 2001. 193-210.

[16] Hammersland, R. (2004), *Large T and small N: A two-step approach to the identification of cointegrating relationships in time series models with a small cross-sectional dimension* , Working Paper 2004/15, Oslo: Norges Bank.

[17] Harvey, A.C. (1981), *The Econometric Analysis of Time Series.* Oxford: Philip Allan.

[18] Johansen, S. (1988), *Statistical analysis of cointegration vectors.* Journal of Economic Dynamics and Control 12, 231-254.

[19] Johansen, S. (1992a), *Cointegration in partial systems and the efficiency of single-equation analysis.* Journal of Econometrics 52, 389-402.

[20] Johansen, S. (1992b), *Testing Weak Exogeneity and the Order of Cointegration in UK Money Demand Data*, Journal of Policy Modeling 14, 313-334.

[21] Johansen, S. (1995), *Likelihood-based inference in cointegrated vector autoregressiv models, Oxford University Press, Oxford.*

[22] Johansen, S and Juselius, K. (1990), *Maximum likelihood estimation and inference on cointegration-With applications to the demand for money.* Oxford Bulletin of Economics and Statistics 52, 169-210.

[23] Johansen, S and Juselius, K. (1990), *Testing structural hypotheses in a multivariate cointegration analysis of the PPP and the UIP for UK.* Journal of Econometrics 53, 211-244.

[24] King, M. (1992): *Europe in the 1990s: The Economic Perspective*, Bank of England Quarterly Bulletin 32, 325-331.

[25] MacKinnon, J.G. (1991), *Critical Values for Cointegration Tests*, Chapter 13 in R.F. Engle and C.W.J.Granger (eds.) Long run Economic Relationships: Readings in Cointegration, Oxford, Oxford University Press.

[26] Obstfeld, M. (1995), *International Capital Mobility in the 1990s*, CEPR Working Paper No. 902. London: Centre for Economic Policy Research.

[27] Osterwald-Lenum, M. (1992), *A note with quartiles of the asymptotic distribution of the maximum likelihood cointegration rank test statistic.* Oxford Bulletin of Economics and Statistics 54, 461-471.

[28] OECD (1994), *The desynchronisation of OECD business cycles*, Economic Outlook, June, 37-44.

[29] Reimers, H.E. (1992) : *Comparisons of Tests for Multivariate Cointegration*, Statistical papers 33, 335-359.

[30] Shiller, R.J. (1979), *The Volatility of Long-Term Interest Rates and Expectations Models of the Term Structure*, Journal of Political Economy 87, 1190-1219.

[31] The Norwegian society of financial analysts (2001), *Recommended Conventions for the Norwegian Certificate and Bond Markets*, Oslo.

[32] Urbain, J.-P. (1992), *On weak exogeneity in error-correction models.* Oxford Bulletin of Economics and Statistics 54, 187-207.

A Tables and Graphs

Table 8: F and related Statistics for Sequential VAR Reduction.

Null Hypothesis[1]			Maintained Hypothesis[2]			
System	k	SC	$VAR(5)$	$VAR(4)$	$VAR(3)$	$VAR(2)$
$VAR(5)$	130	-57.05				
↓						
$VAR(4)$	105	-54.89	0.884 [0.63] $(25, 246)$			
↓						
$VAR(3)$	80	-55.72	0.974 [0.53] $(50, 304)$	1.074 [0.37] $(25, 265)$		
↓						
$VAR(2)$	55	-56.54	1.048 [0.38] $(75, 320)$	1.139 [0.25] $(50, 327)$	1.204 [0.23] $(25, 283)$	
↓						
$VAR(1)$	20	-57.05	1.388* [0.017] $(100, 33)$	1.570** [0.004] $(75, 34)$	1.814** [0.001] $(50, 35)$	2.417** [0.000] $(25, 30)$

Notes:

[1]The first three columns report the vector autoregression with its order, and for that model: the number of unrestricted parameters k and the Schwartz criterion SC.

[2]The three entries within a given block of numbers in the last four columns are: the approximate F-statistic for testing the null hypothesis (indicated by the model to the left of the entry) against the maintained hypothesis (indicated by the model above the entry), the tail probability associated with that value of the F-statistic(in square brackets), and the degrees of freedom for the F-statistic (in parentheses). See Dornik and Hendry (1994) for details on the algebra underlying these calculations. * and ** denote as usual rejection of the corresponding null at levels of 5 and 1 per cent, respectively.

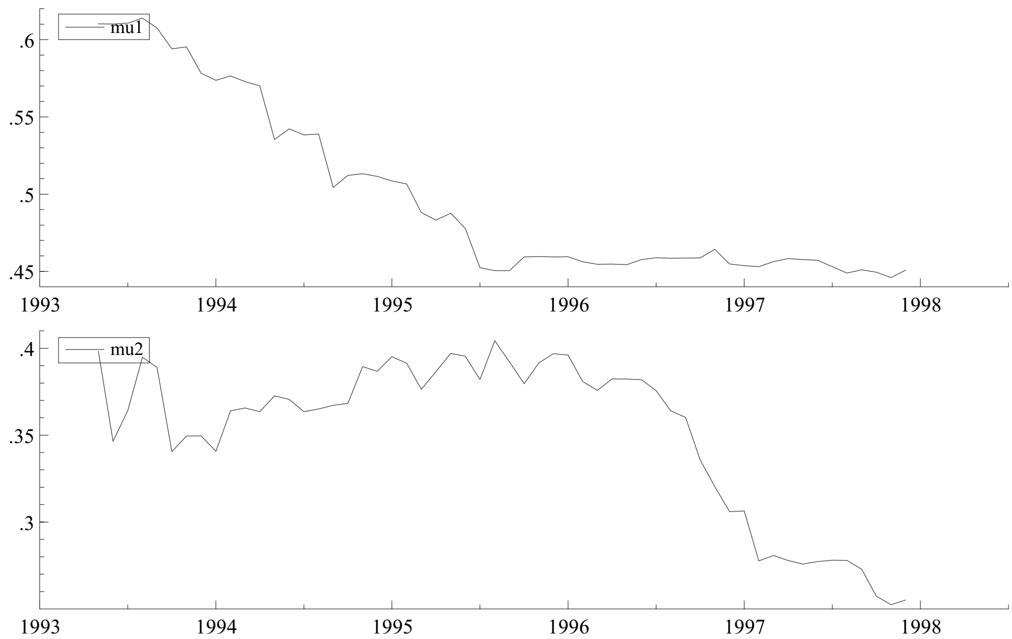

Figure 3: Recursively estimated eigenvalues

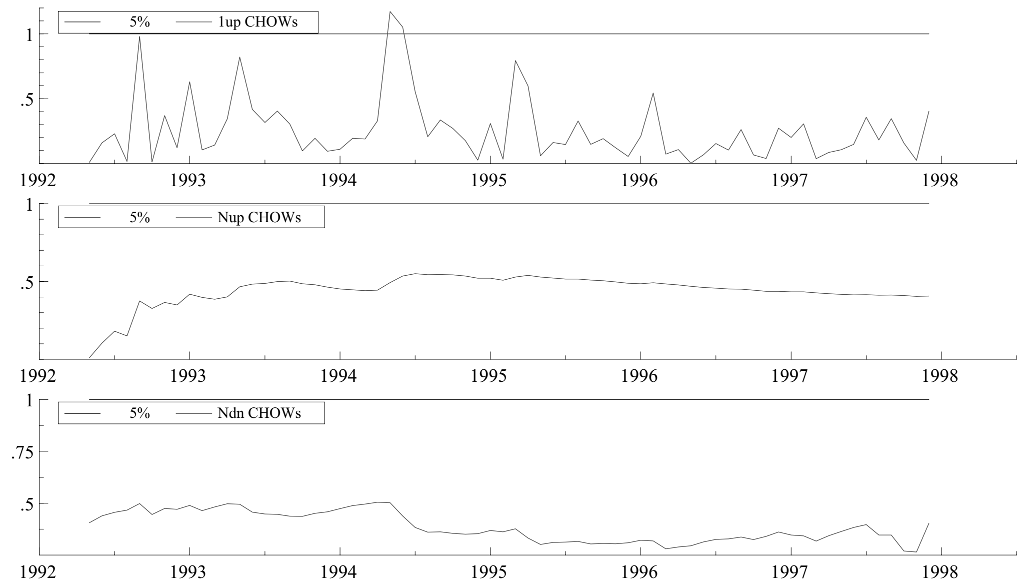

Figure 4: Chow test statistics for parameter stability of the Structural model

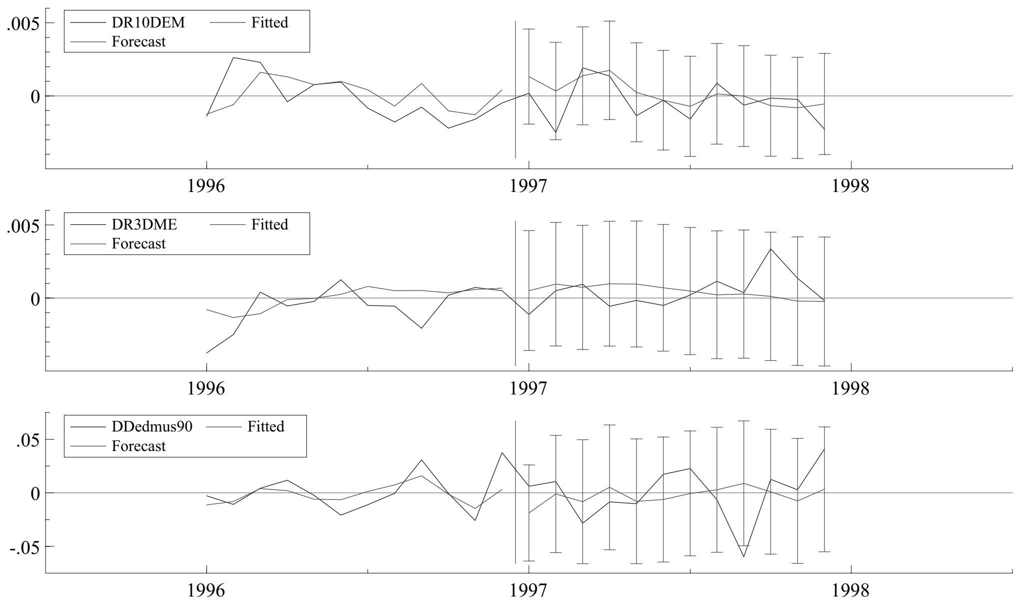

Figure 5: Dynamic forecasts of differenced variables. Estimation period: 1990 (1) to 1996 (12).

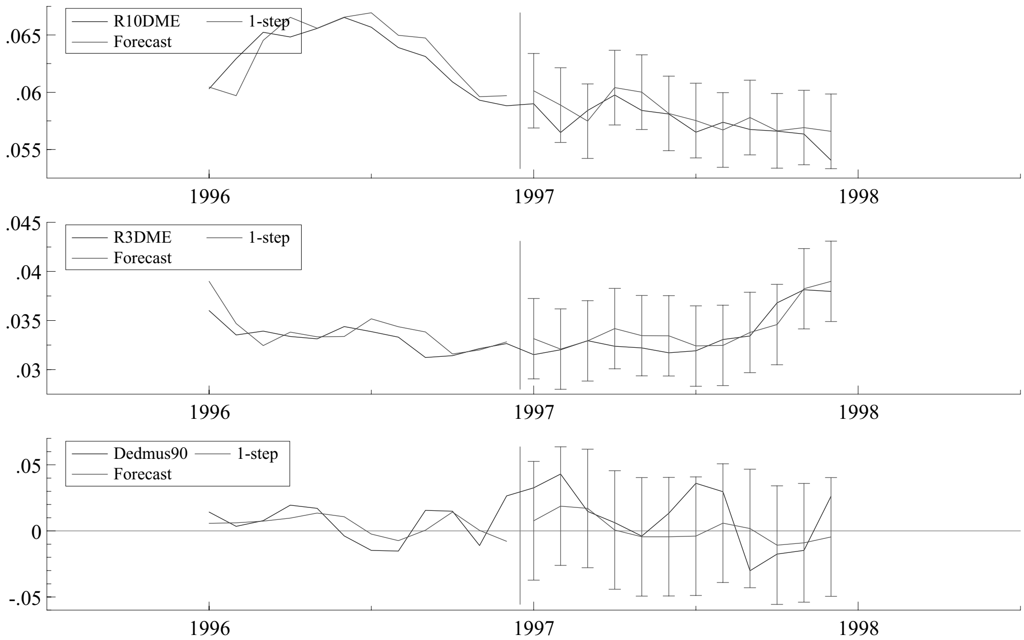

Figure 6: Static forecasts for long- and short-term interest rates in Germany and the rate of depreciation.

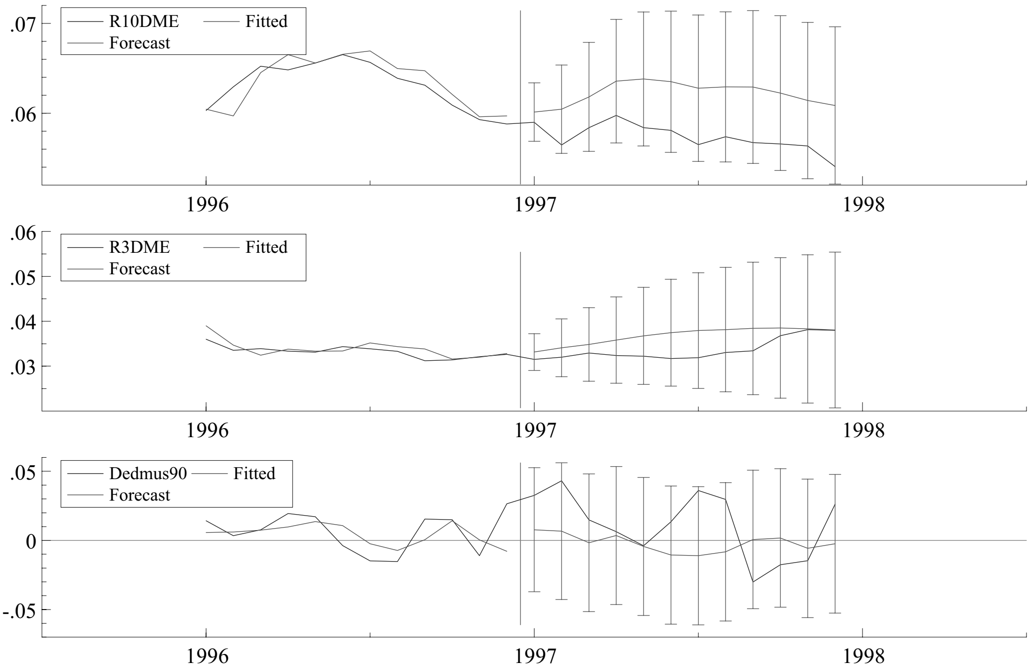

Figure 7: Dynamic forecasts of the rate of depreciation and long- and short-term interest rates in Germany.

WORKING PAPERS (ANO) FROM NORGES BANK 2002-2004

Working Papers were previously issued as Arbeidsnotater from Norges Bank, see Norges Bank's website http://www.norges-bank.no

2002/1 Bache, Ida Wolden
Empirical Modelling of Norwegian Import Prices
Research Department 2002, 44p

2002/2 Bårdsen, Gunnar og Ragnar Nymoen
Rente og inflasjon
Forskningsavdelingen 2002, 24s

2002/3 Rakkestad, Ketil Johan
Estimering av indikatorer for volatilitet
Avdeling for Verdipapirer og internasjonal finans Norges Bank 33s

2002/4 Akram, Qaisar Farooq
PPP in the medium run despite oil shocks: The case of Norway
Research Department 2002, 34p

2002/5 Bårdsen, Gunnar, Eilev S. Jansen og Ragnar Nymoen
Testing the New Keynesian Phillips curve
Research Department 2002, 38p

2002/6 Lindquist, Kjersti-Gro
The Effect of New Technology in Payment Services on Banks'Intermediation
Research Department 2002, 28p

2002/7 Sparrman, Victoria
Kan pengepolitikken påvirke koordineringsgraden i lønnsdannelsen? En empirisk analyse.
Forskningsavdelingen 2002, 44s

2002/8 Holden, Steinar
The costs of price stability - downward nominal wage rigidity in Europe
Research Department 2002, 43p

2002/9 Leitemo, Kai and Ingunn Lønning
Simple Monetary Policymaking without the Output Gap
Research Department 2002, 29p

2002/10 Leitemo, Kai
Inflation Targeting Rules: History-Dependent or Forward-Looking?
Research Department 2002, 12p

2002/11 Claussen, Carl Andreas
Persistent inefficient redistribution
International Department 2002, 19p

2002/12 Næs, Randi and Johannes A. Skjeltorp
Equity Trading by Institutional Investors: Evidence on Order Submission Strategies
Research Department 2002, 51p

2002/13 Syrdal, Stig Arild
A Study of Implied Risk-Neutral Density Functions in the Norwegian Option Market
Securities Markets and International Finance Department 2002, 104p

2002/14 Holden, Steinar and John C. Driscoll
A Note on Inflation Persistence
Research Department 2002, 12p

2002/15 Driscoll, John C. and Steinar Holden
Coordination, Fair Treatment and Inflation Persistence
Research Department 2002, 40p

2003/1 Erlandsen, Solveig
Age structure effects and consumption in Norway, 1968(3) – 1998(4)
Research Department 2003, 27p

2003/2 Bakke, Bjørn og Asbjørn Enge
Risiko i det norske betalingssystemet
Avdeling for finansiell infrastruktur og betalingssystemer 2003, 15s

2003/3 Matsen, Egil and Ragnar Torvik
Optimal Dutch Disease
Research Department 2003, 26p

2003/4 Bache, Ida Wolden
Critical Realism and Econometrics
Research Department 2002, 18p

2003/5 Humphrey, David B. and Bent Vale
Scale economies, bank mergers, and electronic payments: A spline function approach
Research Department 2003, 34p

2003/6 Moen, Harald
Nåverdien av statens investeringer i og støtte til norske banker
Avdeling for finansiell analyse og struktur 2003, 24s

2003/7 Bjønnes, Geir H., Dagfinn Rime and Haakon O.Aa. Solheim
Volume and volatility in the FX market: Does it matter who you are?
Research Department 2003, 24p

2003/8 Gresvik, Olaf and Grete Øwre
Costs and Income in the Norwegian Payment System 2001. An application of the Activity Based Costing framework
Financial Infrastructure and Payment Systems Department 2003, 51p

2003/9 Næs, Randi and Johannes A.Skjeltorp
Volume Strategic Investor Behaviour and the Volume-Volatility Relation in Equity Markets
Research Department 2003, 43p

2003/10 Bjønnes, Geir Høidal and Dagfinn Rime
Dealer Behavior and Trading Systems in Foreign Exchange Markets
Research Department 2003, 32p

2003/11 Lindquist, Kjersti-Gro
Banks' buffer capital: How important is risk
Research Department 2003, 31p

2004/1 Sveen, Tommy and Lutz Weinke
Pitfalls in the Modelling of Forward-Looking Price Setting and Investment Decisions
Research Department 2004, 27p

2004/2 Andreeva, Olga
Aggregate bankruptcy probabilities and their role in explaining banks' loan losses
Research Department 2004, 44p

2004/3 Sveen, Tommy and Lutz Weinke
New Perspectives on Capital and Sticky Prices
Research Department 2004, 23p

2004/4 Bårdsen, Gunnar, Jurgen Doornik and Jan Tore Klovland
A European-type wage equation from an American-style labor market: Evidence from a panel of Norwegian manufacturing industries in the 1930s
Research Department 2004, 22p

2004/5 Holden, Steinar and Fredrik Wulfsberg
Downward Nominal Wage Rigidity in Europe
Research Department 2004, 33p

2004/6 Næs, Randi
Ownership Structure and Stock Market Liquidity
Research Department 2004, 50p

2004/7 Skjeltorp, Johannes A. and Bernt-Arne Ødegaard
The ownership structure of repurchasing firms
Research Department 2004, 54p

2004/8 Skjeltorp, Johannes A.
The market impact and timing of open market share repurchases in Norway
Research Department 2004, 51p

2004/9 Bowdler, Christopher and Eilev S. Jansen
Testing for a time-varying price-cost markup in the Euro area inflation process
Research Department 2004, 19p

2004/10 Eilev S. Jansen
Modelling inflation in the Euro Area
Research Department 2004, 49p

2004/11 Claudia M. Buch, John C. Driscoll, and Charlotte Østergaard
Cross-Border Diversification in Bank Asset Portfolios
Research Department 2004, 39p

2004/12 Tommy Sveen and Lutz Weinke
Firm-Specific Investment, Sticky Prices, and the Taylor Principle
Research Department 2004, 23p

2004/13 Geir Høidal Bjønnes, Dagfinn Rime og Haakon O.Aa. Solheim
Liquidity provision in the overnight foreign exchange market
Research Department 2004, 33p

2004/14 Steinar Holden
Wage formation under low inflation
Research Department 2004, 25p

2004/15 Roger Hammersland
Large T and small N: A three-step approach to the identification of cointegrating relationships in time series models with a small cross-sectional dimension
Research Department 2004, 66p

2004/16 Q. Farooq Akram
Oil wealth and real exchange rates: The FEER for Norway
Research Department 2004, 31p

2004/17 Q. Farooq Akram
En effisient handlingsregel for bruk av petroleumsinntekter
Forskningsavdelingen 2004, 40s

2004/18 Egil Matsen,Tommy Sveen and Ragnar Torvik
Savers, Spenders and Fiscal Policy in a Small Open Economy
Research Department 2004, 31s

2004/19 Roger Hammersland
The degree of independence in European goods markets: An I(2) analysis of German and Norwegian trade data
Research Department 2004, 45s

2004/20 Roger Hammersland
Who was in the driving seat in Europe during the nineties, International financial markets or the BUBA?
Research Department 2004, 35s

Roger Hammersland: Who was in the driving seat in Europe during the nineties, International financial markets or the BUBA?

Working Paper 2004/20

KEYWORDS:

Cointegration
Simultaneous Equation Models
International Interest Rate Linkages
Transmission Mechanism

Lobo Media - 31186