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British Interest Rate Convergence between the US and Europe: A Recursive Cointegration Analysis

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British Interest Rate Convergence between the US and Europe
A Recursive Cointegration Analysis[1]

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Abstract

This paper addresses the question of the British state of convergence towards the Euro area, compared to the USA. Economically, the analysis is based on dependences in the money and capital markets, namely the uncovered interest parity (UIP) and the expectation hypothesis of the term structure (EHT). The econometric procedure consists of backward recursive calculations carried out in a cointegration framework. As the evidence for the single parities remains unconvincing, UIP and EHT are combined in a common model. Generally, the results are in favour of a growing British integration into the European Currency Union.

Keywords: Nominal Convergence, Cointegration, UIP, Term Structure, Euro Area
JEL classification: E43, E44, C32

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1 Introduction

In the year 1999 eleven member states of the European Union (EU) created the euro, a common currency dedicated to support further economic integration in its area. While various countries intend to become part of the EU, succeeded by a membership in the European Monetary Union (EMU), the United Kingdom (UK) did not participate in the monetary development of the community.

Historically the UK has never aimed at the same degree of European integration as comparable countries on the "continent". It entered the European Community (EC) only in 1973, when there already existed elaborate structures in the domain of economic coordination. By the same token, in 1979 the European Currency System (ECS) was founded by all EC members except the UK. Meanwhile acceded, in 1992 Britain left the narrow band of the ECS, caused and followed by a crisis and rearrangement of the European monetary cooperation.

On the one hand the special British stance might be due to political reasons, an argument which cannot be addressed in the present macroeconomic analysis. On the other hand it is argued that the British economy follows trends and patterns different from those of the European partners. In this context the hypothesis of an Anglo-American business cycle plays an important role. It emphasizes economic similarities between the "mother country" Great Britain and the "New World" USA, which are partly based on a similar understanding of the functioning of liberally organized economic systems.

In short, it is widely assumed that the UK shows no sufficient and lasting convergence towards the European continent, especially towards the Euro area. This paper examines the actual state of British interest rate convergence between the two predominant economic blocs Europe and America, strictly speaking Euroland and the USA. The economic approach comprises a joint analysis of linkages between interest rates of different countries and of assets with different maturity, namely the uncovered interest parity (UIP) and the expectation hypothesis of the term structure (EHT). Combined analyses of these relations have been carried out for example by Brüggemann / Lütkepohl (2005), Wolters (2002) and Juselius / MacDonald (2001). However, up until now, there does not seem to be much empirical work conducted in this field, neither in general, nor particularly for the UK.

As my main empirical research method I make use of the time series cointegration analysis. The central estimations are carried out in vector error correction models (VECMs). Formally I follow the procedure proposed by Johansen (1995). Furthermore, aiming at a convergence process, I apply the econometric tools within a backward recursive calculation scheme. This methodology allows to address several questions:

Are there stronger capital market linkages between the UK and the Euro zone or the US? Does the answer change with the foundation of the EMU? Is the British monetary policy able to control the important long-term interest rates, or are there decisive influences from abroad? Based on the results, could the adoption of the Euro be advantageous to the British economic development?

Concerning the last question, a short reference to the theory of optimum currency areas (Mundell 1961) might be useful. Advantages and disadvantages of the adoption of a common currency are to be compared, whilst the former reflect primarily microeconomic developments. The counterarguments deal with macroeconomic considerations, essentially correspondence of shocks and business cycles, exchange rate adjustment, mobility of production factors and flexibility of wages. In my context, the key features are necessity, adequacy and efficiency of an independent national monetary policy, and asset market integration, which is likely to provide the basis of a successful common currency.

The paper is organized as follows: Section 2 introduces elements of the economic theory, which provide the basis of my analysis. Subsequently in section 3, I describe the econometric methodology, mainly the test and estimation procedures. The next section presents the empirical results for UIP, EHT and the combined system. In the end, a summary gives the relevant generalized interpretation of the results and concludes the paper.

2 Economic Theory

The economic rationale of the UIP is the arbitrage condition between spot and forward foreign exchange markets: Interest differentials between assets with equal maturity m measured in local currencies with otherwise similar characteristics must be offset by corresponding differences between the spot exchange rate and the forward rate. To arrive at *un*covered interest parity, the forward rate is replaced by rational expectations, leading to

$$r_{t,m} - r^*_{t,m} = \frac{12}{m}(s_{t+m} - s_t) + \rho_{t,m} + u_{t,m} \ , \tag{1}$$

where $r_{t,m}$ and $r^*_{t,m}$ are logarithms[2] of the annualized domestic and foreign interest rates, and s_t is the spot exchange rate. $u_{t,m}$ is a stationary error term and $\rho_{t,m}$ denotes a risk premium, reflecting risk aversion, differences in credit worthiness etc.
It is a common result[3] that exchange rates are well described by random walks and so are integrated of order zero (I(0)) when differenced.[4] Consequently, any linkage following relation (1) requires interest differentials to be stationary. Hence, in case the interest rates are I(1), it follows that domestic and foreign interest rates should be cointegrated with the vector $(1, -1)$.

The theory of the term structure of interest rates tries to explain the connections between the yields of financial assets of different maturities but otherwise similar qualities. One of the main issues is to understand the interaction between the (short-term) money market and the (long-term) capital or bond market. Especially for monetary policy this transmission mechanism is crucial in deciding about the setting of the central bank interest rates. The EHT states that a long-term bond yield must be equalized by the overall return of a successive investment strategy in short-term assets covering the same period. According to Shiller (1979) for a long-term bond of $m = l$ periods to maturity and a short-term $m = s$ period asset (l/s assumed a natural number) this can be written as

$$r_{t,l} = \theta_{t,l/s} + \frac{s}{l} \sum_{i=0}^{(l/s)-1} E_t r_{t+i,s} \ , \tag{2}$$

where $\theta_{t,l/s}$ denotes the log of a term premium for l/s periods and E_t is the conditional expectation operator given the whole set of information available up to period t. Subtracting $r_{t,s}$ from both sides and rearranging leads to

$$r_{t,l} - r_{t,s} = \theta_{t,l/s} + E_t \sum_{i=1}^{(l/s)-1} (1 - \frac{i}{l/s})\, \Delta r_{t+i,s} \ . \tag{3}$$

That is, the spread between the yields to assets of different maturity forecasts a weighted average of changes in the shorter-term interest rate. The weighting scheme implies that (rationally) expected short-term interest rate changes in the near future carry more importance in determining the spread than those in the rather distant future. Provided that term premia (and errors in

[2]Since all considered interest rates are rather low, one can approximate $log(1 + r) \approx r$ for simplicity.
[3]The formal tests are omitted.
[4]In the UIP context this states implicitly that exchange rates behave like efficient market prices with expected changes of zero. If the exchange rate course deviates from this assumption, if, e.g., price differentials play a substantial role, real interest rates could be considered.

forecasting the future interest rate changes) are stationary and interest rates are integrated of order one, the right hand side of equation (3) will be stationary. It follows that the term spread must be stationary, too, meaning that long- and short-term interest rates are cointegrated with the vector $(1, -1)$.[5]

The last step is to combine the UIP and EHT hypotheses. By doing so it is possible to determine the different weights of the respective influences between several interest rates. Along these lines one can identify the British position in international asset market relationships and address the questions of an independent and effective, specifically British, monetary policy and of capital market integration.

UIP implies that yields of foreign and domestic assets of equal maturity must be cointegrated with the vector $(1, -1)'$ and so does EHT imply the same vector for longer- and shorter-term interest rates within one country. A joint analysis of these four interest rates should theoretically reveal pairwise cointegration relations between all endogenous variables (Hall / Anderson / Granger 1992), so that all interest rates are driven by one common stochastic trend. Other situations are discussed in Wolters (2002): Two cointegrating relations exist, if the system is following two stochastic trends. Accordingly, two parity relations hold, allowing various variants. In the last possible cointegration case the system contains three stochastic trends. This would imply that these trends only cancel out in a single linear combination of all four interest rates.

3 Empirical Foundation

The time series found to be non-stationary, that is why the next logical step is to find common stochastic trends in the data creating process, since only in the presence of cointegration deviations from interest equilibria will be not persistent. With the intention to discover these equilibria, I make use of the Johansen (1995) procedure, estimating VECMs:

$$\Delta y_t = \gamma(\beta' y_{t-1} - \alpha) + \sum_{i=1}^{q} C_i \Delta y_{t-i} + u_t \ , \tag{4}$$

where y_t contains the n endogenous variables, q is the lag length, C_i are nxn short-run coefficient matrices and u_t is an n-dimensional vector of independent white noise errors. β consists of the r cointegrating vectors and γ of the r vectors of parameters reflecting adjustment to the equilibrium relations, each containing a restricted constant from α.

The number of cointegrating relations is constrained according to the results of Johansen trace tests, which check for the rank r of the matrix $\gamma\beta'$. Since r represents the number of linearly independent stationary relations between the variables, $r = 0$ means no cointegration and $r = 1$ a unique relation; $r = n$ should only appear for stationary variables. The number of common stochastic trends in the data creating processes is then equal to $n - r$ (Stock / Watson 1988). The trace test statistic for the null hypothesis of at most r cointegrating relations is given by

$$\Lambda(r) = -T \sum_{i=r+1}^{n} log(1 - \hat{\lambda}_i) \ , \tag{5}$$

where λ_i is the i-th largest eigenvalue of the matrix $\gamma\beta'$ and T the number of observations. Critical values can be taken from Osterwald-Lenum (1992).

As I aim at establishing stylized facts about the convergence development of the British interest parities, system estimations will be carried out backward recursively. This means that beginning

[5] This relation can be established for more than two interest rates (see Hall / Anderson / Granger 1992), which is not considered here, because the main emphasis is on combining EHT and UIP. Furthermore the relation is preserved for non-zero bonds, see Shiller (1979).

in 1994 the starting point of the sample will move successively towards the present, whilst the end point 2005 will be fixed.[6] This type of recursive estimation will result in graphs showing the movement of the respective estimated magnitudes through time. As in the backward recursive estimation the number of degrees of freedom will diminish towards 2005, the smallest estimation period of monthly observations beeing less than two years, and as the trace test is known to be distorted for small samples, I implement a correction of the test statistic based on the response surface analysis in Cheung / Lai (1993).
Since the matrix $\gamma\beta'$ provides only a basis for the cointegration space, it leaves β unidentified. Thus it is feasible to impose at least $r-1$ just identifying restrictions and one normalization on each vector without changing the log likelihood function.[7] Binding restrictions, in the present case motivated economically for example by $\beta = (1, -1)'$, can be checked by likelihood ratio (LR) tests with the null hypothesis accepting the restrictions.
Besides the cointegration analysis, impulse response functions as additional econometric tools will be applied. This is beneficial in the sense that the time profile of the effect of a shock to any of the variables can be measured in a dynamic system. By a simple VECM analysis this cannot be conducted as appropriately, because it is impossible to make the interdependent reactions through time visible by single regression coefficients. I will follow Pesaran / Shin (1998) and Koop / Pesaran / Potter (1996) who introduced the so-called *generalized* impulse response analysis. It omits the shortcomings of having to set either a more or less arbitrary variable ordering or theoretical restrictions. For the formal derivation see the appendix.

4 Empirical Results

4.1 Data

The empirical analysis is based on monthly data from 1994:01 - 2005:06. They are taken from the databases of the European Central Bank (ECB), the Bank of England and the Federal Reserve Bank. From 1994 onwards the ECB publishes aggregated data for the whole Euro area, artificially constructed till 1998. The period length of more than a decade is likely to provide a sufficient number of observations. Moreover, besides the euro introduction, no severe structural changes, like the German unification or oil price shocks, have to be taken into account.
For the UK, Euroland and the US I will use two interest rate series each in order to represent the short and the long term appropriately. The empirical work includes the respective three-month nominal money market rates and yields of five-year constant maturity government bonds, see Figure 1 and 2. In detail, British *Sterling Treasury Bills* (GB5Y), American *Federal Government Securities* (US5Y) and *Euro Benchmark Bonds* (EU5Y), the latter as weighted harmonized EU-12 bonds, are chosen for the long term; the short-term money market rates are the Sterling Libor (GB3M), the Euribor (EU3M) and the US Dollar Libor (US3M). Working with other representative interest rates, for example one-month and ten-year yields, did not decisively change the main results.
Contrary to off-shore interbank rates, government bonds can be expected to be subject to different circumstances like taxation or capital controls. Standard regression estimations would probably be distorted, but dealing with cointegrated time series, these errors in variables should not severely harm the validity of the results due to superconsistency.
The comparison of the long-term yields produces a fair degree of co-movement of all the three lines. For the most time the European interest rate is lowest, followed by the US and the UK. The general trend within the sample is observed to be slightly downward-sloping.

[6]For availability of such recursive results I will not carry out explicit parameter stability tests.
[7]The necessary *and* sufficient condition for identification is derived in Johansen / Juselius (1994).

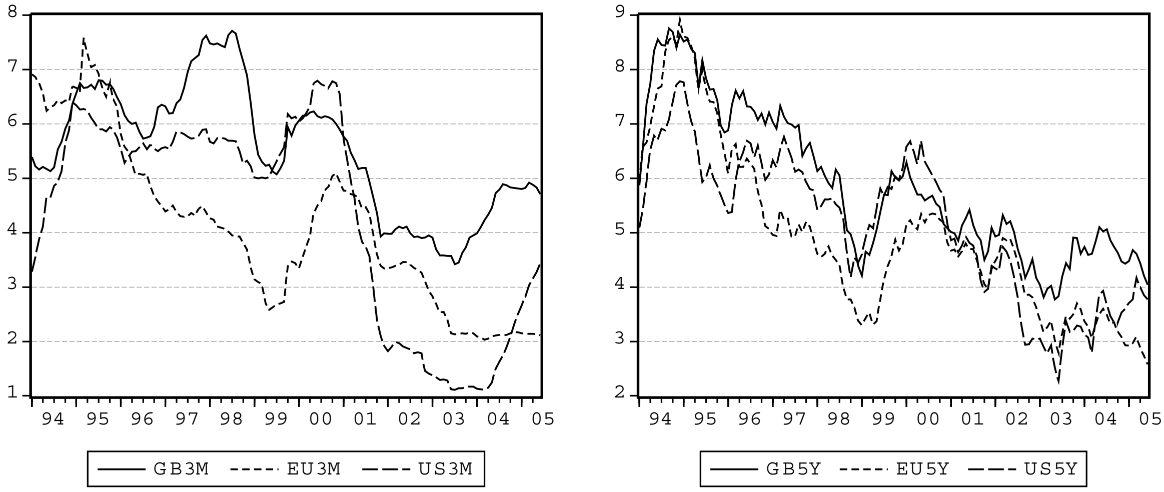

Figure 1: International comparison of the interest rates

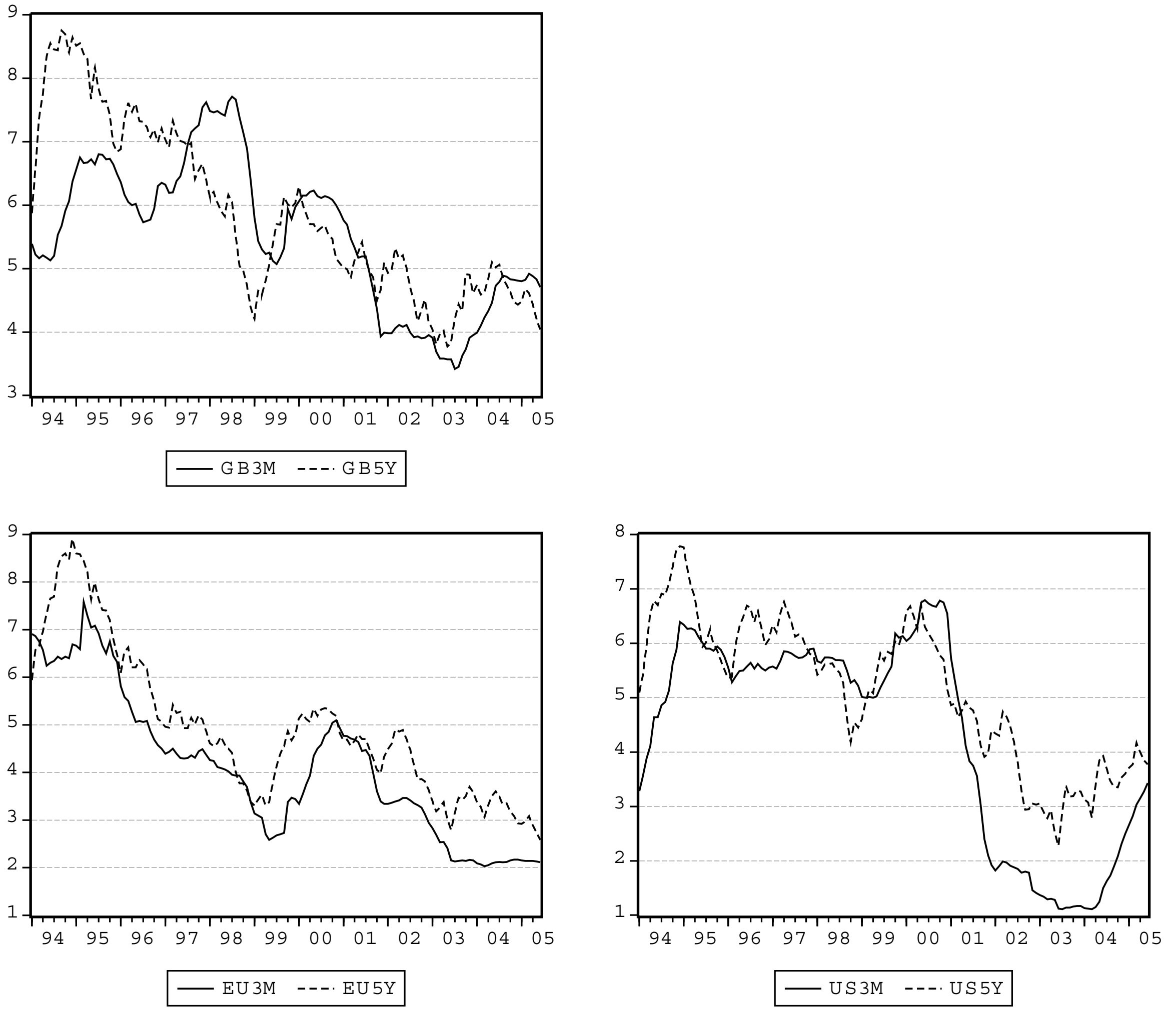

Figure 2: National term structures

In the short-term rate graphs the policy reactions to the business cycle turn out to be more distinct: Around the year 2000 ("Clinton-Boom", "New Economy", etc.) the money market is driven by an upward pressure, and the recession in the new decade is accompanied by a rapid fall in interest rates. In contrast to the long term no well-developed synchrony exists in the short term. For example the mentioned interest lowering in the US exceeds significantly the European ones, possibly corresponding to the more pronounced US business cycle fluctuations, and in 1997/98 Britain exclusively goes through a period of high interest rates.
The European term structure seems at least not to contradict the economic theory. For the UK and the US the lines do not show the same synchrony and the yield curves are partly inverted. Again this could possibly be explained by the higher volatility in the Anglo-American economies. More detailed American, European and especially British idiosyncrasy can be found for example in Artis (2003) and Brooke / Clare / Lekkos (2000).

The integration order of the time series is checked by Augmented Dickey-Fuller (ADF) tests. Table 1 presents the results for the short- and long-term interest rates of the UK, Euroland and the US from 1994:01 - 2005:06. The lag lengths in all models are determined by standard information criteria (Lütkepohl 2005).

	GB3M	EU3M	US3M	GB5Y	EU5Y	US5Y
t-value	-1.45	-1.34	-1.17	-0.67	-0.32	-1.44
lag length k	1	1	1	0	0	1
** * : H_0 can be rejected at 1% respectively 10% significance level						

Table 1: ADF tests for the interest rates

For none of the variables H_0 can be rejected even at the 10% level. Repeating the tests for the first differences H_0 is rejected in all cases at the 1% level. Interest rates are therefore assumed to be I(1).

4.2 Cointegration Tests

In order to gain a general impression of the cointegration conditions, I first investigate the two-dimensional systems, which result directly from the EHT and UIP, respectively. Concerning the EHT, in the VECM equation (4) I set $y_t = (r_{t,3}, r_{t,60})'$ and lag length $q = 1$. Figure 3 contains the backward recursive trace test statistics for the UK, Euroland and the US and the 5% critical value as horizontal line.
In the beginning cointegration for the Euro area is significant, but on the whole there is at best sporadic cointegration. It results that for no country the EHT can be sufficiently confirmed. This fact is in line with the common result suggesting EHT to be in general not valid but only among short-term interest rates (see for example Campbell / Shiller 1991 or Taylor 1992). Longer maturity assets commonly tend to be exposed to instationary term premium effects.
Investigating UIP, $y_t = (r_t, r_t^*)'$ and $q = 1$, except for the UK-US short-run model where q is set to two to avoid autocorrelation. Again the test results for the short- and long-term yields of the UK and Euroland and so too of the UK and the US are displayed graphically (together with 5% critical values), see Figure 4.
First one can see that for both the three-month and the five-year term the cointegration statistic tends more towards significance in the British-European than in the UK-US case. Secondly British-European co-movement obviously becomes stronger around 1999. For the bond yields this effect is only transitory, but the connection of the money market rates does not fall back to the initial level. Nevertheless the two-dimensional international analysis does not differ from the national one in that the cointegration evidence is not convincing.

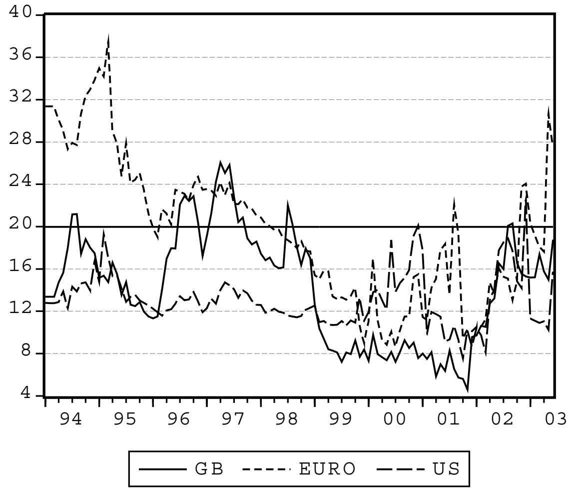

Figure 3: Backward recursive tests for national EHT cointegration

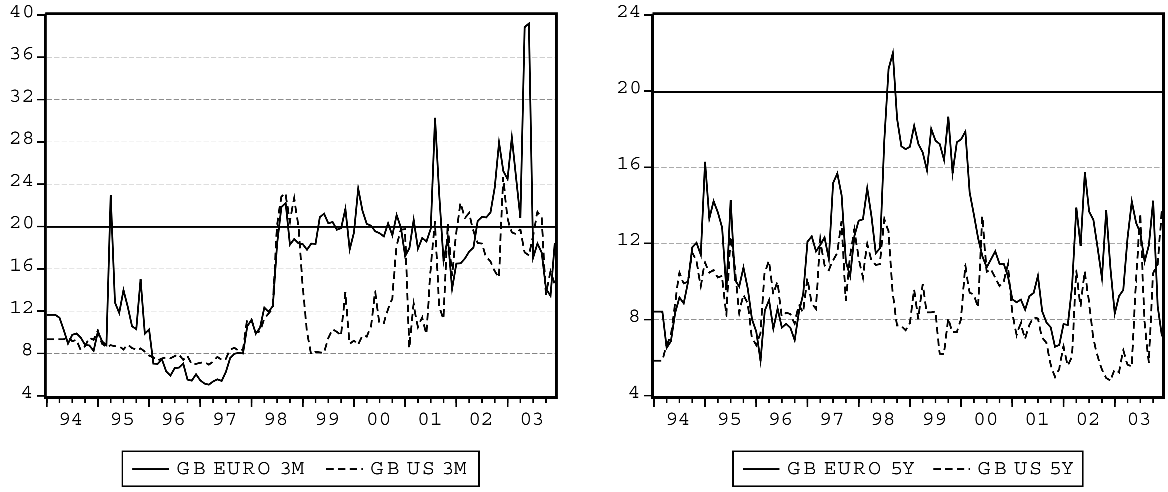

Figure 4: Backward recursive tests for short- and long-term UIP cointegration

As examining exclusively either the EHT or the UIP hypothesis establishes no empirically sufficient results, I extend the analysis to four-dimensional VECMs. In that, the persistences of the deviations from the single parities are treated as stochastic trends, still to be eliminated in further cointegration analysis. In y_t I include the Euro (US) and British short-term rate and the Euro (US) and British long-term yields, that is $y_t = (r^*_{t,3}, r_{t,3}, r^*_{t,60}, r_{t,60})'$. I set $q = 1$ for the US and $q = 2$ for the Euro case. Figure 5 shows the development of the test statistics for one, two and three cointegrating relations, and the corresponding 5% critical values.
From the left graphic it becomes clear that for the UK and Euroland one cointegrating vector is evident throughout the whole sample range, but there is practically no period where two or the theoretically suggested three vectors are significant. The right figure reveals some different pattern: Except for a short time no significant cointegration can be verified. Above all, curves are strikingly falling when reaching 1999.

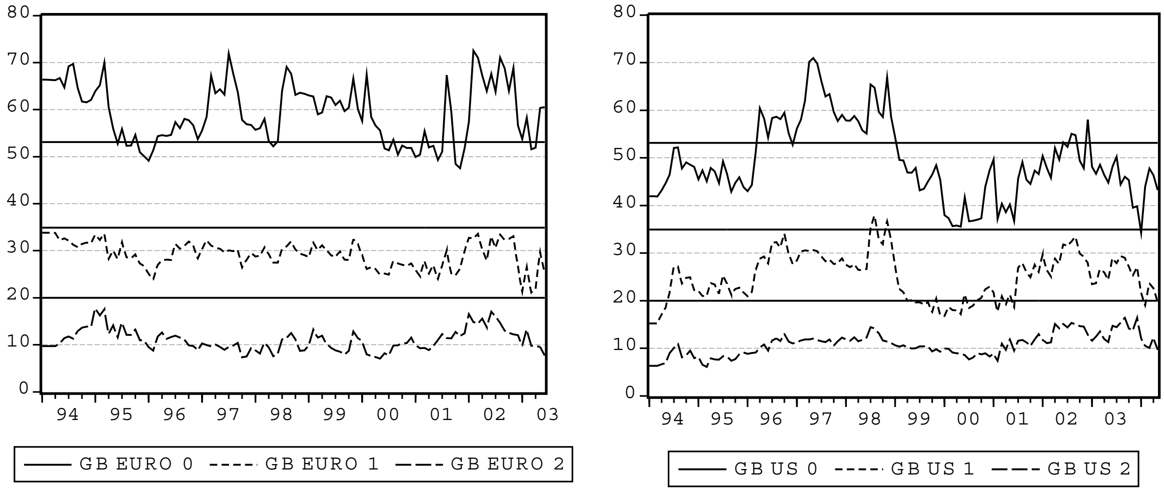

Figure 5: Backward recursive tests for UIP-EHT cointegration

4.3 Model Setting

The estimation of the UK-Euro system over the whole sample (1994:01 - 2005:06) is as in Table 2. The two-dimensional cointegration properties suggest that it shall be unproblematic to normalize the European three-month rate coefficient to unity, thus leaving the presently more interesting British parameters unrestricted.

	EU3M	GB3M	EU5Y	GB5Y
β	1	-0.55	-1.47	0.95
	[–]	[-6.23]	[-11.07]	[5.12]
γ	-0.156	0.039	0.010	0.024
	[-4.80]	[1.58]	[0.20]	[0.47]
α	0.78 [2.12]			
t-values in brackets				

Table 2: UK-Euro cointegrating relation and adjustment, 1994:01-2005:06

The model adequacy is checked by standard residual tests, results are in Table 3. It can be verified that, indicated by the LM tests, choosing $q = 2$ is sufficient for avoiding autocorrelation, and that ARCH effects do not play an important role. Solely the Jarque-Bera results are not universally in favour of normality, but this is just caused by extreme values in the first equation. Table 4 and 5 display the respective results for the UK-US system. Despite the negative trace test results they are presented for reasons of comparability, r is set to one.

4.4 Resursive parameter analysis

Subsequently, I procede with some considerations about the cointegrating vector β. For lacking cointegration the UK-US relations will be examined specifically later on. Figure 6 shows the β development through the sample, β_1 is normalized to unity. Notice that at least the signs of the coefficients are correct, because in the positive area (and therefore alike in the negative area) there are two lines belonging to interest rates of different maturity and nationality. Furthermore I can establish that the European interest rates receive a higher weight in the estimated equilibrium term than their British equivalents, and that β seems to be stable through the whole

equations	$LM(1)$	$LM(2)$	$LM(12)$	JB	$ARCH(1)$
system	20.56	19.87	15.65	230.43	LM
	(0.196)	(0.226)	(0.478)	(0.000)	
ΔEU3M	0.01	0.92	15.27	226.69	0.39
	(0.920)	(0.630)	(0.227)	(0.000)	(0.534)
ΔGB3M	0.23	0.64	5.65	2.75	10.02
	(0.633)	(0.727)	(0.933)	(0.253)	(0.002)
ΔEU5Y	0.21	1.26	9.61	0.84	0.05
	(0.649)	(0.533)	(0.650)	(0.657)	(0.820)
ΔGB5Y	0.26	2.03	8.86	0.14	0.75
	(0.609)	(0.362)	(0.715)	(0.932)	(0.390)
p-values in parentheses					

Table 3: Specification tests UK - Euro

	US3M	GB3M	US5Y	GB5Y
β	1	-0.19	-1.93	0.71
	[–]	[-1.21]	[-9.08]	[3.78]
γ	-0.039	-0.049	0.070	0.006
	[-1.87]	[-3.03]	[2.36]	[1.46]
α	2.54 [3.92]			
t-values in brackets				

Table 4: UK-US cointegrating relation and adjustment, 1994:01-2005:06

equations	$LM(1)$	$LM(2)$	$LM(12)$	JB	$ARCH(1)$
system	19.95	13.27	21.77	68.87	LM
	(0.223)	(0.653)	(0.151)	(0.000)	
ΔUS3M	2.04	3.83	19.08	49.03	3.32
	(0.153)	(0.148)	(0.087)	(0.000)	(0.068)
ΔGB3M	0.27	1.74	5.04	1.88	22.05
	(0.602)	(0.419)	(0.957)	(0.391)	(0.000)
ΔUS5Y	0.05	0.51	21.22	4.67	0.00
	(0.832)	(0.775)	(0.047)	(0.097)	(0.971)
ΔGB5Y	0.82	0.88	7.67	13.28	0.31
	(0.365)	(0.644)	(0.811)	(0.001)	(0.576)
p-values in parentheses					

Table 5: Specification tests UK - US

sample; the deviations before 1999 could possibly be attributed to uncertainty and unstable expectations preceding the foundation of the EMU.

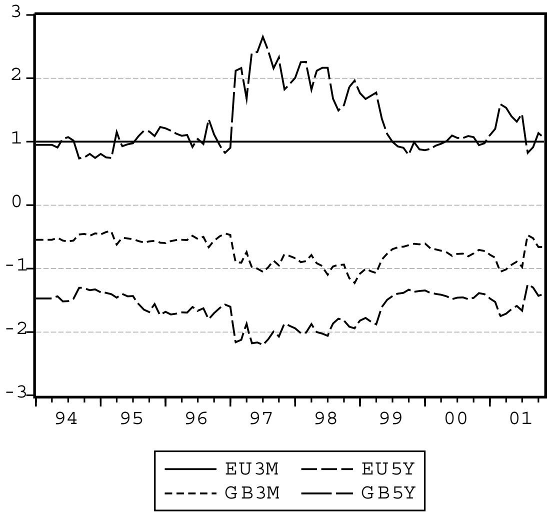

Figure 6: Backward recursive cointegrating parameters UK - Euro

Now I arrive to examine if a certain structure of the cointegrating vector can be defined. First I try if single variables can be excluded from the equilibrium term by restricting the respective parameter to zero. Figure 7 shows the backward recursive test statistics for $\beta_j = 0$ (with $j = 1, 2, 3, 4$ for EU3M, GB3M, EU5Y, GB5Y) and the 5% critical value. None of the four graphs allows me to adopt the underlying constraint. Conclusively, all endogenous variables are necessary elements of the error correction term.

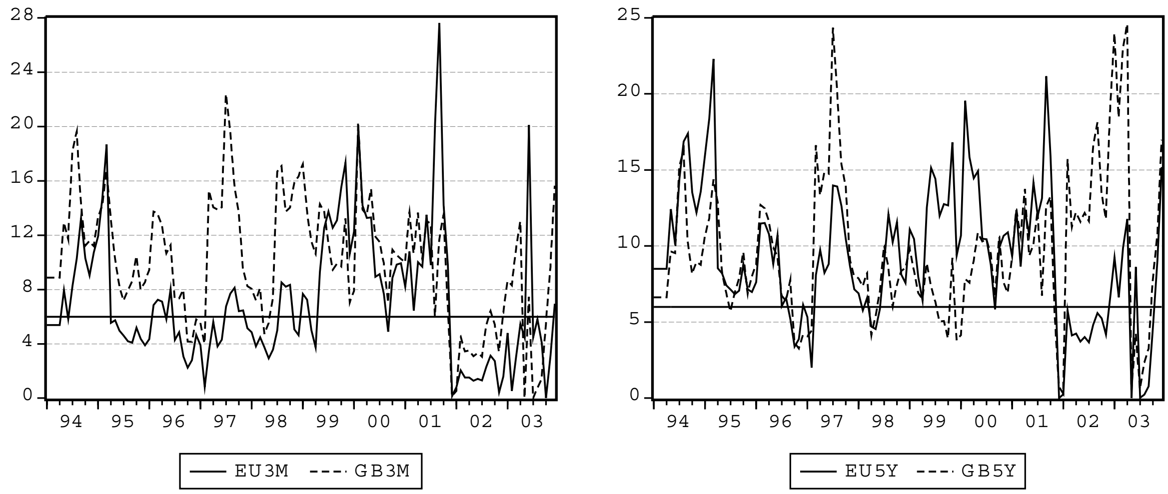

Figure 7: Backward recursive LR tests for $\beta_j = 0$ (UK - Euro)

Following the theoretical suggestion, it is convenient to test restrictions, which allow only spread combinations to the vector β. In that, I constrain the vector to the national term spreads ($\beta_1 = -\beta_3$ and $\beta_2 = -\beta_4$) and to the international interest rate differentials ($\beta_1 = -\beta_2$ and $\beta_3 = -\beta_4$), respectively; the recursive LR statistics and the 5% critical value are given in Figure 8.

The hypothesis containing the EHT spreads is clearly rejected across the whole sample. In con-

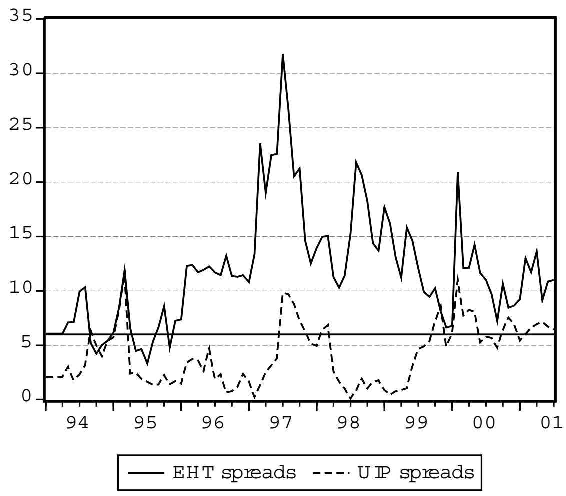

Figure 8: Backward recursive LR tests for the spreads (UK - Euro)

trast, it does not seem to be impossible to define the interest differentials between the UK and Euroland as indeed the variables of importance. Consequently, one stochastic trend each would cancel out between the two short-run respectively long-run rates. Since in a four-dimensional system with only one cointegrating relation there will exist three common trends, one of them is left, which could belong to the British or European term structure. Recalling the trace test graphs in Figure 3, better cointegration values were ascribed to the European comparatively to the British EHT. Therefore the trend is likely to be common to the European interest rates. The fall in their cointegration graph could then possibly explain the rise of the LR graph in the last years.

For now I progress with the question, which variables will move independently and which will guarantee the system adjustment process. Following the usual procedure of this paper, Figure 9 reports the backward recursively estimated t-values[8] of the loading coefficients for all system variables together with the 5% critical values.
At this point, note that an economically right-directed adjustment of the jth variable requires a parameter γ_j, which should not have the same sign as the cointegrating parameter β_j. Reconsidering Figure 6 yields that EU3M and GB5Y should adjust in the negative and GB3M and EU5Y in the positive direction.
Regarding the European interest rates, the following can be observed: The bond yield parameter fluctuates around zero indicating a mainly insignificant adjustment. For the money market rate t-values are significant and right-directed. This does not necessarily imply that the European rate follows the British ones, because I have stated two-dimensional borderline cointegration values for the European term structure, combined with a highly significant adjustment parameter of the three-month rate.[9] The British long-term interest rate has indeed a mostly positive t-value, but it does not decisively reach significance. This changes in the last sample years when, the graph moves in the negative area. The three-month rate adjusts predominantly in the suggested positive direction, significance is partly given. Similar to the cointegrating vector, a general instability can be detected around 1999.
In addition to the equilibrium adjustment this section analyzes short-run effects between the interest rates. Logically the parameters contained in the matrices C_i in equation (4) are the

[8]Weak exogeneity restrictions were checked by LR tests, confirming the t-test results.
[9]The last result has not been made explicit.

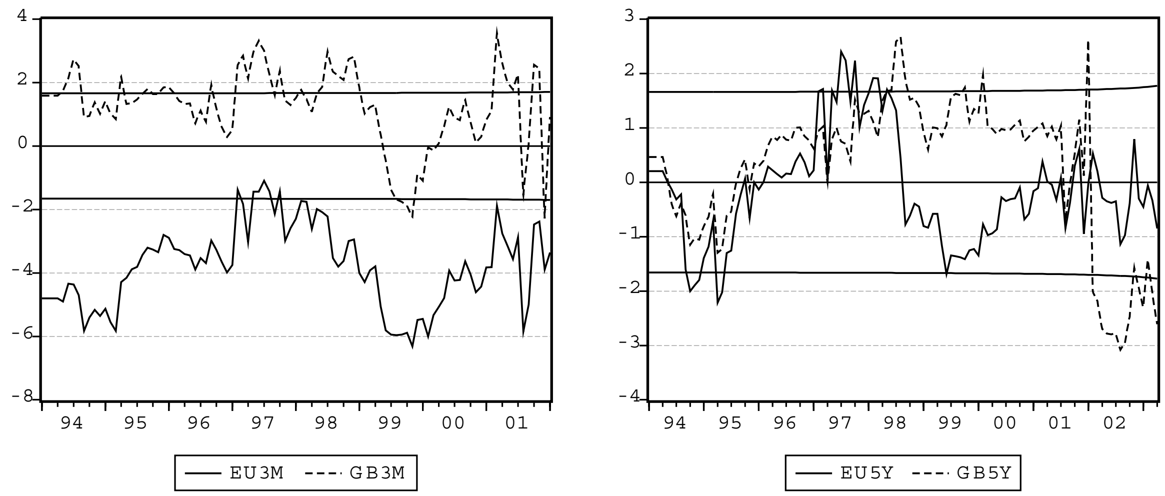

Figure 9: Backward recursive adjustment t-values UK - Euro

matter of interest. Bearing in mind there is no cointegration between the UK and the US, the short run is of particular interest for their economic relations. Here I will check if despite the lack of long-run co-movement the British interest rates are subject to US influences. For this purpose I isolate the lagged differences restricting the error correction relation to zero. Figure 10 then displays the backward recursive t-values of the impact of the US on the UK variables as denoted in the legend together with the 5% critical values. Evidently, this procedure is equivalent to the concept of Granger-causality tests (Granger 1969, Sargent 1976).

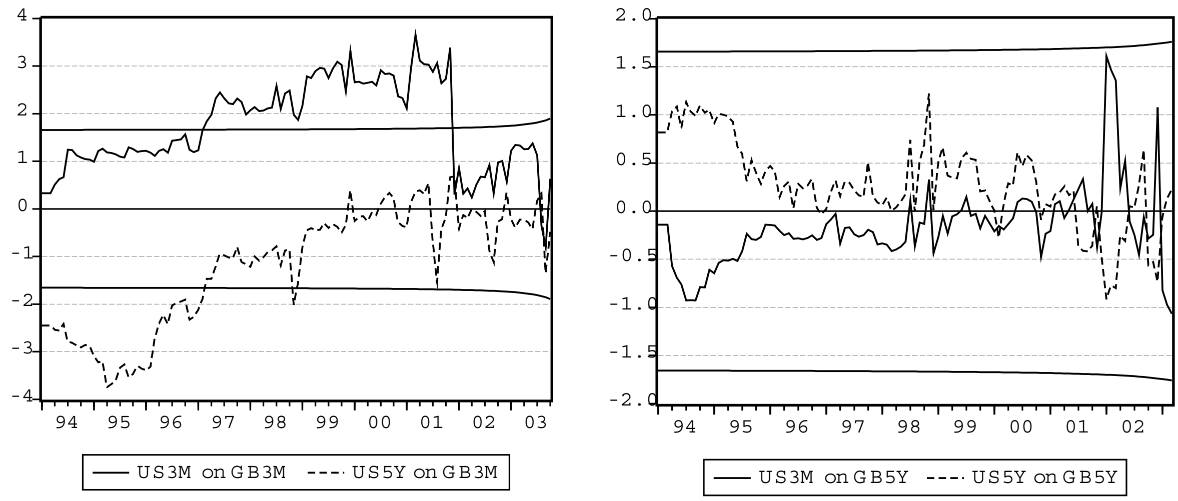

Figure 10: Backward recursive short-run t-values UK - US

The left graphic provides information about the significance of the US short-run parameters in the UK money market equation; US influences on the UK short-term rate cannot be totally excluded, but they are not likely to play an important role in British convergence. The abrupt drop of the US money market influence in 2001 might be related to the terrorist attacks at the same time. For the UK bond yields no American impact can be deduced from the estimations. In the British-European system I examine the short-run influences as part of a model containing a cointegrating equilibrium. As I set $q = 2$, I now check the no (short-run) Granger-causality hypotheses with zero restriction Wald tests[10], confining the analysis to the cross-country effects. Figure 11 gives an overview of the χ^2-statistics and the 5% critical values.

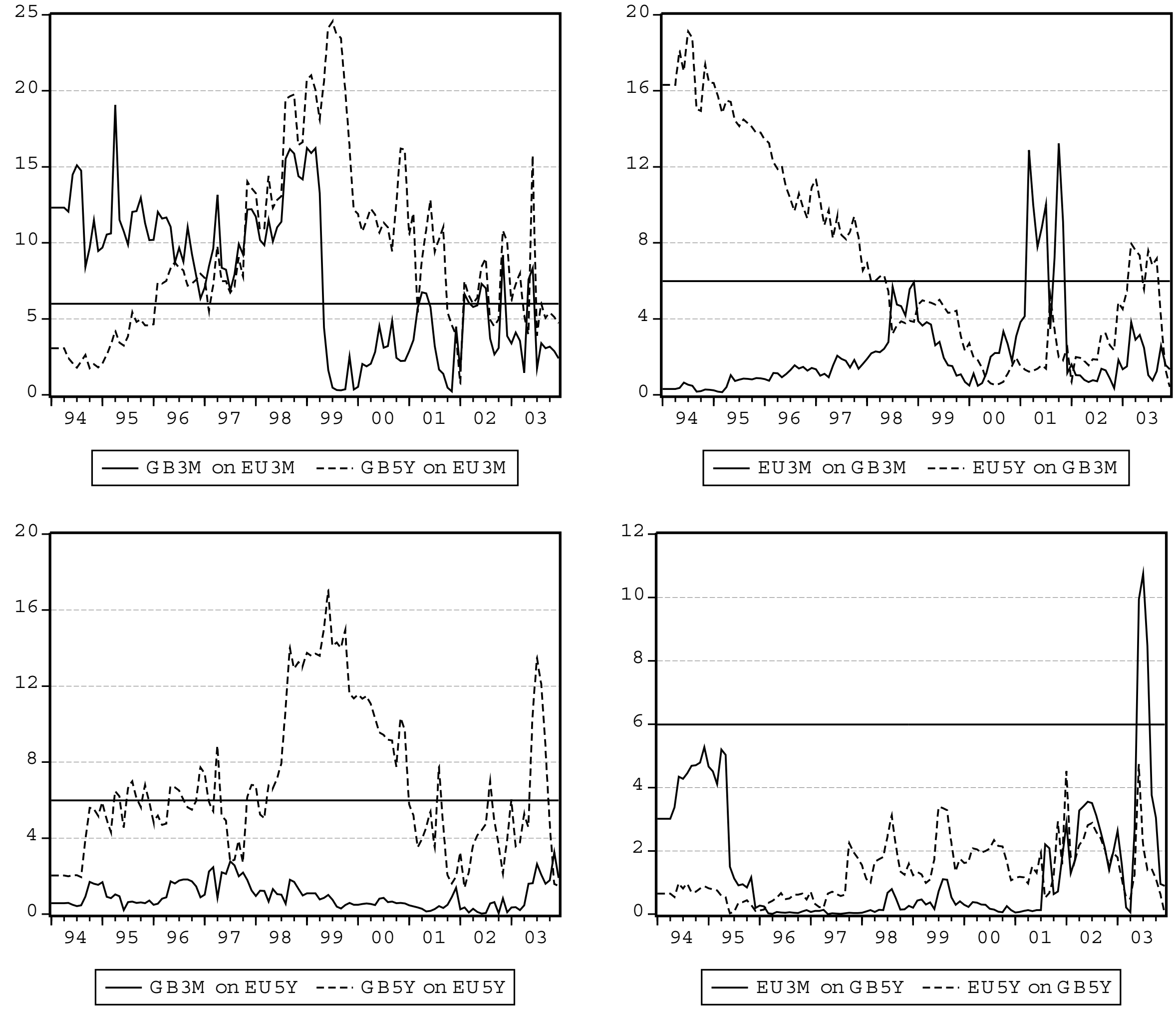

Figure 11: Backward recursive short-run causality tests UK - Euro

Factually, significant parameters can be found for both directions, but mostly without a systematic structure. Above all the British five-year yield apparently has gained explaining power temporarily around 1999, which could be justified by a British leading position in the international financial market competition and its resulting signalling function.

4.5 Impulse Responses

For the UK-US relation neither cointegration nor important short-run influences could be established. Therefore this section will not conduct the impulse response analysis but for the European case. The response functions for the unrestricted system over the whole sample are presented in Figure 12; changing the starting point had nearly no influence on the results.
Generally speaking, the development of the money market rates can be determined by all system variables; all responses are positive, as could be expected. In contrast, the capital market rates react in the main only to their own and to each other's innovations, an indicator for integrated

[10]Using the F- instead of the χ^2-version and overfitting the VAR order, as in Dolado / Lütkepohl (1996), was found not affecting the basic results.

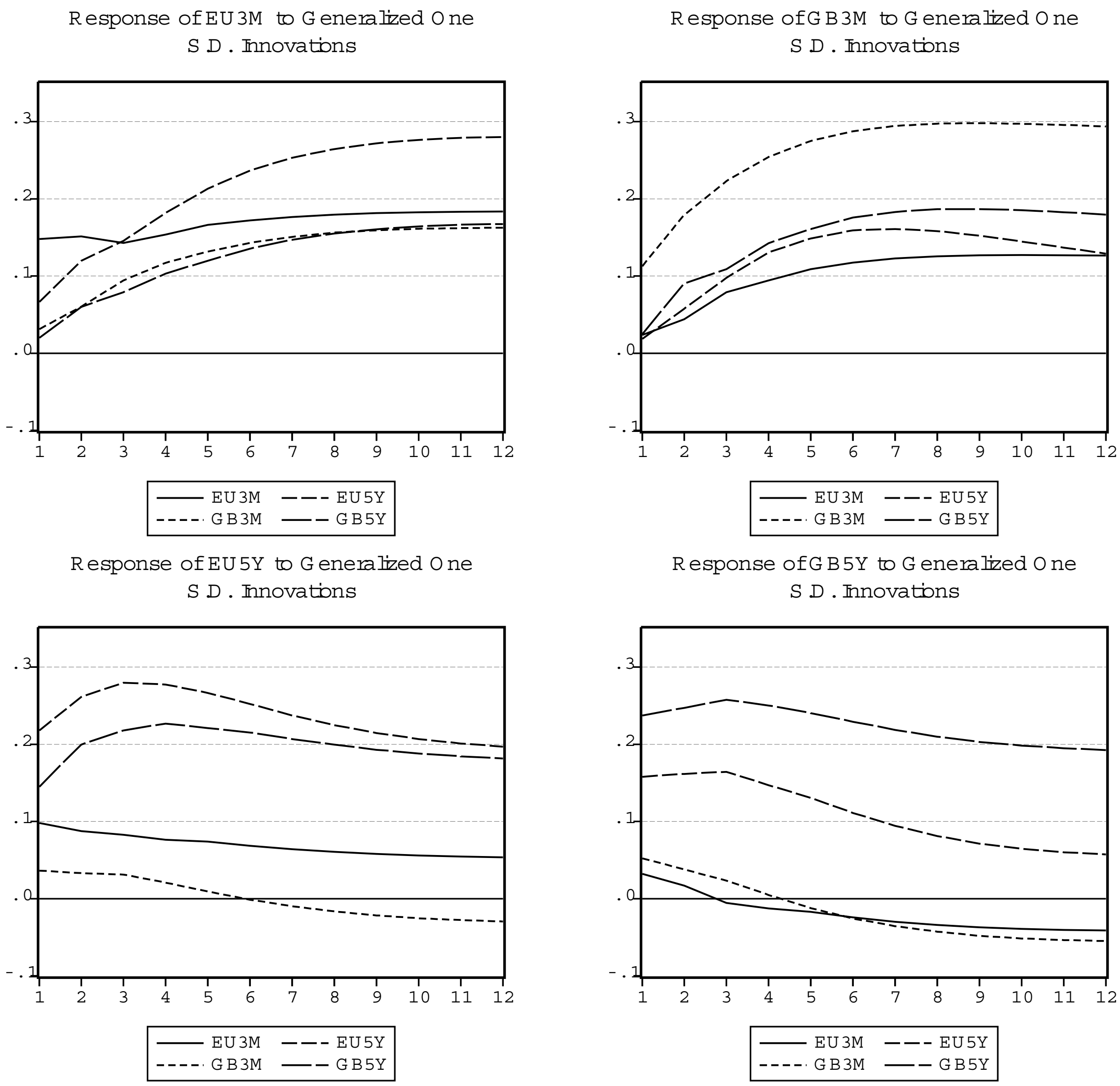

Figure 12: Generalized impulse responses UK - Euro

capital market behaviour. Overally, it should be noted that there appears an undeniable impact of the British on the European rates, as well as in the reverse direction, of course.
For the interpretation it is important to notice, measured system influences can be either due to direct transmission effects or to policy reactions to a certain general trend. Especially in the case of the Euribor the latter explanation seems to be reasonable: Obliged to a stability policy, the ECB makes use of the new information contained in the term structure for taking its monetary decisions.
The long-term yields seem to process the innovations immediately. In contrast it takes a certain time until the effects in the money market reach their maximum, probably as a consequence of delayed policy procedures.

5 Concluding Summary

In the public discussion the UK has mostly been perceived as not aiming at deepening and strengthening of the European integration. Especially abolishing the sterling and becoming member of the EMU evidently is a problematic issue in the general awareness of Great Britain. There are numerous reasons of political and emotional nature involved, though, I focus my attention on analyzing the economic state of British convergence in the field of European money and capital markets and compare it to the USA.

While I endeavour this research within an econometrical framework, my theoretical concept is based on a single and joint examination of UIP and EHT. One major inquiry is if adopting the euro would make sense for the British economy. Other questions arise from reflections on the above mentioned macroeconomic parity relations. Answers will be given in the following together with a summary and interpretation of the empirical results.

Initial analysis of the data led to an overall mixed impression from the theoretical point of view: An UIP co-movement could be presumed for the capital market yields, the EHT structure appears to be best in line with the theory in the Euro area.

The pure EHT analysis did not lead to any sufficient cointegration results. Investigating UIP individually yielded better evidence for the UK-Euro than for the UK-US relation, especially around 1999, but the trace test results were not satisfactory.

In the combined analysis of UIP and EHT I found one significant cointegrating relation between the UK and Euroland. With regard to the negative results of the single parity examinations the theoretical number of three vectors has not been within reach anymore. For the US case no actual cointegration could be established, above all after a sudden fall of the trace test graph in 1999, the year of the euro introduction. Evidently the European economic attraction grew with the beginning of the monetary union, accompanied by a stronger British asset market integration.

The recursively estimated cointegrating vector between the UK and Euroland was fairly stable and right-directed over time. All the interest rates were necessary elements of the error correction; it was acceptable to restrict the vector to the international interest differentials. Hence, one stochastic trend could be assigned each to the money and to the capital market and the third probably to the Euro area financial system. This understanding favours a dominant role of Euroland, aligning well with the higher weight of the Euro interest rates in the cointegrating vector.

For capturing the interest rate causalities I give an overview of the short- and long-term VECM adjustment and the impulse responses:[11] The cointegration loading is significant mainly for the Euro money market rate, presumably caused by the term structure, partly for its British counterpart and for the British capital market rate in the last years. The short-term influences stretch to both directions for UK and Euroland, but for the US they are rather weak. I found strong mutual impulse responses of the interest rates in the, obviously well integrated, capital market. The money market rates seem to be driven by various national and international impacts. Another hint pointing at the good financial market integration is the diminishing of the risk premia on British assets towards the European ones.[12]

Worthwhile to say, these facts trigger some further thoughts: First, the interest linkage of the UK with the Euro area is stronger than with the US. While the European monetary unification in 1999 obviously caused temporary instabilities in both the long- and short-run properties of all the examined models, it also led to an enforced orientation of the UK towards Euroland. Furthermore the British monetary policy control seems to work less efficiently than the ECB. Great Britain's interest rates are subject to significant European impacts and for their part

[11] It should be remembered that the UK-US analysis has been reduced due to lacking cointegration.

[12] The underlying ARMA analysis of the UIP is available upon request.

cause effects in the reverse direction, possibly due to the traditionally strong financial market position, for example of the London Stock Exchange.
In general, results are in favour of a deepening British orientation towards the Euro area. Of course, this does not mean by far a sufficient, or even perfect, economic integration, and of course, the special focus of my convergence report must be taken into account, but provided further appropriate development, one might see my results as fostering an advantageous perspective of euro introduction in the UK.

Appendix

The formal definition of the generalized impulse response function (*GIR*) for the time $t+s$, the given information Ω_{t-1} and the present shock δ_j to the jth element is given by

$$GIR(s,\delta_j,\Omega_{t-1}) = E(y_{t+s}|\delta_j,\Omega_{t-1}) - E(y_{t+s}|\Omega_{t-1}) \ . \tag{6}$$

This equation compares the expected variable values with and without a shock in order to extract the pure innovation effect. For I(1)-variables the calculation of conditional expectations is based on the $MA(\infty)$ representation of the first differences:

$$\Delta y_t = \sum_{i=0}^{\infty} A_i u_{t-i} \ , \tag{7}$$

where technically the A_i matrices can be recursively computed out of the VAR coefficients (see Pesaran / Shin 1996). The innovation expectation conditioned to the defined shock is

$$E(u_t|\delta_j) = \frac{\Sigma f_j \delta_j}{\sigma_{jj}} \ , \tag{8}$$

with f_j being a selection vector with unity as its jth element and zeros elsewhere. The correlation between the residuals in the vector u_t is taken into account by Σ, the variance-covariance matrix of the residuals from equation (4) containing the σ_{ij} as its respective elements. In this, the whole information of the economy's history is included in the derivation of the response structure. Obtaining the impulse responses for the Δy_t obviously requires multiplying A_s in equation (8). Additionally I will scale the function by setting $\delta_j = \sqrt{\sigma_{jj}}$:

$$GIR_{\Delta}(s,\sqrt{\sigma_{jj}},\Omega_{t-1}) = \frac{A_s \Sigma f_j}{\sqrt{\sigma_{jj}}} \ . \tag{9}$$

In the last step I arrive at the impulse responses of the variable *levels* by summing up the respective effects on the *differences*:

$$GIR(s,\sqrt{\sigma_{jj}},\Omega_{t-1}) = \sum_{i=0}^{s} A_i \frac{\Sigma f_j}{\sqrt{\sigma_{jj}}} \ . \tag{10}$$

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