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The Euro and the Transatlantic Capital Market Leadership: A Recursive Cointegration Analysis

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The Euro and the Transatlantic Capital Market Leadership: A Recursive Cointegration Analysis[1]

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Abstract

In this paper, the capital market relations between the Euro area and the USA are subject to investigation. Formally based on the uncovered interest rate parity (UIP), first a long-run equilibrium between Euro and US government bond yields is established in backward recursively estimated vector error correction models (VECMs). Subsequently, the focus lies on interest rate leadership and adjustment as well as capital market integration. One major finding shows, that the foundation of the European Monetary Union (EMU) strengthened its role relative to the USA. Furthermore, the transatlantic connections have become closer in the course time.

Keywords: Capital Market, UIP, Euro, Transatlantic Relations
JEL classification: E44, F36, C32

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1 Introduction

In the year 1999 eleven member states of the European Union joined to create the euro, a common currency dedicated to foster economic integration in its area. Nevertheless, the first years saw a non-trivial depreciation, giving grounds to discussions about the stability of the euro and its strength in the international comparison. Meanwhile, the situation has changed, and concerns are rather directed to export competitiveness.

In this context, one crucial question is the role of the Euro area assets in international capital markets. On the one hand, the long-term interest rate is expected to react with respect to the domestic business cycle situation and monetary policy impulses. On the other hand, arbitrage between bonds denominated in different currencies, as stated by the UIP, brings in foreign influences.

In the first step of the empirical investigation, the UIP will be tested to hold between Euroland and the economic superpower USA. Based on the estimated long-run equilibrium, this paper inquires the adjustment to UIP deviations, and therefore the transatlantic leadership in the financial domain. By the same token, also the short-run is addressed, taking into account direct effects between the interest rates and indirect ones through the exchange rate. Special attention is paid to perceptible impacts of the introduction of the common European currency. At last, risk premia and shock symmetry are investigated as indicators for capital market integration.

In terms of empirical methodology, I mainly employ the time series cointegration analysis. The central estimations are carried out in VECMs, where formally, I follow the procedure proposed by Johansen (1995). Furthermore, in order to shed light on the *development* of the Euro-US relations, with a focus on the euro introduction, I apply the econometric tools within a backward recursive calculation scheme.

Although the literature on UIP topics is well elaborated, analyses including EMU data still remain relatively scarce. Until now, for example Ehrmann and Fratzscher (2002), Wolters (2002), Chinn and Frankel (2003) and Brüggemann and Lütkepohl (2005) have considered interest rate relations between Europe and the US. Predominantly, the European markets have been found depending on US influences, while reverse effects gained little significance. Amongst other results, the present approach demonstrates a change in this pattern, conspicuously coinciding with the foundation of the EMU.

The paper is organised as follows: Section 2 introduces the concept of the UIP, which provides the theoretical basis of the analysis. Subsequently, I describe the econometric methodology, mainly the test and estimation procedures. Section 4 presents the various empirical results of the VECM estimations. In the end, a summary gives the relevant generalised interpretation of the findings and concludes the paper.

2 Economic Foundation

The fundamental theory on international linkages between different asset yields is formalised in the UIP equation. 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 the logarithmic UIP version

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

where $r_{t,m}$ and $r^*_{t,m}$ are the annualised domestic and foreign interest rates, s_t is the spot exchange rate and $u_{t,m}$ a stationary error term. $\rho_{t,m}$ denotes a risk premium, reflecting risk aversion, differences in credit worthiness and such.

It is a common result, that exchange rates are well described by random walks and so are integrated of order zero (I(0)) when differenced.[2] Consequently, any linkage following relation (1) requires interest differentials to be stationary. Hence, in case the interest rates are I(1), domestic and foreign interest rates should be cointegrated with the vector $(1, -1)'$.

The exchange rate development should have no influence on the long-run cointegrating capital market equilibrium, but may of course play an important role in the short-run adjustment processes: On the one hand, interest rate movements might trigger capital flows, which induce exchange rate reactions, and on the other hand, interest rates could react to exchange rates through the UIP arbitrage mechanism.

[2] 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., inflation differentials play a substantial role, real interest rates could be considered.

3 Methodological Proceeding

The basic data generating process in the econometric procedure is the VAR with lag length $q + 1$

$$y_t = c^* + \sum_{i=1}^{q+1} A_i^* y_{t-i} + Bx_t + u_t \ , \tag{2}$$

where y_t contains the n endogenous variables, A_i^* are $n \times n$ coefficient matrices and u_t is an n-dimensional vector of white noise errors. c^* denotes the constants, and x_t holds exogenous variables.

Before proceeding, assume that a unit root process is an acceptable description of the interest rate behaviour. According to Johansen (1995), the commonness of $n-r$ stochastic trends is reflected by a reduced rank of $A^*(1)$, with $A^*(L) = I_n - \sum_{i=1}^{q+1} A_i^* L^i$. Consequently, one can write $A^*(1) = -\alpha\beta'$, where β spans the space of the r cointegrating vectors, and α contains the corresponding adjustment coefficients. Granger's representation theorem leads to the VECM

$$\Delta y_t = \alpha(\beta' y_{t-1} + c) + \sum_{i=1}^{q} A_i \Delta y_{t-i} + Bx_t + u_t \ , \tag{3}$$

with $A_i = -\sum_{j=i+1}^{q+1} A_i^*$, $i = 1, \ldots, q$. This representation assumes that the constant is absorbed in the cointegrating relation.

The unit root behaviour of the time series is checked by the standard ADF test (see e.g. Dickey and Fuller 1979). As deterministic term, a constant is included, except for the tests on first differences. Here, as well as in all subsequent models, the lag length is set following the usual information criteria and autocorrelation tests. Simulated critical values for the null hypothesis of non-stationarity are taken from MacKinnon (1991, 1996).

The likelihood ratio trace test statistic (Johansen 1994, 1995) for the null hypothesis of at most r cointegrating relations is given by

$$\Lambda(r) = -T \sum_{i=r+1}^{n} log(1 - \hat{\lambda}_i) \ , \tag{4}$$

where n is the number of endogenous variables and T the number of observations. $\hat{\lambda}_i$ denotes the i-th largest squared sample canonical correlation between Δy_t and the respective cointegrating relation, both corrected for the influence of the remaining regressors. Critical values are provided by Osterwald-Lenum (1992).

As I aim at establishing stylised facts about the *development* of the Euro-US capital market relations, system estimations will be carried out backward recursively. This means, that beginning in 1990:01, the starting point of the sample will move successively towards the present, whilst the end point 2006:04 will be fixed.[3] These calculations 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 2006, the shortest estimation period of monthly observations being less than two years, and as the trace test is known to be distorted in small samples, I implement a correction of the test statistic based on the response surface analysis in Cheung and Lai (1993).

4 Empirical Evidence

4.1 Data

The capital market rates are represented by 10-year constant maturity standard government bond yields: US *Federal Government Securities* (Federal Reserve) and *Euro Benchmark Bonds* (Eurostat), the latter as weighted harmonised EU-12 bonds. The graphs for the sample 1990:01 - 2006:04 are shown in Figure 1 together with the euro/dollar exchange rate. A close co-movement between the interest rates is evident at least since the late 1990s. The sample trend is slightly downward sloping, and the troughs and peaks relate to the business cycle course, for example in the economic boom at the turn of the millennium. The exchange rate graph clearly makes the quick depreciation and recovery of the euro visible.

Investigating the integration properties of the data, Table 1 provides the ADF test results for the interest and exchange rates. In none of the cases, the null hypothesis of non-stationarity can be rejected at the 10% level. As additionally, the first differences are clearly stationary, I assume all series are integrated of order one.

[3] For availability of such recursive results I will not carry out explicit parameter stability tests.

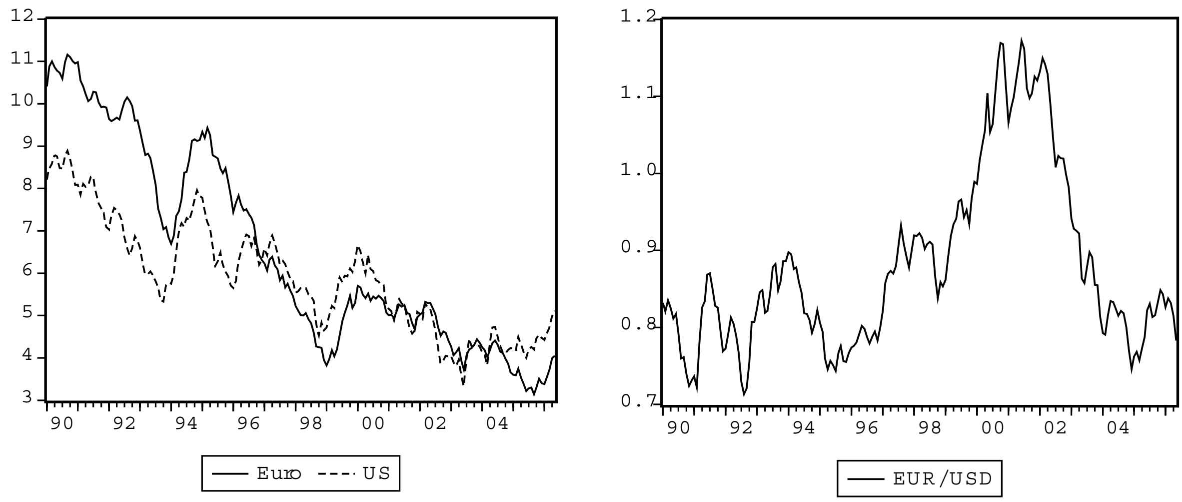

Figure 1: Interest and exchange rates

	Euro	US	EUR/USD
t-value (levels)	-1.66	-2.20	-1.49
lag length	1	1	2
t-value (differences)	-9.89**	-10.41**	-9.50**
lag length	0	0	1
** * : H_0 can be rejected at 1% resp. 10% level			

Table 1: ADF tests (full sample)

4.2 Model Specification

Regarding the bivariate VECM, I include the Euro (y_{1t}) and US (y_{2t}) bond yields as endogenous variables, where the short-run dynamics are augmented by the first contemporaneous difference of the exchange rate. For the interest rates, I follow the Schwarz and Hannan-Quinn criteria, which propose for the whole sample a lag length of one. An error correction term has been estimated in the model equations due to the trace test results in the following section. The system specification tests for the full sample in Table 2 show a satisfying model fit.

The UIP states, that the level of the exchange rate should not be of any importance for the cointegrating relation. Therefore, the VECM now only includes its stationary differences, which are not crucial for the cointegration properties. Since all leads and lags are clearly insignificant, only the contemporaneous values are considered. According to the arbitrage mechanism in (1), the leading ten-year difference should have been included, which is obviously not feasible. The monthly differences may at least approximate the direction of the expectations on revaluation. Furthermore, they probably capture the influence of the interest on the exchange rates (see section 2), which is not related to the ten-year difference from the UIP.

LM(1)	LM(2)	LM(6)	JB	ARCH(1) LM
4.36	13.10	36.20	4.70	9.61
(0.36)	(0.11)	(0.06)	(0.32)	(0.38)
p-values in parentheses				

Table 2: Specification tests (full sample)

4.3 Evidence on UIP Validity

Validity of the UIP certainly requires common stochastic trends between the interest rates. Consequently, Figure 2 shows the backward recursive trace test statistics and the 5% critical value for $H_0 : r = 0$. In general, assuming cointegration between the interest rates seems to be justified. Only around the euro introduction in 1999 the test becomes insignificant. This euro effect will reappear in the subsequent inferences.

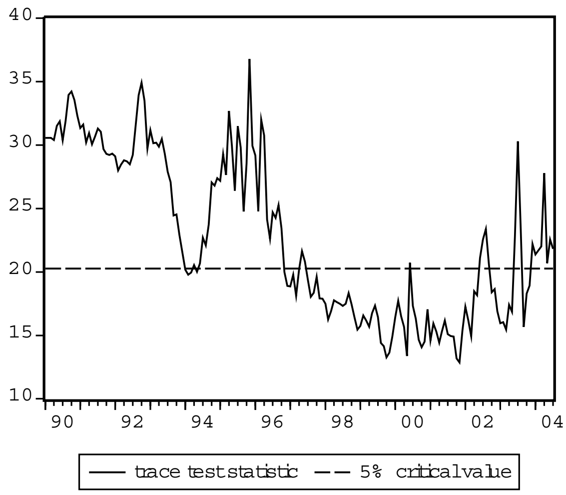

Figure 2: Backward recursive trace tests

Besides cointegration, the UIP states a β vector of $(1, -1)'$. Therefore, Figure 3 shows its backward recursive development through the sample, where β_1 (Euro) is normalised to unity. The predicted value of -1 is within reach throughout the whole sample. The slight deviation in the mid-1990s could possibly be attributed to uncertainty and unstable expectations preceding the foundation of the EMU.

Figure 3: Backward recursive cointegrating parameters

4.4 Leadership in the Capital Market

After the UIP long-run relation has been defined, the reactions of the interest rates to equilibrium deviations shall be investigated. The backward recursive t-values of the respective elements of the α vector (Figure 4) give information about the adjustment significance: At first, both bond yields adjust to the equilibrium path, but this effect becomes insignificant when getting close to the EMU foundation in 1999. Interestingly, while the US t-value quickly returns to its prior size, the Euro line stays between the critical values. This indicates, that from the beginning, the new currency has played a leading role in the international capital markets.

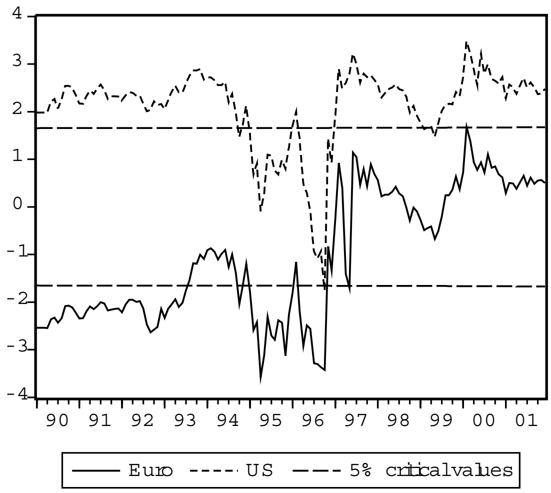

Figure 4: Backward recursive adjustment t-values

Despite the common sense, that Europe highly depends on the economic situation of the US, the Euro long-term yields follow an idiosyncratic course. In view of the crucial role of long-term interest rates for example in determining investment, besides for the capital market, this has also important implications for the real economy. As well, one might draw the conclusion, that the European Central Bank should be able to conduct an independent monetary policy orientated towards the economic needs of the Euro zone.

While the equilibrium adjustment directs at the *long-run* relation between the variables, addressing Granger causality, also the *short-run* dynamics might have important, even if transitory, influences. Consequently, Figure 5 provides the backward recursive t-values for the cross-country lagged interest rate differences (left panel) as well as the exchange rate difference (right panel).

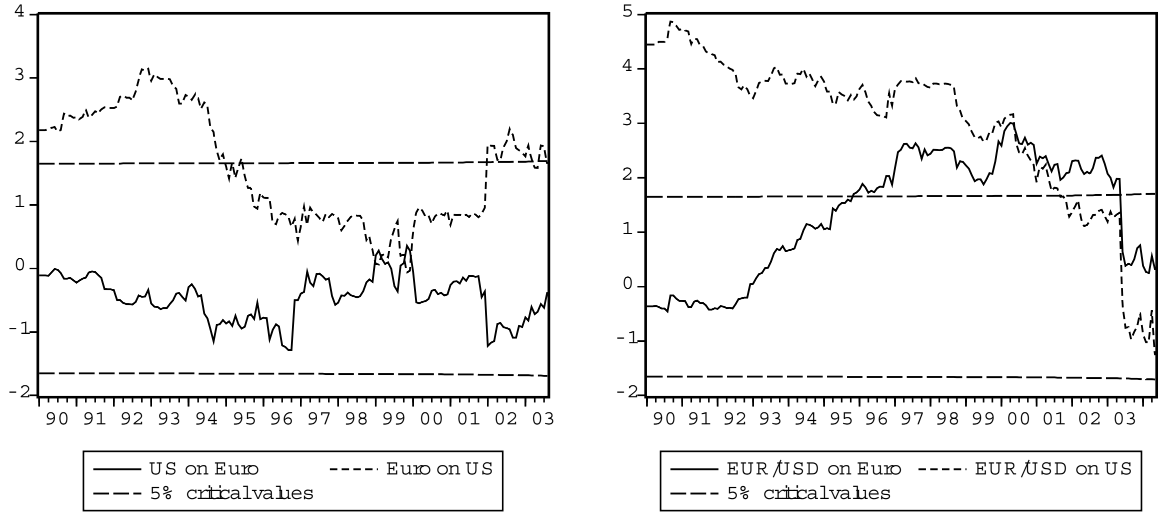

Figure 5: Backward recursive short-run t-values

Evidently, the direct short-run influence from the US on the Euro interest rate is practically zero. For the reverse direction, there appears a pattern similar to the equilibrium adjustment: Impacts exist, but are insignificant around the year 1999. The exchange rate differences are positively connected to both Euro and US yield differences. This constellation suggests intuitively, that a rise in US interest rates appreciates the US dollar (raises the EUR/USD exchange rate), and that due to the euro depreciation, the Euro bond yield must rise following the UIP arbitrage. Through this twofold mechanism, a possible short-run influence from the US on the Euro bonds can be established, but obviously, both of the significances disappear towards the end of the sample period.

The causality analysis shall now be replenished by inquiring the importance of the impacts between the variables with respect to the complete system dynamics. For this purpose, the mutual long-run variance decomposition contributions are computed. Since no sensible decision can be made on the identification of the contemporaneous correlations, I take the mean of the resulting values from the two possible Choleski decompositions as the relevant measure. The backward recursive estimations in Figure 6 do not deviate from the results of the parameter analysis: At the beginning, the influences are at eye level, but later on, the European contribution to the US yield variation gains strength, while the reverse is true for the opposite direction.

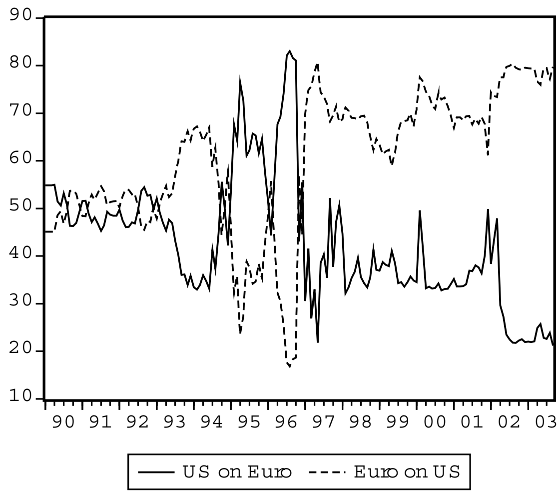

Figure 6: Backward recursive long-run variance decompositions

4.5 Capital Market Integration

At last, I turn to the question, if the capital market links between Euroland and the US have strengthened since 1990. Besides the trace test and the cointegrating vector, which examined the pure validity of the UIP, one could consider the symmetry of the interest rate innovations and the development of a possible risk premium.

Figure 7 shows the backward recursive cross-correlations between the residuals of the two model equations together with the upper standard $2/\sqrt{T}$ confidence bound. The highly significant and rising correlations prove a growing coherence between the bond yield shocks. On a general base, reasons could be seen in common effects of economic news or homogenous policy actions.

The risk premium is measured by the constant from the error correction term, where the cointegrating vector has been restricted to $(1, -1)'$ in order to extract the pure interest differential effect. Together with a two standard error band, the backward recursive intercepts are plotted in Figure 8. At the beginning, the large confidence intervals lead

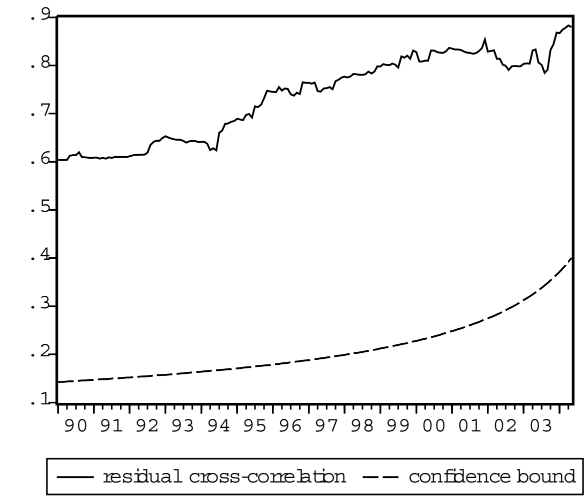

Figure 7: Backward recursive residual cross-correlations

to unclear results, but since 1999, even with smaller standard deviations the risk premia do not differ significantly from zero. While this is in favour of deepening integration, the further deviation is due to the strong US business cycle performance in the last years.

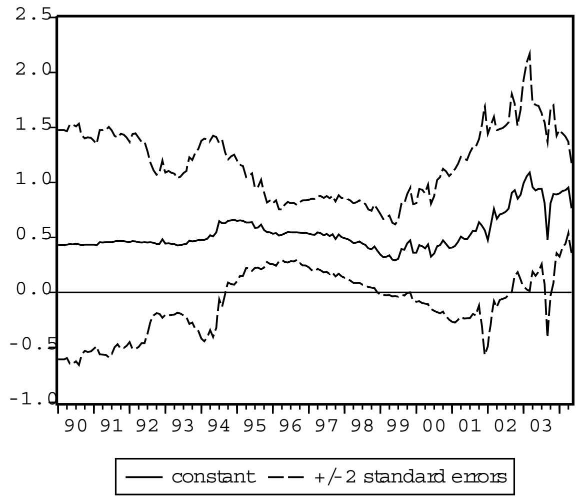

Figure 8: Backward recursive cointegration constants

5 Concluding Summary

Starting out to shed light on the Euro-US capital market connections, this paper naturally concentrates on the long-run UIP-based interest rate equilibrium. Cointegration can be established between the two bond yields, but may not be given for a few years from 1997 on. Similar effects can be found in the cointegrating vector, which deviates from unity exclusively in the mid-1990s, and in the risk premium, which is significant in the same period. Since no further exceptional exogenous events appeared in this period, it can be suggested, that uncertainty and unstable expectations in the run-up to EMU might have caused the economic turbulence. Nonetheless, symmetry of the interest rate innovations rises constantly, indicating a high homogeneity of shocks, and risk premia have a tendency to fall.

The unified Euro zone has at least partly overtaken an economic and financial leading role: Since 1997, the adjustment to the long-run equilibrium takes place exclusively through reactions of the US interest rate. Furthermore, the European bond market has short-run effects on the US, even if insignificant around 1999. Reverse short-run impacts can only be stated through the exchange rate mechanism, and are weakened significantly in the last years. As these results are confirmed by variance decompositions, the creation of a common currency has obviously strengthened the European position in financial markets. For example, this development could have arisen from the better strategic position of one united European central bank, and the lower sensitivity to foreign influences of the monetary union as a whole. Certainly, American weakness, caused for example by the current account and budget deficits, could have played an additional role, but the sudden change is unlikely to be forced by these long-run fundamentals.

The results implicate, that the EMU has adopted a strong position in the international financial markets, which are, for their part, on the road to further integration. For the European economy this means both exposure to the world markets as well as a certain scope for domestic policy, and therefore accordant responsibility as one of the world's strongest economic powers. Above all, the European monetary policy should be aware of this constellation.

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