Interpreting Deviations from Long-run Parity in an I(2) Model

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Abstract The Covered Interest Parity (CIP) theorem states that, in the foreign exchange market, the forward premium should be equal to the differential in returns between two identical assets denominated in different currencies. Models explaining foreign exchange rate often assume that this parity is approximately valid and therefore deviations from this parity should be stationary around zero. The aim of the paper is to examine the dynamics of these deviations using daily data on the EU/US spot and 3-month forward exchange rates and the corresponding money market interest rates, over the period August 2007 to August 2011. We find that I(2) cointegrated models show evidence of such stationary relation even during the financial crisis, when much more complex dynamics are taken into account.

Key words: covered interest parity, polynomially cointegrating relation, I(2) stochastic trend

1 Introduction

Models for exchange rate determination assume the covered interest parity condition to hold as a pulling force for convergence to equilibrium in international money markets. Deviations from this parity can be considered as a response to market frictions of varying nature and can generate profitable arbitrage opportunities if their magnitude is significant. The empirical validation of CIP condition has been the main aim of many studies (Atkins (1993), Balke and Wohar (1997) *inter alias*) where the analysis cover a relatively long period of observation, but in the present paper the attention is focused on the parity during the last recent turbulence in the financial markets, in order to see whether it still holds and under what conditions.

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We examine the dynamics of deviations from the parity for EU/US using daily data. First, we analyse the dataset using cointegration analysis within the I(1) model and we find that the actual deviations cannot be considered as determinations of a stationary zero mean process, even after correcting for short-run effects. Second, we analyse the same dataset within the cointegrated I(2) model and we find that the actual deviations from a relation, identified as the CIP combined with the change in the forward and spot $/€ rate, look quite stationary, though with some more pronounced volatility around the time of the worsening of the crisis.

2 Pulling and pushing forces for CIP in the I(2) model

The empirical analysis
[2] is based on a Cointegrated Vector AutoRegressive model with two lags. The vector time series[3] is $\mathbf{x}_t = \left[f_{12,t}, s_{12,t}, i_{1t}, i_{2t} \right]'$, where f_{12} is the 3-month forward and s_{12} is the spot nominal euro/dollar exchange rates, i_1 is the 3-month Euro-Libor and i_2 is the 3-month US dollar-Libor interest rates[4]. As we can see from Table 1 and according to the number of near unit characteristic roots, the results of the likelihood ratio tests for cointegration rank indices show that we can choose either an I(1) model with r=1 cointegrating relation and (p-r)=3 common stochastic I(1) trends or an I(2) model with r=2 polynomially cointegrating relations and s_2=(p-r-s_1)=1 common I(2) stochastic trend and s_1=1 common I(1) stochastic trend.

Table 1: The LR test statistics for cointegration rank indices (p-values in brackets)

(p-r)	r	$s_2 = 4$	$s_2 = 3$	$s_2 = 2$	$s_2 = 1$	$s_2 = 0$
3	1		310.502	161.501	90.867	**35.387**
			(0.000)	(0.000)	(0.000)	(0.233)
2	2			88.104	**21.927**	**12.358**
				(0.000)	(0.621)	(0.786)

As regards the I(1) model, though the data give some evidence of a marginally significant CIP relation, the deviations from this relation, represented in Fig. 1, appear clearly non stationary, showing persistent deviations, particularly in the second half of 2008. The same empirical analysis has been conducted within the cointegrated I(2) model, whose specification is as follows (Juselius, 2006, p.319):

$$\Delta^2 \mathbf{x}_t = \boldsymbol{\alpha}(\tilde{\boldsymbol{\beta}}'\tilde{\mathbf{x}}_{t-1} + \tilde{\boldsymbol{\delta}}'\Delta\tilde{\mathbf{x}}_{t-1}) + \boldsymbol{\zeta}\tilde{\boldsymbol{\tau}}'\Delta\tilde{\mathbf{x}}_{t-1} + \boldsymbol{\Phi}\mathbf{D}_t + \boldsymbol{\varepsilon}_t, \quad \boldsymbol{\varepsilon}_t \sim N_p(\mathbf{0}, \boldsymbol{\Omega}), \tag{1}$$

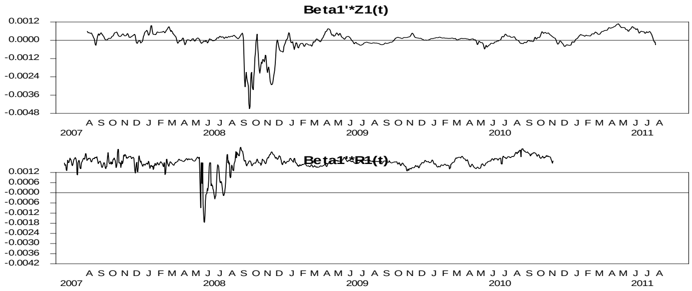
In model (1), $\tilde{\mathbf{x}}_t$ denotes that a trend component has been added to the vector of

[2] Data for the analysis were provided by Bloomberg. Analysis has been performed using CATS which runs together with RATS (Dennis, 2006).

[3] The largest characteristic roots of the unrestricted VAR are: 0.999, 0.991, 0.984, 0.895, 0.895.

[4] The observed data have been substituted by a 3 days moving average, in order to reduce the number of outliers. Nevertheless, few impulse dummies, $\mathbf{D}_t$, have been included in the model at particular dates.

Figure 1: CPI deviations within I(1) model



variables. Quite surprisingly, choosing r=2, s_2=1 and s_1=1, the estimation iterative procedure has reached the final estimates in few iterations.

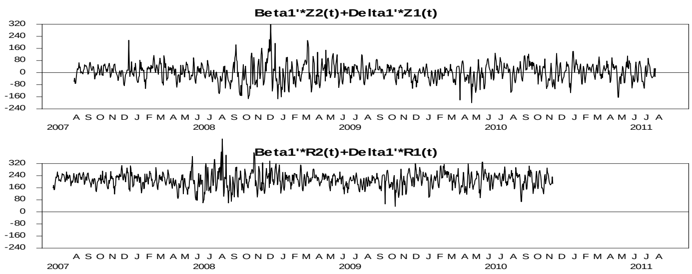
The identified r=2 dynamic long-run equilibrium relations are the following, where the over-identifying restrictions are not rejected with a p-value of 0.960:

$$\hat{\hat{\boldsymbol{\beta}}}'_1\tilde{\mathbf{x}}_t + \hat{\hat{\boldsymbol{\delta}}}'_1\Delta\tilde{\mathbf{x}}_t = (f_{12} - s_{12} - i_1 + i_2) + 1.314\Delta f_{12} + 1.406\Delta s_{12} - 0.162\Delta i_1 - 0.071\Delta i_2 + 0.000001t - 0.002\Delta t$$

$$\hat{\hat{\boldsymbol{\beta}}}'_2\tilde{\mathbf{x}}_t + \hat{\hat{\boldsymbol{\delta}}}'_2\Delta\tilde{\mathbf{x}}_t = f_{12} - 0.996s_{12} - 0.926i_1 + 0.900i_2 + 0.486\Delta f_{12} + 0.520\Delta s_{12} - 0.060\Delta i_1 - 0.026\Delta i_2 + 0.002\Delta t$$

In the first polynomially cointegrating relation, deviations from CIP are shown within the round brackets. These deviations, which are not stationary by themselves over the period, become stationary[5] by adding a linear combination of the growth rates $\Delta\mathbf{x}_t$, as we can see from Fig. 2.

Figure 2: CPI deviations within I(2) model



In the relations the coefficients $\boldsymbol{\delta}'\boldsymbol{\beta}$ describe how the growth rates react to the deviations: in this dynamic system the positive sign of the product of the two estimated coefficients shows that the forward exchange rate reacts adjusting to disequilibrium,

[5] The relation looks quite stationary, apart from some increasing volatility at the time of the deepening of the crisis.

just compensating the increasing disequilibrium shown by the negative sign associated to the spot rate. The same adjusting behaviour is shown by the Euribor interest rate. The second cointegrating relation is very similar to the first one, but it's free from restrictions, apart from the coefficient of the deterministic trend.

These two polynomially cointegrating relations represent the pulling forces of the system. The pushing forces are given by the I(2) and the I(1) stochastic trends. The estimation[6] of the moving average representation of model (1), which expresses the variables $\mathbf{x}_t$ as a function of twice and once cumulated errors, show that the identified I(2) common stochastic trend - which we consider as the main force driving this system of variables during this period of turbulence - results to be made up significantly by the twice cumulated shocks to the Euribor interest rate, and, but with opposite sign, by the twice cumulated shocks to USLibor[7]. This means that the money markets are primary stressing the system and causing its departure from CIP during this period. The estimated loads of this trend exhibit similar coefficients into both exchange rates, indicating that the smooth trending behaviours of exchange rates are driven by this trend.

3 Conclusions

The focus of the paper is on the dynamics of deviations from CIP during the recent financial crisis. Assuming that the parity holds in the long-run, if we simply look at the adjustment behaviour within the I(1) cointegrated model, we are not able to identify the relation which is the pulling force of the system towards stationarity, in fact the resulting deviations are significantly drifting away. If we analyse the same dataset within the I(2) cointegrated model, we can estimate the more complex dynamics characterising the system of variables, identify its pulling and pushing forces and determine how the variables react in order to bring the system back to equilibrium.

References

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[6] Results are not reported for reason of space but are available upon request.
[7] Similar results in terms of identification of the variables driving the I(2) stochastic trend have been described by Juselius (2010).