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Interest parity, cointegration, and the term structure: Testing in an integrated framework☆

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ABSTRACT

In this paper, we develop a methodology for testing jointly the validity of the expectations hypothesis of the term structure (EHTS) and the uncovered interest rate parity (UIRP) within the framework provided by cointegration theory. For this purpose, we use data on interest rates from the U.S. dollar-Libor, GBP-Libor, and Euro-Libor markets with maturities ranging from 7 days to 12 months. The main findings of our analysis are as follows: (i) we fail to find the correct rank of the cointegration space suggested by our methodology; (ii) with the application of tests for parameter stability in cointegrated models, we show that our cointegration results are sample independent and that the estimated coefficients do not suffer from instabilities in recursive estimations; (iii) from the moving average representation of the model, we estimate the common stochastic trends whose components establish, in the USD/Euro case, the interdependence of interest rates in the formation of the driving forces of the system; (iv) we manage to identify with the two theories a sub-space of the estimated cointegration space.

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1. Introduction

The empirical research on the determination of short-term interest rates in an open economy appears to have been conducted on two, apparently different, lines of research. First, the uncovered interest rate parity (henceforth UIRP) doctrine has been invoked to explain the determination of interest rates, usually in association with the market efficiency hypothesis and in cases where the exchange rate changes are in the policy reaction function of central banks (e.g.,Krugman's (1991) target zone models). Alternatively, a number of researchers have chosen to work within the expectations hypothesis of the term structure of interest rates (henceforth EHTS), which is the workhorse among the macro-finance economists for extracting information on future economic activity and the implementation of the monetary policy through the control over short rates. This particular area of research combined with developments in the cointegration theory has produced major contributions in the testing implications of the EHTS (e.g., Campbell & Shiller, 1987; Hall, Anderson, & Granger, 1992).

In this paper, we develop a joint testing methodology of both theories within the framework provided by cointegration theory. In particular, we exploit the idea that if the EHTS holds for the domestic currency and the same is true for the UIRP with respect to a foreign currency, then the expectations theory must hold for the latter currency as well. This has far reaching implications for the independence of monetary policy in the "foreign" country since shifts in the yield curve of one currency will affect, in a predictable way, the interest rates of the other currency as well. The Great Moderation period that started in mid-1980s was characterized by the reduced macroeconomic volatility and the gradual shift of monetary policy towards inflation targeting.[1] This led to a convergence of monetary policies among the major economies of the world, and since the term premium on long-term bonds compensates

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[1] Some analysts believe that the financial crisis in 2007 and the subsequent recession brought the Great Moderation period to an end. This argument is refuted by other who claim that the Great Moderation was just interrupted due to "bad luck" and not from structural changes in the economy or the application of bad policies (Stock & Watson, 2012).

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investors basically for inflation risks, it must have resulted in more predictable short interest rate changes and a smaller contribution of variable risk premia in the determination of long interest rates. Moreover, the global financial turmoil that started with the subprime mortgage loans crisis in 2008 led the same countries to adopt quantitative easing policies in order to appease fears of deflation. Overall, these developments imply that monetary policies of the major economies converged, over the last 15 years, and that the chances are that testable assumptions on the EHTS and the UIRP theories, at least for short- and medium-term interest rates, could be more easily accepted.

The analysis is conducted within the context of cointegration theory, and therefore we examine the existence of long-run relationships among interest rates from the U.S. dollar-Libor, GBP-Libor, and Euro-Libor markets with maturity ranging from 7 days to 12 months. One novelty of our research lies in the fact that we concentrate our research in the period after the introduction of Euro. Methodologically, we depart from other papers since we explore the issue of monetary interdependence in an integrated, as implied by the cointegration theory, way, and not by looking at the reaction of individual interest rates in isolation (e.g., Ehrmann & Fratzscher, 2005).

Our approach focuses on the estimation and the identification of the cointegration space formed by the interest rates of each pair of currencies. First, we employ the full information maximum likelihood multivariate cointegration methodology developed by Johansen (1988, 1991) and Johansen and Juselius (1990, 1992). Second, since in a multivariate framework a vector error correction model (VECM henceforth) may contain multiple cointegrating vectors, a question arises as to whether one can associate particular vectors with the EHTS and identify other ones with the UIRP. Thus, following Johansen and Juselius (1994) and Johansen (1995), we impose independent linear restrictions on the coefficients of the accepted cointegrating vectors. The findings from the VECMs are compared to the ones derived from the moving average (MA) representation of the estimated models. Thus, we estimate the components of the common stochastic trends that facilitate the economic interpretation of the driving forces of the model. Third, given that at least one statistically significant cointegrating vector has been found, we examine the stability of the long-run relationships through time. Hansen and Johansen (1993, 1999) propose three tests for parameter stability in cointegrated VAR systems, which allow us to provide evidence of the sample independence of the cointegration rank as well as of parameter stability.

There are several important findings that stem from our estimation approach. First, we estimate the rank of the cointegration space, among the system of eight interest rates, for each one of the two pairs of markets we examine. The estimated rank does not correspond, in one of the two cases, to the one expected from the joint satisfaction of the two theories. Second, we impose independent linear and homogeneous restrictions, which are implied by the joint satisfaction of the EHTS and the UIRP. This joint structure is shown to be overidentified and the joint restrictions could not be accepted implying that the case of interdependent monetary policies, through the UIRP, is not valid. Then we proceed with the investigation of the source of this failure. We impose various sets of restrictions which apply to a sub-section of the estimated cointegration space. In this partially identified cointegration space, we are able to show that part of the joint restrictions from the EHTS and the UIRP cannot be rejected. The MA representation of the model then identifies the variables that contribute to the estimated common stochastic trends. Finally, we have explored the possibility of instability as a factor that might explain the rejection of the restricted version of the cointegration space. To that end, we apply the recursive tests of Hansen and Johansen (1993, 1999), which show that the dimension of the cointegration space is sample independent and that the estimated coefficients do not exhibit instabilities in recursive estimations, except for a small number of months during 2008.

The rest of the paper is organized as follows. In Section 2, the testing implications, under cointegration, of the two theories are presented, and we propose a simple joint test of both hypotheses. In Section 3, the econometric methodology is presented. Section 4 presents and discusses the empirical results with Section 5 providing our concluding remarks.

2. The expectations hypothesis of the term structure, the uncovered interest rate parity, and cointegration

2.1. Literature review

The issue of the interdependence of domestic and foreign term structures, under perfect capital mobility, has attracted the interest of a rather small number of researchers over the last 30 years. In early studies, Bisignano (1983) and Boothe (1991) confirm the importance of the U.S. in influencing German, Swiss, and Canadian term structures. Holmes and Pentecost (1997) apply cointegration techniques in order to show that the convergence of monetary policies during the exchange rate mechanism (ERM) led to an interdependence of the term structures. In the same line of reasoning,Kugler (2000) shows that the EHTS is less likely to be rejected when the monetary policy is restricted by an exchange rate target as in the ERM because under these circumstances the UIRP is most likely to be empirically validated as well. Ang and Bekaert (1998) adopt a regime switching methodology in order to account for non-linearities in the stochastic behavior of short rates, and they are able to show that multivariate models incorporating international short rates forecast better and match the sample moments better than the univariate ones.

More recent research includes the review paper by Wolters (2003) where mixed results are reported when EHTS and UIRP are jointly tested on Euro area and U.S. data. Brüggemann and Lütkepohl (2005) apply cointegration techniques, similar to the ones adopted in this paper, and find supportive evidence when EHTS and UIRP are jointly tested. They argue that previous studies, like Wolters (2003), had failed to find similar results because they relied on artificial interest rate data provided by the European Central Bank. Then they report structural forecast error variance decomposition calculations, which show that the nonstationary common stochastic trend in their model is associated with the short-term U.S. interest rate. Thus, they conclude that the U.S. monetary policy is a major contributor to the determination of Germany's term structure. Ehrmann and Fratzscher (2005) have examined the monetary interdependence between the U.S. and the Euro area by looking at the effects of monetary policy announcements on the dynamics of interest rates. Bekaert, Wei, and Xing (2007) employ a VAR-based methodology on data for the U.S., Germany, U.K., and Japan in order to test jointly the UIRP and the EHTS. They conclude that there is a limited, currency-dependent, empirical support for the UIRP, but the evidence is strongly negative for the EHTS. Holmes, Otero, and Panagiotidis (2012) employ a panel stationarity testing procedure on Asian term structures where structural breaks and cross-sectional dependence are allowed. Their evidence is supportive of the EHTS while the interdependencies between domestic and foreign term structures exist insofar as differentials between domestic and foreign rates are also stationary. Finally, Krishnakumar and Neto (2012) argue that the failure to find supportive evidence to the two theories might be due to the presence of non-linearities. Therefore, they examine the EHTS and the UIRP for Switzerland/U.S. and Switzerland/Germany in a multivariate three regime threshold vector error correction model. Their testing methodology determines the number of cointegration relationships in each regime and provides evidence according to which the two theories are jointly accepted for the Switzerland/Germany case while they do not hold when U.S. rates are considered.

2.2. Testing implications from cointegration analysis under the joint existence of the EHTS and the UIRP

Let $R(t,n)$ and $R(t,1)$ denote the n and 1-period interest rates, respectively, at time t. The risk-adjusted expectations theory then states

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