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The Spanish term structure of interest rates revisited: Cointegration with multiple structural breaks, 1974–2010

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ABSTRACT

In this paper we consider the possibility that a linear cointegrated regression model with multiple structural changes would provide a better empirical description of the Spanish term structure of interest rates. Our methodology is based on instability tests recently proposed in Kejriwal and Perron (2008, 2010) as well as the cointegration tests developed in Arai and Kurozumi (2007) and Kejriwal (2008). The results obtained are consistent with the existence of linear cointegration between the long and the short run Spanish interest rates. However, our empirical results also show that the cointegrating relationship has changed over time. In particular, the Kejriwal–Perron tests for testing multiple structural breaks in cointegrated regression models suggest a model of two regimes.

1. Introduction

The expectations hypothesis (EH) of the term structure of interest rates is one of the oldest and simplest analytical framework to study rational behavior in financial markets. The EH of the term structure of interest rates, which basically states that the observed term structure can be used to infer market participants expectations about future interest rates, has been at the origin of an extraordinary amount of econometric analysis; see, e. g., Campbell (1995), Campbell and Shiller (1987, 1991), Engsted and Tanggaard (1994a,b), Hall, Anderson, and Granger (1992), Hardouvelis (1994), Jondeau and Ricart (1999), Lanne (2000), Sarno, Thornton, and Valente (2007), Thornton (2006), and Tzavalis (2003).

Understanding the term structure of interest rates has always been viewed as crucial to assess the impact of monetary policy and its transmission mechanism, to predict interest rates, exchange rates and economic activity, and to provide information about expectations of participants in financial markets. However, the term structure of interest rates is likely to be subject to variation as a result of changes in the structure of the economy, like alterations in monetary policy or in the exchange rate regime and reforms in the financial market regulation. Therefore, if the information content of the term structure of interest rates is subject to changes over time, any empirical modeling not accounting for the possible instability in this relationship can produce misleading results.

According to the EH, the long-term interest rates should reflect future short-term changes. Specifically, long-term interest rates would be the average of future expected short rates. Hence, the EH in the context of the cointegration theory suggests that

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the long and short interest rates are linked through a long-run relationship with parameters (1, -1), i.e. that the interest rate spread is mean-reverting. Following the work by Campbell and Shiller (1987), a number of further contributions have arisen. These works have strived to test the EH of the term structure of interest rates applying cointegration techniques on a linear model, leading sometimes to contradictory results. A non-exhaustive list of them would include Stock and Watson (1988), Hall et al. (1992), Engsted and Tanggaard (1994a, b) and Cuthbertson (1996).

In an empirical study, Camarero and Tamarit (2002) extended the analysis on the expectations model of the term structure of interest rates addressing the question of whether the relationship is stable over time, or exhibit a structural break allowing for instability to occur at an unknown point. In their application to the Spanish economy, they found evidence of linear cointegration between long and short interest rates for the period 1980:1–1996:4, with a vector (1, -1) as predicted by the theory. Moreover, the tests for instability and structural change detected the presence of a break in 1994 when two factors that may have affected the term structure of interest rates were acting: first, the devaluations of the peseta, that happened at the end of 1982 and between 1992 and 1995; secondly, the financial changes that were introduced at the beginning of 1994 as a result of the commitments of Spain in the context of the process toward the European Monetary Union.

Camarero and Tamarit (2002) applied several methods to detect the structural changes or instability in the cointegration regressions. The first group of tests is the null hypothesis of no change in cointegrated models proposed by Hansen (1992). These LM test procedures are based on the fully modified estimation method (Phillips & Hansen, 1990) which has been shown to lead to tests with very poor finite sample properties (Carrion-i-Silvestre & Sansó-i-Roselló, 2006). The results reached by Quintos and Phillips (1993) also suggest that the LM tests are likely to suffer from the problem of low power in finite samples. Moreover, simulation experiments carried out by Hansen (2000) show that the LM test behaves quite poorly in the presence of structural changes in the marginal distributions of the regressors. The second group of tests was proposed by Gregory and Hansen (1996a,b) and was considered the residual-based test for the null of no cointegration against the alternative of cointegration with a structural break of unknown timing. A rejection by these tests would then confirm the presence of a cointegrating relationship with a structural break. However, the value of the break associated with the minimal value of a given statistic is not, in general, a consistent estimate of the break date if a change is present. Moreover, these tests are designed to have power against the alternative of a single break in parameters and hence may have low power when the alternative involves more than one break.[1] The third group of tests is the multiple structural changes tests proposed by Bai and Perron (1998a,b) in the context of OLS recursive estimation applied to stationary variables. However, these tests are only valid for stationary variables and the interest rate series are both I(1) (or non-stationary variables).

In this paper, we extend the existing empirical analysis of the term structure model of interest rates in two ways. In the first place, and in order to avoid the econometric problems mentioned above, we make use of recent developments in cointegrated regression models with multiple structural changes. Specifically, we use a new approach proposed by Kejiriwal and Perron (2008, 2010) to test for multiple structural changes in cointegrated regression models. These authors develop a sequential procedure that not only enables detection of parameter instability in cointegration regression models but also allows for consistency of the number of breaks present. Furthermore, we test the cointegrating relationship when multiple regime shifts are identified endogenously. In particular, the nature of the long run relationship between long and short interest rates is analyzed using the residual based test of the null hypothesis of cointegration with multiple breaks proposed in Arai and Kurozoumi (2007) and Kejriwal (2008). In the second place, so as to counter a common criticism to most test of the EH of the term structure of interest rates, in this paper we use a long span of the data (1974:1–2010:2), since the econometric procedures used require a large number of observations. Through our extension we were able to obtain more robust results on the fulfillment of the term structure of interest rates than in previous analysis.[2]

The rest of the paper is organized as follows. A brief description of the underlying theoretical framework is provided in Section 2, the methodology and empirical results are presented in Sections 3 and 4, respectively, and the main conclusions are summarized in Section 5.

2. A simple model of the EH of the term structure of interest rates

The fundamental equation characterizing the EH of the term structure of interest rates states that the long-term interest rate equals an average of current and expected short-term interest rates over the life of the long-term interest rate plus a constant term, representing the time constant term/risk premium ($\phi^{(n)}$)[3]:

$$bonds_t^{(n)} = \frac{1}{k}\sum_{i=0}^{k-1} E_t\left[crm_{t+im}^{(m)}\right] + \phi^{(n)} \tag{1}$$

[1] A recent example is the work of Suardi (2010), who applies the Gregory and Hansen (1996a,b) tests to the Australian term structure of interest rates.

[2] An empirical study by Esteve (2006) extends the analysis of the EH of the term structure of interest rates addressing the possibility that a nonlinear model might provide a better empirical description. In his paper, Esteve (2006) applies the methodology proposed by Hansen and Seo (2002) to test for threshold cointegration to the Spanish term structure of interest rates during the period 1980:1–2002:12. The evidence found by Esteve (2006) clearly rejects the existence of nonlinear cointegration between long and short interest rates and, therefore, a linear cointegration model may provide a more adequate empirical description for the Spanish term structure of interest rates.

[3] See Taylor (1992) and Bekaert and Hodrick (2001) for the possibility that the relationship between long and short interest rates may contain time-varying term/risk premium.