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Structural Breaks and Expectations Hypothesis of the term structure: evidence from Mediterranean Countries

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Abstract:

This paper shows interest on the test of the Expectations Hypothesis of the Term Structure of Interest Rates –EHTS of the EMU Countries and specifically of Spain, Italy, Portugal and Greece for the period 1990 to 2007. The examination is done using short-term and long-term interests for each of the four Countries, and is completed in three stages. First of all, the examination of the interest stationarity took place for each country using modern techniques that take into consideration the existence of structural breaks. In the second stage, the spread stationarity between long-term and short-term interests is analyzed, whereas in the last stage, a Campbell and Shiller (1987, 1991) methodology is used in order to examine if the EHTS is acceptable or no through a non-linear Wald test, while together with this methodology, a Variance Ratio and a Correlation Coefficient between theoretical and actual spread is necessary. The results supports the EHTS for Spain, for Greece and for Italy strongly rejected it for Portugal.

Key words: Expectations Hypothesis of the Term Structure; Structural Breaks; Co-integration with breaks; Two-break LM unit root test; Theoretical Spread

1. INTRODUCTION

Does the slope of the Expectations Hypothesis of the Term Structure of Interest Breaks (EHTS) - the yield spread between the long-term and short-term – is an optimal predictor of future changes in short terms over the life of the «long-term bond»? And if so, is the predictive power of the yield spread in accordance with the expectations theory of the term structure?

These questions are important, both for the forecasting interest rates and for interpreting shields in the yield curve. If the expectations theory is an adequate description of the term structure, then rational expectations of future interest rates are the dominant force determining current long-term interest rates. On the other hand, if the expectations theory is very far from accurate, then predictable changes in excess returns must be the main influence moving the term structure. It makes sense to thoroughly explore the validity of the simple expectations theory before undertaking a detailed study of the sources of predictable time-variation in excess returns.(Hall, Anderson and Granger, 1992)

In this paper we show that certain statements can be made quite generally. For almost any pair of maturities between one month and ten years, the following is true: when the yield spread between the longer – term interest rate and the shorter – term interest rate is relatively high, the yield on the longer – term bond tends to fall over the life of the shorter – term bond. This runs counter to the expectations theory. At the same time, shorter – term rates tend to rise over the life of the longer – term bond, in accordance with the expectations theory. In a nutshell, when the spread is high the long term tends to fall and the short term tends to rise. (Campbell and Shiller, 1987, 1991).

The novelty of this paper lies firstly on the use of most recent data from the 1990 to the end of 2007 for studying the term structure of interest rates in four Mediterranean European Countries (EMU), namely: Spain, Italy, Greece and Portugal. Secondly the paper lies on the use of recently developed Lagrange Multiplier (LM) unit roots test (Lee and Strazicich 2003 as cited in Koukouritakis 2009), and cointegration tests for studying the EHTS in these four countries in the presence of structural shifts, which are likely been caused during the transition period of these countries from centrally planned economies to full EU members. Last but not least, the paper lies on the use of VAR approach proposed by Campbell and Shiller (1987, 1991) for testing economic significance of the EHTS in these countries. Briefly, the results provide support of the statistical and economic significance in all countries apart from Portugal.

The organization of the paper is as follows. In Section 2 we describe briefly the EHTS of interest rates and discuss the testable implications of the theory. Section 3 outlines the unit root and cointegration tests in the presence of structural breaks, which are used in the subsequent analysis. In Section 4 we describe the data and try to interpret our empirical results further. We argue that one simple alternative, in which the yield spread equals its value under the expectations theory, is not consistent with the data. We suggest another alternative, which make the yield spread a constant multiple of its value under the expectations theory. Section 5 concludes.

2. TESTABLE IMPLICATIONS OF THE EHTS

- *The expectations hypothesis*

The expectations hypothesis (EH) of the term structure posits that the return on an n-period bond $R_t^{(n)}$ is determined solely by expectations of (current and) future rates on a set of m-period short rates $r_t^{(m)}$ (where n>m). Using continuously compounded spot rates the "fundamental term structure" relationship is:

$$R_t^{(n)} = (1/k)\sum_{i=0}^{k-1} E_t r^{(m)}{}_{t+im} \qquad (1)$$

where k=n/m is an integer and E_t is the expectations operator (with the information up to and including time t). If there is a time invariant term premium, which is constant for given (n, m) then the (1) will also contain a constant term. The intuition behind (1) is easily seen by taking n=3 and m=1. If $1 is invested at the 3-year spot rate, then the certain amount received after 3-years is $$(1 + R_t)^3$. Alternatively at t=0, the investor can consider investing $1 at the one-period rate r_t and then reinvesting at the one-period rates in years two and three (i.e. rolling over the one-period investment). The latter is a risky strategy and results in expected "dollar" receipts of $$(1+r_t)(1+E_t r_{t+1})(1+E_t r_{t+2})$. The EH assumes investors are risk neutral and that the market is efficient, hence in equilibrium $(1 + R_t)^3 = (1+r_t)(1+E_t r_{t+1})(1+E_t r_{t+2})$.

Taking logarithms of both sides of the latter expression and noting that $\ln(1+r_t)$ is the continuously compounded interest rate, we obtain equation (1).

We can re-arrange (1) in terms of the spread and the change in interest rates (since below we find that these are stationary variables) and (1) can then be seen to imply that the "long - short" spread is an optimal predictor of future changes in short rates, $r_t^{(m)}$:

$$S_t^{(n,m)} = E_t \sum_{i=1}^{k-1} (1 - i/k) \Delta^m r^{(m)}{}_{t+im} = E_t\left[PFS_t^{(n,m)}\right] \qquad (2)$$

where $S_t^{(n,m)} = (R_t^{(n)} - r_t^{(m)})$ is the yield spread. Equation (2) implies that if future short rates are expected to rise, then this will be accompanied by an increase in the spread.

To see the intuition behind (2), again consider the case n=3, m=1. Suppose at t=0, investors believe that inflation in years two and three will be higher (than previously anticipated). Then they will revise upwards their forecasts of the one-period rates pertaining to years 2 and 3, that is $E_t\, r_{t+1}$ and $E_t\, r_{t+2}$, and hence $E_t\, \Delta r_{t+1}$ and $E_t\, \Delta r_{t+2}$ will also rise. Therefore, rolling over "one-period" investments will currently give a higher expected return than investing at the 3-year spot rate. Investors will therefore sell 3-year (zero coupons) bonds to invest in one – year bonds, and the price of 3-year bonds will consequently fall. But the latter implies that their yield R_t will rise, as will the spread $S_t = (R_t - r_t)$.

Arbitrage ensures that R_t increases until the higher spread just equals the (weighted average of) future expected increases in one-period rates, as summarized in (2). For our simple case, Equation (2) is $S_t = (2/3)\ E_t\ \Delta r_{t+1} + (1/3) E_t\ \Delta r_{t+2}$. (Cuthbertson and Bredin, Vol.31, No.3, 2000)

The *perfect foresight spread* PFS_t in (2) is simply the (weighted average) of actual future changes in short term rates (which agents are trying to forecast). However, in the literature it is referred to as the "perfect foresight spread" because under the EH, it can also be interpreted as the spread that would ensue if agents had perfect foresight about future movements in interest rates (i.e. made no forecast errors). (Koukouritakis 2009)

A testable implication of equation (2) is that the spread Granger causes future changes in short rates. If $(R_t^{(n)} - r_t^{(m)})$ are found to be I(1), then $\Delta r_t^{(m)}$ is I(0), which from Equation (2) implies that the spread $S_t = (R_t^{(n)} - r_t^{(m)})$ should also be I(0). The latter implies that $(R_t^{(n)}\ ,\ r_t^{(m)})$ should be co-integrated with a co-integrating vector (1, -1). If we now add the assumption of rational expectations (RE):

$$r^{(m)}{}_{t+im} = E_t r^{(m)}{}_{t+im} + \varepsilon_{t+im} \tag{3}$$

we obtain the following single equation test of the null of the "expectations hypothesis plus rational expectations", EH + RE:

$$PFS_t^{(n,m)} = \alpha + \beta S_t^{(n,m)} + \gamma\,\Omega_t + \varepsilon^*{}_t \qquad (4)$$
$$H_0: \alpha = \gamma = 0,\ \beta = 1$$

ε^*_t is a moving average error of order (n-m-1) consisting of a weighted sum of future values of ε_{t+im} and Ω_t represents the information available to agents at time t, or earlier. Under RE, ε^*_t is independent of Ω_t, and in particular is independent of the yield spread. If there is a constant term premium or if there are differential yet constant transactions costs (between investing "long" and in a series of rolled – over short-term investments) then a $\neq 0$. Under RE the right hand side variables in Equation (4) are independent of ε^*_t (Cuthbertson and Bredin, Vol.31, No.3, 2000)

- *The Theoretical Spread*

Regression tests of the expectations theory have the great merit of simplicity. But they also have some serious disadvantages. First, the regression of the perfect-foresight spread onto the actual spread involves n-period overlapping errors. One only has entirely independent observation of the forecast power of the term structure every n period. While econometric methods are available to correct regression standard errors for overlap, they do not work well when the degree of overlap is large relative to the sample size. (Stock and Richardson (1989) and Hodrick(1990) as cited in Campbell and Shiller,1987, 1991)

Second, regression tests do not tell us how similar the movements of the actual spread are to the movements implied by the expectations theory. We would like to evaluate the ability of the expectations theory to explain the shape of the term structure, and regression tests are not well suited for this purpose.

- *The VAR methodology*

In earlier work, Campbell and Shiller (1987, 1991) proposed a VAR methodology evaluating the economic importance of deviation from the EHTS. They specify a VAR and derive a set of cross-equation restrictions that must hold under the EHTS. Using the VAR, they also compute the theoretical spread, an estimate of the perfect foresight spread, and then they compare it to the actual spread. Significant differences are interpreted as evidence against the EHTS. (Koukouritakis, 2009)

We assume that $x_t \equiv (\Delta R_t^{(m)}, S_t^{(n,m)})$ can be represented by a stationary p-order VAR. This system can be rewritten as a first-order VAR in the companion form $z_t = A z_{t-1} + u_t$ (5), where z_t has 2p elements, first $\Delta R_t^{(m)}$ and p-1 lags and then $S_t^{(n,m)}$ and p-1 lags. The vector z_t summarizes the whole history of x_t. Multi-period interest rate forecasts are easily computed from the companion form, since $E[z_{t+k} \mid x_t, x_{t-1}, \ldots] = E[z_{t+k} \mid z_t] = A^k z_t$.

We next define vectors g and h such that $g'z_t = S_t^{(n,m)}$ and $h'z_t = \Delta R_t^{(m)}$. (These vectors have 2p elements, all of which are zero except for the first element of h and the p+1-st element of g, which equal one). Then we can express the forecast for the theoretical spread as:

$$S'^{(n,m)}_t \equiv h'A[I - (m/n)(I-A^n)(I-A^m)^{-1}](I-A)^{-1} z_t \qquad (6)$$

We call $S'^{(n,m)}_t$ the theoretical spread, since it is the spread which would obtain if the expectations theory were true. It can be implied that

$$S_t^{(n,m)} = g'z_t = S'^{(n,m)}_t \qquad (7)$$

Note that if the expectations theory of the term structure is true, (7) should hold whatever information set economic agents are using. The intuitive explanation is that if term premia are constant, all the relevant information of market participants is embodied in the yield spread $S_t^{(n,m)}$, which is included in the VAR system. Of course, if the expectations theory is not true, then the VAR system may not adequately summarize the information available to the market. (Campbell and Shiller, 1987, 1991)

- *Variance Ratio*

Consider the variance ratio VR = var($S_{(n,m),t}$) / var($S'_{(n,m),t}$), together with the correlation between S_t and S'_t . If the EHTS holds, the correlation should be close to one, and the variances of the actual and the theoretical spreads should behave similarly over time. Thus, the VR should be close to unity. Campbell and Shiller (1991) note that this volatility test is preferable to formal tests of the VAR restrictions, because the latter may lead to rejection of the EHTS even though the deviations are quite small from an economic point of view. (Cuthbertson and Bredin, Vol.31, No.3, 2000)

As noted in the first section of the present paper, the empirical results regarding the validity of the EHTS are mixed. One main reason for the non validity of the EHTS can be found in the segmented markets theory of the term structure. According to this theory, the markets for different maturity bonds are completely separate and segmented, which means hat the interest rate for each maturity bond is determined by the supply and demand for this bond and there are no effects from expected returns on bonds with different maturity. (Mishkin, 1998). In other words, bonds with different maturities are not perfect substitutes, mainly due to uncertainty, since different maturities involve different risks. If there is relatively little shifting among bonds with different maturities, long rates may differ from the average of the current and expect future rates and thus, the EHTS is not valid.

3. Unit Roots and Co-integration with structural breaks

The Mediterranean countries made important economic reforms that are likely to have caused structural breaks in their term structure of interest rates. These reforms are mainly associated with the implementation of several monetary policy regimes by the EMU countries, in order to join Economic and Monetary Union. More specific the operation is analyzed below:

Stage One of EMU

On the basis of the Delors Report, the European Council decided in June 1989 that the first stage of the realisation of economic and monetary union should begin on 1 July 1990. On this date, in principle, all restrictions on the movement of capital between Member States were abolished.

The Committee of Governors of the central banks of the Member States of the European Economic Community, which had played an increasingly important role in monetary cooperation since its creation in May 1964, was given additional responsibilities. These were laid down in a Council Decision dated 12 March 1990. Their new tasks included holding consultations on, and promoting the coordination of, the monetary policies of the Member States, with the aim of achieving price stability. In view of the relatively short time available and the complexity of the tasks involved, the preparatory work for Stage Three of Economic and Monetary Union (EMU) was also initiated by the Committee of Governors.

The first step was to identify all the issues which should be examined at an early stage, to establish a work programme by the end of 1993 and to define accordingly the mandates of the existing sub-committees and working groups established for that purpose.

Stage Two of EMU, establishment of the EMI and the ECB

The establishment of the European Monetary Institute (EMI) on 1 January 1994 marked the start of the second stage of EMU and with this the Committee of Governors ceased to exist. The EMI's transitory existence also mirrored the state of monetary integration within the Community. The EMI had no responsibility for the conduct of monetary policy in the European Union – this remained the preserve of the national authorities – nor had it any competence for carrying out foreign exchange intervention.

The two main tasks of the EMI:

- To strengthen central bank cooperation and monetary policy co-ordination, and
- To make the preparations required for the establishment of the European System of Central Banks (ESCB), for the conduct of the single monetary policy and for the creation of a single currency in the third stage.

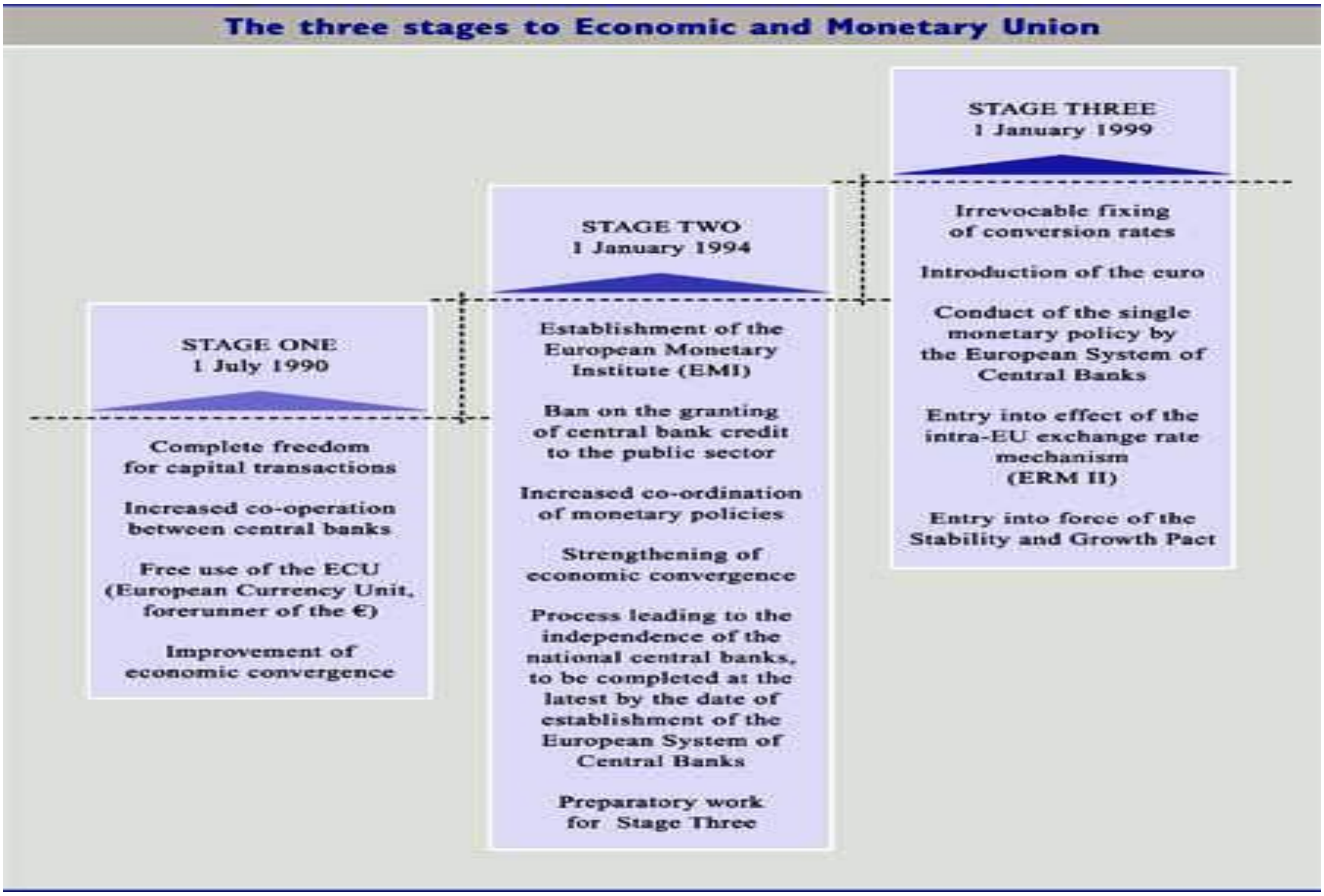
To this end, the EMI provided a forum for consultation and for an exchange of views and information on policy issues and it specified the regulatory, organisational and logistical framework necessary for the ESCB to perform its tasks in Stage Three.

In December 1995 the European Council agreed to name the European currency unit to be introduced at the start of Stage Three, the ‘euro', and confirmed that Stage Three of EMU would start on 1 January 1999. A chronological sequence of events was pre-announced for the changeover to the euro. This scenario was mainly based on detailed proposals elaborated by the EMI.

Stage Three of EMU, irrevocable fixing of exchange rates

On 1 January 1999 the third and final stage of EMU commenced with the irrevocable fixing of the exchange rates of the currencies of the 11 Member States initially participating in Monetary Union and with the conduct of a single monetary policy under the responsibility of the ECB.

The number of participating Member States increased to 12 on 1 January 2001, when Greece entered the third stage of EMU. Slovenia became the 13th member of the euro area on 1 January 2007, followed one year later by Cyprus and Malta, by Slovakia on 1 January 2009 and by Estonia on 1 January 2011. On the day each country joined the euro area, its central bank automatically became part of the Euro system.



Since the presence of structural breaks are known to have significant effects on the properties and interpretation of standard ADF-type unit root tests and Johansen – type co-integration tests, I employ recently developed tests that are valid in the presence of structural shifts in data.

- *Unit root tests with structural breaks*

For the test for unit roots in the data I used the two-break LM test developed by Lee and Strazicich (2003). This test has several desirable properties: firstly, it determines the structural breaks endogenously from the data.

Secondly, its null distributions are invariant to level shifts in a variable and thirdly, it is easy to interpret. By including breaks under both the null and alternative hypotheses, a rejection of the unit root hypothesis implies unambiguously trend stationarity.

Consider this test for the process y_t generated by

$$y_t = \delta' Z_t + e_t, \quad e_t = \beta e_{t-1} + A(L)\varepsilon_t, \quad \varepsilon_t \sim iid\ N(o,\sigma^2) \qquad (8)$$

where A(L) is a k-order polynomial in the lag operator L and Z_t is a vector of exogenous variables of which components are determined by the type of breaks one wishes to examine in the process y_t . Lee and Strazicich (2003) extend Perron's (1989, 1993) single-break models to include two breaks in the level (Model A) and two breaks in both the level and trend (Model C) of y_t. Then for Model A, $Z_t = [1,t,D_{1t}, D_{2t}]'$ where $D_{jt} =1$ for $t\rho T_{Bj} +1$, j=1,2, and zero otherwise; and for Model C, $Z_t = [1,t,D_{1t}, D_{2t}, DT_{1t}, DT_{2t}]'$, where $DT_{jt} = t- T_{Bj}$ for $t\rho\ T_{Bj} +1$, j=1,2, and zero otherwise. T_{Bj} denotes the break point in time.

Equation (8) denotes that y_t has a unit root if β=1, while it is trend stationary if β<1. According to LM principle, a unit root test statistic is obtained from the test regression

$$\Delta y_t = \delta' \Delta Z_t + \varphi S_{t-1} + \Sigma \theta_i \Delta S_{t-i} + u_t \qquad (9)$$

where $S_t = y_t - \psi_X - Z_t\delta$, t=2,…,T, in which δ is a vector of coefficients in the regression of Δy_t on ΔZ_t and $\psi_X = y_1 - Z_1\delta$, where y_1 and Z_1 are the first observations of y_t and Z_t , and u_t is a random error term. The lagged differences of S_{t-i} are included as necessary to correct for serial correlation in u_t. The unit root null hypothesis is described by φ=0 in (9) and can be tested by the LM test statistic:

$$\tau = \text{t-statistic for the hypothesis } \varphi=0 \qquad (10)$$

In order to endogenously determine the location of the two relative breaks $\lambda_j = T_{Bj} / T$, j=1,2, where T is the sample size, the two-break minimum LM test statistic is determined by a grid search over λ:

$$LM_\tau = \inf\{\tau(\lambda)\} \qquad (11)$$

The critical values for (11) are invariant to the break locations (λ_j) for Model A, but depend on the break locations for Model C, and are available in Lee and Strazicich (2003).

- ***Co-integration tests with structural breaks***

As in the case with unit root testing, structural breaks in the data can distort substantially standard inference procedures for co-integration. Thus, it is necessary to account for possible breaks in the data before inference on co-integration can be made.

In the recent literature, there are two main approaches to test for co-integration in the presence of structural breaks. One approach that was developed by Johansen (2000) extends the standard VECM with the number of additional variables in order to account for q possible exogenous breaks in the levels and trends of the deterministic components. In order to test spread stationarity and that the co-integrating vector is (1, -1), we use an approach developed by Lee and Strazicich using unit root tests. (Lee and Strazicich, 2003)

4. Data and Empirical Results

- *Data*

The sample consists of monthly data of varying time spans for the four EMU Countries: Spain, Italy, Portugal and Greece determined by data availability.

I collected data on interest rates of the term structure for each country: Treasury bill yields (short-term) and Government bond yields (long-term). Specifically, for Spain I used a 3-month Treasury bill rates as a short-term and 5-year Government bond yields and 10-year Government bond yields as a long-term, for Italy a 12-month Treasury bill rates as a short-term and 5-year Government bond yields and 10-year Government bond yields as a long-term, for Portugal I used a 2-year Government bond yields as a short-term and 5-year Government bond yields and 10-year Government bond yields as a long-term and for Greece a 12-month Treasury bill rates as a short-term and 5-year Government bond yields and 10-year Government bond yields as a long-term. Table 1 reports the data details and their sources.

Table 1: Description of Data

Country	Time Span	Variables
Spain	1990:01 - 2007:12	3-month Treasury bill rate 5-year Government bond yield 10-year Government bond yield
Italy	1993:01 - 2007:12	12-month Treasury bill rate 5-year Government bond yield 10-year Government bond yield
Portugal	1994:01 - 2007:12	2-year Government bond yield 5-year Government bond yield 10-year Government bond yield
Greece	1994:01 - 2007:12	12-month Treasury bill rate 5-year Government bond yield 7-year Government bond yield

Source: Central Bank of each Country

- *Unit Root results with structural breaks*

Table 2 reports the unit root results from the two-break LM test. Each interest rate series was tested for a unit root at 1%, 5% and 10% levels of significance. In order to determine the number of lags, k, I used a “general to specific” procedure at each combination of break points (λ_1, λ_2).

Initially, the lag-length was set at k=12 and the significance of the last lagged term was examined at the level of 10%. The procedure was repeated until the last lagged term was found to be significantly different than zero, at which point the procedure stops.

As shown in the third column of Table 2, Model C fits the term structure best for Italy and Portugal. Hence, these two countries have experienced two significant shifts both in the deterministic levels and trends of their term structures over the sample period. Model A with only two significant level shifts fits the data best for Spain and Greece.

As shown in the last column of Table 2, the unit root hypothesis with two structural breaks cannot be rejected at any of the three levels of significance for all interest rates. The two breaks of each country were estimated endogenously by the two-break LM test, and are reported in column 5 of Table 2. Not surprisingly, the estimated breaks correspond closely to specific events that have taken place in the four EMU Countries over the sample period.

Table 2: Two-break minimum LM unit root test results

Country	Interest Rate	Model	k[a]	T_B[b]	λ_1, λ_2[c]	LM- statistic
Spain	3-month treasury bill rate	C	5	1995:12, 2003:08	0.1, 0.6	-4.26
	5-year Government bond yield	A	5	1999:08, 1999:10	0.37, 0.38	-3.48
	10-year Government bond yield	A	3	1999:08, 1999:10	0.37, 0.38	-3.09
Italy	12-month Treasury bill rate	C	6	1997:02, 2006:05	0.27, 0.89	-3.86
	5-year Government bond yield	C	6	1997:02, 2000:04	0.27, 0.5	-4.66
	10-year Government bond yield	C	4	1994:11, 1997:09	0.12, 0.31	-5.11
Portugal	2-year Government bond yield	C	11	1997:03, 2003:01	0.2, 0.6	-3.89
	5-year Government bond yield	C	12	2002:02, 2005:03	0.5, 0.8	-4.72
	10-year Government bond yield	C	10	1996:07, 1997:07	0.2, 0.25	-4.72
Greece	12-month Treasury bill rate	C	7	1998:05, 2002:09	0.3, 0.6	-4.44
	5-year Government bond yield	A	10	1995:11, 1997:02	0.15, 0.2	-2.53
	7-year Government bond yield	A	10	1995:09, 1996:05	0.12, 0.17	-2.39

Model A				**Model C**		
Critical values			Break Points	Critical values		
1%	5%	10%	$\lambda = (\lambda_1, \lambda_2)$	1%	5%	10%
-4.54	-3.84	-3.5	λ=(0.2, 0.4)	-6.16	-5.59	-5.27
			λ=(0.2, 0.6)	-6.41	-5.74	-5.32
			λ=(0.2, 0.8)	-6.33	-5.71	-5.33
			λ=(0.4, 0.6)	-6.45	-5.67	-5.31
			λ=(0.4, 0.8)	-6.42	-5.65	-5.32
			λ=(0.6, 0.8)	-6.32	-5.73	-5.32

The critical values for Models A and C are from Table 1, respectively, of Lee and Strazicich (2003)

[a] **k** is the optimal number of lagged first – differenced terms included in the unit root test to correct for serial correlation

[b] T_B denotes the estimated break points

[c] λ_1 and λ_2 are the estimated critical value break points

In relation with the structural breaks, the success of monetary transmission in Spain at this stage was undoubtedly determined by the high integration and expectations of convergence that took place since the entry of the peseta in the European Monetary System. The targets of exchange rates and of stability of interest rates in the financial markets acted as basic elements for monetary transmission.

After strong growth at the end of the 1980s, the economy slowed down, reaching a trough in 1993, recovering thereafter to record 3% average real GDP growth between 1995 and 1998. As regards inflation, inflationary pressures at the end of the 1980s were followed by a steadily declining trend during the 1990s. This helps explain the declining trend also seen in nominal short-term interest rates.

Since 1990, there have been only two periods of monetary policy tightening. The first one, in 1992, was associated with the crises in the European Monetary System (EMS) of that year. The second one, in the first half of 1995, was associated with some signs of inflationary pressure just when the new inflation-targeting monetary policy strategy of the Bank of Spain started to be applied.

In both cases, monetary policy tightening was relatively limited and short-lived. Short-term interest rates went up by between 1.5 and 2 percentage points, and returned to their original level in less than one and a half years. This may limit our ability to capture adequately the response of bank loans to a monetary policy tightening and should be taken into account when interpreting the results below. Turning to loan growth, this has been clearly pro-cyclical; with real growth above 10% in the expansionary phases. But two points are worth mentioning in this respect. First, the steep fall in loan growth between 1989 and 1990 resulted from the introduction of direct credit restrictions by the Bank of Spain. Faced with strong economic and loan growth, increasing inflation rates and restrictions on its capacity to increase interest rates because of the exchange rate commitments implied by the EMS, the Bank of Spain announced, in July 1989, a ceiling on the rate of growth of loans to the end of that year. A new lower ceiling was announced later on for the year 1990. Although the restrictions were not formally imposed, they were very effective in pulling down loan growth, and when they disappeared, at the beginning of 1991, the economy was slowing down and loan growth did not surge. The difficulty in capturing this effect adequately explains why, in the analysis below, we do not take into account the years before 1991. Second, different types of loan behaved differently. While loans to firms reached negative growth rates in the trough, mortgage loans never grew by less than 14% (in nominal terms), averaging annual growth of 21.4% over the whole period. That is to say mortgage loans were clearly less pro-cyclical than consumer loans and, especially, loans to firms.

With respect to deposits, they were less pro-cyclical than loans and their behaviour was affected by some particular events. Thus, the extraordinary growth of deposits around 1990 and 1991 was boosted by strong competition among banks on time-deposit interest rates at that time. On the other hand, the lower growth around 1992-93 and 1997-98 can be explained by a process of substitution of mutual fund shares for bank deposits. This process of substitution was triggered by changes in the tax treatment of capital gains on mutual fund shares. Taxes on those capital gains were lowered twice in the decade; first in 1991 and then in 1996. The process of substitution was very intense and led by banks, which, through affiliates, dominated the market for management of those mutual funds. But it also had strong implications for banks, which faced a lower demand for deposits. We will say more about this below since we take advantage of this particular phenomenon to test the assumptions behind the bank-lending channel of monetary policy.

The different cyclical behaviour of loans and deposits helps explain movements in the average liquidity of banks. Figures 6a and 6b show, for each period, the mean and median of liquidity and capitalisation of the banks included in the final sample used in the regressions. Average liquidity increased during the cyclical downturn, reaching a maximum of around 35% of total assets in the years from 1994 to 1996. Since then, it has declined steadily towards levels of around 25%. This means that liquidity acts as a buffer. When loan demand growth falls behind deposit growth, banks accumulate the excess funds as liquid assets (mainly, government securities). Thus, the deposit business is not just a business deriving solely from the need to fund loans, but, at least for some banks, a business in it. This is important since it means that liquidity need not be just at the minimum necessary for precautionary motives.

Spain adopted the euro at the launch of the European Monetary Union (EMU) in January 1999, and thus, its monetary policy is no longer governed by the Spanish central bank. Rather, the Governing Council of the European Central Bank (ECB) determines Spanish monetary policy, and the Euro system (consisting of the ECB and the central banks of the member states that have adopted the euro) is responsible for its implementation. According to the International Monetary Fund (IMF), the Euro system and the ECB maintain high transparency standards and a commitment to openness. The ECB observes the IMF's standards for monetary policy transparency and pursues an active policy of communication with the public. The sovereign debt crisis in the euro area, triggered by Greece's near-default revealed serious problems of economic governance in the monetary union. At the height of crisis the European Financial Stability Facility was set up by the 16 euro member countries to provide a funding backstop should a euro area Member State find itself in financial difficulties?

Moreover, in case of Italy, although the period 1983:3 - 1998:2 is characterized by different regimes of monetary policy, the estimated system seems to be consistent with a framework where both the interest rate channel and the credit channel are effective. The Italian Lira was later withdrawn from the ERM in 1992, and the interest of the Italian Monetary Authorities shifted even more on the quantity of money and interest rates. Thereafter the nominal exchange rate anchor was substituted by an anti-inflationary target, and the Bank of Italy implemented an increasingly austere policy in order to meet the Maastricht criteria in the wake of Stage III of EMU.

Since the beginning of Stage Three of EMU in 1999 the conduct of monetary policy in the euro area has been guided by the overriding objective of maintaining price stability over the medium term. In assessing risks to price stability in the euro area, the Governing Council has always relied on the framework as laid down in its monetary policy strategy, implying a comprehensive analysis of both economic and monetary trends in the euro area. In the first years of Monetary Union the Governing Council assessed the monetary policy stance at meetings held every two weeks. In November 2001, however, the Governing Council decided that henceforth, it would – as a rule – assess the monetary policy stance only at its first meeting of the month. Accordingly, it was announced that interest rate decisions would normally be taken during that meeting, while at the second meeting of the month the Governing Council would focus on issues related to the other tasks and responsibilities of the ECB and the Euro system. Overall, three phases can be distinguished as regards the direction of monetary policy between January 1999 and June 2003. At the start of 1999 a combination of factors that had already been affecting the countries joining the euro area in 1998 increased downward risks to price stability in the euro area. In reaction to this, the Governing Council decided in April 1999 to reduce the fixed rate on the main refinancing operations to 2.5%.

Later, between the summer of 1999 and late 2000, inflationary pressures gradually mounted in a context of strong economic growth, increasing import price pressures driven by rising oil prices and a weakening exchange rate, and high monetary growth. In this context, the Governing Council gradually increased its key interest rates by a total of 225 basis points from November 1999 to October 2000. Subsequently, following a period of mixed signals around the turn of 2000, as from spring 2001 the evidence increasingly supported the view that inflationary pressures were gradually abating.

Italy adopted the euro at its launch in January 1999, and thus, its monetary policy is no longer governed by the Italian central bank. Rather, the Governing Council of the European Central Bank (ECB) determines Italian monetary policy, and the Euro system (consisting of the ECB and the central banks of the member states that have adopted the euro) is responsible for its implementation. According to the International Monetary Fund (IMF), the Euro system and the ECB maintain high transparency standards and a commitment to openness. The ECB observes the IMF's codes and standards for monetary policy transparency and pursues an active policy of communication with the public. In 2009, the IMF voiced its support for the ECB's accommodative monetary policy in response to the global financial crisis and recession in the European Union (EU). The Fund urged continued monetary easing in order to prevent a still-possible deflationary spiral, and called for quicker action from the EU in order to repair the financial system.

In the late 1980s and early 1990s, as the Portuguese economy began to overheat and international price developments turned less favourable, the inflation rate temporarily resumed an upward trend and the pursuit of disinflation had to rely on a less accommodative stance of exchange rate policy. In the mid-1990s, the deceleration of unit labour costs following the 1993 recession also gave an important contribution to the decline of inflation.

In the monetary and exchange rate policy front, after having abandoned the crawling peg regime in October 1990, the escudo joined the European exchange rate mechanism in April 1992. In December of the same year the remaining restrictions on international capital flows were removed. The continuous decline of inflation since the early nineties and the stability of the exchange rate after 1993 allowed the sustained reduction of interest rates. The process of nominal convergence increased the prospects of EMU participation, which in turn facilitated exchange rate stability and convergence. These developments were reflected in a substantial decrease in the exchange risk premium of the escudo since mid-1995. The sustained and significant reduction of both short and long run nominal interest rates, perceived as being permanent, reduced the liquidity constraints of the economic agents thus contributing to the strong growth in overall credit demand observed in this period.

After the deceleration in the recession period between 1992 and 1994, in 1995-1997 credit resumed the upward trend of the early nineties (average annual growth rate in real terms of 14 per cent in this period compared to 16 per cent in 1991) and strongly accelerated in 1998 and 1999 (annual growth rate in real terms of 24 per cent). Until 1994 deposits behave very much like credit, but from 1995/1996 onwards they clearly exhibit a much smaller growth rate (5.2 per cent in real terms during the period 1995-1997 and 6 per cent in 1998/1999).

In 2005 developments in the Portuguese economy were marked by subdued growth, employment stagnation and an increase in the unemployment rate. Even though GDP growth increased throughout the year, on average and compared with 2004, the economy decelerated significantly, highlighting the absence of a sustained recovery after the 2003 recession. At the same time, the structural situation of public accounts continued to deteriorate in spite of the consolidation measures that have been implemented. Developments in 2005 increased the real divergence from the euro area and reveal the difficulty experienced by the Portuguese economy in adjusting to the monetary union rules and to the intensifying globalization process. Participation in the monetary union implies a regime of lower and less volatile interest rates and the ability to obtain external financing without incurring foreign exchange risk. This reduction in liquidity constraints increased equilibrium private sector indebtedness, with a significant impact on the behaviour of domestic demand. The Portuguese economy virtually stagnated in 2005 and its growth rate was one of the lowest among the advanced economies and the new European Union Member States. Portugal continued thus move away from the average EU per capital income levels. The cumulative divergence since 2000 places this indicator at a level close to that recorded in the early 1990s.

In 2005 the monetary conditions of the Portuguese economy remained overall favourable to economic activity growth. They also continued to make a positive contribution to the reduction of inflation, via the lagged effects of the appreciation of the euro in previous years. In fact, according to estimates based on a monetary conditions index, interest rate developments in recent years have had a positive cumulative impact on GDP growth in 2005, although developments in the effective exchange rate index for Portugal had partly countered this effect.

At any rate the decade of the 1990s proved of especial significance for the Greek economy, it was the decade of convergence. The 1990s was a period during which the Greek economy improved its performance with respect to most economic indicators impressively so as to manage, in the face of judgement by strict criteria, to join the European Monetary Union. During the 1990s, Greece was endowed with a modern financial system and the Bank of Greece acquired state-of-the-art monetary policy instruments and procedures. International organisations have often praised the achievement of Greece: Comparing with the beginning of the nineties, by 1999 the rate of inflation had been reduced by 18 percentage points. Starting from an annual rate of depreciation of the exchange rate against the ECU over 11%, by 1999 we had reached the eve of the irrevocable “locking” of the drachma against the euro; at the same time, the general government deficit as a proportion of GDP had been reduced by 14 percentage points.

Inflation reduction naturally took a prominent position among the ultimate objectives of the monetary policy of the Bank of Greece announced in the course of the period 1990-2000. The Bank aimed at containing inflation to a value which was set progressively lower year after year in the nineties.

Since 1998, the Bank of Greece began to set the inflation ultimate objective for a horizon two years ahead so as to better take into account lags intrinsic in the operation of monetary policy. At the beginning of the nineties (pre-1993), monetary policy in Greece is assigned objectives additional to the reduction of inflation. GDP growth, balance on international payments and banking liberalisation were referred to as such additional aims. Later (in 1998), European Central Bank (ECB) terminology is espoused by the Bank of Greece according to which the central bank may support the “general economic policies” of the government without, however, prejudice to price stability.

After the completion of capital movement liberalisation in Greece in 1994, the exchange rate target was elevated to the status of an *“intermediate”* target, on an equal footing with the intermediate monetary target. Subsequently, the monetary target was progressively de-emphasised by the Bank of Greece, losing the status of an intermediate target (1998) and becoming simply another indicator to be monitored in the context of the formulation of monetary policy.

Although Greece had begun reducing inflation in the early 1990s, in 1995 the governor of the Bank of Greece, Lucas Papademos, took a serious step toward economic reform by introducing the “Hard Drachma Policy.” This monetary policy program, which entailed annual targets for inflation and exchange rates, made rapid progress against inflation, reducing it from over 10 percent in 1995 to less than 5 percent by the start of 1998. The economic reforms of the 1990s were ultimately successful in bringing Greece into compliance with the convergence criteria. On Jan. 1, 2001, Greece officially became a member of the euro zone. As with previous members, the drachma-denominated notes and the euro notes circulated side by side for two months, until the euro became the sole currency on March 1, 2001.

The Greek economy has flourished since it entered the euro zone in 2001. Inflation has averaged 3.3 percent, compared with the 1990-2000 average of 10.4 percent. GDP growth has averaged 4.4 percent, compared with 2.2 percent in the prior period. Unemployment has fallen from its 1999 peak of 12.3 percent to 8.6 percent by the end of 2006. While this jobless figure is higher than anyone wants, it is likely to decline further in the environment of price stability that the European Central Bank fosters.

- ***The Results for Spread Stationarity***

Table 3 reports the results of spread stationarity for each of the four EMU countries. The break points included in each spread are reproduced in the second column of the Table. The lag length, k, was selected using the Akaike information criterion (AIC). The empirical results show stationarity for Spain and Portugal in both short-term spread and long-term spread, but for Greece only in long-term spread. In contrast, the hypothesis of spread stationarity is strongly rejected for Italy.

When we use unit root tests and we conclude that there is spread stationarity, it means that at the same time the co-integrating vector is (1, -1). Consequently, for these three countries for which we have spread stationary, the empirical results are also consistent with prediction of the EHTS.

Table 3: Testing for spread stationarity

Country	Spread Stationarity	Model	k[a]	T_B[b]	λ_1, λ_2[c]	LM- statistic
Spain	10-year Government bond yield - 3-month treasury bill rate	C	4	1993:12, 1995:11	0.2, 0.3	-5.14
	5-year Government bond yield - 3-month treasury bill rate	C	5	1993:12, 1995:11	0.2, 0.3	-5.64 (**) (*)
Italy	10-year Government bond yield - 12-month Treasury bill rate	C	5	1995:02, 2003:06	0.14, 0.7	-4.18
	5-year Government bond yield - 12-month Treasury bill rate	C	3	1996:03, 2004:04	0.2, 0.7	-4.07
Portugal	10-year Government bond yield - 2-year Government bond yield	C	10	1995:12, 2005:03	0.2, 0.8	-5.25
	5-year Government bond yield - 2-year Government bond yield	C	8	1996:08, 2005:04	0.2, 0.8	-5.79 (**) (*)
Greece	7-year Government bond yield - 12-month Treasury bill rate	C	7	1998:01, 2001:11	0.3, 0.5	-4.25
	5-year Government bond yield - 12-month Treasury bill rate	C	0	1997:09, 2000:09	0.2, 0.4	-5.35 (*)

** Rejection of the null hypothesis at the 0.05 level of significance

* Rejection of the null hypothesis at the 0.10 level of significance

Model A				Model C		
Critical values			Break Points	Critical values		
1%	5%	10%	$\lambda = (\lambda_1, \lambda_2)$	1%	5%	10%
-4.54	-3.84	-3.5	λ=(0.2, 0.4)	-6.16	-5.59	-5.27
			λ=(0.2, 0.6)	-6.41	-5.74	-5.32
			λ=(0.2, 0.8)	-6.33	-5.71	-5.33
			λ=(0.4, 0.6)	-6.45	-5.67	-5.31
			λ=(0.4, 0.8)	-6.42	-5.65	-5.32
			λ=(0.6, 0.8)	-6.32	-5.73	-5.32

[a] **k** is the optimal number of lagged first – differenced terms included in the unit root test to correct for serial correlation

[b] T_B denotes the estimated break points

[c] λ_1 and λ_2 are the estimated critical value break points

➢ *The theoretical spread and the VAR results*

This section analyses the results from the VAR models for $\Delta r_{m.t}$ and $S_{(n.m).t.}$ For checking the hardness of the results again, I estimated two VARs for each country: one that includes the long rate breaks and another that includes the short rate breaks. The appropriate lag length, k, for each VAR was chosen using the likelihood ratio test. Also for each VAR, I performed a multivariate LM test for serial correlation.

Table 4 reports the VAR results. Apart from the breaks included in the VAR and the selected lags, the Table reports in column 5 the autocorrelation relationship for each country. As shown in the Table we do not have autocorrelation for none of the four EMU countries. More, as shown in the last column of Table 4, the null hypothesis of no serial correlation in the VAR error term cannot be rejected in all cases, even at the 10% level of significance, which strengthens the validity of the empirical findings.

Table 4: VAR model for ($S_{(n,m),t}$, $\Delta r_{m\,t}$)

Country	Spread	Breaks included in the var	k[a]	LM test	R^2	
					$\Delta r_{m,t}$ -eqn	$S_{(n,m),t}$ -eqn
Spain	5-year Government bond yield - 3-month treasury bill rate	1993:12, 1995:11	4	8.98 (0. 06)	0.49	0.86
Italy	10-year Government bond yield - 12-month Treasury bill rate	1995:02, 2003:06	12	3.11 (0. 53)	0.36	0.87
	5-year Government bond yield - 12-month Treasury bill rate	1996:03, 2004:04	12	3.95 (0. 41)	0.42	0.81
Portugal	5-year Government bond yield - 2-year Government bond yield	1996:08, 2005:04	2	3.2 (0. 4)	0.27	0.7
Greece	5-year Government bond yield - 12-month Treasury bill rate	1997:09, 2000:09	3	8.79 (0. 06)	0.55	0.88

Numbers in the LM test column are multivariate LM test statistics, which under the null hypothesis of no autocorrelation, are distributed as x^2 asymptotically, with degrees of freedom d^2 , where d=2 is the dimension of the VAR. Numbers in the parentheses are p-values.

[a] k denotes the estimated lag length in each VAR

In Table 5, column 4, reports the Wald test results for testing the VAR restrictions. These restrictions cannot be rejected at the 5% level of significance since the p-values are not that low. However, the case of rejection of the cross – equation restrictions does not mean that the EHTS is devoid of any economic content. As indicated by Campbell and Shiller (1991), it is quite possible that minor deviations from the EHTS may lead to statistical rejection of theory. For this reason, the economic significance of the EHTS has been also evaluated by computing the variance ratio of the $S_{(n,m),t}$ to the $S'_{(n,m),t}$ and examining the correlations between them.

Columns 6 and 7 of Table 5 show the results for the variance ratio and the correlation coefficient corr($S_{(n,m),t}$, $S'_{(n,m),t}$) between the actual and the theoretical spread, respectively. Column 6 shows that for VARs of Spain, Italy and Greece the variance ratios are not greater than two SDs from unity.

More, column 7 indicates that the correlation coefficient between $S_{(n,m),t}$ and $S'_{(n,m),t}$ is high and close to unity. This implies that for these three countries, the deviations from the EHTS are not economically or statistically significant. In contrast, there is evidence against the EHTS for Portugal. For this country, the variance ratio is very low and greater than two SDs from unity, while the correlation coefficient between the actual and the theoretical spread is quite low and far from unity.

Table 5: Testing the EHTS of interest rates

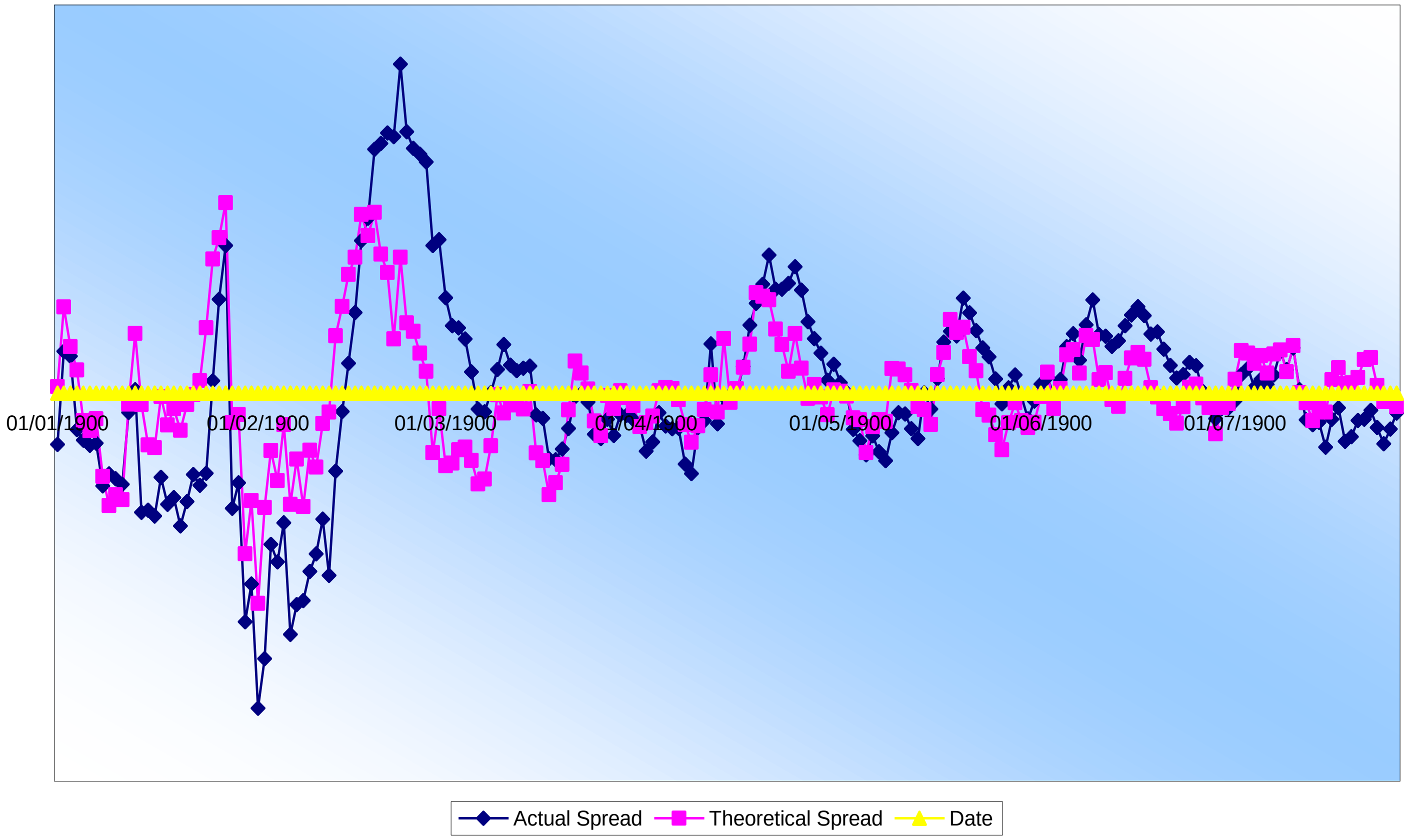
Country	**Spread**	**Breaks included in the var**	**Wald tests**		**VR**	**Corr**
			Test statistic	***df***		
Spain	5-year Government bond yield - 3-month treasury bill rate	1993:12, 1995:11	11.1 (0. 19)	4	0.75 (1. 47)	0.93 (0. 27)
Italy	10-year Government bond yield - 12-month Treasury bill rate	1995:02, 2003:06	25 (0. 4)	4	0.69 (0. 25)	0.44 (0. 87)
	5-year Government bond yield - 12-month Treasury bill rate	1996:03, 2004:04	27.8 (0. 26)	4	0.79 (0. 42)	0.21 (0. 68)
Portugal	5-year Government bond yield - 2-year Government bond yield	1996:08, 2005:04	26.3 (2. 71)	4	0.09 ➔ (0. 08)	0.01 (2. 73)
Greece	5-year Government bond yield - 12-month Treasury bill rate	1997:09, 2000:09	6.4 (0. 17)	4	0.38 (0. 33)	0.98 (0. 04)

df are the degrees of freedom. Numbers in the parentheses in column 4 are p-values. Numbers in the parentheses in columns 5 and 6 are standard errors.

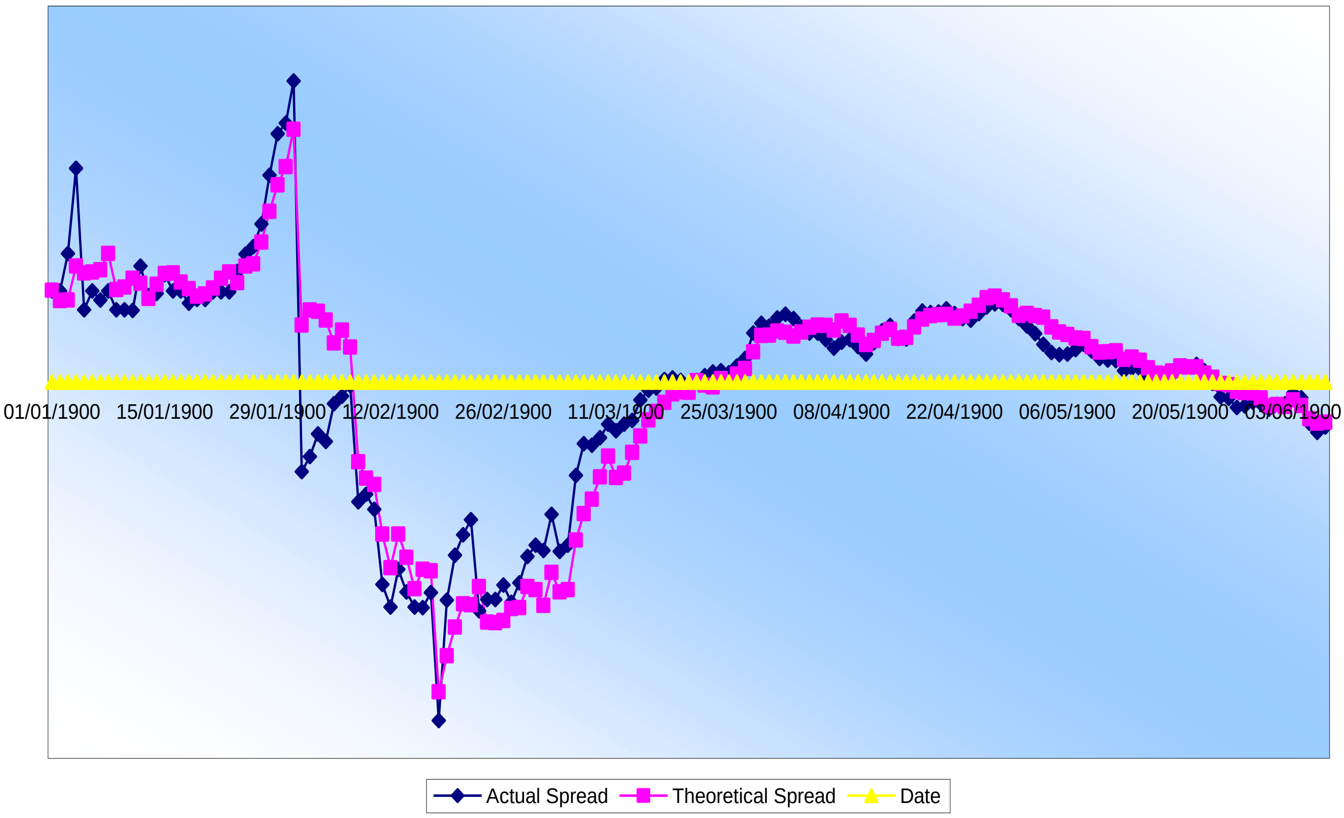
➔ A variance ratio that is greater than two SDs from unity

The following figures which plot the $S_{(n,m),t}$ and the $S'_{(n,m),t}$ between the interest rates of each of the above four EMU countries, conveys similar information. For Spain, Italy and Greece, the actual and the theoretical spread seem to move together over time, while for Portugal the low correlation between the actual and the theoretical spread is clear.

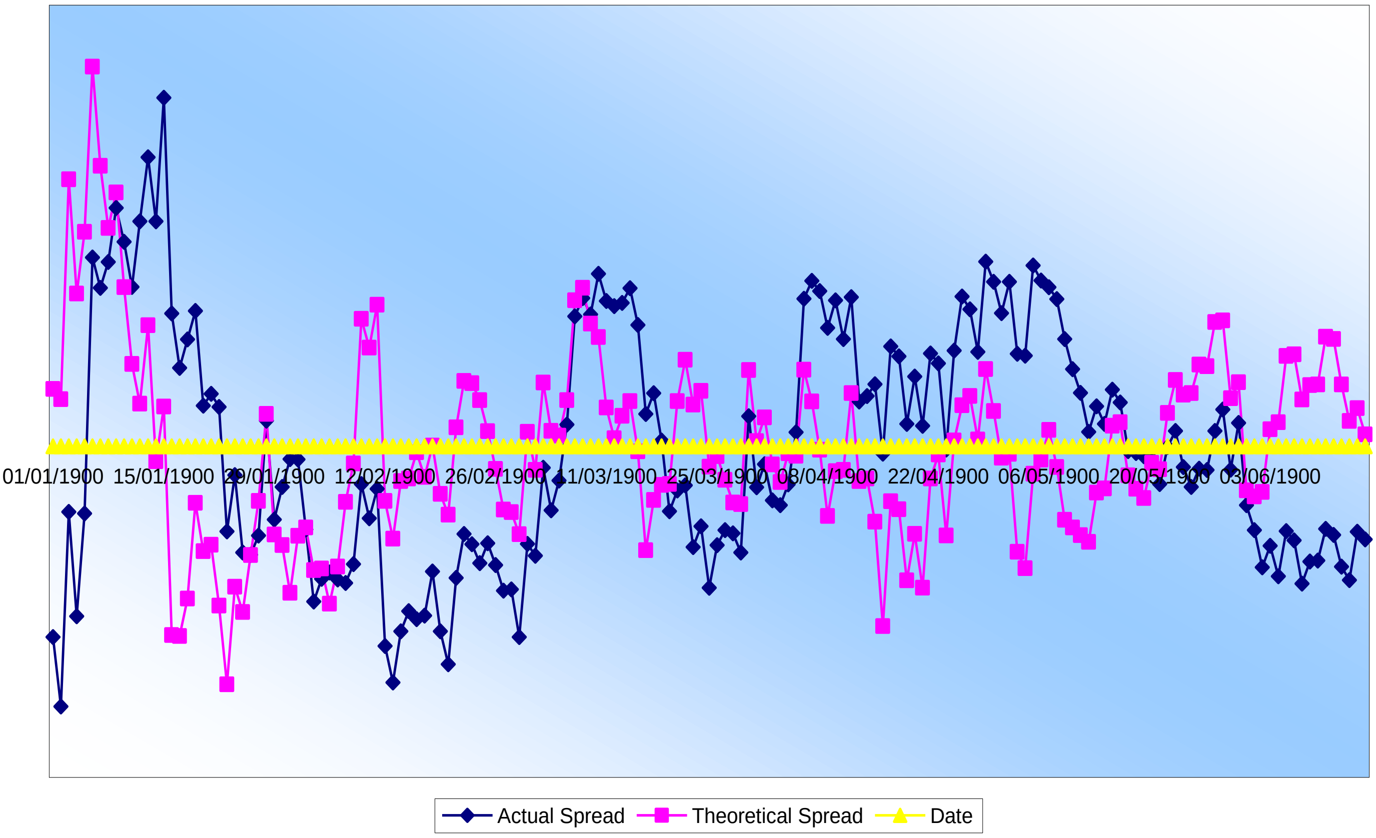
Spain: Short rate breaks



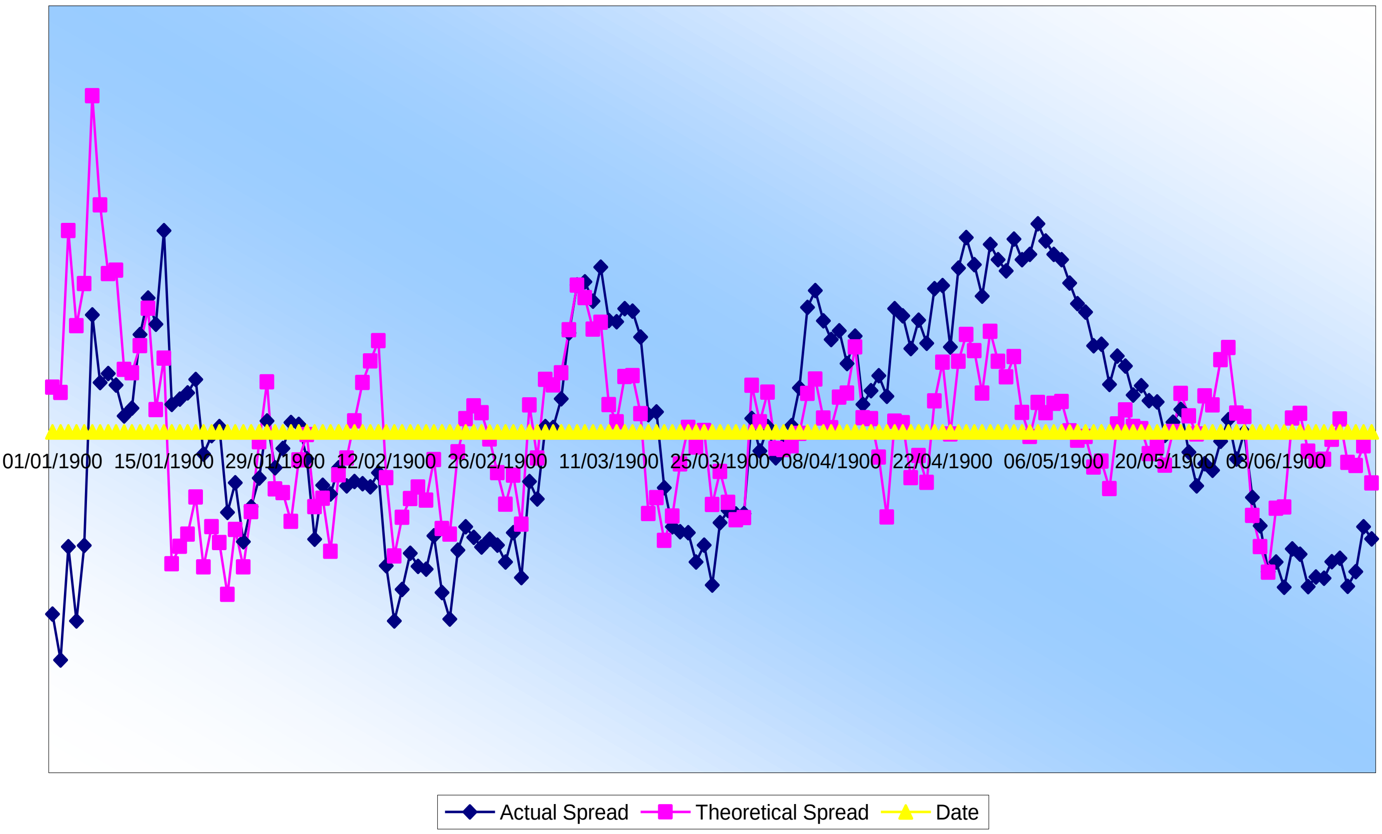
Greece: short rate breaks



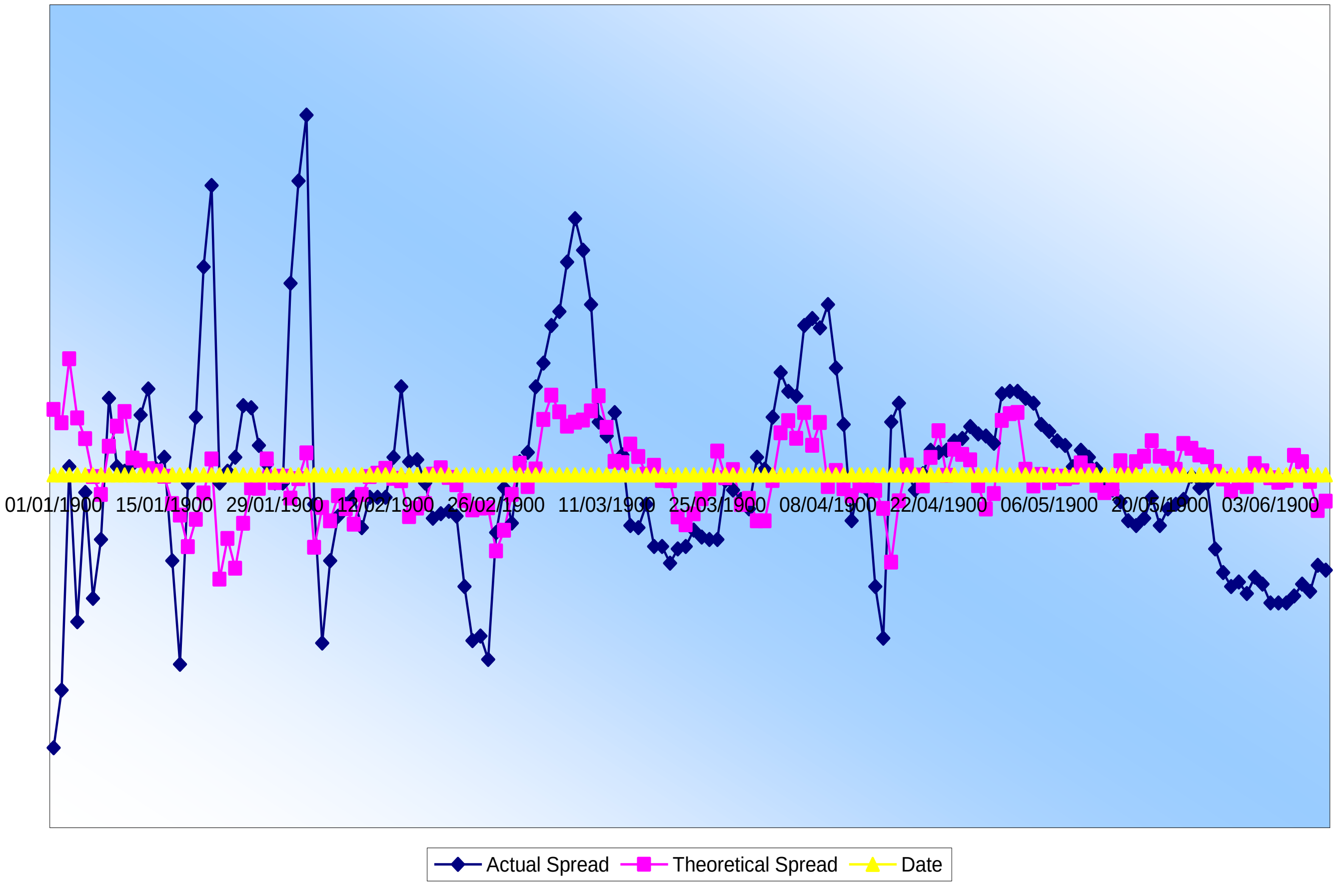
Italy: Short rate breaks



Italy: Long rate breaks



Portugal: Short rate breaks



Combining these results with the results of the previous section, they clearly provide support of the empirical adequacy of the EHTS only in the case of Spain, Italy and Greece. On the contrast, for Portugal the EHTS is strongly rejected. Those results are accurate for three basic reasons: first, the use of unit root and co-integration testing in the presence of structural breaks, which allows avoiding distortions in standard inference procedures, second, the implementation of cross-equation restriction tests and variance ratio estimations and third, the use of the large time span for the countries of the sample.

The implementation of these techniques in the present study led to no rejection of the (1, -1)' null hypothesis for the co-integrating vector, in the case of Spain, Italy and Greece, while it gave a clear-cut result for Portugal, which is against EHTS, since the cross-equation restrictions are strongly rejected and the variance ratio is very low and greater than two SDs from unity.

5. Conclusion

One danger is that fractures within the euro area will distract the ECB from staying on top of inflation. A particular worry is what could be called the PIGS—Portugal, Italy, Greece and Spain, Europe's negative version of the fast-growing BRICs. The fear is that these countries may be in a hole they cannot easily climb out of and that the ECB will be pressed into running a looser monetary policy to save them.

Portugal, Greece and Spain have all enjoyed a cyclical boost that eventually led to overheating. Portugal's economy was the first to break down and is a warning to the others. Its boom in the second half of the 1990s was fed by a sharp decline in borrowing costs on the mere prospect of euro membership. The unemployment rate fell as low as 3.8%, but a red-hot economy fuelled wage inflation, which made it harder for local firms to compete with foreign rivals. Rapid growth in spending sucked in imports, and the current account, which was in balance in 1995, had sunk into a deficit of 10% of GDP by 2000.

Portugal has since struggled to regain its cost advantage and so it has failed to get its economy moving again. Its current-account deficit is still large, at 8% of GDP, and unemployment, at 7.6% in the first quarter of this year, is almost double the rate at the end of the boom years. GDP has fallen in two out of the past three quarters.

Spain and Greece enjoyed similar booms and may now be about to suffer a similar hangover (as, indeed, may Ireland). As in Portugal, there has been a rapid loss of international competitiveness. Wage costs in both countries have risen sharply compared with their main trading partners since 1999. Spain's current-account deficit widened to almost 10% of GDP by last year; Greece's shortfall was 12% of its GDP

Italy has not followed exactly the same path, but shares some of these ills: a high real exchange rate, a current-account deficit and a weak economy. Worse, it missed out on the boom after the euro. Instead, it has suffered from the slowest growth in the euro area, alongside Germany. And its loss of competitiveness has been every bit as bad as Spain's. So it is in many ways the biggest casualty of the new system.

Some people argue that the strains of living with the same short-term interest rate could even lead to the break up of the euro area. But the cost for any of the PIGS of leaving would be far higher than the short-term fix from devaluation. Indeed, Mr Mayer reckons a breakaway by a “hard euro” faction of strong economies is more plausible—if still highly improbable.

Such fears are not new. Senior ECB officials point out that the regional strains within the euro area are not much greater than those in America, the only other currency zone of comparable GDP. A one-size-fits-all interest-rate policy is the price you pay for the benefits of a monetary union. If countries such as Spain, Greece and Ireland had still had their own currencies, the credit crunch would probably have damaged them more than it did.

Countries will make the best of their circumstances. Spain's economy may be struggling, but it has a fiscal cushion to ease the transition from housing- to export-led growth. Spain's budget surplus was 2% of GDP last year. If it moves to a deficit of 3% of GDP, that would provide a huge fiscal stimulus.

Indeed, the loss of competitiveness in Spain (and elsewhere) may be more apparent than real. The trend in productivity could be stronger than official data suggest, because much of the country's recent growth has been in the construction industry, where efficiency is low. Mr Ubide believes that the monetary straitjacket will lead to faster reform. When GDP growth was healthy, there was little incentive to liberalize the economy.

Using a number of long-term and short term maturities on monthly EMU money market rates from 1990 to 2007, I perform a number of tests of the EHTS of the term structure of interest rates for EMU countries. On balance, my results would appear to lend support to the EHTS, except for Portugal. Turning to the bivariate VAR I find that the forecast of future changes in short rates (i.e. theoretical spread) moves closely with the actual spread, apart from the case of Portugal. Both the standard deviations ratio and correlation co-efficient for the theoretical spread relative to the actual spread give results in favor of the EHTS. However, I do provide a number of reasons why the cross-equation restrictions may de rejected, even though the EHTS remains a good representation of the data.

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