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EXPECTATIONS AND THE BEHAVIOUR OF SPANISH TREASURY BILL RATES

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Expectations and the Behaviour of Spanish Treasury Bill Rates. [1]

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ABSTRACT. Rational Expectations models are tested here under the standard assumptions of the Expectations Hypothesis (EH) of interest rates. We examine the theoretical unbiasedness of the spread of interest rates by predicting changes in the shorter spot rates. Unit root tests are applied and VAR systems are specified as a framework to apply Johansen's Maximum Likelihood Cointegration Analysis. Homogeneity and exogeneity tests are also carried out. Finally, we provide some Vector Error Correction Models (VECM) to determine the significance of the main assertions of the EH. Our VECM are coherent with the EH. We conclude that, by providing stability and strengthening the monetary transmission mechanism, the Spanish Treasury bills played a very relevant role in the monetary policy applied in Spain in order to enter the EMU.

KEYWORDS: Spanish Treasury bill rates, Term Structure of Interest Rates, Expectations Hypothesis, Autoregressive Vectors, Cointegration and Error Correction Models.

1 .- INTRODUCTION.

Over the last few years, the availability of cointegration techniques has given rise to an important amount of research, which has contributed to a better understanding of the Term Structure of Interest Rates (TSIR) of financial assets. Most of the studies have been conducted on the basis of the Expectations Hypothesis (EH) plus the assumption of rational expectations. The research work has been carried out by testing models related with the hypothetical unbiasedness of the spread of interest rates, which acts as a predictor of the changes in the shorter spot rates. The interest in these studies has been renewed because Central Banks have changed their monetary control strategy. Now the TSIR plays a relevant role as an indicator of the rate of inflation, which the monetary policy aims at reaching. This new interest has inspired the present study, which was designed to test the EH by considering the TSIR of the Spanish Treasury bills known as “Letras del Tesoro” (LT). The relevant issue here is the fact that when the EH holds in the Spanish market, monetary policy makers can relate expected shifts in interest rates with the slope of the TSIR represented by the spread.

These types of studies concerning the EH are always controversial, not only because of the great deal of related literature, but because it is frequently found that there are other alternative hypotheses which could better explain the behaviour of the economic agents in the financial markets. As surveyed in Shiller (1990), those alternatives are the so-called Preferred Liquidity, Preferred Habitat and the Segmentation Hypothesis. And as summarised by Nuñez (1995), the study of the EH and other alternatives in the context of the TSIR is relevant from the point of view of saving, investment and consumer decision-making. It is also useful for monitoring the execution of the monetary policy. In financial economics, the EH study is quite relevant in making decisions about treasury management, strategies of investment and valuation, and hedging assets.

The works of Campbell and Shiller (1987, 1991) are the seminal references for the studies of the EH carried out over the last decade. When a wide maturity spectrum of public debt interest rates issued by US government was observed, these authors found little or no support for the EH in cases of a short term maturity, but they also conclude that EH holds in the long term to the maturity spectrum. On the other hand, Hall, Anderson and Granger (1992) came to favourable conclusions about the EH. These authors analysed US Treasury Bills and found a cointegrated relationship of interest rates in the period in which interest rates were an instrument of monetary policy applied by the US Federal Reserve. This contradiction between the above-mentioned studies and others (reviewed in Cuthbertson [1996a]) shows that the feasibility of the EH has not always been demonstrated. Furthermore, whether the EH holds or not depends on the period of the study, the monetary policy regime and the maturity spectrum of the assets.

With similar aims to those above, Engsted (1994) and Engsted and Tangaard (1994) achieved results in favour of the EH. They respectively carried out a cointegration analysis of U.S. and Danish Treasury bills and bonds. They studied systems of more than two interest rates simultaneously, and applied homogeneity and weak exogeneity tests to a cointegrated VAR, by testing the EH restrictions within the cointegration space. Johansen and Juselius (1992) propose such tests, among others. Some studies such as the ones carried out by Hurn, Moody and Muscatelly (1995) and Cuthbertson (1996b) used a cointegration analysis that took into account the relationship between the actual spread and the expected spread, or "perfect foresight spread". These empirical studies are based on the TSIR of the London Interbank Market. In both, the results were in favour of the EH. However, in the first there is a slight significance for the shorter term while, in the second study, the spread between 12 and 6 months is found to be non-relevant from the EH point of view.

Several studies of the EH have been carried out in Spain and alternative theories have often been compared. The initial reference is the work by Berges and Manzano (1988). They used an ARIMA model taking the TSIR of the Spanish *Pagarés del Tesoro*. They came to the conclusion that the EH should be rejected, and indirectly, that the Market Segmentation Hypothesis should be plausible due to the role played by the fiscal discrimination which at that time was in favour of private investors and against banking institutions. Similarly, but focusing on the EH, Martín and Pérez (1990) applied their analysis to the interest rates of the Spanish Interbank Market. The result is weak evidence of the EH measured by the scarce significance of the forward interest rates as predictors of the spot ones.

Other studies which are worth quoting here are the ones by Ezquiaga, (1990, 1991), Freixas and Novales (1992), Goerlich, Maudos and Quesada (1995) and Dominguez and Novales (1998) The latter two found results in favour of the EH. The first explains the shift in the Spanish monetary policy regime in 1984 while the second deals with the predictive power of the spread and forward rates of Euro-deposits in pesetas. The other two previous studies, based on models related with the volatility of interest rates, concluded with arguments in favour of alternative hypotheses, such as the *Preferred Habitat*. These arguments dealt with the significance of the so-called term premium and its variability in time. Nevertheless, only the most recent of these studies is based on a cointegration analysis—in a somewhat similar way to the one we propose here.

Our empirical research is conducted on the basis of data collected from the Official Statistics Bulletin of the *Banco de España* (the Spanish Central Bank) from July 1987 to September 1998. We use data concerning interest rates of 1, 3, 6 and 12 months to maturity throughout that period. Our work is based on spread models in which we assume market efficiency—the state of equilibrium being the one in which the behaviour of the market participants happens to be independent of any particular term to maturity. Unit root tests are applied and VAR systems are specified as a framework to apply Johansen's Maximum Likelihood Cointegration Analysis (Johansen, 1988). Homogeneity and exogeneity tests are also carried out. Finally, we provide some Vector Error Correction Models (VECM) to determine the significance of the main assertions of the EH.

This study differs from others that deal with the Spanish TSIR because it takes an alternative approach from the point of view of the use of data and the econometric methodology. The previous papers, carried out some years ago, were based on interest rate data taken from the Spanish interbank market. Those were the only data available at that time that were made up of series of rates long enough to perform the empirical analysis of the term structure. Nevertheless, they were affected by problems of liquidity and solvency risk as well as by a lack of representation of the whole spectrum of the TSIR. The latter is due to the fact that in the Spanish interbank market most of the dealing is carried out with maturity at less than one week. Here we use interest rates taken from the public debt market, which are free of the aforementioned problems. Fortunately, nowadays we have access to some series of rates long enough to be used for empirical analysis.

Previous studies carried out with Spanish data have used ARIMA models. Cointegration is used here because, as is well known, it allows us to study data by levels and it provides us with a way to perform a dynamic empirical analysis based on Vector Error Correction Models (VECM). Furthermore, in our models here we test the alternative hypothesis of non-constant premium risk directly. Such an approach has not been attempted before in Spain. This study, then, represents a new contribution to the research of the behaviour of Spanish interest rates. A cointegrating relationship between interest rates of different maturity is found in which the spreads determine changes in the interest rates of shorter maturity. Our VECM are coherent with the EH. Thus, our results have the notable implication of providing empirical evidence that can be interpreted to conclude that the expectations of the participants in the Treasury bill market have been formed in accordance with the EH, reinforcing the credibility in the monetary policy applied during the analysed period. Therefore, we can say that the Spanish Treasury bills have played a very relevant role. They have provided stability and have strengthened the monetary transmission mechanism of the monetary policy that was applied in Spain throughout the convergence of the European financial systems in order to achieve integration in the EMU.

The rest of this paper is organised as follows. In section II, we review some concepts related to the EH. In section III, we explain the methodology applied in this research. In section IV, we expose the empirical results regarding the cointegration implications of the EH, and in the final section the main conclusions of this study are considered.

2.- THE TERM STRUCTURE OF INTEREST RATES AND THE EXPECTATIONS HYPOTHESIS.

The expression “Term Structure of Interest Rates” (TSIR) refers to the hypothetical relationship between the yields to maturity of homogeneous financial assets. With those assets, we can build up the yield curve of the market. As interest rates change over time, the yield curve implied by the TSIR consequently changes.

Generally speaking, the consideration of homogeneous assets implies that the solvency and the liquidity risk are identical along all terms to maturity. The Spanish public debt is considered free of those risks due to its good rating. Hence, in this study we take the LT's yields as homogeneous. The comparison between such Public Debt assets of different maturity offers us an argument about the expectations represented by changes in spot interest rates, which could be observed in the future.

From the point of view of the EH, it is assumed that there is a perfect substitution among the homogeneous assets of different maturity. Therefore, we do not take transaction cost into account. The market is in equilibrium when the yields to maturity are negotiated in such a way that market participants show no preference to either investing or borrowing in assets of any particular maturity. With the EH, we state that the market is efficient and investors are risk neutral (constant premium risk). If there were any opportunity of getting some advantage in any particular term, the arbitrage operations would immediately restore the equilibrium in the market. Hence, the expected profit from a long-term investment would be the same as that of a rollover strategy, which is the one in which we make continuous reinvestment at the end of shorter periods that together make up the whole long term period. That is:

$$(1+R_{n,t})^{n} = (1+R_{n-1,t})^{n-1} * (1+R_{1,t+n-1}) \qquad (1)$$

$R_{n,t}$: Interest rate in the moment "t" for "n" units of time to maturity.

$R_{n-1,t}$: Interest rate in the moment "t" for "$n-1$" units of time to maturity.

$R_{1,t+n-1}$: Interest rate in the moment "$t+n-1$" for one unit of time to maturity.

As expressed in Shiller (1990), the EH could be derived in a way in which the investors are considering the alternative of investing in the short or in the long run. When interest rates are expected to drop, they invest in assets of longer maturity. Such behaviour causes long-term rates to fall as well, at least whilst the cutting in the short-term rates is expected, and the excessive demand for long-term assets slows down. Hence, a downward sloping TSIR shows expectations of a drop in interest rates and, conversely, a rise in the slope means that interest rates are also expected to go up.

The long-term investment at the rate R_n is equivalent to successive reinvestment at a shorter term of maturity at rate R_1 and its successive expected rates, $E_t R_{1,t+1}$, etc. Thus, we have:

$$(1+R_{n,t})^n=(1+R_1)*(1+E_t R_{1,t+1})*(1+E_t R_{1,t+2})*\ldots*(1+E_t R_{1,t+n-1}) \qquad (2)$$

Taking logs in *(2)* and applying the approximation $\ln(1+z)\approx z$ for $|z| < 1$, we get the next linear relationship:

$$(R_{n,t}) = (1/n)\ [R_{1,t} + E_t\, R_{1,t+1} + E_t\, R_{1,t+2} + \ldots + E_t\, R_{1,t+n-1}\ ] \qquad (3)$$

This last equation is the foundation for the analysis of the evolution of the spot interest rates. For instance, if in "*t*" it is expected that rates are going to rise ($E_t\, R_{1,t+j} > E_t\, R_{1,t+j-1}$), the consequence should be the one in which long run rates (R_{nt}) should rise more than the shorter rates $R_{1,t}$. In that sense, the yield curve should have a positive slope because $R_{n,t} > R_{n-1t} > R_{1t}$.

On the basis of the EH, equation (*3*) can be generalised to the next expression, which it is called the "Fundamental Term Structure Equation":

$$R_{nt} = 1/n \sum E_t\, R_{1,t+j} + \phi_{1,t+n-1} \qquad (4)$$

Where E_t expresses the expectations operator in the moment "*t*" and $\phi_{1,t+n-1}$ is a constant that represents the time premium. When such a term is zero, the EH is called Pure Expectations Hypothesis (PEH).

The equation *(4)* can be transformed into:

$$(\mathrm{R}_{\mathrm{n,t}} - \mathrm{R}_{1,\mathrm{t}}) = 1/\mathrm{n} \sum_{\mathrm{i}=1}^{\mathrm{n}-1} \sum_{j=1}^{j=i} \mathrm{E}_{\mathrm{t}}\ \Delta R_{1,t+j} + \phi_{n,t} \qquad (5)$$

These last two expressions are the underpinning of the EH approach. Through them, we assume that interest rates of longer maturity can be expressed as a function of an average of spot shorter rates and their expected future values. The difference between long-short rates (the spread) would collect the market expectations about future changes in shorter rates.

3.- METHODOLOGY.

Generally, interest rates are found to be variables that follow nonstationary *I(1)* processes and their corresponding spreads are stationary vectors. Hence, most of the empirical studies are based on testing whether, in a multivariable VAR system of "*n*" interest rates, it is possible to find up to "*n-1*" cointegrated relations defined by the relationship between spreads. When that is the case, a cointegration analysis proposed by Johansen (1988) can be carried out. In this context, testing the EH implies the imposition of homogeneity restrictions and testing for weak exogeneity in the cointegrating space. It implies that we have to formulate similar hypotheses as the ones we find in Johansen, and Juselius (1992).

From the point of view of the EH, the fundamental idea lies in the fact that cointegration between different interest rates is compatible with the continuous adjustment of the level of interest rates in the market. Although in the short run, rates may move in a different way, there is a path of a long-term equilibrium relationship between rates of different maturity. However, any deviation from this equilibrium path would give rise to arbitrage opportunities which would again restore the balanced relationship.

After testing for the non-stationarity of a set of interest rates and coming to the conclusion that they follow an I(1) process, we can form a vector of $\boldsymbol{x(t)}$ interest rates and find other vectors of constants $\boldsymbol{\beta_1, \beta_2,... \beta_n}$ in such a way that we may have $\boldsymbol{\beta\, x(t)}$ linear combinations that go to make up an *I(0)* stationary process. If that were the case, the $\boldsymbol{\beta}$ vectors would constitute the cointegrating space for the $\boldsymbol{x(t)}$ interest rates. Coming back to equation *(5),* we can see that if the right hand side is stationary, so is the left hand side, *(1,-1)*' being the cointegrating vector for $\boldsymbol{x(t)}$. In general, each interest rate at time "*t*" with a particular term "*n*" $(R_{n,t})$ should be cointegrated with the interest rate for one period in the moment "*t*" $(R_{1,t})$. The spread $(R_{n,t} - R_{1,t})$ should be the result of the $\boldsymbol{x(t)}$ stationary linear combinations.

By considering different pairs of interest rates $[R_{1,t};\ R_{2,t}]$, $[R_{1,t};\ R_{3,t}]$, $[R_{1,t};\ R_{n,t}]$, and leaving the premium term $\phi(n)$, there will be different linear combinations

$\beta_1\ R_{1,t}...\ +\ \beta_n\ R_{n,t}$ (see Engsted and Tangaard, 1994). Thus, we can formulate equation *(4)* as:

$$\beta_1 R_{1,t} + ... + \beta_n R_{n,t} = (\beta_1 + \beta_2 + ... + \beta_n) R_{1,t} + \frac{\beta_2}{2} \sum_{j=1}^{2-1} E_t [R_{1,t+j} - R_{1,t}] + ... \frac{\beta_{n-1}}{n} \sum_{j=1}^{n-1} E_t [R_{1,t+j} - R_{1,t}] \qquad (6)$$

If $R_{1,t+j}$ is an I(1) process, $E_t[R_{1,t+j} - R_{1,t}]$ should be a stationary I(0) process. Therefore the expression of the LHS of equation *(6)* will be stationary if $\beta_1 + \beta_2 + \beta_n = 0$. Then we will have a cointegrating system with "*n*" interest rates in which the sum of the cointegrating coefficients is equal to zero. In that case, under the EH we would have "*n-1*" cointegrating vectors which should satisfy the restrictions of zero sum.

As $\boldsymbol{x(t)}$ is a vector of interest rates and $\boldsymbol{\beta}$ a matrix of $\boldsymbol{\beta}$ cointegrating vectors, we can write the cointegrating space as a stationary process:

$$\boldsymbol{Z_t = \beta' X_t} \qquad (7)$$

In which:

$$X_t = \begin{bmatrix} R_{1,t} \\ R_{2,t} \\ . \\ . \\ . \\ R_{n,t} \end{bmatrix} \quad (8) \quad \text{and} \quad \beta = \begin{bmatrix} \beta_{11} & \beta_{12} & \cdots & \beta_{13} \\ \beta_{21} & \beta_{22} & \cdots & \beta_{23} \\ . & . & \cdots & . \\ \beta_{i1} & \beta_{i2} & \cdots & \beta_{ij} \end{bmatrix} \quad (9)$$

The relationship between the interest rates of different terms to maturity can be established by means of a VAR error correction model with *k* lags, *VAR(k)*, which we represent here as a first order differentiated system with lag levels as in the expression:

$$\boldsymbol{\Delta X_t = \Gamma_1\ \Delta X_{t-1} + ... + \Gamma_{k-1}\ \Delta X_{t-k+1} + \Pi X_{t-1} + \mu_0 + \mu_1\ t + \psi D_t + \varepsilon_t} \qquad (10)$$

where X is a column vector of the n stochastic variables of the system, D_t is a column vector of dimension $(s\!-\!1)$ dummy variables with zero mean, and μ_0 is a constant and μ_1 represents the trend coefficient. In this system, we can use the maximum likelihood method proposed by Johansen (1988), the eigenvalue and the trace tests, and decide the cointegrating rank *r* which corresponds to the factorisation **Π=αβ'**. Since **α** and **β** are *(n x r)* matrices, where **α** represents the coefficients that determine the influence of the "speed of adjustment" of the error correction term in the ΔX_t equations and **β** is a matrix of long-run cointegrating vectors.

The first condition for the HE to hold is that the cointegrating rank should be $r = n - 1$. The second one is homogeneity in the cointegrating space. In that way, the **H** matrix represents the zero sum restriction of the cointegrating coefficients as has been considered in *(6)*:

$$\mathbf{H} = \begin{bmatrix} 1 & 1 & 1 & \dots & 1 \\ -1 & 0 & 0 & \dots & 0 \\ 0 & -1 & 0 & \dots & 0 \\ . & . & . & \dots & . \\ 0 & 0 & 0 & \dots & -1 \end{bmatrix} \quad (11)$$

Therefore, the n – 1 spreads, *S*, should be stationary. Being $S_i=R_{i,t}-R_{1,t}$, and $i = 2,3, \ldots, n$. The restriction above mentioned forms the null hypothesis H_0: $\boldsymbol{\beta} = \mathbf{H}\,\boldsymbol{\varphi}$. Given that **H** imposes *k* restrictions, it will be of dimension *(nxs)*, since *(s=n-k)*, while **φ** is an *(sxr)* matrix of parameters to be estimated involving all *r* cointegration vectors. Johansen and Juselius (1992) showed that such a hypothesis can be tested with the likelihood ratio test, using the critical values that correspond to the χ^2 distribution.

In a similar way, we can test for weak exogeneity in the α_{ij} coefficients of matrix **α**. In particular, we are interested in testing the statement of the EH in which the spread between the long and the shorter rates causes the changes for the shorter spot interest rate. The hypothesis to be tested is H_0: **α=Aψ**, where A is a matrix with a number of columns less than *n* and **ψ** is a matrix whose dimension matches the ones of **A** and **α.**

As an example of the last test, we can propose the hypothesis that the shorter interest rate $R_{1,t}$ enters in any cointegrating vector. In this way, it would not be determined either by longer rates or by any spread. If we consider the matrix **A** with *n x (n-1)* dimensions:

$$\mathbf{A} = \begin{bmatrix} 0 & 0 & ... & 0 \\ 1 & 0 & ... & 0 \\ 0 & 1 & ... & 0 \\ . & . & ... & . \\ 0 & 0 & ... & 1 \end{bmatrix} \quad (12)$$

We thus give way to a new restricted model. Using a likelihood ratio test involving the restricted and unrestricted models, we can ascertain whether the restrictions are valid or not. Actually, it represents a weak exogeneity test in the first equation of the VAR system. Therefore, if the necessary rank condition and the sufficient homogeneity and weak exogeneity conditions hold, we can form VECM of interest rates and test their performance.

The term premium in equations *(4)* and *(5)* is a key issue in testing the validity of the EH. In our models, we include such a term as a constant restricted into the cointegrating space. In order to test its relevance, firstly, we restricted the value of this term to zero in each cointegrating vector and, secondly, we made the restrictions that all constant terms are equal to each other. These are LR-tests checking for both the pure Expectations Hypothesis and for the more general Expectations Hypothesis, respectively. If we cannot reject such restrictions, we can say that our data exclude a time-varying risk premium which supports the argument that the EH holds in the market of the Spanish Treasure bills.

4.- EMPIRICAL RESULTS.

As mentioned in the Introduction, the data are taken from the Statistics Bulletin of the Bank of Spain. We use monthly average interest rates, which are the ones dealt with by the members of the secondary market of the LT. For the rates of 12-month maturity, we use the average effective rates that correspond to the initial issue of the Public Debt for one-year maturity. We standardise the series of 1, 3, 6 and 12 months rates by expressing them as effective rates and finally transforming the data into series of continuously compound interest rates, as proposed by Ezquiaga (1991). We have followed the criteria stated by Cuenca (1994) to select average effective rates. Generally, this is the most commonly accepted way to proceed in studies where monetary variables are involved. The analysed period runs from the initial months of issuing the LT (July 1987) to September 1998; that is, four months after the adhesion of the peseta to the European Monetary Union.

Figure 1 represents the paths of the LT rates along the period July 1987–September 1998. The evolution is very similar for all rates. Although they increase and decrease in the same way, in some periods the rates of longer maturity are found to be lower than the shorter ones. This has happened when a more restrictive monetary policy has been carried out. In all cases, the interest rates seem to be non-stationary variables. Taking the first difference, the series seem to be stationary, as shown in figure 2. The opposite happens in figure 3, where the spreads are represented. All the spreads seem to be stationary.

Figure 1.-Interest rates of the LT Spanish Treasure bills for 1, 3, 6 and 12 months (R1,R3,R6 and R12).

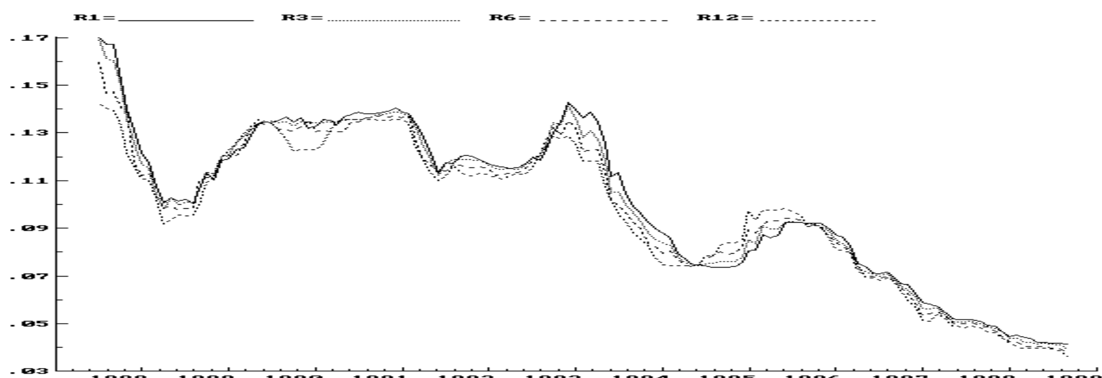


Figure 2.- First differences of L.T. rates.

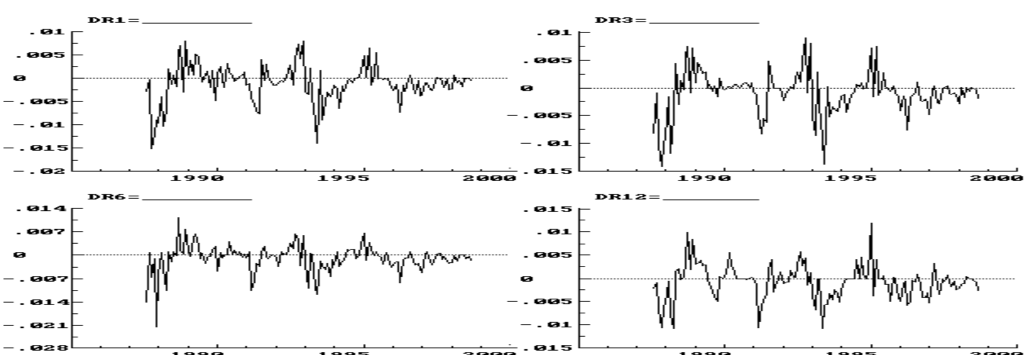
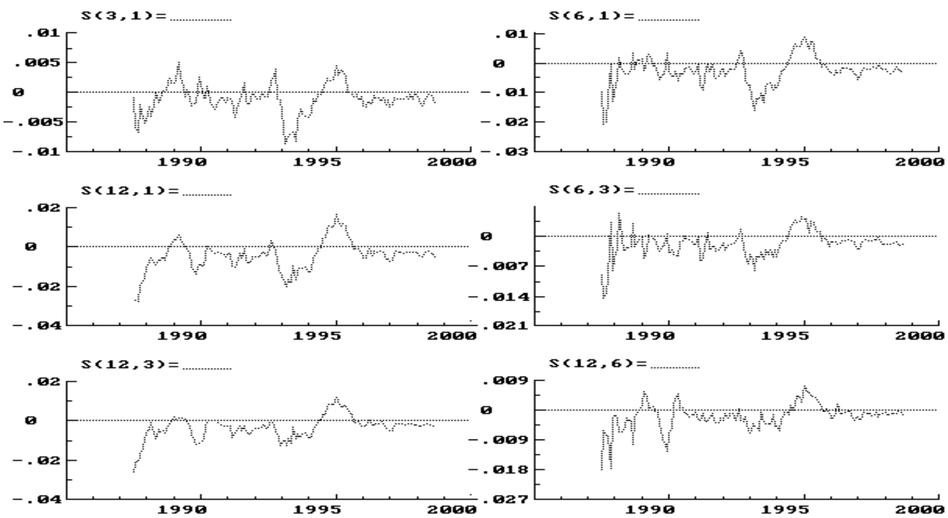


Figure 3.- Cointegrating spreads between L.T. rates of all maturities.



As the first figure suggests, the series are *I(1).* We tested for the presence of non-stationarity. Table 1 collects all the Augmented Dickey and Fuller (ADF) 1979 and Philips and Perron (PP) 1988 unit root tests. They were performed following the Dickey-Pantula procedure (Dickey and Pantula 1987). In all cases, we rejected the null hypothesis of the existence of a unit root in the first variables that were taken as differenced for just one time (figure 2). With the variables in levels, there is no evidence against the null of the presence of one unit root.

TABLE 1.- Unit root test of the spot interest rates and the residuals of the cointegrating regression.

VARIABLE	ADF TEST	PP TEST
ΔR^1	-3.822 ** (2) -3.863 ** (2)	-7.140 ** -7.428 **
R^1	-1.089 (3) -1.276 (3)	-2.093 -1.363
ΔR^3	τ: -4.574** (2) τ_μ:-4592** (2)	-8021** -8.199**
R^3	τ: -0.812 (3) τ_μ: -0.485(3)	-1.833 -0.841
ΔR^6	τ: -4,074** (4) τ_μ: -4,148** (4)	-8,327** -8,190**
R^6	τ: -0.842 (5) τ_μ:-0.200 (5)	-1.227 -0.08
ΔR^{12}	τ: -3.974** (2) τ_μ: -4.081 ** (2)	-19.709** -10.679**
R^{12}	τ: -1.180 (3) τ_μ: -0.935 (3)	-1.733** -0.687**

NOTES: The figures in brackets correspond to the number of lags to carry out the ADF test, which we selected following a sequential strategy as in Campbell and Perron (1991). In the case of the PP test, the truncation lag was set at four periods following the correction proposed by Newey and West (1987). The τ, τ_μ and τ_τ are the ADF statistics which allow for no constant and no trend, a constant, and a constant and a trend, respectively. The same sequence applies to the Z-PP statistics. ** and * denote rejection of the null hypothesis of non stationarity at 1% and 5% significance level. The critical values are the ones taken from MacKinnon (1991) as reported by the E-Views program, version 2.0 (1995).

The results of the same tests applied to the cointegrating spreads, plotted as in Figure 3, are shown in Table 2. As we can see, the spreads are stationary *I(0)* variables. Hence, we came to the conclusion that in this part of the analysis the interest rates could be described as integrated *I(1)* processes that could be cointegrated in stationary *I(0)* spreads. That gave us the chance to test the EH in VAR systems by following the sequence described at the methodology section.

TABLE 2.- Unit root tests of the spreads of interest rates.

VARIABLE	ADF TEST	PP TEST
$\Delta(R^3-R^1)$	τ:-10.605** (1) τ_μ:-10.623** (1)	-13.620** -13.582**
R^3-R^1	τ: -3.338* (4) τ_μ: -3.643* (4)	-3.404* -3.859*
$\Delta(R^6-R^1)$	τ: -5856** (3) τ_μ: -5.810** (3)	-14.422** -14.406**
R^6-R^1	τ: -2.592** (4) τ_μ: -3.089** (4)	-3.274** -3.842**
$\Delta(R^{12}-R^1)$	τ: -7.030** (1) τ_μ: -7.032** (1)	-11.202** -11.192**
$R^{12}-R^1$	τ: -3.715** (2) τ_μ:-4.029** (2)	-3.361** -3.575**
$\Delta(R^6-R^3)$	τ: -8.154** (3) τ_μ: -8.090** (3)	-19.174** -18.181**
R^6-R^3	τ: -2.366 * (4) τ_μ: -2.948 *(4)	-4.659** -5.473**
$\Delta(R^{12}-R^3)$	τ: -7.038** (1) τ_μ:-7.035** (1)	-12.048** -12.041**
$R^{12}-R^3$	τ: -3.734** (2) τ_μ:-4. 080** (2)	-4.235** -4.473**
$\Delta(R^{12}-R^6)$	τ: -5.975** (3) τ_μ: -5.984** (3)	-16.650** -16.591**
$R^{12}-R^6$	τ: -4.889** (4) τ_μ:-5.262** (4)	-5.727** -6.132**

NOTES: The figures in brackets correspond to the number of lags to carry out the ADF test, which we selected following a sequential strategy as in Campbell and Perron (1991). In the case of the PP test, the truncation lag was set at four periods following the correction proposed by Newey and West (1987). The τ, τ_μ and τ_τ are the ADF statistics which allow for no constant and no trend, a constant, and a constant and a trend, respectively. The same sequence applies to the Z-PP statistics. ** and * denote rejection of the null hypothesis of non stationarity at 1% and 5% significance level. The critical values are the ones taken from MacKinnon (1991) as reported by the E-Views program, version 2.0 (1995).

After proving that the variables are integrated of order one, the main problems that we faced by implementing the cointegrating technique were related to the following issues: setting the appropriate lag-length of the VAR models, testing for reduced rank (the number of cointegrating relations) and identifying whether there were trends in the data and therefore whether deterministic variables should enter the cointegration space or not. In fact, we have to take those factors into account all together.

We started our test of the EH[1] by specifying VAR systems with a constant parameter, taking the interest rates that were lagged enough to get non-autocorrelated residuals. Afterwards, we sequentially diminish the number of lags until we find a parsimonious VAR system. We do such a reduction following the Hendry (1988) general to the specific procedure while being consistent with non-autocorrelated residual testing with the correspondent Portmanteau Statistics. Although we have tested our models with dummy variables (not reported here), mainly taking account for the period of the "monetary storm" (September 1992 to March 1993), we do not find them significant and consequently we do not include those variables. As we are interested in testing for the term premium, we have restricted the constant parameter to the cointegrated space in order to proceed in applying LR tests. The VECM models are specified without drift term. In any case, we have included a trend term, which is commonly excluded in models with interest rates. Generally, before applying our regressions in a multivariable framework, we have carried out the Generalised Method of Moments (GMM) regression of all the cointegrating relationships (not reported here). The results are unambiguously in favour of a cointegrating *CI(1,-1)* relationship.

Table 3 presents the results of the maximum likelihood tests, i.e. the λmax. and trace as Johansen (1988), and Johansen and Juselius (1990) proposed. We show the results for the hypothesis in which the "*n*" interest rates are cointegrated and generate "*n-1*" cointegrating vectors defined by their corresponding spreads. The results allow us to accept the hypothesis that the rank of the cointegrating space is "*n-1*" in all cases. Thus, in a first approach we confirm the implications of the EH related with the TSIR of the Spanish LT.

TABLE 3.- Cointegration analysis of the *Letras del Tesoro* interest rates.

	Hypothesized number of cointegrating relationships	*Maximum Eigenvalue and Trace statistics for existence of* r*-cointegrating relationships over LT term structure*				*Homogeneity test*	*Exogeneity tests*	*Premium tests*	
								Homogeneity plus zero constant parameter in the cointegration space	*Homogeneity plus constant parameter in the cointegrating space*
VARIABLE	H_0:Rang	$\lambda_{máx}$	Critical value	λ_{trace}	Critical value	H_0: $\beta=H\varphi$	H_0:$\alpha=A\psi$		
R1R3 (2)	r = 0 r ≤ 1	30.04** 1.586	15.7 9.2	31.99** 1.586	20.0 9.2	1.517 (0.218)	26.074 (0.000)** 13.657 (0.000)**	3.360 (0.186)	------
R1R6 (3)	r = 0 r ≤ 1	41.08** 1.119	15.7 9.2	42.19** 1.119	20.0 9.2	1.988 (0.158)	39.599 (0,000)** 8.683 (0.003)**	7.0916 (0.288)	-----
R1R12 (3)	r = 0 r ≤ 1	18.79* 1,185	15.7 9.2	20.09* 1,185	20.0 9.2	1.603 (0,205)	15.267 (0,000)** 1.1333 (0.287)	1.603 (0.205)	------
R3R6 (4)	r = 0 r ≤ 1	24.74** 1.577	15.7 9.2	26.32* 1.577	20.0 9.2	4.235 (0,0396)	16.663 (0,000)** 3.598 (0.0578)	7.847 (0.019)	-----
R3R12 (3)	r = 0 r ≤ 1	20.9** 1.388	15.7 9.2	22.29* 1.388	20.0 9.2	1.609 (0.204)	10.673 (0,001)** 0.251 (0.615)	4.126 (0.127)	-----
R6R12 (3)	r = 0 r ≤ 1	26.55** 1.604	15.7 9.2	28.16** 1.604	20.0 9.2	1.695 (0.192)	15.054 0,000)** 0.130 (0.717)	2.667 (0.263)	-----
R1R3R6 (3)	r = 0 r ≤ 1 r ≤ 2	35.48** 24.84** 1.705	22.0 15.7 9.2	62.02** 2654* 1.705	34.9 20.0 9.2	3.534 (0.170)	27.884 (0,000)** 19.208 (0.000) ** 7.533 (0.023)*	8.071 (0.089)	7.664 (0.053)
R1R3R12	r = 0 r ≤ 1 r ≤ 2	60.62** 18.42* 1.088	22.0 15.7 9.2	80.13** 19.51 1.088	34.9 20.0 9.2	2.135 (0.343)	47.583 (0.000) ** 23.967 (0.000) ** 9.628 (0.008)**	4.038 (0.400)	4.000 (0.261)
R1R6R12 (3)	r = 0 r ≤ 1 r ≤ 2	52.97** 23.58** 1.26	22.0 15.7 9.2	77.72** 24.76* 1.26	34.9 20.0 9.2	1.450 (0.484)	38.169 (0,000)** 10.243 (0.006)** 22.89 (0.000)**	3.08 (0.379)	5.752 (0.218)
R3R6R12 (3)	r = 0 r ≤ 1 r ≤ 2	50.26** 17.04* 1,419	22.0 15.7 9.2	68.6** 18.35*	34.9 20.0 9.2	2.848 (0240)	16.732 (0,000)** 6.954 (0.030) * 12.948 (0.001)**	6.008 (0.198)	4.005 (0.260)
R1R3R6R12 (3)	r = 0 r ≤ 1 r ≤ 2 r ≤ 3	73.21** 31.03** 20.38** 1.214	28.1 22.0 15.7 9.2	125.8** 52.63** 21.6* 1.214	53.1 34,9 20,0 9,2	2.301 (0.5123)	33.191 (0.000)** 30.563 (0.000)** 10.562 (0.014)* 21.761 (0.000)**	9.494 (0.147)	9.004 (0.108)

NOTES: The numbers in brackets beside the variables represent the number of lags used in the VAR system. *Maximum Eigenvalue* and *Trace* statistics as defined in Johansen (1988). The critical values testing for the presence of *r* cointegrating relationships have been obtained using PcFiml version 8.0 (1994). The symbols ** and * denote rejection of the null hypothesis of at most *r* cointegrating relationship at 1% and 5% significance level. The last four columns on the right report the *LR* test, implying ** and * a rejection of the null hypothesis at 1% and 5% significance level (*p*-values are in brackets). Critical values reported by the same programme as before.

[1] As software, we used the PcGive-Pc-Fiml programme (Doornik and Hendry, 1994) to conduct our study.

The results of testing for the homogeneity and exogeneity hypothesis, as in expressions *(11)* and *(12)*, are also set out in Table 3. Generally, we accept the homogeneity hypothesis. The only exception is the one of the spread between rates of six and one month yield to maturity. In the case of the exogeneity tests, the results were that in all the cases of the shorter rates of each equation, we could reject the null hypothesis of zero value of each particular row of the α_{ij} coefficients or weighting factors. It implies that the long-run spreads enter as determinants of the changes in shorter rates. In the last two columns of Table 3 the LR tests for liquidity/risk premium are reported. In all cases, we cannot reject the null that the constant parameters, which are included in the cointegrating vectors, are zero and equal for any term. Therefore, these last results in favour of the pure Expectations Hypothesis are supportive to one of the main assumptions of the EH.

As set out in Engle and Granger (1987), the cointegrating relationship implies that we can specify an error correction model and vice-versa. In our case, we again start by specifying a VAR system, but now we take the variables in first differences and we include the cointegrating relations represented by the spreads as error correction terms. In other words, we model the hypothesis that the spreads between long and short-run rates determine the variation in the rates of shorter term to maturity. In this way, we can try to test whether the spreads can measure anticipated changes in the shorter LT rates, thus representing the expectations of the market participants. Our analysis is limited to systems with only two equations. We follow this method because in each case the cointegrating vector is well defined. Therefore, it allows us to avoid multi-equation systems in which the cointegrating vectors are not defined due to possible linear combinations among themselves. The results of our full information maximum likelihood (FIML) estimations are reported from Table 4-a to Table 4-f. On the right hand side of each Table, we include the statistics for autocorrelation, normality, ARCH process and heteroscedasticity.

TABLE 4.A.- Vector error correction model (VECM)of the 3 and 1-month interest rates

Equation	Variable	Coeff.	Std error	*t* Value	HCSE		
DR1	DR1_1	0.5810	0.1781	3.262	0.2406	Autoc.	AR 1-7F(7,120)=1,4463[0,0640]
	DR3_1	-0.5376	0.1980	-2.714	0.2524	Norm.	χ^2_2 = 12.375 [0,0O21]**
	DR3_2	0.1461	0.0838	1.742	0.1064	ARCH	ARCH 7 F(7,113)= 2.5216[0,0190]*
	CIR3R1_1	-0.9070	00.1474	-6.151	0.19271	Heteros.	F (10,116)=8.3877[0,0000]**
DR3	DR1_1	0.6776	0.1926	3.517	0.2610	Autoc.	AR 1-7F(7,117)=0.9792 [0.4496]
	DR3_1	-0.5269	0.2142	-2.460	0.2675	Norm.	χ^2_2 = 7.1148 [0.0285]*
	DR3_2	0.0471	0.0906	0.520	0.1365	ARCH	ARCH 7 F(7,113)= 3.6802[0,0000]**
	CIR3R1_1	-0.7337	0.1594	-4.601	0.1932	Heteros.	F (10,116)=5.8572[0,0000]**

NOTES WHICH ARE APPLIABLE TO ALL TABLES FROM TABLE 4-A TO TABLE 4-F: The estimated results have been obtained by using the PcFIML programme version 8.0 (1994).The Variables initially denoted by CIR... represent the cointegrating relationship. The HCSE column refers to the Heteroscedastic-consistent standard errors. The next columns are the single equation diagnostics tests for Autocorrelation, Normality, ARCH processes and Heteroscedasticity. ** and * respectively indicate statistical significance at 1% and 5% level.

TABLE 4.B.- Vector error correction model of the 6 and 1-month interest rates.

Equation	Variable	Coeff.	Std error	*t* Value	HCSE		
DR1	DR1_1	0.1413	0.0719	1.964	0.0936	Autoc.	AR 1-7F(7,117)= 1.1335[0.3470]
	DR1_2	0.1189	0.0703	1.689	0.0812	Norm.	χ^2_2 = 6.7845 [0.0336]*
	DR6_3	0.2697	0530	5.080	0.0727	ARCH	ARCH 7 F(7,110)= 1.135 [03466]
	CIR6R1_1	-0.2674	0.05580	-4.793	0.0746	Heteros.	F (14,109)= 2.8822 [0.0010]**
DR6	DR1_1	0.4699	0.1009	4.655	0.1756		
	DR1_2	0.2901	0.1022	2.837	0.1646	Autoc.	AR 1-7F(7,117)= 2.0832[0.0506]
	DR6_1	-0.2261	0.0972	-2.326	0.1426	Norm.	χ^2_2 = 31.285 [0,0000]**
	DR6_2	-0.2463	0.0875	-2,858	0.1125	ARCH	ARCH 7 F(7,110)= 1.2988 [0.2576]
	CIR6R1_1	-0.2055	0.0770	-2704	0.0927	Heteros.	F (14,109)= 4.2293 [0,0000]**

TABLE 4.C.- Vector error correction model of the 12 and 1-month interest rates.

Equation	Variable	Coeff.	Std error	*t* Value	HCSE		
DR1	DR1_1	0,25988	0.0741	3.028	0.1198	Autoc.	AR 1-7F(7,117)= 2,0715[0.0529]
	DR1_3	0.0796	0.0612	1.300	0.0760	Norm.	χ^2_2 = 11.893 [0.0026]**
	DR12_2	0.2363	0.0863	2.738	0.12172	ARCH	ARCH 7 F(7,110)= 4.9089 [00001]**
	CIR12R1_1	-0.1268	0.0334	-3.796	0.0439	Heteros.	F (14,109)= 3.3753 [0,0002]**
DR12	DR1_1	0.3104	0.0888	3.494	0.1013	Autoc.	AR 1-7F(7,117)= 1.1945 [0.3113]
	DR1_2	-0.2282	0.0776	-2.939	0.0626	Norm.	χ^2_2 = 24.078 [0,0000]**
	DR12_1	0.2347	0.0878	2.673	0.0996	ARCH	ARCH 7 F(7, 110)= 0.4252 [0.8847]
	DR12_2	0.2697	0.0966	2.791	0.0965	Heteros.	F (14,109)= 0.6904 [0,0023]**

TABLE 4.D.- Vector error correction model of the 6 and 3-month interest rates.

Equation	Variable	Coeff.	Std error	*t* Value	HCSE		
DR3	DR3_1	0.2710	0.0736	3.681	0.1140	Autoc.	AR 1-7F(7,117)= 1.6569 [0.1264]
	DR3_2	0.1465	0.0744	1.970	0.1036	Norm.	χ^2_2 = 7.2671 [0,0264]*
	DR3_3	-0.2031	0.0703	-2.888	0.0737	ARCH	ARCH 7 F(7,110)= 4.182 [0,0004]**
	DR6_3	0.4004	0.0658	6.078	0.0953	Heteros.	F (14,109)= 2.6694 [0.0022]**
	CIR6R3_1	-0.2453	0.0623	-3.934	0.0955		
DR6	DR3_1	0.7050	0.1054	6.686	0.1925	Autoc.	AR 1-7F(7,117)= 1.5319 [0.1632]
	DR3_2	0.3847	0.1101	3.482	0.1374	Norm.	χ^2_2 = 13.723 [0,001]**
	DR6_1	-0.3392	0.0880	-3.854	0.1366	ARCH	ARCH 7 F(7,110)= 2.1872 [0,0407]*
	DR6_2	-0.2511	0.0884	-3.010	0.1074	Heteros.	F (14,109)= 2.1104 [0.0164]*

TABLE 4.E.- Vector error correction model of the spreads between 12 and 3-month interest rates.

Equation	Variable	Coeff.	Std error	*t* Value	HCSE		
DR3	DR3_1	0.2680	0.0775	3.455	0.1098	Autoc.	AR 1-7F(7,117)= 1,0653 [0.3902]
	DR12_2	0.2344	0.0845	2.772	0.1090	Norm.	χ^2_2 = 17.67 [0.001]**
	CR12R3_1	-0.1529	0.0362	-4.2115	0.0449	ARCH	ARCH 7 F(7,110)= 3.1801 [0.0042]**
						Heteros.	F (14,109)= 3.2903 [0,002]**
DR12	DR3_1	0.3297	0.0945	3.487	0.1158		AR 1-7F(7,117)= 1.2872 [0.2626]
	DR3_2	-0.2492	0.0766	-3.253	0.0711	Autoc.	χ^2_2 = 21.376 [0,000]**
	DR12_1	0.1845	0.0838	2.201	0.0955	Norm.	ARCH 7 F(7,110)= 0.5726 [0.7728]
	DR12_1	0.3296	0.1004	3.281	0.10075	ARCH	F (14,109)= 1.227 [0.2665]

TABLE 4.F.- Vector error correction model of the 12 and 6-month interest rates.

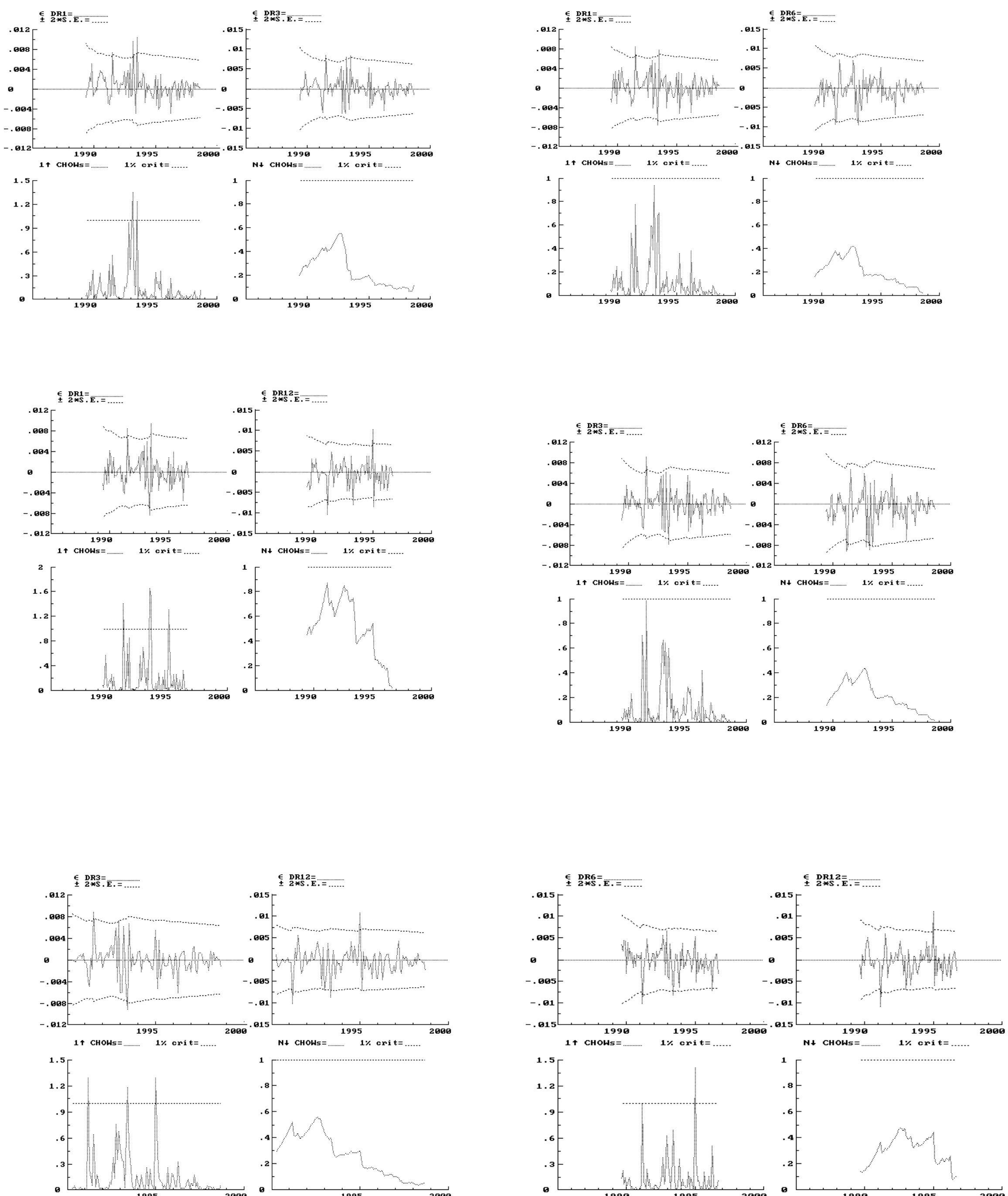
Equation	Variable	Coeff.	Std error	*t* Value	HCSE		
DR6	DR6_1	0.2111	0.1059	1.999	0.0982	Autoc.	AR 1-7F(7,113)= 1.8033 [0.0933]
	DR6_2	0.2307	0.0672	3.524	0.0711	Norm.	χ^2_2 = 17.299 [0,0002]**
	DR6_3	0.1920	0.0682	2.813	0.0892	ARCH	ARCH 7 F(7,106)= 0.2659 [0.9658]
	DR12-1	0.1352	0.1151	1.174	0.1244	Heteros.	F (18,101)= 0.60317 [0.8896]
	CIR12R6_1	-0.2756	0.0572	-4.817	0.0749		
DR12	DR6_1	0.2476	0.1045	2.368	0.1162	Autoc.	AR 1-7F(7,113)= 0.9478 [0.4729]
	DR6_2	0.2940	0.0667	4.406	0.0778	Norm.	χ^2_2 = 27.209 [0,0000]**
	DR12-1	0.1444	0.0678	2.130	0.0713	ARCH	ARCH 7 F(7,106)= 0.7398 [0.6387]
	DR12-1	0.2221	0.1111	1.998	0.1346	Heteros.	F (18,101)= 1.0142 [0.4509]

With the idea of taking into account the problem of the presence of heteroscedasticity and ARCH process (frequently found in financial time series), we included the HCSE (heteroscedasticity-consistent standard errors). This is the estimation of the standard errors of the regression coefficients that are consistent with the presence of heteroscedastic residuals related with the regressors, as proposed by White (1980). Taking the latter into account, we found statistically significant results for the coefficients of our cointegrating vectors which formed our error correction terms (represented at the tables 4A-4F as the ones preceded by CI...) with *t-values* greater than four in almost all cases. Consequently, we found that the spreads caused the changes in shorter rates. The negative of the error correction terms in the dynamic equations could be associated with the tightening of the monetary policy, which occurred in Spain in the years before and after the signing of the Maastricht Treaty. The intention was to make nominal interest rates and inflation converge towards the European rates. About this time, the tight monetary policy provoked an increase in short-term interest rates but a reduction in long-term rates. It was caused by the economic agents belief that such monetary strategy would reduce the inflation rates.

In accordance with the results of the exogeneity tests (Table 3) in the VECM, we found that, when we do not reject the null of such tests, the cointegrating spreads do not enter and in most of the equations do not explain the changes in longer rates. As it can be seen in Tables 4-a to 4-f, the speed of adjustment of the long-run equilibrium relationship decreases as the maturity gap between each pair of rates increases. On the one hand, this result is coherent with the EH because along the TSIR of the LT the greater the maturity difference between assets is, the slower the adjustment of their convergence is in the long run. On the other hand, the Bank of Spain control of the yield curve spread is more effective in the short term. The long term is also affected by other considerations such as long-term expectations of inflation and real activity.

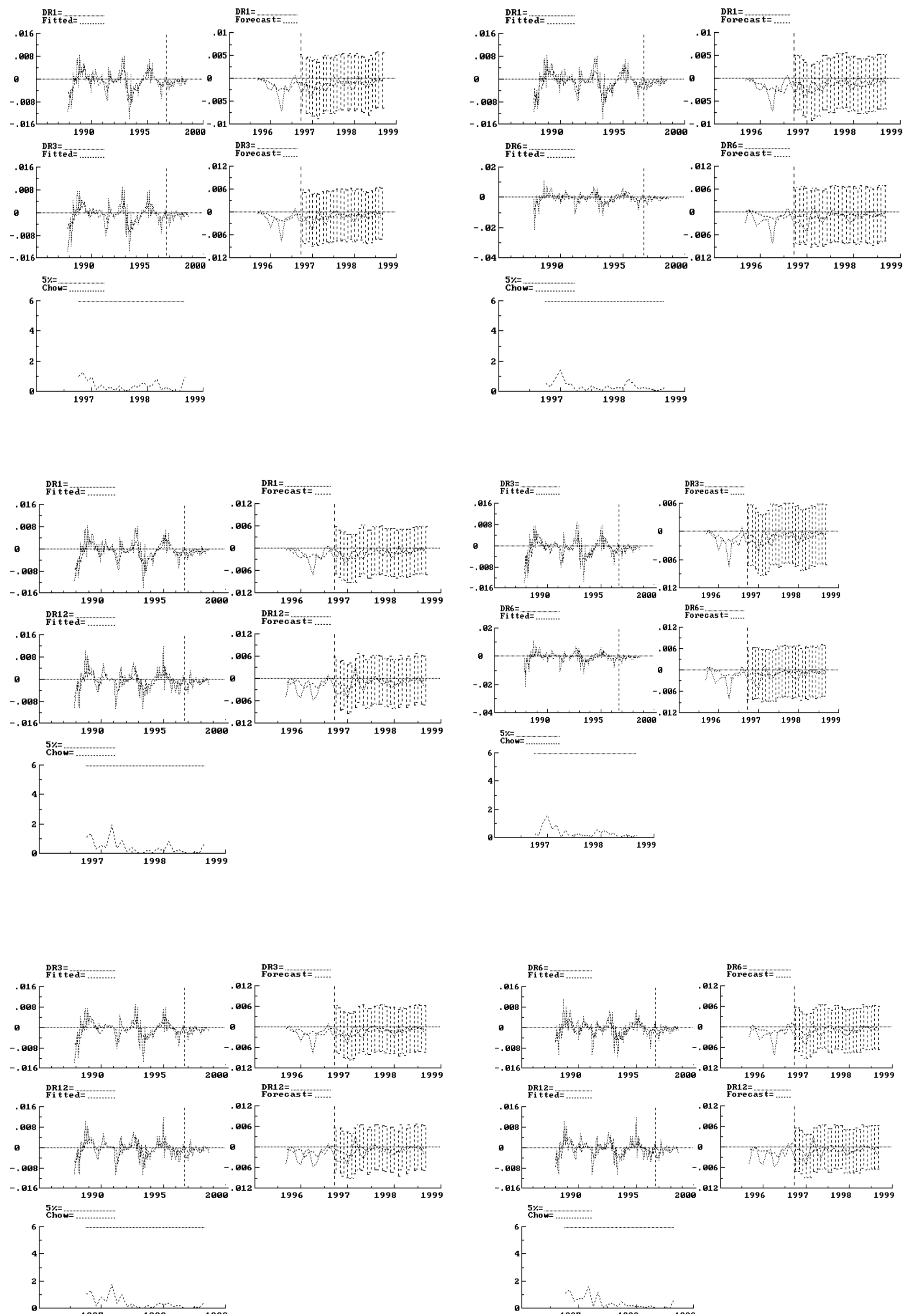
From a structural point of view, we can say that the models are stable. These are the results from the recursive Chow test reported in Figure 4. The residuals of the equations are not autocorrelated, but they do not follow a normal distribution. Besides this circumstance, we could deem the models as relevant in the sense argued by Gonzalo (1994). This argument lies on the empirical fact that Johansen's cointegration method does not give worse results than using other methods and is a robust estimation even when the errors are non-normal.

Figure 4.- Recursive "Chow" test for reduced form VECM. Here we follow the same sequence as in systems reported from Table 4.A until Table 4.F.



On these bases, we trusted our models and set a 24-month 1-step forecast, as is plotted in Figure 5. For all models, we obtained parameter constancy and the forecast lay within their two standard deviation spectrum. In all cases, our models provided very well fitted forecasts that reinforced our results in favour of the EH.

Figure 5.- 1-step forecasts for the equations of the VECM (as in Tables 4ª-4F)and parameter constancy tests



5.- CONCLUSIONS.

Our study reports on cointegration testing of the Expectations Hypothesis (EH) of the term structure of interest rates. We have worked with series of monthly data on interest rates for 1, 3, 6 and 12-month maturity of the Spanish *Letras del Tesoro*. These assets provided us with an appropriate set of data to test the EH because we were dealing with the observed TSIR and we did not have to estimate it as we should have to do if we were dealing with coupon-paying bonds. Furthermore, the period of study, from July 1987 to September 1998, is homogeneous enough to be considered stable from the point of view of the monetary regime carried out by the Bank of Spain.

We have tested the cointegration implications of the EH. Our results were that the applied unit root tests allowed us not to reject that interest rates are I(1) variables. This was confirmed by applying the so-called Johansen's maximum likelihood method in VAR systems. We found that, in all cases, we have *n-1* I(0) cointegrating vectors. Thus, we could accept that the necessary condition of the EH holds. In the spread models, we found complete empirical evidence which supported the EH in all cases. In the β matrix, which defines the structure of the cointegrating vectors, practically all of the homogeneity tests proved that we could not reject the hypothesis of the interest rates cointegrating in their correspondent spreads with the unity as parameter value. In the α matrix, which represents the rhythm of the adjustment of the long-run cointegration relationship, the exogeneity tests allowed us to conclude that, for all cases, the spreads entered in a cointegrated VAR of interest rates. This was all confirmed in the VEC models in which we can say that the spreads were significant and that they caused (in Granger's sense) the changes in the shorter-term interest rates. That is, the spreads can be a realistic measure of the anticipated changes in the shorter-term LT rates and represent the expectations of the market participants.

The empirical evidence obtained by our analysis of the spread seems to be a common feature of some studies, such as the ones by T. Engsted and C. Tangaard (1994), and E. Dominguez and A. Novales (1998). Nevertheless, the results of most of these studies are not entirely conclusive in favour of the EH. The reason for this finding comes from the empirical fact that the sample periods and the monetary policy regimes of the countries used in the different studies produce heterogeneous results. As it has been discussed in the Introduction section, the EH usually holds during periods of stability in the applied monetary policy.

With the tests applied here, we have confirmed the stability and significance of the parameters of our models in the whole sample period. We provide well-fitted models and satisfactory forecasts, which match accurately enough the real ex-post observed data. The changes in short-term rates are implied by the spread, or yield slope, between shorter and longer-term rates. The rhythm of adjustment is slower with the cointegrating spreads of the longer gap. In recent years, the monitoring of the yield slope has become a very important indicator of monetary policy. In that sense, our results here, in favour of the EH, have the notable implication of providing empirical evidence that can be interpreted as showing that the expectations of the market participants and monetary policy follow the same trend.

As Estrella and Mishkin (1997) point out, the credibility of the monetary policy is reflected in the TSIR. When the market believes the monetary strategy, an increase in Central Bank rates tends to flatten the yield curve. As it has been discussed in our research, the EH is more likely to hold under a stable monetary regime. In that case, the fixed income securities portfolio managers can estimate that the risk premium is negligible. At least in assets of less than one-year maturity. Generally, it is admitted that the monetary transmission channel ensures a stable relationship between the target interest rate and the interest rates of the Treasury bills. Thus, we conclude that the Spanish Treasury bills, whose TSIR has been analysed here, have played a very relevant role in giving stability and reinforcing the monetary transmission mechanism of the monetary policy, which has been applied in Spain throughout the process of convergence of the European financial systems in order to achieve integration in the EMU.

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A) DATA.

The time series are monthly data starting in July 1987 and finishing in September 1998.

R1, R3, R6 and *R12* are respectively the one, three, six and twelve-months rates to maturity of the Spanish Treasury bills, “Letras del Tesoro” (LT). They have been taken from the Economics Bulletin of the Bank of Spain. They have been published as monthly average rates traded between the members of the market (“Mercado de deuda del Estado anotada”). Data series are reported in chart 55 of the Bulletin (“Tipos de interés: mercados de valores a corto plazo”).

The *spreads* have been calculated from each pair of spot interest rates by taking the difference between the one of longer maturity and the one of shorter maturity.