A Regime Switching Examination of the Gilt-Equity Yield Ratio

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Abstract

A crucial issue for financial markets valuation is the interrelationship between the balance sheet figures in stock markets and economic conditions. In this framework empirical research has concentrated on the derivation of the aggregate fair values in stock markets through the examination of the equilibrium relationship between bonds, stocks and dividends. In this paper we contribute to the aforementioned literature by examining the issue of the Bond Equity Yield Ratio (BEYR) for UK markets by lifting the restriction of linearity in the long run cointegration relations and the underlying VECM. Specifically we apply the regime switching framework of Gregory and Hansen (1996) for the long-run equilibriums and the one of Krolzig (1997) for the short run, examining the allocation of capital among the UK bond and stock market for the period of 1987:1-2007:1. Our findings confirm the substitution effect among stocks and bonds in the long run and highlight the importance of market conditions for the allocation of capital among stocks and bonds.

Keywords: Bond equity-yield ratio, dividend yield, regime switches, cointegration.

JEL Classifications: G12, G14, G15.

1. Introduction

The aim of this paper is to investigate the relationships between stock index prices, dividends and interest rates. Specifically empirical and theoretical literature on stocks' prices valuation always incorporates, directly or indirectly, a substitution effect among stocks and bonds, standing as the assets compensating for different states of the market. The examination of the relationship between stock prices, dividends and government bond yields has occupied the researchers over the last two decades.

It is worth noting that British academics concentrate the majority of studies in this field. The model proposed by the British academics is the so-called Gilt Equity Yield Ratio (GEYR)[1] and is very similar to BEYR ratio. According to Mills (1991) the GEYR ratio was very important for the market practitioners in UK in order to forecast future movement in prices. Three years later Clare *et al*. (1994) use GEYR as a guide for investment decisions and evaluate three separate trading rules over the period 1990-1993. The authors conclude that GEYR is a useful predictor of equity returns. Levin and Right (1998) extend the work of Clare *et al*. (1994) and through a wide sample of 14 years (1982-1996) find that GEYR ratio alone is not possible to provide a profitable asset allocation decision criterion. Finally Harris and Sanchez-Valle (2000) and Brooks and Persand (2001) suggest that the Gilt Equity Yield Ratio has substantial explanatory power for UK equity returns.

Giot and Petitjean (2004) use the Bond Equity Yield Ratio in order to investigate the long term relationship between stock index prices, dividends and bond yields. By using an extensive sample of seven countries (Germany, Belgium, France, Japan, The Netherlands, the UK and the US) for the time period 1973-2004, the authors empirically investigate their assumptions by using first cointegration analysis and then they extend Brooks and Persand's regime switching approach by adding another trading rule. Giot and Petitjean provide evidence that a long term cointegrating relationship exists between stock index prices, stock index earnings and government bond yields.

Special attention over the last few years has concentrated from the researchers to a similar with BEYR valuation method, the so-called Fed-model. The Fed-model

[1] Gilt Equity Yield Ratio is defined as the ratio of the coupon yield on long-term UK government bonds to the dividend yield on the stock index.

assesses stock markets by comparing stock and bond yields. According to this model, the stock market's earnings yield should be compared to 10-year government bond yield. If earnings yield exceeds bond yield then stocks are cheap. In contrast when 10-year government bond yield exceeds earnings yield, stocks are expensive. The only difference between BEYR and Fed-model is that in BEYR framework researchers use dividends and in the Fed-model they use the anticipated earnings.

The organization of this paper is as follows. Sections 2 and 3 present the theoretical and methodological frameworks respectively and in section 4 we present the empirical results. Finally section 5 concludes the paper.

2. Theoretical Background

To this end we use a modern valuation ratio: the Bond Equity Yield Ratio (BEYR). BEYR is defined as the ratio of the coupon yield on long government bonds to the dividend yields. Financial literature indicates that there is a strong relationship between stock prices, dividends and interest rates. A simple explanation for this conclusion is the dividend discount model developed by Gordon (1962). According to this model the fundamental stock price of a given company is:

$$P_0 = \frac{D_{t+1}}{k_e - g} = \frac{kE_{t+1}}{r_f + \pi - g} \tag{1}$$

Where D_{t+1} is the expected dividend for the following year, k is the payout ratio, E_{t+1} is the expected earnings, k_e is the cost of equity, g is the growth rate for dividends, π is the risk premium and r_f is the risk free rate.

From the above model one can realize the obvious relationship between stock prices and bond yields. More specifically, because the cost of equity k_e depends on the prevailing interest rates, falling bond yields lead to higher stock prices. Additional to that, Durre and Giot (2005) support the notion "that except the pure mechanical relationship implied by the equation (1), market participants constantly arbitrage the stock and bond markets". The authors strongly believe that there is a substitution effect between stocks and bonds and the basis for this substitution effect is the relationship of the dividend yield to the bong yield.

In order to avoid theoretical maneuvers around equation 1, aiming to state the relation between stocks and bonds, we proceed to some transformations of the initial relation. Specifically just taking the logarithms of the right hand side of equation (1), results to the relation under investigation in the empirical literature of BEYR:

$$\log(D_{t+1}) - \log(r_f + \pi - g) = d_{t+1} - [\log(r_f) + \log(C)] \cong d - r - c \qquad (2)$$

Where, r stands for the log of the discount factor of equation 1 and d for the dividend yield. As is illustrated, r, is formulated by the risk free incorporated in government bonds, and some constant factor c, capturing the premium investors pay to balance risk while they are compensated for the growth of the dividends paid for the share. In order to formulate the investigation framework for our analysis we rely upon the examination of stationarity characteristics of relation (2). Specifically we examine the hypothesis the bond yields and stocks' dividend yields to be cointegrated, resulting to stationary differentials, while allowing for a constant factor to capture risk premiums and other factors.

$$[(d - r) + c] \sim N(0 \quad , \quad \sigma) \qquad (3)$$

However the risk premium investors pay for allocating capital between government bonds and stocks is not constant over time and varies with economic and financial market conditions. Similar time-varying features are found to characterize the dividend policies of the companies listed in a stock exchange. Of course idiosyncratic factors, for both roots of non-linearties, are aggregated in case one examines stock market indices' figures, resulting only to systemic factors altering the dividend yield policy and the variation of risk of listed companies, an effect resulting to the smoothening of the respective variations. As a result, it is rational to expect that the underlying relation incorporated in the BEYR, will not stay constant for the whole of the sample examined, especially in case the investigated period contains more than one market states.

In this framework the regime switching econometric methodology, first formulated by Hamilton (1989), is valuable in revealing economic relations that do not stay permanently in their initial state. This methodology, further enhanced by Gregory and Hansen (1996) for cointegrating relations and Krolzig (1997) for the VECM, permits one to examine the underlying relations in a non-linear fashion. Following the aforementioned econometric papers, the present analysis incorporates non-linear methodology in examining both the long-run equilibrium relation and the short-run adjustment mechanism of the relation among bonds and stocks. Our results indicate that significant effects are exercised by markets' conditions on the investment decision of capital allocation among alternative investments.

3. Data and Methodology

The data set we use contains yields of the benchmark UK government bonds (Gilts) with a term to maturity of ten years and dividend yields of the FTSE for the respective stock market index. The period we examine begins in 1987:1 and ends in 2007:1 containing 240 monthly observations for each series. The specific period was chosen in order to examine in depth the alterations brought about by the different market conditions experienced during the twenty years of our sample, containing major crises such as the 'Black Monday', the stirling devaluation, the LTCM, the Russian crisis and the dot-com bubble. As a result, it provides a basis for investigation of the effects the changing market conditions have on the examined relation between stocks and bonds through the BEYR.

In order to investigate the existence of significant interactions among the bond yields and the stock market's dividend yields, we apply cointegration analysis in order to estimate the formulation of stationary long run equilibrium relation and the resulting VECM in order to approach the short run adjustments. Additionally, in both the long-run and the short-run structures, we take into account the regime switching properties of the underlying relations. Relation (3) is investigated, thus, by applying, initially, Johansen's (1988, 1992) cointegration analysis for I(1) series. Relation (4) illustrates the general cointegration analysis model.

$$\begin{aligned} &\Delta X_t = c_0 + \Pi \ X_{t-1} + \sum_{j=1}^{n} \sum_{l=1}^{k-1} \Gamma_{j_i} \Delta X_{j\,t-l} + U_t, \\ &U_t \sim NID\ (0, \Sigma) \end{aligned} \tag{4}$$

Specifically, $c_0 = \Pi\mu$ while the formulation $\Pi = a\beta'$ stands for the cointegration vectors containing the equilibrium relations of the underlying variables. Initially we test for the existence of stationary equilibrium relations by applying Johansen's cointegration rank tests λ_{trace} and $\lambda_{\max}$ (for a more detailed analysis of the cointegration rank tests see Johansen 1988 and Johansen and Juselius 1992). The coefficients β represent the composition of the long-run structure of the cointegration vectors while a reports the adjustment coefficients to the long run relations. In order to trace the formulation of the long-run cointegration relations we impose structural hypotheses in the long run coefficients following the theoretically imposed relation between stocks and bonds. Additionally the revealing of the long run structure permits the investigation of the short run relations incorporated in the coefficients of the lagged variables and the error correction mechanism.

Following Gregory and Hansen (1996), we adopt examine the possibility of structural breaks altering the initial cointegration tests' results. The authors argue that should a structural break be evident in the data in some time during the sample period, this could result in rejection of the cointegration hypothesis, although the series could be cointegrated prior or posterior to the structural break. As a result one endangers rejecting a true hypothesis should no structural break methodology be applied. As a result we employ the structural methodology introduced by Gregory and Hansen (1996) to account for structural breaks in the cointegration vectors. The representation of their methodological framework is given by relation (5) below.

$$F_{10y,t} = c_1 + c_2 v_{t\tau} + \alpha_{1_1} v_{2t} + \alpha_2 s_{10y,t} v_{t\tau} + e_t \qquad (5)$$

Specifically according to Gregory and Hansen's (1996) formulation, in cointegrating relations of two series potential regime switching properties (captured by the unobserved variable ν) could be adequately explained as stemming from the constant factor (c), the trend (a) of the series or a full structural break of the system (both c and a) as illustrated by equation (5). Gregory and Hansen (1996) use the Philipps and Perron's Z statistic for the residual of the earlier relation's regression, in order to specify regime shifts. They state that in case cointegration for the underlying time span is rejected by the (non-) stationarity tests of Dickey and Fuller, the structural break characteristics of the system should be examined in order to reevaluate the initial results of the cointegration tests. However even if cointegration is evident (through e.g. Johansen rank tests) according to Trenkler (2005) and Lütkepohl, Saikkonen and Trenkler (2004) the structural stability of the vectors should be examined in order for the VECM relations to be reported in a robust way.

Finally after having specified the long run structure for the whole sample and its sub-samples, we examine the short run effects among the bond and stock dividend yields. In this respect, the second contribution of the present paper is that we allow for the short-run dynamics to follow non-linear formulation. Specifically following Krolzig's (1997) methodological framework incorporating Markov Switching effects in VARs and VECMs we estimate the following relation(s) for the shot run:

$$\begin{aligned} &\Delta X_t = c_0 + \sum_{r=1}^{n-p} \alpha_r(s) VEC_{r\,t-1} + \sum_{j=1}^{n} \sum_{i=1}^{k-1} \Gamma(s)_{ji} \Delta X_{j\,t-i} + U_t, \\ &t = 1, 2, \ldots, T \\ &U_t \sim NID\ (0, \Sigma(s)) \end{aligned} \tag{6}$$

$$\begin{aligned} &P = \begin{bmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{bmatrix} \\ &p_{11} = \Pr ob[s_t = 0 | s_{t-1} = 0] = p \qquad p_{12} = \Pr ob[s_t = 0 | s_{t-1} = 1] = 1 - p, \\ &p_{21} = \Pr ob[s_t = 1 | s_{t-1} = 0] = 1 - q \qquad p_{22} = \Pr ob[s_t = 1 | s_{t-1} = 1] = q \end{aligned} \tag{7}$$

Modifying relation (4) by introducing a state dependent variable, we get (6) which represents the MS-VECM formulation through which we specify the lead-lag effects between the futures and spot bond yields and the adjustment to the long-run equilibrium relations in a non-linear framework. Specifically the coefficients *a* represent the adjustment coefficients of the cointegrating vectors, estimated on the basis of the specification of the long-run relations according to the long-run structure decomposition, while the vector Γ represents the lagged values of the underlying variables. The difference from the standard VECM variable lies on the inclusion of the unobserved state variable *s*, which captures the regime switching mechanism in the underlying short run relations. Specifically $s \in \{0,1\}$, while the state in which the model's formulation belongs, follows the stochastic Markov chain process. Following Krolzig (1997) by applying Hamilton's (1989) EM algorithm, it is possible to specify the state the model belongs to, according to the matrix of transitional probabilities given in (7).

4. Empirical Results

Initially we examine the cointegration properties among the UK FTSE dividend yields and the yields of Gilts. Specifically, as argued in the previous section, the significance of the relation between the stock fundamentals from the side of dividends and the cost of capital, captured through the long term rate, would indicate rational pricing of the stock market if the two series were indicated to formulate a stationary long run relation. As a result we run Johansen's rank tests to trace cointegration relations among *d* and *r*. Table 1 reports the respective results.

Table 1: Cointegration Tests (1987:1-2007:1)

	$\lambda_{\max}$		λ_{trace}	
$\mathrm{H}_0 : p - r = 2$	10.32	15.88*	13.03	20.25*
$\mathrm{H}_0 : p - r = 1$	2.71	9.17*	2.71	9.17*
* 95% Critical Values from McKinnon et al. (1999)				

The results from both the λ_{trace} and the $\lambda_{\max}$ tests indicate that for the whole sample there exists no cointegration relation among the dividend and the Gilt yields. This result would stand as an adequate finding to reject the Bond-Equity Yield relation and thus state that the pricing of the UK stock exchange is not in line either with theory or with fundamentals. However, as stated in Gregory and Hansen (1996), the examination of cointegration, can be biased in case a structural break is present in the period examined rejecting, thus, the cointegration hypothesis instead of accepting it. As a consequence, in order to robustly state that there exist no cointegration relation, one need to examine the structural stability of the system, as described in the methodological section, through Gregory and Hansen's (1996) structural break cointegration test. In order to do so we run the tests and should a break be confirmed we divide the sample period and run again the test for the two sub-periods. This procedure is repeated until either no break is revealed or not enough data are left in the remaining period. The results of the G-H test are presented in Table 2, below.

Table 2: G-H Tests for Cointegration With Structural Breaks

Period	*Z-Statistic*
1987:1 – 2007:1	-6.320** (1990:6)
1987:1 – 1990:6	-2.150 (1990:3)
1990:6 – 2007:1	-6.188** (1998:6)
1998:6 – 2007:1	-5.525* (1998:10)
Critical Values: 1% -5.97 and 5% -5.50, ** significance in a 1% c.l., * significance in 5% c.l.	

As can be seen from the results of the Gregory Hansen's tests for cointegration with structural breaks, there exist three significant breaks in the sample but only two can be stated as unambiguous. Specifically the full sample is divided in three sub-periods, namely 1987:1-1990:6, 1990:6-1998:6 and 1998:6-2007:1. This result indicates that significant alterations are evident between the three periods in line with rationality, as the long run relation between stocks and bonds is expected to vary in line with market conditions. Specifically the initial turbulent 90's are indicated to stand as a quite different case compared with the prior and posterior periods. In order to obtain a more in depth view on the structure of the relation, cointegration relations are again tested for the specified sub-periods. Table 3 contains the respective Johansen's cointegration tests.

Table 3: Cointegration Tests (sub-periods)

	$\lambda_{\max}$	λ_{trace}
1987:1 – 1990:6		
$\mathrm{H}_0 : p - r = 2$	8.48	10.97
$\mathrm{H}_0 : p - r = 1$	2.49	2.49
1990:6 – 1998:6		
$\mathrm{H}_0 : p - r = 2$	18.43*	22.45*
$\mathrm{H}_0 : p - r = 1$	4.01	4.01
1998:6 – 2007:1		
$\mathrm{H}_0 : p - r = 2$	20.24*	22.63*
$\mathrm{H}_0 : p - r = 1$	2.39	2.39

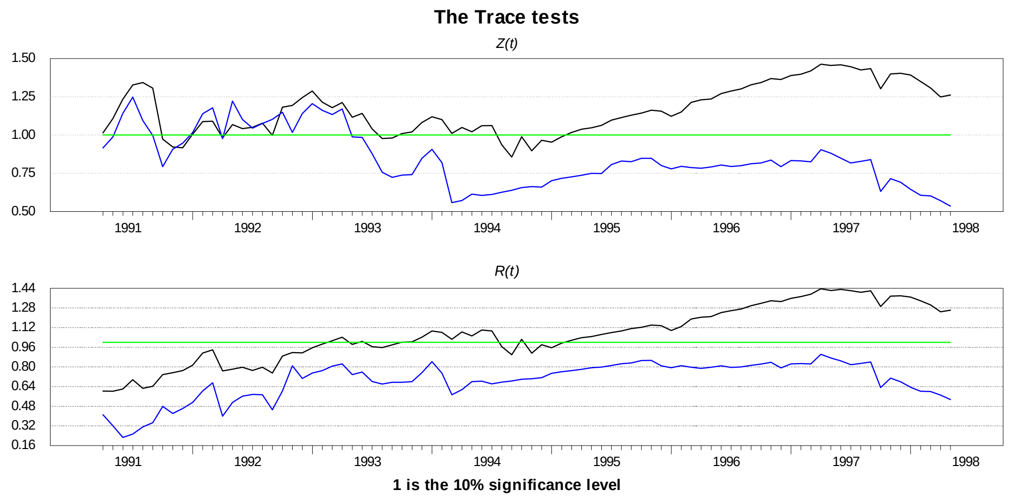
* Denotes significance in a 95% confidence interval according to critical values from McKinnon et al. (1999) and Osterwald-Lennum (1992).

The results of the cointegration tests for the sub-periods indicated by G-H tests are substantially different compared to the initial ones for the whole period. Specifically apart from the first period (1987:1 – 1990:6), the rest of the sample confirms the existence of stationary long run equilibrium relations among the UK dividend and bond yields. As a result, two main effects should be highlighted in this point. Fist that there exist significant alterations in the underlying relations between bonds and dividends, thus accepting or rejecting the efficient pricing by markets, according to theory, among different periods. Additionally the long run relations are revealed only under the condition that the structural break effects are taken into consideration. Specifically, while the initial cointegration tests failed to highlight evidence of cointegration, when structural differentiations in the underlying sample are taken into consideration, the cointegration tests indicate existence of significant long run equilibrium relations between the stock dividend yields and bond yields in line with BEYR theory. This result indicates that the stock market pricing largely encompasses the investors' perception on the earnings' growth prospects, in line with relation (1).

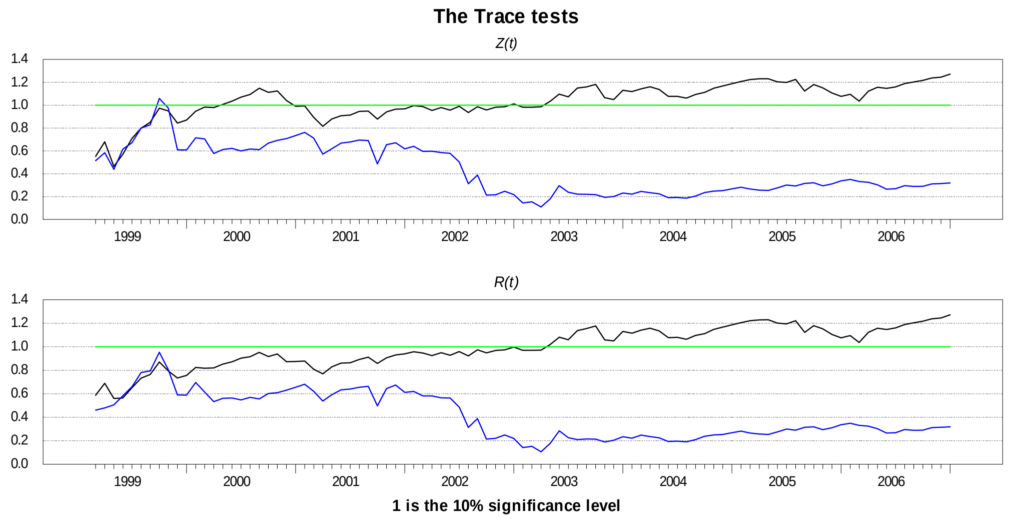
Finally the recursive estimation of the cointegration relations (Hansen and Johansen 1999) presented in Figure 1, confirm the stability of the cointegration vectors specified for each if the two sub-periods for which cointegration is accepted. Specifically in both cases the cointegration relations exceed the threshold, indicated by the straight line at the value of 1.

Figure 1: Recursively Estimated Trace Tests

1990:6 – 1998:6



1998:6 – 2007:1



However further investigation of the long run structure and its impact on the adjustment mechanism supplements the analysis and illustrates the significance of the long run structure (and thus the GEYR) for the pricing process. Table 4 contains the decomposition of the long run relations, as formulated by testing the restrictions imposed in the cointegration vector. The structure of the cointegration space is important in order to determine the significance of the adjustment coefficients, extracting results on the short run effects of the GEYR. Indicatively in the first period (1990-1998) the relation between the dividends and the bond yields, was formulated in a close fashion as the (1 -1 *c*) structure is confirmed, illustrating that the dividend yield tends to follow closely the pattern of bond yields with some premium (of around 67 basis points), indicating the alternative character of the two investment choices. However, in the last sub-period, the positive relation between the long run coefficients indicates that investors may follow strategies that do not take bonds and stocks as alternatives but as complements of their portfolio. This result is in line with reported literature that highlights the dynamic characteristics of the stock-bonds correlation. Additionally the last sub-period is related, in a great extent, with rising stock market conditions, indicating a divergence of the pricing of stocks and bonds.

Table 4: Johansen's Cointegration Tests for the Sub-Periods

Sub-Period	β_d	β_G	c	$(\beta_d \quad \beta_G \quad c)$*
1990:6 – 1998:6	-1	1	-0.673	0.00 (0.95)
1998:6– 2007:6	0.321	1	-1.900	0.00 (1.00)

* X^2 tests for the structure of the cointegration space, p-values in parentheses

Finally we examine the short run adjustment dynamics and interactions among the dividend yield and bond yields. Following Krolzig (1997), we again apply structural methodology, referring to the use of MS-VECM. Table 5 contains the results of the tests (LR and AIC) comparing the linear against the alternative Markov Switching formulation of the VECM.

Table 5: Tests of the Regime Switching Mechanism

1990:6 – 1998:6		
	Linear System	MS-VECM
AIC	-7.501	-7.609
Linearity LR Test	36.375 [0.000]	
1998:6 – 2007:1		
	Linear System	MS-VECM
AIC	-6.595	-6.637
Linearity LR Test	30.311 [0.001]	

Note: p-values in brackets

As exhibited in table 5, the linear decomposition of the short run structure is rejected while simultaneously the regime switching formulation is indicated to add informational efficiency in the system of interactions. Consequently, the MS-VECM formulation is indicated to be more efficient in the illustration of the underlying relations among the dividend and the bond yields, for the short run. Accordingly we adopt this formulation in examining the system's short run structure and Table 6 presents the transition matrix of the probabilities p_{ij} while Figure 2 illustrates the probabilistic characterisation of the respective periods' observations, according to the dominating regime.

Table 6: The Transition Probabilities Matrices

1990:6 – 1998:6		
	Regime 1	Regime 2
Regime 1	0.935	0.064
Regime 2	0.336	0.664
1998:6 – 2007:1		
	Regime 1	Regime 2
Regime 1	0.863	0.137
Regime 2	0.999	0.000

Figure 2: Probabilities of Regimes

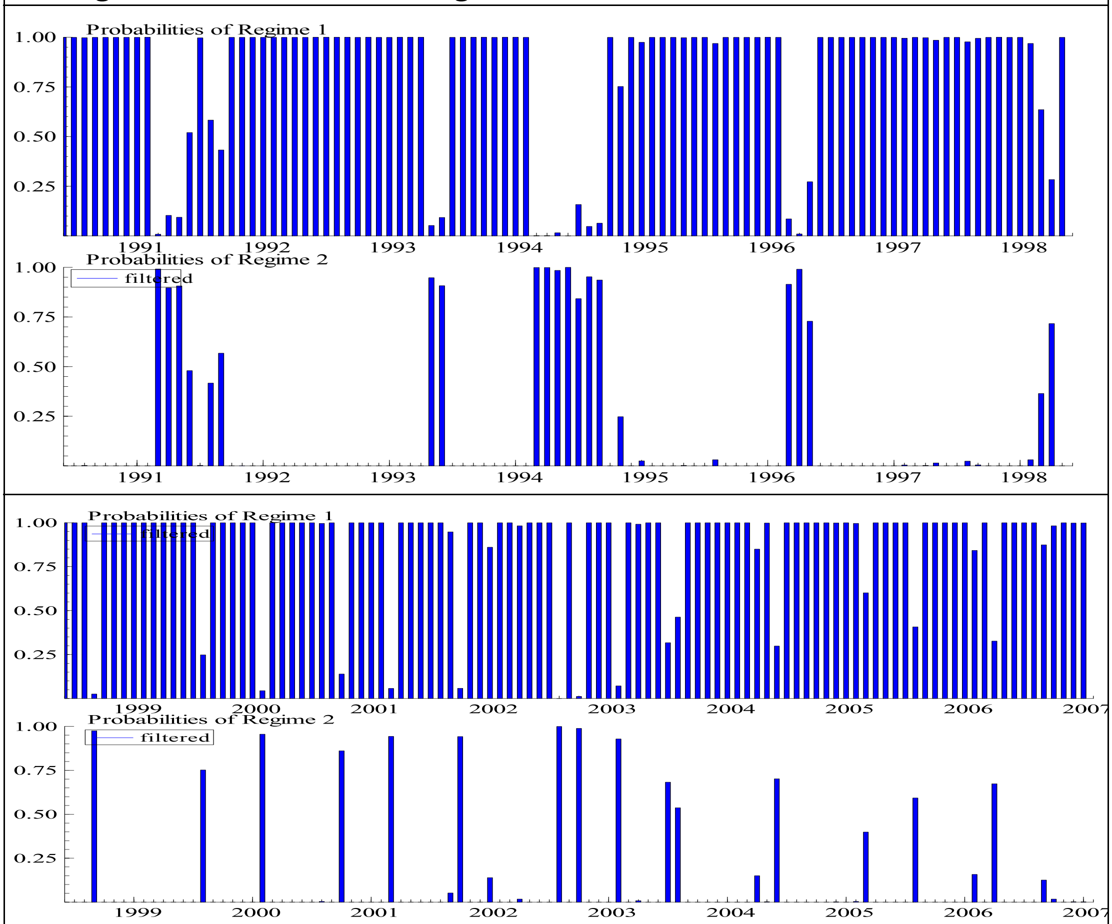


Table 7: The MS-VECM				
	Regime 1		Regime 2	
	d	*r*	*d*	*r*
1990:6 – 1998:6				
d(-1)	-	0.316 (2.238)	-	-
r(-1)	-0.437 (-2.545)	-0.494 (-3.046)	0.892 (4.209)	-
ECM	-0.173 (-2.711)	-	-	0.516 (2.858)
1998:6 – 2007:1				
d(-1)	-	-	-	-
r(-1)	-	-	-0.920 (-4.246)	1.048 (7.568)
ECM	-	0.132 (2.253)	-0.483 -6.650)	0.304 (7.935)

The results of the investigation of the short-run structure, indicates that the underlying variables are not always affected significantly by the long run equilibrium formulated between the dividend and the bond yield. In the first period (1990:6-1998:6) the regime switching mechanism differentiation is twofold. First, the error correction mechanism exercises significant effects on the dividend yield, in the first regime and on the bond yield in the supplementary regime. Thus it indicates that adjustment towards the long run equilibrium is time varying according to the prevailing structure. Additionally there exist significant interactions in the first regime between the system's variables, while in the second regime the bond yield significantly affects the dividend yield. In the second period the error correction mechanism is significant for the bond yield in both regimes, indicating that the respective variable significantly adjust throughout the whole period, while the dividend yield adjusts only under the second regime's formulation. In the same regime the effects of the bond yield are indicated to be significant for the dividend yield, while the latter does not affect the bond yield.

5. Conclusion

In the present paper we have illustrated the significant relation between the bond and the dividend yields, using data for the UK stock and bond market. Our results lie on the side of accepting the close relation, formulated by the BEYR. However structural methodology used has provided the efficient platform for this investigation, as the initial results with typical cointegration tests, are indicated to be significantly different when structural breaks, indicate by Gregory and Hansen (1996) tests, are taken into account. Overall the results of our analysis support the theoretical foundations of BEYR both for the long run and the short run structure.

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