ISCTE Business School
Instituto Universitário de Lisboa

COINTEGRATION ANALYSIS – GILT-EQUITY YIELD RATIO IN *PIGS* AND GERMANY
(econometric study using VAR/VECM methodologies)

Mónica Filipa Moreira da Silva

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Supervisor:
Prof. José Dias Curto, ISCTE Business School, Departamento de Métodos Quantitativos

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Resumo

The Gilt-Equity Yield Ratio (GEYR) tem-se mostrado uma ferramenta importante para os analistas de mercados na tomada de decisão, quanto à compra e venda de ações *vs* obrigações, mostrando-se um rácio sensível a situações de *mispring*. Deste modo, o objectivo do estudo, passa pela análise da existência de cointegração do GEYR entre os PIGS e a Alemanha, averiguando se resultados estão condicionados pela situação económica de cada país.

O estudo apresenta duas metodologias para o cálculo do rácio: a primeira utiliza como denominador do rácio o *dividend yield índex* e a segunda utiliza os *earnings yield índex*. Utilizando como numerador comum *bond yield.* Para o período em análise, constatou-se que a estratégia predominante nas duas metodologias é "comprar ações".

Considerando a primeira metodologia de cálculo do rácio, foi verificada a existência de cointegração do GEYR entre os países Portugal, Irlanda, Grécia, e Espanha. De acordo com a segunda metodologia a hipótese de cointegração do GEYR não é constatada para nenhum dos países. Concluindo-se que para esta metodologia de cálculo, a análise da relação do GEYR entre os países não é útil para uma tomada de decisão. Por sua vez, a Alemanha não está cointegrada (em ambas as metodologias) com nenhum dos PIGS, indicando-nos que o rácio não se mostrou uma boa ferramenta para analisar países com situações económicas diferentes.

A causalidade de Granger é também testada para as séries estacionárias em nível, (as quais se verificam apenas na segunda metodologia) concluindo-se, deste modo, não existir relação de causalidade entre as séries.

Palavras-chave: Rácio "Gilt-Equity Yield", regras de decisão, não estacionariedade, cointegração, Modelo Vetorial de Correção de Erros.

JEL Sistema de Classificação:

C32 - Time-Series Models; Dynamic Quantile Regressions; Dynamic Treatment Effect Models;
G01 - Financial Crises;
G11 - Portfolio Choice; Investment Decisions

Abstract

The Gilt-Equity Yield Ratio (GEYR) has been displayed as an important tool for market analysts on decision making as to the buy and sell of equities *vs*. bonds, being a sensitive ratio to "mispricing" situations. Therefore, the goal of this study is to check the existence of cointegration of the GEYR between PIGS and Germany, by examining whether the results are conditioned by the economic situation of each country.

This study shows two methodologies for the computation of the ratio: the first uses as ratio denominator the dividend yield index and the second uses the earnings yield index. We use as the common numerator the bond yield. It is eminent that the predominant strategy in both methodologies is to "buy equities".

Considering the first methodology of the ratio computation, the existence of cointegration of the GEYR between Portugal, Ireland, Greece and Spain was verified. In conclusion, according to the second methodology, the cointegration hypothesis of the GEYR is not found in any of the countries, inferring that the GEYR comparison between countries is not useful for decision making. On the other hand, Germany is not cointegrated (in both methodologies) with any country of PIGS and that indicates that the ratio did not present to be a good indicator to analyze countries with different economic situations.

The Granger causality is also tested to the stationary series in level (which are only verified in the second methodology), concluding that there is no causality relationship between them.

Keywords: Gilt-Equity Yield Ratio, trading rule, nonstationarity, cointegration, VECM.

JEL Classification System:

C32 - Time-Series Models; Dynamic Quantile Regressions; Dynamic Treatment Effect Models;
G01 - Financial Crises;
G11 - Portfolio Choice; Investment Decisions

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Basic Notation

ADF	Augmented Dickey-Fuller (unit root test)
AEG	Aumented Engle-Granger
AIC	Akaike's information criterion
AR	Autoregressive
BEYR	Bond-Equity Yield Ratio
Cov	Covariance
DF	Dickey-Fuller
DPS	Dividends per stock
DSP	Difference Stationary Process
DW	Durbin Watson
ECM	Error Correction Model
EG	Engle-Granger
EPS	earnings per stock
GEYR	Gilt-Equity Yield Ratio
KPSS	Kwiatkowski, Phillips, Schmidt and Shin (test)
L	Lag operator
N(μ, σ2)	Univariate normal distribution with expected value μ and variance σ2
OLS	Ordinary Least Square
PP	Phillips-Perron (unit root test)
PIGS	Portugal, Ireland, Greece and Spain
R2	Coeficiente de determinação
SIC	Schwartz information criterion
TSP	Trend Stationary Process
VAR	Vector Autoregressive
Var	Variance
VECM	Vector Error Correction Model
WN	White noise

1. Sumário Executivo

É evidente o crescente desenvolvimento de análises relacionadas com mercados financeiros, principalmente na vertente do mercado bolsista. A procura por indicadores sinalizadores de estratégias eficientes do mercado é cada vez mais notória, levando a uma necessidade sistemática de desenvolvimento de investigação nesta área. Os mercados bolsistas são de extrema importância para as economias, uma vez que são uma das principais formas de financiamento das empresas, permitindo assim a expansão dos seus negócios. Esta vantagem aparece associada à liquidez das ações, passíveis de aquisição e de venda frequente, oferecendo uma liquidez superior a outros investimentos como o imobiliário ou arte. A evolução do mercado de ações é representativa da dinâmica de uma economia, e normalmente, o crescimento dos mercados acionistas, está associado ao aumento do investimento empresarial e da confiança dos consumidores.

Tendo em conta a importância deste tipo de mercados, sentiu-se a necessidade de estudar um rácio que permitisse relacionar os rendimentos do investimento em obrigações e ações - o chamado Gilt–Equity Yield Ratio (GEYR), visando perceber os movimentos dos mercados e quais as suas tendências de investimento, se preferencialmente ações ou pelo contrário, obrigações. A componente diferenciadora desta dissertação, evidencia-se perante a carência de estudos, que simultaneamente analisem o rácio e investiguem a existência de cointegração do GEYR entre países.

Deste modo, testa-se a existência de uma relação de equilíbrio de longo prazo do GEYR para os países Portugal, Irlanda, Grécia, Espanha (PIGS) e Alemanha, considerando-se duas metodologias de cálculo. A primeira consiste no rácio entre *bond yield* e *dividend yield índex* e a segunda considera o rácio entre *bond yield* e *earnings yield index.* Toda a informação necessária para o seu cálculo foi retirada dos índices bolsistas de cada um dos países em estudo. Os resultados obtidos para o cálculo do rácio indicam, que para o período em análise (períodos trimestrais de 1997 a 2012) a estratégia predominante em ambas as metodologias para a generalidade dos países é "*buy equities".* Visando mostrar que as ações dos índices representativos de cada país estão subavaliadas.

Para a primeira metodologia, os testes de análise de raízes unitárias/estacionariedade ADF, KPSS e PP, evidenciam a não estacionariedade do GEYR para todos os países, na segunda metodologia verifica-se a estacionariedade do GEYR para Portugal, Irlanda e Grécia.

A aplicação do teste de cointegração de Johansen e, posteriormente a aplicação do modelo vetor de correção de erro (VECM), aplicado às séries que se evidenciaram cointegradas, indica-nos que efetivamente existe cointegração entre as séries, apenas na a primeira metodologia de cálculo abordada. De acordo com uma análise bivariada verifica-se que o GEYR de Portugal (variável dependente) está cointegrado com o GEYR da Irlanda assim como com a Grécia e o GEYR da Grécia (variável dependente) está cointegrado com o GEYR de Portugal assim como com a Espanha. Outra análise interessante é que a cointegração também é verificada entre o GEYR de Espanha (variável dependente) e o GEYR de Portugal. Contudo, quando consideramos o GEYR de Portugal como a variável dependente, através da análise do teste VECM, verifica-se que a estimativa do coeficiente da equação de cointegração não é estatisticamente significativa.

Na segunda metodologia, as únicas séries que se revelam não estacionárias, em nível com a mesma ordem de integração, são o GEYR da Alemanha e Espanha. Estas séries evidenciaram-se não cointegradas, sendo que, todas as regressões que se possam efetuar entre elas incorrem em relações espúrias, isto é, relações sem sentido, não proporcionando ao investidor uma análise eficiente.

A aplicação dos testes de causalidade de Granger às séries estacionárias em nível, (na segunda metodologia) para Portugal, Grécia e Irlanda indicam que, efetivamente, não se verifica uma relação de causalidade. Assim sendo, não faz sentido procedermos à estimação dos coeficientes dessa regressão, através do modelo vetor autoregressivo (modelo VAR). Não existindo uma dependência de curto prazo entre as variáveis, o investidor também não deve considerar uma análise sincrónica deste rácio entre os países mencionados.

A contribuição deste estudo para a literatura econométrica e financeira, visa evidenciar que, utilizando a segunda metodologia de cálculo, o GEYR não se revela um bom indicador para uma comparação entre os países. Uma vez que não foram encontradas evidências de uma relação de dependência tanto de curto, como de longo prazo entre as séries. Por outro lado, a primeira metodologia abordada para o cálculo do rácio revela-se bastante interessante numa análise de longo prazo, entre os países com situação económica idêntica, pois a evidência de cointegração é notória. Ainda assim, salienta-se o facto da cointegração do GEYR não ser verificada em todos os países dos "PIGS". Outra conclusão evidente é que o GEYR da Alemanha nunca se mostra cointegrado com o GEYR dos denominados PIGS, devido à situação económica da Alemanha ser mais estável comparativamente à situação económica que os PIGS enfrentam.

Nesta dissertação, não foi possível o desenvolvimento do estudo das propriedades de relacionamento da cointegração, inerentes às variáveis contempladas na equação de cointegração. No entanto, num futuro estudo poderá ser bastante interessante a aplicação dos testes de exogeneidade, de assimetria e de proporcionalidade às diferentes variáveis em estudo.

2. Introduction

Since the 1990s there is a great skepticism by the academic about traditional ratios that evaluate stocks and bonds, like the traditional *dividend yield ratio* (D / P) or *price-to-earning* (P / E) ratios. Financial ratios present some limitations. In the case of the dividend yield ratio, its variation relies heavily on companies' information disclosure, thereby presenting restrictions to those who have not access to this kind of information. On the other hand, the precaution to take with earnings ratio is essentially due to the stock price which is based on numerous factors besides net income, like an industry-wide drop in revenue prospects. There are also legal actions against the company, healthy-publicized warranty claims, the existence of valuable patents and so much more.

Loss of confidence in this type of ratios is easily noticeable majorly in periods of crisis since the financial stabilization policies impacts on financial markets volatility, thereby adding uncertainty to the investments. Throughout the years it has been shown that the analysis of these ratios could not be restricted to mere historic data, because they reflect structural breaks that occur on external factors, such as political, economic and/ or financial, differing in each country coming from periods with more instability and they should be analyzed in detail and individually.

With this all said, due to that loss of confidence in traditional ratios, it was considered the need of finding a ratio that gathered financial securities – stocks and bonds – and capable of sustaining more consistently trading decisions of the investors. In recent years, as a result the financial community redirected its attention to an 'enhanced' evaluation ratio, the Gilt-Equity Yield Ratio (GEYR). According to Clare, Thomas and Wickens (1994) it is a key indicator to know if the investment should be made on stocks or bonds. In Portugal, the GEYR is still a much underutilized ratio since the investors continue to base their decisions on traditional ratios. In countries like the UK and the USA it is becoming more and more used in order to ensure efficiency in investments made on the capital markets. It is also important to refer that the designation GEYR was developed by the British authors/researchers and it is often designated as BEYR (Bond-Equity Yield Ratio).

There are some studies that analyze this ratio and according to Mills (1991) the GEYR was an extremely valuable ratio for the market practitioners in the UK in order to estimate future movement in prices. After three years Clare *et al.* (1994) used GEYR as a driver for investment decisions and evaluated three different trading rules between 1990 and 1993. The authors conclude that GEYR is a beneficial predictor of equity returns.

Levin and Right (1998) strained the work of Clare *et al.* (1994) and they found, through a wide sample of 14 years (1982-1996) that the GEYR by itself is not capable of providing a profitable asset allocation decision criterion. Lastly Harris and Sanchez-Valle (2000) and Brooks and Persand (2001) recommended that the Gilt-Equity Yield Ratio had considerable explanatory power for the UK equity returns.

Giot and Petitjean (2004) used the BEYR to investigate the long term relationship between stock index prices, dividends and bond yields. By using a wide sample of 7 countries (Germany, Belgium, France, Japan, The Netherlands, the UK and the US) between 1973 and 2004, the authors empirically investigated their molds by using first cointegration analysis and then they stretched Brooks and Persand's regime exchanging approach by adding another trading rule. Giot and Petitjean made clear that a long-term cointegrating relationship subsists between stock index earnings, stock index prices and government bond yields.

It is notorious the lack of articles and studies about the GEYR that contemplate international relationships ascertaining the existence of long-term relationships between the countries (cointegration), so it becomes interesting to understand through joint analysis of securities (stocks and bonds) the behavior of one country facing another. This thesis is a pioneer, because it contemplates countries that were never considered so far (such as Portugal) and that are living a similar period of economic and financial recession (except for Germany) and also for the fact of the GEYR is being calculated through two methodologies (which will be described *a posteriori*).

Due to the lack of empirical research, the thesis aims to present a synthesis of the econometric models that allows us to explain the relationship that could exist between GEYR in the set of countries named PIGS and Germany. Can we conclude that Germany GEYR is related with the same ratio of Portugal, Ireland, Greece and Spain? This is the main question that we want to answer.

Having said this, the goal of this thesis is in an initial phase to compute the GEYR and analyze its results to Portugal, Greece, Italy, Ireland and Germany and according to the historical data comprehend the investment trend, whether if it is stocks or bonds in each country. After the ratio calculus it will be studied the behavior of the series individually to understand if they are stationary or not, applying the unit root test (ADF test) and other common tests to conclude about the stationarity of the series (KPSS and PP). For the series that initially present themselves stationary (series in levels) we use the Granger causality test to understand if the results of the GEYR in one country have any causality relationship with the GEYR results in another country. After the Granger causality analysis, it will be estimated the VAR model in order to obtain the short-term dependencies.

Finally, to the series that are nonstationary it is applied the cointegration tests in order to determine the existence of long-term relationships of the GEYR between countries and for that it is used the Jonhasen method along with the VECM, in order to estimate the coefficients of the cointegrating equations in the long and short terms. In order to achieve the outlined goals, to apply and estimate different econometric models methodologies, we use *Eviews* software.

The study is organized as it follows: in chapter two it is presented a brief literature review to describe modeling and cointegration techniques to better understand how the GEYR is modeled and estimated; in the third chapter we describe and explain how the GEYR can be computed. In this study, the ratio is computed with the first input earnings yield index and bond yield and subsequently with the dividend yield index and bond yield. Chapter four describes briefly the methodology under the GEYR analysis, especially econometric cointegration techniques. Data analysis and empirical results are presented and discussed in chapter five. In this chapter we analyzed the series behavior for each country and we test the stationarity of the series. Subsequently, the cointegration test is applied to nonstationary series. The critical analysis generated by each output and the presentation of cointegrating equations will be done in this chapter as well. Finally the conclusions and main contributions of this study are presented in Chapter 6.

3. Literature Review

In this chapter we present a brief literature review about the development of the Gilt-Equity Yield Ratio (GEYR) and we discuss also some of the econometric methodologies that will be applied to the ratio. In this analysis the main subjects are: The GEYR Development, Stationarity, Granger Causality and Cointegration.

Until the year 1994 there were some studies related with existing movements on the market that analyzed variables like stocks, bonds, and dividend yields, amongst others. Until this time the GEYR had not yet been developed. There are lots of papers and investigations about the variations that occurred on the capital markets and we just refer a few on this thesis in order to frame the GEYR in the financial literature. In this literature review it is important to mention studies that aid understanding not only the principal theme, but all its implications. Down below there is a brief description of the withdrawn analysis from the articles related with the stock, bonds and interest markets, amongst other financial securities along with an econometric approach.

Chen, Roll and Ross (1986) investigated the influence of inflation on interest rates (short and long-term), on production growth, on real consumption growth and consequently they verified the impact of those variations on the return of US stocks. The main conclusion is that a raise on internal production increases significantly the excess returns, whilst a raise on inflation reduces it.

After this study, Giovannini and Jorion (1987) evidenced that the excess returns are negatively correlated with the nominal interest rate and stocks volatility presents a positive correlation with the nominal interest rate. In 1991 came Chen reaffirming the previous study, but he considered the correlation between more variables demonstrating the excess returns are negatively related to real economic growth and positively related to future economic growth.

Sentana and Wadhwani (1989) and Campbell and Hamao (1989) evidenced that equity returns in Japan can be predicted by using equity market dividend yield and an equivalent set of Japanese interest rates and yields spreads. Another study developed by Shah and Wadhwani (1990) mentions that through predictive power of the dividend yield and the term structure of interest rates for equity returns in 15 countries, the obtained results in the US should not be generalized to other countries, except for the UK, because markets work on distinct ways. Contrasting to Shah and Wadhwani's (1990) results, Clare and Thomas (1992) found that several yields spread together with other 'technical' variables and that increased the predictive power for German, Japanese, British and American equity and government bond markets during the 1980s.

The concept of correlation was widely investigated as we already verified in article from Giovannini and Jorion (1987) previously described. That investigation process led to the need of developing studies of cointegration in order to analyze determined characteristics of series that correlation do not allow us (e.g. long-term relationships between variables). Some studies will be highlighted throughout the next paragraphs related to the cointegration development. Cointegration analysis started being developed over 20 years ago by Granger (1981), Engle and Granger (1987) and Granger and Hallman (1991) contributions. They can reveal regular stochastic trends in financial time series data and that cointegration can be useful for long-term investment analysis. It has been proven by Granger and Hallman (1991) that investment decisions based only on short-term returns are inadequate, so it is important to consider the long-term relationships of asset prices. They also demonstrate that Hedge strategies established on correlation require constantly portfolio rebalancing, whilst strategies strictly based on cointegration do not need this rebalancing.

Bierens (1997), Park and Phillips (1988, 1989), Phillips and Hansen (1990), Saikkonen (1991), Sims *et al*. (1990) or Stock and Watson (1988) contributed to the development of approaches that can be considered an analysis of cointegration. Those approaches can be divided in parametric or non-parametric modeling. A non-parametric approach goes back to the theory developed by Engle and Granger (1987)[1]. The core of this approach is only on testing and estimating cointegration relationships, whilst all other characteristics of data generating process are processed as nuisance parameters. There are other authors for the parametric approach and the most popular is Johansen (1995). Other authors who deserve equal spotlight and also considered in this dissertation are Dickey and Fuller (1979) that concentrate their studies on the existing hypothesis of a unit root.

[1] Clive W.J. Granger and Robert F. Engle shared a Nobel Prize in Economics in 2003. One of the contributions for which they have been awarded was cointegration. The second awarded contribution is the so-called ARCH models that allows to model time-varying conditional variances, a pertinent phenomenon in e.g. financial time series. Note as a historical remark that several other researchers were also 'close to discovering' cointegration around the same time, e.g. Box and Tiao (1977) and Kräamer (1981).

One of the studies that involved the concept of cointegration along with stocks and bonds was Wainscott's (1990). He who used monthly returns of the US common stocks and long-government bonds examined the existing correlation between the two variables. The sample period lasted between January of 1925 and June of 1988. He calculated the correlation between bond yields and stocks using temporal horizons of 1, 2, 5 and 10 years. The main conclusion is that the correlation was unstable. Thus, if correlations are used for asset allocations, yield forecasts will be imprecise. In fact, correlation versus cointegration was also piece of work of several articles and according to Alexander and Dimitriu (2002), the use of cointegration for long-term inferences does not forbid the use of correlation as a short-term guide. For instance, short-term correlation can be utilized as a stock selection technique followed by a portfolio optimization based on cointegration.

According to Alexander (1999), the cointegration technique for time series modeling is common in financial markets applications. This author states that, a multivariate system will provide important information about the equilibrium price of financial assets and causality of returns within the system. Arbitrage between spot prices and future prices, modeling the structure of the yield curve, negotiations through a construction of "index tracking" and spreads, these are some of the applications of cointegration reviewed by the author in the article. It presents an international cointegrated portfolio model of stocks utilized for hedging within the European countries, Eastern Europe and Asia.

Opposing to the traditional strategies of "index tracking" and long-short equity based on correlation, Alexander and Dimitriu (2002) executed the optimization of a portfolio based on cointegration. They used it as a negotiation strategy based on index tracking that aims to replicate a reference source of market accurately in terms of returns and volatility. They also use cointegration to determine a neutral strategy of long-short equity market: aiming to minimize volatility and generate stable returns over all circumstances of the market. To validate its applicability, they took stocks of the Dow Jones Index Average (DJIA) and the presented results, strongly justifying, the use of cointegration to determining financial assets allocation.

More recently, Dunis and Ho (2005) equally used the cointegration concept to derivate a quantitative portfolio of European stocks in the context of two applications: the classical strategy of index tracking and the neutral strategy of long-short equity market. They use the data of the

Index Dow Jones EUROStoxx50 and its constituents stocks, within the period from 04-01-1999 to 30-06-2003. Still, the presented results improve the cointegration technique to the assets allocation, i.e. the results show that the designed portfolios are strongly cointegrated with the benchmark and indeed demonstrate good tracking performance.

Afterwards and using recent econometric methods in empirical research about relationships between stock prices, bond yields and dividend yields came the authors Mills (1991) and Clare, Thomas and Wickens (1994). The main goal of these authors was to verify empirically if there were a stable relationship between bond yields and dividend yields that could be used by the portfolio analysts to determine the attractiveness of equities comparing to the investment on bonds. Mills (1991) still developed another study that tested the existence of cointegration between equity prices, dividends and bonds and used the logarithms of the variables through observations at the end of each month since January of 1969 until May of 1989. These observations were removed from Financial Times Actuaries 500 equity index, the associated dividend index and the Par yield on twenty-year British Government stocks. The main conclusions to retain from this study is that Mills evidenced that each series was integrated of order 1 and posteriorly estimated the error correction model between stock prices, dividends and bond yields. After applying the necessary tests to this estimation, Mills found evidences about the existing long-term stable relation between bond yields and dividend yields.

However, in spite of this vast number of empirical studies related with financial markets, few analyzed the relationship between stocks and bonds simultaneously, verifying short and long-term relationships in each of these financial securities.

Due to this Clare, Thomas and Wickens (1994) estimated a ratio which contemplated gilt yields over dividend yields, calling it Gilt-Equity Yield Ratio (GEYR). In this study they realized that when the GEYR assumes big values, bonds should be purchased and consequently a low value of the GEYR means that bonds should be sold.

After this study others have been produced in financial markets literature. Next, we refer a few of them. Clare *et al.* (1994) used the GEYR to assure more efficient investment decisions evaluating three separate trading rules. The first trading rule is established on Hoare Govett (1991) GEYR trading thresholds - " A value of GEYR less that 2 is taken to be a signal to buy equity, while a value greater than 2.4 is taken as a signal to sell equity". The second trading rule is established on a regression model which contains lagged values of the GEYR and dummy variables for the oil price shock, the 1975 equity market boom and the 1987 stock market crash. The third trading rule is established on a regression model consequent of a formal arbitrage relationship between the returns on bonds and equity. Comparing these trading rules over the forecasting period considered, directs them to accomplish that the GEYR is actually a useful predictor of equity returns. Other concern that emerged from the study of Clare *et al.* (1994) was to interpret signals that indirectly could condition the GEYR values. For them, one of the most important variables that should be considered to understand the GEYR behavior was inflation. The main conclusion is that inflation should be considered in the ratio because it has influences on the GEYR result, since it increases with inflation. The goal should be to compare real measures (contemplating the inflation rate) instead of nominal measures. In opposite, Durré and Giot (2007) evidenced that one of the drawbacks from this ratio would be the same of being indirectly dependent of some implicit variables, as in the case of inflation and it could influence wrongly the results of the GEYR, leading to incorrect conclusions.

The study of Clare *et al*. (1994) is extended by Levin and Right (1998) in a number of ways. Levin and Right (1998) center their study on the hypothesis that the balanced value of the GEYR fluctuates over time and expected inflation is one of the foremost factors responsible for this change. The difference between the balanced GEYR and the observed GEYR is properly modeled. This difference is important because movement in the observed value of the GEYR triggered by mispricing can be distinguished from movement in the observed value of the GEYR triggered by other variables that are straightly connected to the GEYR. In the empirical analysis of this study, the conclusion, just like Clare *et al*. (1994), is that the GEYR is a useful measure that includes information that can be utilized to guide investment decisions, but this ratio should not be analyzed by itself so there is a more efficient investment criterion.

After the presented studies we show others that decided to expand the GEYR investigation to a comparison optic between countries, analyzing the ratio behavior in each country. According to Harris and Sanchez-Valle (2000) and Brooks and Persand (2001), they recommend that the Gilt-Equity Yield Ratio has considerable explanatory power for the UK equity returns. There were considered three goals for the study developed by Harris and Sanchez-Valle (2000): the first one was to compare the predictive ability of the GEYR amongst the variables that he considered important for the study – lagged equity return, the dividend yield and the yield spread between long and short bonds. Unlike other studies previously presented, this one did not pay attention only to the most recent lags of each variable, but instead investigated the information content of up to six lags. The second goal of the study was to examine whether the triumph of the GEYR in explaining equity returns in the UK was corresponded by a comparable success in the US. Many of the variables that were found to clarify returns in the US have been found to be equally effective in other international equity markets and so one might assume the performance of the GEYR to be alike in the two countries. But like it has been presented, Clare *et al*. (1994) conjectured that for institutional reasons, the GEYR was expected to be less successful in the US than in the UK. The last goal of that study was to investigate the success of the GEYR in forecasting long horizon returns. The empirical results of this study sustains an existing evidence that the GEYR has considerable explanatory power for the UK equity returns and that it can be effectively employed in a trading rule that excess returns over a simple buy-and-hold tactic in the equity market. Other conclusion is that there is evidence that the relationship between the GEYR and returns has not been even over time in the UK and in the US. The fault of this instability may well be for the fact that the GEYR reflects inflationary expectations, which have undeniably been far from constant over the sample period. Lastly, it has also been shown that information about subsequent monthly returns was not confined to the most recent lags of each variable.

Brooks and Persand (2001) study differ from others already presented because it extends its analysis to the switching approach regime by adding another trading rule. It has been made known that such a model yields forecasts which engenders investment decisions with powerfully superior risk-return characteristics when compared with a buy-and-hold tactic for the UK and slightly better of the US and German markets. The Markov switching model offers superior forecasting to its competitors (GARCH, AR and SETAR), for the UK when evaluated in this way, although the Markov approach is inferior on standard forecast errors grounds. Later, Giot and Petitjean (2007) confirmed in an article the conclusions presented by Brooks and Persand (2001).

Giot and Petitjean (2004) used the Bond-Equity Ratio[2] in order to investigate the long-term relationship between stock index prices, dividends and bond yields. As it has been already

[2] The ratio is the equal to the GEYR, but when it is applied outside the UK some authors rather call it Bond-Equity.

referred, these authors stated that using cointegrated the VECM model, it is possible to evaluate more efficiently predictive capacity of the GEYR, because the variables coefficients presented on the VECM are statistically significant. In this study it is shown evidence about cointegration of the variables (stock index prices, dividends and bond yields).

In this study it is presented an international analysis of the GEYR based on the models previously described, the existence or non-existence of cointegration will be crucial to understand predictive power of the GEYR in the countries considered. Concepts above described will be developed throughout the thesis.

4. GEYR – Description and Analysis

In this chapter we describe the Gilt-Equity Yield Ratio, deepen its definition and the variables that it uses. Section 4.1 lists all the details about the GEYR, starting to enumerate every country this thesis addresses, as well as the two methodologies of the GEYR calculus utilized, explaining carefully the differences between both. Still in this section it will be presented strategies of investment decisions based on the ratio values. In section 4.2 we point out some advantages and limitations arising from the development in studies which are based on the GEYR.

4.1. Description of the Gilt-Equity Yield Ratio

As a result of loss of confidence in traditional ratios of performance evaluation of the market, it is becoming more necessary to get ways of providing greater efficiency on investments. The Gilt-Equity Yield Ratio or Bond-Equity Yield Ratio (different names for the same ratio) delivered useful information, demonstrating investment trends of equities and bond markets.

In this dissertation this ratio will be computed for 5 countries according to the information provided by 10 years government bonds and the representative indexes of each stock market per country:

Portugal – PSI 20 *(Portuguese Stock Index)*
Ireland – ISEQ (*Irish Stock Exchange Quotien)*
Greece – ASE *(Athens Stock Exchange)*
Spain - IBEX 35 *(Iberia Exchange)*
Germany – DAX 30 (*Deutscher Aktien-Index)*

The GEYR is defined as a ratio that contemplates long-term government bond market yield and stock market yield. The bond and stock market yields are respectively approximated by the yield-to-maturity on long-term government bonds and by the equity yield of the most representative stock index. Equity markets concern to the obtained yield of companies listed in index, i.e. it is the yield from the index. In the GEYR computation, the stock market index of each country allowed us to collect information about the dividend yield index and 10-year government bonds allowed us to withdraw information about the bond yield variable. This information was extracted from the representative indexes of each country through Bloomberg terminal. Notice that in this study, the GEYR is perceived as market analysis study, i.e. the goal is to see the market yield as a whole and not individualize it for each constituent company of the index. Therefore, every time we address implicit variables in the computation of the ratio, that's a different approach referring to global market of stocks/ bonds concerning each country, according to the representative indexes previously described.

In the last few years it has been placed special attention to the GEYR development. Some researches concentrate their attention to a similar ratio, the so-called Fed-model, which weighs stock markets by comparing stock and bond yields. According to the Fed-model, the stock market earnings yield index should be compared to 10-year government bond yield (Vila Wetheritt and Weeken, 2002). When earnings yield index is superior to bond yield, stocks are considered cheap. On the other hand, if 10-year government bond yield exceeds earnings yield, stocks are considered expensive. The difference between the GEYR and the Fed-model is that in the GEYR framework researchers utilize dividends yield index and in the Fed-model they use earnings yield Index. As it is known, financial ratios are financial instruments of analysis that should be used individually. By presenting two kinds of ratios, it is also provided a comparison between them, increasing information range in order to enable value added on decision-making by analysts and so empowering investments efficiency. Therefore, in the first case, the GEYR takes the dividend yield index as input. In alternative it features the earnings yield (inverse of price-to-earnings ratio).

So, we will now present the general formula for the GEYR computation:

$$GEYR = \frac{Bond\ Yield}{Dividend\ Yield\ Index} \quad (1)$$

Bond Yield – 10-years Government Bond Yield for each country or coupon amount/ price bond (R_f)

Dividend Yield Index – Dividend per "stock's"/Price per "Stock's" – in this case the "stock" represent the "equity", i.e. most representative stock index.

This is equivalent to:

$$GEYR = \frac{d_b/P_B}{d_e/P_E} \tag{2}$$

Where:

$\boldsymbol{P_B}$ – Price of Bonds

$\boldsymbol{P_E}$ – Price of Equity

$\boldsymbol{d_b}$ – Coupon

$\boldsymbol{d_e}$ – Dividend from equity

According to the Fed-model (GEYR1) the ratio will be:

$$GEYR1 = \frac{Bond\ Yield}{Earnings\ Yield\ Index} \tag{3}$$

Where:

Bond Yield – 10-years Government Bond Yield for each country or coupon amount/ price bond ($\boldsymbol{R_f}$)

Earnings Yield Index – Inverse of price-earnings ratio (1/ (P/E)) or EBIT/ Enterprise Value

The main goal of this ratio is to detect mispricing situations between equity markets and bonds markets, providing arbitrage opportunities between the two financial securities. To be able to detect these situations, it becomes important to know how to interpret the results that come from the ratio. According to Brooks (2001, p.11), "If the GEYR becomes high relative to its long-term level, equities markets are viewed as being expensive relative to bonds. The expectation then is that for given levels of bond yields, equity yields must increase which will occur through a fall in equity market prices. Similarly, if the GEYR is way below its long-term level, bonds are considered expensive relative to stocks, and by the same analysis, the price of the latter is expected to increase." Thus, in its crudest form, an equity trading rule based on the GEYR would say **"If the GEYR is low, buy equities; if the GEYR is high, sell equities"** (Brooks and Persand, 2001, p. 11).

However, the corresponding level of a "low" or "high" value of the GEYR depends on the methodology that is being used. It all starts by analyzing the critical values of the first methodology of the GEYR (the one that contemplates dividend yield index). According to Hoare Govett[3] (1991) the GEYR rule states that investors should buy equities if the GEYR < 2, sell equities and invest in gilts if the GEYR > 2.4. This means that if the value of the GEYR is superior to 2.4, then stocks are overvalued[4] and consequently we should sell them and invest in bonds, in order to be able to relish the arbitrage strategy. On the other hand, if the GEYR value is inferior to 2, stocks are undervalued[5], which means, a stock is valuing less than its book value. If the GEYR is between 2 and 2.4, the market is balanced and in these conditions it should sustain unchanged this position, because there is no possibility of arbitrage. Another ratio indicator that may provide us additional information about the market behavior is the payout ratio that is related to the results from the dividend yield index. Low payout ratio means that a company is mainly focused on retaining its earnings more than paying out dividends. This ratio also indicates how well earnings upkeep the dividend payments. The lower the ratio, the more secure is the dividend, since smaller dividends are easier to payout than larger dividends. We can affirm that generally a low payout, (usually inferior to 50%) tends to provide a higher value for the GEYR and if this value is superior to 2.4, *ceteris paribus*, consequently the best trading strategy will be to sell equities. On the contrary, a higher value for payout (generally superior to 50%), *ceteris paribus*, tends to provide a lower value for the GEYR and if this value is inferior to 2, the best strategy will be to buy equities.

Down below there is a Table 1 that demonstrates briefly the contents previously described.

[3] After conducted studies, he defined that critical values should be used as rule by the analysts.
[4] When stock price is superior to its intrinsic value.
[5] When stock price is inferior to its intrinsic value.

Table 1: Strategy Decision with the GEYR results (using dividends yield index)

This table sums up trading strategies considering the critical values used on the first approach of the GEYR computation that uses dividend yields as denominators.

GEYR - using the Dividend Yield	Equity Market	Decision
IF GEYR **> 2.4**	Overvalued	Sell equity
IF GEYR **< 2**	Undervalued	Buy equity
2 < IF GEYR **< 2.4**	Equilibrium	Hold position

Using the second methodology for the GEYR1 computation, in which the only difference is that earnings yield are considered on the formula's denominator, the result analysis is slightly different. GEYR1 ratios greater than 1 imply that equity markets are overvalued, while numbers less than 1 mean they are undervalued, or that prevailing bond yields are not adequately pricing. If the GEYR1 is above normal levels the assumption is that the price of stocks will decrease thus lowering the GEYR1. When the GEYR1 value is equal to 1, we can affirm that it is better to hold position in the market and not buy or sell securities. So, the return to get bonds is higher than equity, if the GEYR1 has values superior to one, which means we must invest in bonds, i.e sell equity and buy bonds. This happens like this because, since stocks have prices above their intrinsic value, we are selling them for a superior value, obtaining an "earning". On the other hand we should invest in bonds. On the opposite, if the value of earnings yield rises, it will cause a result on the GEYR1 inferior to 1. By then, we should buy equities and sell bonds and, we should buy stocks because their value is below their intrinsic value, so we spend less to obtain them. Down below there is a summary Table 2 that identifies arbitrage opportunities before the GEYR1 results.

Table 2: Strategy Decision with the GEYR1 results (using earnings yield)

This table sums up trading strategies considering the critical values used on the second approach of the GEYR computation that uses earning yields as denominators.

GEYR* – using Earnings Yield	Equity Market	Decision
IF GEYR1 > **1**	Overvalued	Sell equity
IF GEYR1 < **1**	Undervalued	Buy equity
IF GEYR1 = **1**	Equilibrium	Hold position

According to Brooks (2001) the accuracy of this ratio varies from country to country and considering the agreed dividend distribution policy, the one that through the years has been suffering major alteration, there is no precise way to evaluate the results of this ratio. Moreover, the results of both ratios may not be in conformity. For instance, one can state that the best strategy will be sell equities and the other may state that the best strategy it to buy equities markets. In these cases, it is preferable to call on other indicators or financial ratios, in order to complement the analysis and comprehend the best market trend. In the empirical results chapter we will analyze the history of the ratio and understand which were predominant strategies in each country.

4.2. Pros and Cons of the GEYR

As in all financial ratios, this one also presents some pros and cons, since they have implicit variables that not always range in the same way, like the dividend distribution policy. The preference between high or low dividends ranges according not only to the company, but also to the surrounding political and economic environments where the company is inserted. The advantages of opting for low dividends go through the existence of personal taxes that generally favor capital gains to the detriment of the dividends and the cost of issuing new stocks. Buyback stocks has, like increasing the dividends value, a flag effect to the market and due to that, these indicators should be analyzed and pondered individually when a decision based on the GEYR is being made, so that afterwards a conclusion may be drawn. A company will opt for buyback stocks when it believes that equities are overvalued. Therefore, rather than just distribute equities to stockholders, the company will be investing, enabling the possibility of selling equities when their price is rising. Due to information asymmetry, the market faces buyback stocks by the company as a sign that they are undervalued and consequently the equities price raises, being another argument in favor of buyback stocks.

On the other hand, the inherent advantages of a high dividend distribution policy are due: to the information asymmetry, indicating that sometimes stockholders do not have access to the same information that managers do; to the agency costs[6] that reflect the conflicts inherent to the interests between stockholders and managers and still the fact of immediate income preference due to transaction costs. Transaction costs are well-reflected on the GEYR, so it is important that this "invisible" cost is always pondered by the analysts when analyzing the values from the ratio.

More recently some analysts have been analyzing the power of the GEYR. According to John Higgins at Capital Economics[7] "equities are real assets". So at the very least "this suggests we ought to be comparing the dividend yield with the yield on index-linked gilts (which offer an inflation-linked return), rather than conventional gilts". There is also the problem that the dividend yield on stocks is influenced by the expected real (post-inflation) growth rate for equities. As a result, the difficulty with the GEYR is that we are not comparing equal terms. Gilt yields are nominal measures, i.e. inflation expectations affects them, whilst the dividend yield is a real measure, which means is not as affected. To get a glimpse of how this works, picture that long-term inflation expectations fall abruptly without affecting real economic growth, risk or real interest rates. There would be a fall in nominal gilt yields, but no alteration in the dividend yield. The GEYR would fall as well. However, it would be wrong to say that equities had abruptly become cheap, since – ex hypothesis – nothing has happened to them; real growth and the real discount rate applied to this growth haven't changed. Consequently, the annual earnings yield on stocks (an annual earnings figure divided into the stock price) is perhaps a better guide to expected equity returns than dividend yields.

So it is important to present in this study the so-called Fed-model, in order to increase predictive power before the initial GEYR formula. This method was widely popularized in the US by the analysts, magazines and financial newspapers and it stated that the 10-year government bond yield should be contrariwise related to the expected earnings yield of the S&P500 index. In this model, the equity yield is proxied by the expected earnings yield. In practice, this model proposes asset allocation decisions based on the perceived degree of over and underpricing of the S&P500

[6] Debt agency costs: reflects a conflict of interests between stockholders and debt holders, i.e., the optimal decision for the stockholder may not be the optimal decision for the debt holder. Agency cost equity: conflict of interests between stockholders and managers. The manager who makes the decisions may be acting in his own best interest which may not be the stockholder's best interest.

[7] John Higgins is Capital Economics' Senior Markets Economist with 15 years of experience in financial markets as a trader, analyst and economist. Higgins identifies values in global asset markets based on our macroeconomic and policy projections. He contributes and edits our Capital Daily and he is responsible for producing regular updates and thematic pieces on key market developments.

concerning its fair value. Still, despite of the shaky theoretical foundations of the GEYR, proponents underline its strong relevance as an empirical description of stock prices (Lander, Orphanides and Douvogiannis, 1997; Asness, 2003; Campbell and Vuolteenaho, 2004). The clean 'mechanical' relationship implicit by the GEYR is attractive for instinctive reasons. Firstly, market participants persistently arbitrage the stock and bond markets, allocating financial resources between equities and long-term bonds by actively relating the corresponding bond and stock market yields. To be involved in such operation, market participants rely on the 'substitution effect' between stocks and bonds. Secondly, they take advantage of low interest rates in order to buy stocks on margin through 'carry trade' operations. Stock markets indirectly take advantage from a low-rate environment as portfolio managers incur low borrowing costs when they are buying stocks. These portfolio managers sell their stocks to hide their rising borrowing costs, when interest rates rise. Due to these reasons, there are many practitioners that view the GEYR as an augmented valuation ratio, which not only takes stock/ earning yields into account, but also compares them to bond yields.

5. Methodology

In this chapter we present and explain some concepts to better understand the application of cointegration tests. Section 5.1 refers to some basic concepts that are needed to the previous study of time series, like the case of stationarity/ nonstationarity distinction, as well as different approaches of data processing when we stand before nonstationary series (hypothesis that turn the series stationary). In section 5.2 we explain the Granger causality and this test is only applied to the stationary series, so its interpretation and analysis will be presented in this section. Lastly, in section 5.3 it will be presented inherent concepts to the cointegration study such as the Engle-Granger (two-step method) and the Johansen method. Also featured are some implicit methodologies in these methods, such as VAR, VECM and the Dickey-Fuller test.

5.1. Stationarity

When we work with econometric models and posteriorly apply cointegration tests, the first step is to check the series behavior and draw some conclusions on **stationarity**. A time series is composed of random variables$\{Y_t\}$, therefore these sets of variables are sorted in time, therefore we have a stochastic process[8]. There are two types of stationary: the strictly stationary and weakly stationary. A strictly stationary process i for any $t_{1,}t_2, \dots ,t_T \in Z, any\ k \in Z\ and\ T = 1,2, \dots$

$$Fy_{t1}, y_{t2}, \dots , y_{tT}(y_1, \dots , y_T) = Fy_{t1+k}, y_{t2+k}, \dots , y_{tT+k}\ (y_1, \dots , y_T) \qquad (4)$$

Where F represents the joint distribution function of the random variables' set. It can also be stated that the probability measure for the sequence $\{y_t\}$ is the same for$\{y_{t+k}\}\ \forall\ k.$ A strictly stationary series tells us that there are no changes in the series over time. Its behavior is always constant and there are no structural breaks, i.e. the distribution of its values remains the same as

[8]Family of random variables indexed by *t* elements that belong to a certain timeslot. Intuitively, if a random variable is a real number that ranges randomly, a stochastic process is a temporal function that ranges randomly, in a simplified way and so we can say that stochastic processes are randomly processes that depend on time.

time passes by, implying that the probability that y falls within a particular interval is the same as now as it is at any time in the past or in the future.

The weakly stationary is more usual and better to analyze financial and economic series. This concept consists in:

Mean: $\mu_t = E(Y_t)$; (5)

Variance: $\sigma_t^2 = var\ (Y_t)$; (6)

Autocovariance: $\gamma_{t1,t2} = cov(Y_{t1};\ Y_{t2})$; (7)

The unknown parameters are $\mu_t, \sigma_t, \gamma_{t1,t2}$ and they change with t. Therefore, the statistical proprieties of the stationary concept of a time series do not change over time, i.e. a stationary series has, as it was previously presented a constant mean, a constant variance and a covariance between lagged values of the series depend only on the lag, in other words, the temporal "distance" between them (Gujarati (2005)). Simultaneously, nonstationary series may be detected by their mean, since in a nonstationary series it ranges over time, consequently the series will show several types of tendencies, thereby not obeying to the stationary rules. To estimate a "good" model is not enough the confirm the stationarity of a series, we have to analyze its residues, i.e. a process in which its mistakes present zero mean, constant variance and no serial correlation and that is called white noise[9]:

$$E(\varepsilon_t) = 0 \quad (8)$$

$$Var\ (\varepsilon_t\ ) = \sigma^2 \quad (9)$$

$$cov\ (\varepsilon_t, \varepsilon_{t-k}) = E\ (y_t \times y_{t-k}) = 0 \quad (10)$$

When we stand before the white noise process, we can conclude that the series is stationary. Understanding white noise is tremendously important for at least two different reasons: First, processes with such richer dynamics are built up by taking simple transformations of white noise. Second, one-step-ahead forecast errors from good models should be white noise. After all, if such forecast errors are not white noise, then they are serially correlated, which means that they are

[9] WN implies stationary, but a series can be stationary and not be WN.

forecast, and if forecast errors are forecast, then the forecast cannot be very good. Thus it is important that we understand and be able to recognize white noise.

As it is obvious, in the financial and economic world, the majority of the series are nonstationary, due to the existence of structural breaks that provoke unexpected alterations. In other words, the common characteristic between nonstationary series is that they have a increasing tendency over time, making their mean non-constant. When we have a stationary series, shocks tend to gradually disappear. This means that a shock at time *t* will have a small effect in period *t +1*, a smaller effect in time *t +2* and so on. This situation is not the same as in the case of nonstationary data, where the persistence of shocks will always be infinite, so that for a nonstationary series, the effect of a shock during time *t* will not have a smaller effect in time *t* +1 and in time *t* +2 and so on. Therefore, it is important to develop methods and models that can study nonstationary series behavior and consequently obtain a good predictive model. The development of the cointegration concept becomes thereby important, since it's one of the technics applied to the nonstationary series with the objective of checking the existence of any long-term equilibrium relationship between them. Having said this, here are two very distinct models that allow nonstationary series transformations. The model (or process) in trend stationary (TSP – Trend Stationary Process) and by differentiation of stationarity (DSP – Difference Stationary Process) or unit root.

According to the hypothesis TSP the series Y_t is:

$$y_t = f(t) + \mu_t \tag{11}$$

Where $f(t)$ is a time fuction and μ_t represents a stationary process. For example, assuming a linear deterministic trend, the most ordinary hypothesis, we'd have:

$$y_t = \beta_0 + \beta_{1t} + \varepsilon_t \tag{12}$$

However, because economic series generally have a growth tax approximately constant, the exponential trend model reveals itself frequently more accurate:

$$y_t = \exp[\beta_0 + \beta_{1t} + \mu_t] \tag{13}$$

$$\ln(y_t) = \beta_0 + \beta_{1t} + \mu_t \tag{14}$$

Nevertheless, in this model, deviations from the trend μ_t are white noise, i.e. are stationary. Although the persistence of structural breaks on economic series makes us conclude that not always deviations from the trend are stationary. In these cases, the best way would be to use the DPS (Difference Stationary Process) model. Imagining, e.g., a random walk with drift[10]:

$$y_t = \beta_1 + y_{t-1} + \varepsilon_t \quad (15)$$

In this case we can easily verify the presence of a increasing tendency (since $\beta_1 > 0$). The major difference of this model comparing to the TSP model is that this one introduces a stochastic trend. In other words, deviations from the deterministic trend, according to the DSP or unit root hypothesis, are nonstationary. If the series is differentiated *d* times before becoming stationary, then it contains *d* unit roots and we say it is integrated of order *d*, denoted by $I(d)$. Box Jenkins (1944) and more recently Nelson and Plosser (1982) argue that not all nonstationary series can be converted into stationary series by differentiation, however there is strong evidence that most of the economic and financial series tend to be differentiated of order 1, denoted by $I(1)$. If we have more than one series under study, all of them have to be stationary with the same order of integration so that we can apply cointegration tests. Cointegration tests will be applied to the series in level (Gujarati, 2000 and Terrence, 2003). The denotation for a stationary series is $I(0)$. In order to verify if the series was sufficiently differentiated to become stationary, there are the unit root tests. Hypothesis to test are the following:

H_0: $the\ series\ posseses\ unit\ root$ (unit root test)
H_1: $the\ series\ does\ not\ possesses\ unit\ root$
Consider the easiest example and tested through OLS the model AR (1):

$$y_t = \beta_1 + \rho\, y_{t-1} + \mu_t, \quad \mu_t \sim iid\ (0, \sigma_\varepsilon^2) \quad (16)$$

In this case, the test statistic will be:

[10] Random Walk concept: taking several consecutive steps, each in a random direction. The direction of a point on the way to the next is chosen randomly and no direction is more likely than another. If the series that is being fitted by a random walk model has an average upward (or downward) trend, it is expected to continue likewise in the future. We should include a non-zero constant term in the model i.e., assume that the random walk undergoes "drift".

H_0: ρ = 1

H_a: ρ ≠ 1.

Equation 16 may be rewritten as:

$$\Delta y_t = \beta_1 + (\rho - 1)y_{t-1} + \mu_t \qquad (17)$$

Making $(\rho - 1) = \delta$ we have:

$$\Delta y_t = \beta_1 + \delta y_{t-1} + \mu_t \qquad (18)$$

In this case, we are testing:

H_0: $\delta = 0$

H_a: $\delta \neq 0$

We can conclude that we stand before a model in which there is no serial correlation of errors, therefore if we effectively do not reject H_0, it means that $\Delta y_t = \mu_t$, i.e. we stand before a random walk[11] series. Because μ_t is white noise, it is stationary, which means the first differences of a random walk temporal series are stationary.

It is important to reference that Dickey and Fuller show that, under the null hypothesis in which $\delta = 0$, the estimated *t* value of the coefficient y_{t-1} follows a τ (*tau*) statistic. These authors calculated critical values of the *tau* statistics based on Monte Carlo simulations. MacKinnon prepared more extended tables that nowadays are incorporated in several econometric software. In specialized literature, *tau* statistics or *tau* test τ is known as the Dickey-Fuller (DF) test, in order to honor its founders. It is interesting to notice that when the hypothesis $\delta = 0$ is rejected (i.e. the temporal series is stationary) we can use the usual *t* Student test. This Dickey-Fuller test can be applied to the following models:

$$\Delta y_t = \delta y_{t-1} + \mu_t, \qquad (19)$$

$$\Delta y_t = \beta_1 + \delta y_{t-1} + \mu_t, \qquad (20)$$

$$\Delta y_t = \beta_1 + \beta_2 t + \delta y_{t-1} + \mu_t, \qquad (21)$$

Where *t* is a time variable or tendency.

[11] Random Walk concept: taking several consecutive steps, each one in a random direction. The direction of a point on the way to the next is chosen randomly and no direction is more likely than another.

When executing the Dickey-Fuller test, the assumption was that the μ_t error was non-correlated. In case μ_t presents autocorrelation, Dickey and Fuller developed a test known as the Augmented Dickey-Fuller (ADF) test. This test is driven by an "augment" of the three precedent equations by adding lagged values of the dependent variable Δy_t. Specifically using y_t , which is a random walk with its derivative around a stochastic tendency, we use the ADF test, which consists in estimating the following regression:

$$\Delta y_t = \beta_1 + \beta_2 t + \delta y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta y_{t-i} + \varepsilon_t \qquad (22)$$

Where ε_t is a process of white noise and $\Delta y_{t-1} = y_{t-1} - y_{t-2}$, $\Delta y_{t-2} = y_{t-2} - y_{t-3}$ ...
The number of lags (=k) to be included is often determined empirically, so the idea is to include a sufficient number of terms so that the error in the equation 22 does not present serial correlation, i.e. so that the behavior of errors is near white noise. In the ADF test we continue to test a null hypothesis $\delta = 0$ and it follows the same asymptotic distribution just like in the Dickey-Fuller statistics, therefore we can use the same critical values.

Generally, we can say that tests are executed until we obtain stationarity, in other words, we start to test the original series of the null hypothesis H_0 of nonstationarity against the stationarity alternative. If it does not reject H_0, the series contains a unit root and we will have to obtain the first difference, so we return to test stationarity. If the null hypothesis is rejected, the series is *I* (1), otherwise we will determine the second difference and we return to repeat the test.

The emerging problem in this test faces the choice of the number of lags. The strategy adopted initially to the problem resolution consisted in starting with k=0, effectuating DF tests regression and augmenting the equation with lags of Δy_t until the residual autocorrelation (evaluated with the Breusch-Godfrey statistics) symptoms disappear.

However, more recently, the inverse strategy from general to particular has been obtaining more favorable arguments, especially when the main objective lies on the control of tests dimension. Thus begins a process with a *k* sufficiently elevated (depending on the sample dimension) and it tries to simplify autoregression with individual *t*-tests over more elevated lag coefficients, until we obtain a rejection. Some software, as in *Eviews*, present tests indicating the optimal lag number that minimizes the information criteria values (AIC, SIC, amongst others). That resource will be used in empirical results. The Akaike Criterion suggests always the greater order, the

Schwarz Criterion suggests always the minor order and Hanna-Quinn Criterion suggests usually an order between both suggested orders by the other two criterions. It is important to notice that just because there is a trend in the suggested orders by the criterions that does not mean that the 3 of them cannot agree.

Besides the DF and the ADF tests, there are others with the same purpose, such as the KPSS (Kwiatkowski-Phillips-Schmidt –Shin, 1992), which possesses as null hypothesis the series stationary, i.e. the unit root inexistence and the PP (Phillips-Perro, 1998), which possesses as null hypothesis the existence of a unit root just like the ADF test. The combination of these tests may generate four conclusions. The following Table 3elucidates these combinations.

Table 3: Results combination of the KPSS and PP tests

This table elucidates existing combinations according to the KPSS and PP tests and the results and conclusions of those combinations (Billi *et al* (1996)).

KPSS	PP	Conclusion
H0 Non rejection	*H0* Rejection	Strong evidence of a stationary covariance process.
H0 Rejection	*H0* Non rejection	Series with unit root, so nonstationary.
H0 Non rejection	*H0* Non rejection	Generates indetermination over data generating process.
H0 Rejection	*H0* Rejection	The generating process is not I (0) neither I (1), indicating a probable fractional integration.

Therefore, a joint analysis of these tests may provide greater accuracy of the order of integration suitable to the series and consequently better investments decisions.

An additional motivation to the study of univariate properties of economic series – i.e. to the unit root tests – lies on inference problems that may occur on regression models that involve integrated variables. In other words, a previous execution of that univariate analysis for each involved series is imperative for a good modeling and inference before multivariate time series.

An example that better illustrates this importance is the spurious or meaningless regression (concept first used by Yule in the 1920s). In simple terms, a spurious regression is an economic meaningless regression, but the use of traditional statistical tools reveals itself deceiving.

The use of statistics such as the coefficient of determination[12] (R^2) and in general correlation coefficients or t and F statistics, suggests the existence of causality relations between variables that in fact do not exist. In these situations it is more likely to obtain deceiving statistic results, in particular the R^2 may assume high values and very often the t-ratio testing the hypothesis $H_0: \beta = 0$ vs $H_1: \beta \neq 0$[13] may fall in the critical region of the test.

According to Granger and Newbold (1974) and later Phillips they suggested that after running the regression of the first differences, if $R^2 > DW$[14] (a R^2 near zero and Durbin Watson statistic near two), this is a major rule to suspect that an estimated regression is spurious. The use of correlation to measure the long-term relationship between nonstationary time series can lead to the risk of conducting spurious regressions, so if we stand before variables that are cointegrated, and the hypothesis of existing spurious relationships is set apart.

5.2. Granger Causality

Correlation does not necessarily imply causation in any meaningful sense of that word. The econometric graveyard is full of magnificent correlations, which are simply spurious or meaningless.

According to the approach of Granger (1969) on the issue of a stationary series X causes stationary series Y is concerned on how much of the current Y can be explained by past values of X and then to see whether adding lagged values of X can improve the explanation. Y is said to be Granger-caused by X if X helps in the prediction of Y, or equivalently if the coefficients on the lagged $X's$ are statically significant. Notice that two-way causation is frequently the case; X granger causes Y and Y granger causes X. It is important to note that the statement "X Granger causes Y" does not imply that Y is the effect or the result of X. Granger causality measures precedence and information content, but does not by itself indicate causality in a more common

[12] R^2 indicates how much of the dependent variable variance (y) is explained by the independent variable variance (x). Values range from 0 to 1, and the greater the value, the more explanatory is the model.
[13] To the regression $y_t = \alpha + \beta x_t + \mu_t$
[14] The **Durbin–Watson statistic** is a statistic test used to detect the presence of autocorrelation (a relationship between values separated from each other by a given time lag) in residuals (prediction errors) from a regression analysis. It is named after James Durbin and Geoffrey Watson. General rule, we admit a DW inferior to 1,5 as an evidence of positive serial correlation and a DW superior to 2,5 as evidence of negative serial correlation.

use of the term. We should pick a lag length, k, that corresponds to reasonable beliefs about the longest time over which one of the variables could help predict the other and the lag choice must correspond to the one that minimizes the information criteria.

The Granger causality is defined by two components: “The first is that the cause occurs before the effects, the second reports that the cause includes information about the effects that is unique and it is not in another variable”.

In formal terms, the test involves estimate the following regressions:

$$x_t = \sum \alpha_i \; x_{t-1} + \sum \beta_i \; y_{t-1} + \varepsilon_t \qquad (23)$$

$$y_t = \sum \alpha_i \; y_{t-1} + \sum \beta_i \; x_{t-1} + \varepsilon_t \qquad (24)$$

Where ε_t are the residuals that we assume to be uncorrelated. *I* takes integer values (0, 1, 2…*i*) and *t* is time.

Equation 23 states that current values of X are related to past values of X itself and the lagged values of Y. Equation 24, on the other hand, suggests a behavior similar to the variable Y. In general terms, if variable X Granger-cause changes in variable Y, then X must precede Y changes temporarily. Notice that the X and Y variables must be stationary so that we can apply the causality test. If the lagged coefficients of Y are jointly different of zero in equation 23, we can say that Y causes Granger X. If the lagged coefficients of X are jointly different of zero in equation 24, we can say that X causes Granger Y.

In conclusion, the null hypothesis of the Granger Causality test is that X does not Granger-cause Y in the first regression and that Y does not Granger-cause X in the second regression.

5.3. Cointegration

The concept of cointegration was introduced by Engle and Granger (1981). The economical interpretation runs as it follows – if two or more nonstationary series are bounded by a linear combination:

$$\ln y_{1t} - \beta \ln y_{2t} = \mu_t \tag{25}$$

In order to exist a long-term equilibrium relationship, so even if they present an isolated stochastic tendency, in the long-term, series will have a route quite close. The difference between series will be stationary and they are told cointegrated (Engle and Granger, 1987). In the above described equation, β denotes the cointegration parameter[15] which is not null and μ_t[16] represents the obtained residues from the regression of $\ln y_{1t}$ over $\ln y_{2t}$.

According to the definition of Engle and Granger (1987), if y_t is a vector of *n* elements:

$$y_t = (y_{1t}, y_{2t}, \dots, y_{nt}) \tag{26}$$

We say that the variables are cointegrated of order *(d, b)* and we denote it as $y_t \sim CI(d, b)$ if: every y_t elements are *I(d)*, which means, individually series will have to be integrated of the same order; there is a $\alpha = (\alpha_1, \alpha_2, \dots, \alpha_n)$ vector, where the linear combination $Z_t = \alpha y_t = (\alpha_1 y_{1t}, \alpha_2 y_{2t}, \dots, \alpha_n y_{nt})$ is integrated of order *(d, b)*, in other words, is integrated of inferior order, where $d \geq b \geq 0 \; e \; \alpha \neq 0$.

The α vector represents the cointegrating vector and if y_t is a vector with *n* elements, then it can only exist until *n*-1 cointegrating vectors. According to the literature we have essentially two methods to estimate that vector. The first one starts with a statistical analysis, therefore obtaining the cointegrating vector, making the dynamic specification posteriorly. This method is known as the two-steps method (Engle-Granger Methodology).

[15] The cointegrating parameter ß is super-consistent, i.e. it converges asymptotically to its true value at a much faster rate than the usual least squares estimator with stationary variables (Stock, 1987).
[16] The obtained μ_t residues are self-correlated, since they capture omitted dynamic terms and any bias due to endogeneity (Engle and Granger, 1987). In other words, to maintain long-term equilibrium captured by the parameter ß, it must occur some dynamic adjustment process of the short-term variable.

Another methodology known as the Johansen approach is more general, where a dynamic equation system is used. This methodology is utilized when there is more than one cointegrating vector. Johansen proposes two statistics to test the significance of cointegrating vectors that will be mentioned and deepen down below.

5.3.1. Engle-Granger Test: Two-steps method

One of the possibilities to check the existence of cointegration is the Engle and Granger method which consists in obtaining estimations of equilibrium potential errors ($\mu_t{}'s$) estimating with the OLS the parameters of the potential cointegration equation. In other words, if $\varepsilon_t = \hat{\mu}_t = y_{t+1} - \hat{\lambda}_1 - \hat{\lambda}_2 y_{t2} - \cdots - \hat{\lambda}_k y_{tk}$, it is all about effectuating unit root tests over OLS residuals.

However, when we use OLS residuals, the distribution (asymptotic) of test statistics is no longer the DF, but the Engle-Granger (EG), so-called because these were the first authors to obtain tables of critical values. In reality, critical values are now even more demanding (higher absolute values) and they are more demanding the greater the number of stochastic regressors included. This happens because OLS residuals tend to present a "more stationary than real errors" behavior and this tendency accentuates when the referred number increases. Just like in the DF and ADF tests we also have AG and AEG (when necessary we introduce the lag of the dependent variable), nevertheless in many texts, these tests continue to be denominated by AD and ADF.

However, given the "super consistency" of the OLS estimator in case of cointegration, Engle and Granger proposed a two-step estimation method. In the first step the vector of cointegration is estimated, i.e. we estimate long-term multipliers based on static regression:

$$y_t = \lambda_1 + \lambda_2 x_t + \lambda_3 z_t + \mu_t \qquad (27)$$

In the second step, the OLS residuals of the first step are used as estimators of equilibrium errors[17]:

$$\Delta y_t = \alpha \hat{\mu}_{t-1} + \delta_1 \Delta y_{t-1} + \gamma_{10} \Delta x_t + \gamma_{11} \Delta x_{t-1} + \gamma_{20} \Delta z_t + \gamma_{21} \Delta z_{t-1} + \varepsilon_t \qquad (28)$$

[17] The concept of ECM (error correction model) will be posteriorly developed.

And notice that in this equation, because all involved variables are stationary, inference usual methods are valid since $\varepsilon_t \sim iid$.

5.3.2. Johansen Method

The Johansen Method is based on the VAR model (vector autoregressive) without constrains, representing in terms of levels of relevant variables for the analysis. To illustrate the VAR model, consider the following vector equation:

$$y_t = \Pi_1 y_{t-1} + \cdots + \Pi_p y_{t-p} + \mu + \varepsilon_t \qquad (29)$$

Where $y_t$represents a vector with k endogenous[18] nonstationary variables, Π_i represent matrixes $k \times k$ of parameters and μ_t represents a vector of integrated residuals and *iid* (independent and identically distributed) with average equal to zero and a matrix with contemporaneous Ω variances and covariances. The matrix Ω is positive defined and so the residuals are not correlated in series, but they might be contemporaneously correlated. The vector equation 29 is mentioned in the reduced form, so each variable in y_t is dependent of their lagged values, of the lagged valued of other variables of the system and of the μ constant.

The vector autoregressive models (VAR) appeared in the 1980s as a response to the criticism to the large number of constrains imposed to estimations made by structural models. Accordingly to Sims (1980), this kind of model allows modeling dynamic relationships between joint endogenous variables, unimposing strong constrains *à priori* when we stand before particular structural relationships or exogeneity[19] of some variables. The idea was to develop dynamic models with minimal constrains, in which all economic variables would be treated as endogenous. Therefore, VAR models examine linear relationships amongst every variable and lagged values of their self and of all other variables, just imposing constrains of the choice of the relevant set of

[18] Variables determined by the solution of economic models. The models are built to estimate the value of those variables from shocks or changes in the economy.

[19] Exogenous variables: Decisive variables of economic models. Economic models are built based on these variables, assuming that their values are not affected by other variables in the model. Therefore, other variables in the model are not able to affect this variable. Shocks or changes in the economy are represented by changes in exogenous variables. From these shocks, the model is solved mathematically to determine the value of the endogenous variables.

variables and the maximum number of lags which is normally chosen based of statistic criterion – Akaike (AIC) or Schwarz (SIC)[20].

As a result, Johansen methodology involves generally the following previous steps:

1º - Testing the order of integration of the variables of the model falling back on ADF tests, for instance;
2º - Choosing the lag number of the VAR model and identifying eventual exogenous variables (including deterministic variables) to include in the cointegrating space, so that the residual be white noise.

When the variables in y_t are integrated of order 1, I (1), or integrated of superior order, the estimation of the VAR model with no constrains, represented on equation 21, may lead to spurious regressions, unless it is present at least in one cointegrating vector. As referred above, if a linear combination of two or more integrated variables of order 1 or superior is stationary, then those variables are denominated as cointegrated. The cointegrating equation may be interpreted as a long-term equilibrium relationship between variables.

When transforming every variable, turning them stationary, they lose consequently every long-term relationship. A solution for such problem is to use an error corrector model (ECM) mechanism, suggested by Engle and Granger (1987) and posteriorly by Johansen (1988) who recovered lost relationships with differentiation.

The Johansen Method consists essentially on the study of the cointegrating characteristic (*r*) of the VAR system. For that purpose, the system represented of equation 29 may be written in the following form of error correction (VECM)

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \mu + \varepsilon_t \tag{30}$$

[20] Schwarz criterion: Given any two estimated models, the model with the lower value of SIC is the one to be preferred.
Akaike criterion: Given a set of candidate models for the data, *the preferred model is the one with the minimum AIC value.* Hence AIC not only rewards goodness of fit, but also includes a penalty that is an increasing function of the number of estimated parameters.

Where $\Pi = \sum_{i=1}^{p} \Pi_i - I$ and $\Gamma_i = -\sum_{j=t+1}^{p} \Pi_j$

This system specification contains information about the adjustment parameters of the model in the short and long terms, through $\hat{\Gamma}$ and $\hat{\Pi}$ estimates, respectively. If y_t is a vector of variables I (1), then Δy_t and $\Gamma_i \Delta y_{t-i}$ are I *(0)* and Πy_{t-1} is a linear combination of variables I (1), being itself I (0), given the assumptions related to the disturbances. The matrix $\Pi_k$may be factored as $\Pi = \alpha\beta$ where α represents the speed adjustment (factor loadings) to the disequilibrium and β is the matrix of long-term coefficients, i.e. the cointegrating vectors (the error correcting mechanism in the system). This happens when there are *r* cointegrating vectors, where $0 < r < k$. The cointegrating vectors denote a mechanism of error correction in the VAR system.

Once determined the number of cointegrating relationships and estimated the matrixes β and α, the VAR is estimated incorporating those cointegration relationships. When the cointegrating characteristic *r* is equal to the number of endogenous variables in system *k*, the variables in level are stationary and the usual methods of estimation of the VAR can be utilized. When r=0, we have $\Pi = 0$, there is no cointegrating relationship amongst variables of the system. In this case, we should use VAR in the first differences, not involving long-term elements. Notice that the determination of the cointegrating characteristic is all about determine how many cointegrating vectors there are in β or, equivalently, how many columns are null in matrix α. This is equivalent to determine the number of rows linearly independents that exist in matrix Π. Johansen (1990) proposed two tests to assess the hypothesis of the cointegrating characteristic:

The statistics of the trace and maximum eigenvalue statistic:

Trace Test:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} \ln(1 - \hat{\lambda}_i), i = (r + 1, \dots, n) \qquad (31)$$

Maximum Eigenvalue test:

$$\lambda_{max}(r, r + 1) = -T \ln(1 - \hat{\lambda}_{r+1}) \qquad (32)$$

Where T is the number of observations; r= 0, 1… g-1, r is the number of cointegrated vectors under the null hypothesis and $\hat{\lambda}_i$ is the estimated value of the i^{th} ordered eingenvalues from the Π matrix. Intuitively, the larger the $\hat{\lambda}_i$, the lager and more negative will be the $\ln(1 - \hat{\lambda}_i)$ and hence the lager will be the test value. The eigenvalues will have associated different cointegrating vectors, the eigenvectors. A significantly non-zero eigenvalue indicates a significant cointegrating vector. In the first case the alternative hypothesis is that the characteristic is *k* and in the second case, the alternative hypothesis is that the characteristic is *r+1*.

The test for cointegration between variables is calculated by looking at the rank of the matrix Π considering its eigenvalues. The rank of the matrix is equal to the number of its characteristic roots (eigenvalues) that are different from zero. The eigenvalues, denoted by λ_i are put in ascending order $\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_g$. If λ_s are roots, in this context they must be less than 1 in absolute value and positive, and λ_1 will be the largest (close to one) while λ_g will be lowest (close so zero). If variables are not cointegrated, the rank of Π will not be significantly different from zero, so $\lambda_i \approx 0, \forall_{i.}$. The test statistics actually incorporate $\ln(1 - \lambda_i)$ rather than λ_i themselves, but still, when $\lambda_i = 0, \ln(1 - \lambda_i) = 0$.

Therefore, according to the trace test, the objective is to test H_0 successively, if r=0 (non existence of cointegrating vectors), $r \leq 1, r \leq 2$ ..., until H_0 is not rejected. The second test (Maximum Eigenvalue Test) contemplates the hypothesis that there are at most *r* cointegrating vectors against the alternative of existing *r+1*. The corresponding value of *r* coincides with the number of cointegrating vectors. Both presented tests have an asymptotic distribution than their critical values were obtained by Johansen and Juselius (1990). The trace test is still presented by Johansen (1988).

Generally, if the test statistics is greater than the critical value from Johansen's tables, we reject the null hypothesis that there are *r +1* (for λ_{trace}) or more than *r* (for λ_{max}). The test is conducted in a sequence and under the null, *r = 0, 1… g-1* so that the hypothesis for λ_{max} are:

$$H_0: r = 0 \; versus \; H_1: 0 < r \leq g$$
$$H_0: r = 1 \; versus \; H_1: 1 < r \leq g$$
$$H_0: r = 2 \; versus \; H_1: 2 < r \leq g$$
$$H_0: r = g - 1 \; versus \; H_1: r = g$$

The Johansen method allows a large variety of hypothesis tests involving the coefficients α and β using Likelihood Ratio tests (Johansen e Juselius, 1990)[21].

The Error Correction model becomes important since it allows the connection between aspects related to the short and long terms dynamics. Hence, the "mechanisms" of error correction intend to provide a path to combine modeling advantages both in level and in differences. The error correction model intends both the dynamics of the adjustment process in the short (variations) and long (levels) terms and they are modeled simultaneously. If the series under study in this thesis (GEYR for the 5 countries) are nonstationary but integrated of the same order, we can utilize tools of cointegration to analyze the existing relationship of the ratio between countries. In this case, although the series are stationary, if a linear combination of those variables are stationary, then series are said to be cointegrated, thus there is long-term dependency.

[21] Among these, we highlight the tests of proportionality between the variables and the tests of weak exogeneity. In a bivariate context, if the variables are cointegrated, the characteristic of Π is equal to 1, so that α and β are the vectors of the type (2 × 1). In this case, the proportionality test variable is equivalent to test if β = (1, -1). The test of weak exogeneity, on the other side, is equivalent to test, for example, if the i^{th} row of α is zero. In this case, the i^{th} endogenous variable is said to be weakly exogenous concerning β parameters (Menezes et al. 2002). However, these concepts are outside the scope of this work.

6. Empirical Study

In this chapter we present all the empirical results and the computation of all tests described in the previous chapter. In section 6.1 we start by doing an economic analysis of PIGS and especially the indicators that the GEYR encompasses. Afterwards, by introducing all the information about the GEYR computation for the countries under study, analyzing individually every series. We analyze its empirical distribution through graphical analysis and through a computation of some statistics, in order to evaluate some location and dispersion measures. This analysis is effectuated for the two computation methodologies of the GEYR presented in chapter 4.

In section 6.2, the goal is to analyze the order of integration of the series and the individual behavior of each one of them, i.e. if they are stationary or nonstationary. For that we apply the Augmented Dickey Fuller test and to sustain that, the analysis of the PP and KPSS tests is also presented. Only after we apply these tests and verify the order of integration of the series we are able to understand to which series we can apply cointegration procedures.

In section 6.3 we apply cointegration analysis using the Johansen cointegration tests. Both Trace statistic and Maximum Eigenvalue statistic were used to confirm the presence of one cointegrating long-term relationship between the GEYR series for each country under study. With the cointegration condition valid, the VEC model estimation for each cointegration relationship was estimated. For the variables that do not present themselves cointegrated, the short-term dependence for the variations of the series (log first differences) will be verified in the subsequent section.

Lastly, in section 6.4, the Granger causality tests will be applied to the series that revealed to be stationary in levels. Therefore, the main goal in this section is to verify if there is any causality relationship between variables, i.e. if there is short-term dependency. If the relationship exists, then the VAR model will be estimated. All these econometric procedures will be applied through the *Eviews* software (econometric software) which contains all tests. It is also important to refer that this econometric analysis will be applied to the GEYR values, resulting from the two different computing methodologies. The series resulting from them first methodology are denominated as GEYR and the series from the second are denominated as GEYR1.

6.1. Data Analysis

In this section we introduce the GEYR time series data set. First we evaluate its behavior by presenting its chronogram and by performing a descriptive statistics analysis. The data consists in the *Bloomberg European Dated Forties Oseberg Erofisk Price* and it was obtained through the Bloomberg terminal[22].

One of the main goals is to analyze and understand the GEYR behavior and for that we utilize two methodologies with different variables implicit in the ratio computation. The purpose of using two computing methodologies is to verify if both give the same investment decisions or, instead, if both give us contradictory decisions. To be able to obtain a larger temporal period we opt to collect quarterly data (through a quarterly analysis) instead of monthly data. Therefore, the historical data refers to the third quarter of 1977 until to the second quarter of 2012 for Portugal, Ireland, Greece, Spain (PIGS) and Germany, contemplating the two approaches of the GEYR computation. It is important to refer that initially Italy was considered in the study, however all the information available on *Bloomberg* required to the GEYR computation only existed after 2003. Since in a cointegration analysis every series need to have the same sample period, we opted to remove Italy from the study in order to not jeopardize the remaining countries, considering that the number of observations would be substantially reduced.

Figure 1- PIGS, PIIGS and PIIGGS

The "PIGS" was an acronymic used in the financial crisis of 2008-2009 in order to characterize the most indebted countries. At the end of 2011, Italy was also considered in the set of countries called as PIIGS. More recently, at the beginning of 2012, Great Britain was included in this lot, adding a "G" – PIIGGS (Figure 1)

On the other hand, it is favorable to include in this study only PIGS, because the indebtedness of these countries was given the same sample period, whilst the behavior of the indebtedness of Italy and Great Britain revealed to be different only after 2011.

[22] A service that provides financial news and data to some companies and organizations.

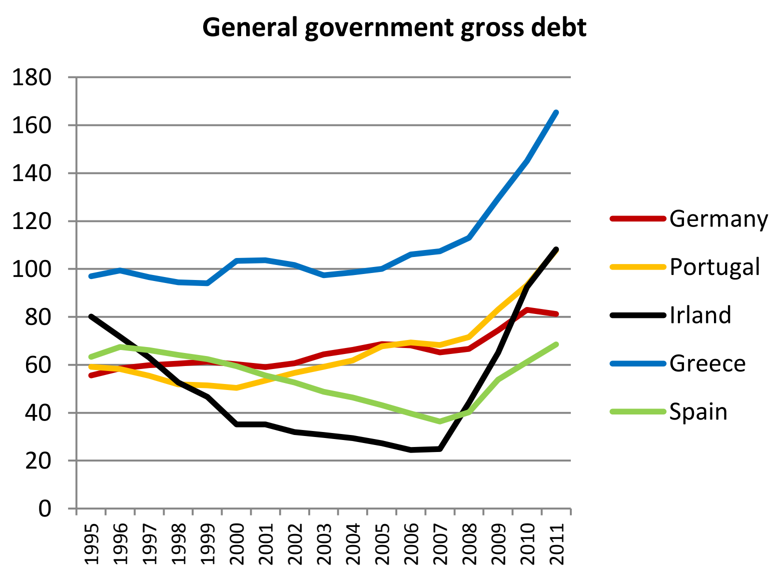
Contrasting with countries that go through great indebtedness (PIGS) in Europe, Germany was chosen to verify if trading decisions in this country are similar to the indebted countries or, on the other hand, decisions tend to lead an opposite behavior. It becomes interesting to understand the GEYR movements of European countries that have higher government debt versus the country with greater economic stability, and if this set of countries with contrasting economic situations may or not be related when we talk about the GEYR. It is also interesting to check if Germany has some influencing power over decision making of other countries, changing their behavior according to its investment purpose. For instance, will a sell equity decision, in the long-term, indicated by the GEYR in Germany tends to provide the same decision to other countries?

6.1.1. Analysis of economic indicators of the countries in study

Initially it is important to understand what is like the economy in each country under study, because the GEYR computation is sensitive to economic variations that occur in each country, hence the relevance of this analysis, since it allows the vindication of some conclusions that will be drawn during this chapter.

Accordingly to Figure 2, we realize that Ireland, when it comes to the government gross debt, revealed after 2007 large changes passing from the value of 20% GDP in 2007 to values above 100% in 2011. It is also after 2008 that generally government gross debt increases in every country, but Germany presents drop-offs in this indicator in 2011. Greece is the country that presents government debt values superior to the other countries. Lastly we can see that Portugal

Figure 2 - Evolution of Government Debt PIGS and Germany

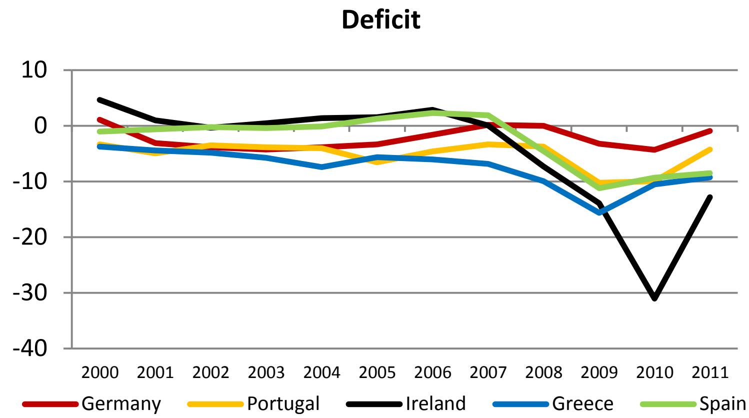


Source: Eurostat

Note: the vertical axis of the graphic corresponds to the% of GDP and million EUR always presented a tendency of behavior similar to Germany, having values relatively superior only after 2006. On the other hand, since 2007, Spain presents an increasing trend to government debt.

The highlighted country when it comes to government revenue is Germany followed by Portugal. The country that reveals fewer entries of revenues is Ireland. A relative analysis to the expenditure is not so linear. Until 2007 Ireland was presented as a country that had less expenditure, however after that year revealed a major irregularity in its values, obtaining very high levels in 2010 (superior to 65%) and a drop-off to 50% in 2011 (see Annex 1). It is noticeable that after 2008, Spain is the only country below Germany when it comes to expenditures, however when it comes to revenues it lies way below Germany (see Annex 1).

Figure 3 - Deficit for PIGS and Germany



Source: Eurostat

Note: vertical axis of the graphic % of GDP

Lastly, in Figure 3 we can see that generally all countries present deficit, Ireland is the one that presents higher deficit in 2010 and Greece from 2000 until 2009 is the country that presents higher deficit. After 2007, Germany presents minor deficit distinguishing from the others and it is important to reference that Germany's public deficit presented values too close to zero (-0.9). Portugal presented an improvement in the deficit from 2010 to 2011. The indicators explain the GEYR behavior throughout the temporal horizon, since simultaneously they make bond yield or dividend yield variables vary. The confidence that investors put in each country is also crucial to the variations of the GEYR values and these indicators help to provide less or more confidence to the analysts regarding the countries.

Throughout the study we can verify that the peak of deficit that occurred in Ireland in 2010 had an impact in the GEYR value (see Figure 4), registering a drop-off in the GEYR value in the last quarter of 2010.

After an economic analysis of the countries involved in the GEYR, we present the number of observations and the considered variables in the ratio computation in a more evocative and perceptible way in the following table:

Table 4: Data set to calculate GEYR

This table presents the size of the sample that we will consider in our study to every country for the two methodologies of computation (GEYR and GEYR1). It also indicates the variables for the ratio computation according to the information from *Bloomberg* Terminal.

Meth.	Country	Index	Period	No. of Obs.	Variables for the GEYR computation
GEYR	Portugal	PSI 20	Q3 1997 - Q2 2012	n=60	*- Portuguese Government Bonds 10 Year - Equity Dividend Yield*
	Ireland	FTSEMIB			*- Ireland Government Bonds 10 Year - Equity Dividend Yield*
	Greece	ASE			*- Greece Government Bonds 10 Year - Equity Dividend Yield*
	Spain	IBEX 35			*- Spanish Govt Generic Bonds 10 Year - Equity Dividend Yield*
	Germany	DAX30			*- German Government Bonds 10 Year - Equity Dividend Yield*
GEYR1	Portugal	PSI 20	Q3 1997 - Q2 2012	n=60	*- Portuguese Government bonds 10 Year - Earnings Yield*
	Ireland	FTSEMIB			*- Ireland Government Bonds 10 Year - Earnings Yield*
	Greece	ASE			*- Greece Government Bonds 10 Year - Earnings Yield*
	Spain	IBEX 35			*- Spanish Govt Generic Bonds 10 Year - Earnings Yield*
	Germany	DAX30			*- German Government Bonds 10 Year - Earnings Yield*

It is also important to refer how will we denominate and describe the series under study for a better understanding throughout the empirical study. For that, here is the following table:

Table 5 – Description of variables

The objective of the conception of this table is to when we are analyzing the tables from the outputs of *Eviews*, we can understand which variables are being tested and analyzed and what do the used acronyms mean.

First Methodology Using dividends yield	Second Methodology Using earnings yield	
Variables	**Variables**	**Description**
GEYR_Portugal	GEYR1_Portugal	Gilt-Equity Yield Ratio for Portugal
GEYR_Ireland	GEYR1_Ireland	Gilt-Equity Yield Ratio for Ireland
GEYR_Greece	GEYR1_Greece	Gilt-Equity Yield Ratio for Greece
GEYR_Spain	GEYR1_Spain	Gilt-Equity Yield Ratio for Spain
GEYR_Germany	GEYR1_Germany	Gilt-Equity Yield Ratio for Germany
LogGEYR_Portugal	LogGEYR1_Portugal	Natural logarithm Gilt-Equity Yield Ratio for Portugal
LogGEYR_Ireland	LogGEYR1_Ireland	Natural logarithm Gilt-Equity Yield Ratio for Ireland
LogGEYR_Greece	LogGEYR1_Greece	Natural logarithm Gilt-Equity Yield Ratio for Greece
LogGEYR_Spain	LogGEYR1_Spain	Natural logarithm Gilt-Equity Yield Ratio for Spain
LogGEYR_Germany	LogGEYR1_Germany	Natural logarithm Gilt-Equity Yield Ratio for Germany

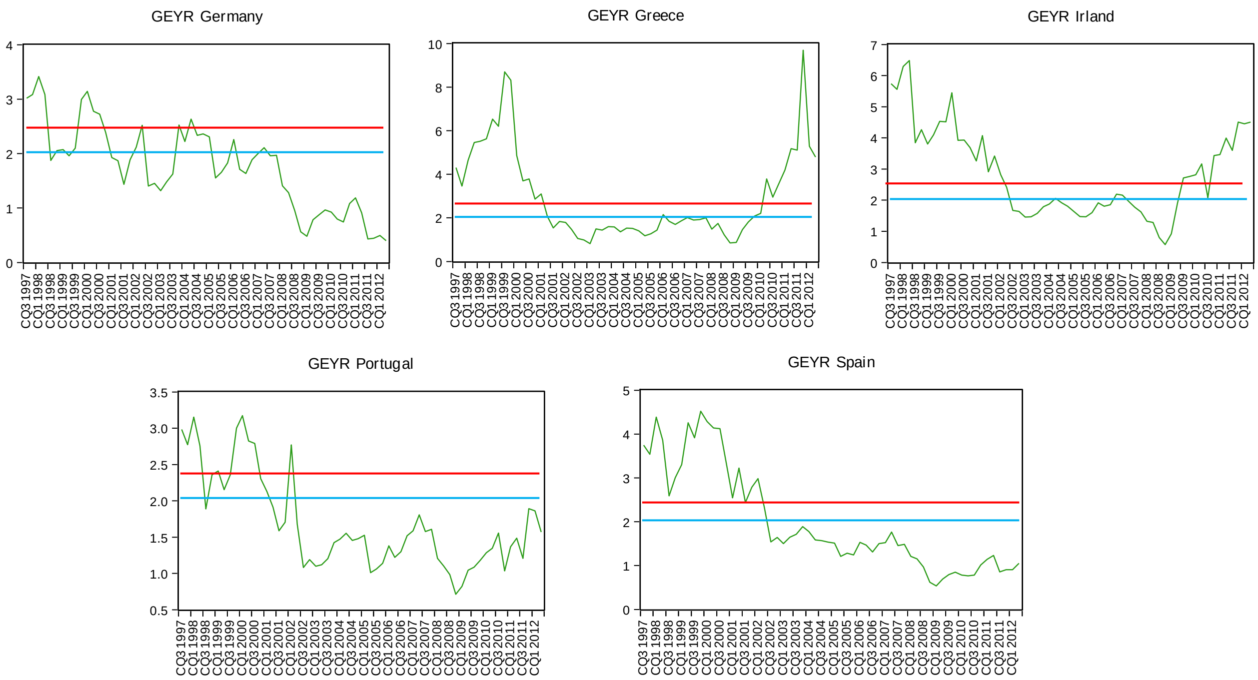
Note: the denomination for the first differences of logarithms is DlogGEYR with the indication of each country.

The next step is to analyze individually the behavior of each series through graphics and they will be presented for the two methodologies already explained and identified.

6.1.2. GEYR using dividend yield (GEYR)

Initially we analyze the individual behavior of the GEYR series for each country, in order to identify if the data generating stochastic process of each series is stationary or nonstationary, since in general we suppose that economic and financial series are not affected by the time variable. Hence, a first step to identify the behavior of the studied series is made through graphic representation of the data. Figure 4 shows the obtained results for the series under study.

Figure 4 - Evolution of GEYR for the five countries being studied



Legend:
Above 2.4 Sell Equity
Below 2 Buy Equity

Source: Bloomberg

Through graphical analysis it seems that the five series are nonstationary since they do not show constant mean and variance, on the contrary the value irregularity is quite notorious. This behavior would already be expectable, because the ratio computation involves variables directly linked to the financial market, so being exposed to the volatile of these financial securities.

As it was mentioned in the chapter related with the ratio description, it is important to analyze the results for each country according to the decision rule developed by Hoare Govett which is applied to the first methodology of the GEYR computation – bond yield ratio over dividend yield. Therefore, for a better analysis we present the following table that mentions timeslots, specifying when to buy or sell equities according to the results.

Table 6 – Trading decisions for different timeslots: 1st methodology (GEYR)

This table indicates which are the periods in which we should buy or sell equities according to the results obtained by the ratio computation. The obtained values for sell equity decision were all superior to 2.4 and the obtained values to buy equities were inferior to 2, all the remaining slots that are not presented, show values between 2 and 2.4 and the trading decision is to hold equities.

Decision	GEYR Portugal	No.	GEYR Ireland	No.	GEYR Greece	No.	GEYR Spain	No.	GEYR Germany	No.
Sell Equity *Overvalued* *>2,4*	Q3 1997 - Q2 1998 Q1 1999 Q4 1999 - Q3 2000 Q1 2002	**10**	Q3 1997 - Q2 2002 Q3 2009 - Q2 2010 Q4 2010 - Q2 2012	31	Q3 1997 - Q1 2001 Q2 2010 - Q2 2012	24	Q3 1997 - Q1 2002	19	Q3 1997 - Q2 1998 Q4 1999 - Q3 2000 Q2 2002 Q4 2003 Q2 2004	11
Buy Equity *Undervalued* *<2*	Q3 1998 Q2 2001 - Q4 2001 Q2 2002 - Q2 2012	**45**	Q3 2002 - Q1 2004 Q3 2004 - Q3 2006 Q2 2007 - Q2 2009	25	Q3 2001 - Q4 2005 Q2 2006 - Q4 2006 Q2 2007 - Q3 2007 Q1 2008 - Q3 2009	30	Q3 2003 - Q2 2012	40	Q3 1998 Q2 1999 Q1 2001 - Q4 2001 Q3 2002 - Q3 2003 Q2 2005 - Q4 2005 Q2 2006 - Q1 2007 Q3 2007 - Q2 2012	38

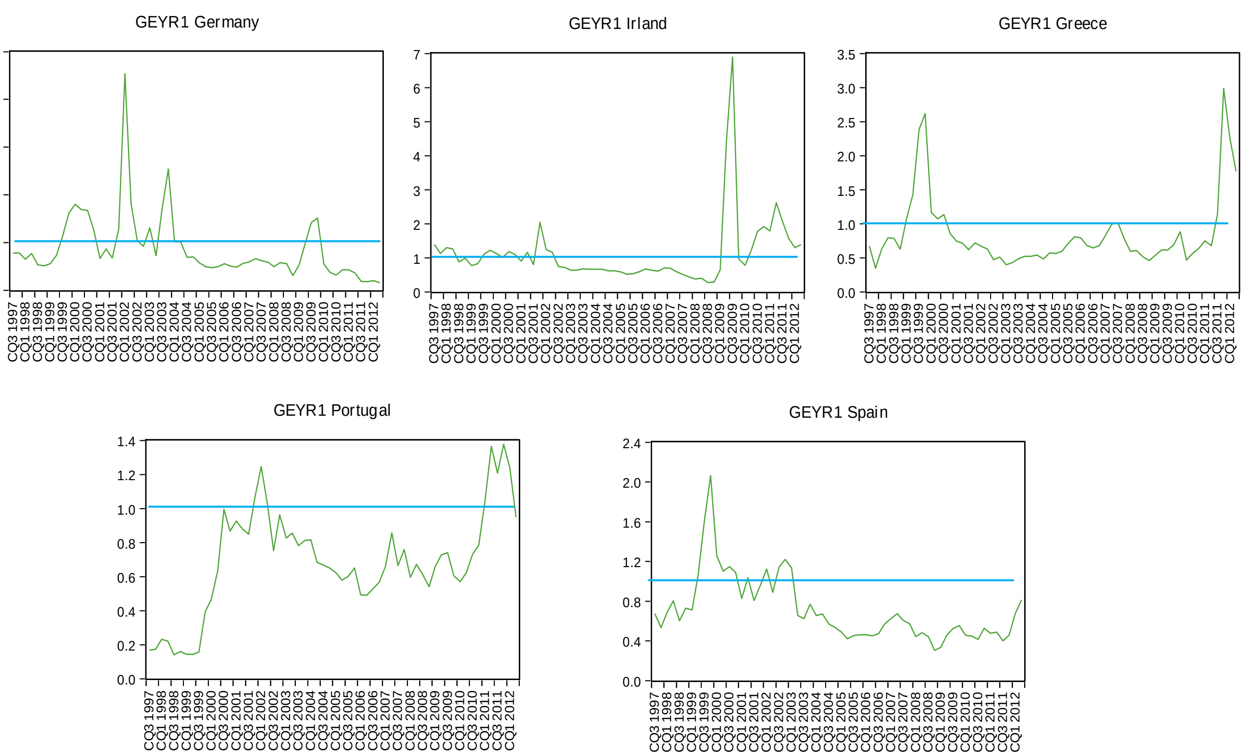
As we can see, Germany is the country that most varies its trading decisions. On the other hand, Spain is the country that presents more stability, there are few changes on strategy (Annex 2). Only for Greece and Ireland the ratio indicates for the years of 2011 and 2012 (period of economic recession) to sell equity strategy, suggesting that equities are overvalued, hence we should sell equities and invest in bonds because its yield has an increasing trend (bond yield is notoriously higher in this period when comparing to other periods). All other countries in the referred years present a buy equities strategy indicating that equities are undervalued. When equities are undervalued is due to their values being below their intrinsic value, so it is a good time to invest, buying equities, because dividend yields present more profitable values than bond yields (values for dividend yield show a tendency to increase and bond yield to decrease). We can still affirm that these occurring fluctuations are caused by the period of economic instability and that has an impact on the referred periods and on the mentioned countries. It is demonstrated in the initial periods of the series that all countries, in general, present the same behavior, confirming the sell equity decision. However, in the periods of 2010, 2011 and 2012 the tendency of similar strategy decisions between countries is not verified (see Annex 2), since Greece and Ireland have opposite decisions (sell equity) as to the Germany decision (buy equity).

In every country and according to the sample period, buy equities strategy predominates except for Ireland which presents more sell equity strategy periods, so it is important to study in the next section the cointegration of these series to understand if there is any long-term relationship of the GEYR between the countries, i.e. if a common trend of series is verified concerning the investment behavior based on the GEYR results.

6.1.3. GEYR using earnings yield (GEYR1)

This methodology well-known as Fed-model is more recent and for that there is still a lot to develop. Resembling the previous topic, it becomes necessary to analyze series through graphics to understand the individual behavior. Then we will present series denominated as GEYR1 for each country.

Figure 5 - Evolution of GEYR1 for the five countries being studied

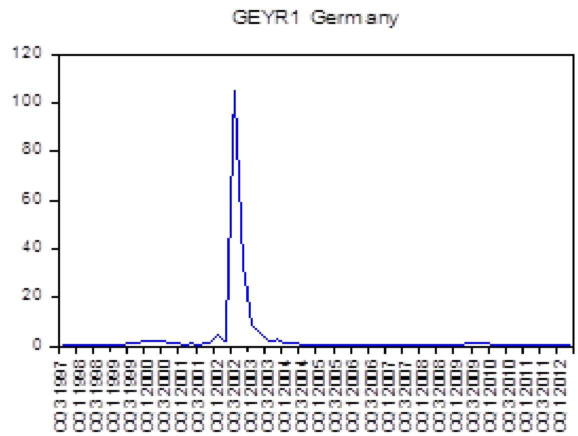


Legend:
Above 1 Sell Equity
Below 1 Buy Equity

Source: Bloomberg

This GEYR1 methodology is designated by the ratio between bond yield and earnings yield index (inverse of price earnings ratio) and as we can see it presents slightly different conclusions comparing to the previous, since not every series give us indications of nonstationarity. Greece and Ireland present series relatively constant, presenting only some structural breaks.

Figure 6 – Original series of GEYR of Germany, without extreme point.



Source: Bloomberg

It is important to refer that for the GEYR1 computation of Germany it was necessary to conduct an adjustment of the price earnings ratio values because there were extreme points at the end of 2002 and beginnings of 2003. We could not withdraw these values from the series and since we are carrying a joint analysis we would also have to withdraw the same observations from the other series. According to Figure 6, before proceeding to the series transformation, as we can see, the values for the GEYR1 in 2003 were resoundingly high as consequence of the high price earnings ratio value. After a wide research we managed to understand that those values were a reflection of the restructuration of the German Stock Exchange due to the closure of the *Neuer Markt*[23] which enabled a positive impact on the stock price, increasing the price earnings ratio value. That restructuration enabled the choice between two transaction segments: Prime Standard and Domestic Standard. Prime Standard counted with more rigid rules of corporative governance and incorporated and substituted *Neuer Markt.* According to news from the business newspaper other factors inherent to high market were justified by: "*The main factors leading to the high market shares of Germany were the first signs of reactivation of the U.S. economy, the hopes of a new economic momentum in Germany in 2004 and the Anglo-American military success in major combat in the Iraq war, analysts said*."

[23] Neuer Markt was the largest new stock market that was introduced in Europe in the 1990s and aimed to address small and medium sized pioneering growth firms. That access to public equity markets is mainly valuable for such firms. Nevertheless, the conception of the Neuer Markt had some regulatory flaws and it developed along with a remarkable stock price bubble that broke enthusiastically in early 2000. Therefore, the status of the Neuer Markt suffered from an unexpected decline in market value and plentiful insolvencies and scandals.

So, as a result of this increase the inverse price earnings ratio caused a very high value on GEYR1 in the mentioned period. It is predictable that the investment decision for this period is sell equity, as stated by Peter Stanyer (*Guide Investment Strategy*, 2010, pp. 91-130), the high price earnings ratio (P/E) indicates that the stock market expects the company's earnings to grow fast and vice versa.

To avoid this structural break to the interval of the third quarter of 2002 to the third quarter of 2003 it was considered an average of the previous quarters namely for the third quarter of 2002 it was considered the average of the third quarters of previous years and so on. That said, for a better analysis of the rules of investment decision, taking into account the second methodology discussed in the study, we present the following Table 7 specifying in which periods one should choose to buy or sell equities according to the results obtained for GEYR1.

Table 7 – Trading decisions for different timeslots: 2nd methodology (GEYR1)

This table indicates in which periods one should buy or sell equities according to the results of the computation of the ratio. The values obtained for the decision sell equity are all above 1, the values obtained to buy equity are less than 1. In equilibrium situations the value of the ratio is equal to 1 and in that case should hold equity.

Decision	GEYR1 Portugal	No	GEYR1 Ireland	No	GEYR1 Greece	No	GEYR1 Spain	No	GEYR1 Germany	No
Sell Equity Overvalued *>1*	Q4 2001 - Q2 2002 Q1 2011 - Q1 2012	8	Q3 1997 - Q2 1998 Q3 1999 - Q4 2000 Q2 2001 Q4 2001 - Q2 2002 Q2 2009 - Q3 2009 Q2 2010 - Q2 2012	25	Q1 1999 - Q3 2000 Q3 2007 Q3 2011 - Q2 2012	12	Q2 1999 - Q4 2000 Q2 2001 Q1 2002 Q3 2002 - Q1 2003	12	Q3 1999 - Q4 2000 Q4 2001- Q3 2002 Q1 2003 Q3 2003 - Q2 2004 Q3 2009 - Q4 2009	17
Buy Equity Undervalued *<1*	Q3 1997 - Q3 2001 Q3 2002 - Q4 2010 Q2 2012	52	Q3 1998 - Q2 1999 Q1 2001 Q3 2001 Q3 2002 - Q1 2009 Q4 2009 - Q1 2010	35	Q3 1997 - Q4 1998 Q4 2000 - Q2 2007 Q4 2007 - Q2 2011	48	Q3 1997 - Q1 1999 Q1 2001 Q3 2001 - Q4 2001 Q2 2002 Q2 2003 - Q2 2012	48	Q3 1997 - Q2 1999 Q1 2001 - Q3 2001 Q4 2002 Q2 2003 Q3 2004 - Q2 2009 Q1 2010 - Q2 2012	43

As we can verify the results did not comply at all-time intervals with the methodology discussed above. The major difference between the two methodologies is based mainly in the initial periods

(1997-2002) in which, in the first methodology most quarters showed us to sell equity while using the second method of computation, the opposite happens, the decision to trading that prevails is to buy equity. For this period the country that reflect largest unconformities on the methodology previously addressed is Portugal, Ireland being the country that is more consistent in the two addressed methodologies (see Annex 2). We can also see that between 1997 and 2002, for the second methodology, the decisions of Germany, overall were equal to the decisions of other countries (except Portugal) verifying a common behavior among countries regarding the results obtained from the ratio. This way especially in this period, we can see that in some ways the economic or financial context of countries under study may have influenced investment decisions across countries (see Annex 3Annex 2).

Also in this methodology the predominant strategy is to buy equities for all countries being a reflection of the time horizon used and also of the countries covered in this study. It is because of the disagreement existing between the values of the financial ratios that we reinforce the idea that for better investment decision, investors must always examine the variables that make up the ratios separately for each time period and complete their analysis with other financial ratios, for example, the so-called traditional ratios – price earnings ratio, dividend per share among others, and with other information based on fundamental analysis.

It is still observable through Table 7 that the countries that mostly vary its investment decision according to the results of the ratio are Germany and Ireland and also those countries with the highest values compared to other countries (see Annex 2).

Through the graphical display (Figure 5), excluding other visible structural breaks, it is also evident that Ireland and Greece are those that deviate less from number 1 (equilibrium value) presenting a possible behavior of a stationary series.

Complementing the earlier analysis it becomes interesting to observe and examine some descriptive statistics of the study variables. Therefore in the next subsection we present a joint analysis of the two experimental series addressed.

6.1.4. Joint analysis of the data

Considering the first methodology, and in accordance to the descriptive statistics presented in Table 8 we can see that countries with higher coefficient of variation for the GEYR are Greece and Spain, showing the countries with the highest volatility. The less volatile country in the GEYR variations is Portugal. In the second methodology, the higher coefficients of variation for the GEYR1 are Ireland and Germany that are the two countries that, as we had said initially, exhibit extreme points in some periods of time thus increasing the value attributed to the variation occurred. However, especially in the case of Ireland, although the coefficient of variation is among the highest, if we exclude the extreme points of the graphical view, it is clear that this country presents a more stationary behavior over the others. The countries in the second methodology that present less volatility results in the GEYR1 are Portugal and Spain indicating that there is little variation in values obtained by calculating the ratio. As we can verify, once again both methodologies give different results, even contradictory, as in Spain that in the first approach presents itself as has the highest volatility country and the lowest volatility in the second methodology.

It is normal for this type of situation to happen because the variables used to calculate the GEYR are different, the first methodology considers in the denominator dividend yields and the other considers earnings yield (inverse of price earnings ratio). As it is well-known, the extreme points are more evident in the second methodology, this because when we use the inverse price earnings ratio this indicator is more sensitive to "boom's" registered in the economy (reflected by the stock price). This is the reason why in general we can see that the coefficients of variation are higher in the second than in the first methodology (Table 8). On the other hand, the first methodology presents itself all over the time frame with plenty irregularities showing in all series a typical behavior of nonstationarity. A measure of asymmetry of the distribution is shown by the Skewness coefficient. Whenever this is zero that is because we have a symmetric distribution, for the first methodology the value of this coefficient closer to zero is referring to the GEYR of Germany and for the second methodology it is Portugal. A distribution with a positive Skewness (where the mean is higher than the median) has more data on the right tail, therefore the first methodology for Ireland, Portugal and Spain, Greece have more values on the right tail of the distribution. In the second approach (Table 9) that predominance occurs in all countries.

A value of Kurtosis for a normal distribution has to be three. A distribution that has a kurtosis value greater than three (leptokurtic) has a peak around the mean greater than the peak of the normal distribution and the tails are "heavy" when compared to the normal case. On the contrary, when this value is lower than three we face the so-called platykurtic distributions which have a lower peak around the mean and their tails are more "thin".[24]. In general in both presented methodologies the values tend to be smaller than three, except with Greece in the two methodologies and Spain in the second methodology. The amount corresponding to the measure of kurtosis closer to three is regarding to Portugal's GEYR to both methodologies.

Jarque Bera[25] test emerged because of the need of drawing conclusions more objective about the normality of the series. This test contemplates simultaneously the Kurtosis and Skewness measure. In this study we verify that considering a significance level of 5%, normality hypothesis (null hypothesis) is rejected in the first methodology for series of the countries: Greece, Portugal and Spain and the countries where we can assume that follow a normal distribution are Ireland and Germany. In the case of the second approach only for Portugal the normal assumption is not rejected.

Table 8- Descriptive Statistics of GEYR (using dividend yield)

This table presents some descriptive statistics of the series for the first methodology of computation of the GEYR that is using dividend yields. The figures were generated using *Eviews*.

	GEYR_GERMANY	GEYR_PORTUGAL	GEYR_IRELAND	GEYR_GREECE	GEYR_SPAIN
Mean	1.7564	1.6873	2.8672	2.9690	1.9872
Median	1.8716	1.5212	2.5664	1.9661	1.5308
Maximum	3.4132	3.1724	6.4821	9.6850	4.5187
Minimum	0.4018	0.7133	0.5726	0.8232	0.5351
Std. Dev.	0.7819	0.6448	1.4321	2.0785	1.1665
Skewness	0.0415	0.8703	0.6559	1.3497	0.8406
Kurtosis	2.2387	2.6860	2.6167	4.2788	2.3747
Coef. of variation	0.4452	0.3821	0.4995	0.7001	0.5870
Jarque-Bera	1.4664	7.8215	4.6696	2.2305	8.0433
Probability	0.4804	0.0200	0.0968	0.0000	0.0179

[24] For example Bernoulli distribution follows this behavior
[25] Tests the hypothesis of Skewness=0 and Kurtosis =3

Table 9 - Descriptive Statistics of GEYR1 (using earnings yield)

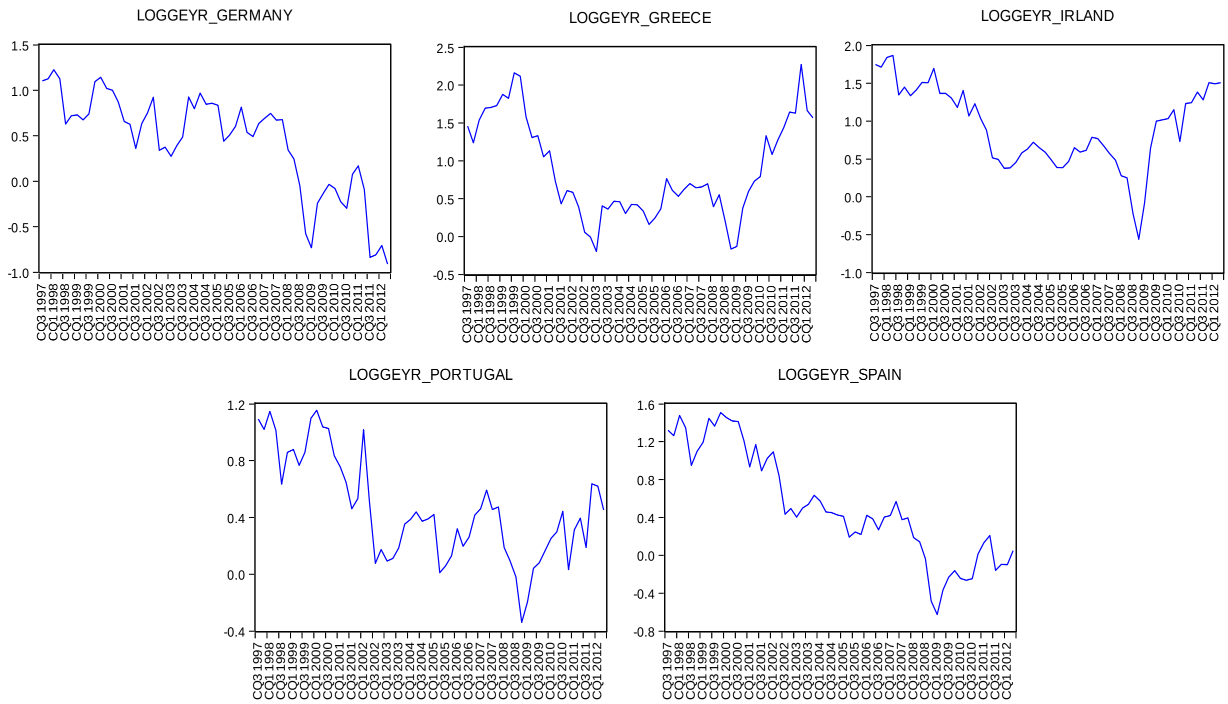
This table presents some descriptive statistics of the series in question for the second methodology of computation of the GEYR, i.e. using earnings yields. The figures were generated using *Eviews*.

	GEYR1_GERMANY	GEYR1_PORTUGAL	GEYR1_IRELAND	GEYR1_GREECE	GEYR1_SPAIN
Mean	0.8692	0.6870	1.1160	0.8412	0.7112
Median	0.6577	0.6657	0.8141	0.6736	0.6141
Maximum	4.5393	1.3775	6.8965	2.9858	2.0642
Minimum	0.1570	0.1397	0.2722	0.3485	0.3037
Std. Dev.	0.6866	0.3053	1.0005	0.5322	0.3286
Skewness	2.9412	0.0409	3.9295	2.5161	1.7186
Kurtosis	1.5082	2.8758	2.1422	9.0388	6.6838
Coef. of variation	0.7899	0.4444	0.8965	0.6326	0.4621
Jarque-Bera	4.5141	0.0553	1.0028	1.5448	6.3462
Probability	0.0000	0.9727	0.0000	0.0000	0.0000

6.1.5. Analysis of logarithms of the series.

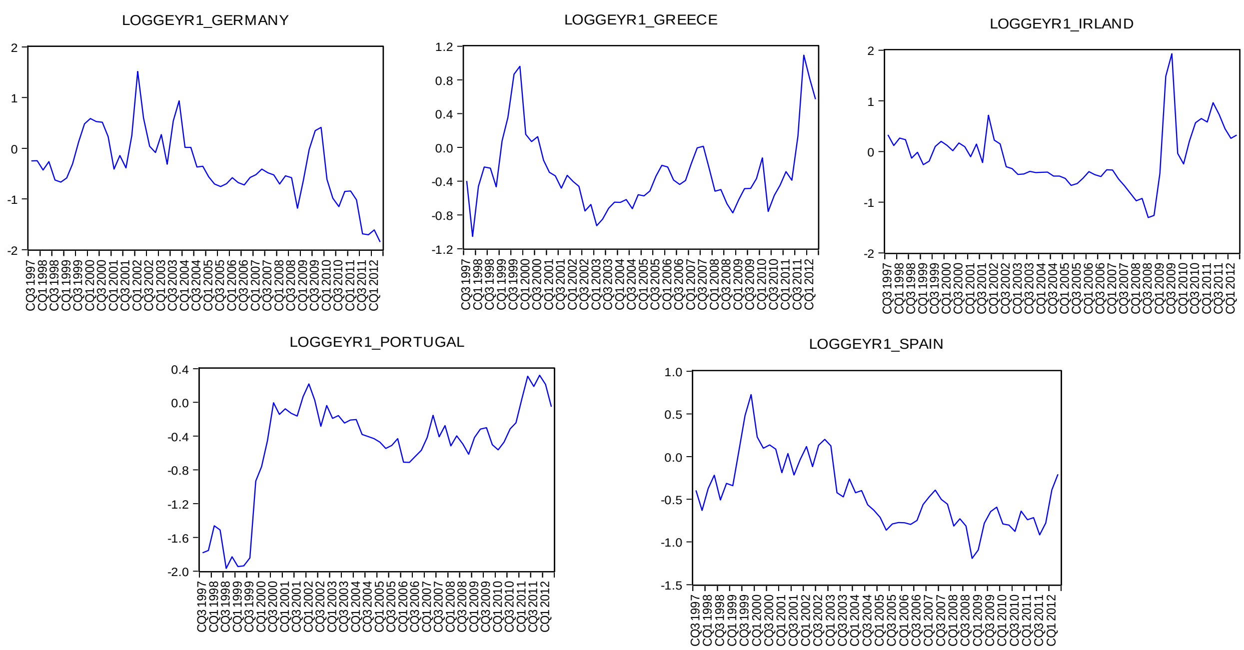
Generally in all series and according to both methodologies there is no common behavior on the considered series. The original values of the series were transformed into natural logarithms, and these are the series that will be considered in the application for testing during this study. Next we present the chronogram for each series.

Figure 7 – Graphics of the studied series' logarithms - 1st methodology



Source: *Bloomberg*

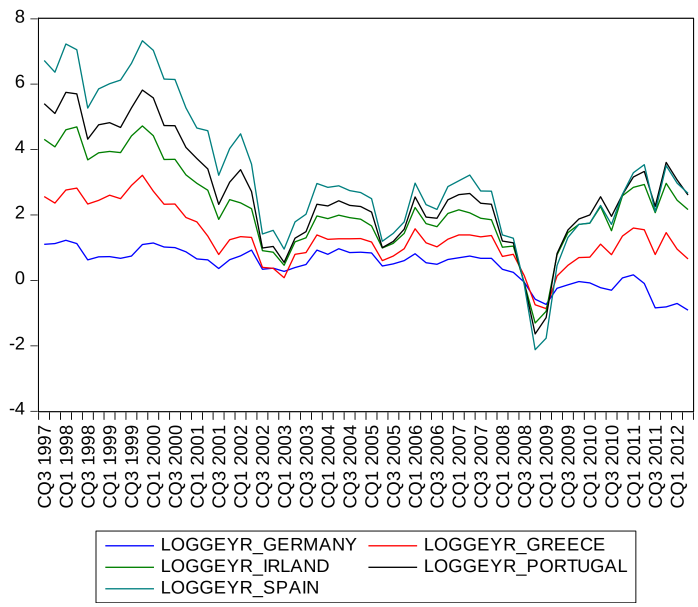
Figure 8 – Graphics of the studied series' logarithms - 2nd methodology



Source: *Bloomberg*

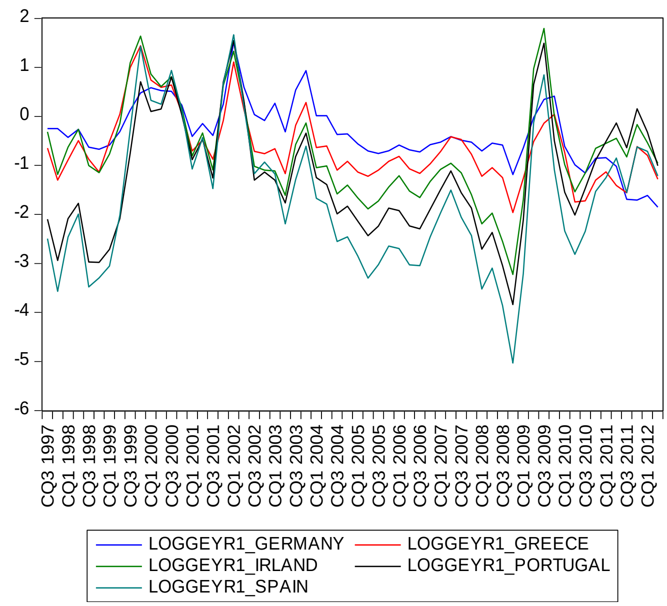
In both methodologies we can verify that the series are quite irregular and not always progressing in the same direction, which means there are periods in which when in some countries there is an increasing trend and others have a decreasing trend. It is clear that, due to the irregularity of the series we can conclude that series seem to be nonstationary. As we can see in Figure 2 during the most recent periods, Ireland started to have an increasing trend comparable to Greece in what concerns the Government Debt economic indicator (although the rates are minor in Ireland where the trend was similar to the Greek one). For a better understanding of the set of variables' behavior, it is important to analyze Figure 9 and Figure 10.

Figure 9 - Evolution of the series' logarithms of the GEYR for all countries – 1st methodology



Source: Bloomberg

Figure 10 – Evolution of the series' logarithms of the GEYR for all countries – 2nd methodology



Source: Bloomberg

In both methodologies the GEYR for Spain, Ireland and Portugal behave in a similar way over time, which means that the difference between observations at any certain time remains approximately constant throughout the whole time period. This is the intuitive idea of cointegration, introduced by Granger (1981) and later published by Engle and Granger (1987) in their seminar paper. Such behavior would be expected because these countries were in the financial and economic crisis that occurred at the same time. Germany differs from all the other countries, in both methodologies, which was also expectable given that it is the most important economy in Europe, being the fourth largest economy worldwide after the United States of America, China and Japan. This means that the economic recession that is verified in PIGS does not occur, at least not with the same intensity, in Germany.

Thus, according to the first methodology and through graphic analysis, there are evidences that cointegration may exist amongst the GEYR of Portugal, Ireland, Greece and Spain because they present similar behaviors and tend to be nonstationary. It is also likely that Germany isn't cointegrated with none of the PIGS, presenting a performance dissimilar from those (see Figure 9).

At last, looking at the second methodology it is possible to understand the trend-behavior of Greece, within the most recent periods (2011 and 2012) which meets the remaining countries that encounter themselves in a great economic instability (see Figure 10) It was in late 2010 that crisis in Greece worsened, due to the discovery that the Greek government was concealing macroeconomic data, one of those being the real national debt value (see figure 2 that highlights the high values of the governmental debt in Greece), indicator that justifies the trend behavior of the GEYR that was calculated to Greece, because it is an indicator that causes a variation of the variables that are implicit in the computation of that ratio.

As it had been verified upon an individual analysis of each set, Greece and Ireland were the countries that presented the most stationary behavior trend. However, it is not clear through a graphic analysis, the behavior of the series relative to the existence of cointegration, making it difficult to draw evident conclusions, such as we did in the first methodology. Therefore, only in the following section of the study, one can draw right conclusions about the nonstationarity of the series and consequently the possible existence of cointegration.

6.2. Unit root test and nonstationarity

As Engle and Granger (1987) have pointed out, individual economic variables may be nonstationary and wonder through time, but a linear combination of them may, over time, converge to a stationary process. Such a process, if present, may reflect the long-term equilibrium relationship and is referred to as the cointegrating equation. Like so, the main goal in this section is to verify the statistical priorities of the GEYR and the GEYR1 series for the five countries in order to understand if these series are stationary or not, and which is their order of integration. For this effect we use the ADF, KPSS and PP tests which will be applied to the series in level (natural logarithm) but also to the first differences of logarithms of the series that revealed to be nonstationary in terms of levels.

6.2.1. Unit root test for GEYR (1st methodology)

In this section we show the unit root tests results that are demonstrated in the following Table 10.

Table 10 - Unit root tests (1st methodology) - GEYR

This table was built based on the outputs generated in *Eviews* and it describes the tests applied to the first methodology of GEYR,

		ADF*			KPSS*		PP*		
		statistic	prob.	Reject Ho**	statistic	Reject Ho***	statistic	prob.	Reject Ho**
Level	LogGEYR_Portugal	-2.438265[b]	0.1081	*Not*	0.176573[a]	*Yes*	-2.438265[b]	0.1359	*Not*
	LogGEYR_Ireland	-1.020377[c]	0.2733	*Not*	0.224266[a]	*Yes*	-1.064822[c]	0.3359	*Not*
	LogGEYR_Greece	-0.834437[c]	0.3503	*Not*	0.232870[b]	*Not*	-0.834437[c]	0.3503	*Not*
	LogGEYR_Spain	-2.582475[a]	0.2896	*Not*	0.088884[a]	*Not*	-2.689797[a]	0.2446	*Not*
	LogGEYR_Germany	-2.515122[a]	0.3201	*Not*	0.174064[a]	*Yes*	-2.628297[a]	0.2698	*Not*
First Differences	LogGEYR_Portugal	-8.387006[c]	0.0000	*Yes*	0.077173[b]	*Not*	-8.387006[c]	0.0000	*Yes*
	LogGEYR_Ireland	-7.070848[c]	0.0000	*Yes*	0.234208[b]	*Not*	-7.071833[c]	0.0000	*Yes*
	LogGEYR_Greece	-7.984838[c]	0.0000	*Yes*	0.213789[b]	*Not*	-7.981459[c]	0.0000	*Yes*
	LogGEYR_Spain	-7.523993[c]	0.0000	*Yes*	0.124767[b]	*Not*	-7.592529[c]	0.0000	*Yes*
	LogGEYR_Germany	-6.889259[c]	0.0000	*Yes*	0.243341[b]	*Not*	-7.098868[c]	0.0000	*Yes*

to verify the existence of a unit root or not, meaning if the series are stationary or nonstationary. They were used three tests and the conclusion to withdraw prevailed with the concordance of at least two tests. They were applied to the series in levels and to the first differences of logarithms aiming to understand which was the integration level of the series (how many times did it need to differentiate itself to become stationary).

a - trend and intercept; b – intercept; c- None; ADF e PP critical values: -3.487845 [a], -2.911730 [b], -1.946447 [c]; KPSS critical values: 0.1460 [a], 0.4630 [b]; * Significant at 5% level; ** Ho: Exist unit root (not stationary); H_1: Don´t exist unit root (stationary);*** Ho: stationary, H_1: Not stationary

Note: the number of lags to the ADF test was, in all variable cases, zero.

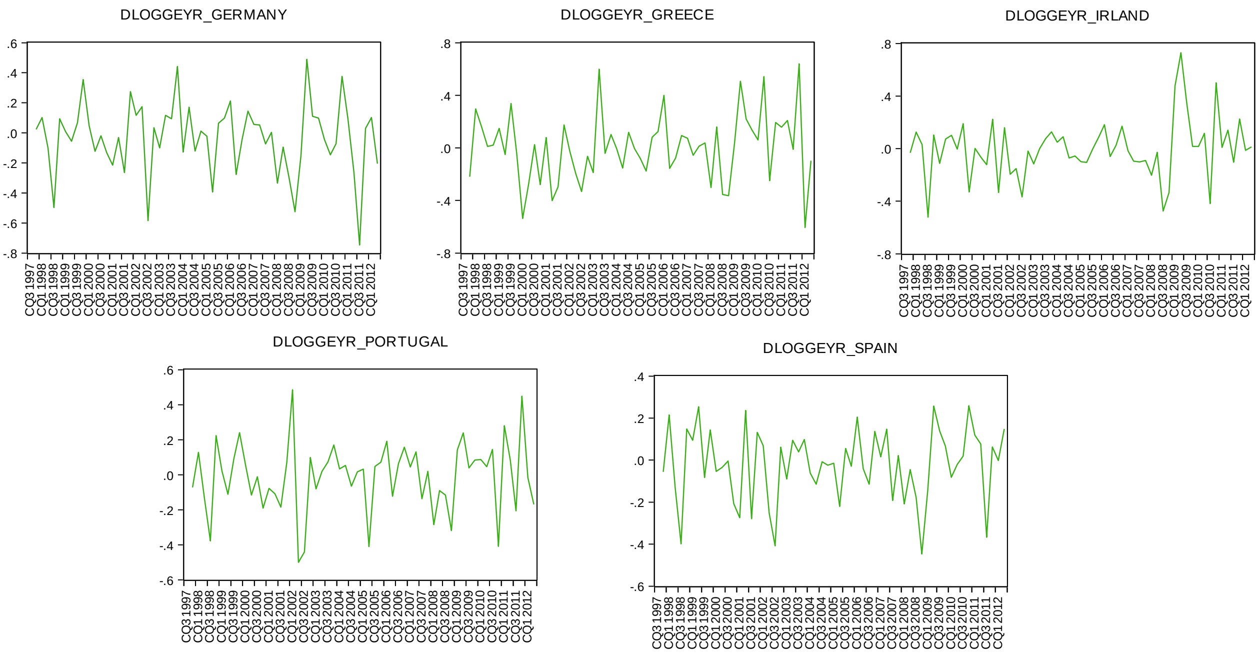
Note: ADF automatic lag length based on SIC; Para PP and KPSS automatic lag length based on Newey-West using Bartlett kernel.

Table 10 shows the results of ADF, KPSS and PP tests for the series in levels as well as for the first differences of logarithms. Considering a significance level of 5% it is possible to verify that both the ADF and PP tests point for the nonstationarity of all series, in other words, the series possess unit roots. However, only for GEYR of Greece and Spain as the KPSS test showed discordant results, verifying the stationarity to these countries series. As in the ADF and PP tests the decision is to not reject the null hypothesis and because that conclusion prevails in at least two tests, it is assumed that all series are nonstationary in levels. It is important to refer that whenever "trend" and "intercept" estimated values are statistically significant for a 5% significance level these are considered, otherwise they would be removed from the tests[26] and we would select the option "none". Even though in all hypothesis: "trend", "intercept and trend" or "none" for the ADF and PP tests always show that series are nonstationary. These results were expected according to the chronograms presented before. Since the unit root tests confirm that the series are nonstationary, it was held their transformation into stationary ones through the application of the first differences of logarithms, as theory suggests. Thus, we can see that the ADF, KPSS, PP tests applied to the first differences of logarithms of the series show that them are stationary. Therefore, we can say that for the ADF and PP tests the null hypothesis is rejected and there is no unit root for the series mentioned, the null hypothesis for the KPSS test is not rejected, confirming also the stationary series.

In short the series of the GEYR for each country for the first differences of logarithms do not exhibit unit roots, this means that not only are they stationary, but they are integrated of order zero (I (0)). It is interesting to observe the behavior graph after transformation into stationary series. Figure 11 shows this behavior.

[26] When probability was greater than 0.05, there is no trend or intercept respectively, and these should be excluded from the analysis for better accuracy of results

Figure 11 – Graphics of the first differences of logarithms of the series



Source: *Bloomberg*

As we can see, the series also graphically seem to be stationary because they show constant mean and variance over the time horizon, showing no trend when compared to the graphs for the levels of variables. Because the first differences of logarithms of the temporal series generate stochastic processes of zero-order, I (0) integration, it can be said that the series in level are order one, I (1) integrated. Although the series are stationary in first difference of logarithms, the cointegration tests should be applied in level series.

6.2.2. Unit root test for GEYR1 (2nd methodology)

Down below there is Table 11with the results of the stationarity tests. Before examining the unit roots test it is important to remind that, according to the second methodology of computing the GEYR1 and after individual graphical display we can see that especially Ireland showed a typical behavior of a stationary series (having only a few more evident structural breaks). Thus, at least for the GEYR1 of Ireland it is expected a stationary series in level.

Table 11 - Unit root tests (2nd methodology) – GEYR1

This table was built based on the outputs generated on *Eviews* and describes the tests applied to the second GEYR1 methodology to verify the existence of unit root or not, in other words, whether the series are stationary or nonstationary. We used three tests and the conclusion to be draw prevailed with the concordance of at least two tests. These were applied to the series in level and to the first level differences in order to realize which was the order of integration of the series (how many times there was the need to differentiate the series so it became stationary).

		ADF*			KPSS*		PP*		
		statistic	prob.	Reject Ho	statistic	Reject Ho	statistic	prob.	Reject Ho
Level	LogGEYR1_Portugal	-2,337638[c]	0.0199	*Yes*	0.132479[a]	*Not*	-2,310140[b]	0.0213	*Yes*
	LogGEYR1_Ireland	-3,687973[c]	0.0004	*Yes*	0.215284[b]	*Not*	-3,095448[c]	0.0025	*Yes*
	LogGEYR1_Greece	-2,029514[c]	0.0415	*Yes*	0.125205[b]	*Not*	-2,107413[c]	0.0347	*Yes*
	LogGEYR1_Spain	-1,428651[c]	0.1413	*Not*	0.107594[a]	*Not*	-1,350587[c]	0.1621	*Not*
	LogGEYR1_Germany	-3,002455[a]	0.1403	*Not*	0.134561[a]	*Not*	-3,039320[a]	0.1307	*Not*
First Differences	LogGEYR1_Spain	-7,493711[c]	0.0000	*Yes*	0.125719[b]	*Not*	-7,645432[c]	0.0000	*Yes*
	LogGEYR1_Germany	-7,363664[c]	0.0000	*Yes*	0.209481[b]	*Not*	-7,973299[c]	0.0000	*Yes*

a - trend and intercept; b – intercept; c- None; ADF e PP critical values: -3.487845 [a], -2.911730 [b], -1.946447 [c]; KPSS critical values: 0.1460 [a], 0.4630 [b]; * Significant at 5% level; ** Ho: Exist unit root (not stationary); H_1: Don´t exist unit root (stationary);*** Ho: stationary, H_1: Not stationary

Note: The number of lags to the ADF test was zero for all countries except for Ireland which the result was one.

Note: To ADF automatic lag length based on SIC; To PP and KPSS automatic lag length based on Newey-West using Bartlett kernel.

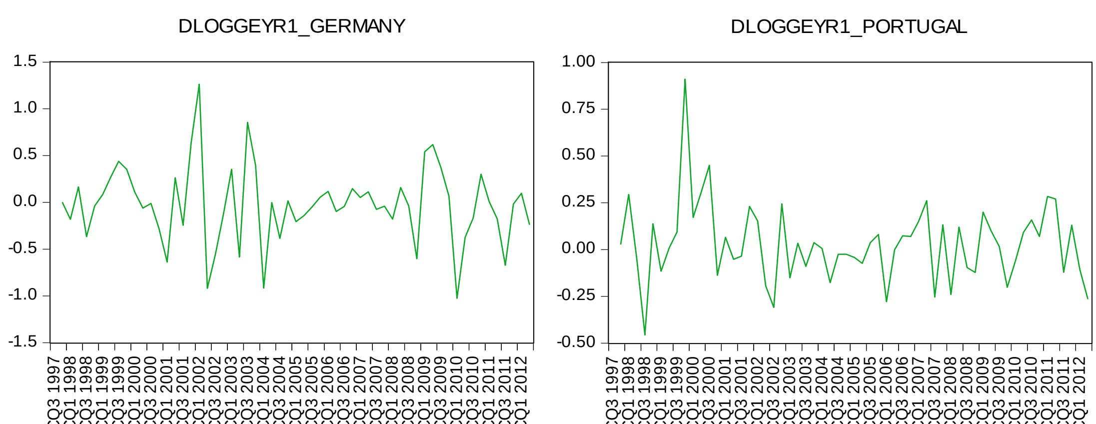
Table 11 addresses the unit roots tests to the second GEYR1 methodology. We used three tests to test stationarity: ADF, PP and KPSS. In accordance with the previous analysis every time the "trend" values and / or "trend and intercept" aren't statistically significant they will not be considered in the analysis. After observing the table it is possible to verify that it's necessary an individual analysis to each series. For GEYR1 of Portugal considering a 5% significance level, we can see that all tests indicate that the series is stationary. For a 10% significance level ADF and PP also indicate the stationarity, but for a 1% significance level in these two tests nonstationarity of the series is verified. The KPSS test for a 1% and 5% significance level indicates stationarity of the series and with a 10% significance level, the test states that the series is nonstationary disagreeing with the ADF and PP tests results. For the GEYR1 of Ireland, stationarity is clearly verified for all significance levels. The results of GEYR1 of Greece tell us that for the three tests whether for a 5% and 10% significance levels, the series is stationary. Still, for a 1% significance level ADF and PP tests show us that stationarity is not verified but for the KPSS (for the same significance level) the series demonstrate to be stationary.

Finally, for the series in level of GEYR1 of Spain and Germany the ADF and PP tests present nonstationary for all significance levels (1%, 5% and 10%). However, for the KPSS with a significance level of 5% it appears that it indicates that both series are stationary in level.

Initially we verified by graphical display that some series presented a stationarity behavior trend which was confirmed with tests of stationarity. Therefore, given that our analysis is done at 5%, and maintaining the same decision in at least two of the tests, we can conclude that the series in level of the GEYR1 of Portugal, Greece and Ireland are stationary and the series in level of the GEYR1 of Germany and Spain are nonstationary. To the series in level of the GEYR1 of Portugal, Greece and Ireland it will be applied Granger causality tests to verify the existence of causality in a series facing another and to the GEYR1 series of Germany and Spain it will be applied cointegration tests (bivariate cointegration) in order to verify the existence of a long-term relationship between the two.

The next step is to check the order of integration of the two nonstationary series (Germany and Spain), therefore we proceed to the application of the ADF, PP and KPSS tests to the first differences of logarithms for the GEYR1 series of Germany and Spain and the results are visible in Table 11. To all showed significance levels of the first differences of logarithms, series reveal to be stationary. Observing such scenario graphically through Figure 12, we conclude that the series under consideration are presented with a mean and a variance more constant over time frame. The series in level generate a stochastic process of order of integration one (I (1)) and the series of first differences of logarithms are shown both as I (0). Verifying that the order of integration of both series is the same, we are able to carry the application of cointegration tests to the GEYR1 series of Germany and Spain and they must be applied to the series in level.

Figure 12 - Graphs of the first differences of logarithms of the series



Source: Bloomberg

Following is a conclusive table showing the procedure in the stationary and nonstationary series verified through tests of stationarity.

Table 12- Summary of the series behavior
This table is in summarized form so that we are able to perceive the treatment to apply to the series according to the initially obtained results, differing according to the first and second methodology.

	1st methodology		2nd methodology	
Series in Level		**Conclusion**		**Conclusion**
LogGEYR_Portugal	nonstationary	Apply cointegration tests and VECM	stationary	Apply Granger Causality and VAR
LogGEYR_Ireland	nonstationary		stationary	
LogGEYR_Greece	nonstationary		stationary	
LogGEYR_Spain	nonstationary		nonstationary	Apply cointegration tests and VECM
LogGEYR_Germany	nonstationary		nonstationary	

6.3. Cointegration and estimated VEC Model

6.3.1. Cointegration tests

The methodology of cointegration analysis is described in section 5.3 therefore the purpose of the cointegration test is to identify the possible long-term relationship between the series, so it was used the cointegration test developed by Johansen and Juselius (1990)[27] with complement of the Vector Error Correction Model (VECM) to do better econometric analysis involving not only the short term but also the long term.

It is also used the statistic Maximum Eigenvalue test and Trace test to determine the number of cointegrating vectors. These tests have as null hypothesis the absence of any cointegrating vector against the alternative hypothesis of the existence of at least one cointegration vector (this concept will be developed later). It will be performed a bivariate cointegration analysis considering the series two-by-two in order to test which are the combinations which have similar long-term behavior. It will be computed the respective tests to both GEYR methodologies, approached in this study.

[27] Johansen and Juselius (1990) procedure has the advantage of imposing certain hypothesis over economic theory as well as verify the presence of weak exogeneity between on or several systems.

First it is determined the number of optimal lags using the Akaike (1973), Hannan and Quinn (1979) and Schwarz (1978) information criteria (IC) (see Annex 3). The number of optimal lags is presented in table 13. In the second step, given the optimal lag length, the cointegration rank is obtained through the Trace test and the Maximum-Eigenvalue test (both test statistics have non-standard distributions and their critical values have been tabulated by Johansen in 1988).

Table 13 – Choosing of the Optimal Lag

	Optimal lags
1st methodology	
Germany - Greece	1
Germany -Ireland	1
Germany- Portugal	1
Germany - Spain	1
Greece - Ireland	1
Greece - Portugal	1
Greece - Spain	1
Ireland - Portugal	1
Ireland - Spain	1
Portugal - Spain	1
2nd methodology	
Germany-Spain	2

The two tests to determine the rank of the coefficient matrixΠ, i.e. the trace and the maximum eigenvalue test are reported in Table 14 and Table 16

The column Rank r identifies the null hypothesis of each cointegration test performed. Here, $r = 0$ corresponds to the null hypothesis that there are no cointegrating vectors, that is, the cointegrating rank is zero, and $r \leq 1$ corresponds to the null hypothesis that there is at most one cointegrating vector, that is, the cointegrating rank is less than or equal to one.

6.3.1.1 Cointegration Analysis for the first methodology

Table 14 shows the obtained results after the tests application. It presents the column of the test statistics (Trace test and Max. Eigenvalue) and the respective probability (see Annex 4).

Table 14- Bivariate cointegration for 1st methodology GEYR

This table demonstrates the possible variable combinations according to our series and to each of them it was tested the hypothesis of cointegration resourcing the Johansen tests on *Eviews*.

Variables - LogGEYR	Rank	Eingenvalue	Trace statistic	prob.*	Max. Eigenvalue Statistic	prob.*
Germany – Greece	r=0	0.072554	4.373557	0.8712	4.368583	0.8185
	r≤1	8.57E-05	0.004973	0.9428	0.004973	0.9428
Germany –Ireland	r=0	0.163602	10.40495	0.2509	10.36177	0.1893
	r≤1	0.000744	0.043186	0.8353	0.043186	0.8353
Germany- Portugal	r=0	0.098632	6.023354	0.6928	6.022848	0.6103
	r≤1	8.73E-06	0.000506	0.9841	0.000506	0.9841
Germany – Spain	r=0	0.078868	5.574943	0.7451	4.764808	0.7712
	r≤1	0.013871	0.810135	0.3681	0.810135	0.3681
Greece – Ireland	r=0	0.171150	12.74934	0.1243	10.88756	0.1599
	r≤1	0.031590	1.861782	0.1724	1.861782	0.1724
Greece – Portugal	r=0	0.267482	19.48423	0.0352	18.05350	0.0369
	r≤1	0.024366	1.430726	0.2316	1.430726	0.2316
Greece – Spain	r=0	0.255315	19.54853	0.0344	17.09802	0.0501
	r≤1	0.041370	2.450512	0.1175	2.450512	0.1175
Ireland – Portugal	r=0	0.279089	21.74856	0.0164	18.97988	0.0268
	r≤1	0.046614	2.768676	0.0961	2.768676	0.0961
Ireland – Spain	r=0	0.107115	9.081440	0.3579	6.571224	0.5410
	r≤1	0.042356	2.510216	0.1131	2.510216	0.1131
Portugal – Spain	r=0	0.220197	24.33676	0.0065	18.26888	0.0343
	r≤1	0.099332	6.067887	0.0138	6.067887	0.0138

*significance level at 5% - MacKinnon-Haug-Michelis (1999) p-values

For a 5% significance level, both trace and maximum-eigenvalues statistics reject the null of non-cointegration (r=0) for the combinations of the series: Greece-Portugal, Greece-Spain, Ireland-Portugal. In both tests, there is only one cointegration vector (situation in green on the table), since we do not reject the hypothesis of having at most one cointegration vector (r≤1). For the combination Portugal – Spain in both tests, we verify that in fact there is cointegration between series (because we do not reject the null hypothesis of non-cointegration, r=0), however in this case there should exist at least two cointegration vectors because the hypothesis of having at most one cointegration vector is rejected.

In short terms, at a 5% significance level, it is possible to conclude that the results from the cointegration analysis, according to the two tests, indicate that there is a long-term relationship between Greece–Portugal, Greece-Spain, Ireland-Portugal and Portugal-Spain. Therefore, the investment strategies based on the GEYR results for the combination of these countries (the ones that are cointegrated) tend to be similar, because they present a long-term equilibrium relationship (they move in the same way). This means that when a variation in the GEYR of one country occurs it varies the results of the GEYR of another country.

The conclusion described above is resumed on Table 15 to significance levels of 1% and 5% to all combinations according to both tests.

Table 15- Number of cointegration vectors of Johansen tests

This table indicates the number of cointegration vectors for each combination used in this study to trace and Max-eigenvalues tests and significance levels of 5%.

	Trace test	Max-Eigen Test
1st methodology	**5%**	**5%**
Germany – Greece	0	0
Germany –Ireland	0	0
Germany- Portugal	0	0
Germany – Spain	0	0
Greece – Ireland	0	0
Greece – Portugal	1	1
Greece – Spain	1	1
Ireland – Portugal	1	1
Ireland – Spain	0	0
Portugal – Spain	2	2

As we can verify, even though PIGS are all in a similar economic situation, not all are cointegrated. Still, the existing cointegrations are effectively within countries that are going through an identical period of economic recession that in a way would be expected.

Another conclusion is that Germany's ratio is not cointegrated with any country of PIGS and that reveals that investment decisions based on the Germany's GEYR results do not follow the same trends of the other countries and vice versa. This conclusion would also be expectable since Germany has a very different economic situation in Europe. We also verify in the historical analysis effectuated in section 6.1 that the behaviors for the first methodology of the Portuguese and Greek GEYRs were quite similar and that was proven to be an indication that there was cointegration between these countries regarding the values from the GEYR.

6.3.1.2 Cointegration Analysis for the second methodology

For the second methodology it is important to remember that we will only verify cointegration for series in level that present themselves nonstationary. Having said this, the combination to verify cointegration will be Germany–Spain.

Table 16- Bivariate cointegration for 2nd methodology GEYR1

This table shows Johansen tests generated by *Eviews*, analyzing the existence of cointegration for the only possible combination according to the second methodology (nonstationary series in level).

Variables: logGEYR1	Rank	Eigenvalue	Trace statistic	prob.	Max. Eigenvalue Statistic	prob.
Germany – Spain	r=0	0.130632	10.82698	0.0878	7.979355	0.1037
	r≤1	0.048731	2.847622	0.1082	2.8476622	0.0818

Significance level at 5% - MacKinnon-Haug-Michelis (1999) p-values
Note: the assumption considered in accordance to the software is: “deterministic trend in data, no intercept no trend”

We are able to verify that according to the presented results for a significance level of 5% we cannot verify the existence of cointegration for the ratio combination that was presented, because we cannot reject the null hypothesis of non-cointegration for both tests. This lack of cointegration suggests that no long-term linkage between the variables exists and GEYR1 of Germany and GEYR1 of Spain can diverge without bound. Due to this fact, no VEC models were estimated.

In conclusion, we are able to apply the VECM to the combinations of variables that are cointegrated to estimate the coefficients of the cointegration equation, understanding if they are statistically significant or not. One the other hand, all variable combinations that show themselves non-cointegrated should be analyzed more carefully considering they incur on spurious relationships, i.e. the regression of a variable versus another leads to inconsistent results (Granger and Newbold, 1974) in which conventional significance tests point out the existence of relationships between variables that in fact do not exist.

A spurious regression is a “nonsense” regression. Therefore, for the nonstationary series in level combinations that are non-cointegrated (there is no long-term relationship between them) we stand before a spurious relationship. We can also verify for the first differences of logarithms (stationary series) of the series the relation of causality amongst them (short-term relationship) through Granger causality tests. For that, in section 6.4 Granger causality tests will be also applied to the first differences of logarithms of these variables so we can prove that effectively there is no sense in recede a variable depending on another.

6.3.2. Bivariate VEC Model

The estimated vector error correction model for each bivariate cointegrated relationship was defined according to the deterministic trend specification[28] applied to each bivariate cointegration relationship (see Annex 5).

Table 17 reports the coefficients estimation included in the vectors α and β for each bivariate vector error correction model.

The results of column β refer to the estimation of long-term parameters (with error correction adjustments), indicating if the coefficients of the cointegration equation are statistically significant or not. The corresponding values to the column α represent the coefficients estimation of first differences, i.e, short-term adjustment of first differences of the series' logarithms, for the first and second lag. These two columns indicate if there is a short-term relationship between the first differences of variables' logarithms under study.

[28] VECM was applied in accordance with the defined assumptions when we applied the cointegration tests. For all the combinations the existence of a vector of cointegration was under the assumption: "Quadratic Trend, Intercept and Trend".

Table 17- Bivariate VEC Model

This table shows which estimated coefficients are statistically significant for the construction of the cointegration equation considering long-term adjustment with short-term coefficients adjustments. The number of lags considered was the one the minimized SIC and AIC. The variables correspond to the GEYR logarithms, but in order to make this table more perceptible we chose to put only the indication of countries..

Dependent Variable (LogGEYR)	Independent Variable (LogGEYR)	B	Test Statistic$_{\beta}$~	α1 (DLOGgeyr-1)	Test Statistic$_{\alpha}$~	α2 (DLOGgeyr-2)	Test Statistic$_{\alpha}$~
Portugal	Ireland	-0.666224	-3.39924**	0.085403	0.59272	-0.024180	-0.18943
	Spain	-0.119499	-0.61817	0.021335	0.08883	0.082300	0.37522
	Greece	-0.797796	-4.48082**	-0.043136	-0.37104	-0.218838	-1.87948
Ireland	Portugal	0.131698	1.08533	0.216818	0.89031	-0.134731	-0.67602
Greece	Portugal	0.224541	2.40192*	0.247744	0.93598	0.215043	0.95632
	Spain	0.189646	4.19211**	0.500450	2.08812*	0.825488	3.70711**
Spain	Portugal	-0.544474	-2.77729**	-0.156193	-0.89565	-0.316718	-1.98635*
	Greece	-0.597649	-4.18825**	-0.084793	-0.82584	-0.179221	-1.64114

(**) and (*) indicate the reject of the null at 0.01 and 0.05 significance levels
Note: *t* statistic critical values: -2.58 or 2.58 at 1% significance level and -1.96 or 1.96 at 5% significance level..
Test hypothesis *t* - Ho: βj = 0; H1: βj ≠0

As we can observe, the combinations Portugal-Spain and Ireland-Portugal (considering the first country the dependent variable and the second the independent variable) do not present for the parameter β statistically significant coefficients, leading us to the conclusion that these variables do not present a long-term relationship (they are not cointegrated). All other combinations for parameter β present statistically significant coefficients at 1% significance level, except the combination Greece-Portugal that only presents itself statistically significant for a significance level at 5%. Consequently, we can affirm that in fact the variables are cointegrated. Notice that in the combination Portugal-Spain there is no long-term relationship, but it is interesting to realize that when we consider Spain as a dependent variable, that long-term relationship between variables comes into existence, meaning that variations that occur in the GEYR values of Portugal (independent variable) provoke variations in the GEYR of Spain (dependent variable) and consequently, according to the trading rules, the investment strategy tends to be the same. The interpretation is identical when we address the Ireland-Portugal combination. For the combinations that are cointegrated and consequently with the coefficients estimation statistically significant, we can affirm that alterations that occur in the GEYR values in one country provide alterations in the GEYR values of another country, meaning that both countries present common behavior.

In a short-term analysis we can verify that the estimations for coefficients of first differences of the variables' logarithms (series variations) are generally not statistically significant, so there is no short-term relationship between variables. We exclude from this conclusion the combinations Greece-Spain and Spain-Portugal. The combination Greece (dependent variable) and Spain (independent variable) presents an α coefficient statistically significant for a significance level of 1% and 5% for the first and second lag, respectively. The combination Spain-Portugal presents an α coefficient statistically significant for a 5% significance level only in the second lag, in these cases there is a short-term dependence between variables.

Generally, we also verify that the coefficients estimations of first differences of the series' logarithms that present a short-term relationship statistically significant have low values. As it was explained in the methodology, α coefficients show the speed of adjustment of the respective variables in direction to long-term equilibrium. So a small coefficient shows that the speed adjustment is slow, i.e. short-term correction is slow towards cointegrating equilibrium. Therefore, if there is any disequilibrium, the short-term correction will be also slow towards cointegration equilibrium.

In a conclusive way we present a table that indicates which of the series under study demonstrate themselves effectively cointegrated. Table 18 presents those combinations. Notice that analysts when analyzing countries for the GEYR, can only consider series that are cointegrated, because combinations that are non-cointegrated can be spurious relationships that may lead us to wrong investment decisions.

Table 18 – Summary of cointegrated variable combinations

This table is intended to summarize the information described above. The letter "C" corresponds to the existence of cointegration and the letters "NC" correspond to non-cointegration.

		Independent Variables				
	1st methodology	GEYR Portugal	GEYR Ireland	GEYR Greece	GEYR Spain	GEYR Germany
Dependent Variables	GEYR Portugal	-	C	C	NC*	NC
	GEYR Ireland	NC*	-	NC	NC	NC
	GEYR Greece	C	NC	-	C	NC
	GEYR Spain	C	NC	C	-	NC
	GEYR Germany	NC	NC	NC	NC	-
	2nd methodology					
	GEYR1 Germany	-	-	-	NC	-

*verified only through VECM

6.4. Granger Causality tests and VAR estimated

The main objective of this section is to apply the Granger Causality test to the stationary in level variables and for this it is important to understand if there is any causal relationship between them or, on the opposite they don't influence each other. Posteriorly, if we verify any causal relationship statistically significant between variables, we estimate the regression coefficients through VAR[29] model.

This test is also applied to the first differences of series' logarithms, of the series in level that are nonstationary and not cointegrated (verified through Johansen test), so we can prove that effectively the variables do not have any relationship and, when we are effectuating a regression we are standing before a spurious relationship.

[29] Applied only to short-term relations, stationary series.

Table 19 – Series combinations that will be tested through Pairwise Granger causality tests.

The purpose of this table is to understand which are the combinations that we should apply the Granger causality tests, i.e. which series are stationary.

	1st methodology	2nd methodology
Stationary Series in Level	N/A	Portugal- Ireland; Portugal- Greece; Ireland- Greece
First difference of non-cointegrated series in level. Johansen test	Germany - Portugal; Germany - Ireland; Germany - Greece; Germany – Spain	Germany – Spain

As we can see in Table 19, there are only series in levels that are stationary in the second methodology of the GEYR1 computation. The results of the Granger Causality tests for the presented combinations are reflected on the following table (see Annex 6).

Table 20 - Pairwise Granger Causality test

This table was built based on the outputs generated by *Eviews* and indicates the statistic of the test and the probability of the Granger Causality test for each pair of possible combinations. The optimal lag was chosen based on criteria information via lag structure of the VAR model. The first country corresponds to the independent variable (xt) and the second country to dependent variable (yt).

Pairwise Granger Causality	Test statistic ~ F	Pob.*	
LogGEYR1: Portugal - Ireland	0.06798	0.7953	Stationary series in level
LogGEYR1: Ireland-Portugal	0.14468	0.7051	
LogGEYR1: Portugal-Greece	1.14629	0.2889	
LogGEYR1: Greece-Portugal	1.18749	0.2805	
LogGEYR1: Greece - Ireland	0.00054	0.9815	
LogGEYR1: Ireland - Greece	1.85283	0.1789	
DlogGEYR1: Spain- Germany	0.36471	0.5484	First differences of non-cointegrated series
DlogGEYR1: Germany_ Spain	1.42213	0.2382	
DlogGEYR: Ireland_Germany	0.72679	0.3976	
DlogGEYR: Germany_Ireland	1.56492	0.2162	
DlogGEYR:Greece_ Germany	0.52225	0.4729	
DlogGEYR:Germany_Greece	1.11569	0.2955	
DlogGEYR:Portugal_ Germany	1.99539	0.1634	
DlogGEYR:Germany_Portugal	0.06650	0.7975	
DlogGEYR:Spain_ Germany	0.12231	0.7279	
DlogGEYR:Germany_ Spain	0.79101	0.3777	

*at a 5% significance level. Note: Ho: x does not Granger Cause y

As we can see, in any presented combinations in Table 20 the null hypothesis that "x does not Granger causes y" is not rejected, i.e. there is no Granger causal relationship in any presented variable combinations. So, we can state that there is no sense in effectuating regressions between these variables.

For stationary series in level we can verify that there is no causal relationship between the presented combinations, i.e. the short-term dependency is not verified. For the second methodology of the GEYR there is no sense in regress the series of the GEYR of Portugal with Ireland, Portugal with Greece and Greece with Ireland and the same analysis is taken for the inverse combinations of those variables (exchanging the dependent variable with the independent variable). The GEYR for these countries may be a good indicator for each country individually (isolated analysis only for the country alone and not as a comparison strategy with other countries), however for an analysis between these countries it won't add any value to the analyst, because the GEYR of a country do not influence the behavior of the GEYR of another country. Since that short-term dependency does not exist for the pair of the presented variables, there is no sense in estimating the VAR, because the variables have no Granger causal relation.

As to the first differences of logarithms of the series in level that are non-cointegrated, the Granger Causality test only confirmed what was expected, proving that we are standing before spurious regressions, i.e. there is no sense in regressing the GEYR of Germany according to PIGS and or the other way around (regressing the GEYR of PIGS according to Germany) in both methodologies. This conclusion is justified because the German financial market is quite different from PIGS, and such conclusion was evident when we were making this study, since Germany's behavior was set apart from other countries, not only graphically but also through some descriptive statistics previously analyzed.

7. Conclusion

This study is intended to ascertain the existence of cointegration, i.e. the existence of long-term equilibrium relationships of the Gilt-Equity Yield Ratio amongst the countries: Portugal, Ireland, Greece, Spain (PIGS) and Germany. The reporting analysis is quarterly starting in July 1997 and ending in June 2012. There are some studies that already worked on this ratio, however, none of them had approached the relationship between these countries according to the results from the GEYR computation. Also in the GEYR computation we had in account two methodologies, the first using the bond yield over dividend yield ratio and the second using bond yield over earnings yield index (inverse price earnings ratio). The second methodology of the GEYR computation is also known as Fed-model.

The first conclusion to draw from this study is that according to the first methodology, generally the series present themselves more irregular, their behavior is not constant. According to the second methodology some countries behave less irregular and in a certain way they are more stationary. However, in this second approach the evidence of structural breaks and extreme points were notorious. According to the trading rules presented to the GEYR, the predominant investment strategy in the historical analysis of the series is the buy equity strategy in both approached methodologies, only Ireland presents in the first methodology predominance to the sell equity strategy.

Posteriorly we proceeded to the application to the unit root tests showing that to the first methodology all series presented themselves nonstationary, whilst in the second methodology of the GEYR computation only Germany and Spain presented themselves nonstationary. The GEYR of Portugal, Ireland and Greece presented stationary series and so the treatment of them was different comparatively to the other nonstationary series.

The first finding in this study is that after the application the cointegration tests to the nonstationary series in both methodologies we verified the existence of a long-term dependency of the GEYR for the variable combinations: Greece – Portugal, Greece-Spain, Ireland- Portugal and Portugal-Spain. To the series that are cointegrated we proceeded to the application of the Vector Error Correction Model in order to check if effectively the coefficients of the cointegration equation were statistically significant for the pair of possible combinations under study. Therefore, in the bivariate analysis we came to the conclusion that the GEYR of Portugal (dependent variable) is cointegrated with the GEYR of Ireland (independent variable) and with the GEYR of Greece (independent variable), thus the GEYR of Greece (dependent variable) is cointegrated with the GEYR of Portugal (independent variable) and with the GEYR of Spain (independent variable). Finally, the GEYR of Spain (dependent) is cointegrated with the GEYR of Portugal (independent variable) and with the GEYR of Greece (independent variable). For this group of variables any variations that occur in the GEYR of a certain country provoke variations in the result of the GEYR of another country. With this bivariate analysis, by altering the dependent variable according to the two variables under study, it became notorious that not all countries were "simultaneously" cointegrated, meaning that, for instance, alterations in the GEYR of Spain when this one is considered a dependent variable provoke alterations in the GEYR of Portugal (independent variable), but when the GEYR of Portugal becomes the dependent variable, we cannot draw the same conclusion. Conclusively, through the VECM analysis we verify that the combinations Portugal-Spain, being Portugal the dependent variable and for the combination Ireland-Portugal, being Ireland the dependent variable, the estimation for the coefficient of the cointegration equation did not reveal to be statistically significant, so we conclude that those combinations are not cointegrated.

For an analysis of short-term relationships it was verified that, generally, the presented estimations for variables variations (log first differences) did not reveal to be statistically significant, so we conclude that a short-term relationship between variables is not verified. From this conclusion we withdraw the combinations of the variables Greece (dependent variable) – Spain (independent variable) and Spain (dependent variable) – Portugal (independent variable) and we present coefficient estimations, for the short-term relationship, which are statistically significant, yet with low values.

Since Germany presents an economic panorama quite different from PIGS we already expected that it did not have the same cointegration relationship with any of those countries that present a higher level of economic recession. We conclude that the GEYR was not a good indicator to compare countries with different economic situations, i.e. all regressions made with the GEYR of Germany vs. the GEYR of PIGS would incur in spurious relationships producing deceiving results for the investor.

Lastly, for the series that initially revealed themselves stationary in the study, we verified a Granger causality relationship amongst them, concluding that none of them presented a Granger causal relationship. Therefore, according to the second methodology addressed in the study, it does not make sense to analyze the GEYR regressions for Portugal, Ireland and Greece that even though being stationary, have no relation. Because a short-term relation between stationary variables was not verified, the Vector Autoregressive Model (VAR) stopped making sense being applied.

A motivation for a posterior study related with this theme goes through the development of the characteristics of the cointegration relationships properties, i.e. which studies to variables like exogeneity, proportionality and asymmetry should be applied and analyzed for a better conclusion about the characteristics under study. Another interesting resembling topic is to consider inflation in the computation of the GEYR to make it a nominal measure minimizing the inconveniences that the ratio has been demonstrating.

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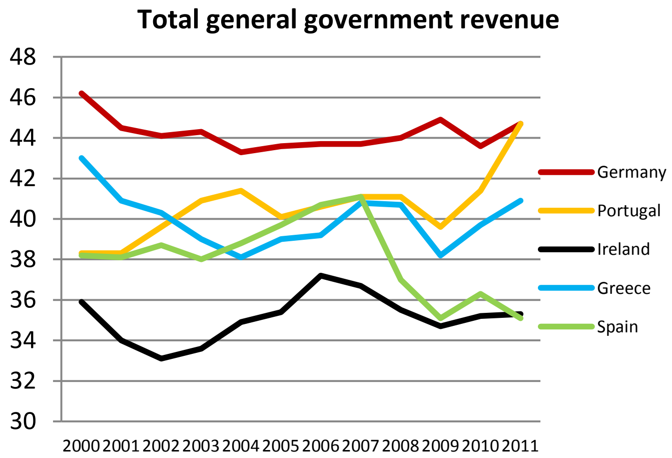
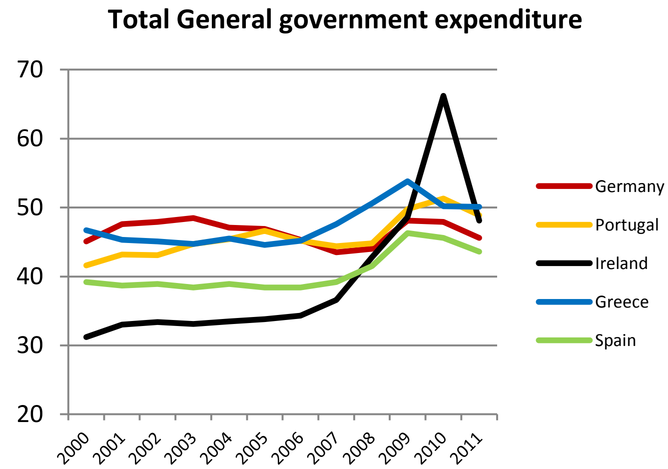
Económico, http://economico.sapo.pt/

ANNEX

Annex 1 - Economic Indicators - Government Revenues and Expenditures





Annex 2 - GEYR computation for five countries using two methodologies

	First methodology - using dividend yield					Second methodology - using earnings yield				
	GEYR Portugal	GEYR Ireland	GEYR Greece	GEYR Spain	GEYR Germany	GEYR1 Portugal	GEYR1 Ireland	GEYR1 Greece	GEYR1 Spain	GEYR1 Germany
CQ3 1997	2,98	5,74	4,30	3,74	3,02	0,168	1,392	0,672	0,673	0,779
CQ4 1997	2,77	5,56	3,45	3,54	3,09	0,173	1,125	0,349	0,532	0,781
CQ1 1998	3,15	6,30	4,65	4,39	3,41	0,232	1,301	0,631	0,688	0,652
CQ2 1998	2,76	6,48	5,45	3,86	3,08	0,220	1,260	0,794	0,804	0,769
CQ3 1998	1,89	3,85	5,51	2,59	1,87	0,140	0,878	0,783	0,601	0,533
CQ4 1998	2,36	4,26	5,63	3,00	2,06	0,160	0,986	0,627	0,731	0,513
CQ1 1999	2,41	3,81	6,53	3,30	2,07	0,143	0,771	1,079	0,711	0,557
CQ2 1999	2,15	4,10	6,20	4,26	1,96	0,144	0,826	1,429	1,071	0,732
CQ3 1999	2,36	4,53	8,69	3,92	2,10	0,158	1,104	2,383	1,615	1,135
CQ4 1999	3,00	4,51	8,31	4,52	2,99	0,393	1,219	2,617	2,064	1,615
CQ1 2000	3,17	5,45	4,86	4,28	3,14	0,467	1,130	1,166	1,256	1,798
CQ2 2000	2,82	3,92	3,69	4,14	2,78	0,635	1,014	1,071	1,102	1,691
CQ3 2000	2,79	3,93	3,79	4,12	2,72	0,996	1,183	1,135	1,146	1,670
CQ4 2000	2,30	3,68	2,87	3,35	2,39	0,868	1,097	0,860	1,092	1,258
CQ1 2001	2,13	3,26	3,10	2,55	1,93	0,927	0,904	0,745	0,828	0,664
CQ2 2001	1,91	4,07	2,07	3,22	1,87	0,880	1,158	0,714	1,035	0,864
CQ3 2001	1,59	2,91	1,54	2,44	1,43	0,849	0,803	0,617	0,806	0,677
CQ4 2001	1,70	3,42	1,83	2,78	1,89	1,070	2,046	0,719	0,964	1,282
CQ1 2002	2,77	2,81	1,79	2,98	2,12	1,246	1,247	0,668	1,123	4,539
CQ2 2002	1,68	2,42	1,48	2,32	2,52	1,027	1,161	0,630	0,888	1,812
CQ3 2002	1,08	1,67	1,06	1,54	1,41	0,753	0,739	0,471	1,143	1,040
CQ4 2002	1,19	1,64	0,99	1,64	1,45	0,962	0,715	0,509	1,222	0,920
CQ1 2003	1,10	1,46	0,82	1,50	1,32	0,827	0,635	0,396	1,134	1,310
CQ2 2003	1,12	1,46	1,50	1,65	1,48	0,856	0,642	0,427	0,654	0,730
CQ3 2003	1,20	1,58	1,44	1,71	1,62	0,783	0,676	0,486	0,624	1,717
CQ4 2003	1,42	1,79	1,59	1,89	2,52	0,812	0,659	0,522	0,768	2,544
CQ1 2004	1,47	1,88	1,58	1,78	2,22	0,816	0,663	0,521	0,655	1,017
CQ2 2004	1,55	2,06	1,36	1,58	2,63	0,684	0,665	0,539	0,671	1,015
CQ3 2004	1,45	1,91	1,53	1,57	2,33	0,667	0,615	0,484	0,569	0,690
CQ4 2004	1,48	1,81	1,52	1,53	2,36	0,650	0,615	0,571	0,534	0,701
CQ1 2005	1,52	1,64	1,40	1,51	2,31	0,623	0,589	0,563	0,491	0,570
CQ2 2005	1,01	1,47	1,18	1,21	1,55	0,579	0,513	0,597	0,421	0,495
CQ3 2005	1,06	1,47	1,27	1,28	1,66	0,601	0,532	0,711	0,454	0,470
CQ4 2005	1,14	1,60	1,44	1,25	1,83	0,650	0,590	0,807	0,462	0,496
CQ1 2006	1,38	1,92	2,15	1,53	2,26	0,492	0,673	0,794	0,461	0,558
CQ2 2006	1,22	1,80	1,84	1,47	1,71	0,491	0,634	0,678	0,452	0,506
CQ3 2006	1,30	1,85	1,70	1,31	1,63	0,529	0,610	0,644	0,473	0,485
CQ4 2006	1,52	2,20	1,87	1,50	1,89	0,567	0,698	0,675	0,570	0,563

CQ1 2007	1,59	2,16	2,01	1,52	2,00	0,660	0,694	0,826	0,623	0,592
CQ2 2007	1,81	1,96	1,90	1,76	2,11	0,857	0,582	0,996	0,675	0,664
CQ3 2007	1,58	1,77	1,93	1,46	1,96	0,665	0,508	1,013	0,605	0,616
CQ4 2007	1,61	1,62	2,00	1,49	1,97	0,759	0,439	0,780	0,573	0,592
CQ1 2008	1,21	1,32	1,48	1,21	1,41	0,596	0,379	0,596	0,444	0,495
CQ2 2008	1,10	1,29	1,74	1,15	1,28	0,672	0,396	0,606	0,483	0,580
CQ3 2008	0,98	0,80	1,22	0,97	0,95	0,610	0,272	0,513	0,443	0,558
CQ4 2008	0,71	0,57	0,85	0,62	0,56	0,540	0,283	0,461	0,304	0,306
CQ1 2009	0,82	0,92	0,88	0,54	0,48	0,659	0,648	0,538	0,334	0,525
CQ2 2009	1,04	1,91	1,46	0,69	0,78	0,728	4,413	0,614	0,458	0,975
CQ3 2009	1,08	2,72	1,82	0,79	0,88	0,741	6,896	0,615	0,525	1,417
CQ4 2009	1,18	2,77	2,08	0,85	0,96	0,605	0,962	0,690	0,553	1,512
CQ1 2010	1,29	2,81	2,21	0,78	0,92	0,570	0,782	0,882	0,454	0,542
CQ2 2010	1,35	3,16	3,79	0,77	0,80	0,624	1,230	0,468	0,448	0,373
CQ3 2010	1,56	2,08	2,95	0,78	0,74	0,731	1,767	0,565	0,417	0,316
CQ4 2010	1,03	3,43	3,58	1,01	1,08	0,784	1,920	0,639	0,527	0,426
CQ1 2011	1,37	3,47	4,20	1,14	1,19	1,042	1,785	0,751	0,477	0,430
CQ2 2011	1,48	3,99	5,17	1,23	0,91	1,365	2,615	0,678	0,489	0,361
CQ3 2011	1,21	3,60	5,11	0,85	0,43	1,209	2,074	1,143	0,400	0,184
CQ4 2011	1,89	4,51	9,69	0,91	0,45	1,378	1,568	2,986	0,459	0,181
CQ1 2012	1,86	4,45	5,28	0,91	0,49	1,239	1,296	2,262	0,676	0,200
CQ2 2012	1,57	4,51	4,79	1,05	0,40	0,950	1,384	1,769	0,813	0,157

Legend: Red Color – Sell equity; Green color – Buy equity; White color – hold position

Annex 3 - Optimal Lag: Outputs *Eviews*

VAR Lag Order Selection Criteria
Endogenous variables: LOGGEYR_GERMANY LOGGEYR_GREECE
Exogenous variables: C
Date: 09/13/12 Time: 19:57
Sample: 1 60
Included observations: 55

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-95.86286	NA	0.120381	3.558650	3.631644	3.586877
1	7.159906	194.8067*	0.003287*	-0.042178*	0.176803*	0.042504*
2	8.415633	2.283140	0.003635	0.057613	0.422583	0.198750
3	9.872028	2.542071	0.003994	0.150108	0.661066	0.347699
4	11.66271	2.995322	0.004342	0.230447	0.887392	0.484493
5	12.94911	2.058249	0.004817	0.329123	1.132056	0.639624

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

VAR Lag Order Selection Criteria
Endogenous variables: LOGGEYR_GERMANY LOGGEYR_IRELAND
Exogenous variables: C
Date: 09/13/12 Time: 19:59
Sample: 1 60
Included observations: 55

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-82.02703	NA	0.072787	3.055528	3.128522	3.083756
1	26.24153	204.7260*	0.001642*	-0.736056*	-0.517074*	-0.651373*
2	26.80914	1.032029	0.001862	-0.611242	-0.246272	-0.470105
3	28.25085	2.516442	0.002047	-0.518213	-0.007255	-0.320621
4	29.97112	2.877531	0.002231	-0.435313	0.221632	-0.181267
5	32.73786	4.426784	0.002345	-0.390468	0.412466	-0.079967

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

VAR Lag Order Selection Criteria
Endogenous variables: LOGGEYR_GERMANY LOGGEYR_PORTUGAL
Exogenous variables: C
Date: 09/13/12 Time: 19:59
Sample: 1 60
Included observations: 55

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-52.79326	NA	0.025141	1.992482	2.065476	2.020709
1	25.83036	148.6701	0.001667*	-0.721104*	-0.502122*	-0.636422*
2	28.14663	4.211405	0.001774	-0.659878	-0.294908	-0.518741
3	29.74654	2.792570	0.001939	-0.572602	-0.061644	-0.375010
4	36.90232	11.96966*	0.001734	-0.687357	-0.030412	-0.433311
5	37.90583	1.605626	0.001944	-0.578394	0.224539	-0.267893

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

VAR Lag Order Selection Criteria
Endogenous variables: LOGGEYR_GERMANY LOGGEYR_SPAIN
Exogenous variables: C
Date: 09/13/12 Time: 20:00
Sample: 1 60
Included observations: 55

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-62.40417	NA	0.035658	2.341970	2.414964	2.370197
1	46.30001	205.5497*	0.000792*	-1.465455*	-1.246473*	-1.380773*
2	47.47286	2.132441	0.000878	-1.362649	-0.997680	-1.221513
3	47.74993	0.483624	0.001008	-1.227270	-0.716313	-1.029679
4	49.47211	2.880742	0.001098	-1.144441	-0.487495	-0.890394
5	49.98063	0.813622	0.001253	-1.017477	-0.214544	-0.706977

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

VAR Lag Order Selection Criteria
Endogenous variables: LOGGEYR_GREECE LOGGEYR_IRELAND
Exogenous variables: C
Date: 09/13/12 Time: 20:00
Sample: 1 60
Included observations: 55

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-55.93908	NA	0.028188	2.106876	2.179870	2.135103
1	17.20917	138.3167*	0.002281*	-0.407606*	-0.188624*	-0.322924*
2	18.15150	1.713330	0.002551	-0.296418	0.068551	-0.155282
3	20.13639	3.464521	0.002750	-0.223141	0.287816	-0.025550
4	20.92550	1.319975	0.003100	-0.106382	0.550564	0.147664
5	23.31199	3.818373	0.003304	-0.047709	0.755225	0.262792

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

VAR Lag Order Selection Criteria
Endogenous variables: LOGGEYR_GREECE LOGGEYR_PORTUGAL
Exogenous variables: C
Date: 09/13/12 Time: 20:01
Sample: 1 60
Included observations: 55

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-53.55061	NA	0.025843	2.020022	2.093016	2.048249
1	24.20837	147.0352*	0.001768*	-0.662123*	-0.443141*	-0.577441*
2	27.86672	6.651536	0.001792	-0.649699	-0.284729	-0.508562
3	31.10733	5.656350	0.001845	-0.622085	-0.111127	-0.424493
4	32.44653	2.240113	0.002039	-0.525328	0.131617	-0.271282
5	34.68841	3.587011	0.002185	-0.461397	0.341536	-0.150896

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

VAR Lag Order Selection Criteria
Endogenous variables: LOGGEYR_GREECE LOGGEYR_SPAIN
Exogenous variables: C
Date: 09/13/12 Time: 20:01
Sample: 1 60
Included observations: 55

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-93.41473	NA	0.110127	3.469626	3.542620	3.497854
1	28.88796	231.2633	0.001492*	-0.832290*	-0.613308*	-0.747607*
2	30.55278	3.026937	0.001625	-0.747374	-0.382404	-0.606237
3	34.00030	6.017500	0.001661	-0.727284	-0.216326	-0.529692
4	39.69222	9.521018*	0.001567	-0.788808	-0.131862	-0.534762
5	44.75726	8.104066	0.001515	-0.827537	-0.024603	-0.517036

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

VAR Lag Order Selection Criteria
Endogenous variables: LOGGEYR_IRELAND LOGGEYR_PORTUGAL
Exogenous variables: C
Date: 09/13/12 Time: 20:02
Sample: 1 60
Included observations: 55

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-32.56686	NA	0.012049	1.256977	1.329971	1.285204
1	32.20850	122.4843*	0.001322*	-0.953036*	-0.734055*	-0.868354*
2	34.49009	4.148335	0.001408	-0.890549	-0.525579	-0.749412
3	37.95968	6.056024	0.001438	-0.871261	-0.360304	-0.673670
4	39.92598	3.289071	0.001554	-0.797308	-0.140363	-0.543262
5	43.69880	6.036524	0.001574	-0.789047	0.013886	-0.478547

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

VAR Lag Order Selection Criteria
Endogenous variables: LOGGEYR_IRELAND LOGGEYR_SPAIN
Exogenous variables: C
Date: 09/13/12 Time: 20:02
Sample: 1 60
Included observations: 55

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-75.34081	NA	0.057077	2.812393	2.885387	2.840620
1	44.99955	227.5527*	0.000830*	-1.418165*	-1.199184*	-1.333483*
2	46.06974	1.945804	0.000924	-1.311627	-0.946657	-1.170490
3	46.96414	1.561136	0.001037	-1.198696	-0.687739	-1.001105
4	50.35565	5.673061	0.001063	-1.176569	-0.519624	-0.922523
5	52.27349	3.068555	0.001153	-1.100854	-0.297921	-0.790354

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

VAR Lag Order Selection Criteria
Endogenous variables: LOGGEYR_PORTUGAL LOGGEYR_SPAIN
Exogenous variables: C
Date: 09/13/12 Time: 20:03
Sample: 1 60
Included observations: 55

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-32.18162	NA	0.011881	1.242968	1.315962	1.271195
1	49.18621	153.8592	0.000713	-1.570408	-1.351426*	-1.485726*
2	49.51327	0.594653	0.000816	-1.436846	-1.071876	-1.295709
3	50.55769	1.822998	0.000910	-1.329371	-0.818413	-1.131779
4	61.79603	18.79867*	0.000701*	-1.592583*	-0.935638	-1.338537
5	64.01640	3.552595	0.000752	-1.527869	-0.724936	-1.217368

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

VAR Lag Order Selection Criteria
Endogenous variables: LOGGEYR1_GERMANY LOGGEYR1_SPAIN
Exogenous variables: C
Date: 09/13/12 Time: 20:06
Sample: 1 60
Included observations: 55

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-72.14940	NA	0.050823	2.696342	2.769336	2.724569
1	-6.069008	124.9520*	0.005318	0.438873	0.657855*	0.523555*
2	-1.413628	8.464328	0.005197*	0.415041*	0.780011	0.556178
3	0.405322	3.174895	0.005636	0.494352	1.005309	0.691943
4	2.842363	4.076504	0.005984	0.551187	1.208132	0.805233
5	5.567356	4.359989	0.006300	0.597551	1.400484	0.908051

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Annex 4 - Cointegrations tests: Output *Eviews*

Date: 09/13/12 Time: 20:08
Sample: 1 60
Included observations: 58
Series: LOGGEYR_GERMANY LOGGEYR_GREECE
Lags interval: 1 to 1

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	0	0	0	0	0
Max-Eig	0	0	0	0	0

*Critical values based on MacKinnon-Haug-Michelis (1999)

Date: 09/13/12 Time: 20:08
Sample: 1 60
Included observations: 58
Series: LOGGEYR_GERMANY LOGGEYR_IRELAND
Lags interval: 1 to 1

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	0	0	0	0	0
Max-Eig	0	0	0	0	0

*Critical values based on MacKinnon-Haug-Michelis (1999)

Date: 09/13/12 Time: 20:09
Sample: 1 60
Included observations: 58
Series: LOGGEYR_GERMANY LOGGEYR_PORTUGAL
Lags interval: 1 to 1

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	0	0	0	0	0
Max-Eig	0	0	0	0	0

*Critical values based on MacKinnon-Haug-Michelis (1999)

Date: 09/13/12 Time: 20:10
Sample: 1 60
Included observations: 58
Series: LOGGEYR_GERMANY LOGGEYR_SPAIN
Lags interval: 1 to 1

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	0	0	0	0	0
Max-Eig	0	0	0	0	0

*Critical values based on MacKinnon-Haug-Michelis (1999)

Date: 09/13/12 Time: 20:10
Sample: 1 60
Included observations: 58
Series: LOGGEYR_GREECE LOGGEYR_IRELAND
Lags interval: 1 to 1

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	0	0	0	0	0
Max-Eig	0	0	0	0	0

*Critical values based on MacKinnon-Haug-Michelis (1999)

Date: 09/13/12 Time: 20:10
Sample: 1 60
Included observations: 58
Series: LOGGEYR_GREECE LOGGEYR_PORTUGAL
Lags interval: 1 to 1

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	0	0	0	0	1
Max-Eig	0	0	0	0	1

*Critical values based on MacKinnon-Haug-Michelis (1999)

Date: 09/13/12 Time: 20:14
Sample: 1 60
Included observations: 58
Series: LOGGEYR_GREECE LOGGEYR_PORTUGAL
Lags interval: 1 to 1

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	0	0	0	0	1
Max-Eig	0	0	0	0	1

*Critical values based on MacKinnon-Haug-Michelis (1999)

Date: 09/13/12 Time: 20:15
Sample: 1 60
Included observations: 58
Series: LOGGEYR_GREECE LOGGEYR_SPAIN
Lags interval: 1 to 1

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	0	0	0	0	1
Max-Eig	0	0	0	0	1

*Critical values based on MacKinnon-Haug-Michelis (1999)

Date: 09/13/12 Time: 20:15
Sample: 1 60
Included observations: 58
Series: LOGGEYR_IRELAND LOGGEYR_PORTUGAL
Lags interval: 1 to 1

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	0	0	0	0	1
Max-Eig	1	0	0	0	1

*Critical values based on MacKinnon-Haug-Michelis (1999)

Date: 09/13/12 Time: 20:18
Sample: 1 60
Included observations: 58
Series: LOGGEYR_IRELAND LOGGEYR_SPAIN
Lags interval: 1 to 1

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	0	0	0	0	0
Max-Eig	0	0	0	0	0

*Critical values based on MacKinnon-Haug-Michelis (1999)

Date: 09/14/12 Time: 11:54
Sample: 1 60
Included observations: 58
Series: LOGGEYR_PORTUGAL LOGGEYR_SPAIN
Lags interval: 1 to 1

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	0	0	0	0	2
Max-Eig	0	0	0	0	2

*Critical values based on MacKinnon-Haug-Michelis (1999)

Date: 09/14/12 Time: 11:51
Sample: 1 60
Included observations: 57
Series: LOGGEYR1_SPAIN LOGGEYR1_GERMANY
Lags interval: 1 to 2

Selected (0.05 level*) Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	0	0	0	0	0
Max-Eig	0	0	0	0	0

*Critical values based on MacKinnon-Haug-Michelis (1999)

Annex 5 - VECM Outputs *Eviews*

Error Correction:	D(LOGGEYR_PORTUGAL)	D(LOGGEYR_IRELAND)
CointEq1	-0.666224 (0.19599) [-3.39924]	-0.286143 (0.26365) [-1.08533]
D(LOGGEYR_PORTUGAL(-1))	0.039910 (0.18104) [0.22045]	0.216818 (0.24353) [0.89031]
D(LOGGEYR_PORTUGAL(-2))	-0.148842 (0.14816) [-1.00463]	-0.134731 (0.19930) [-0.67602]
D(LOGGEYR_IRELAND(-1))	0.085403 (0.14409) [0.59272]	-0.100214 (0.19382) [-0.51704]
D(LOGGEYR_IRELAND(-2))	-0.024180 (0.12764) [-0.18943]	0.044420 (0.17170) [0.25870]
C	-0.055698 (0.04857) [-1.14669]	-0.097629 (0.06534) [-1.49418]
@TREND(1)	0.001381 (0.00139) [0.99167]	0.002968 (0.00187) [1.58508]

Error Correction:	D(LOGGEYR_PORTUGAL)	D(LOGGEYR_GREECE)
CointEq1	-0.797796 (0.17805) [-4.48082]	-0.662392 (0.27578) [-2.40192]
D(LOGGEYR_PORTUGAL(-1))	0.217004 (0.17089) [1.26985]	0.247744 (0.26469) [0.93598]
D(LOGGEYR_PORTUGAL(-2))	0.090537 (0.14518) [0.62363]	0.215043 (0.22487) [0.95632]
D(LOGGEYR_GREECE(-1))	-0.043136 (0.11626) [-0.37104]	-0.247181 (0.18007) [-1.37269]
D(LOGGEYR_GREECE(-2))	-0.218838 (0.11644) [-1.87948]	-0.130759 (0.18035) [-0.72505]
C	-0.063871 (0.04748) [-1.34532]	-0.083944 (0.07354) [-1.14153]
@TREND(1)	0.001849 (0.00138) [1.34468]	0.002956 (0.00213) [1.38772]

Error Correction:	D(LOGGEYR_IRELAND)	D(LOGGEYR_PORTUGAL)
CointEq1	0.131698	0.306632
	(0.12134)	(0.09021)
	[1.08533]	[3.39924]
D(LOGGEYR_IRELAND(-1))	-0.100214	0.085403
	(0.19382)	(0.14409)
	[-0.51704]	[0.59272]
D(LOGGEYR_IRELAND(-2))	0.044420	-0.024180
	(0.17170)	(0.12764)
	[0.25870]	[-0.18943]
D(LOGGEYR_PORTUGAL(-1))	0.216818	0.039910
	(0.24353)	(0.18104)
	[0.89031]	[0.22045]
D(LOGGEYR_PORTUGAL(-2))	-0.134731	-0.148842
	(0.19930)	(0.14816)
	[-0.67602]	[-1.00463]
C	-0.097629	-0.055698
	(0.06534)	(0.04857)
	[-1.49418]	[-1.14669]
@TREND(1)	0.002968	0.001381
	(0.00187)	(0.00139)
	[1.58508]	[0.99167]

Error Correction:	D(LOGGEYR_GREECE)	D(LOGGEYR_PORTUGAL)
CointEq1	0.224541	0.270441
	(0.09348)	(0.06036)
	[2.40192]	[4.48082]
D(LOGGEYR_GREECE(-1))	-0.247181	-0.043136
	(0.18007)	(0.11626)
	[-1.37269]	[-0.37104]
D(LOGGEYR_GREECE(-2))	-0.130759	-0.218838
	(0.18035)	(0.11644)
	[-0.72505]	[-1.87948]
D(LOGGEYR_PORTUGAL(-1))	0.247744	0.217004
	(0.26469)	(0.17089)
	[0.93598]	[1.26985]
D(LOGGEYR_PORTUGAL(-2))	0.215043	0.090537
	(0.22487)	(0.14518)
	[0.95632]	[0.62363]
C	-0.083944	-0.063871
	(0.07354)	(0.04748)
	[-1.14153]	[-1.34532]
@TREND(1)	0.002956	0.001849
	(0.00213)	(0.00138)
	[1.38772]	[1.34468]

Error Correction:	D(LOGGEYR_GREECE)	D(LOGGEYR_SPAIN)
CointEq1	0.189646	0.129622
	(0.04524)	(0.03095)
	[4.19211]	[4.18825]
D(LOGGEYR_GREECE(-1))	-0.336432	-0.084793
	(0.15008)	(0.10267)
	[-2.24166]	[-0.82584]
D(LOGGEYR_GREECE(-2))	-0.399721	-0.179221
	(0.15963)	(0.10921)
	[-2.50409]	[-1.64114]
D(LOGGEYR_SPAIN(-1))	0.500450	0.284915
	(0.23967)	(0.16396)
	[2.08812]	[1.73770]
D(LOGGEYR_SPAIN(-2))	0.825488	0.247916
	(0.22268)	(0.15234)
	[3.70711]	[1.62740]
C	-0.098859	-0.062919
	(0.06519)	(0.04460)
	[-1.51648]	[-1.41081]
@TREND(1)	0.004518	0.001742
	(0.00194)	(0.00133)
	[2.32626]	[1.31124]

Error Correction:	D(LOGGEYR_SPAIN)	D(LOGGEYR_GREECE)
CointEq1	-0.597649	-0.874399
	(0.14270)	(0.20858)
	[-4.18825]	[-4.19211]
D(LOGGEYR_SPAIN(-1))	0.284915	0.500450
	(0.16396)	(0.23967)
	[1.73770]	[2.08812]
D(LOGGEYR_SPAIN(-2))	0.247916	0.825488
	(0.15234)	(0.22268)
	[1.62740]	[3.70711]
D(LOGGEYR_GREECE(-1))	-0.084793	-0.336432
	(0.10267)	(0.15008)
	[-0.82584]	[-2.24166]
D(LOGGEYR_GREECE(-2))	-0.179221	-0.399721
	(0.10921)	(0.15963)
	[-1.64114]	[-2.50409]
C	-0.062919	-0.098859
	(0.04460)	(0.06519)
	[-1.41081]	[-1.51648]
@TREND(1)	0.001742	0.004518
	(0.00133)	(0.00194)
	[1.31124]	[2.32626]

Error Correction:	D(LOGGEYR_ SPAIN)	D(LOGGEYR_ PORTUGAL)
CointEq1	-0.544474	0.147152
	(0.19604)	(0.23804)
	[-2.77729]	[0.61817]
D(LOGGEYR_SPAIN(-1))	0.211549	0.021335
	(0.19780)	(0.24018)
	[1.06949]	[0.08883]
D(LOGGEYR_SPAIN(-2))	0.258192	0.082300
	(0.18064)	(0.21934)
	[1.42933]	[0.37522]
D(LOGGEYR_PORTUGAL (-1))	-0.156193	-0.139736
	(0.17439)	(0.21175)
	[-0.89565]	[-0.65991]
D(LOGGEYR_PORTUGAL (-2))	-0.316718	-0.312410
	(0.15945)	(0.19361)
	[-1.98635]	[-1.61364]
C	-0.066713	-0.075762
	(0.04757)	(0.05776)
	[-1.40240]	[-1.31164]
@TREND(1)	0.001597	0.002020
	(0.00138)	(0.00167)
	[1.16088]	[1.20948]

Error Correction:	D(LOGGEYR _PORTUGAL	D(LOGGEYR_ SPAIN)
CointEq1	-0.119499	0.442155
	(0.19331)	(0.15920)
	[-0.61817]	[2.77729]
D(LOGGEYR_PORTUGAL (-1))	-0.139736	-0.156193
	(0.21175)	(0.17439)
	[-0.65991]	[-0.89565]
D(LOGGEYR_PORTUGAL (-2))	-0.312410	-0.316718
	(0.19361)	(0.15945)
	[-1.61364]	[-1.98635]
D(LOGGEYR_SPAIN(-1))	0.021335	0.211549
	(0.24018)	(0.19780)
	[0.08883]	[1.06949]
D(LOGGEYR_SPAIN(-2))	0.082300	0.258192
	(0.21934)	(0.18064)
	[0.37522]	[1.42933]
C	-0.075762	-0.066713
	(0.05776)	(0.04757)
	[-1.31164]	[-1.40240]
@TREND(1)	0.002020	0.001597
	(0.00167)	(0.00138)
	[1.20948]	[1.16088]

Annex 6 - Granger Causality test: Outputs *Eviews*

Pairwise Granger Causality Tests
Date: 09/12/12 Time: 11:20
Sample: 1 60
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
LOGGEYR1_IRELAND does not Granger Cause LOGGEYR1_PORTUGAL	59	0.14468	0.7051
LOGGEYR1_PORTUGAL does not Granger Cause LOGGEYR1_IRELAND		0.06798	0.7953

Pairwise Granger Causality Tests
Date: 09/12/12 Time: 11:22
Sample: 1 60
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
LOGGEYR1_GREECE does not Granger Cause LOGGEYR1_PORTUGAL	59	1.18749	0.2805
LOGGEYR1_PORTUGAL does not Granger Cause LOGGEYR1_GREECE		1.14629	0.2889

Pairwise Granger Causality Tests
Date: 09/12/12 Time: 11:25
Sample: 1 60
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
LOGGEYR1_GREECE does not Granger Cause LOGGEYR1_IRELAND	59	0.00054	0.9815
LOGGEYR1_IRELAND does not Granger Cause LOGGEYR1_GREECE		1.85283	0.1789

Pairwise Granger Causality Tests
Date: 09/12/12 Time: 11:31
Sample: 1 60
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
DLOGGEYR_IRELAND does not Granger Cause DLOGGEYR_GERMANY	58	0.72679	0.3976
DLOGGEYR_GERMANY does not Granger Cause DLOGGEYR_IRELAND		1.56492	0.2162

Pairwise Granger Causality Tests
Date: 09/12/12 Time: 11:32
Sample: 1 60
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
DLOGGEYR_GREECE does not Granger Cause DLOGGEYR_GERMANY	58	0.52225	0.4729
DLOGGEYR_GERMANY does not Granger Cause DLOGGEYR_GREECE		1.11569	0.2955

Pairwise Granger Causality Tests
Date: 09/12/12 Time: 11:34
Sample: 1 60
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
DLOGGEYR_PORTUGAL does not Granger Cause DLOGGEYR_GERMANY	58	1.99539	0.1634
DLOGGEYR_GERMANY does not Granger Cause DLOGGEYR_PORTUGAL		0.06650	0.7975

Pairwise Granger Causality Tests
Date: 09/12/12 Time: 11:34
Sample: 1 60
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
DLOGGEYR_SPAIN does not Granger Cause DLOGGEYR_GERMANY	58	0.12231	0.7279
DLOGGEYR_GERMANY does not Granger Cause DLOGGEYR_SPAIN		0.79101	0.3777

Pairwise Granger Causality Tests
Date: 09/12/12 Time: 11:47
Sample: 1 60
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
DLOGGEYR1_SPAIN does not Granger Cause DLOGGEYR1_GERMANY	58	0.36471	0.5484
DLOGGEYR1_GERMANY does not Granger Cause DLOGGEYR1_SPAIN		1.42213	0.2382