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THE INFLUENCE OF RATING NOTATIONS ON THE GOVERNMENT BOND YIELDS OF GREECE, IRELAND AND PORTUGAL: AN ECONOMETRIC APPROACH

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Resumo

Actualmente, no mundo económico e financeiro tem-se questionado a existência, ou não, de influência das notações de *rating* sobre as *government bond yields.* Como tal, o presente estudo tem como objectivo verificar a existência de relação entre estas variáveis junto dos três países da zona Euro que recorreram a um plano financeiro de ajuda externa para colmatarem as dificuldades decorrentes da crise financeira. Uma vez que o presente estudo está associado ao desenvolvimento e expansão da recente crise do *subprime*, será efectuada uma abordagem às suas características. O presente trabalho encontra-se, então, estruturado em duas partes. A primeira parte foca-se numa abordagem à literatura existente relativamente à dívida soberana, com particular destaque para o risco associado ao financiamento de estados soberanos através de *government bonds*, envolvendo questões relacionadas com as *yields* e as notações de *rating*. Numa segunda parte é efectuada uma análise concreta entre as variáveis em estudo, através de alguns instrumentos económetricos, como o VAR (Vector Autoregression), com o objectivo de constatar possíveis inter-relações. Desta forma, pretende-se verificar a existência de influência das notações de *rating* sobre as *government bond yields.* Concluiu-se que existe uma divergência quanto ao papel que cada agência de *rating* tem nas *government bonds* dos países sob estudo em diferentes maturidades. As *yields* da Grécia são influenciadas pela Fitch; as Irlandesas estão sujeitas às notações da Moody's e da S&P; enquanto as de Portugal sentem a pressão das notações atribuídas pelas três agências de *rating*.

Palavras-chave: Dívida Soberana, Influência, *Government Bond Yields*, Notações de Rating

JEL Classification System: C19; H63

Abstract

At the current moment in the economic and financial world, it is being questioned if it exists, or not, influence of the rating notations assigned by rating agencies on government bond yields. Therefore, the main goal of this project is to study the relationship between those variables within the three Eurozone countries that had to resort to a financial rescue program to cope with the difficulties caused by the financial crisis. Since this study is motivated by the development and expansion of the recent subprime crisis, it will be made a brief discussion of its characteristics. The project is then structured in two main parts. The first part is a literature review on sovereign debt, with particular emphasis on the risk associated to sovereign states financing, through government bonds, which involves some issues like the yields and the sovereign credit rating notations. The second part performs an empirical analysis of the relationship between government bond yields and credit ratings through specific econometric instruments, such as VAR (Vector Autoregression). This project aims to verify whether rating notations influence government bond yields. It was concluded that the role of the credit rating agencies on the different maturities of the three countries differs. The Greek government bond yields are influenced by Fitch; Irish yields are subjective to Moody's and S&P notations; while Portugal feels the pressure of the three rating agencies announcements.

Key-words: Sovereign Debt, Influence, Government Bond Yields, Rating Notations

JEL Classification System: C19; H63

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Abbreviations

ADF – Augmented Dickey-Fuller

AIC – Akaike Information Criterion

AR (p) – Autoregressive process

CDS – Credit Default Swap

DP – Default Probabilities

EAD – Exposure At Default

ECB – European Central Bank

EFSF – European Financial Stability Fund

EFSM – European Financial Stabilization Mechanism

EU – European Union

FITCH_GR / FITCH_IRL / FITCH_PT – Rating notations assigned by Fitch to Greece, Ireland and Portugal

GDP – Gross Domestic Product

GR_2Y / GR_5Y / GR_10Y – Maturity of Greek yields with 2, 5 and 10 years

IMF – International Monetary Fund

IRL_2Y / IRL_5Y / IRL_10Y – Maturity of Irish yields with 2, 5 and 10 years

IV – Instrumental Variables

JB – Jarque Berra

KPSS – Kwiatkowski-Phillips-Schmidt-Shin

LGD – Loss Given Default

MOODYS_GR / MOODYS_IRL / MOODYS_PT – Rating notations assigned by Moody's to Greece, Ireland and Portugal

OLS – Ordinary Least Squares

PP – Phillips-Perron

PT_2Y / PT_5Y / PT_10Y – Maturity of Portuguese yields with 2, 5 and 10 years

HQ – Hannan-Quinn information criterion

S&P – Standard & Poor's

SC – Schwarz information Criterion

SPS_GR / SPS_IRL / SPS_PT – Rating notations assigned by S&P to Greece, Ireland and Portugal

U.S. – United States

U.K. – United Kingdom

VAR – Vector Autoregression

VAT – Value Added Tax

VECM – Vector Error Correction Model

Sumário Executivo

O despoletar da crise do *subprime*, em 2007, nos Estados Unidos da América, que abalou e ainda abala o mundo, veio pôr em causa muitos dos procedimentos que se tinham até então, principalmente, ao nível do risco de crédito. Uma vez que a assimetria de informação e a sua influência na avaliação, compreensão, mensuração e *hedging* estavam no cerne da crise, tornou-se claro que o contágio e a exposição ao risco soberano iriam caracterizar os mercados financeiros. Face a esta situação de incerteza, os investidores deslocaram, com maior intensidade, as suas atenções para investimentos que lhes garantissem maior segurança.

No entanto, a implusão da bolha imobiliária, que provocou perdas de 100 mil milhões de euros aos 6 principais bancos irlandeses, a divulgação dos resultados negativos registados pela Grécia em 2009 (défice de 13% e dívida pública superior a 110% em relação ao Produto Interno Bruto) levou a que os mercados se questionassem sobre a possibilidade de incumprimento por parte do Tesouro da Grécia, pressionando, desta forma, os respectivos activos financeiros. Como consequência, estes passaram a encontrar-se associados a risco de incumprimento, que associado a um contexto macroeconómico caracterizado por menor liquidez e maior aversão ao risco, marcava o início de uma desconfiança face à dívida soberana.

A desconfiança em relação à credibilidade das contas públicas gregas e as reduzidas perspectivas de crescimento económico, o colapso da economia Irlandesa, assim como os excessivos níveis de dívida pública em alguns países europeus, tornaram os investidores sensíveis a notícias relacionadas com os mais diversos países da Zona Euro. Em face do quadro apresentando, países como a Grécia, Irlanda e Portugal começaram a sentir maiores dificuldades no processo de obtenção de liquidez nos mercados secundários sem o auxílio de terceiros, tornando-se alvos de movimentos especulativos por parte dos mercados. Concretamente, os activos financeiros destas economias apresentaram-se enquanto alvos de uma enorme pressão, em particular com a subida das *yields* soberanas e com *downgrades* da dívida pública.

Como resultado, as *government bonds* destes países deixaram de ser *risk-free* assets (na ascenção académica do termo) e passaram a assumir características associadas a produtos de crédito. Uma vez que as probabilidades de *default* são atribuídas por agências de *rating*, como a S&P, Moody's e Fitch, começaram a surgir fortes dúvidas em relação à validade dos seus *ratings*, uma vez que não advertem o mercado da iminência de crises. Esta é a razão para muitos analistas acreditarem que as agências de *rating* atribuem notações com base numa relação de causa-efeito, onde a razão para o desfazamento do *downgrade* é a consequência da existência de forte risco de *default* do emitente da obrigação. Muitos analistas alegam, também, que o *rating* é desfasado porque as agências, apenas, atribuem a notação quando o mercado já conhece o risco de *default.*

Daí uma das questões actualmente em destaque na actualidade económica e financeira, ser a da existência de influência das notações de *rating* dos países sobre as respectivas *government bond yields*. Como tal, neste projecto é efectuada uma análise à existência de relações entre as *government bond yields* da Irlanda, Grécia e Portugal e as notações de *rating* atribuídas pelas principais agências de crédito através de alguns instrumentos económetricos, como o VAR, em que o objectivo se prende com a verificação de possíveis inter-relações entre as variáveis em estudo.

1. Introduction

The subprime crisis, which affected and still affects the world, came into question by many of the behaviors that were held so far, especially in terms of credit risk analysis. This happened because of the asymmetry of information and its consequence on terms of evaluation, comprehension, mensuration and hedging by the agents on the market. Since these features were in the core of the crisis, it became clear that contagion and exposure to sovereign credit risk would characterize the financial markets. Given this uncertainty, investors changed their attention to investments that guarantee greater security. In addition, financial markets have pressed certain Eurozone countries due to their fragility of public accounts and structural problems, which led rating agencies to concentrate their focus in countries like Ireland, Greece and Portugal. This debt crisis raised the levels of speculation on the markets, as well as downgraded sovereign credit rating and widening of government bond yields. Hence, it is important to comprehend what was behind the crisis and to understand its characteristics in order to desiccate the problems involved in sovereign debt.

The sovereign debt has become one of the major concerns of the crisis, especially because of its impact on economic recovery and its importance on country economic growth. However, sovereign debt is an instrument to obtain liquidity that has implicit two premises: (1) honoring contractual obligations or (2) default. The previous choice results from a political decision, influenced by macroeconomic factors and by the result of comparison studies between the values of the two strategies. This can explain why some literature and also this project focus on the country's willingness-to-pay and capability to repay. Since defaults related to sovereign debt make it more difficult for countries to access the capital markets, it is important to take into account its relation with credit risk and other sources that influence it, such as country risk, political risk, systematic risk, interest rate risk and liquidity risk. Thus, the way as sovereign debt is assessed depends on obligations and on three major underlying components – Exposure At Default (EAD), Default Probabilities (DP) and Loss Given Default (LGD) – and their correlations.

The macroeconomic environment, characterized by low liquidity and high risk-aversion, marked the sovereign debt crisis, provoking higher instability and strong speculation on the financial markets. The fears surrounding the probability of country default had pressured its financial assets. As a consequence, the assets of certain countries started to be associated with the risk of default and the government bonds of these countries were no longer risk-free assets. These bonds started to assume characteristics that are associated to credit products. By this way, as government bond yields are generally coherent with macroeconomic fundamentals, factors like the world economy, volatility or distance to default can be important to assess risk.

Since the default probabilities of a sovereign are assigned by rating agencies, many analysts believe that these agencies attribute rating notations based on a cause-effect relationship, where the reason to the lagged downgrade is a consequence of the existence of a higher level of risk concerning the probability of default of the issuer of the bond. Consequently, doubts are beginning to arise in relation to the trustiness of the sovereign credit ratings assigned by rating agencies, since they don’t warn the markets against the imminence of crisis. On the contrary, rating notations are assigned when the market already knows the country’s risk of default.

Thus, one of the issues that are currently highlighted in the economic and financial reality is the existence of influence from rating notations on government bond yields. To answer this question, it will be performed a concrete analysis to the existence of a relationship between the government bond yields of Greece, Ireland and Portugal and the rating notations attributed by the main credit rating agencies, such as Standard & Poor’s (S&P), Moody’s and Fitch. To do so, it will be used specific econometric instruments, such as VAR, in order to analyze the possible inter-relationships among the variables under study.

2. Credit risk and the subprime crisis

In the past, the capacity of banks in acquiring money abroad to lend inwards, allowed imbalance economies to minimize the effects of excessive external debt. However, with the subprime crisis, this intermediation is becoming more expensive to banks because to borrowing money they have to pay more for their debts. Consequently, the companies and families support higher rates in their loans. Since subprime refers to loans conceded to borrowers with negative credit histories, it is incorporated high levels of risk of defaulting on credit obligations.

Before the crisis, mortgages encroached the subprime market, creating scenario based on less rigorous loan standards. This approach allowed higher risk borrowers to insure mortgages in order to benefit from better terms than what was possible with normal mortgage guaranteeing criterions. It was also possible to off-load these riskier loans through securitization, which is a financial practice of combining different sorts of contractual debt, such as loans or residential mortgages, and selling consolidated debt as bonds or pass-through securities to different investors. The mix of low borrowing costs and the increased access to credit enlarged the level of United States (U.S.) home possession (in what can be called *subprime mortgage euphoria*). Therefore, while lenders thought that the possibilities of borrowers defaulting were smaller, a rise on the property's underlying prices were becoming a reality, what was diminishing the real Loan-To-Value ratios (the amount of a first mortgage guarantee as a percentage of the total evaluated value of real property). However, lenders believed, at this time, that home values would protect them against possible losses (Moore and Brauneis, 2008).

Nevertheless, in 2006 and throughout 2007, when the majority of particular agents defaulted on their mortgages, the value of the underlying assets fell as housing prices dropped. Therefore, mortgage owners were forced to restructure their loan at higher rates. A trend of mortgage defaults in the subprime market was led, essentially, by factors like the deterioration of housing prices, the increase of interest rates and the increase of mortgage costs. Consequently, these defaults caused a negative relationship between market prices and liquidity, implying a higher risk of price fluctuations and superior horizons on loans conceded. All of these effects, jointly with the poor quality of the collaterals and the credit quality underlying subprime mortgage resulted in the weakness of the U.S. housing market and in the breakdown of credit institutions in the

U.S. (Saunders and Allen, 2010). The problem was that, until the housing bubble burst, the conditions associated to the acceptance and maintenance of credit risk weren't duly 'considered' in the lenders business plans (Moore and Brauneis, 2008).

Later, in 2008, while mortgage securities suffered from a decrease in prices and market liquidity, the uncertainty and the increase of the overnight interest rates led to higher spreads. To avoid the default risk, banks engaged a process of underlying risk diversification. As a result, credit became an 'instrument' that was negotiated on the markets, instead of being held on the balance sheets of financial intermediaries. This sort of credit risk transference technique had the goal of improving the resistance of the financial system to financial and possibly economic shocks. The major idea was to split the risk and distribute it (originate-to-distribute model) to non-bank players, in order to provide liquidity in the markets and/or to alleviate and absorb those possible shocks (Spaventa, 2007). With the originate-to-distribute model, lenders decrease their exposure and no longer need to maintain the risk of credit until the end of maturity. However, as prices and market liquidity of guarantees broke down, refinancing by rolling-over became virtually unsupportable and banks had to provide extra liquidity. Since some banks had no longer enough capability to provide the liquidity required by the market, part of the credit risk that had been moved to the market reemerged on the bank books. The accuracy and firmness of the market lack of liquidity during the crisis can be explained by the overhanging risk supported by the financial institutions', their necessity to increase capital and uncertainty and information asymmetry. The malfunction of financial markets and the lack of liquidity led central banks of the U.S., Eurozone, United Kingdom (U.K.) and others, to provide injections of liquidity (Goldstein, 2008). As a consequence, all of these factors contaminated the global economy and helped to create financial macroeconomic imbalances that increased instability in the financial markets (Spaventa, 2007).

Presently, it is believed that subprime crisis emerged three forces: (1) the contraction in market liquidity; (2) higher leverage levels; and (3) lack of risk-mitigation (Corrigan, 2008). Also according to Corrigan (2008), the changes in investors' risk mentality, which moved from risk-taking to risk-aversion as a result of the unknown, produced a financial gridlock.

When financial institutions concede loans to borrowers, the goal is to protect them against counterparty credit risk. Hence, individual lenders will demand higher spreads, better credit quality guarantee coverage, and superior haircuts to short-term debt. However, what will happen in all financial system is the gridlock. Corrigan (2008) argues that gridlock happens when it is recognized that, at any point in the future, the quantity of the credit quality guarantee in the system is not enough, meaning that micro behaviors can have negative macroeconomic consequences.

By this way, the subprime crisis has emphasized the necessity for transparent and robust ways of valuing, hedging, measuring and comprehending the importance of different sorts of risk. According to Bielecki (2011), there are four procedures that are essential when analyzing credit risk:

1. The knowledge of the sources of exposures and the detection of the contributor's main risk;
2. The assess of how risk factors influence credit risk;
3. The adjustment of the credit conditions, accordingly to the risk taken situation;
4. Hedge exposures.

Hence, it can be said that, possibly, credit risk is at the center of the subprime crisis. Firstly, because of its origins in U.S. trade conditions in U.S. subprime and secondly, because of all the extents that were the core of the contagion: "*lack of depth of secondary markets, interbank market freeze, credit crunch, and so on*" (Bielecki *et al*, 2011: 16).

This contagion and exposure led some financial institutions, such as Citigroup or Merrill Lynch, to turn to sovereign wealth funds in order to retrieve their capital losses (Moore and Brauneis, 2008). As the financial sector felt the effects of defaulted loans, unsuccessful investments and higher levels of debt, the market assessments of foreign debt suffered the consequences.

Thus, the sovereign debt has also become one of the main concerns of the crisis. Especially, because of its impact on the economic recovery that threatens global financial stability.

3. An insight into some sovereign features

The recent subprime crisis has caused, among other things, a fiscal deterioration that was responsible for severe challenges in the financial and economic system, such as lower levels of liquidity and higher levels of risk-aversion. As consequence, financial stability began to be questioned as the capacity for recovery decreased. This macroeconomic environment led public finances from several developed countries, as well as some emerging countries, to become unsustainable (Jeanneret, 2010). As it was seen on this crisis, the financial sector can fast spill over into the public sector. Conversely, the financial and other business can be haunting by concerns about sovereign risk. Nevertheless, this situation increases the degree of uncertainty about the governments' capability to repay its debt and the concerns about its possibility of default. As such, it is crucial to analyze and understand sovereign debt and the credit risk associated.

3.1. Sovereign Debt

Financial intermediaries have a significant role-play in the progress of an economy due to their ability in grant credit. By providing present value of a given amount of cash, *via* a promise of payment of the same amount in the future, they assume confidence in the debtors' solvency, which gives the adequate conditions to satisfy governments' needs.

It is possible to define governments' debt or public debt as the accrual of borrowing from foreign and domestic creditors, in short-term or long-term. Since this form of debt is owned by a state (that have sovereign status), the legal framework has been identified as 'sovereign debt' (Ang and Longstaff, 2011). Sovereign debt has a great importance to an economy of a give country, not only because of its impact on the stability of the financial sector but also because of the large and rapidly increasing size of it (Longstaff *et al*, 2011). This type of debt can be obtained through bank loans, loans from other states or institutions, or securities issued by the debtor countries, which can be traded on the international bond market.

Before the subprime crisis, it wasn't easy to imagine that a country could face a default situation. But, nowadays, there is a bigger concern about the probability of a payment default related with government bankruptcy. The problem was that the bursting of the housing bubble, which led to the collapse of the Irish economy and the distrust of credibility on Greek public accounts, made the investors very sensitive. This susceptibility was felt not only to negative prospects related with these two countries, but to further aspects related with other Eurozone countries, like Portugal, which was also vulnerable in terms of public accounts. These countries became speculation targets on the markets, especially because of their higher levels of public debt (in relation to the Gross Domestic Product (GDP)) (see figure 1) and their subsequent difficulty on getting funds through this channel.

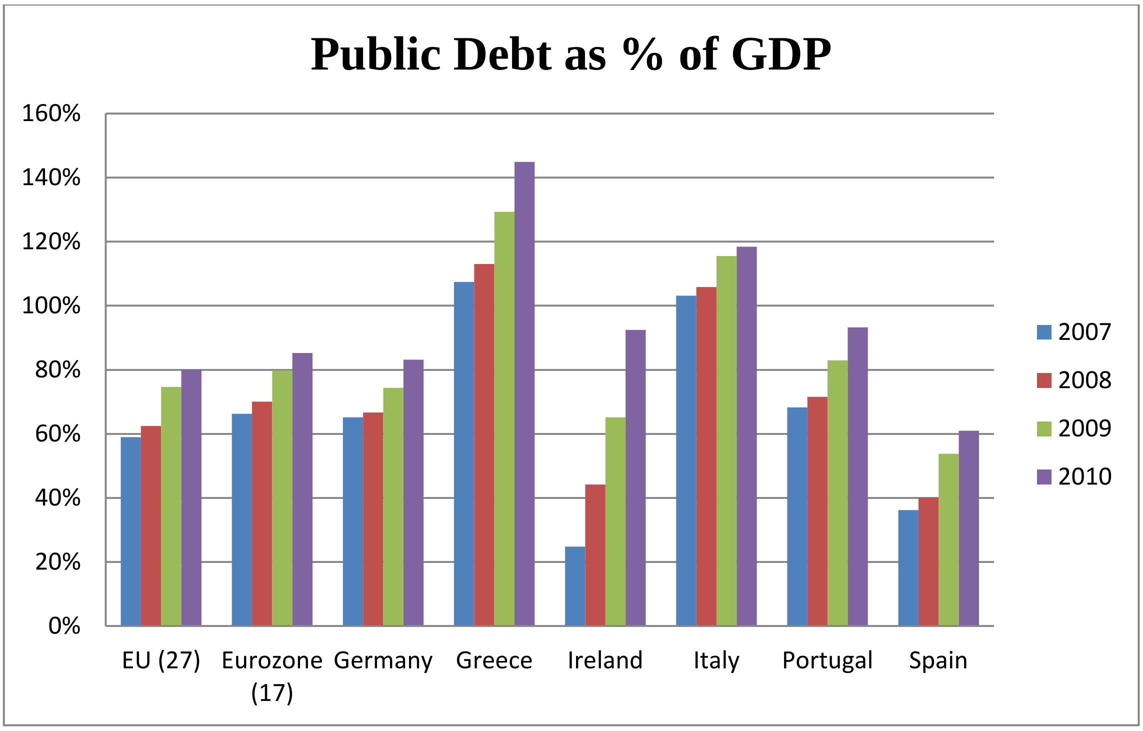


Figure 1 – Public debt as % of GDP from some Eurozone countries. Despite the Irish large growth of its public debt from 2007 to 2008, as a result of the losses of their banks due to the bursting of the housing bubble, it is clearly evident that, since 2008, there is an increase of the public debt in all countries analyzed on the figure, as well as in the European Union (EU-27) and Eurozone (17). Source: Eurostat.

Consequently, some countries began to have some difficulties in financing its public debt without the help of lenders. As such, the levels of concern revealed the risk associated to a settlement determined by specific arrangements that are related with sovereign debt and include, among other things, the timing of the exchange value and the final payment (Risk Management Group, 2000). Thus, the assets of some countries started to be associated with risk of default, which associated to a macroeconomic environment characterized by lower liquidity and higher risk-aversion marked a period of sovereign debt crisis.

The crisis developed a greater concern about the sovereign debt thematic, since defaults make it more difficult for a country to access capital markets in the future, which is detrimental to a country's economic growth. Thus, the probability that a sovereign nation will be incapable to service its debt becomes higher and the cost of insurance of sovereign nations against adverse economic conditions can also increases (Wrigth, 2011). It is important to take this into account because, like other debt instrument, sovereign debt has credit risk incorporated. This is one of the most critical risk factors because it has implicit the risk of the governments' failure to pay its debt obligations (commonly associated to loans or bonds), which involves a loss of principal by the lender (Anderson, 2007). For instance, Westphalen (2001) argues that the government decision about honoring contractual obligations or defaulting is a political decision influenced by macroeconomic factors and by the result of the comparison between the values of the two strategies. Nevertheless, the reputation, trust, costs of having assets abroad and the facility of trade on international markets will be penalized if the sovereign nation defaults.

In the past few years, the available literature on government borrowing has been focusing on a country's willingness-to-pay and capability to repay.

The first issue is essentially related with the incentives that sovereign nations have to repay their debts within the existing international legal framework. There is no insolvency code for government borrowers and lenders cannot take control of a country. Moreover, lenders cannot seize a significant amount of its assets in the event of a sovereign default (missing collateral) (Gelos *et al*, 2011). In contrast, the claims on the assets of a corporate debt contract are executable. However, according to Borensztein and Panizza (2009), in the case of sovereign debt, many assets are protected against legal actions and so it is very difficult to apply positive court judgments (missing legal enforcement). Still, economists have pointed reputation (excluding form future credit) and direct sanctions as two reasons for sovereign nations repay their debt obligations. The reputation describes the past history of debt issuing and debt repayment, which consequently can influence lenders' expectations concerning about future debt servicing behavior. The costs can be measured in the difficulty of future access to credit markets, and in the decrease on trade, as a result of the decline of commercial credit lines and seize of the country's assets in the creditor legal system. The benefits are the real value of the outstanding debt (Britto, 2004). The direct sanctions can lead to a loss of government control. So, the government borrower will try to maintain its ability to repay in order to corroborate the lender's expectations since the cost of not being creditworthy is higher than the benefit, or in other words, these spillovers produce a cost of defaulting that can explain why governments repay their debts (Longstaff *et al*, 2011).

The other central question on government borrowing literature involves the concern that lenders have about the government's capability to repay. As sovereign risk is involved in a complex system which comprises the country's net wealth and the economic (solvency and liquidity), political (willingness-to-pay, credibility) and institutional aggregation (market integration, cooperative enforcement), the capability of a country to borrow money depends on its perceived capability to repay and on the motivations that will have (Karmann and Maltritz, 2003). A country's solvency depends on the size of its outstanding debt (Britto, 2004), but political effects also have an impact on the amount that a country can borrow. Consequently, the inherent risk that arises from the political activities and other significant internal forces can threat the expected returns, since internal political economy commands the country's willingness to make sacrifices in order to repay (Hatchondo *et al*, 2007). Finally, global factors, like the interest rate, can disturb the cost of servicing the debt. Countries that are more susceptible to shocks have a higher concern in preserving access to credit markets, in order to decrease the probability of default (Gelos *et al*, 2011).

Therefore, it can be concluded that, sovereign debt have into account the risk related to national government, government-owned utility, or any credit backed by a government guarantee that cannot fulfill its debt responsibility, which drives to government's default on its liabilities (Karmann and Maltritz, 2003).

3.2. Sovereign credit risks

The existent literature reveals that sovereign risk can be a severe restraint to the total amount of sovereign debt that can be issued (Wrigth, 2011). However, in a globalized world, the health of the financial sector and other sources of risk are closely connected with the sovereign nations. All of these factors have an important role in the increase/decrease of sovereign's credit risk. Therefore, sovereign credit risk shouldn't be analyzed in isolation, due to the interconnection that it has with other risks factors. It is therefore crucial to see how it is linked with other sources of risk.

3.2.1. Country Risk

Besides credit exposures related to the international activities, such as foreign exchange, country risk also considers the banking crisis, the level of Value Added Tax (VAT), the inflation, the public *deficit*/GDP ratio or the public-sector debt/GDP ratio. If the country is facing high levels of VAT, inflation, public *deficit*/GDP ratio and public-sector debt/GDP ratio, the lenders will make higher provisions against the possible incapacity of covering exploration costs, which will increase sovereign credit risk (Ahmad and Ariff, 2007). For instance, the declines in aggregate demands as a consequence of higher levels of VAT will tight the government borrowing constraints and the increase in fiscal *deficit* will reduce the capability to repay sovereign debt, increasing the probability of default. Thus, it is possible to say that the macroeconomic performance prospects affect the investment demand and the investors' assessment of the country risk. Consequently, country risk will affect exposure, but it will also cause an increase on the average number of defaults. Thus, sovereign credit risk and the incapability of a country repay its debt increases (Saunders and Allen, 2002).

3.2.2. Political Risk

Domestic policy is responsible for some deliberations about political and legal structure, the cost of making payments on debt, the definition of the available amount to help businesses and the development and strength of the financial markets. If the political situation in a country is unstable, it can introduce uncertainty, which leads to a deterioration in the levels of investment and demand for credit (Arteta and Hale, 2008). Therefore, the governmental environment has an important guidance on sovereign credit risk due to the stability/instability that it provides to its country.

3.2.3. Systematic Risk

The complexity and the asymmetric information that exists in markets can lead to an underestimation of the credit risk. This can fuel credit booms and the intensification of systemic risks. Supposedly, lenders should keep an asset until the maturity that is related with movements that have counterparties incorporated subjected to default risk. Hence, the latent future value during the credit horizon period is the sovereign credit risk exposure, since they represent the value of the future flows that a defaulted government will not pay (Bessis, 2002). Since the value of these instruments constantly fluctuates with the market parameters, sovereign credit risk can also varies with market movements during the life period of a transaction.

3.2.4. Interest Rate and Liquidity Risk

If a government has difficulties in selling assets for its full value, as a consequence of the uncertainty on the secondary market and subsequent to the unknown future of short-term financial obligations, lenders have to face higher levels of exposure. Therefore, deteriorating market liquidity induces lenders to embrace longer horizons and to demand higher interest rates and bond prices, as a technique to transfer the predictable cost, allied with a liquidity shock, to the borrower (Cai and Thakor, 2008). This means that higher interest rates correspond to lower levels of return. In the opposite, when interest rates are at a low level, a high return is expected. As a result, risk exposure related to government's failure may increase that allied with interest rates influence sovereign credit risk.

3.3. Sovereign credit risk components

Thus, the way sovereign credit risk is assessed depends on the obligation and on three major underlying components – Exposure At Default (EAD), Default Probabilities (DP) and Loss Given Default (LGD) (Bessis, 2002).

$$E[Default\ Loss] = EAD\ \times \underbrace{DP\ \times LGD}_{\text{Sovereign credit risk}} \tag{1}$$

EAD is the amount of risk or, in other words, is the credit exposure amount. It can be reflected through fixed exposures, committed and unused lines of credit and variable exposures (Bessis, 2002). Fixed exposures arise from buying bonds or when lenders give the money directly to debtors. The committed and unused lines of credit occur when the borrower can distort part of the credit line before its financial difficulties are recognized. Finally, the variable exposures are a result of Over-The-Counter transactions in derivatives. Credit exposure is related to the event of a default with zero recovery and to the evaluation of the amount of outstanding obligation if that default happens (Bessis, 2002). Nevertheless, to cope with credit exposure, the lender should consider it as the total line of credit (it can overstate the credit exposure) or compute it as being a portion of the entire line of credit (portion constructed from an analysis of previous similar lines of credits).

Default probabilities represent the odds of defaulting through risk classes. The probability that default happens during a certain period of time describes default risk, which is the impossibility of a government to settle the outstanding debt on a contract. This situation provokes a reduction in interest rates and in the value of the issued bonds, but also an enlargement of the maturities (Gaillard, 2012). As a consequence, the investor's lose the remainder of the forthcoming coupon payments and the principal on the bond. This reflects either depreciations or expansions of the borrower's credit situation, which translates into higher or lower default probabilities (credit quality that influences credit rating) (Bessis, 2002).

In relation to the LGD or recovery rate, it gives the portion of the exposure that may be recovered through bankruptcy proceedings and it decreases the loss under default. Despite the lending being primarily dependent on the borrower's capability to pay, it is also dependent on the covenants or guarantees that are stipulated in the lending contract. Thus, even taking into account the residual risk associated with the guarantees, including the adjustment for the volatility of the instrument's market value, its value shouldn't be ignored due to the limitation that allowances to the lender's loss under default and to the borrower's risk-taking tendency (Bessis, 2002). However, the possible recovery of the money or the guarantees, in an occasion of default, is undefined due to the influence of some factors, such as legal procedures, nature of credit risk, situation of the obligor at the time of default and situation of the economic environment.

3.4. Sovereign credit risk correlations

External conditions and economic cycles are positively correlated with sovereign credit risk. As a consequence, the risk of losses and the shape of loss distributions are driven by these issues (Bessis, 2002).

To analyze the impact of those structural variables, two sorts of models have been used: structural and reduced (intensity) forms. The first one deduces the default probabilities and sovereign credit risk, which are dependent on governments' assets and liabilities. On the other hand, the reduced model is based on the market prices of the governments' default securities (like Credit Default Swaps (CDS) which is a contract, indexed to a single reference asset, that offers protection against a default event on that asset) to seize the expansion of its risk. This model also assumes that governments' default time is conducted by a default intensity that diverges according to variations in macroeconomic environments. Therefore, it is possible to classify sovereign credit risk as the product of the intensity of default and the LGD, as it was mentioned before. This means that sovereign credit risk is influenced by different risk sources, some mutual to all governments and others peculiar to each one (Elizalde, 2005).

Since all governments are inclined to migrate to poorer credit conditions when the state of the economy deteriorates, list individual risks to a set of common factors will drive the default and migration probabilities (credit events). The perception is that common factors have an effect in the credit standing of debtors. As so, the types of credit events that sovereign debt might involve are default, restructuring or a switch of regime, like defaults of another government bond that changes the perceived risk of future defaults or elect a new government (Pan and Singleton, 2008). To correlate sovereign credit risk events, it is needed to link their risk drivers (economic indexes connected to country factors). As they result from factor models, it is common to say that risk drivers are variables that have direct impact on sovereign credit risk events. Consequently, the parameters that influence risk drivers are risk factors (Bessis, 2002). These conditions are, therefore, imperative because sovereign credit risk is the risk of loss associated to a government defaulting (Embrechts *et al*, 2009). It is not only non-payments that are enclosed, but also variations in risk situation that affect the market value of transacted debt.

4. Government Bonds

Economies are subject to inter-temporal fluctuations but, standard preferences indicate that agents wish to smooth this volatility (Silva, 2012). Buying bonds issued by governments can be a way used by agents to achieve this goal. A bond is a debt security which matures at a specific date in the future, and pays interests periodically in the form of coupons, repaying its face-value at the maturity date. In sequence, government bonds are a form of securitized debt, issued by a government in order to collect funds to increase the available liquidity and to cover expenditure that isn't netted by their tax revenues. Thus, this type of debt represents a form of sovereign debt financing. It represents a promise of paying to the holder a certain level of interest during the lifetime of the bond and to repay the full amount on an agreed date. At any time, the fair price represents the present value of the future cash flows:

$$P = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} \tag{2}$$

where P is the price of the bond, C is the coupon (interest) plus principal payments at date t, T is the number of periods to maturity and r is the discount rate, or required return or yield to maturity (Pereira, 2010).

The price of a bond varies due to several factors, such as the interest rate sensitivity and the perceived credit quality of the bond issuer. Relatively to the first one, if the interest rate increases, investors will sell their bonds in order to guarantee the capital gains, which will consequently drop the prices. If interest rates are expected to decrease, the prices will rise because investors will buy bonds, with the purpose of confining higher yields and to obtain future capital gains. Regarding to the perceived credit quality of the bond issuer, if creditors are not sure about the governments' capability or willingness-to-pay its obligations, governments' may have to pay a higher interest rate. Otherwise, the value of the bond depreciates. As a last resource, when governments' aren't capable of issuing the necessary amount of bonds to cover their debts, they have to reduce expenditures, increase taxes or borrow from the International Monetary Fund (IMF), European Financial Stability Fund (EFSF) or European Financial Stabilization Mechanism (EFSM). This last scenario happened recently with Ireland, Greece and Portugal. Nevertheless, when a country issues different bonds, its price reflects the risk adjusted loss in case of default and is equally determined with the maturity structure of debt. Thus, whatever disturbs interest rates – inflation, economic growth and market expectations – also disturbs bonds. These are the reason why before investing in government bonds, investors must assess some risks, such as country risk, political risk, inflation risk, and interest rate risk, as it was referred earlier on the previous chapter.

In the occurrence of default of a government, the maturity structure of debt replicates a trade-off between liquidity benefits of short-term debt and hedging benefits of long-term debt. Short-term debt is more liquid due to the higher consumption conditions but it is also a riskier instrument, because rolling-over is an expensive attempt in upcoming environments that have the possibility of high interest rates. In this way, it also influences the borrower to repay its debt in the near future, in order to avoid the costs of defaulting. On the other hand, issuing long-term debt provides a hedge opportunity, but in adverse conditions its value decreases more than the value of short-term debt. As such, the borrower can have some problems saving the necessary amount of money to repay long-term debt, and that's why consumption cannot be raised as much as with long-term debt. The value of outstanding long-term debt has implicit the aggregate risk-adjusted default probabilities during a certain period of time, so it is more sensitive to variations in default risk than the value of short-term debt (Arellano and Ramanarayanan, 2008). While short-term debt can increase incomes in an upper scale, the long-term debt offers a hedge opportunity against the necessity of roll-over short-term debt at a high interest rate. This might reflect a greater return to lenders who assess a higher probability of default. Thus, higher short-term debt positions on financial crisis circumstances can be a better choice to cope with the illiquidity of long-term debt and the snugger accessibility of its supply.

The evolution of government bonds has played a crucial part of public and private agents' business life. For public agents because they can deduce from the correspondent prices in markets and infer certain indicators that can help measuring inflation and production. To private agents because they can use these securities as an investment asset, like a guarantee, that can help pricing fixed income securities and hedging interest rate connected to sovereign risks (Menkveld *et al*, 2004). Since the yields related to government bonds are rising, as a result of higher risk connected to this type of debt instrument, it is interesting to analyze the relationship between those yields and the rating notations associated.

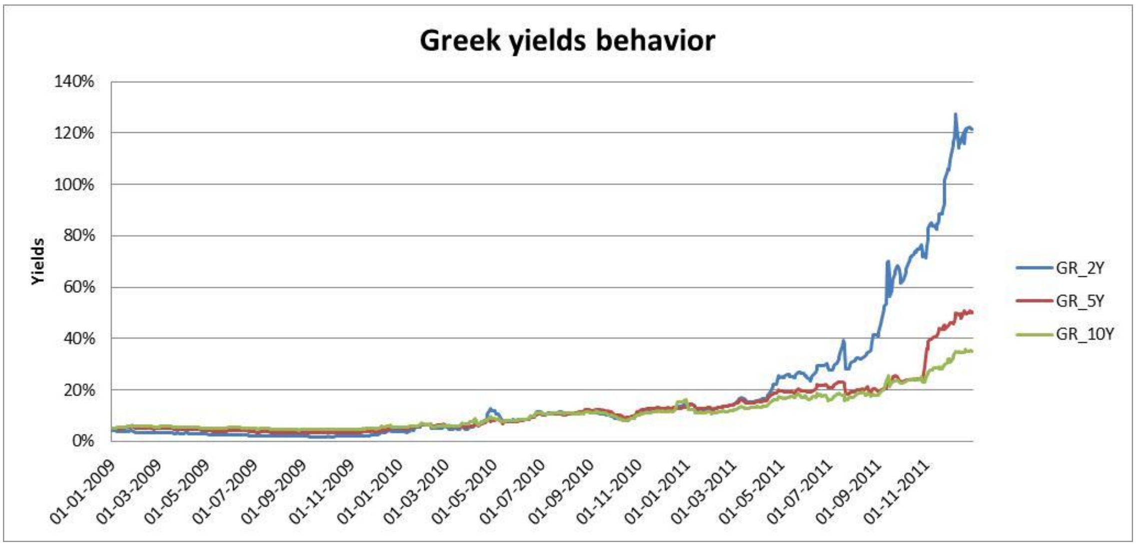
4.1. Government bond yields

The stability that government bonds provide to the investors is an important factor to consider when assessing the sovereign credit risk. Ability to repay debt, and the probability associated to this context has an implicit risk, which means that the yields are correlated with perceived risk. So, the higher the perceived risk, the higher the yield demanded by the lenders (Ahmad and Ariff, 2007). Recently, it was observed several sovereign credit downgrades, larger levels of volatility and an increased uncertainty about the sovereign debt as a risk-free asset. As a result, government bonds are no longer the risk-free assets they were in the past and started to assume characteristics seen on several credit products. And so, the necessary premium to persuade investors investing on a bond of a given maturity with higher probability of default enlarged in most economies hit by the crisis (Arellano and Ramanarayanan, 2008).

It is possible to describe yield as a representation of the income return required on an investment, or in other words, it refers to the interest or dividends expressed annually as a percentage based on the investment costs, its current market value or its face value. Generally it doesn't contain the price variations, at the difference of the total return. Using the bond pricing equation that referred earlier, it can be defined the yield to maturity as the return on the bond demanded by the market. Hence, solving the bond pricing equation in order to achieve *r* (call it *y*), it can be obtained:

$$y: P = \sum_{t=1}^{T} \frac{C_t}{(1+y)^t} \tag{3}$$

So, it can said that prices are usually quoted in the percentage of the face value, which means that, if the investment has a higher percentage of risk, the yield should be higher when compared to a safe investment. Normally, the yield curve (the term structure of interest rates), that replicates the relationship between market compensation and the remaining time to maturity of debt securities, reflects lower returns in the short-term and higher returns in long-term. This happens because investors usually require higher returns to the titles that have longer maturity (Arellano and Ramanarayanan, 2008). This is a consequence of the uncertainty related to the probability of default in the far future if the borrower is affected by a series of adverse shocks and collects debt. On the other hand, long-term yields increase less than short-term yields due to the probability of borrower's repaying, which may increase over an extensive time horizon if a series of favorable shocks happens and debt decreases (Arellano and Ramanarayanan, 2008). Conversely, in periods of low income and high debt, the probability of default is higher in the near future, so yields with lower maturity are higher than yields with higher maturity. On certain government bond yields, as a consequence of the subprime crisis, this relation was seen because investors that held portfolios with several Mediterranean sovereign risks concentrated an excessively level of risk and subsequently, their yields were affected.



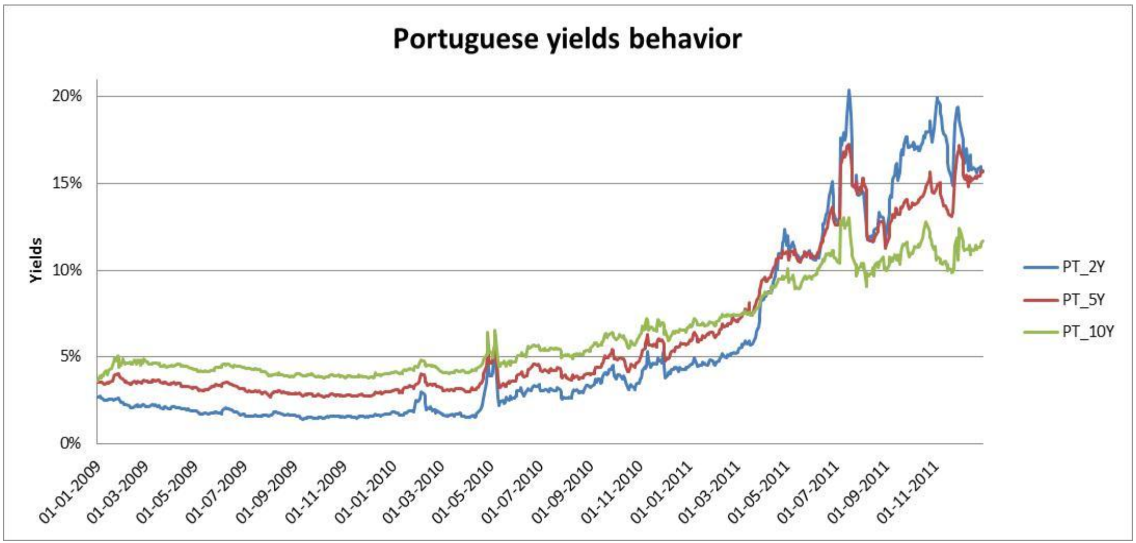


Figure 2 – The Greek and the Portuguese government bond yields behavior. In this figure it is possible to see that in April 2010, the Greek yields start to describe an inverted behavior, while the Portuguese yields describe the same shape in April 2011. This means that yields with less maturity, normally characterized by less uncertainty, were in higher values when compared to yields with longer maturity. Source: Reuters.

Therefore, as can be seen on figure 2, after the financial rescue of Greece (April 2010) and Portugal (April 2011), the yields of these two countries assumed an inverted trajectory. This means that investors were demanding a higher return to buy Greek and Portugal debt at 2 years when compared to the bonds at 10 years.

Government bond yields are generally coherent with macroeconomic fundamentals and so, there are some factors that determine it (Westphalen, 2001; Wrigth, 2011; De Santis, 2012):

- Quantity of debt: higher levels increases the expectations that the country will not be able to fulfill with its debt service, leading to a rise in the yields;
- Yields maturities: the necessary time until investors receive the return on investment is an indicator of market liquidity preference. Therefore, as higher is duration, upper is the sensitivity to yields changes because the forces that determine bond prices and yields include expectations about long-term future default probabilities;
- Probability of default: as it was mentioned before, default is the government incapacity to pay the promised coupon payments and principal. Consequently, the lenders will demand sanctions that can reduce the country’s wealth growth rate. A greater probability means a higher leverage, which implies a higher yield;
- Volatility: when international market presents higher levels of volatility, the possibilities of country’s wealth defaults increases and so, the yields can also increase.
- World economy: an auspicious economic setting means that country’s wealth growth rate can increase. This reveals that there is some dependence on the business cycle. As such, an increase in the growth rate can lead to a fall in the yields.

However, there are also other determinant factors, unrelated with macroeconomic fundamentals, such as: (a) changes in the risk aversion from international investors; (b) asymmetric information; (c) political risk; (d) contagion effect; and (e) incomprehension of the impact of external factors that can influence the performance variables on the sovereign debt, increasing the yields and downgrading the rating notation (Bellas et al, 2010; Barbosa and Costa, 2010).

4.2. Sovereign credit ratings

In the last years, as a consequence of the subprime crisis, the search for sovereign credit ratings information has increased dramatically. This has happened because rating agencies rate the risk of defaulting on debt obligations of sovereign governments to creditors, in concrete, those issued in the capital markets.

A sovereign nation's credit rating is an assessment of the creditworthiness of that same nation, based on its existing liabilities, its borrowing and repayment history and its overall business performance. Sovereign nation credit ratings predict the likelihood of default on financial obligations but it also works as a tool for measuring and limiting risk (Becker and Milbourn, 2011).

Sovereign credit ratings exist in both foreign and local currency ratings. The servicing of local currency debt obligations of a government are met through its powers of taxation and its control of the monetary and financial systems. Foreign currency debt, in contrast, must be serviced by obtaining foreign exchange, usually through exchanging local currency on the currency markets. However, some governments can obtain foreign currency directly through the commodity assets they have in control (Langohr and Langohr, 2008).

So, sovereign nation's credit ratings help investors take into consideration the implicit risk by giving information about the probability of a borrower to default on its obligations and other forms of failure when one of the parts in the contract misses a predetermined payment (Bessis, 2002). By dropping investor's uncertainty about risk exposures related to the governments' probability to repay the loan, sovereign credit ratings give the possibility to many governments and domestic firms to access international capital markets and to obtain lower debt issuance and interest costs (Cantor and Packer, 1995). However, since the beginning of the subprime breakdown, the market participants had censured the role of the rating agencies (Hassan and Kalhoefer, 2011). The difficulty of evaluating sovereign risk has led to agency divergences and public controversy, which has raised some doubts in the financial markets surrounding the rating agencies efficiency, especially because of their lack of prevention on the subprime crisis. When the agencies analyze sovereign nations credit risk they need to take into account aspects that not only disturb solvency, but also that have an impact in the willingness to pay, such as the stability of political organizations, social and economic structure and integration into the world economic system (Cantor and Packer, 1995).

According to Cantor and Packer (1995), the commonness of agencies' divergences reproduces the relative inexperience in rating sovereign credits and obstacles in measuring political and economic impacts that disturb countries creditworthiness. Political impacts are the real challenge to credit rating agencies, since they, in a statistical way of seeing the problem, are discrete variables that have a direct relation with the continuous variables. To measure financial and economic impacts, rating agencies such as Moody's (free-standing company), Standard and Poor's (S&P) and Fitch use models to classify information about the issuer and the bond issue like GDP growth, GDP *per capita*, inflation rates, fiscal and external balances, foreign debt, economic development measures and default history (see appendix 1). Summing up, rating is a representation of all this synthesized information (Langohr and Langohr, 2008). After assessing the credit conditions of the borrower, agencies give a rating according to a credit rating class based on the governments' capabilities to repay the outstanding debt. According with figure 3, S&P/Fitch and Moody's use the following classification to long-term obligations[1]:

Long-Term Obligation Ratings

S&P / Fitch	Moody's	Meaning
AAA	Aaa	Highest quality minimal credit risk
AA	Aa	High quality
A	A	Strong payment capacity
BBB	Baa	Adequate protection, moderate credit risk
BB	Ba	Likely to pay, but ongoing uncertainty
B	B	High risk
CCC	Caa	Current vulnerability to default
CC	Ca	
C	C	Nonpayment highly likely; in default (Moody's)
D	–	In Default

Table 1 – Long-Term Obligation Ratings of S&P, Fitch and Moody's. The figure describes the qualitative character of the long-term obligation ratings assigned by the three rating agencies. Source: Langohr and Langohr, 2008; Jorion and Zhang, 2007.

[1] The short-term classification is different and it is not referred because it is the long-term obligation rating that it is used in this project.

Relatively to table 1, rating notations BBB/Baa or superior refers to "investment-grade" obligors while ratings BB/Ba or inferior means that the obligors have "speculative-grade". To each category can also be added a + or - sign (S&P and Fitch) or 1, 2, 3 numbers (Moody's) to demonstrate the relative standing about the credit situation of the borrower (Jorion and Zhang, 2007).

There are also rating outlooks that describe the probable direction of a sovereign's rating and are divided into four categories: positive, negative, stable and developing. A positive outlook means that the rating can be raised in the future, while a negative one means that the rating can drop in the future. On the other hand, a stable outlook means that rating can stay unchanged, while a developing position means that a rating is depending upon an event and thus can raise or drop. However, these outlooks don't mean that an upgrade or a downgrade is certain (Gaillard, 2012). In cases of ratings with historical downgrades, it is more probable to see future downgrades and defaults, which can provoke negative effects on a country's domestic economy and enable contagion in international economies (Güttler and Raupach, 2010).

It is also important to refer that Cantor and Packer's (1995) work also concludes that the relationship between sovereign ratings and market yields suggests that the financial markets know the problems in determining sovereign credit risk. In fact, in many cases, credit rating agencies use a 'sovereign ceiling' practice, which means that private borrowers cannot obtain a better rating than their sovereign nation (Arteta and Hale, 2008). Hence, credit becomes more expensive for domestic firms and they decrease their borrowing. The dimension of the drop in credit will hinge on the price elasticity of request for credit (Arteta and Hale, 2008). However, as the public sector gets involved with sustaining financial institutions, public exposure to private risks grows. This leads to higher levels of contagion among weaker mature market sovereigns, especially in countries that are affected by higher sovereign funding costs, inducing market volatility and short-term financing strains. Furthermore, the rank-orderings of sovereign risks expressed in the market yields often diverge from the rankings given by the agencies. Despite the increasing importance of sovereign ratings for international bond market, Cantor and Packer (1995) argue that sovereign credit ratings influence on specific market yields seems limited. In this work, this influence will be tested by analyzing the relationship between government bond yields of the three Eurozone countries that were financially rescued and their correspondent credit ratings.

5. Data

Since the beginning of the financial crisis, the trustiness of the three main credit rating agencies, S&P, Moody's and Fitch, has been challenged with critics to their rating practices allocations. The problem was that, until July 2008, there were very few rating notations assigned. This has implicit that rating agencies have not predicted the macroeconomic weaknesses of European economies, showed especially with the financial crisis. For instance, after the bursting of the housing bubble, the large losses recorded by Irish banks that were guaranteed by the Irish government and the announcement of negative Greek's wealth results, in 2009, meant that the markets should concern about the possibility of a government default. Consequently, rating agencies has been accused of their role on the macroeconomic declining of some countries because of the successive downgrades announcements to certain European sovereign debts, which started, especially, with the Greek debt. After Greece, rating agencies continued issue downgrades to other countries, such as Ireland and Portugal, which resulted in bursting national economies (Hassan and Kalhoefer, 2011).

The pick of announcements was reached in 2009. After that, the announcements reduced, even though they remained quite large (Arezki *et al*, 2011). Since downgrades caused sovereign debt problems to certain European countries and concerns about the possible end of the Euro-currency, many in the financial markets have questioned the credibility of the ratings, especially, as being the best way to notify the market on bond risks (Hassan and Kalhoefer, 2011).

Thus, the first idea of this study was to analyze the relationship between long-term rating notations, by the three main rating agencies (S&P, Moody's and Fitch and the long-term government bond yields (2, 5 and 10 year's maturity) of the first twelve Eurozone countries, during the period of 2001 and 2011.

However, after some research it was noticeable that mostly of these countries have constant ratings, with few or no changes until 2008. This situation led to an impossible analysis of the ratings impact in the yields of those countries. Therefore, the data was reduced to a list of three countries that belong to Eurozone, namely Greece, Ireland and Portugal. These countries were chosen because they composed the Eurozone countries that suffered the most impacts in their financial, economic and political realities, as a consequence of the subprime crisis.

For instance, at the end of 2009, it was announced that Greek *deficit* would reach to the historic level of 12.7% of GDP and its public debt to 130% of GDP (Faria and Villalobos, 2011). This is a result of the large structural *deficits* that Greek government incurred to finance unemployed, civil servants and pensioners, which served to sustain Greek inflexible labor markets. Since the austerity policies to balance the public accounts weren't having the needed effect, a financial rescue plan was necessary. On April 23, 2010 it was established a loan of €110 billion (€80 from Eurozone and €30 from IMF) with an interest rate of approximately 5% and a credit line of 3 years (Gaspar, 2010). This situation was inevitable and the only solution was to resort to the financial rescue, especially, because financial markets probably wouldn't refinance Greek debt, by purchasing government bonds. Consequently, on April 27, the sovereign rating concerning the long-term obligation of Greece suffered a downgrade. Since the country's condition didn't improve, a second financial rescue plan was negotiated (more 130 billion euros, the acceptance of a greater debt relief by private investors (53.5% of the nominal value, instead of 50%), the decrease of the interest rate from 5.2% to 4.2% and the enlargement of the credit line to 7 and half years) (Carregueiro, 2012). This situation implied a partial restructuring and heavy losses of interest to the taxpayers of the solvents nations.

On the other hand, the estimated recapitalization of the Irish banking system in €59 billion turned the market's attention to this country. The problem was that the bursting of the housing bubble as a result of the credit expansion in Ireland, due to attractive tax burden, provoked substantial losses that were socialized when the Irish government gave guarantees to all bank liabilities. Nevertheless, the public *deficit* of 31.3% of GDP and the public debt of 92.5% of GDP, as a consequence of the spending increases to support the insolvent banking system and due to high exposure of the banks, caused some pressure on Irish government bond yields. It was then that on November 21, 2010 Ireland formalized a bailout request of €85 billion (€17.5 billion from domestic financing, €17.7 billion from EFSF, €22.5 billion from IMF, €22.5 billion from EFSM and €4.8 billion from U.K., Sweden and Denmark) with an interest rate of 5.83% and a credit line of 7 and half years (Jornal de Negócios Online, 2010).

More recently, it was Portugal turn. The high public debt and *deficit* (93% and 9.8% of GDP, in 2010, respectively) reflects an economic structure not aligned to the consumers' reality and maintained, artificially, by massive government spending. The weak competitiveness of the Portuguese economy, its inflexible labor market and its large public sector generate huge tax burden. As a consequence, control the trade *deficit* has become increasingly difficult. Since the Portugal reality's regarding the structural *deficits* was similar to Greece, the financial markets began to concern about the capability of Portugal in fulfill with its debt responsibilities. Thus, in January 2011, during an auction of debt tittles from Portugal, the government was paying more than 7% for 10-year bonds. This situation was considered unsustainable and the pressure over the government bond yields increased, leading Portugal to request a financial rescue plan. On April 6, 2011 the request was made and it was established a loan of €78 billion (€26 from IMF, €26 from EFSF and €26 from EFSM) with an interest rate of 3.25% (related to the IMF loan) and 5.1% (related to EFSF and EFSM loan) and a credit line of 3 years (Económico, 2011; Agência Lusa, 2011; European Comission). These events led financial markets began to worry with the probability of default of these countries, pressuring their financial assets. As a result, these assets became associated to risk of default, which allied to an unfavorable macroeconomic environment, characterized by lower liquidity and higher risk-aversion, led to the growth of government bond yields and to rating downgrades.

Nevertheless, after defining the countries to use in this study, another problem was found. Only after the subprime crisis affected Europe, the rating agencies 'started' to measure the creditworthiness of the euro countries, as it was mentioned before. This means that analyze the relationships between rating notations and yields before 2009 would skew the results. Therefore, analyze these relationships could lead to wrong conclusions about the impact of rating notations in yields.

So, the data is defined as a daily sample long-term government bond yields of different maturities (2, 5 and 10 years – obtained from Thomson Reuters Datastream) with a total of 782 observations from each country (Greece, Ireland and Portugal), starting from 01/01/2009 until 12/31/2011. The data set comprises the rating notations (excluding outlooks), attributed to these countries by the three main rating agencies (S&P, Moody's and Fitch – obtained from Bloomberg Hardware), during the period under review.

6. Methodology

In order to perform an empirical analysis of the problem under study in this project, it was decided to use an approach based on the VAR.

Being the main goal of this study to access the relationship between two economic and financial variables and the influence of one variable on another, *à priori*, the VAR was the chosen model for this work. This is because VAR has the required characteristics to allow the verification of the influence of the variation in rating notations and its consequent impact on the government bond yields trajectory.

However, these two variables are built in a different way than the common variables used in a VAR. This happens because the variable yields, which has an AR (p) process (autoregressive), validated by Box-Pierce test (as it will be verified later on), represents a continuous series related with the period from 2009 until 2011 on a daily-day basis. On the other hand, the variable rating notation is a discrete variable that reflects a transformation of a qualitative character into a quantitative one (see table 2).

Numerical Transformation of Ratings

S&P / Fitch	Moody's	Rating Classification
AAA	Aaa	1
AA+	Aa1	2
AA	Aa2	3
AA-	Aa3	4
A+	A1	5
A	A2	6
A-	A3	7
BBB+	Baa1	8
BBB	Baa2	9
BBB-	Baa3	10
BB+	Ba1	11
BB	Ba2	12
BB-	Ba3	13
B+	B1	14
B	B2	15
B-	B3	16
CCC+	Caa1	17
CCC	Caa2	18
CCC-	Caa3	19
CC	Ca	20
C	C	21
D	_	22

Table 2 – Numerical transformation of ratings. This figure represents the transformation of a qualitative rating classification into a quantitative one. Source: Gaillard (77: 2012).

For the problem in analysis, an approach using VAR was considered to be the better choice. Since the purpose of the work consists on the observation of the influence of changes in credit rating notations on the different government bond yields maturities of three Eurozone countries, the use of different approaches, instead of VAR, wouldn't produce consistent results due to the characteristics of the variables in question and the goals meant to achieve. According to the prevailing circumstances of this project, an approach through Ordinary Least Squares (OLS) or Instrumental Variables (IV) model would not encounter with the goals of the present study, since these models gain efficiency as a set of explanatory and correlated variables are introduced. So, an analysis with only two variables would provoke a set of structural problems and less significant results. Moreover, an analysis through a PROBIT or a LOGIT models involves circumstances similar to those previously reported for the OLS and IV models. Thus, VAR can be seen as the best possible model to apply to the problem inherent to this study, since it is a natural extension of the univariate autoregressive model that captures the linear interdependencies among multivariate time series. The VAR model it is valuable to describe the dynamic behavior of economic and financial time series, to identify relationships between the variables, and also to produce forecasting results (Hamilton, 1994). A simple VAR for two variables *y* and *z* can be described as:

$$y_t = \alpha^y + \beta^y y_{t-1} + \gamma^y z_{t-1} + \varepsilon_t^y \quad (4)$$

$$z_t = \alpha^z + \beta^z y_{t-1} + \gamma^z z_{t-1} + \varepsilon_t^z \quad (5)$$

Where the α's and β's are parameters and the epsilons are white noise, i.e., $E(\varepsilon_t^i) = 0$, $Var(\varepsilon_t^i) = \sigma^2$ and $Cov\ (\varepsilon_t^i, \varepsilon_s^j) = 0$, and $i, j = y, z$ and $i \neq j, t \neq s$.

Before the estimation of VAR, it is relevant and essential to measure their type of distribution implicit to residuals of the variables, the correlation between them, their stationary character, as well as the optimal number of lags. These procedures are important to obtain a relatively consistent, econometrically and economically viable VAR model.

To test the distribution implicit to the residuals, it was used the Jarque-Bera (JB) analysis. This test determines the existence of normality on the distribution of the residuals of the model, which is indispensable to obtain valid results with statistical significance (Jarque and Bera, 1980).

$$JB = n\left[\frac{S^2}{6} + \frac{(k-3)^2}{24}\right] \to \chi^2_{(2)} \tag{6}$$

After the verification of normality it was made a validation to the degree of correlation between the variables, by using a normal correlation test.

Regarding to the behavior of the variables of the chosen series, and taking into account the size of the sample and the existence of an AR process, it was decided to perform an analysis to the existence of unit root using the Augmented Dickey-Fuller (ADF) test, Phillips-Perron (PP) test, and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test (Dickey and Fuller, 1979; Phillips and Perron, 1988; Kwiatkowski *et al*, 1992):

$$ADF: \Delta y_t = \alpha y_{t-1} + x_t'\delta + \varepsilon_t \tag{7}$$

$$PP: Z_\alpha = t_\alpha \left(\frac{\gamma_0}{f_o}\right)^{1/2} - \frac{T(f_0 - \gamma_0)\left(se(\hat{\alpha})\right)}{2f_0^{\frac{1}{2}}s} \tag{8}$$

$$KPSS: LM = \sum_t \frac{s(t)^2}{(T^2 f_0)} \tag{9}$$

It was decided to use the three tests simultaneously, in order to prove the existence of a unit root and accepting a result in the case of common conclusions between them.

However, there is a dispute among the stationary and non-stationary of the variables in a VAR analysis. Sims (1980) defends that VAR models provide a free method to estimate economic relationships being a valid alternative to the hard restrictions in structural models. He also argues that there is no problem when variables contain a unit root, since the goal of a VAR analysis is to see the inter-relationships between the variables, not to determine the parameter estimates. The main argument against 1st difference is that it 'throws away' information regarding the variations in the data, such as the possibility of co-integration. Besides, it is also argued that the data doesn't need to be corrected because in the VAR model a trending variable is well estimated by a unit root plus drift.

As it is usually in this type of analysis, when there is a unit root in one or more variables, it is advisable to identify the existence of co-integration among them. For that, it can be resorted the use of the Johansen Cointegration Test or the Engle-Granger Cointegration test (in this study it was chosen the first one). Although the corresponding results of this test, for certain maturities it is indicated the presence of co-integration equations, but these results can be considered invalid, once that one of the variables was discrete. With this context, it was possible to continue the study by using a bivariate normal VAR. However, if the variable wasn't a discrete one and the test even so indicated co-integration, it should had been necessary to apply a correction of VAR, through the Vector Error Correction Model (VECM) (Bhar and Hamori, 2005). This model, essentially, smooth's the variables and includes a co-integrating vector into the regression. Moreover, it was also decided not to use the Granger Causality approach, since the variable yield is non-stationary, which would invalidates the obtained results. This variable wasn't transformed into a stationary one, since, as stated before, the goal of this study was to determine interdependence relationship between the yields and the rating notations and not the quantitative impact.

At last, before performing the analysis of the relationship between the variables through VAR, it was necessary to know the optimal number of lags. For that, it was resorted the use of the function lag length criteria, based on Akaike Information Criterion (AIC). This test was chosen, instead of Schwarz information Criterion (SC) or Hannan-Quinn information criterion (HQ), based on Liew arguments (2004). The author argues that AIC provides the best probability of not under-estimating the optimal lag length.

$$AIC_p = -2T\left[\ln(\widehat{\sigma_p^2})\right] + 2p \qquad (10)$$

After testing the existence of a relationship between the variables, it was considered relevant to the project to obtain extraordinary results through VAR. Those results were consisted with the use of the impulse-response function, the variance decomposition and the graphic analysis of residual variation (Mills and Markellos, 2008).

Impulse-response function:

$$c_{ij,h} = \frac{\delta_{y_{i,j}}}{\delta_{\varepsilon_{j,t-h}}} = \frac{\delta_{y_{it+h}}}{\delta_{\varepsilon_{j,t}}} \qquad (11)$$

Variance decomposition:

$$\mathrm{V_{ij,h}} = \frac{\sigma_j^2 \sum_{l=0}^{h-1} c_{ij,l}^2}{\sum_{m=1}^{k}(\sigma_m^2 \sum_{l=0}^{h-1} c_{im,l}^2)} \qquad (12)$$

7. Studying the influence of rating notations[2]

According to Cantor and Packer (1995), sovereign credit ratings are correlated with yields, even though it is not clear that ratings really influence yields. However, in De Santis recent paper (2012), it was stated that the rating notations assigned between September 2008 and August 2011 affected, strongly, the yields of the Euro area. In this project, with the use of an aggregate analysis of the yields of different maturities in the three countries as well as of the rating notations assigned by the rating agencies, it was inferred a set of common outcomes.

Given the size of the sample (782 observations) and the results of the JB test, it is possible to conclude that the residuals of the VAR (showed later) have a Gaussian distribution (see appendix 2), which eliminates possible biases of the several statistics related to the VAR model. Relatively to the presence of correlation among the variables, the ratio reflects the existence of a significant portion of common variance between the variables (see appendix 3), which proves, superficially, the possible relationship between them, even if only at time 0. It was also set the existence of an AR (p) process on the yield variable (which is a usual consideration when financial time series are analyzed) (see appendix 4), possibly validating the use of VAR. Regarding the analysis of the presence of unit root in the variable yield, and since the variable rating is a discrete and qualitative variable, it was observed that all the yields, in the different maturities, concerning the three countries analyzed, have a non-stationary behavior (corroborated by the ADF, PP and KPSS tests – see appendix 5). As previously mentioned, there is no barrier to the use of the VAR in a context of spurious behavior in one of the variables, since it does not excludes the possibility of identifying relationships between the variables and the period of its effect.

After carried out joint analysis tests, whose results were common to the different countries, it was time to do an individual analysis of each country. Recall that the meaning of the abbreviations for the variables under study is shown on page XI.

[2] The information regarding rating assignments by the three rating agencies concerning the three countries were based on news from Jornal de Negócios, Moody's and Fitch websites and Bloomberg Hardware, from January 2009 to December 2011.

7.1. Greece

When the VAR outcomes related to Greece were achieved, it was verified that only the rating notations assigned by Fitch had influence on the evolution of Greek yields, more precisely, in yields with 2 and 10 years maturity (see VAR equations and table 3).

$$\begin{aligned}GR\_2Y_t = {} & c_1 + \pi_{11}^1 GR\_2Y_{t-1} + \pi_{12}^1 GR\_2Y_{t-2} + \pi_{13}^1 GR\_2Y_{t-3} + \pi_{14}^1 GR\_2Y_{t-4} \\ & + \pi_{15}^1 GR\_2Y_{t-5} + \pi_{16}^1 GR\_2Y_{t-6} + \pi_{17}^1 GR\_2Y_{t-7} + \pi_{18}^1 GR\_2Y_{t-8} \\ & + \pi_{11}^2 FITCH\_GR_{t-1} + \pi_{12}^2 FITCH\_GR_{t-2} + \pi_{13}^2 FITCH\_GR_{t-3} \\ & + \pi_{14}^2 FITCH\_GR_{t-4} + \pi_{15}^2 FITCH\_GR_{t-5} + \pi_{16}^2 FITCH\_GR_{t-6} \\ & + \pi_{17}^2 FITCH\_GR_{t-7} + \pi_{18}^2 FITCH\_GR_{t-8} + \varepsilon_t\end{aligned} \tag{13}$$

$$\begin{aligned}FITCH\_GR_t = {} & c_2 + \pi_{21}^1 GR\_2Y_{t-1} + \pi_{22}^1 GR\_2Y_{t-2} + \pi_{23}^1 GR\_2Y_{t-3} + \pi_{24}^1 GR\_2Y_{t-4} \\ & + \pi_{25}^1 GR\_2Y_{t-5} + \pi_{26}^1 GR\_2Y_{t-6} + \pi_{27}^1 GR\_2Y_{t-7} + \pi_{28}^1 GR\_2Y_{t-8} \\ & + \pi_{21}^2 FITCH\_GR_{t-1} + \pi_{22}^2 FITCH\_GR_{t-2} + \pi_{23}^2 FITCH\_GR_{t-3} \\ & + \pi_{24}^2 FITCH\_GR_{t-4} + \pi_{25}^2 FITCH\_GR_{t-5} + \pi_{26}^2 FITCH\_GR_{t-6} \\ & + \pi_{27}^2 FITCH\_GR_{t-7} + \pi_{28}^2 FITCH\_GR_{t-8} + \varepsilon_t\end{aligned} \tag{14}$$

$$\begin{aligned}GR\_10Y_t = {} & c_1 + \pi_{11}^1 GR\_10Y_{t-1} + \pi_{12}^1 GR\_10Y_{t-2} + \pi_{13}^1 GR\_10Y_{t-3} + \pi_{14}^1 GR\_10Y_{t-4} \\ & + \pi_{15}^1 GR\_10Y_{t-5} + \pi_{16}^1 GR\_10Y_{t-6} + \pi_{17}^1 GR\_10Y_{t-7} \\ & + \pi_{11}^2 FITCH\_GR_{t-1} + \pi_{12}^2 FITCH\_GR_{t-2} + \pi_{13}^2 FITCH\_GR_{t-3} \\ & + \pi_{14}^2 FITCH\_GR_{t-4} + \pi_{15}^2 FITCH\_GR_{t-5} + \pi_{16}^2 FITCH\_GR_{t-6} \\ & + \pi_{17}^2 FITCH\_GR_{t-7} + \varepsilon_t\end{aligned} \tag{15}$$

$$\begin{aligned}FITCH\_GR_t = {} & c_2 + \pi_{21}^1 GR\_10Y_{t-1} + \pi_{22}^1 GR\_10Y_{t-2} + \pi_{23}^1 GR\_10Y_{t-3} \\ & + \pi_{24}^1 GR\_10Y_{t-4} + \pi_{25}^1 GR\_10Y_{t-5} + \pi_{26}^1 GR\_10Y_{t-6} + \pi_{27}^1 GR\_10Y_{t-7} \\ & + \pi_{21}^2 FITCH\_GR_{t-1} + \pi_{22}^2 FITCH\_GR_{t-2} + \pi_{23}^2 FITCH\_GR_{t-3} \\ & + \pi_{24}^2 FITCH\_GR_{t-4} + \pi_{25}^2 FITCH\_GR_{t-5} + \pi_{26}^2 FITCH\_GR_{t-6} \\ & + \pi_{27}^2 FITCH\_GR_{t-7} + \varepsilon_t\end{aligned} \tag{16}$$

Vector Autoregression Estimates
Sample (adjusted): 1/13/2009 12/30/2011
Included observations: 774 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	GR_2Y	FITCH_GR
GR_2Y(-1)	1.131815	0.005623
	(0.03516)	(0.00639)
	[32.1945]	[0.87976]
GR_2Y(-2)	-0.252700	-0.004793
	(0.05259)	(0.00956)
	[-4.80515]	[-0.50129]
GR_2Y(-3)	0.041496	-0.000402
	(0.05260)	(0.00956)
	[0.78893]	[-0.04199]
GR_2Y(-4)	0.096574	-0.000371
	(0.05242)	(0.00953)
	[1.84214]	[-0.03896]
GR_2Y(-5)	-0.115563	0.000510
	(0.05242)	(0.00953)
	[-2.20458]	[0.05355]
GR_2Y(-6)	0.247335	-0.002394
	(0.05257)	(0.00956)
	[4.70511]	[-0.25046]
GR_2Y(-7)	-0.293801	-0.001139
	(0.05257)	(0.00956)
	[-5.58912]	[-0.11918]
GR_2Y(-8)	0.150733	0.002728
	(0.03564)	(0.00648)
	[4.22985]	[0.42111]
FITCH_GR(-1)	0.018628	0.992665
	(0.19991)	(0.03635)
	[0.09318]	[27.3122]
FITCH_GR(-2)	0.163787	0.000631
	(0.28169)	(0.05121)
	[0.58145]	[0.01232]
FITCH_GR(-3)	0.106448	-0.000745
	(0.28171)	(0.05122)
	[0.37786]	[-0.01454]
FITCH_GR(-4)	-0.138243	-0.000828
	(0.28174)	(0.05122)
	[-0.49068]	[-0.01617]
FITCH_GR(-5)	-0.383145	0.001060
	(0.28178)	(0.05123)
	[-1.35972]	[0.02070]
FITCH_GR(-6)	0.079029	0.002645
	(0.28211)	(0.05129)
	[0.28014]	[0.05158]
FITCH_GR(-7)	-0.973644	-5.54E-05
	(0.28205)	(0.05128)
	[-3.45209]	[-0.00108]
FITCH_GR(-8)	1.168679	0.006326
	(0.20158)	(0.03665)
	[5.79771]	[0.17260]
C	-0.331747	0.002803
	(0.15861)	(0.02884)
	[-2.09162]	[0.09719]

Vector Autoregression Estimates
Sample (adjusted): 1/12/2009 12/30/2011
Included observations: 775 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	GR_10Y	FITCH_GR
GR_10Y(-1)	1.002262	-0.032563
	(0.03566)	(0.01850)
	[28.1055]	[-1.76048]
GR_10Y(-2)	-0.003028	0.060635
	(0.05064)	(0.02627)
	[-0.05979]	[2.30851]
GR_10Y(-3)	-0.101788	-0.030413
	(0.05071)	(0.02630)
	[-2.00743]	[-1.15638]
GR_10Y(-4)	0.045037	0.004352
	(0.05084)	(0.02637)
	[0.88589]	[0.16504]
GR_10Y(-5)	0.138101	0.016905
	(0.05073)	(0.02631)
	[2.72240]	[0.64247]
GR_10Y(-6)	-0.019228	-0.002219
	(0.05073)	(0.02631)
	[-0.37901]	[-0.08432]
GR_10Y(-7)	-0.068256	-0.014598
	(0.03601)	(0.01868)
	[-1.89546]	[-0.78158]
FITCH_GR(-1)	0.108034	0.996390
	(0.06992)	(0.03627)
	[1.54511]	[27.4741]
FITCH_GR(-2)	-0.250154	-0.001691
	(0.09876)	(0.05122)
	[-2.53300]	[-0.03301]
FITCH_GR(-3)	0.070322	-0.010582
	(0.09915)	(0.05143)
	[0.70928]	[-0.20578]
FITCH_GR(-4)	0.053371	0.011290
	(0.09918)	(0.05145)
	[0.53811]	[0.21945]
FITCH_GR(-5)	0.051080	-0.001437
	(0.09914)	(0.05142)
	[0.51526]	[-0.02795]
FITCH_GR(-6)	-0.347641	-0.001559
	(0.09875)	(0.05122)
	[-3.52049]	[-0.03043]
FITCH_GR(-7)	0.338631	0.004478
	(0.07031)	(0.03647)
	[4.81625]	[0.12280]
C	-0.117269	0.023284
	(0.04868)	(0.02525)
	[-2.40912]	[0.92219]

Table 3 – VAR estimation of Greek yields with 2 and 10 years maturity with Fitch.

Thus, only the rating notations assigned by Fitch showed statistical significance for the yields behavior. Then, it was integrated a number of 8 optimal lags for an analysis of the yields with 2 years maturity and 7 optimal lags to yields with 10 years maturity (see appendix 6.1-6.9). In the case of yields with 2 years maturity, the effect of rating notations occurred, solely, on seventh lag, with a length of 2 periods. However, the effect registered on the yields with 10 years maturity showed an influence on second lag and subsequently on sixth and seventh lags.

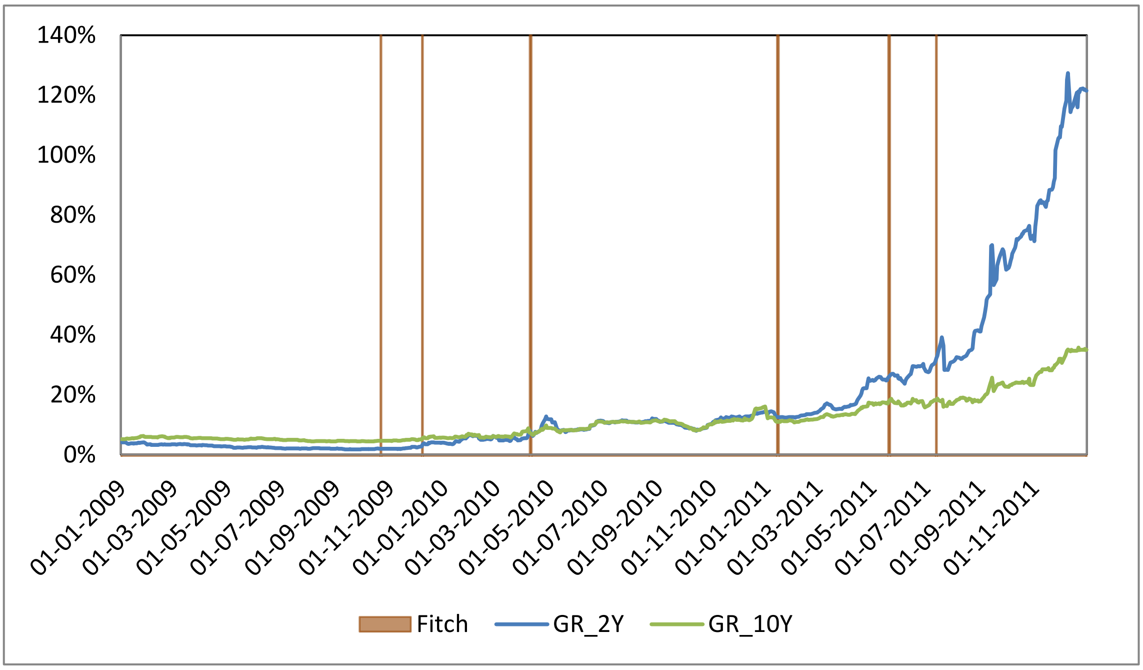


Figure 3 – Greek government bond yields and the respective rating notations. This figure shows the Greek yields behavior from 2009 until the end of 2011 and the days of the announcements of rating changes assigned by Fitch.

The Greek case is special, not merely by registering an influence from only one rating agency, but mainly due to the economic, financial, political and social circumstances that the country had experienced. During the period under review, Fitch assigned 6 rating notations to the Greek long-term obligations, as it is possible to see on figure 3. For instance, in October 2009 and in December 2009, Fitch made 2 downgrades, decreasing 1 level in each demote (from A to A- and from A- to BBB+, respectively). In October 2009, the reason beyond the mutation on the rating notation was related to the national elections for a new government, while in October, 4 it was the adverse situation due to the higher level of *deficit* and public debt. In December 2009, Fitch claimed that the exasperation of fiscal *deficit*; the political pressure from EU to the new government to control the public finances and decrease the public *deficit*; the governmental instability sensed to put in practice a fiscal consolidation program; the explosive public *deficit* (12.7% of GDP) and public debt (130% of GDP); the tax increase; and the uncertainty about the possibility of ECB stop funding Greece from an indirect way, could lead Greece to an incapability of fulfill its responsibilities. Thus, the inevitable financial bailout led Fitch to downgrade on April 9, 2010 again the sovereign credit rating of Greece. The economic and financial performance of Greece and the high debt burden made the solvency of the country very vulnerable to adverse shocks, being necessary a high consolidation effort. Consequently, the high public *deficit* that undertook the fiscal consolidation effort carried on 2010 and the drop prediction of 3% of GDP in 2011 by Fitch, had difficult the end of the recession period and put pressure on the Greece rating notations. Thus, in January 2011, Fitch made one more downgrade to Greece. However, it was in May 2011 and in July 2011 that the downgrades were sharper (decreased of 3 and 4 levels, respectively). The difficulty in implementing fiscal and structural reforms, to ensure the country's solvency and to accomplish the target of 5.7% of *deficit* in 2011, the inevitable debt default, the absence of a new rescue program fully credible and the uncertainty surrounding the role of creditors in debt rescheduling were reasons mainly beyond these downgrades. This situation caused an abnormal behavior on the Greek yields performance.

Thus, the question about the rating notations being assigned based on a cause-effect process and having a negative influence on the yields, pressured by the markets, was confronted, once more, by the fact that Fitch clustered a set of rating announcements for Greece, in such a short period of time. This situation, allied to the demanding requirements for the country to continue to be funded, have led to an explosive yields growth in the different maturities, with particular relevance in the yields with 2 years maturity.

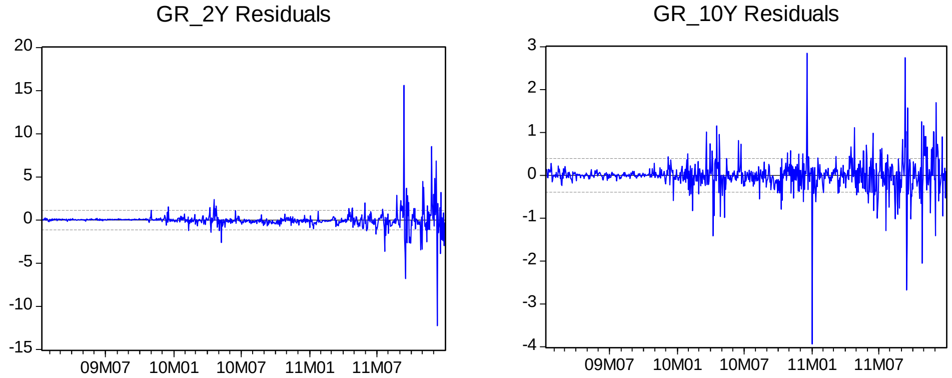


Figure 4 – Residuals of Greek yields with Fitch.

The inverted yield curve registered among the Greek yields enhanced a high degree of volatility associated to the yields with 2 years maturity (see figure 4). In any case, the residuals related with the VAR regressions had significantly higher absolute records when compared with Ireland and Portugal, as it will be mentioned later.

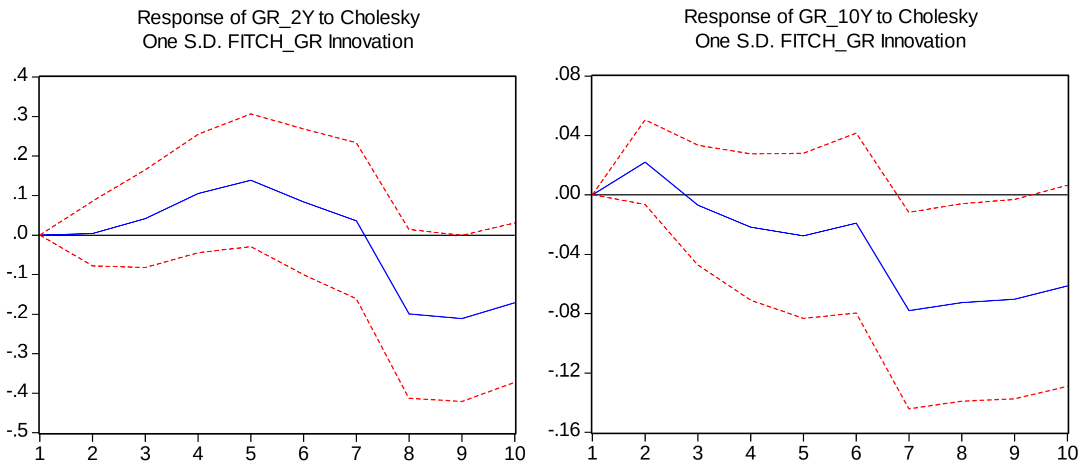


Figure 5 – Impulse-response of Greek yields.

Regarding the response of Greek yields with 2 and 10 years to an impulse of rating notations assigned by Fitch, it is possible to note that the response of the yields to an impulse of 1 standard-deviation on rating was strong (see figure 5). Since there are other factors, such as speculation and uncertainty about the default probability of Greece, these impulse-responses cannot be analyzed so firmly, since it cannot be made a precise perception of the isolated impact of rating notations on the yields behavior.

Variance decomposition of Greek yields		
Periods	GR_2Y with Fitch notations	GR_10Y with Fitch notations
1	0	0
2	0	0,16
3	0,04	0,11
4	0,24	0,17
5	0,5	0,25
6	0,53	0,26
7	0,47	0,83
8	0,83	1,17
9	1,18	1,42
10	1,33	1,54

Table 4 – Variance decomposition of Greek yields.

Finally, it was verified that for a ten period analysis, through a variance decomposition of Greek yields, there is a greater influence of Fitch on the variance of yields with 10 years maturity, when compared to the values achieved of yields with 2 years maturity.

7.2. Ireland

After specifying the optimal number of lags to be allocated to each of the VAR performed to the Irish government bond yields, of different maturities, with their ratings notations, assigned by the three rating agencies, it was measured the statistical significance of the variable rating (and its respective lags) with the yield (see appendix 6.10-6.18). As a result, it was observed that only the rating notations assigned by Moody's had a significant statistically relation with the yield of 2 and 5 years maturity, for one period of influence. On the other hand, the rating notations attributed by S&P were only valid with the yield of 10 years maturity, for two periods of length. Table 5 reflects what was stated before (also see VAR equations 17-22). Noteworthy, that rating notations assigned by Fitch had no influence on the Irish yields of different maturities.

$$IRL\_2Y_t = c_1 + \pi_{11}^1 IRL\_2Y_{t-1} + \pi_{12}^1 IRL\_2Y_{t-2} + \pi_{11}^2 MOODYS\_IRL_{t-1} + \pi_{12}^2 MOODYS\_IRL_{t-2} + \varepsilon_t \tag{17}$$

$$MOODYS\_IRL_t = c_2 + \pi_{21}^1 IRL\_2Y_{t-1} + \pi_{22}^1 IRL\_2Y_{t-2} + \pi_{21}^2 MOODYS\_IRL_{t-1} + \pi_{22}^2 MOODYS\_IRL_{t-2} + \varepsilon_t \tag{18}$$

$$IRL\_5Y_t = c_1 + \pi_{11}^1 IRL\_5Y_{t-1} + \pi_{12}^1 IRL\_5Y_{t-2} + \pi_{13}^1 IRL\_5Y_{t-3} + \pi_{11}^2 MOODYS\_IRL_{t-1} + \pi_{12}^2 MOODYS\_IRL_{t-2} + \pi_{13}^2 MOODYS\_IRL_{t-3} + \varepsilon_t \tag{19}$$

$$MOODYS\_IRL_t = c_2 + \pi_{21}^1 IRL\_5Y_{t-1} + \pi_{22}^1 IRL\_5Y_{t-2} + \pi_{23}^1 IRL\_5Y_{t-3} + \pi_{21}^2 MOODYS\_IRL_{t-1} + \pi_{22}^2 MOODYS\_IRL_{t-2} + \pi_{23}^2 MOODYS\_IRL_{t-3} + \varepsilon_t \quad (20)$$

$$IRL\_10Y_t = c_1 + \pi_{11}^1 IRL\_10Y_{t-1} + \pi_{12}^1 IRL\_10Y_{t-2} + \pi_{11}^2 SPS\_IRL_{t-1} + \pi_{12}^2 SPS\_IRL_{t-2} + \varepsilon_t \quad (21)$$

$$SPS\_IRL_t = c_2 + \pi_{21}^1 IRL\_10Y_{t-1} + \pi_{22}^1 IRL\_10Y_{t-2} + \pi_{21}^2 SPS\_IRL_{t-1} + \pi_{22}^2 SPS\_IRL_{t-2} + \varepsilon_t \quad (22)$$

Vector Autoregression Estimates
Sample (adjusted): 1/05/2009 12/30/2011
Included observations: 780 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	IRL_2Y	MOODYS_IRL
IRL_2Y(-1)	1.333814	0.029847
	(0.03359)	(0.02641)
	[39.7054]	[1.13009]
IRL_2Y(-2)	-0.350168	-0.022421
	(0.03368)	(0.02648)
	[-10.3974]	[-0.84679]
MOODYS_IRL(-1)	0.093392	0.991753
	(0.04567)	(0.03591)
	[2.04490]	[27.6206]
MOODYS_IRL(-2)	-0.079820	0.001686
	(0.04566)	(0.03590)
	[-1.74811]	[0.04697]
C	0.022337	0.005927
	(0.01563)	(0.01228)
	[1.42955]	[0.48250]

Vector Autoregression Estimates
Sample (adjusted): 1/06/2009 12/30/2011
Included observations: 779 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	IRL_5Y	MOODYS_IRL
IRL_5Y(-1)	1.222725	0.063045
	(0.03581)	(0.04068)
	[34.1470]	[1.54986]
IRL_5Y(-2)	-0.132564	-0.079979
	(0.05651)	(0.06420)
	[-2.34581]	[-1.24584]
IRL_5Y(-3)	-0.097304	0.028178
	(0.03587)	(0.04075)
	[-2.71248]	[0.69147]
MOODYS_PT(-1)	0.076461	0.989352
	(0.03167)	(0.03598)
	[2.41415]	[27.4975]
MOODYS_PT(-2)	-0.048036	-0.005069
	(0.04459)	(0.05066)
	[-1.07723]	[-0.10007]
MOODYS_PT(-3)	-0.025125	0.008444
	(0.03170)	(0.03601)
	[-0.79269]	[0.23450]
C	0.028864	-0.019575
	(0.01630)	(0.01852)
	[1.77029]	[-1.05685]

Vector Autoregression Estimates
Sample (adjusted): 1/05/2009 12/30/2011
Included observations: 780 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	IRL_10Y	SPS_IRL
IRL_10Y(-1)	1.372035	-0.000112
	(0.03310)	(0.02961)
	[41.4478]	[-0.00377]
IRL_10Y(-2)	-0.379594	0.009680
	(0.03327)	(0.02976)
	[-11.4100]	[0.32529]
SPS_IRL(-1)	0.108151	0.983992
	(0.04016)	(0.03592)
	[2.69282]	[27.3910]
SPS_IRL(-2)	-0.102869	0.006927
	(0.03999)	(0.03577)
	[-2.57214]	[0.19365]
C	0.028080	-0.012624
	(0.01459)	(0.01305)
	[1.92480]	[-0.96739]

Table 5 – VAR estimation of Irish yields of different maturities with the respective rating notations.

According to the main conclusions that can be drawn from the VAR simulations, it appears that the influence of Moody's focuses mostly on yields with a strong growth trend (2 and 5 years maturity), while S&P is associated to a less sturdy yield (10 years maturity). Moreover, the yields with maturities of 2 and 5 years are the ones that show an inverted yield curve, situation that mainly occurs, during the penultimate modification of Moody's rating notation assigned at 04/15/2011. On this date, Moody's performed a very strong downgrade (decreased of 5 levels, from Aa2 to Baa1). On the other hand, it is also important to mention that S&P doesn't perform sharp downgrades on the yield with 10 years like Moody's on the maturities enounced (always changes of 1 level with the exception of the assignment on 11/23/2010, where there was a decrease of 2 levels).

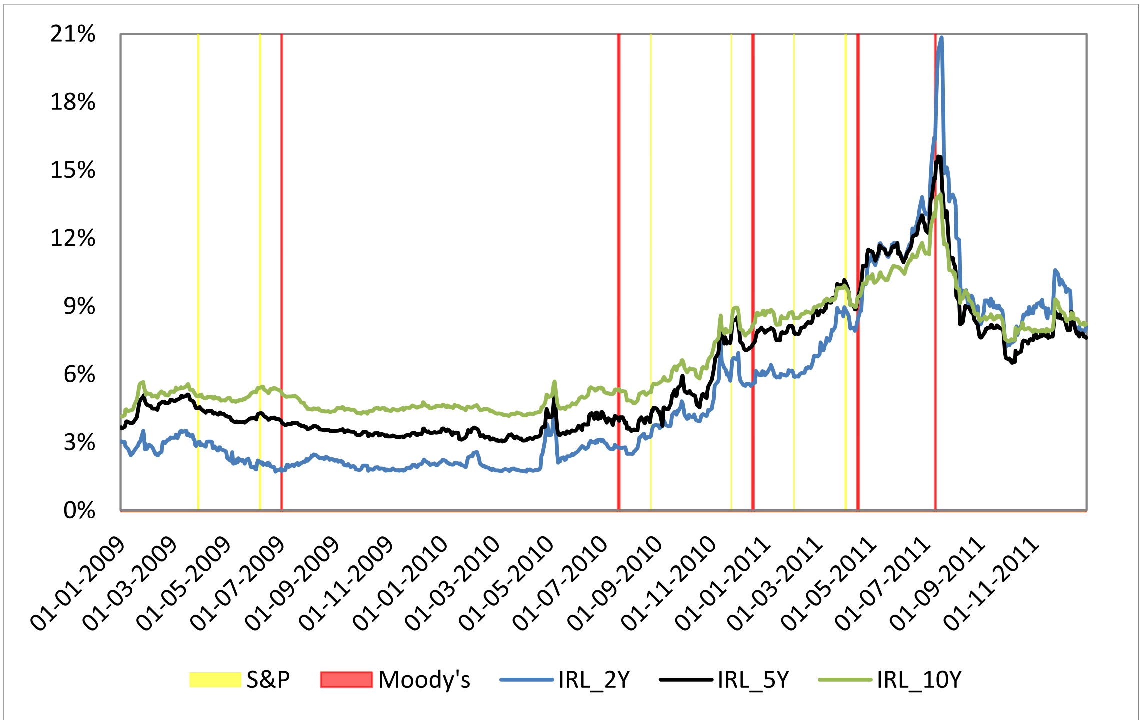


Figure 6 – Irish government bond yields and the respective rating notations. This figure shows the Irish yields behavior from 2009 until the end of 2011 and the days of the announcements of rating changes assigned by S&P and Moody's.

Given the global economic and financial context and taking into account that countries like Ireland have now greater needs for short-term liquidity, the inherent risk associated with small maturities funding had increased. At the same time, it is in this context that Moody's performs rigorous downgrades, resulting in a low deterministic tendency in the yields of 2 and 5 years, as it is possible to see in the last chart. This behavior of higher levels of growth from the yields with 2 and 5 years matches the fact that Moody's was the last rating agency to issue downgrades in the period under review. However, it is curious to observe that both S&P and Moody's attribute rating notations to Ireland in a short period of time between them. The increase of financing costs due to tight conditions of access to credit, and the crisis in real estate segment implied a possible deterioration of the Irish economy, which could increase the financial burden and its financing needs, advocate S&P and Moody's. Thus, the cost of saving and recapitalize the banking system in 2009 led S&P and Moody's to downgrade Irish long-term government bond ratings. These ratings started to reflect the risk of a gradual deterioration in the Irish debt affordability (the share of government revenue used for interest payments) and finance-ability (the cost at which can raise further debt). Consequently, the instability around Ireland increased and the bailout request made in November 2011 led both agencies to downgrade Irish rating. In February 2011, S&P assigned another downgrade due to the fears surrounding a possible requirement of further reinforcements of capital by the banking system (Carregueiro, 2011). These restructuring, where the Irish state took majority control over the six major banks, was based on 2 pillars banks (Bank of Ireland and Allied Irish Bank PLC). However, the fear of German, French and English banks concerning to the fall of the Irish banking system and the possibility of the Irish external debt to achieve 170% of the GDP, led Moody's to downgrade 5 levels (from Aa2 to Baa1) the sovereign credit rating of Ireland in April 2011. S&P also decreased the Irish rating but only in one level (Cavaleiro, 2011).

Besides the proactive response of Irish government and the appropriated internal policies taken, it is clear that markets are guided through other factors. Otherwise, Moody's wouldn't have penalized Ireland with another downgrade in July 2011.

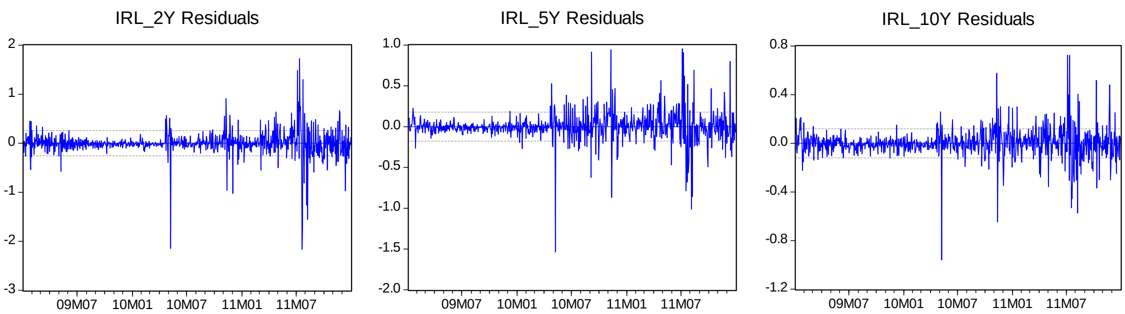


Figure 7 – Residuals of IRL_2Y and IRL_5Y with Moody's and IRL_10Y with S&P.

It also coincides that the three VAR regressions performed show periods of similar volatility in Irish yields (see figure 7). Still, the yields with 2 years maturity have greater peaks of variance which brings even more strength to the importance of smaller maturities funding, in detriment of other maturities.

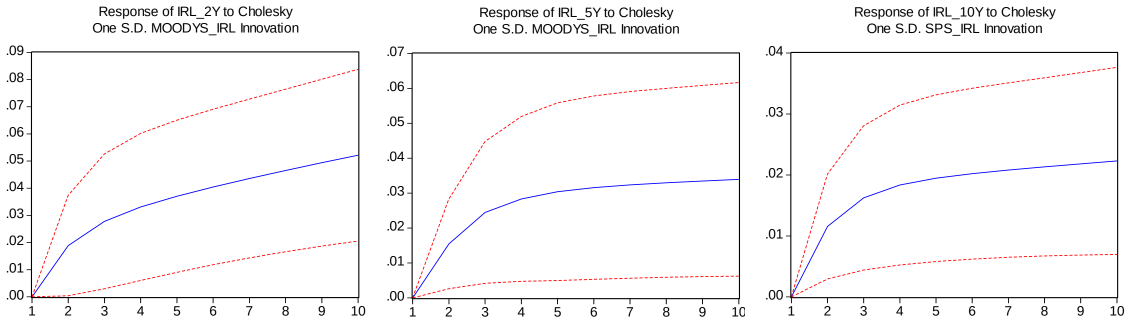


Figure 8 – Impulse-response of Irish yields.

Regarding the impulse response graphs (see figure 8), it seems that the response of yields with 2 and 5 years maturity to changes in rating notations assigned by Moody's are more pronounced than the responses of yields with 10 years maturity to changes in rating notations attributed by S&P. This is consistent with the fact that Moody's made more accentuated downgrades than S&P, which means that, possibly, the yields with smaller maturities are more sensitive to variations in rating notations than the yields with longer maturities, since these last ones have intrinsic characteristics that makes them not so volatile neither so sensitive to variations of a single factor.

Variance decomposition of Irish yields			
Periods	IRL_2Y with Moody's notations	IRL_5Y with Moody's notations	IRL_10Y with S&P notations
1	0	0	0
2	0,19	0,3	0,32
3	0,35	0,6	0,54
4	0,48	0,81	0,68
5	0,6	0,95	0,78
6	0,72	1,06	0,86
7	0,84	1,15	0,92
8	0,95	1,22	0,98
9	1,08	1,29	1,04
10	1,2	1,35	1,1

Table 6 – Variance decomposition of Irish yields.

Finally, through a variance decomposition of Irish yields, it is found that for a ten period analysis there is a greater influence of Moody's on the variance of yields with 5 years, when compared to the values achieved by the analysis of yields with 2 and 10 years maturity.

7.3. Portugal

Looking to the results obtained for Portugal, it was possible to note that both rating notations assigned by S&P and Moody's were statically significant to explain all Portuguese government bond yields of different maturities. Regarding to the significance of rating notations attributed by Fitch, these only had effect on the yields with 10 years maturity. Since the three credit rating agencies show influence on the explanation of Portuguese yields variation, it was decided to analyze individually the role of each agency on the yields explanation. This type of analysis has the purpose to make the results clearer to the reader.

Relatively to Portuguese government bond yields and S&P, see table 7 and VAR equations 23-28.

$$PT\_2Y_t = c_1 + \pi_{11}^1 PT\_2Y_{t-1} + \pi_{12}^1 PT\_2Y_{t-2} + \pi_{13}^1 PT\_2Y_{t-3} + \pi_{14}^1 PT\_2Y_{t-4} + \pi_{11}^2 SPS\_PT_{t-1} + \pi_{12}^2 SPS\_PT_{t-2} + \pi_{13}^2 SPS\_PT_{t-3} + \pi_{14}^2 SPS\_PT_{t-4} + \varepsilon_t \tag{23}$$

$$SPS\_PT_t = c_2 + \pi_{21}^1 PT\_2Y_{t-1} + \pi_{22}^1 PT\_2Y_{t-2} + \pi_{23}^1 PT\_2Y_{t-3} + \pi_{24}^1 PT\_2Y_{t-4} + \pi_{21}^2 SPS\_PT_{t-1} + \pi_{22}^2 SPS\_PT_{t-2} + \pi_{23}^2 SPS\_PT_{t-3} + \pi_{24}^2 SPS\_PT_{t-4} + \varepsilon_t \tag{24}$$

$$PT\_5Y_t = c_1 + \pi_{11}^1 PT\_5Y_{t-1} + \pi_{12}^1 PT\_5Y_{t-2} + \pi_{13}^1 PT\_5Y_{t-3} + \pi_{14}^1 PT\_5Y_{t-4} + \pi_{11}^2 SPS\_PT_{t-1} + \pi_{12}^2 SPS\_PT_{t-2} + \pi_{13}^2 SPS\_PT_{t-3} + \pi_{14}^2 SPS\_PT_{t-4} + \varepsilon_t \tag{25}$$

$$SPS\_PT_t = c_2 + \pi_{21}^1 PT\_5Y_{t-1} + \pi_{22}^1 PT\_5Y_{t-2} + \pi_{23}^1 PT\_5Y_{t-3} + \pi_{24}^1 PT\_5Y_{t-4} + \pi_{21}^2 SPS\_PT_{t-1} + \pi_{22}^2 SPS\_PT_{t-2} + \pi_{23}^2 SPS\_PT_{t-3} + \pi_{24}^2 SPS\_PT_{t-4} + \varepsilon_t \tag{26}$$

$$PT\_10Y_t = c_1 + \pi^1_{11}PT\_10Y_{t-1} + \pi^1_{12}PT\_10Y_{t-2} + \pi^1_{13}PT\_10Y_{t-3} + \pi^1_{14}PT\_10Y_{t-4} + \pi^2_{11}SPS\_PT_{t-1} + \pi^2_{12}SPS\_PT_{t-2} + \pi^2_{13}SPS\_PT_{t-3} + \pi^2_{14}SPS\_PT_{t-4} + \varepsilon_t \quad (27)$$

$$SPS\_PT_t = c_2 + \pi^1_{21}PT\_10Y_{t-1} + \pi^1_{22}PT\_10Y_{t-2} + \pi^1_{23}PT\_10Y_{t-3} + \pi^1_{24}PT\_10Y_{t-4} + \pi^2_{21}SPS\_PT_{t-1} + \pi^2_{22}SPS\_PT_{t-2} + \pi^2_{23}SPS\_PT_{t-3} + \pi^2_{24}SPS\_PT_{t-4} + \varepsilon_t \quad (28)$$

Vector Autoregression Estimates
Sample (adjusted): 1/07/2009 12/30/2011
Included observations: 778 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	PT_2Y	SPS_PT
PT_2Y(-1)	1.160838	0.029364
	(0.03574)	(0.01144)
	[32.4833]	[2.56613]
PT_2Y(-2)	-0.070849	-0.033166
	(0.05419)	(0.01735)
	[-1.30743]	[-1.91140]
PT_2Y(-3)	-0.261589	0.006879
	(0.05392)	(0.01727)
	[-4.85101]	[0.39838]
PT_2Y(-4)	0.153861	-0.001207
	(0.03546)	(0.01136)
	[4.33871]	[-0.10629]
SPS_PT(-1)	0.246479	0.987703
	(0.11059)	(0.03541)
	[2.22880]	[27.8930]
SPS_PT(-2)	-0.419956	-0.001132
	(0.15514)	(0.04968)
	[-2.70700]	[-0.02280]
SPS_PT(-3)	0.215826	0.212565
	(0.15584)	(0.04990)
	[1.38494]	[4.25987]
SPS_PT(-4)	0.007452	-0.205552
	(0.11140)	(0.03567)
	[0.06689]	[-5.76278]
C	-0.227300	0.039399
	(0.07658)	(0.02452)
	[-2.96831]	[1.60684]

Vector Autoregression Estimates
Sample (adjusted): 1/07/2009 12/30/2011
Included observations: 778 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	PT_5Y	SPS_PT
PT_5Y(-1)	1.171604	0.035660
	(0.03610)	(0.01596)
	[32.4523]	[2.23458]
PT_5Y(-2)	-0.085913	-0.024411
	(0.05513)	(0.02437)
	[-1.55849]	[-1.00178]
PT_5Y(-3)	-0.178927	-0.013114
	(0.05468)	(0.02417)
	[-3.27200]	[-0.54253]
PT_5Y(-4)	0.078420	0.005955
	(0.03587)	(0.01586)
	[2.18614]	[0.37559]
SPS_PT(-1)	0.191161	0.984105
	(0.08022)	(0.03546)
	[2.38289]	[27.7521]
SPS_PT(-2)	-0.378291	-0.001310
	(0.11229)	(0.04964)
	[-3.36887]	[-0.02638]
SPS_PT(-3)	0.237037	0.212987
	(0.11312)	(0.05000)
	[2.09548]	[4.25962]
SPS_PT(-4)	-0.016276	-0.205616
	(0.08085)	(0.03574)
	[-0.20131]	[-5.75322]
C	-0.125079	0.047526
	(0.05108)	(0.02258)
	[-2.44869]	[2.10489]

Vector Autoregression Estimates
Sample (adjusted): 1/07/2009 12/30/2011
Included observations: 778 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	PT_10Y	SPS_PT
PT_10Y(-1)	0.839541	0.036178
	(0.03504)	(0.01802)
	[23.2952]	[2.00765]
PT_10Y(-2)	0.126755	-0.025508
	(0.04699)	(0.02350)
	[2.69735]	[-1.08561]
PT_10Y(-3)	-0.042048	0.007852
	(0.04643)	(0.02322)
	[-0.90552]	[0.33818]
PT_10Y(-4)	0.044070	-0.008394
	(0.03557)	(0.01778)
	[1.23905]	[-0.47200]
SPS_PT(-1)	0.330891	0.988770
	(0.07063)	(0.03532)
	[4.68492]	[27.9984]
SPS_PT(-2)	-0.407876	-0.010401
	(0.09971)	(0.04986)
	[-4.09071]	[-0.20863]
SPS_PT(-3)	0.076321	0.213565
	(0.10078)	(0.05039)
	[0.75728]	[4.23801]
SPS_PT(-4)	0.042715	-0.206195
	(0.07164)	(0.03582)
	[0.59628]	[-5.75660]
C	-0.075385	0.039012
	(0.03484)	(0.01742)
	[-2.16359]	[2.23925]

Table 7 – VAR estimation of Portuguese yields of different maturities with S&P.

According to the VAR outcomes of Portuguese government bond yields with S&P, it was verified an optimal number of 4 lags to all yields with different maturities. It is also interesting to mention that in all cases, the first two lags have explanatory effect over the yields, but in the yields with 5 years maturity the influence extends to the third consecutive lag.

About the relationship between Portuguese yields and Moody's, this can be seen from table 8 and VAR equations 29-34.

$$PT\_2Y_t = c_1 + \pi^1_{11}PT\_2Y_{t-1} + \pi^1_{12}PT\_2Y_{t-2} + \pi^1_{13}PT\_2Y_{t-3} + \pi^1_{14}PT\_2Y_{t-4} + \pi^2_{11}MOODYS\_PT_{t-1} + \pi^2_{12}MOODYS\_PT_{t-2} + \pi^2_{13}MOODYS\_PT_{t-3} + \pi^2_{14}MOODYS\_PT_{t-4} + \varepsilon_t \tag{29}$$

$$MOODYS\_PT_t = c_2 + \pi^1_{21}PT\_2Y_{t-1} + \pi^1_{22}PT\_2Y_{t-2} + \pi^1_{23}PT\_2Y_{t-3} + \pi^1_{24}PT\_2Y_{t-4} + \pi^2_{21}MOODYS\_PT_{t-1} + \pi^2_{22}MOODYS\_PT_{t-2} + \pi^2_{23}MOODYS\_PT_{t-3} + \pi^2_{24}MOODYS\_PT_{t-4} + \varepsilon_t \tag{30}$$

$$PT\_5Y_t = c_1 + \pi^1_{11}PT\_5Y_{t-1} + + \pi^1_{12}PT\_5Y_{t-2} + + \pi^1_{13}PT\_5Y_{t-3} + + \pi^1_{14}PT\_5Y_{t-4} + \pi^1_{15}PT\_5Y_{t-5} + \pi^2_{11}MOODYS\_PT_{t-1} + \pi^2_{12}MOODYS\_PT_{t-2} + \pi^2_{13}MOODYS\_PT_{t-3} + \pi^2_{14}MOODYS\_PT_{t-4} + \pi^2_{15}MOODYS\_PT_{t-5} + \varepsilon_t \tag{31}$$

$$MOODYS\_PT_t = c_2 + \pi^1_{21}PT\_5Y_{t-1} + \pi^1_{22}PT\_5Y_{t-2} + \pi^1_{23}PT\_5Y_{t-3} + \pi^1_{24}PT\_5Y_{t-4} + \pi^1_{25}PT\_5Y_{t-5} + \pi^2_{21}MOODYS\_PT_{t-1} + \pi^2_{22}MOODYS\_PT_{t-2} + \pi^2_{23}MOODYS\_PT_{t-3} + \pi^2_{24}MOODYS\_PT_{t-4} + \pi^2_{25}MOODYS\_PT_{t-4} + \varepsilon_t \tag{32}$$

$$PT\_10Y_t = c_1 + \pi^1_{11}PT\_10Y_{t-1} + \pi^1_{12}PT\_10Y_{t-2} + \pi^1_{13}PT\_10Y_{t-3} + \pi^2_{11}MOODYS\_PT_{t-1} + \pi^2_{12}MOODYS\_PT_{t-2} + \pi^2_{13}MOODYS\_PT_{t-3} + \varepsilon_t \tag{33}$$

$$MOODYS\_PT_t = \\ = c_2 + \pi_{21}^1 PT\_10Y_{t-1} + \pi_{22}^1 PT\_10Y_{t-2} + \pi_{23}^1 PT\_10Y_{t-3} \\ + \pi_{21}^2 MOODYS\_PT_{t-1} + \pi_{22}^2 MOODYS\_PT_{t-2} + \pi_{23}^2 MOODYS\_PT_{t-3} \\ + \varepsilon_t \tag{34}$$

Vector Autoregression Estimates
Sample (adjusted): 1/07/2009 12/30/2011
Included observations: 778 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	PT_2Y	MOODYS_PT
PT_2Y(-1)	1.187139	-0.005954
	(0.03545)	(0.01968)
	[33.4904]	[-0.30252]
PT_2Y(-2)	-0.113298	0.008128
	(0.05202)	(0.02888)
	[-2.17795]	[0.28141]
PT_2Y(-3)	-0.241817	0.005899
	(0.05017)	(0.02786)
	[-4.81950]	[0.21173]
PT_2Y(-4)	0.132876	0.005127
	(0.03322)	(0.01845)
	[3.99966]	[0.27792]
MOODYS_PT(-1)	0.066244	0.986661
	(0.06499)	(0.03609)
	[1.01932]	[27.3422]
MOODYS_PT(-2)	0.649351	0.000389
	(0.09125)	(0.05067)
	[7.11599]	[0.00768]
MOODYS_PT(-3)	-0.902075	0.003863
	(0.09415)	(0.05228)
	[-9.58122]	[0.07388]
MOODYS_PT(-4)	0.243788	-0.011146
	(0.06945)	(0.03856)
	[3.51024]	[-0.28904]
C	-0.103203	0.046752
	(0.03516)	(0.01952)
	[-2.93552]	[2.39495]

Vector Autoregression Estimates
Sample (adjusted): 1/08/2009 12/30/2011
Included observations: 777 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	PT_5Y	MOODYS_PT
PT_5Y(-1)	1.178680	-0.005240
	(0.03602)	(0.02732)
	[32.7271]	[-0.19178]
PT_5Y(-2)	-0.103281	0.035114
	(0.05561)	(0.04219)
	[-1.85729]	[0.83228]
PT_5Y(-3)	-0.147280	-0.035821
	(0.05305)	(0.04025)
	[-2.77608]	[-0.88993]
PT_5Y(-4)	-0.024255	-0.019595
	(0.05146)	(0.03904)
	[-0.47136]	[-0.50191]
PT_5Y(-5)	0.072312	0.053361
	(0.03388)	(0.02571)
	[2.13426]	[2.07583]
MOODYS_PT(-1)	0.068862	0.972796
	(0.04750)	(0.03604)
	[1.44966]	[26.9924]
MOODYS_PT(-2)	0.456731	0.001500
	(0.06637)	(0.05035)
	[6.88196]	[0.02980]
MOODYS_PT(-3)	-0.610171	-0.000190
	(0.06830)	(0.05182)
	[-8.93344]	[-0.00366]
MOODYS_PT(-4)	0.157023	-0.014799
	(0.07172)	(0.05441)
	[2.18945]	[-0.27198]
MOODYS_PT(-5)	-0.041524	0.006883
	(0.05067)	(0.03844)
	[-0.81954]	[0.17904]
C	-0.009612	0.020753
	(0.01681)	(0.01275)
	[-0.57183]	[1.62725]

Vector Autoregression Estimates
Sample (adjusted): 1/06/2009 12/30/2011
Included observations: 779 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	PT_10Y	MOODYS_PT
PT_10Y(-1)	0.846335	-0.023797
	(0.03416)	(0.02838)
	[24.7724]	[-0.83850]
PT_10Y(-2)	0.131751	0.041420
	(0.04438)	(0.03687)
	[2.96851]	[1.12346]
PT_10Y(-3)	-0.003639	0.014567
	(0.03444)	(0.02861)
	[-0.10565]	[0.50916]
MOODYS_PT(-1)	-0.002292	0.977696
	(0.04333)	(0.03599)
	[-0.05289]	[27.1622]
MOODYS_PT(-2)	0.415820	-0.000647
	(0.06057)	(0.05032)
	[6.86476]	[-0.01286]
MOODYS_PT(-3)	-0.394083	-0.000871
	(0.04304)	(0.03575)
	[-9.15593]	[-0.02437]
C	0.065287	-0.064968
	(0.02727)	(0.02265)
	[2.39431]	[-2.86822]

Table 8 – VAR estimation of Portuguese yields of different maturities with Moody's.

According to the results concerning the relationship between the Portuguese government bond yields with rating notations assigned by Moody's, it is possible to identify an influence on the second period, as a consequence of a downgrade attributed by this credit rating agency. This effect is continuous during a length of 3 consecutive lags, for yields with 2 and 5 years maturity and during 2 consecutive lags, for yields with 10 years maturity. Also the number of lags that registry an effect of the rating notations assigned by Moody's on the yields of different maturities is identical to what was verified in the case of S&P. The only exception occurs on the yields with 2 years maturity, where the number of periods of the rating notations attributed by Moody's has a higher length (5 lags).

Comparatively to Portuguese yields and Fitch, it should be seen table 9 and the following VAR equations.

$$\begin{aligned} PT\_10Y_t = {} & c_1 + \pi^1_{11} PT\_10Y_{t-1} + \pi^1_{12} PT\_10Y_{t-2} + \pi^1_{13} PT\_10Y_{t-3} + \pi^1_{14} PT\_10Y_{t-4} \\ & + \pi^1_{15} PT\_10Y_{t-5} + \pi^1_{16} PT\_10Y_{t-6} + \pi^1_{17} PT\_10Y_{t-7} \\ & + \pi^2_{11} FITCH\_PT_{t-1} + \pi^2_{12} FITCH\_PT_{t-2} + \pi^2_{13} FITCH\_PT_{t-3} \\ & + \pi^2_{14} FITCH\_PT_{t-4} + \pi^2_{15} FITCH\_PT_{t-5} + \pi^2_{16} FITCH\_PT_{t-6} \\ & + \pi^2_{17} FITCH\_PT_{t-7} + \varepsilon_t \end{aligned} \quad (35)$$

$$\begin{aligned} FITCH\_PT_t = {} & c_2 + \pi^1_{21} PT\_10Y_{t-1} + \pi^1_{22} PT\_10Y_{t-2} + \pi^1_{23} PT\_10Y_{t-3} \\ & + \pi^1_{24} PT\_10Y_{t-4} + \pi^1_{25} PT\_10Y_{t-5} + \pi^1_{26} PT\_10Y_{t-6} + \pi^1_{27} PT\_10Y_{t-7} \\ & + \pi^2_{21} FITCH\_PT_{t-1} + \pi^2_{22} FITCH\_PT_{t-2} + \pi^2_{23} FITCH\_PT_{t-3} \\ & + \pi^2_{24} FITCH\_PT_{t-4} + \pi^2_{25} FITCH\_PT_{t-5} + \pi^2_{26} FITCH\_PT_{t-6} \\ & + \pi^2_{27} FITCH\_PT_{t-7} + \varepsilon_t \end{aligned} \quad (36)$$

Vector Autoregression Estimates
Sample (adjusted): 1/12/2009 12/30/2011
Included observations: 775 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	PT_10Y	FITCH_PT
PT_10Y(-1)	0.829974	0.013920
	(0.03623)	(0.02172)
	[22.9110]	[0.64078]
PT_10Y(-2)	0.135987	0.001117
	(0.04691)	(0.02813)
	[2.89898]	[0.03972]
PT_10Y(-3)	-0.053434	0.011368
	(0.04715)	(0.02828)
	[-1.13320]	[0.40203]
PT_10Y(-4)	0.066869	-0.024042
	(0.04703)	(0.02820)
	[1.42185]	[-0.85248]
PT_10Y(-5)	0.017403	-0.005889
	(0.04691)	(0.02813)
	[0.37099]	[-0.20935]
PT_10Y(-6)	-0.096471	0.015362
	(0.04666)	(0.02798)
	[-2.06755]	[0.54903]
PT_10Y(-7)	0.056653	0.003998
	(0.03582)	(0.02148)
	[1.58148]	[0.18613]
FITCH_PT(-1)	0.132020	0.992288
	(0.05607)	(0.03362)
	[2.35463]	[29.5122]
FITCH_PT(-2)	-0.023557	-0.001711
	(0.07894)	(0.04734)
	[-0.29841]	[-0.03614]
FITCH_PT(-3)	-0.162694	-0.000341
	(0.07895)	(0.04734)
	[-2.06080]	[-0.00720]
FITCH_PT(-4)	0.117313	0.000254
	(0.07917)	(0.04747)
	[1.48183]	[0.00536]
FITCH_PT(-5)	0.068587	0.000437
	(0.07927)	(0.04754)
	[0.86525]	[0.00920]
FITCH_PT(-6)	-0.108700	0.376209
	(0.07930)	(0.04756)
	[-1.37068]	[7.91071]
FITCH_PT(-7)	0.016235	-0.381211
	(0.05676)	(0.03404)
	[0.28602]	[-11.1994]
C	0.080277	-0.021473
	(0.02749)	(0.01649)
	[2.91986]	[-1.30243]

Table 9 – VAR estimation of Portuguese yield with 10 years maturity with Fitch.

Looking at the relationship among the rating notations assigned by Fitch on the Portuguese yields, the relation is verified solely on the yields with 10 years maturity, even when the periods of influence are irregular. In other words, there is effect on the first lag, on the second stops but it reverts on the third lag. On the following lags there is no influence.

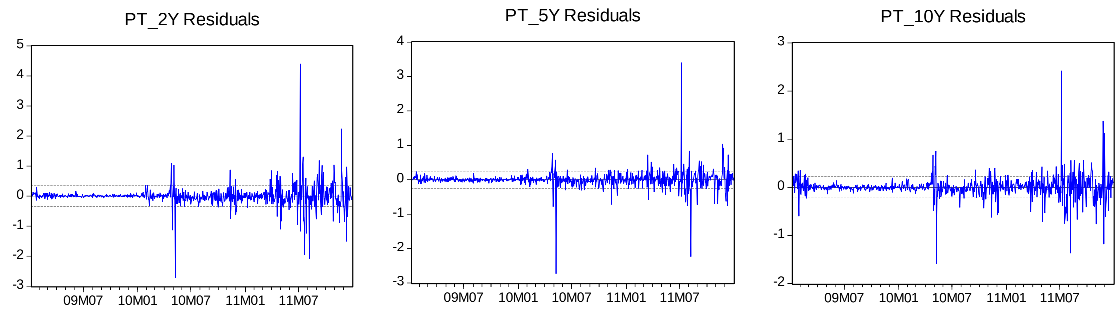


Figure 9 – Residuals of Portuguese yields with S&P.

According with the residuals from the VAR of the Portuguese yields in relation to S&P, it was verified that the volatility associated to the yields of different maturities have a similar behavior. However, the yields with smaller maturity (2 and 5 years) show higher peaks of variance, as it is possible to see from figure 9.

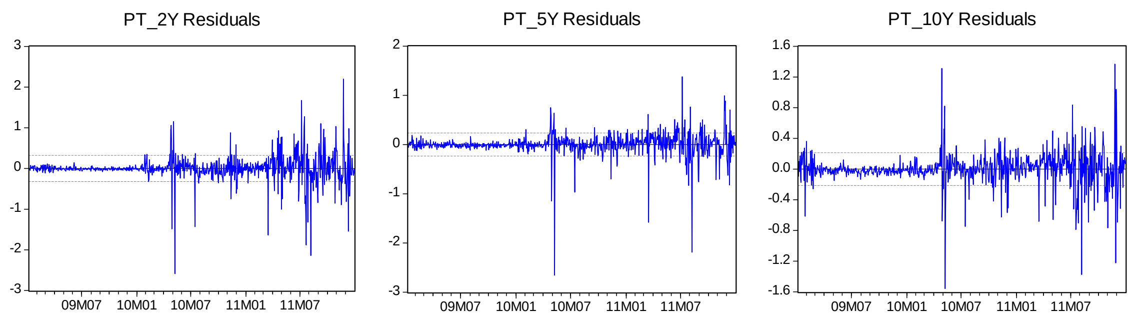


Figure 10 – Residuals of Portuguese yields with Moody's.

After the analysis of the residual on the VAR between the yields in relation to Moody's, it was clear that the peak of volatility registered on the Portuguese government bond yields occurred mainly in the middle of 2010 and after the bailout request made by Portugal to international entities, namely IMF and ECB.

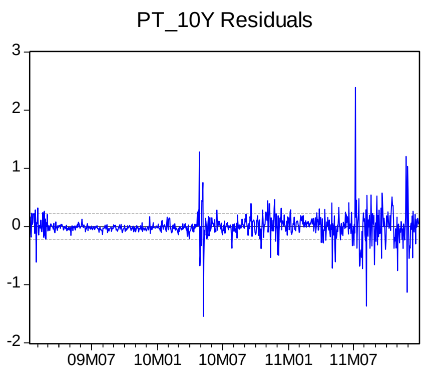


Figure 11 – Residuals of Portuguese yield with 10 years maturity with Fitch.

Regarding the residuals of the yield with 10 years maturity with Fitch, it was registered a similar distribution as the one verified by S&P and Moody's.

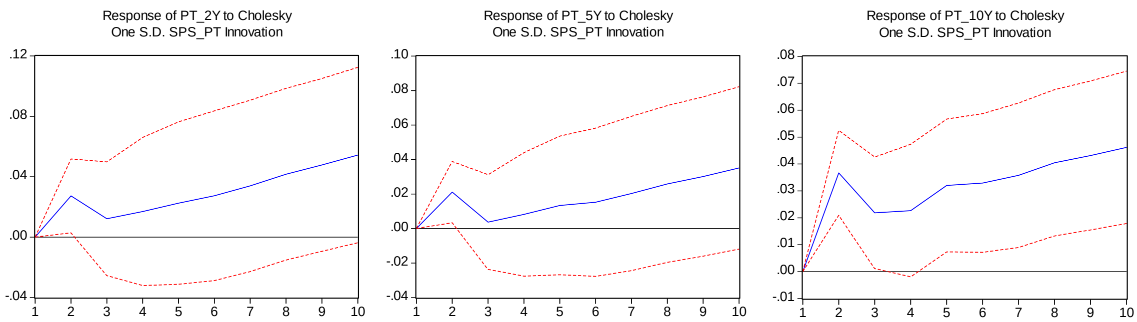


Figure 12 – Response of Portuguese yields to S&P impulse.

The response of the yields of different maturities in relation to the impulse of rating notations assigned by S&P shows similar behaviors in all maturities (see figure 12). These are characterized by an initial positive impulse, followed by such a called 'correction', since it can be seen an inverse impulse. In particular, the impulses related to the yields with 5 years maturity assume a lower proportion in comparison with other maturities.

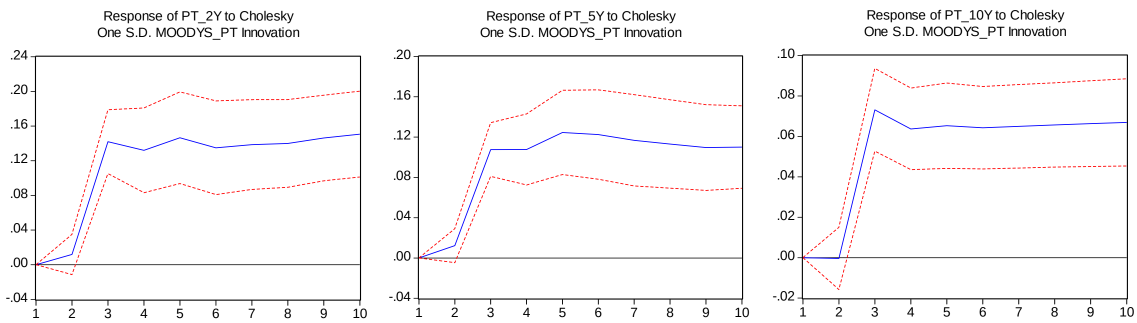


Figure 13 – Response of Portuguese yields to Moody's impulse.

In relation to the chocks caused by the variance of the rating notations assigned by Moody's (see figure 13), it seems that the delay of 1 lag in the effect over the Portuguese yields, verified earlier when the VAR was examined, reproduces an initial reduced impulse, being followed by one chock quite pronounced in the second period that corresponds to the first moment of influence verified. This panorama is common to the different maturities analyzed.

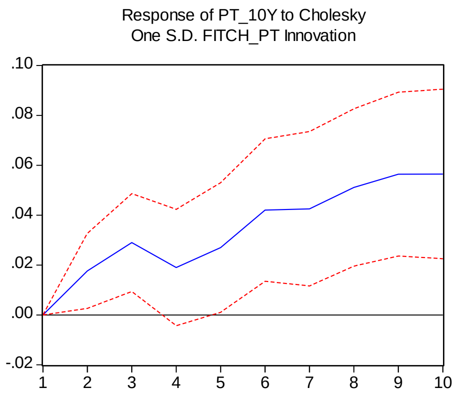


Figure 14 – Response of Portuguese yield with 10 year maturity to Fitch impulse.

In the case of impulse-response function of the Portuguese government bond yield with 10 years maturity to the rating notations assigned by Fitch, it appears that there is an unbalanced course, in agreement with irregular influence of the rating notations for the sample in analysis.

Variance decomposition of Portuguese yields							
Periods	PT_2Y with S&P notations	PT_5Y with S&P notations	PT_10Y with S&P notations	PT_2Y with Moody's notations	PT_5Y with Moody's notations	PT_10Y with Moody's notations	PT_10Y with Fitch notations
1	0	0	0	0	0	0	0
2	0,26	0,3	1,57	0,06	0,11	0	0,37
3	0,18	0,18	1,50	4,50	4,99	4,55	0,96
4	0,18	0,15	1,54	6,17	7	6,16	1,02
5	0,21	0,16	1,84	7,81	9,19	7,30	1,26
6	0,27	0,18	2,10	8,77	10,7	8,04	1,91
7	0,34	0,22	2,39	9,64	11,8	8,64	2,48
8	0,46	0,29	2,76	10,4	12,5	9,15	3,25
9	0,59	0,38	3,14	11,2	13	9,59	4,09
10	0,75	0,49	3,55	12	13,5	9,98	4,82

Table 10 – Variance decomposition of Portuguese yields.

From the analysis of the variance decomposition, it can be stated that there are high percentages of variance of the yields as a consequence of the rating notations attributed by Moody's. In some cases, those percentages achieve values near 10% (see table 10). However, it is not possible to establish a comparison with Fitch, since there is no influence of its rating notations on the Portuguese yields with smaller maturities (2 and

5 years). This situation diverges from the Irish case, in which the percentages of yields variance decomposition are much lower, not exceeding values higher than 1.4%.

After analyzing individually the influence of rating notations assigned by the different credit rating agencies on the yields of different maturities, it is time to proceed to an aggregate analysis of the Portuguese government bond yields behavior.

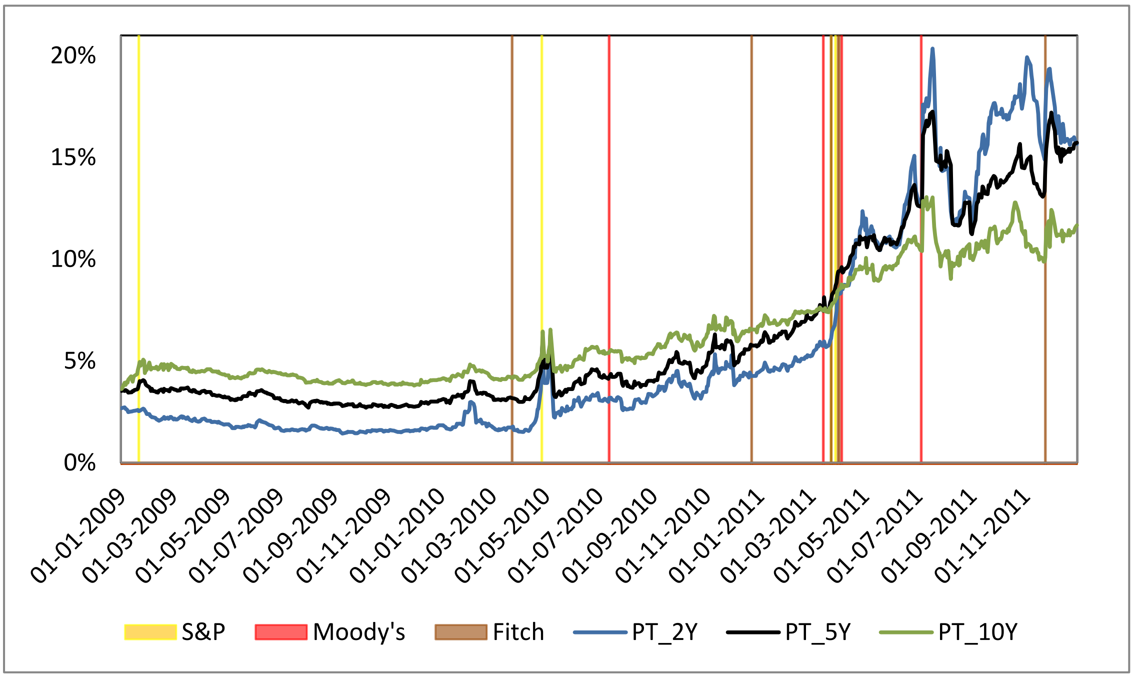


Figure 15 – Portuguese government bond yields and the respective rating notations. This figure shows the Portuguese yields behavior from 2009 till the end of 2011 and the days of the announcements of rating changes assigned by the three credit rating agencies.

In 2009, the Portuguese government applied several structural reforms to cope with the difficulties revealed with the crisis. However, S&P considered that these measures were insufficient to keep stable the Portuguese long-term obligation rating and, as a consequence, the agency decreased the rating from level AA- to A+ (Carregueiro, 2009). However, it was in 2010 and in 2011 that Portugal attended a sequence of downgrades in the sovereign rating, never seen before. First, in March 2010 Fitch decreased the sovereign rating of Portugal due to the national public finance context and to the slippage of the national accounts, making it difficult to implement fiscal new reforms. Then, in April 2010 S&P made a downgrade of 2 levels to Portugal as a consequence of the fragility of the public accounts, of the dependence on external funding, low productivity, stagnation of investment and decline in domestic credit (Garrido and Gaspar, 2010). In July 2010 Moody’s decreased the Portuguese rating also by 2 levels, from Aa2 to A1. In this downgrade the reasons beyond were related with the decline of the financial strength of the Portuguese government in the medium-term and the deterioration of the public debt. Lastly, in December 2010 Fitch made another downgrade to Portugal based on greater funding difficulties and on the expected recession for 2011.

Nevertheless, during the period that anticipated the bailout request, March and beginning of April 2011, there was a high concentration of rating downgrades assigned by the rating agencies with short periods of time between them (see figure 15). For instance, S&P had an interval of 5 days from one assignment to another one (March, 24 and March, 29); Fitch waited 8 days until change its Portuguese rating notation (March, 24 and April, 1), while Moody's took 21 days (March, 15 and April, 5). *Inclusive*, in the first assignment from the three agencies, all of them decreased the rating notation of Portugal in 2 levels (S&P from level A- to BBB and Fitch/Moody's from level A+/A1 to A-/A3). Curiously, S&P and Fitch assigned rating notations on the same day (March, 24). Fitch made these downgrades as a consequence of government's fall and as a result of the European summit, where it has been established that Portugal would have to request external funding. On the contrary, S&P and Moody's considered the weak economic growth and competitiveness of Portugal, the difficulty of the banking sector and public enterprises to access capital markets and the inflationary pressures that made increase the funding costs.

Thus, the market uncertainty regarding Portugal's capability to pay its debt increased, implying an increased risk proportionally higher on yields with less maturity, causing an inverted yield curve. This is the result of greater needs for short-term financing. Moreover, it is important to mention that the effect of rating notations assigned to Portugal extended in time, since the investors gave more importance to the existing rating. As a consequence, there was an increase of the volatility regarding the Portuguese yields, in the different maturities.

8. Concluding remarks

Despite the actual thoughts regarding the influence of the rating notations assigned by the rating agencies on the government bond yields, it is possible to conclude that the results obtained aren't so different from the reality. However, they are not also so linear like the majority of the agents of the market think. For instance, while in Greece and in Portugal, the corresponding agencies assigned ratings before the financial bailout request, in Ireland, the downgrade happens after the request. Nevertheless, during the request period, there are many rating notations assigned.

After the econometric analysis, it became clearer that there are differences concerning the role of the credit rating agencies on the different maturities of the three countries. For example, while in Greece and Ireland, it is only verified the influence of one and two agencies, respectively, in Portugal, the three have influence on the country's government bond yields. More precisely, the Greek government bond yields are influenced by Fitch, Irish yields are subjected to notations of Moody's and S&P, and Portugal feels the pressure of the three rating agencies announcements. On the other hand, it is possible to note that, regardless of the relationship between the government bond yields and the rating agencies, all of them have a specific influence in each country. Fitch effect is registered in Greek government bond yields with 2 and 10 years maturity, but also on the Portuguese yields with 10 years maturity; Moody's announcements influence the Irish government bond yields with 2 and 5 years, while all maturities of Portuguese yields tested feels Moody's role; S&P are related with the Irish yields with 10 years maturity but it also have consequences on the Portuguese government bond yields of different maturities. Another fact is that in Ireland, both S&P and Moody's attribute rating notations in a short period of time between them but the inverted yield curve occurs, mainly, during the penultimate modification of Moody's rating notation. Notwithstanding, S&P and Fitch assigned rating notations to Portugal on the same day and during the bailout request, with 2 downgrades from each agency with a short period of time between them. Also, in the first assignment, all the agencies decreased the rating notation of Portugal in 2 levels. It is also interesting to refer that each agency has influence on 2 countries and Moody's influence is felt more on yields with smaller maturities, while Fitch role is verified more on yields with longer maturities.

Regarding the behavior of the yields, the inverted yield curve registered among the three countries yields enhances a higher degree of volatility associated to smaller maturities, which is in accordance with what is recorded by the residuals test. Through the impulse response function it was also possible verified that yields with smaller maturities are more sensitive to variations in rating notations than the yields with longer maturities, in the different countries relatively to the respective rating assignment.

For the future, it would be interesting to analyze, if possible, the quantitative impact of the rating agencies on the yields, but also to test the correlations that exists between the countries government bond yields.

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Appendix

Appendix 1

Sovereign Ratings Methodology Profile

Political risk
- Stability and legitimacy of political institutions
- Popular participation in political processes
- Orderliness of leadership succession
- Transparency in economic policy decisions and objectives
- Public security
- Geopolitical risk

Economic structure
- Prosperity, diversity, and degree to which economy is market oriented
- Income disparities
- Effectiveness of financial sector in intermediating funds; availability of credit
- Competitiveness and profitability of nonfinancial private sector
- Efficiency of public sector
- Protectionism and other nonmarket influences
- Labor flexibility

Economic growth prospects
- Size and composition of savings and investment
- Rate and pattern of economic growth

Fiscal flexibility
- General government revenue, expenditure, and surplus/deficit trends
- Compatibility of fiscal stance with monetary and external factors
- Revenue-raising flexibility and efficiency
- Expenditure effectiveness and pressures
- Timeliness, coverage, and transparency in reporting
- Pension obligations

General government debt burden
- General government gross and net (of liquid assets) debt
- Share of revenue devoted to interest
- Currency composition and maturity profile
- Depth and breadth of local capital markets

Offshore and contingent liabilities
- Size and health of NFPEs
- Robustness of financial sector

Monetary flexibility
- Price behavior in economic cycles
- Money and credit expansion
- Compatibility of exchange-rate regime and monetary goals
- Institutional factors, such as central bank independence
- Range and efficiency of monetary policy tools, particularly in light of the fiscal stance and capital market characteristics
- Indexation and dollarization

External liquidity
- Impact of fiscal and monetary policies on external accounts
- Structure of the current account
- Composition of capital flows
- Reserve adequacy

External debt burden
- Gross and net external debt, including nonresident deposits and structured debt
- Maturity profile, currency composition, and sensitivity to interest rate changes
- Access to concessional funding
- Debt service burden

NFPEs—Nonfinancial public sector enterprises.

Appendix 1.1 – S&P sovereign ratings methodology. Source: S&P (http://www.standardandpoors.com/prot/ratings/articles/en/eu/?articleType=HTML&assetID=1245319266873)

Moody's Sovereign Rating Methodology

Economic structure and performance	Nominal GDP (US$ Bil.)
	Population (Mil.)
	GDP per capita (US$)
	GDP per capita (PPP basis, US$)
	Nominal GDP (% change, local currency)
	Real GDP (% change)
	Inflation (CPI, % change Dec/Dec)
	Unemployment Rate
	Gross Investment/GDP
	Gross Domestic Saving/GDP
	Nominal and Real Exports of G & S (% change, US$ basis)
	Nominal and Real Imports of G & S (% change, US$ basis)
	Openness of the Economy
	Government Effectiveness (Index Ranging from -2.50 to 2.50)
Government finance	General Government Revenue/GDP
	General Government Expenditures/GDP
	General Government Financial Balance/GDP
	General Government Primary Balance/GDP
	General Government Debt (US$ Bil.)
	General Government Debt/GDP
	General Government Debt/General Government Revenue
	General Government Interest Payment/General Government Revenue
	General Government FC & FC-indexed Debt/General Government Debt
External payments and debt	Nominal Exchange Rate (local currency per US$, Dec)
	Real Effective Exchange Rate (% change)
	Relative Unit Labor Costs
	Current Account Balance (US$ Bil.)
	Current Account Balance/GDP
	External Debt (US$ Bil.)
	Short-term External Debt/Total External Debt
	External Debt/GDP
	External Debt/Current Account Receipts
	Interest Paid on External Debt (US$ Bil.)
	Amortization Paid on External Debt (US$ Bil.)
	Net Foreign Direct Investment/GDP
	Net International Investment Position/GDP
	Official Forex Reserves (US$ Bil.)
	Net Foreign Assets of Domestic Banks (US$ Bil.)
Monetary, external vulnerability and liquidity indicators	M2 (% change Dec/Dec)
	Short-term Nominal Interest Rate (% per annum, Dec 31)
	Domestic Credit (% change Dec/Dec)
	Domestic Credit/GDP
	M2/Official Foreign Exchange Reserves (X)
	Total External Debt/Official Foreign Exchange Reserves
	Debt Service Ratio
	External Vulnerability Indicator
	Liquidity Ratio
	Total Liabilities Due BIS Banks/Total Assets Held in BIS Banks
	"Dollarization" Ratio
	"Dollarization" Vulnerability Indicator

Appendix 1.2 – Moody's sovereign rating methodology. Source: Gaillard, 2009

Sovereign Rating Model – Independent Variables

Variable	Derivation and description
Macroeconomic	
Consumer Price Inflation	3 year average (centred on current year) of annual change in consumer price index (CPI). The forecast at time t rather than the actual outturn is used, signified by 'HF'.
Real GDP Growth	3 year average (centred on current year) of annual change in real GDP. The forecast at time t rather than the actual outturn is used, signified by 'HF'.
Real GDP Growth Volatility	Natural log of the trailing 10 year standard deviation of average annual change in real GDP.
Public Finances (General Government)	
Budget Balance	3 year average (centred on current year) of general government (budget) balance (GGB) as a percent of GDP. The forecast at time t rather than the actual outturn is used, signified by 'HF'.
Gross Debt	3 year average (centred on current year) of gross (general) government debt (GGD) as a percent of GDP. The forecast at time t rather than the actual outturn is used, signified by 'HF'.
Interest Payments	3 year average (centred on current year) of gross government interest payments (GGI) as a share of general government revenues (REV).
Public Foreign Currency Debt	3 year average (centred on current year) of public foreign currency denominated (and indexed) debt (PFCD) as a share of gross (general) government debt (GGD).
External Finances	
Commodity Dependence	Non-manufactured merchandise exports as a share of current account receipts (CXR).
Current Account Balance plus net Foreign Direct Investment	3 year average (centred on current year) of current account balance (CAB) plus net foreign direct investment (FDI) as a percent of GDP.
Gross Sovereign External Debt	3 year average (centred on current year) of gross sovereign external debt (GPXD) as a share of gross external debt (GXD).
External Interest Service	3 year average (centred on current year) of external interest service expressed as a share of current external reciepts (CXR).
Official International Reserves	Year-end stock of international reserves (including gold) expressed as months' cover of import payments (CXP).
Structural	
Financial Market Depth	Natural log of financial assets (sum of the outstanding stock of public and private sector debt securities, market capitalisation of the domestic stock market, private sector credit and official international reserves) relative to GDP.
GDP per Capita	Percentile rank of GDP per capita in US dollars at market exchange rates.
Composite Governance Indicator	Average percentile rank of World Bank governance indicators: 'Rule of Law'; 'Government Effectiveness'; 'Control of Corruption'; 'Voice & Accountability' and 'Political Stability'.
Reserve Currency Status	Reserve currency status: 3 = 'strong'; 2 = 'medium'; 1 = 'low'; 0 = none.
Years since default	Non-linear function of the time since the last default (since 1980); the indicator is zero if there has been no default. For each year that elapses, the impact on the model output declines.

Note: For expanded definitions of Sovereign indicators, please refer to the "Definitions and Sources" section of Fitch's Sovereign Data Comparator.
Source: Fitch

Appendix 1.3 – Fitch sovereign rating methodology. Source: Fitch (http://www.fitchratings.com/creditdesk/reports/report_frame.cfm?rpt_id=648978)

Appendix 2

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 774

Component	Jarque-Bera	df	Prob.
1	158549.8	2	0.0000
2	723612.2	2	0.0000
Joint	882162.1	4	0.0000

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 780

Component	Jarque-Bera	df	Prob.
1	55111.03	2	0.0000
2	793587.6	2	0.0000
Joint	848698.6	4	0.0000

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 780

Component	Jarque-Bera	df	Prob.
1	21410.38	2	0.0000
2	759013.1	2	0.0000
Joint	780423.4	4	0.0000

Appendix 2.1 – VAR Residual Normality between GR_2Y, GR_5Y, GR_10Y and S&P.

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 774

Jarque-Bera	df	Prob.
159315.3	2	0.0000
1007408.	2	0.0000
1166723.	4	0.0000

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 780

Component	Jarque-Bera	df	Prob.
1	55377.95	2	0.0000
2	1124418.	2	0.0000
Joint	1179796.	4	0.0000

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 781

Component	Jarque-Bera	df
1	21257.20	2
2	1158966.	2
Joint	1180223.	4

Appendix 2.2 – VAR Residual Normality between GR_2Y, GR_5Y, GR_10Y and Moody's.

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 774

Component	Jarque-Bera	df	Prob.
1	173520.9	2	0.0000
2	2064769.	2	0.0000
Joint	2238290.	4	0.0000

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 780

Component	Jarque-Bera	df	Prob.
1	54920.02	2	0.0000
2	2265104.	2	0.0000
Joint	2320024.	4	0.0000

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 775

Component	Jarque-Bera	df	Prob.
1	18767.70	2	0.0000
2	2048889.	2	0.0000
Joint	2067657.	4	0.0000

Appendix 2.3 – VAR Residual Normality between GR_2Y, GR_5Y, GR_10Y and Fitch.

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 780

Component	Jarque-Bera	df	Prob.
1	16832.93	2	0.0000
2	1215889.	2	0.0000
Joint	1232722.	4	0.0000

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 779

Component	Jarque-Bera	df	Prob.
1	6830.872	2	0.0000
2	1178663.	2	0.0000
Joint	1185494.	4	0.0000

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 780

Component	Jarque-Bera	df	Prob.
1	4772.773	2	0.0000
2	1194430.	2	0.0000
Joint	1199203.	4	0.0000

Appendix 2.4 – VAR Residual Normality between IRL_2Y, IRL_5Y, IRL_10Y and S&P.

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 780

Component	Jarque-Bera	df	Prob.
1	16302.91	2	0.0000
2	7507814.	2	0.0000
Joint	7524117.	4	0.0000

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 779

Component	Jarque-Bera	df	Prob.
1	6877.709	2	0.0000
2	7345645.	2	0.0000
Joint	7352523.	4	0.0000

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 780

Component	Jarque-Bera	df	Prob.
1	4481.126	2	0.0000
2	7262242.	2	0.0000
Joint	7266723.	4	0.0000

Appendix 2.5 – VAR Residual Normality between IRL_2Y, IRL_5Y, IRL_10Y and Moody's.

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 780

Component	Jarque-Bera	df	Prob.
1	17552.31	2	0.0000
2	3677355.	2	0.0000
Joint	3694907.	4	0.0000

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Date: 03/27/12 Time: 01:39
Sample: 1/01/2009 12/30/2011
Included observations: 779

Component	Jarque-Bera	df	Prob.
1	6894.525	2	0.0000
2	3589537.	2	0.0000
Joint	3596431.	4	0.0000

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 780

Component	Jarque-Bera	df	Prob.
1	4755.485	2	0.0000
2	3651349.	2	0.0000
Joint	3656104.	4	0.0000

Appendix 2.6 – VAR Residual Normality between IRL_2Y, IRL_5Y, IRL_10Y and Fitch.

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 778

Component	Jarque-Bera	df	Prob.
1	62553.43	2	0.0000
2	2221541.	2	0.0000
Joint	2284094.	4	0.0000

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 778

Component	Jarque-Bera	df	Prob.
1	153228.0	2	0.0000
2	2216434.	2	0.0000
Joint	2369662.	4	0.0000

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 778

Component	Jarque-Bera
1	23560.38
2	2297960.
Joint	2321520.

Appendix 2.7 – VAR Residual Normality between PT_2Y, PT_5Y, PT_10Y and S&P.

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 778

Component	Jarque-Bera	df	Prob.
1	8588.018	2	0.0000
2	3727924.	2	0.0000
Joint	3736512.	4	0.0000

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 777

Component	Jarque-Bera	df	Prob.
1	43720.95	2	0.0000
2	3392570.	2	0.0000
Joint	3436291.	4	0.0000

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 779

Component	Jarque-Bera	df	Prob.
1	5395.915	2	0.0000
2	3662169.	2	0.0000
Joint	3667565.	4	0.0000

Appendix 2.8 – VAR Residual Normality between PT_2Y, PT_5Y, PT_10Y and Moody’s.

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 775

Component	Jarque-Bera	df	Prob.
1	58415.62	2	0.0000
2	1033165.	2	0.0000
Joint	1091581.	4	0.0000

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 775

Component	Jarque-Bera	df	Prob.
1	135317.2	2	0.0000
2	975397.0	2	0.0000
Joint	1110714.	4	0.0000

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
H0: residuals are multivariate normal
Sample: 1/01/2009 12/30/2011
Included observations: 775

Component	Jarque-Bera	df	Prob.
1	20857.81	2	0.0000
2	1000740.	2	0.0000
Joint	1021598.	4	0.0000

Appendix 2.9 – VAR Residual Normality between PT_2Y, PT_5Y, PT_10Y and Fitch.

Appendix 3

	GR_2Y	GR_5Y	GR_10Y	SPS_GR	MOODYS_GR	FITCH_GR
GR_2Y	1.000000	0.955971	0.952822	0.846739	0.816545	0.843520
GR_5Y	0.955971	1.000000	0.980825	0.883718	0.880840	0.875096
GR_10Y	0.952822	0.980825	1.000000	0.931086	0.928681	0.921566
SPS_GR	0.846739	0.883718	0.931086	1.000000	0.977100	0.981869
MOODYS_GR	0.816545	0.880840	0.928681	0.977100	1.000000	0.966071
FITCH_GR	0.843520	0.875096	0.921566	0.981869	0.966071	1.000000

Appendix 3.1 – Correlation between GR_2Y, GR_5Y, GR_10Y and S&P, Moody's, Fitch.

	IRL_2Y	IRL_5Y	IRL_10Y	SPS_IRL	MOODYS_IRL	FITCH_IRL
IRL_2Y	1.000000	0.968334	0.961037	0.876516	0.891354	0.812946
IRL_5Y	0.968334	1.000000	0.991422	0.859024	0.854266	0.809290
IRL_10Y	0.961037	0.991422	1.000000	0.890799	0.877734	0.852460
SPS_IRL	0.876516	0.859024	0.890799	1.000000	0.965122	0.950891
MOODYS_IRL	0.891354	0.854266	0.877734	0.965122	1.000000	0.921047
FITCH_IRL	0.812946	0.809290	0.852460	0.950891	0.921047	1.000000

Appendix 3.2 – Correlation between IRL_2Y, IRL_5Y, IRL_10Y and S&P, Moody's, Fitch.

	PT_2Y	PT_5Y	PT_10Y	SPS_PT	MOODYS_PT	FITCH_PT
PT_2Y	1.000000	0.989330	0.970572	0.910961	0.968889	0.955915
PT_5Y	0.989330	1.000000	0.984024	0.925266	0.969305	0.967804
PT_10Y	0.970572	0.984024	1.000000	0.950080	0.955336	0.960648
SPS_PT	0.910961	0.925266	0.950080	1.000000	0.915780	0.954596
MOODYS_PT	0.968889	0.969305	0.955336	0.915780	1.000000	0.946178
FITCH_PT	0.955915	0.967804	0.960648	0.954596	0.946178	1.000000

Appendix 3.3 – Correlation between PT_2Y, PT_5Y, PT_10Y and S&P, Moody's, Fitch.

Appendix 4

Sample: 1/01/2009 12/30/2011
Included observations: 782

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.969	0.969	736.56	0.000
		2	0.937	-0.024	1426.4	0.000
		3	0.905	-0.018	2070.9	0.000
		4	0.873	-0.008	2672.1	0.000
		5	0.843	-0.003	3232.8	0.000
		6	0.813	-0.008	3754.9	0.000
		7	0.783	-0.012	4240.2	0.000
		8	0.752	-0.047	4687.7	0.000
		9	0.721	-0.009	5099.5	0.000
		10	0.690	-0.005	5477.9	0.000
		11	0.663	0.031	5827.5	0.000
		12	0.637	0.007	6150.9	0.000
		13	0.613	-0.002	6450.0	0.000
		14	0.592	0.057	6730.0	0.000
		15	0.573	0.004	6992.2	0.000
		16	0.552	-0.034	7236.2	0.000
		17	0.533	0.009	7463.7	0.000
		18	0.515	0.006	7676.2	0.000
		19	0.496	-0.015	7874.2	0.000
		20	0.478	-0.016	8057.8	0.000
		21	0.461	0.018	8229.2	0.000
		22	0.447	0.028	8390.3	0.000
		23	0.433	0.005	8541.9	0.000
		24	0.419	-0.018	8683.9	0.000
		25	0.404	-0.007	8816.4	0.000
		26	0.391	0.003	8940.1	0.000
		27	0.378	0.017	9056.3	0.000
		28	0.366	-0.001	9165.2	0.000
		29	0.354	-0.009	9267.4	0.000
		30	0.343	0.002	9363.3	0.000
		31	0.332	0.011	9453.6	0.000
		32	0.323	0.007	9538.7	0.000
		33	0.314	0.003	9619.2	0.000
		34	0.304	-0.016	9694.8	0.000
		35	0.293	-0.011	9765.5	0.000
		36	0.283	0.004	9831.5	0.000

Appendix 4.1 – Autocorrelation of GR_2Y

Sample: 1/01/2009 12/30/2011
Included observations: 782

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.972	0.972	742.10	0.000
		2	0.944	-0.033	1441.9	0.000
		3	0.915	-0.004	2101.4	0.000
		4	0.887	-0.021	2721.3	0.000
		5	0.858	-0.022	3302.3	0.000
		6	0.831	0.012	3847.4	0.000
		7	0.803	-0.026	4357.3	0.000
		8	0.774	-0.028	4832.0	0.000
		9	0.747	0.015	5274.8	0.000
		10	0.722	0.008	5688.3	0.000
		11	0.697	0.004	6074.6	0.000
		12	0.673	-0.013	6434.8	0.000
		13	0.649	-0.007	6770.1	0.000
		14	0.624	-0.022	7081.0	0.000
		15	0.601	0.005	7369.4	0.000
		16	0.577	-0.021	7635.8	0.000
		17	0.555	0.027	7883.0	0.000
		18	0.535	0.010	8113.0	0.000
		19	0.516	-0.004	8326.7	0.000
		20	0.496	-0.004	8525.1	0.000
		21	0.479	0.019	8710.0	0.000
		22	0.464	0.026	8883.4	0.000
		23	0.455	0.114	9050.7	0.000
		24	0.449	0.027	9213.6	0.000
		25	0.442	-0.007	9371.9	0.000
		26	0.436	0.001	9526.0	0.000
		27	0.430	-0.003	9675.8	0.000
		28	0.424	0.002	9821.7	0.000
		29	0.418	0.000	9963.8	0.000
		30	0.412	-0.009	10102.	0.000
		31	0.406	-0.002	10236.	0.000
		32	0.400	0.011	10367.	0.000
		33	0.394	0.010	10494.	0.000
		34	0.389	-0.003	10619.	0.000
		35	0.383	-0.022	10739.	0.000
		36	0.376	-0.015	10855.	0.000

Appendix 4.2 – Autocorrelation of GR_5Y

Sample: 1/01/2009 12/30/2011
Included observations: 782

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.977	0.977	749.59	0.000
		2	0.954	-0.018	1465.1	0.000
		3	0.931	-0.014	2147.0	0.000
		4	0.908	-0.012	2796.2	0.000
		5	0.885	0.006	3414.6	0.000
		6	0.863	-0.016	4002.7	0.000
		7	0.840	-0.023	4560.5	0.000
		8	0.816	-0.023	5088.1	0.000
		9	0.794	0.008	5587.5	0.000
		10	0.773	0.033	6062.0	0.000
		11	0.754	0.031	6514.5	0.000
		12	0.735	-0.027	6944.8	0.000
		13	0.718	0.030	7355.4	0.000
		14	0.701	0.014	7747.8	0.000
		15	0.686	0.020	8124.0	0.000
		16	0.671	-0.019	8484.0	0.000
		17	0.655	-0.006	8828.2	0.000
		18	0.640	-0.003	9157.2	0.000
		19	0.626	0.007	9472.0	0.000
		20	0.612	0.006	9773.4	0.000
		21	0.600	0.031	10064.	0.000
		22	0.589	0.015	10343.	0.000
		23	0.580	0.035	10615.	0.000
		24	0.569	-0.029	10877.	0.000
		25	0.559	0.006	11130.	0.000
		26	0.549	0.004	11374.	0.000
		27	0.539	-0.006	11611.	0.000
		28	0.530	0.006	11839.	0.000
		29	0.521	-0.000	12060.	0.000
		30	0.512	0.006	12274.	0.000
		31	0.504	0.008	12482.	0.000
		32	0.496	0.000	12682.	0.000
		33	0.488	0.013	12877.	0.000
		34	0.480	-0.003	13066.	0.000
		35	0.471	-0.015	13248.	0.000
		36	0.463	-0.004	13425.	0.000

Appendix 4.3 – Autocorrelation of GR_10Y

Sample: 1/01/2009 12/30/2011
Included observations: 782

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.997	0.997	779.99	0.000
		2	0.992	-0.177	1554.2	0.000
		3	0.987	-0.084	2321.7	0.000
		4	0.982	-0.031	3081.7	0.000
		5	0.977	0.007	3834.2	0.000
		6	0.970	-0.098	4578.3	0.000
		7	0.964	0.003	5313.8	0.000
		8	0.958	0.048	6040.9	0.000
		9	0.952	0.009	6759.8	0.000
		10	0.946	0.034	7471.1	0.000
		11	0.940	-0.109	8173.9	0.000
		12	0.934	0.049	8868.4	0.000
		13	0.928	0.011	9554.9	0.000
		14	0.922	0.038	10234.	0.000
		15	0.917	0.087	10906.	0.000
		16	0.912	-0.059	11572.	0.000
		17	0.907	0.016	12231.	0.000
		18	0.902	0.018	12885.	0.000
		19	0.897	-0.008	13532.	0.000
		20	0.893	0.025	14173.	0.000
		21	0.888	-0.059	14809.	0.000
		22	0.884	0.025	15439.	0.000
		23	0.879	0.054	16063.	0.000
		24	0.875	0.013	16683.	0.000
		25	0.871	-0.024	17297.	0.000
		26	0.867	-0.067	17906.	0.000
		27	0.862	0.066	18510.	0.000
		28	0.858	0.031	19110.	0.000
		29	0.855	-0.016	19704.	0.000
		30	0.851	0.015	20295.	0.000
		31	0.847	0.019	20880.	0.000
		32	0.844	0.037	21462.	0.000
		33	0.840	-0.043	22040.	0.000
		34	0.837	0.011	22614.	0.000
		35	0.833	-0.084	23184.	0.000
		36	0.829	0.011	23749.	0.000

Appendix 4.4 – Autocorrelation of IRL_2Y

Sample: 1/01/2009 12/30/2011
Included observations: 782

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.997	0.997	779.99	0.000
		2	0.992	-0.177	1554.2	0.000
		3	0.987	-0.084	2321.7	0.000
		4	0.982	-0.031	3081.7	0.000
		5	0.977	0.007	3834.2	0.000
		6	0.970	-0.098	4578.3	0.000
		7	0.964	0.003	5313.8	0.000
		8	0.958	0.048	6040.9	0.000
		9	0.952	0.009	6759.8	0.000
		10	0.946	0.034	7471.1	0.000
		11	0.940	-0.109	8173.9	0.000
		12	0.934	0.049	8868.4	0.000
		13	0.928	0.011	9554.9	0.000
		14	0.922	0.038	10234.	0.000
		15	0.917	0.087	10906.	0.000
		16	0.912	-0.059	11572.	0.000
		17	0.907	0.016	12231.	0.000
		18	0.902	0.018	12885.	0.000
		19	0.897	-0.008	13532.	0.000
		20	0.893	0.025	14173.	0.000
		21	0.888	-0.059	14809.	0.000
		22	0.884	0.025	15439.	0.000
		23	0.879	0.054	16063.	0.000
		24	0.875	0.013	16683.	0.000
		25	0.871	-0.024	17297.	0.000
		26	0.867	-0.067	17906.	0.000
		27	0.862	0.066	18510.	0.000
		28	0.858	0.031	19110.	0.000
		29	0.855	-0.016	19704.	0.000
		30	0.851	0.015	20295.	0.000
		31	0.847	0.019	20880.	0.000
		32	0.844	0.037	21462.	0.000
		33	0.840	-0.043	22040.	0.000
		34	0.837	0.011	22614.	0.000
		35	0.833	-0.084	23184.	0.000
		36	0.829	0.011	23749.	0.000

Appendix 4.5 – Autocorrelation of IRL_5Y

Sample: 1/01/2009 12/30/2011
Included observations: 782

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.997	0.997	779.79	0.000
		2	0.992	-0.185	1553.5	0.000
		3	0.987	-0.041	2320.3	0.000
		4	0.982	-0.032	3079.9	0.000
		5	0.976	0.017	3832.2	0.000
		6	0.971	-0.050	4576.8	0.000
		7	0.965	0.008	5313.7	0.000
		8	0.960	0.042	6043.4	0.000
		9	0.955	0.024	6766.3	0.000
		10	0.950	-0.019	7482.3	0.000
		11	0.944	-0.004	8191.5	0.000
		12	0.939	0.002	8893.9	0.000
		13	0.934	-0.028	9589.5	0.000
		14	0.930	0.118	10279.	0.000
		15	0.926	0.101	10965.	0.000
		16	0.922	-0.068	11645.	0.000
		17	0.919	0.008	12322.	0.000
		18	0.915	0.003	12994.	0.000
		19	0.911	-0.027	13661.	0.000
		20	0.908	-0.005	14324.	0.000
		21	0.904	-0.056	14982.	0.000
		22	0.900	0.041	15635.	0.000
		23	0.896	-0.012	16283.	0.000
		24	0.891	-0.024	16926.	0.000
		25	0.887	-0.013	17563.	0.000
		26	0.882	-0.044	18195.	0.000
		27	0.878	0.002	18820.	0.000
		28	0.873	0.103	19441.	0.000
		29	0.869	-0.015	20056.	0.000
		30	0.865	-0.016	20666.	0.000
		31	0.861	0.053	21271.	0.000
		32	0.857	0.018	21872.	0.000
		33	0.854	-0.003	22469.	0.000
		34	0.850	-0.035	23062.	0.000
		35	0.847	-0.047	23650.	0.000
		36	0.843	-0.028	24234.	0.000

Appendix 4.6 – Autocorrelation of IRL_10Y

Sample: 1/01/2009 12/30/2011
Included observations: 782

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.991	0.991	770.88	0.000
		2	0.981	-0.061	1527.2	0.000
		3	0.970	-0.031	2268.2	0.000
		4	0.960	0.034	2995.1	0.000
		5	0.951	0.003	3708.2	0.000
		6	0.941	-0.004	4407.9	0.000
		7	0.931	-0.027	5093.6	0.000
		8	0.921	-0.012	5765.3	0.000
		9	0.911	0.014	6423.4	0.000
		10	0.901	-0.023	7067.7	0.000
		11	0.890	-0.062	7697.0	0.000
		12	0.878	-0.033	8310.4	0.000
		13	0.866	0.003	8908.3	0.000
		14	0.857	0.137	9494.4	0.000
		15	0.849	0.027	10070.	0.000
		16	0.839	-0.096	10633.	0.000
		17	0.828	-0.057	11183.	0.000
		18	0.817	-0.033	11718.	0.000
		19	0.804	-0.072	12237.	0.000
		20	0.790	-0.076	12739.	0.000
		21	0.775	-0.058	13223.	0.000
		22	0.761	0.052	13690.	0.000
		23	0.749	0.110	14142.	0.000
		24	0.736	-0.085	14580.	0.000
		25	0.723	0.002	15004.	0.000
		26	0.712	0.059	15415.	0.000
		27	0.701	0.089	15814.	0.000
		28	0.692	0.089	16203.	0.000
		29	0.683	-0.037	16582.	0.000
		30	0.673	-0.057	16952.	0.000
		31	0.663	-0.001	17311.	0.000
		32	0.653	-0.021	17660.	0.000
		33	0.643	-0.058	17998.	0.000
		34	0.633	-0.030	18327.	0.000
		35	0.622	-0.010	18645.	0.000
		36	0.612	0.115	18953.	0.000

Appendix 4.7 – Autocorrelation of PT_2Y

Sample: 1/01/2009 12/30/2011
Included observations: 782

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.988	0.988	767.02	0.000
		2	0.976	-0.033	1516.3	0.000
		3	0.964	-0.011	2247.8	0.000
		4	0.952	0.008	2962.2	0.000
		5	0.941	0.017	3660.4	0.000
		6	0.930	0.004	4343.1	0.000
		7	0.919	0.007	5010.9	0.000
		8	0.908	-0.006	5663.7	0.000
		9	0.897	-0.000	6302.1	0.000
		10	0.886	-0.024	6925.4	0.000
		11	0.874	-0.047	7532.5	0.000
		12	0.862	0.003	8123.8	0.000
		13	0.851	0.046	8701.1	0.000
		14	0.842	0.086	9267.6	0.000
		15	0.835	0.034	9824.7	0.000
		16	0.826	-0.043	10371.	0.000
		17	0.818	-0.015	10907.	0.000
		18	0.809	-0.013	11432.	0.000
		19	0.799	-0.025	11945.	0.000
		20	0.788	-0.057	12445.	0.000
		21	0.777	-0.021	12931.	0.000
		22	0.766	0.010	13405.	0.000
		23	0.756	0.014	13866.	0.000
		24	0.745	-0.045	14315.	0.000
		25	0.734	0.003	14752.	0.000
		26	0.725	0.081	15179.	0.000
		27	0.717	0.047	15597.	0.000
		28	0.710	0.036	16007.	0.000
		29	0.703	-0.002	16409.	0.000
		30	0.696	-0.007	16804.	0.000
		31	0.689	-0.002	17192.	0.000
		32	0.682	-0.018	17572.	0.000
		33	0.675	-0.008	17945.	0.000
		34	0.668	-0.015	18310.	0.000
		35	0.660	-0.017	18667.	0.000
		36	0.653	0.010	19018.	0.000

Appendix 4.8 – Autocorrelation of PT_5Y

Sample: 1/01/2009 12/30/2011
Included observations: 782

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.988	0.988	766.16	0.000
		2	0.977	0.057	1517.0	0.000
		3	0.967	0.012	2253.1	0.000
		4	0.957	0.018	2975.5	0.000
		5	0.948	0.004	3684.4	0.000
		6	0.938	-0.018	4379.4	0.000
		7	0.929	0.032	5062.0	0.000
		8	0.919	-0.027	5731.3	0.000
		9	0.910	0.015	6388.2	0.000
		10	0.901	0.002	7033.0	0.000
		11	0.891	-0.056	7663.9	0.000
		12	0.882	0.045	8283.0	0.000
		13	0.873	0.012	8890.8	0.000
		14	0.867	0.104	9490.8	0.000
		15	0.861	0.022	10083.	0.000
		16	0.855	0.009	10669.	0.000
		17	0.849	-0.039	11246.	0.000
		18	0.842	0.010	11815.	0.000
		19	0.836	-0.008	12376.	0.000
		20	0.828	-0.057	12928.	0.000
		21	0.820	-0.025	13469.	0.000
		22	0.811	-0.039	13999.	0.000
		23	0.803	0.023	14520.	0.000
		24	0.795	-0.010	15031.	0.000
		25	0.785	-0.077	15530.	0.000
		26	0.774	-0.033	16016.	0.000
		27	0.766	0.107	16493.	0.000
		28	0.759	0.055	16962.	0.000
		29	0.753	0.016	17423.	0.000
		30	0.746	0.011	17877.	0.000
		31	0.739	-0.019	18323.	0.000
		32	0.733	0.027	18762.	0.000
		33	0.727	-0.016	19195.	0.000
		34	0.721	-0.027	19621.	0.000
		35	0.713	-0.049	20038.	0.000
		36	0.706	0.007	20448.	0.000

Appendix 4.9 – Autocorrelation of PT_10Y

Appendix 5

Null Hypothesis: GR_2Y has a unit root
Exogenous: Constant
Lag Length: 7 (Automatic based on SIC, MAXLAG=20)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		5.786939	1.0000
Test critical values:	1% level	-3.438572	
	5% level	-2.865059	
	10% level	-2.568699	

*MacKinnon (1996) one-sided p-values.

Appendix 5.1 – Unit root test to GR_2Y using ADF.

Null Hypothesis: GR_2Y has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		5.417926	1.0000
Test critical values:	1% level	-3.438497	
	5% level	-2.865026	
	10% level	-2.568681	

*MacKinnon (1996) one-sided p-values.

Appendix 5.2 – Unit root test to GR_2Y using PP.

Null Hypothesis: GR_2Y is stationary
Exogenous: Constant
Bandwidth: 22 (Newey-West using Bartlett kernel)

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		2.072696
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Appendix 5.3 – Unit root test to GR_2Y using KPSS.

Null Hypothesis: GR_5Y has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=20)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		3.433257	1.0000
Test critical values:	1% level	-3.438508	
	5% level	-2.865030	
	10% level	-2.568684	

*MacKinnon (1996) one-sided p-values.

Appendix 5.4 – Unit root test to GR_5Y using ADF

Null Hypothesis: GR_5Y has a unit root
Exogenous: Constant
Bandwidth: 9 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		3.473964	1.0000
Test critical values:	1% level	-3.438497	
	5% level	-2.865026	
	10% level	-2.568681	

*MacKinnon (1996) one-sided p-values.

Appendix 5.5 – Unit root test to GR_5Y using PP.

Null Hypothesis: GR_5Y is stationary
Exogenous: Constant
Bandwidth: 22 (Newey-West using Bartlett kernel)

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		2.612555
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Appendix 5.6 – Unit root test to GR_5Y using KPSS.

Null Hypothesis: GR_10Y has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=20)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		2.520536	1.0000
Test critical values:	1% level	-3.438497	
	5% level	-2.865026	
	10% level	-2.568681	

*MacKinnon (1996) one-sided p-values.

Appendix 5.7 – Unit root test to GR_10Y using ADF.

Null Hypothesis: GR_10Y has a unit root
Exogenous: Constant
Bandwidth: 7 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		2.721411	1.0000
Test critical values:	1% level	-3.438497	
	5% level	-2.865026	
	10% level	-2.568681	

*MacKinnon (1996) one-sided p-values.

Appendix 5.8 – Unit root test to GR_10Y using PP.

Null Hypothesis: GR_10Y is stationary
Exogenous: Constant
Bandwidth: 22 (Newey-West using Bartlett kernel)

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		2.834938
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Appendix 5.9 – Unit root test to GR_10Y using KPSS.

Null Hypothesis: IRL_2Y has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=20)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.418196	0.5744
Test critical values:	1% level	-3.438508	
	5% level	-2.865030	
	10% level	-2.568684	

*MacKinnon (1996) one-sided p-values.

Appendix 5.10 – Unit root test to IRL_2Y using ADF.

Null Hypothesis: IRL_2Y has a unit root
Exogenous: Constant
Bandwidth: 8 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.367404	0.5993
Test critical values:	1% level	-3.438497	
	5% level	-2.865026	
	10% level	-2.568681	

*MacKinnon (1996) one-sided p-values.

Appendix 5.11 – Unit root test to IRL_2Y using PP.

Null Hypothesis: IRL_2Y is stationary
Exogenous: Constant
Bandwidth: 22 (Newey-West using Bartlett kernel)

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		2.573992
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Appendix 5.12 – Unit root test to IRL_2Y using KPSS.

Null Hypothesis: IRL_5Y has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic based on SIC, MAXLAG=20)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.345774	0.6097
Test critical values:	1% level	-3.438518	
	5% level	-2.865035	
	10% level	-2.568686	

*MacKinnon (1996) one-sided p-values.

Appendix 5.13 – Unit root test to IRL_5Y using ADF.

Null Hypothesis: IRL_5Y has a unit root
Exogenous: Constant
Bandwidth: 12 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.324432	0.6199
Test critical values:	1% level	-3.438497	
	5% level	-2.865026	
	10% level	-2.568681	

*MacKinnon (1996) one-sided p-values.

Appendix 5.14 – Unit root test to IRL_5Y using PP.

Null Hypothesis: IRL_5Y is stationary
Exogenous: Constant
Bandwidth: 22 (Newey-West using Bartlett kernel)

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		2.382359
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Appendix 5.15 – Unit root test to IRL_5Y using KPSS.

Null Hypothesis: IRL_10Y has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=20)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.308119	0.6275
Test critical values:	1% level	-3.438508	
	5% level	-2.865030	
	10% level	-2.568684	

*MacKinnon (1996) one-sided p-values.

Appendix 5.16 – Unit root test to IRL_10Y using ADF.

Null Hypothesis: IRL_10Y has a unit root
Exogenous: Constant
Bandwidth: 9 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.256777	0.6512
Test critical values:	1% level	-3.438497	
	5% level	-2.865026	
	10% level	-2.568681	

*MacKinnon (1996) one-sided p-values.

Appendix 5.17 – Unit root test to IRL_10Y using PP.

Null Hypothesis: IRL_10Y is stationary
Exogenous: Constant
Bandwidth: 22 (Newey-West using Bartlett kernel)

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		2.609989
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Appendix 5.18 – Unit root test to IRL_10Y using KPSS.

Null Hypothesis: PT_2Y has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic based on SIC, MAXLAG=20)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.252468	0.9290
Test critical values:	1% level	-3.438529	
	5% level	-2.865040	
	10% level	-2.568689	

*MacKinnon (1996) one-sided p-values.

Appendix 5.19 – Unit root test to PT_2Y using ADF.

Null Hypothesis: PT_2Y has a unit root
Exogenous: Constant
Bandwidth: 10 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.201178	0.9357
Test critical values:	1% level	-3.438497	
	5% level	-2.865026	
	10% level	-2.568681	

*MacKinnon (1996) one-sided p-values.

Appendix 5.20 – Unit root test to PT_2yYusing PP.

Null Hypothesis: PT_2Y is stationary
Exogenous: Constant
Bandwidth: 22 (Newey-West using Bartlett kernel)

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		2.641206
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Appendix 5.21 – Unit root test to PT_2Y using KPSS.

Null Hypothesis: PT_5Y has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=20)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.057445	0.9623
Test critical values:	1% level	-3.438508	
	5% level	-2.865030	
	10% level	-2.568684	

*MacKinnon (1996) one-sided p-values.

Appendix 5.22 – Unit root test to PT_5Y using ADF.

Null Hypothesis: PT_5Y has a unit root
Exogenous: Constant
Bandwidth: 13 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		0.458111	0.9852
Test critical values:	1% level	-3.438497	
	5% level	-2.865026	
	10% level	-2.568681	

*MacKinnon (1996) one-sided p-values.

Appendix 5.23 – Unit root test to PT_5Y using PP.

Null Hypothesis: PT_5Y is stationary
Exogenous: Constant
Bandwidth: 22 (Newey-West using Bartlett kernel)

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		2.782537
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Appendix 5.24 – Unit root test to PT_5Y using KPSS.

Null Hypothesis: PT_10Y has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=20)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.355635	0.9138
Test critical values:	1% level	-3.438508	
	5% level	-2.865030	
	10% level	-2.568684	

*MacKinnon (1996) one-sided p-values.

Appendix 5.25 – Unit root test to PT_10Y using ADF.

Null Hypothesis: PT_10Y has a unit root
Exogenous: Constant
Bandwidth: 13 (Newey-West using Bartlett kernel)

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.198000	0.9361
Test critical values:	1% level	-3.438497	
	5% level	-2.865026	
	10% level	-2.568681	

*MacKinnon (1996) one-sided p-values.

Appendix 5.26 – Unit root test to PT_10Y using PP.

Null Hypothesis: PT_10Y is stationary
Exogenous: Constant
Bandwidth: 22 (Newey-West using Bartlett kernel)

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		3.008777
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Appendix 5.27 – Unit root test to PT_10Y using KPSS.

Appendix 6

VAR Lag Order Selection Criteria
Endogenous variables: GR_2Y SPS_GR
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 770

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-5377.011	NA	4006.616	13.97146	13.98353	13.97610
1	-1079.562	8561.412	0.057492	2.819640	2.855846*	2.833574*
2	-1074.438	10.18135	0.057324	2.816721	2.877064	2.839944
3	-1069.733	9.324445	0.057219	2.814890	2.899370	2.847402
4	-1064.625	10.09644	0.057055	2.812012	2.920629	2.853813
5	-1064.249	0.739905	0.057595	2.821427	2.954181	2.872517
6	-1061.265	5.867592	0.057747	2.824065	2.980957	2.884445
7	-1054.956	12.37223	0.057402	2.818068	2.999096	2.887736
8	-1045.579	18.34117	0.056606*	2.804100*	3.009265	2.883057
9	-1043.435	4.181454	0.056880	2.808922	3.038224	2.897168
10	-1038.154	10.27382*	0.056691	2.805595	3.059034	2.903130
11	-1035.336	5.467436	0.056866	2.808665	3.086242	2.915490
12	-1033.783	3.004861	0.057229	2.815022	3.116735	2.931135

* indicates lag order selected by the criterion

Appendix 6.1 – VAR Lag Order Selection Criteria of GR_2Y with S&P

VAR Lag Order Selection Criteria
Endogenous variables: GR_5Y SPS_GR
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-4583.148	NA	479.2260	11.84793	11.85995	11.85255
1	-336.0683	8461.235	0.008297	0.883897	0.919956	0.897771
2	-314.0087	43.83402	0.007919*	0.837232*	0.897330*	0.860355*
3	-313.9547	0.107018	0.008000	0.847428	0.931565	0.879800
4	-310.7833	6.269120	0.008017	0.849569	0.957745	0.891190
5	-304.6763	12.04037*	0.007974	0.844125	0.976340	0.894995
6	-304.1323	1.069700	0.008045	0.853055	1.009309	0.913174
7	-303.2388	1.752353	0.008110	0.861082	1.041376	0.930451
8	-302.5438	1.359588	0.008180	0.869622	1.073955	0.948240

* indicates lag order selected by the criterion

Appendix 6.2 – VAR Lag Order Selection Criteria of GR_5Y with S&P

VAR Lag Order Selection Criteria
Endogenous variables: GR_10Y SPS_GR
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-4117.360	NA	143.8234	10.64434	10.65636	10.64896
1	-252.9063	7698.950	0.006693	0.669008	0.705067*	0.682882*
2	-248.2268	9.298452	0.006681*	0.667253*	0.727351	0.690376
3	-248.1180	0.215657	0.006748	0.677307	0.761444	0.709679
4	-243.2356	9.651294*	0.006733	0.675027	0.783203	0.716648
5	-240.2112	5.962794	0.006750	0.677548	0.809764	0.728419
6	-237.4541	5.421502	0.006772	0.680760	0.837014	0.740879
7	-234.8896	5.029749	0.006797	0.684469	0.864763	0.753838
8	-233.2571	3.193258	0.006839	0.690587	0.894919	0.769204

* indicates lag order selected by the criterion

Appendix 6.3 – VAR Lag Order Selection Criteria of GR_10Y with S&P

VAR Lag Order Selection Criteria
Endogenous variables: GR_2Y MOODYS_GR
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 770

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-5572.664	NA	6660.126	14.47965	14.49172	14.48429
1	-1224.029	8663.385	0.083670	3.194881	3.231087*	3.208815
2	-1213.225	21.46812	0.082204	3.177208	3.237551	3.200431*
3	-1208.438	9.487474	0.082037	3.175163	3.259643	3.207675
4	-1204.273	8.231683	0.082002	3.174736	3.283353	3.216537
5	-1204.201	0.143622	0.082843	3.184936	3.317690	3.236026
6	-1201.424	5.459541	0.083106	3.188114	3.345005	3.248493
7	-1195.345	11.92134	0.082659	3.182714	3.363742	3.252382
8	-1185.367	19.51502*	0.081386*	3.167187*	3.372352	3.246144
9	-1183.441	3.757233	0.081826	3.172574	3.401876	3.260820
10	-1179.605	7.462223	0.081861	3.173000	3.426440	3.270536
11	-1176.349	6.318470	0.082020	3.174931	3.452508	3.281756
12	-1175.711	1.233378	0.082741	3.183666	3.485379	3.299779

* indicates lag order selected by the criterion

Appendix 6.4 – VAR Lag Order Selection Criteria of GR_2Y with Moody's

VAR Lag Order Selection Criteria
Endogenous variables: GR_5Y MOODYS_GR
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-4724.690	NA	690.8441	12.21367	12.22569	12.21829
1	-468.8166	8478.755	0.011692	1.226916	1.262975	1.240790
2	-444.3142	48.68834	0.011089*	1.173938*	1.234036*	1.197061*
3	-443.5532	1.508191	0.011182	1.182308	1.266445	1.214680
4	-443.3670	0.367938	0.011293	1.192163	1.300339	1.233784
5	-437.6282	11.31451*	0.011242	1.187670	1.319885	1.238540
6	-436.5080	2.202789	0.011326	1.195111	1.351366	1.255231
7	-436.0891	0.821559	0.011432	1.204365	1.384658	1.273733
8	-435.3995	1.348908	0.011530	1.212919	1.417251	1.291536

* indicates lag order selected by the criterion

Appendix 6.5 – VAR Lag Order Selection Criteria of GR_5Y with Moody's

VAR Lag Order Selection Criteria
Endogenous variables: GR_10Y MOODYS_GR
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-4263.144	NA	209.6187	11.02104	11.03306	11.02567
1	-385.5807	7725.068*	0.009429*	1.011836*	1.047895*	1.025710*
2	-384.3872	2.371627	0.009498	1.019088	1.079186	1.042211
3	-379.6567	9.375397	0.009480	1.017201	1.101338	1.049573
4	-375.9521	7.323016	0.009487	1.017964	1.126140	1.059585
5	-374.9204	2.034058	0.009560	1.025634	1.157849	1.076504
6	-371.9857	5.770926	0.009587	1.028387	1.184641	1.088506
7	-368.4674	6.900193	0.009599	1.029632	1.209925	1.099000
8	-366.3319	4.177198	0.009645	1.034449	1.238782	1.113067

* indicates lag order selected by the criterion

Appendix 6.6 – VAR Lag Order Selection Criteria of GR_10Y with Moody's

VAR Lag Order Selection Criteria
Endogenous variables: GR_2Y FITCH_GR
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 770

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-5289.488	NA	3191.898	13.74413	13.75619	13.74877
1	-1093.045	8360.187	0.059541	2.854662	2.890867*	2.868595*
2	-1088.079	9.867922	0.059392	2.852152	2.912495	2.875375
3	-1083.350	9.370166	0.059279	2.850261	2.934741	2.882773
4	-1078.659	9.274176	0.059173	2.848464	2.957081	2.890265
5	-1078.426	0.458209	0.059755	2.858250	2.991004	2.909340
6	-1075.287	6.172793	0.059889	2.860485	3.017376	2.920864
7	-1068.691	12.93515	0.059487	2.853742	3.034770	2.923410
8	-1042.577	51.07340*	0.056166*	2.796305*	3.001470	2.875262
9	-1040.243	4.554184	0.056410	2.800630	3.029933	2.888877
10	-1035.631	8.972447	0.056321	2.799041	3.052480	2.896576
11	-1032.208	6.641676	0.056406	2.800539	3.078116	2.907364
12	-1031.728	0.928575	0.056925	2.809682	3.111396	2.925796

* indicates lag order selected by the criterion

Appendix 6.7 – VAR Lag Order Selection Criteria of GR_2Y with Fitch

VAR Lag Order Selection Criteria
Endogenous variables: GR_5Y FITCH_GR
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-4514.071	NA	400.8873	11.66943	11.68145	11.67406
1	-336.5436	8322.671	0.008307	0.885126	0.921184	0.898999
2	-314.8711	43.06507	0.007936*	0.839460*	0.899558*	0.862583*
3	-314.4118	0.910255	0.008009	0.848609	0.932746	0.880981
4	-314.2538	0.312227	0.008089	0.858537	0.966713	0.900158
5	-308.3239	11.69127	0.008049	0.853550	0.985765	0.904420
6	-306.9354	2.730368	0.008104	0.860298	1.016553	0.920418
7	-304.6561	4.470236	0.008140	0.864745	1.045038	0.934113
8	-296.4784	15.99617*	0.008052	0.853949	1.058282	0.932567

* indicates lag order selected by the criterion

Appendix 6.8 – VAR Lag Order Selection Criteria of GR_5Y with Fitch

VAR Lag Order Selection Criteria
Endogenous variables: GR_10Y FITCH_GR
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-4070.853	NA	127.5378	10.52417	10.53619	10.52879
1	-253.8270	7604.462	0.006709	0.671388	0.707446*	0.685261*
2	-251.1512	5.316954	0.006732	0.674809	0.734907	0.697932
3	-248.0902	6.066624	0.006748	0.677236	0.761373	0.709608
4	-243.3264	9.416943	0.006735	0.675262	0.783438	0.716883
5	-242.4958	1.637533	0.006790	0.683452	0.815667	0.734322
6	-239.8266	5.248773	0.006813	0.686890	0.843145	0.747010
7	-226.2709	26.58594*	0.006647*	0.662199*	0.842492	0.731567
8	-224.4463	3.569099	0.006685	0.667820	0.872152	0.746437

* indicates lag order selected by the criterion

Appendix 6.9 – VAR Lag Order Selection Criteria of GR_10Y with Fitch

VAR Lag Order Selection Criteria
Endogenous variables: IRL_2Y SPS_IRL
Exogenous variables: C
Date: 04/16/12 Time: 14:42
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3315.592	NA	18.11669	8.572588	8.584607	8.577212
1	531.0657	7663.495	0.000883	-1.356759	-1.320700	-1.342885
2	581.8893	100.9907	0.000782*	-1.477750*	-1.417652*	-1.454627*
3	582.4651	1.141034	0.000789	-1.468902	-1.384765	-1.436530
4	583.4436	1.934318	0.000795	-1.461095	-1.352919	-1.419474
5	583.6940	0.493743	0.000803	-1.451406	-1.319191	-1.400536
6	583.7634	0.136386	0.000811	-1.441249	-1.284995	-1.381130
7	584.6820	1.801533	0.000818	-1.433287	-1.252993	-1.363918
8	590.4958	11.37220*	0.000814	-1.437974	-1.233641	-1.359356

* indicates lag order selected by the criterion

Appendix 6.10 – VAR Lag Order Selection Criteria of IRL_2Y with S&P

VAR Lag Order Selection Criteria
Endogenous variables: IRL_5Y SPS_IRL
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3166.773	NA	12.33312	8.188043	8.200062	8.192667
1	837.6206	7977.745	0.000400	-2.148891	-2.112832	-2.135017
2	865.3084	55.01774	0.000376	-2.210099	-2.150001*	-2.186976*
3	869.6875	8.679000	0.000376*	-2.211079*	-2.126942	-2.178707
4	872.3581	5.279162	0.000377	-2.207644	-2.099468	-2.166023
5	872.7333	0.739717	0.000380	-2.198277	-2.066062	-2.147407
6	874.7983	4.060532	0.000382	-2.193277	-2.037023	-2.133158
7	880.1432	10.48275*	0.000381	-2.196753	-2.016459	-2.127384
8	883.6728	6.904152	0.000382	-2.195537	-1.991204	-2.116919

* indicates lag order selected by the criterion

Appendix 6.11 – VAR Lag Order Selection Criteria of IRL_5Y with S&P

VAR Lag Order Selection Criteria
Endogenous variables: IRL_10Y SPS_IRL
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2905.238	NA	6.274463	7.512242	7.524262	7.516867
1	1115.984	8011.271	0.000195	-2.868175	-2.832116	-2.854301
2	1179.837	126.8818	0.000167*	-3.022835*	-2.962737*	-2.999712*
3	1180.588	1.488156	0.000168	-3.014439	-2.930302	-2.982067
4	1182.872	4.515271	0.000169	-3.010006	-2.901830	-2.968385
5	1185.271	4.728829	0.000170	-3.005867	-2.873652	-2.954997
6	1188.512	6.374508	0.000170	-3.003908	-2.847654	-2.943789
7	1193.719	10.21205	0.000169	-3.007027	-2.826733	-2.937658
8	1199.901	12.09173*	0.000169	-3.012664	-2.808331	-2.934046

* indicates lag order selected by the criterion

Appendix 6.12 – VAR Lag Order Selection Criteria of IRL_10Y with S&P

VAR Lag Order Selection Criteria
Endogenous variables: IRL_2Y MOODYS_IRL
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3642.933	NA	42.21085	9.418431	9.430451	9.423056
1	38.67339	7334.673	0.003151	-0.084427	-0.048369	-0.070554
2	91.05310	104.0827*	0.002780*	-0.209440*	-0.149342*	-0.186317*
3	93.07733	4.011852	0.002795	-0.204334	-0.120197	-0.171962
4	93.48950	0.814755	0.002821	-0.195063	-0.086887	-0.153442
5	94.05074	1.106517	0.002846	-0.186178	-0.053962	-0.135307
6	94.39446	0.675902	0.002873	-0.176730	-0.020476	-0.116611
7	95.27756	1.731968	0.002896	-0.168676	0.011618	-0.099307
8	95.80100	1.023899	0.002922	-0.159693	0.044640	-0.081075

* indicates lag order selected by the criterion

Appendix 6.13 – VAR Lag Order Selection Criteria of IRL_2Y with Moody's

VAR Lag Order Selection Criteria
Endogenous variables: IRL_5Y MOODYS_IRL
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3549.529	NA	33.15931	9.177078	9.189097	9.181702
1	344.9338	7758.736	0.001428	-0.875798	-0.839739	-0.861924
2	374.5558	58.86123*	0.001336	-0.942005	-0.881907*	-0.918882*
3	378.8496	8.509994	0.001335*	-0.942764*	-0.858627	-0.910392
4	380.9915	4.234021	0.001342	-0.937963	-0.829786	-0.896341
5	382.1544	2.292718	0.001352	-0.930632	-0.798416	-0.879761
6	385.5181	6.614413	0.001354	-0.928987	-0.772733	-0.868868
7	386.1490	1.237370	0.001366	-0.920282	-0.739988	-0.850913
8	388.0125	3.645209	0.001373	-0.914761	-0.710428	-0.836144

* indicates lag order selected by the criterion

Appendix 6.14 – VAR Lag Order Selection Criteria of IRL_5Y with Moody's

VAR Lag Order Selection Criteria
Endogenous variables: IRL_10Y MOODYS_IRL
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3314.837	NA	18.08139	8.570637	8.582657	8.575262
1	625.5246	7850.177	0.000692	-1.600839	-1.564780	-1.586965
2	686.0572	120.2831*	0.000598*	-1.746918*	-1.686820*	-1.723795*
3	689.9476	7.710531	0.000598	-1.746635	-1.662498	-1.714263
4	690.8430	1.769920	0.000603	-1.738612	-1.630436	-1.696991
5	693.2531	4.751686	0.000605	-1.734504	-1.602289	-1.683634
6	697.5818	8.512097	0.000605	-1.735354	-1.579099	-1.675234
7	701.4452	7.577036	0.000605	-1.735001	-1.554707	-1.665632
8	702.5951	2.249172	0.000609	-1.727636	-1.523303	-1.649018

* indicates lag order selected by the criterion

Appendix 6.15 – VAR Lag Order Selection Criteria of IRL_10Y with Moody's

VAR Lag Order Selection Criteria
Endogenous variables: IRL_2Y FITCH_IRL
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3512.833	NA	30.15955	9.082256	9.094275	9.086880
1	331.8593	7659.581	0.001477	-0.842014	-0.805955	-0.828140
2	381.2368	98.11718*	0.001314*	-0.959268*	-0.899170*	-0.936145*
3	381.7295	0.976525	0.001326	-0.950206	-0.866069	-0.917834
4	382.4395	1.403444	0.001337	-0.941704	-0.833528	-0.900083
5	382.6736	0.461573	0.001350	-0.931973	-0.799758	-0.881103
6	387.3170	9.130816	0.001348	-0.933636	-0.777381	-0.873516
7	389.7156	4.704101	0.001353	-0.929498	-0.749204	-0.860129
8	390.3131	1.168906	0.001365	-0.920706	-0.716373	-0.842088

* indicates lag order selected by the criterion

Appendix 6.16 – VAR Lag Order Selection Criteria of IRL_2Y with Fitch

VAR Lag Order Selection Criteria
Endogenous variables: IRL_5Y FITCH_IRL
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3320.977	NA	18.37055	8.586503	8.598523	8.591128
1	637.2719	7885.813	0.000671	-1.631194	-1.595135	-1.617320
2	663.6535	52.42229*	0.000633	-1.689027	-1.628929*	-1.665904*
3	668.2114	9.033341	0.000632*	-1.690469*	-1.606332	-1.658097
4	669.9931	3.522098	0.000636	-1.684737	-1.576561	-1.643116
5	672.8670	5.666084	0.000638	-1.681827	-1.549612	-1.630957
6	674.7293	3.662096	0.000641	-1.676303	-1.520049	-1.616184
7	675.3027	1.124481	0.000647	-1.667449	-1.487155	-1.598080
8	676.3903	2.127523	0.000652	-1.659923	-1.455591	-1.581306

* indicates lag order selected by the criterion

Appendix 6.17 – VAR Lag Order Selection Criteria of IRL_5Y with Fitch

VAR Lag Order Selection Criteria
Endogenous variables: IRL_10Y FITCH_IRL
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3060.773	NA	9.378198	7.914142	7.926161	7.918766
1	915.5219	7921.766	0.000327	-2.350186	-2.314127	-2.336312
2	976.1396	120.4522	0.000282*	-2.496485*	-2.436387*	-2.473362*
3	977.7852	3.261327	0.000284	-2.490401	-2.406264	-2.458029
4	978.6374	1.684669	0.000286	-2.482267	-2.374091	-2.440646
5	983.1400	8.877241	0.000286	-2.483566	-2.351351	-2.432696
6	988.3659	10.27620*	0.000285	-2.486734	-2.330479	-2.426614
7	990.5414	4.266648	0.000287	-2.482019	-2.301726	-2.412651
8	991.1523	1.195060	0.000289	-2.473262	-2.268929	-2.394644

* indicates lag order selected by the criterion

Appendix 6.18 – VAR Lag Order Selection Criteria of IRL_10Y with Fitch

VAR Lag Order Selection Criteria
Endogenous variables: PT_2Y SPS_PT
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3351.054	NA	19.85524	8.664222	8.676242	8.668847
1	285.6002	7245.117	0.001664	-0.722481	-0.686422	-0.708607
2	301.8638	32.31709	0.001613	-0.754170	-0.694072	-0.731047
3	306.7742	9.732049	0.001609	-0.756523	-0.672386	-0.724151
4	333.1811	52.19972*	0.001518*	-0.814422*	-0.706245*	-0.772800*
5	333.9993	1.612989	0.001531	-0.806200	-0.673984	-0.755329
6	335.9485	3.833055	0.001539	-0.800901	-0.644646	-0.740781
7	337.8678	3.764206	0.001547	-0.795524	-0.615231	-0.726156
8	338.7905	1.804787	0.001560	-0.787572	-0.583240	-0.708955

* indicates lag order selected by the criterion

Appendix 6.19 – VAR Lag Order Selection Criteria of PT_2Y with S&P

VAR Lag Order Selection Criteria
Endogenous variables: PT_5Y SPS_PT
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3102.155	NA	10.43659	8.021072	8.033092	8.025697
1	540.6249	7257.321	0.000861	-1.381460	-1.345401	-1.367586
2	558.1878	34.89878	0.000832	-1.416506	-1.356408*	-1.393383
3	565.0437	13.58779	0.000825	-1.423885	-1.339749	-1.391514
4	583.8703	37.21542*	0.000794*	-1.462197*	-1.354021	-1.420576*
5	586.4911	5.167147	0.000797	-1.458633	-1.326418	-1.407763
6	588.0827	3.129652	0.000802	-1.452410	-1.296156	-1.392291
7	592.1278	7.933525	0.000802	-1.452527	-1.272233	-1.383158
8	592.8737	1.458988	0.000809	-1.444118	-1.239786	-1.365501

* indicates lag order selected by the criterion

Appendix 6.20 – VAR Lag Order Selection Criteria of PT_5Y with S&P

VAR Lag Order Selection Criteria
Endogenous variables: PT_10Y SPS_PT
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2585.874	NA	2.749061	6.687013	6.699033	6.691638
1	642.0878	6430.901	0.000663	-1.643638	-1.607579	-1.629764
2	657.8010	31.22333	0.000643	-1.673904	-1.613807*	-1.650782
3	659.6630	3.690394	0.000646	-1.668380	-1.584243	-1.636008
4	677.4981	35.25528*	0.000624*	-1.704129*	-1.595953	-1.662508*
5	678.1322	1.250334	0.000629	-1.695432	-1.563217	-1.644562
6	679.5444	2.776987	0.000633	-1.688745	-1.532491	-1.628626
7	682.4583	5.714760	0.000635	-1.685939	-1.505645	-1.616570
8	684.0261	3.066710	0.000639	-1.679654	-1.475321	-1.601036

* indicates lag order selected by the criterion

Appendix 6.21 – VAR Lag Order Selection Criteria of PT_10Y with S&P

VAR Lag Order Selection Criteria
Endogenous variables: PT_2Y MOODYS_PT
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3343.087	NA	19.45069	8.643637	8.655656	8.648261
1	-65.78658	6529.196	0.004127	0.185495	0.221554	0.199369
2	-49.58562	32.19260	0.003999	0.153968	0.214066	0.177091
3	2.682437	103.5907	0.003530	0.029244	0.113381	0.061616
4	16.67748	27.66463*	0.003440*	0.003417*	0.111593*	0.045038*
5	19.90255	6.358457	0.003447	0.005420	0.137635	0.056290
6	22.53042	5.167475	0.003459	0.008965	0.165220	0.069085
7	24.76365	4.379891	0.003475	0.013531	0.193824	0.082899
8	28.40850	7.129589	0.003478	0.014448	0.218781	0.093066

* indicates lag order selected by the criterion

Appendix 6. 22 – VAR Lag Order Selection Criteria of PT_2Y with Moody's

VAR Lag Order Selection Criteria
Endogenous variables: PT_5Y MOODYS_PT
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3154.643	NA	11.95258	8.156701	8.168720	8.161325
1	188.4047	6660.181	0.002140	-0.471330	-0.435271	-0.457456
2	206.1617	35.28444	0.002065	-0.506878	-0.446780	-0.483755
3	261.2751	109.2299	0.001809	-0.638954	-0.554817*	-0.606582*
4	266.6427	10.61043*	0.001803	-0.642488	-0.534311	-0.600866
5	271.4395	9.457231	0.001799*	-0.644546*	-0.512331	-0.593676
6	271.8422	0.791851	0.001816	-0.635251	-0.478997	-0.575132
7	273.1788	2.621559	0.001829	-0.628369	-0.448076	-0.559001
8	274.0271	1.659284	0.001844	-0.620225	-0.415892	-0.541608

* indicates lag order selected by the criterion

Appendix 6.23 – VAR Lag Order Selection Criteria of PT_5Y with Moody's

VAR Lag Order Selection Criteria
Endogenous variables: PT_10Y MOODYS_PT
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2923.666	NA	6.580466	7.559860	7.571879	7.564484
1	288.6296	6399.689	0.001652	-0.730309	-0.694250	-0.716435
2	297.0963	16.82388	0.001633	-0.741851	-0.681753	-0.718728
3	337.2712	79.62318*	0.001487*	-0.835326*	-0.751189*	-0.802954*
4	338.1303	1.698254	0.001499	-0.827210	-0.719034	-0.785589
5	340.9137	5.487617	0.001504	-0.824066	-0.691851	-0.773196
6	343.6665	5.413226	0.001509	-0.820844	-0.664589	-0.760724
7	344.5657	1.763586	0.001521	-0.812831	-0.632538	-0.743463
8	346.4160	3.619305	0.001529	-0.807277	-0.602944	-0.728659

* indicates lag order selected by the criterion

Appendix 6.24 – VAR Lag Order Selection Criteria of PT_10Y with Moody's

VAR Lag Order Selection Criteria
Endogenous variables: PT_2Y FITCH_PT
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3384.189	NA	21.63015	8.749842	8.761862	8.754467
1	106.6436	6954.604	0.002643	-0.260061	-0.224002	-0.246187
2	121.5149	29.55057	0.002570	-0.288152	-0.228054	-0.265029
3	124.8768	6.662962	0.002574	-0.286503	-0.202366	-0.254131
4	134.2573	18.54294	0.002539	-0.300407	-0.192230	-0.258785
5	134.7989	1.067675	0.002561	-0.291470	-0.159255	-0.240600
6	135.2297	0.847088	0.002585	-0.282247	-0.125993	-0.222128
7	194.8770	116.9828*	0.002239*	-0.426039*	-0.245745*	-0.356670*
8	198.0273	6.162186	0.002244	-0.423843	-0.219511	-0.345226

* indicates lag order selected by the criterion

Appendix 6.25 – VAR Lag Order Selection Criteria of PT_2Y with Fitch

VAR Lag Order Selection Criteria
Endogenous variables: PT_5Y FITCH_PT
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3081.195	NA	9.886368	7.966911	7.978931	7.971536
1	361.9700	6859.638	0.001366	-0.919819	-0.883760	-0.905945
2	378.6864	33.21675	0.001322	-0.952678	-0.892580	-0.929555
3	382.5263	7.610503	0.001323	-0.952264	-0.868127	-0.919892
4	385.0318	4.952733	0.001328	-0.948403	-0.840227	-0.906782
5	387.1407	4.157711	0.001334	-0.943516	-0.811301	-0.892646
6	387.5412	0.787593	0.001347	-0.934215	-0.777961	-0.874096
7	449.0229	120.5805*	0.001161*	-1.082747*	-0.902453*	-1.013378*
8	450.5723	3.030658	0.001168	-1.076414	-0.872082	-0.997797

* indicates lag order selected by the criterion

Appendix 6.26 – VAR Lag Order Selection Criteria of PT_5Y with Fitch

VAR Lag Order Selection Criteria
Endogenous variables: PT_10Y FITCH_PT
Exogenous variables: C
Sample: 1/01/2009 12/30/2011
Included observations: 774

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2784.647	NA	4.594609	7.200638	7.212657	7.205262
1	462.3988	6468.920	0.001054	-1.179325	-1.143266*	-1.165451
2	470.4732	16.04454	0.001043	-1.189853	-1.129755	-1.166730
3	471.3375	1.712934	0.001052	-1.181751	-1.097614	-1.149379
4	473.4410	4.158008	0.001057	-1.176850	-1.068674	-1.135229
5	473.7099	0.530186	0.001067	-1.167209	-1.034994	-1.116339
6	475.9182	4.342404	0.001072	-1.162579	-1.006325	-1.102460
7	536.5875	118.9871*	0.000926*	-1.309012*	-1.128718	-1.239643*
8	539.2479	5.204094	0.000929	-1.305550	-1.101218	-1.226933

* indicates lag order selected by the criterion

Appendix 6.27 – VAR Lag Order Selection Criteria of PT_10Y with Fitch