Is Free Riding affecting Market Discipline in the Euro Sovereign Bond Market?

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"The reasonable man adapts himself to the world. The unreasonable man persists in trying to adapt the world to himself. Therefore all progress depends on the unreasonable man."

- George Bernard Shaw -

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Abstract

The aim of this research is to investigate how the failure of the members of the EMU to uphold the goals of the Stability and Growth Pact (SGP) has affected the Euro sovereign bond markets and its ability to enforce market discipline. To date 7 of the 11 member states of the Euro zone have violated the principles of this pact, and yet the bond market has shown little appetite to punish those with high deficits and national debts. The danger going forward is that each country will find ways to justify growing fiscal deficits, contented in the knowledge that there will be no formal pressure from other EMU countries and that the interest rate burden will be the equivalent for all EMU countries. Thus, there appears to be an element of "free-riding" by those governments who feel there is an unwritten bail-out in the workings of the system (despite official pronouncements to the contrary). Therefore my research investigates whether monetary union has weakened the disciplinary function of the Euro debt markets.

To this end, I carried out an investigation of the microstructure of European bond markets, and in particular the effects on Liquidity risk with the introduction of electronic trading. There is clear evidence that increased transparency has benefited the bond market by increasing liquidity and thereby reducing liquidity risk. Building a testable model I place the "liquidity risk premium" in its historical context and highlight the dominant role of credit risk in explaining the yield differential with the eurozone. I expand on the research carried out by Cantor and Packer (1996) on the determinants of sovereign's yields and apply their model to the members of the eurozone. This shows that one of the two pillars of the SGP, government deficits, is almost completely ignored by the market in assessing sovereign risk. Instead, GDP per Capita and Debt/GDP seem to be the main drivers in determining the yield of a sovereign. Also, in contrast to Cantor and Packer results, where the yield curve increases in a convex shape as the risk of

default increases, the eurozone curve is much more concave in nature, which agrees with my "free-riding" hypothesis.

Building on the research carried out by Dunne, Moore and Portes (2006), I employ cointegration to model the inter-relationships between different issuer bonds. However, rather than look for a benchmark issuer, I use the model to explore the common regional drivers and investigate the systemic effects that resemble a tacit "bail-out" condition. I show that the regional effect dominates the individual or country specific risk within the bond market. This shows that investors see the eurozone as a single bloc rather than as separate issuers individually responsible for their own debt. Using an Error Correction Model I investigate the short-run dynamics of bond yields and relate these to the underlying fundamentals of the respective issuer, with low risk issuers having higher speed-of-adjustments than high risk sovereigns. This corresponds to investors views of the 'core members' eg. Germany, France etc. are more homogeneous than and the 'outer members', Italy, Greece, Portugal etc. In conclusion, my research shows that there are significant issues of "free-riding" within the eurozone bond market and it is still far from efficient.

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1. Introduction

The launch of the euro on January 1st, 1999, constitutes a milestone in the history of Europe because it was marked by the simultaneous abandonment of the national sovereignty of eleven countries on the conduct of their monetary policy. The European Central Bank has been ever since solely responsible for determining the common monetary policy for all the euro-denominated countries, while control of fiscal policy has remained with the member states. The start of EMU eliminated exchange rate risk between the currencies of participating member states, thereby creating the conditions for a substantially more integrated public debt market in the Euro area. Since then the market has grown in size and even surpassed those of the U.S. and Japan.

Prior to EMU, a number of committees were set up to research and advise the various governments on the implementation of monetary union. The most important of these was the Delors committee whose report proved the basis of the 1992 Maastricht Treaty. In it the Delors Committee acknowledged that market forces can exert a disciplinary influence but noted that the "constraints imposed by market forces might either be too slow and weak or too sudden and disruptive". The Committee concluded that countries in EMU should accept some constraints on their fiscal policy. Lamfalussy (1989) pointed out that closer economic integration might generate expectations that a country in a critical condition would in the end be bailed out by the other member countries. For this reason the fiscal stance of governments might have not been fully embedded in credit risk premia. The European Commission (1990) took a similar view and concluded that there was a need for rules and procedures at the Community level. Therefore the Stability and Growth Pact (SGP) was created to stop countries from free-riding, to ensure sustainable public finances and to prevent countries from running high deficits and debts that could adversely affect all members in the monetary union.

However since then, 7 of the 11 member states of the Euro zone have breached the criteria set by the SGP and yet none have faced sanctions. The danger going forward is that each country will find ways to justify growing fiscal deficits, happy in the knowledge that there will be no formal pressure from other EMU countries and that the interest rate burden will be the shared among all EMU countries. Since the launch of the euro, yield spreads between European bonds have narrowed considerably. For example, on Feb. 24 2006, the German 10-year bond yielded 3.90%, while Italy's 10-year bond paid 4.11%. That 21-basis-point spread is a far cry from 1995, when the gap between Italian and German sovereign debt was more than 600 basis points. But Italy still carries a public debt that amounts to over 100% of gross domestic product. The question now becomes whether monetary union weakened the disciplinary function of the debt markets.

There is now a real possibility that the discipline imposed on finance ministers by the bond market by widening credit spreads has been blunted. This has occurred by negating the impact of the "no bail out rule" (Article 103 of the EC Treaty) and many market participants now regard this rule as illusory. If a State becomes subject to the Excessive Deficit Procedure of the SGP, the sanctions that are imposed only increase the cost of borrowing and risk de-stabilising the State at precisely the most sensitive moment. This is the key reason why many market participants doubt that the SGP would ever be rigorously applied. There lies the contradiction at the heart of the system; the circumvention of the rules of the SGP by the member states has meant that the bond markets no longer view the aims of the pact as enforceable. Therefore the issue of 'free riding', where states run high budgetary deficits secure in the knowledge that they would not be penalised as part of the euro club, which the SGP was meant to prevent may be failing. In particular, it is often implicitly accepted that, in the unlikely event of a

European sovereign default, the other countries would come to the rescue in order to save the single currency.

The risks raised by Lamfalussy prior to the creation of the single currency now seem to be crystallising. With the convergence of yields there is the real possibility that the fiscal stance of individual sovereigns may not be fully embedded in their credit risk premia. The current wisdom is that yield differentials are determined by credit and liquidity risks alone; this however completely ignores the possibility of free-riding. This is one of the first studies that investigates whether free-riding is a significant component of the yield differential. A full investigation of the economic determinants of the different sovereign yields is carried out to see if the credit risk premium is applied consistently throughout the bond market. The yield differential or sovereign risk premia within EMU is defined in the academic literature as consisting of both the default and liquidity risk, therefore interest rate risk and other forms of risk are not included.

The issue of free-riding will also have an impact on market discipline; as noted by the Delors Committee the "constraints imposed by market forces might either be too slow and weak or too sudden and disruptive". If market participants believe that sovereigns will be bailed-out then any increase of the yield spread will occur slowly in response to increases to the Debt/GDP. However, any re-evaluation of the no-bailout clause, e.g. Italy allowed to default, may cause a sharp correction in the entire market, with the spill-over impacting on other euro sovereigns. This again is one of the first studies that investigates the bond market dynamics from the point of view of market discipline. Indeed according to Kim, Lucey and Wu (2004) "To date there is little evidence of the extent, still less the dynamics, of European bond market integration". A large part of my research will be to investigate the dynamics of the bond market and examine whether the market forces have indeed been too slow and weak since the beginning of the market, and there is a possibility of a sharp correction.

1.1 Motivation and Aims

The motivation for this research derives from the announcement in November 2005 by the president of the European Central Bank in which he clarified the Bank's open market procedures, that it would no longer accept government securities as collateral if they were rated below A- by Standard & Poor's and Fitch or A3 by Moody's. Previously, it had been widely considered that all European government securities carried the same risk of default. In other words, they were accepted "without consultation". Although all EMU countries' sovereign debt is (currently) rated above A-, these comments have direct consequences. The ECB's clarification serves as a reminder that the Central Bank is not there to act as a lender of last-resort for governments (it is even less inclined to do so as it does not wish to be saddled with bonds from poor quality issuers). As such, the Bank has given a clear indication to the markets that they should establish a hierarchy between public debt securities. Even within a monetary union, which by definition eliminates exchange rate risks, differing budget situations and growth prospects should be reflected in suitable risk premia.

The above announcement highlights that ECB's concern that the issues raised by both Lamfalussy and the Delors committee prior to the introduction of the euro are now having a direct effect on the future stability of the bond market. The Stability and Growth Pact has not stopped public accounts from deteriorating and even with enormously different budget situations, nominal long-term interest rates have converged considerably with monetary union. The bond markets now seem to only marginally differentiate between the government securities of each member state. Even if the risk of default by an EMU member remains hypothetical, the ECB has taken the initiative by clarifying its eligibility policy for government bonds and has called on bond market participants to fulfil their role as assessors of risk. Additionally, it reminds member states that while they may be able to undermine the spirit of the SGP with impunity, the

discipline exercised by the market will have direct costs in terms of an increased debt burden. The ECB's intervention serves as a clear reminder that each member state is responsible for the solvency of its own accounts.

The aim of this research is to investigate how the failure of the sovereigns to uphold the goals of the SGP has affected the bond markets and their ability to enforce market discipline. The SGP was created to stop countries from free-riding, to ensure sustainable public finances and to prevent countries from running high deficits and debts that could adversely affect all members in the monetary union. Both the bond market and the Credit Rating Agencies (CRAs) should react to any deterioration of economic fundamentals if they worked efficiently. The aim of this thesis is therefore to assess if the above market participants still carry out the role of sovereign risk adjudicators or if they believe that the "no bail out rule" is meaningless and this is the reason behind the negligible yield differential.

1.2 Contribution to Current Research

My research focuses on 3 main topics; Free-Riding, Market Discipline and Market Integration and how they affect the Euro sovereign debt market. I draw on a vast field of academic and market literature to create a theoretical underpinning to my research. Specifically there are three papers which I draw on extensively, these are the "Determinants and Impacts of Sovereign Credit Ratings" by Cantor and Packer (1996), "Yield Spreads on EMU Government Bonds" by Codogno, Favero and Missale (2003) and "Benchmark Yield Undershooting in the EMU" by Antzoulatos and Vallianatos (2002). Much of the current academic research has focused on trying to explain the current yield differentials by referencing the risk and liquidity premia for various sovereigns. In this thesis I re-investigate these assumptions, most of which were made shortly after the inception of the bond market in 1999. The European bond market has been in existence for more than 7 years and now is a very good time to carry out an extensive exploration of this area.

To investigate the issues raised by Lamfalussy I examine the determinants of bond yields along the lines already explored by Cantor and Packer (1996). They highlight a number of important economic variables that explain almost 92% of the yield variation. I was able to reduce the number of variables in their model to allow me to create a more specific model based on the EMU sovereigns, (Chapter 5.5 & 5.6). This allowed me to compare the fiscal profile of all the euro sovereign bonds with their associated bond yields. Using Germany as a benchmark and the ECB overnight rate as the risk-free rate, I then created a risk/return profile from which I could contrast my expected yield based on economic data with that returned by the market and found that the possibility of free-riding could not be discounted (Chapter 5.7). To my knowledge this is the first study that raises the probability that free-riding effects have a significant effect on sovereign yields.

To investigate the issues raised by Delors Committee on market discipline and financial market integration, I employ econometric analysis, specifically cointegration analysis to look at how closely integrated the European bond markets have become. Dunne, Moore and Portes (2006) are one of the few studies to have tested for cointegration in government bond markets. However, the authors give no theoretical background as to what is the common stochastic force that drives all the Euro government bond yields. They also do not look at the micro-structure of the EuroMTS market when they look to identify the benchmark bond. EuroMTS is a quote driven market, which means prices are supplied irrespective of supply and demand constraints. Therefore it is my hypothesis that the "price discovery" mechanism cannot be identified from this market. Instead the Eurex Futures market, which is an order driven market, better encapsulates the information component of risk as defined by theoretical economics, and this information is immediately transferred into the bond market.

The justification for this hypothesis comes from a specific market event, the Dr. Evil trade which I describe in detail in section 6.4.1. At its core is the idea that 3 main contracts on Eurex Futures market which correspond to 3 separate market maturities, short, medium and long drive the bond market prices (Chapter 6.4 & 6.6). The fact that each individual sovereign bond shares a common stochastic component, which I identify as the Euro-wide regional price of risk, and which I demonstrate to be the principal driver of bond prices. This regional risk reduces 'own-country' or country-specific risk to a minor role in comparison. As Lamfalussy feared, the level of bond market integration that has occurred among European bonds has led to a weakening of market discipline and the perception of the possibility of financial bailouts. Chapters 6.4 to 6.6 contain some of the more original ideas in this thesis and demonstrate the contribution that this thesis makes in the field of euro sovereign risk.

In chapter 7, I reinvestigate the reasoning behind the remaining yield differentials which are currently perceived to be credit and liquidity risk (Codogno, Favero and Missale). I investigate the microstructure of European bond markets, and in particular the effect that the introduction of electronic trading and the "liquidity pact" may have had on bond prices. From chapter 5.6, I found that the economic variables could adequately explain the yield without having to take account of liquidity for all but 2 years of my data 2002 & 2003. This finding coincided with of the hypothesis of Villarroya (2003) which stated that smaller sovereigns such as Ireland and Finland could never achieve a similar yield to the deeper more liquid markets of Germany and France. This statement was however proven to be incorrect as both these sovereigns have achieved yields lower than that of Germany, (May & July 2006). I look to place liquidity risk in its historical perspective, and show that it has been superseded by the risk of free-riding in explaining yield differentials, (Chapter 7.3).

In this chapter I also investigate the short-term dynamics of the bond market, Antzoulatos and Vallianatos (2002) found that they could rank the sovereign issuers speed-of-response to a change in the German yield by liquidity. I re-ran the same experiment, but instead of using data from 2000, I used data from 2007 and found that I was no longer able to rank the issuers either by liquidity or credit risk. However, I extended their research by building on the cointegration results of the previous chapter, to develop an Error Correction Model that allowed for the feedback from one issuer to another which was not incorporated into the experiment of Antzoulatos and Vallianatos. The results of the speed-of-adjustments from this model showed that issuers with high credit ratings had also high speed-of-adjustments, and vice-versa. This is in line with my previous results and highlights the dominant role of credit risk within the short-term dynamics.

To my knowledge this is one of the first studies that uses cointegration within the bond market to compare how the speed of adjustment parameters differ across various euro sovereigns thus allowing us greater insight into both the long-run and short-run dynamics of the euro sovereign bond market. I show that all euro sovereign bonds of similar duration are cointegrated in the long-run and investigate how the short-run dynamics or "appetite for risk" affects each sovereign. The literature is silent on the time-varying nature of the euro bond market integration in terms of returns. My research aims to address this void and provide empirical evidence of the nature of the bond market integration amongst the existing EU members. Specifically, measures of dispersion and co-movement of yield spreads can shed light on the extent to which shocks are common, or not, across European sovereign markets. Therefore, the error correction coefficients serve two purposes: to identify the direction of causality between the yields and to measure the speed with which deviations from the long-run relationship are corrected by changes in the underlying yields. A better understanding of the dynamic relationship between these markets will be created, and this is critical for the efficient pricing of securities and the evaluation of regulatory policies.

In this thesis I bring together the literature of Sovereign risk with that of Free-riding, Moral Hazard and Market Discipline to bring a completely fresh and unique view to this area of research. To the best of my knowledge, this is the first study that looks to demonstrate both theoretical and empirical knowledge as to what drives the Euro bond market, and the first that specifically looks at the credit risk component from the point of view of market discipline.

1.3 Structure of the Thesis

In order to construct a suitable framework for the thesis, Chapter 2 analyses various theoretical and empirical issues in assessing Euro sovereign risk. Examination of the literature helps highlight the rationale behind the aims of the thesis, and specify exactly the areas of research worth contemplation. Within this section I distil down the vast academic literature written on this subject to give the thesis the foundations from which I can develop my theories about the risk of default associated with euro sovereign bonds.

Chapter 3 sets out the history of the creation of both the single currency and the European bond market. The European bond market is now one of the biggest financial debt markets in the world comparable in size and depth to the US and Japan, however it is unique in the fact that it has 11 different issuers of sovereign debt. As a monetary union the markets faces different pressures and therefore require different rules and regulations to ensure it functions efficiently. I also show how the creation of electronic markets and IT have revolutionised the bond markets. The reduction in trading costs and new transparency for clients into the pricing of euro sovereign bonds was a shock to the market, similar in impact to the big bang experienced by the London Stock Exchange in 1986 when it was automated.

In chapter 4 I investigate the determinants of yields along the lines already explored by Cantor and Packer. However, in my research I restrict the dataset to only include members of the euro zone and investigate how various economic variables impact the yield. By creating a model of the yield versus these key economic variables, I was able to explore a number of topics including Liquidity and Credit risk. I was able to expand on these results and create a Liquidation Risk Ratio which allowed comparison of individual sovereigns current payment ability. This showed that Free-riding could not be ruled out as a significant component within the bond market.

In chapter 5 I focus on the level of bond market integration that has occurred among European bonds and the impact that this will have on market discipline. Using cointegration analysis I show that all Euro member bond yields of equal duration share a common stochastic force. The integration of yields in the bond market signifies that regional effects have become dominant over own country effects in EU bond markets and the ability of the market to discipline finance ministers by increasing the credit spread is no longer being employed by the market. I raise this as further evidence that bond market participants are viewing the "no bail out rule" as meaningless.

In Chapter 6, I expand on the cointegration results to investigate the dynamics of the yield spread, and the reasons why it exhibits the properties of a stationary process. The yield spread is the "common attractor" that ensures that the yields to not drift apart in the long-run. The current wisdom is that yield differentials are now mainly determined by credit and liquidity risk. However, while there is almost no research on the common non-stationary force, there is even less research on the dynamics of the stationary force. While a large amount of research is focused on the determinants of the yield spread, there is little research focusing on their dynamics. If, as according to the Delors findings, the short-term dynamics can be sudden and disruptive then this is a serious gap in the research, which I look to fill.

Finally chapter 7 contains the conclusions and insights of the previous chapters. The chapters of this thesis are meant to flow one into another, the first half discussing the infrastructure and the second half discussing the dynamics and theoretical underpinning of the yield differential. Therefore the conclusions are built one on top of the other in a concise format. I also discuss possible future research, especially on the dynamics of the bond market, and possible methods to reduce the credit risk component further.

2. A Review of the Literature

2.1 Introduction

In order to construct a suitable framework for this thesis, I review various theoretical and empirical issues in assessing Euro Sovereign Risk. However, my main focus is concentrated on the 3 main themes that I wish to research; Free Riding, Market Discipline and Moral Hazard within the European monetary union. These topics allow tremendous scope for in-depth research from political science to market microstructure on a topic that is at the core of EMU, i.e. the Stability and Growth Pact. As mentioned in the introduction fiscal discipline is based on two mechanisms, the SGP and the bond market. There is a vast amount of academic literature on the former, but almost nothing has been written on the latter and this is the area that I focus on.

One of the main concerns for the members of the Euro club was that the debt of one of their number would grow unmanageable and they would have to come to its assistance. The SGP was the therefore introduced and its aim was to reduce the ability of a member to free-ride on the credit profile of its fellow members, thereby reducing the benefits of monetary union for all. However the pact has been so abused it is now almost meaningless. Therefore we must turn to the bond market to see if it can instil some market discipline in the fiscal policies of various sovereigns. However as sovereigns are both issuers of debt and regulators of the market the concerns associated with moral hazard are very clear. The remaining sections look at the bond market in greater detail to provide foundations on which I develop my theories. As the eurozone bond market itself is only in its infancy, the amount of literature on the subject is limited. Therefore this research will add to the growing literature in areas such as eurozone bond market dynamics and the determinants of sovereign risk within the bond market.

2.2 Europe's Free Rider Problem

In economics free riders are players who consume more than their fair share of a resource, or contribute less than a fair share to the costs of its production. The free rider problem then becomes how to prevent free riding from taking place or limit the negative effects and is very closely connected with game theory. Pettit (1986) outlines the free-rider problem in detail and introduces the concept of the "foul dealer". He concludes, "The free rider seeks to benefit by the efforts of others, the foul dealer to benefit at their expense" (Pettit, 1986, p 374) states that a foul dealer does not only not co-operate but tries to take advantage of the co-operators in a manner where the co-operators are left worse off then if they had not co-operated in the first instance.

Argentina is a good example of a country which suffers from this problem as it is unable to set effective restrictions on its provincial governments. Therefore the provincial governments routinely run budget large deficits that end up being financed by the central bank (Nicolini et al. (2002)). Expectations of bailouts from the central government only increase the provinces incentives to behave in a financially reckless manner. For related discussions of Argentina, see the work of Cooper and Kempf (2001a and b) and Tommasi et al. (2001). The United States on the other hand seems to have solved the free-rider problem among its states[1]. The central government has enacted a system of fiscal transfers and central tax raising powers that have reduced the scope for local or state governments to run large deficits. If a US state suffers a loss in tax revenue, such as happened in Mississippi due to the hurricane, then it pays less to the federal bank, while transfers from the federal bank to the affected state are put in place to allow the state to invest in infrastructure projects, which stimulates recovery in the local state. There is no

[1] Orange County tried unsuccessfully to get California to bail it out in the 1990s. Its subsequent bankruptcy caused financial losses to investors which led to contagion in the US municipal bond market (Halstead, Hedge, and Klein 2004).

such mechanism in place within EMU that would allow transfers from the central government to individual states in such cases.

Beetsma, Debrun and Klaassen (2001) investigated how the impact of policy coordination could work in the EMU and its potential benefits and drawbacks. There is extensive literature on the benefits from international cooperation in setting fiscal policy. This literature shows that cooperation is advantageous if a country's fiscal policy affects world prices and real interest rates. (For details on this result, see the work of Chari and Kehoe (1990) and Canzoneri and Diba (1991)). The kind of desirable cooperation that this literature points to applies to the relationship between for example, Germany and Canada as well as to that between Germany and Italy; however, it is not especially related to countries being in a monetary union.

Uhlig (2002) focuses his discussion of free-riding in the Eurozone on the effects of centralised monetary policy combined with decentralized fiscal policy. He regards the SGP as essential in avoiding free riding in the form of excessively high deficits in member states. Excessive levels of debt might lead to a crisis, in which the ECB might be morally, although not legally, bound to bail out insolvent countries. The aim of the European Central Bank.(ECB) is to maintain price stability and this may require assisting a sovereign who is having problems meeting its commitments. Therefore a sizeable proportion of the literature studies how policymakers could reform or even eliminate the need for the SGP under certain conditions (Fourçans and Warin, 2000; Leith and Wren-Lewis, 2002; Vranceanu and Warin, 2001). However, this should be balanced with another strand which employs moral hazard or "post-contractual opportunism" approach: where once a country has joined EMU, even if it was not a free-rider before, it may become one (Dixit, 2001; Dixit and Lambertini, 2001), notably if one country already contravenes the SGP (De Haan, Berger and Jansen, 2003).

2.3 Market Discipline in the Euro Debt Markets

The potential effect of public debt on sovereign bond yields is an important issue for policy makers and economists. If sovereign bond yields include risk premia, increasing indebtedness may cause bond yields to increase, raising the cost of borrowing and imposing discipline on governments. It is obvious that certain preconditions must be satisfied for markets to properly discipline fiscally profligate states in a monetary union: markets must be open, information easily available and the sovereign borrowers must be able to react to their rising debt costs before access to market is barred. There must be no expectation of bailouts or additional intervention with the market process (Lane, 1993). Increased financial market integration can be expected to improve the first two conditions, even with debt market deficiencies as highlighted by the behavioural finance literature, rational bubbles and moral hazard within the banking system.[2]

According to Lane (2003) monetary unions have the ability to strengthen the fiscal discipline of its members. In addition the few studies on sovereign borrower responses to changes in the cost of debt (Bayoumi, Goldstein and Woglom, 1995, or Heinemann and Winsche, 2001) find evidence of bond markets ability to restrain excessive accumulation of debt by sovereigns. However, a number of studies have raised the possibility that bond market participants may react in a non-linear fashion (Ardagna, Caselli and Lane, 2004), reacting slowly to rising debt initially and eventually refusing to hold the debt at any price. An example of these are the "Bond Vigilantes" of the 1970s in the UK and the "Gilt Strikes" which saw investors refuse to purchase UK debt when inflation reached 20%.

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[2] In this respect, the case of the New York debt crisis of the 1970s could be used by some Maastricht criteria proponents as an example of slow and abrupt reactions of capital markets vis-a-vis a fiscal authority inside a currency union. However, the reaction of capital markets at that time can also be considered to have worked properly (Fuest, 1993, pp.134-135). In a more recent paper, Cohen and Portes (2004) see problems of market discipline in the case of confidence crises, but they do not differentiate between fixed and flexible exchange rate regimes.

Market discipline of this kind may be especially relevant and important in a monetary union, such as the US or the EMU, in which the governments of the member states can issue debt, but do not have the possibility to monetize and inflate away excessive debts. A monetary union would only be able to prevent capital markets from demanding higher risk premiums for higher debt if the efficiency of the exchange rate market is not replicated by the market for debt. This may be because a flexible exchange rate was able to react faster and in a more appropriate way than sovereign risk premium. Since exchange rates tend to be more volatile than their underlying factors, this could mean an exponential political cost of fiscal instability instead of more linear cost development for sovereign debt interest rates in a monetary union or a fixed exchange rate regime (similar to the thinking by Tornell and Velasco, 1995 and 1998). However, exchange rates are subject to many influences and even countries with prudent fiscal policies may see their exchange rate come under pressure, reducing the effectiveness of exchange rate movements to penalise profligate governments.[3]

Lane (1993) also stresses the importance of governments' sensitivity to market signals, that is whether, by how much and how quickly do sovereign borrowers respond to market incentives. Policy-makers' reaction time may be excessively long if they have short time horizons. The debt structure also contributes to it. While the increase in yields on new bonds may immediately signal market's reaction to excessive borrowing, the burden on the budget may increase slowly if most of the debt is made of long-term bonds. In the case of Italy, which is the country where - due to the relatively short duration of debt and to its high level - the impact of a change in interest rates is strongest, a 1 percentage point increase in the interest rate on all maturities will only induce an increase in interest

[3] So-called models of second and third generation for the explanation of currency crises point in this direction, including contagion effects that originate, in this case, outside the monetary union countries. See Pesenti and Tille (2000) for an overview.

expenditure of 0.2 percentage points of GDP in the first year and 0.5 in the second year, while it will take many years for the rise to exert its full impact.

The issue of free-riding was considered so important in the context of EMU that the European Commission under the leadership of Jacques Delors set out to investigate mechanisms that could be implemented to reduce its negative impact. The conclusions were published in 1989 and became known as the Delors report, which eventually led to the creation of the Stability and Growth Pact. They noted that while markets can exert fiscal discipline on irresponsible governments, the "constraints imposed by market forces might either be too slow and weak or too sudden and disruptive" (Committee for the Study of Economic and Monetary Union, 1989, p. 24). The report concluded that those countries that joined the EMU should accept some constraints on their fiscal policy. Also Lamfalussy (1989) raised his concerns that closer economic integration could increase expectations that a country which is having difficulty meeting its financial obligations would look for assistance from other members and in effect be "bailed out" from meeting its responsibilities. He notes that sovereigns are not subject to the same market discipline constraints as companies in the bond market. The European Commission (1990) took a comparable view and concluded that formal rules and procedures were required. From this the Stability and Growth Pact (SGP) was developed to prevent countries from free-riding, and to ensure sustainable public finances and to stop countries running high deficits and debts that would negatively impact all members in the monetary union. However, the pact has proved to be unenforceable which must lead us to the view that there is the real possibility that free-riding now plays a significant role in fiscal policy and the risk premium in euro bond yields as predicted by Lamfalussy.

2.4 Moral Hazard

Moral hazard is the possibility that a party protected from risk may behave differently from the way it would behave if it were fully exposed to that risk, Dembe and Boden (2000). In the European bond market this may play a significant role if indebted governments come to expect bail-outs by other euro member governments of the European Central Bank (ECB). This may encourage unsustainable borrowing in the future, if those that take the risks come to believe that they will not have to carry the full burden of losses. Credibly ruling out the prospect of a bailout may prove to be the "Achilles' heel" of market discipline (Lane, 1993, p. 83). Presently, the probability of a bail-out by fiscal transfers is low due to the absolute prevention of such help in the EU treaties. But there remains the possibility of a bailout by the ECB until a government is actually allowed to default. Bond markets will reflect this possibility in their sovereign interest rate premium, which would lower the risk of default. The problem is that, similar to the moral hazard of financial systems, the default of one union member (especially if it is one of the larger ones) may cause such a high macroeconomic instability for the whole union that even an independent central bank, due to its commitment to price stability, will have to trigger a bailout (Kamin, 2002).

How exactly could such a scenario play out?[4] Assuming the largest national debtor in EMU, the Italian government, decided to default on its debt (for simplicity, the assumption here is that it totally defaults which may be quite unrealistic since tax income can be expected to meet at least part of the interest rate liabilities). The economic agents immediately affected would be the holders of Italian government bonds (private or institutional investors like pension funds) who have to write off these assets as loss. This

[4] Eichengreen and Wyplosz (1998, pp. 78-83) try to simulate a debt run scenario for EMU and use Scandinavian government reaction to drops in house prices in the late 1980s and early 1990s as a proxy for the sensitivity of public authorities to strain on bank's balance sheets. They conclude that such dangers would likely only be relevant for banking

may cause problems for them to meet their own liabilities, possibly triggering a strain on the overall financial system.[5] As we have seen recently with the sub-prime crisis, the political pressure to stabilize the financial institutions and stop the financial strain transferring to the broader economy means that moral hazard implications can be ignored, at least in the short-run (Weiner 2007).

Returning to the bond market, we can see that moral hazard is almost taken for granted. The fact that sovereigns control the supply of bond issues, and through financial regulations control the demand for these securities by ensuring pension, insurance and investment companies hold a large percentage of their assets in government bonds demonstrates the degree of control the sovereigns have over this market, (Di Giorgio and Di Noia 2001). This combined with the fact that governments are also the de-facto regulators of the secondary markets as can be seen from the experience of Citigroup (Chapter 6.4.1) means that moral hazard is intimately interwoven within the very fabric of the bond market. The fact that there is not a library full of books written on the subject demonstrates how closed the market is in reality, and how little protection is perceived to be required by investors. This is not because the risk is not real, but the risk manifests itself through the currency markets rather than the bond market, as governments prefer to print more money than default on their bonds[6]. Historically, the subsequent currency devaluation has a disproportionate impact on foreign investors when compared to domestic debt holders. The eurozone is unique in this respect, the fact that the sovereigns cannot print money means that they cannot monetise their debts away, yet

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systems in Spain and Italy, and cast doubt on contagion effects for the rest of the monetary union.

[5] A recent example of such an anticipated domino effect and subsequent central bank bailout is the LTCM debacle in the US in September 1998 that was countered by the US Fed with direct liquidity support for LTCM and interest rate cuts.

[6] Corsetti, Pesenti, and Roubini (1999) look to explain the Asian crisis as due to moral hazard-induced over-investment, large current account deficits and excessive external borrowing. Lane and Phillips (2000), e.g., demonstrates in an event study that IMF lending could contribute to moral hazard. Dell'Ariccia, Schnabel, and Zettelmeyer (2006) supply

also the increasing level of debt may not affect the currency immediately, especially if other governments are reducing their overall debt levels.

Much of the academic literature on moral hazard that is of relevance to my research relates to federal states such as the USA. However, the moral hazard problem there is negligible as bail-outs are very rare. This absence of bail-out expectations could explain why there is a clearer relationship between fiscal variables and interest rate premia in US states and municipalities compared to OECD sample values[7]. Most literature on moral hazard within EMU continues in the same vein, investigating how interest rate premia change with respect to fiscal policy. A number of studies provide evidence of a structural break with the beginning of EMU (Bernoth, von Hagen, and Schuknecht (2004), Heppke-Falk and Hufner (2004), Bernoth and Wolff (2006))[8]. However, the results do not allow any conclusion on bail-out expectations since the introduction of the euro was anticipated and coincided with a number of institutional changes, e.g., of budgetary institutions (Hallerberg and Wolff 2006).

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empirical evidence for declining investor moral hazard after the unexpected non-bail-out in the Russian crisis of 1998.

[7] This may result from the greater labor and capital mobility in US states, which reduce states' tax capacities. For a survey table see Lemmen (1999). Further studies on this topic are, e.g., Capeci (1991, 1994), Bayoumi, Goldstein, and Woglom (1995).

[8] However Codogno, Favero, and Missale (2003) deny a structural break.

2.5 Sovereign Debt – Incentives and Penalties

The study of sovereign debt can be divided between theoretical analysis and empirical research. In the former category a lot of studies utilize game theory analysis and optimisation techniques in order to determine the incentives of sovereigns to issue bonds and service their debt, as well as the incentives of their creditors to provide the capital. Eaton and Gersovitz (1981) stress that the analysis of these financial transactions are made very complicated by the fact that default and bankruptcy are possible strategies. For them, wholesale borrowing by foreign governments in international capital markets creates a requirement for the literature of borrowing in domestic markets to be expanded. The main feature that international lending models must incorporate is that there are no explicit international mechanisms to obstruct a government from repudiating its debt. It also assumes that borrowers are intrinsically dishonest and will not fulfil their obligations if it is not to their benefit. Eaton, Gersovitz and Stiglitz (1986) in their research discuss why insolvency is neither a sufficient nor a necessary condition for the announcement of default, since the debt of a country is normally less than the value of the assets of the government and the citizens of the country. The conclusion to their research states that even if adverse selection and moral hazard can explain a certain amount of the behaviour, what is really important is to understand the incentives. I utilize their idea in chapter 4.7 to show that free-riding is a real possibility within the bond market. I show that within the euro bond market, sovereign debt levels and GDP per capita, gives a better explanation of the yield spread than debt/GDP levels alone.

A number of studies have been carried out in order to better understand these incentives. Eaton and Gersovitz (1981) model the benefits from defaulting against the costs to the growth rate volatility inside the country. Allen (1983) tried to model why in credit markets borrowers can be restricted in the amount they borrow. His explanation is that in comparison to other markets, the time between the transfer of capital and its subsequent

repayment increases the risk to the lender but not the borrower. The borrower can decide not to pay if the venture in which the borrowed money was invested is unsuccessful or indeed if the borrower simply decides he no longer wants to meet his obligations. His conclusion is similar to Bulow and Rogoff (1989a, 1989b) in that contracts are only enforceable if the current payment of the borrower is less than the value of future access to the capital markets (sometimes referred to as reputation costs) and the potential for retaliatory actions by the lender by way of sanctions and trade barriers. Therefore failure of a sovereign to fulfil its debt-servicing obligations in agreement with contracts is a last resort in emerging markets.

However, on occasion an event occurs where a sovereign is no longer in the position to continue meeting its debt servicing obligations and the level of debt becomes unsustainable. This can occur because of changes in circumstances (a sharp and unanticipated permanent drop in the price of a key export, oil for example) or for other reasons. Eaton and Gersowitz (1981a) develop an intertemporal competitive equilibrium model of sovereign debt.[9] Under the assumption of non-stochastic output they demonstrate that there exists an equilibrium in which a borrower who needs to borrow repeatedly optimises by repaying in periods of high income and borrows in periods of low income. The borrower chooses to repay because the future cost of being excluded from Capital markets is higher than the short term benefit defaulting. Kletzer and Wright (2000) expand on this by using an infinitely repeated game to model borrowing and lending as an intertemporal barter without external enforcement of commitments. The relationship provides sufficient incentives for all parties to cooperate and provides adequate punishments for any agent who deviates. In their model, reputational risk alone can sustain intertemporal exchange with lending.

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[9] Eaton and Gersowitz allow for additional penalties as well as an embargo on future borrowing. Reputation-based models, such as Grossman and Van Huyck (1998) rule out the existence of direct sanctions.

In a model which explores the need for penalties other than cancellation of future lending, Bulow and Rogoff (1989b) consider a small repeating borrower who produces a single good while subject to random shocks to output. They demonstrate that in any sequential equilibrium with perfect information, a lender will refuse to lend under a pure reputation contract. Their critical assumption being that the sovereign has the ability to smooth its output shocks with cash-in-advance contracts. Therefore in a reputation based model, the sovereign will inevitably decide to default in the future because increased saving (with the help of cash-in-advance contracts) allow him to hedge the country's future stochastic output as well as loss of access to further lending. Lenders will therefore refuse to lend in equilibrium. The introduction of additional penalties, e.g. economic and political sanctions, are thus a necessity in order to achieve a positive-lending equilibrium. Bulow and Rogoff (1989a) show that the threat of economic and political sanctions will enforce a debt contract with positive lending and ensure constant servicing of the debt. Bulow and Rogoff also show that in equilibrium, bargaining will produce an efficient outcome. The renegotiated debt servicing will fall in one of three zones: (1) the sovereign will repay a fraction of total output which is equal to the minimum of the sovereign's gains from trade, (2) the cost of the sanctions to the sovereign and (3) the bargained debt servicing. In their model, lending is positive but may lie well below the present value of feasible debt servicing, i.e. there is credit rationing.

The history of sovereign debt shows us that partial debt renegotiations are the rule rather than the exception. Yield premium on sovereign debt issued by a sovereign with a high debt/GDP ratio tend to be higher (see Edwards (1984)). Yield premium on sovereign debt issued by a sovereign with significant exports are lower (see Edwards (1984) and Cantor and Packer (1996)), I investigate a number of these issues in respect to the euro-zone bond market in chapter 4 and find my results consistent with the above authors.

Recent empirical literature has revealed examples which support both reputation and sanctions as important arguments. In his analysis of American states defaulting during the 1840's, English (1996) shows that even though eight States defaulted between 1841 and 1843, most of them (17 of the states), chose not to do so despite the fact that creditors could not enforce payments by imposing military or trade sanctions during that time period. Therefore, English concludes that the history of defaults of individual states in the USA is consistent with reputational models which regard the cost of default as the loss of future access to international credit markets.

Compared to sovereign debt there is a vast literature on corporate debt. This is mainly because in comparison to the sovereign market, there is much greater flexibility in the corporate bond market. One of the most important differences between the two is a sovereign's lack of transferable collateral (Eichengreen and Portes 1995; Cohen and Portes, 2003). Another difference, and what is important in the context of this research is the managing of the debt, while the management of the firm can be easily changed, that of a sovereign government is not an option. Therefore sovereigns with a long history of prudence and good financial management will be seen as a much lower risk than sovereigns with dubious records or unstable governments. If investors perception of a sovereign's risk increases, the yield required by investors to hold the debt will increase which raises the debt service burden on the issuer. This vicious spiral has the ability of provoking a debt crisis. This may happen if the fundamentals out of which a country can service its debt depend partly on its ability to get lenders to roll-over its old debt into new issues, similar to Italy. Self-fulfilling debt crises are a phenomenon whose theoretical rationale has been explored in the literature (Calvo, 1988; Cole and Kehoe, 1996, 2000). Any mechanism that is geared towards maintaining *ex-post* efficiency of debt workouts is then bound to reduce the risk of a confidence crisis. In particular, a mechanism which guarantees an efficient debt write-off *ex-post* can eliminate the risk of a confidence crisis

(Cohen, 2003). This is one of the key advantages of an orderly workout mechanism: by guaranteeing that *ex-post* resolution of the crisis is efficient, it deters the emergence of ex-ante confidence crises.

2.6 The Economics behind the Bond Market

Interest rates on bonds are determined in the financial markets by the demand for, and supply of capital funds.[10] Eventually, the propensity to save determines the supply of loanable funds (demand for bonds), and the productivity of capital determines the demand for funds (or the supply of bonds). In the specific instance of the government bond market, however, the supply of bonds results from the government's fiscal position.[11] Sovereigns finance their spending and investment by taxing their citizens or borrowing from investors by issuing debt. The amount of debt issued (i.e., the demand for funds or supply of bonds) depends on the sovereigns financing needs; i.e., the difference between their tax revenues and expenditures. The effect on interest rates of changes in a sovereign's fiscal position depends on the assumptions made regarding the consumption level of citizens and the savings decisions of investors. In the economic literature there are three main schools of thought concerning the economic effects of government fiscal positions (Bernheim 1989): the Neoclassical, Keynesian, and Ricardian paradigms. The central issues among these schools of thought are whether investors are far-sighted and whether they consider government bonds as wealth.

In the Neoclassical paradigm consumers are assumed to be far-sighted and plan the rate of consumption over their entire lifetime (i.e., individuals having finite life spans). In this framework, an increase in the government's budget deficit would shift tax liabilities

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[10] The equilibrium interest rate is the price where savings and investment schedules in the economy intersect. This equilibrium corresponds to an economy operating at full capacity with stable inflation. For small open economies this requires the exchange rate be in equilibrium also.

[11] This does not preclude public spending on productive investment projects.

onto future generations, raising the lifetime consumption of individuals of the current generation (Diamond 1965). In a closed economy with full employment, the incentive to aggregate demand generates higher interest rates and forces out private investment. In an open economy, the expanded budget deficit will eventually impact the exchange rate and therefore net exports. In a small open economy (where the world interest rate is dominant), all the adjustment occurs through net exports.

According to the Keynesian framework a significant number of citizens are myopic or liquidity-constrained and it assumes the economy begins in a position of underemployment.. They will ignore future increases in tax which are necessary to finance a rise in government expenditure. In this framework, an increase in the sovereign's budget deficit leads to a proportionate increase in nominal income and aggregate demand. Because of the increase in nominal GDP, aggregate national savings may or may not decline so the impact on interest rates is unclear. In both paradigms, an exogenous change in the fiscal position shifts the investment/savings (IS) curve, since economic agents consider sovereign bonds to be wealth, thereby affecting the interest rate. While self-equilibrating forces and the full-employment assumption return the economy to its equilibrium state in the neoclassical model, a fiscal shock could have a permanent impact in the Keynesian framework if the shock occurs in a position of underemployment.

In the modern Ricardian paradigm, rational and far-sighted individuals appreciate that government spending must be paid for either now or in the future (Barro 1974). Government expenditure (or dissaving) will be compensated by increased household saving in expectation of future tax liabilities.[12] Ricardian equivalence, however requires

[12] An increase in the deficit which reflects additional public spending on profitable investment projects would not be expected to require further taxes later and thus should not extract a private saving response.

a number of rigorous assumptions, including infinite foresight and the absence of liquidity constraints. Moreover, to achieve infinite foresight with finite lived individuals it must be assumed that successive generations are connected by a purely altruistic bequest motive, with the implication that consumption will be determined as a function of dynastic resources (i.e. total resources of an individual and all of their descendants), unaffected by the timing of taxes (Bernheim 1987, 1989).[13]

2.7 EMU Bond Market

Sovereign bond markets play an important role in the financial system, governments and central banks, can use the secondary bond market to gather information on how participants are assessing inflation and output outlook from pricing in these markets. Financial Institutions use these securities as a risk-free investment asset[14], as a benchmark for pricing corporate fixed-income securities, as collateral and for hedging interest rate risks. The Euro bond market fulfils all these requirements for the eurozone area and allows us to compare yields between issuers. Yield spreads offer us a simple measure of the bond market's assessment of the risk of default and the degree of financial integration among EMU member States. Hence, research on the determinants of yield spreads will allow us insight into a number of issues. The first issue being why has the risk of default decreased since Monetary Union when countries have lost, with monetary independence, the option of printing money to pay their debts? Secondly, has the convergence of yield spreads resulted because market participants have come to believe that the ECB and other euro-area members will bail-out a sovereign who may default?

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[13] This dynastic view of the family assumes that each family is an infinitely lived unit; this differs considerably from the neoclassical model and the life-cycle model which assumes finite lifetimes. Other intertemporal models combine the infinite horizon approach with a constant probability of death, no bequests, and a positive birth rate (Yaari 1965, Blanchard 1985, Buiter 1988). These latter models imply that government deficits/surpluses are largely, but not completely offset by private saving.

[14] Harris (2003) estimates that government bonds account for 10% of U.S. capital wealth; while common stocks represent 20%.

Thirdly, do yield spreads capture the degree of financial integration and if so, how quickly does risk flow from one sovereign to another?

2.7.1 The Convergence of Yields within the Euro Bond Market

This section provides a review of selected literature on yield convergence within the Euro bond market. The forces that drive convergence can be found to stem from domestic, regional and global economic trends and policies. On the global scale, the fact that the main economic centres, US, Japan and Europe all had historical low levels of nominal interest rates combined with the benefits of globalisation, especially low imported inflation from Emerging countries have meant that yields have converged globally. This combined with the removal of capital controls and advances in information technology are widely cited in the literature as contributing factors to interest rate convergence.[15] Within the eurozone region, the primary factor driving yield convergence was the introduction of the single currency and the transfer of power from the national central banks to the ECB of setting interest rates. The ECB (2003b) itself, pointed to significant convergence in the long-term bond yields of the sovereigns that adopted the euro in January 1999. They conclude that the convergence was driven by expectations of the euro adoption and by the subsequent elimination of the exchange rate risk.

However according to the literature, the removal of exchange risk alone could not justify the degree of convergence of bond yields. Instead the creation of the SGP and the restrictions placed on governments to ensure prudent fiscal management also played a significant role. Côté and Graham (2004) show that following the adoption of the Maastricht Treaty the exchange risk premium declined gradually and was essentially

removed by the time the euro was introduced in January 1999. Their empirical evidence displays that prior to the creation of the euro, EMU member states bond yields had converged to that of Germany, its largest member. As demonstrated by Bernoth *et al.* (2004), the debt/GDP and deficit indicators explain the difference in yields or yield spreads in long-term interest rate risk between EU Member States. They state that the divergence in budgetary positions and debt levels explain why yields have not converged further. They also state that the yield spread can be directly linked to the default risk premium, which in turn is reflected in the sovereigns credit rating. This research is consistent with Gjersem (2003) who also highlighted the importance of eliminating exchange rate risk. He credits yield convergence to the fiscal rules laid out in the SGP and their continuous monitoring. This ultimately leads to the convergence of credit ratings to the highest level. The improved fiscal discipline enforced by the SGP and requirements for membership of the euro currency drove convergence of bond yields to historical lows. He ascribes the remaining yield spreads to differences in credit ratings, liquidity and issuance techniques in the primary market.

Pagano and von Thadden (2004) confirm Gjersems' conclusion that sovereign bonds are still not perfect substitutes although yields have converged significantly in the transition to EMU. Their explanation is that the remaining yield differentials reveal small disparities in fundamental risk. Bernoth, Von Hagen and Schuknecht (March 2004) show that the yield differential corresponds to levels of government indebtedness both before and after the start of EMU. Danthine *et al.* (2001) suggest that the segmentation of the bond market by the sovereign generates liquidity risk in the smaller markets which in turns accounts for yield differentials between similar sovereign issues. Hartmann *et al.* (2003) concur that the euro bond market is still segmented, since the pricing of sovereign

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[15] Grimes (1994) finds that New Zealand's bond yields are considerably driven by foreign yields, in addition to domestic short-term interest rates and the ratio of foreign debt to GDP.

bonds with the same credit rating have not fully converged. Bernoth, Von Hagen and Schuknecht, in their revised paper (March 2006) conclude "In the euro-denominated debt market, however, these liquidity risk premiums have vanished with the start of EMU." We will explore the yield differential further in the next section.

The topic of fiscal convergence was intensely researched before the creation of the SGP, and a number of these studies investigated how long-term bond yields adjust to budgetary conditions are mentioned here. Orr, Edey, and Kennedy (1995) for example, examine a sample of seventeen OECD industrialized countries and found that the rate of return on capital, and government deficits relative to GDP were important variables in determining the trend in real long-term interest rates. Their panel error-correction model results suggested that a 1% point deterioration in the fiscal position may raise long term interest rates by around 15 basis points. Knot and de Haan's (1995) results, based on five European countries, suggest an even greater effect, in the order of 40 to 60 basis points on the long-term yield. Established on a loanable-funds equilibrium approach, Correia-Nunes and Stemitsiotis (1995) find sound empirical support for their hypothesis of a positive relationship between nominal long-term interest rates and budget deficits for ten OECD countries after accounting for public debt, short term interest rates, expected inflation and real GDP growth. Their country-by-country findings show that a 1% point deterioration in the fiscal position could raise long-term interest rates by between 25 to 30 basis points in Ireland, Belgium and Germany, and in the region of 55 basis points in France and the Netherlands.

2.7.2 Yield Spreads; the role of Credit and Liquidity

The elimination of exchange rate risk within the eurozone removed the most important source of yield differences between sovereign bonds, Blanco (2002). The residual disparity according to the bulk of the literature can be accounted for by Credit and Liquidity risk. Bernoth, Hagen and Schuknecht (2003) state that *"the main analytical problem is whether these interest differentials can be explained by default risk and/or liquidity risk premium."* The Credit Rating Agencies have assigned a range of ratings to the Euro members from AAA/Aaa status in Germany, France, Finland, Austria, Ireland and the Netherlands, AA+/Aa1 for Belgium and Spain, AA/Aa2 for Portugal and Italy and A+/A1 for Greek bonds which correspond directly to their probability of default. While Euro sovereigns have never actually defaulted, the range of ratings show that some issuers have a higher probability than others and this must be accounted for in the yield.

The importance of credit spreads in explaining the yield differential have been demonstrated by Codogno, Favero and Missale (2003). They note that "*the risk of default is a small but important component of yield differentials."* and "*liquidity factors play a smaller role".* They downgrade the role of liquidity and lack of uniformity of bond issuance in explaining yield differentials. They demonstrate that further fiscal convergence and especially in debt-to-GDP ratios, is required before a reduction in yield differentials would occur in the euro area.[16] This contradicts Blanco (2001), who finds significant liquidity premium in the relative pricing of German bonds. "The fact that German government bond yields are still below those of bonds issued by governments with much better debt positions has been interpreted as showing that bond yields do not reflect fiscal performance appropriately" (Reuters, June 2002). I will show in my research, how the nature of liquidity has changed since the creation of the bond market

(Chapter 5.6) to the present day and therefore both authors are correct, but only for the specific time period that they researched.

Favero, Pagano and von Thadden (2004) are amongst the few researchers who expand the scope of the current research to look outside the traditional credit/liquidity considerations in explaining yield differentials to investigate the importance of using the Eurex futures to hedge interest rate risk: "...bonds traded in the cash market are not considered as a perfect hedge for position in the bund future." The fact that non-German bonds are hedged using a German future means that market participants must take into account credit and liquidity considerations as well as the usual Basis risk when managing their positions. This inefficiency in the euro bond market, due to the imperfect hedge, has important implications for policy makers who wish to make the market more open and transparent. I will discuss this further in Chapter 6.4.1 where Citigroup tried exploit this inefficiency and demonstrated among other issues the close integration of the bond market.

At the core of my research is the hypothesis that the importance of liquidity risk has diminished over time due to a number of issues that have put in place by the issuers and markets, such as the creation of the EuroMTS exchange and the subsequent introduction of the "Liquidity Pact" between issuers and bond dealers. It is noticeable in the literature at the total lack of interest by researchers of the fundamental changes that have taken place in the structural and practical operations of the bond market and how these have affected the yield differential. There is almost no mention of the "Liquidity Pact" and their agreements to quote 2-way prices for 5 hours every trading day, with Bid/Ask spreads that are defined by the sovereigns themselves. Also the separation of liquidity

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[16] Their view contrasts with the widespread assumptions of both market participants and policymakers that the usual liquidity indicators, bid-ask spreads, trading volumes, and outstanding amounts explain a sizeable part of yield differentials since the EMU inception.

between the inter-dealer market and the dealer-to-client market is never mentioned in any paper. According to research carried out by Gómez-Puig (2003) they conclude that liquidity, measured by bid-ask spreads, plays an important role in explaining the yield differential. From their research you get the understanding the bid-ask spreads are developed by an organic process in the market between buyers and sellers, while the facts are that these spreads are forced on the dealers every month by the issuers, so that the dealers fulfil their "Liquidity Pact" obligations and get preferential access to the Issuers Primary bond market.

I do not state in my research that liquidity risk is unimportant; however, like inflation, once it is contained then one can focus on other risks. Liquidity risk therefore depends on the frame of reference as to its impact, and is a multi-faceted concept as I discuss further in Chapter 6. A clear understanding of Liquidity risk is important in terms of my research as I focus on the Credit aspect of the yield differential and look to explain any deviation from the point of view of Free Riding, whereas every other academic paper states that this deviation is because of liquidity risk. From the literature we see that there are three mains schools of thinking to explain why liquidity should be priced by financial markets; Illiquidity (i) creates trading costs, (ii) can itself create additional risk, and (iii) it can interact with fundamental risk. The "trading cost view" maintains that illiquid securities must offer investors a higher return to offset their larger transaction costs. This observation that was first proposed and tested by Amihud and Mendelson (1986), has been the foundation of a extensive empirical literature. Subsequent research on stock markets confirmed this view of an important relationship between liquidity and returns: among these, Brennan and Subrahmanyam (1996), Datar, and Eleswarapu (1997), Naik and Radcliffe (1998), Chordia, Roll and Subrahmanyam (2000). Amihud and Mendelson (1991) expanded their research to look at the liquidity effects on fixed-income security markets (US Treasury market), and found similar results with the less liquid treasury

notes with a maturity of six months or less exceeding the yield to maturity on the more liquid treasury bills. Later research by Warga (1992), Daves and Ehrhardt (1993), Kamara (1994) and Krishnamurthy (2000) all agreed with their results, however Strebulaev (2001) found that the difference in yields between notes and bills is less than previously assumed, particularly when bills are on-the-run. An interesting piece of research carried out recently by Goldreich, Hanke and Nath (2002) found that the liquidity premium depended on the expected future liquidity of the security rather than its current liquidity. This could easily be translated to the Euro bond market, as dealers expect issues to be liquid in the future due to the "Liquidity Pact", thus the premium on liquidity will diminish.

The second component of the "liquidity risk view" focuses on the variability of the liquidity risk over time and its unpredictable nature. Liquidity risk can be an integral part of the fundamental risk of the overall security. This means during periods of financial stress, where previous liquid securities are having to be re-priced because of changing investor sentiment, securities can become illiquid which in turn raises the costs of trading and increases the fundamental risks further. Acharya and Pedersen (2004) demonstrate using a CAPM framework that liquidity risk should be priced in correlation with asset fundamentals. Ellul and Pagano (2004) illustrate that the initial under valuing of IPO shares compensate investors for the liquidity risk they are exposed to in after-market trading. Gallmeyer, Hollifield and Seppi (2004) create a model of liquidity risk where traders possess asymmetric information about future liquidity, so the less knowledgeable traders try to learn from the current amount of trading volume how much available liquidity there could be in the future. They conclude that the current liquidity risk is a predictor of future liquidity risk, and is therefore already priced. In the context of the euro bond market, this 2nd component can be seen to be addressed by the Delors committee which noted that the stresses that could be brought to bear on the financial

markets may be ".....too sudden and disruptive" if left to themselves, and was further justification for the creation of the Liquidity Pact by the sovereigns.

The third aspect of the "liquidity risk view" shows that liquidity risk may affect changes in the fundamental risk of the security itself. Changes to fundamental risk are shown to have less of an influence on prices of bonds which are currently illiquid, but has greater influence on prices for bonds which are expected to become illiquid in the future. Vayanos (2004) created a model where fund managers who face investors withdrawing their funds when their performance falls below a threshold value are more likely to liquidate their positions at times of high volatility. This raises the liquidity premium of investors at times of high market volatility and generates a flight to liquidity. In the Euro bill market Biais, Renucci and Saint-Paul (2004) found that when volatility is high, yields are lower for bills with a larger outstanding supply which are likely to be the most liquid. Gravelle (1999) finds that the correlation between bid-ask spreads (one measure of liquidity, for a fuller discussion see chapter 7.3) and the total supply of debt is negative. He concludes that total volume of supply will have a positive effect on its liquidity risk. From this, he suggests that liquidity depends on market size and that all debt issued by a sovereign is homogeneous. Therefore, the liquidity premium is assumed to be proportional to the ratio of the debt issued by a government. This view is widespread throughout the academic literature on the Euro bond market, and is often backed up by statistics on trading activity, where Italian and German securities are among the largest in the world. Cheung, de Jong and Rindi (2004) provide some information about the trading activity on the MTS trading system which is the largest interdealer trading platform for European government bonds. They find that some 85% of all trading activity in the running 10-year bonds stems from trading in Italian BTP securities. Throughout Chapter 4, I contrast my hypothesis and results to those of

Gravelle and show that his simple measure of debt/GDP is no longer sophisticated enough to model either liquidity risk or explain the yield differentials.

2.7.3 Integration Models of European Bond Markets

The theory of financial market integration is central to international finance and it is clear that financial market integration changes with economic conditions. The explanation that is generally supplied in economic textbooks is that the degree of risk aversion of investors changes with time and events and they require in turn a varying return for holding risky financial assets. Therefore, most research has allowed integration to vary over time and with events, see for example, Bekaert and Harvey, (1995), Aggarwal et al., (2003) and Barr and Priestley (2003). Ilmanen (1995) presented one of the first estimations on time-varying returns with an asset pricing model. Christiansen (2003) used the AR-GARCH model of Bekaert, Harvey and Ng (2003) to investigate volatility spill-over in European bond markets. She supplies empirical evidence that shows regional effects have become dominant over both own country and global effects in EU markets since the introduction of the single currency. Driessen, Melenberg and Nijman (2003) also find that economic convergence necessary for EU membership has predictably led to high degree of bond market convergence. However, according to Kim, Lucey and Wu (2004) "to date there is little evidence of the extent, still less the dynamics, of European bond market integration". In chapter 6 and 7, I have researched the dynamics of the Euro bond market in great detail and my findings are in agreement with those authors mentioned previously. However, I go much further in my research than simply trying to quantify the degree of integration, but instead try to identify the regional effect as mentioned by Christiansen and its interaction with individual sovereigns in the hope of explaining the dynamics of integration as indicated by Kim, Lucey and Wu.

Renewed academic interest in integration resulted from advances in econometrics and specifically the development of cointegration analysis in the late 1980s by Nobel prize winning economists Robert Engle and Clive Granger. Their method combined short-run dynamics with long-run equilibrium by having an error-correction mechanism return short-run deviations in the series back towards its long-run equilibrium. Many studies in the early 1990s examined the impact of specific events on the interconnections of equity markets using cointegration analysis. While the results are often inconsistent, cointegration itself has implications for asset diversification and the efficient market hypothesis. The concept of asset diversification is credited to Markowitz (1952), and in an international context to Grubel (1968) and encourages investors to diversify their portfolios, thereby reduce their overall risk while keeping their return constant, so long as the markets are not perfectly correlated (mean-variance efficient portfolio). Cointegration implies that there is a common force which brings these markets together in the long-run, and so the possibilities of any gains from diversification may be greatly diminished in the long-run.

If identical assets offer the same returns on different markets, then those markets are said to be completely integrated; the converse is true for segmented markets. It is generally accepted that capital mobility restrictions and foreign entry barriers to markets, in the shape of limits to ownership and taxes on dividends and capital gains, serve to segment markets. Blackman et al. (1994) have found that the stock indices of 18 countries show no evidence of integration for the period 1970-1979, but that there is evidence of integration for the period 1984-1989. The 1984-1989 period of integration coincided with developments in financial deregulation and advances in communications. This has led Blackman et al. (1994) to conclude that, as a result of the abolition of exchange controls, the easing of capital gains tax on foreign investors and developments in global communications, markets have become increasingly integrated. Rogers (1994) has

studied the relationship between entry barriers and price movements in emerging stock markets and has concluded that countries with a greater number of restrictive entry barriers are less responsive to global shocks when compared to countries with fewer restrictions. Othchere and Lamba (2001), using cointegration methodology, find that the South African stock market has become increasingly more integrated with its major trading partners after the fall of Apartheid and the relaxation of entry barriers.

With respect to the efficient market hypothesis, there is the possibility that there is no relationship between market efficiency and cointegration. Initially it was suspected that cointegration between two prices could imply an inefficient market, because an error-correction model would be able to predict at least one of the prices, Granger (1986). However, inefficient markets and predictability are two different topics. Inefficient markets are primarily associated with taking long/short positions in under/overvalued stocks which generate abnormal profits. On the other hand, predictability (particularly with regard to the short term) would imply making an informed decision on the movement of country A's market given innovations in country B's market, both of which are interconnected. Therefore, caution should be exercised when drawing conclusions about whether cointegration implies anything about market efficiency. This view is supported by Dwyer and Wallace (1992), Engle (1996), Masih and Masih (2000), and Darrat and Zhong (2002). A more appropriate method for determining whether markets are efficient is the use of IRFs estimated via a VAR, that measures the lagged response of a market. If two markets are shown to be interdependent, then in an efficient markets hypothesis, there should be no lagged market adjustments long or large enough to exploit. This method is used by Eun and Shim (1989), Rogers (1994) and Chowdhury (1994).

Studies on cointegration among government bond markets in the literature are very rare compared to those on stock markets. Smith (2002) is one of the few studies to have tested for cointegration in international government bond markets. He uses the Johansen and Juselius (1990) techniques on bond index returns and finds a cointegrating vector. Dunne, Moore and Portes (2006) use cointegration to search for the benchmark bond within the euro bond market; While they do not try to explain the reasons for yield differentials, they are the first researchers to use cointegration to explain the dynamics of Euro sovereign yields, thus implicitly accepting that they share a common stochastic force. In chapter 7.5.1 I question their hypothesis that the benchmark security is contained within the bond market and raise instead the hypothesis that the benchmark resides in the Eurex futures market, which is interconnected by basis risk with the EuroMTS bond markets. They also give no theoretical explanation for the common stochastic force, that their cointegrated model implies exists. I propose my hypothesis in chapter 6.4.1 that it is the Euro-wide regional risk that is now the dominant driver of euro yields, and explore the impact that this has for market participants.

The literature is also scant on the time varying nature of bond market integration in EU members, despite this having serious implications for policy making in an enlarged EU. It is vital to consider the time varying nature of financial market integration as economic fundamentals are changing in European economies. Antzoulatos and Vallianatos (2002) wrote one of the few studies that investigated the short-run dynamics of the bond market after its creation. They found a statistically significant undershooting in response to changes in the German yield on the other euro sovereigns which they conclude is due to liquidity risk. Overshooting/undershooting is a characteristic of many economic and financial models; Dornbusch (1976) demonstrates that exchange rates can overshoot in reply to monetary policy changes if there is slow adjustment of price levels. Campbell and Schiller (1991), Hardouvelis (1994) and Sutton (1997, 1998), show that long-term

interest rates overreact to changes in the expected future short rates and this is generally explained by violations of rational expectations (Hardouvelis [1997]). Poteshman (2001), looking at the options markets, shows that investors under react to adjustments in instantaneous variance and overreact during periods of changing variance, and this behaviour is consistent with the Barberis et al.. (1998) assumptions that investors will overreact to information that is preceded by large amounts of similar information. In Chapter 7.5 I re-research the period under investigation by Antzoulatos and Vallianatos, but unlike them I use cointegration analysis. Their regression model could not take account of the correction or return to equilibrium, that the cointegration model so effortlessly incorporates. I compare the speed-of-adjustment of yield spreads between their study and mine for the year 2001 and find very similar results. However, when I run my model again with more recent data up to 2007, I find that the rankings of speed-of-adjustments have changed and are better explained along the lines of default risk rather than liquidity risk. This is further evidence, that the causes of the observed yield differentials have changed over time, which is in agreement with the time-varying nature of integration and investor risk as described in the literature at the start of this section. My results are consistent with Codogno, Favero and Missale (2003) who also highlight the increasing importance of default risk in explaining yield differentials between Euro sovereigns. A general criticism of cointegration studies is that insufficient efforts are made to identify trend(s) and link these to theory. This is one the main achievements of my research, I demonstrate that the entire Euro sovereign bond market is cointegrated, and develop a theory that unifies the reasons behind the stochastic "force" that drives the market, and look at its implications for the bond market.

2.8 Conclusion

One of the primary reasons the Stability and Growth Pact was created, was to prevent some countries from behaving as fiscal free-riders. The SGP has since been weakened by its early supporters, Germany and France and the question now becomes, is there any other process that will prevent such free-riding? The president of the European Central Bank has called on two participants to fulfil this role; these are the bond markets and the Credit Rating Agencies. The review of the literature however shows mixed results; few studies on sovereign borrower reactions to changes in the cost of debt find evidence of capital markets being able to restrain excessive debts by governments. In a free-market economy can investors expect the Credit Rating Agencies to give a fair and objective rating if the state retains the power to negatively influence their interests via regulation and governmental restrictions? The recent investigation by the US senate into the role of the CRAs in the Enron scandal have greatly damaged the reputations of the CRAs and the way the sovereign issuers punished Citigroup in the primary bond market raise the issue of moral hazard within the bond market.

Yield spreads provides a simple measure of the market's assessment of the risk of default and reflect small disparities in fundamental risk. The proof that this risk premium is an effective mechanism in ensuring governments control their fiscal polices is unsubstantiated in the literature. My work is unique in the fact that it looks at the risk component from the point of view of market discipline. Much of the current research assumes that the yield spread can be explained by default and liquidity risk, which ignores the possibility of free-riding that was raised by Lamfalussy. Thus, in this thesis I bring together the literature of Sovereign risk with that of Free-riding, Moral hazard and Market discipline to bring a completely fresh view to this area of research.

3. EMU – One Currency, Many Bond Markets

3.1 Introduction

European Monetary Union (EMU) took over 40 years of intensive economic integration between western European nations, which started with the integration of coal and steel industries in the early 1950s. In 1957, the Treaty of Rome created the European Economic Community (EEC) and the European Atomic Energy Community (Euratom). In 1969 at the Hague summit, the EEC decided to make economic and monetary union (EMU) an official goal of European integration. This culminated in 1993 with the Maastricht Treaty and the creation of what we now call the EU. By this stage the European Community had grown to 12 members, including the recent members of Greece (1981), Spain (1986), and Portugal (1987)[17]. The treaty set out a common system of justice, foreign and security policy, as well as laying out the three steps required for Monetary Union to take place by 1993: (1) capital flows to be completely free within the EU, (2) by 1999, member states joining the euro currency had to satisfy the convergence criteria such that economic policies were coordinated between members, (3) The European Central Bank to be created alongside the official euro currency where member states conversion rates were irrevocably set. In 1995, 3 new members were welcomed to the EU, Austria, Finland and Sweden, bringing to 15 the number of member states[18,19]. At the launch of the euro in 1999, 11 of the 15 EU countries replaced their national currencies with that of the Euro and by 2002, the euro became the sole legal currency.

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[17] The original member states of the EU were Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, and the United Kingdom.

[18] Norway and Switzerland, are members of the European Free Trade Association, but not of the EU.

[19] 10 new European countries joined the EU on 1 May 2004: Poland, Hungary, the Czech Republic, Estonia, Latvia, Lithuania, Slovakia, Slovenia, Cyprus, and Malta. The plan is for these new members to adopt the euro when they satisfy the convergence criteria. Bulgaria and Romania are currently termed "acceding countries" and are expected to join in 2007. Candidate countries for future accession include: Turkey, Macedonia and Croatia; and potential candidate countries include: Albania, Bosnia and Herzegovina, Serbia and Montenegro, and Kosovo.

The countries that did not join in EMU were the United Kingdom, Sweden, Denmark, and Greece (Greece later joined in 2001).

3.2 Political and Monetary Union

While political convergence may have been slowly happening over the previous 40 years, the individual member states economies proved some what less manageable. The fundamental economic variables between member states were too divergent to allow countries such as Italy, Spain and Greece to join the single currency on a strict economic basis. However, as EMU is now more than just an economic community these countries were allowed to join, so long as they continued to work to fulfil the Maastricht criteria. This is a very important issue, because while all members share the same currency and monetary policy, each individual country is permitted to control its own fiscal policy. Therefore, as mentioned previously in the literature review both France and Germany wanted some restrictions on member participants to ensure the currency's stability.

They commissioned Delors to look at this issue and in his report he agreed that countries which joined the EMU needed to accept some constraints on their fiscal policy. He noted that 'Market Discipline' alone could not guarantee the sustainability of member states public finances. His report advised on the need of a co-coordinating pact between the members to deal with the 'free rider' problem and the risk of default. The aim of this pact should be to help member states to control their debt and deficits, while providing stability for the ECB and the market. The implementation of this common monetary policy and the monitoring of the pact required the creation of a number of European institutions as well as the strengthening and deepening of the capital markets. The success of this will be discussed in the following sections.

3.2.1 The Creation of European Institutions

To facilitate closer integration, a number of institutions were created which were empowered to make decisions on behalf of the citizens of Europe on specific matters of joint interest. The decision making process involves three main institutions:

- The European Parliament, which represents the EU's citizens and is directly elected;
- The Council of the European Union, which represents the individual member states;
- The European Commission, which seeks to uphold the interests of the Union as a whole.

These institutions develop the policies and laws which apply throughout the EU. In practice, the European Commission generally proposes a new law and the Parliament and Council will then vote on whether to adopt them. In addition the EU has a number of other organizations that carryout specific roles, e.g. The European Central Bank (ECB) controls monetary policy. Only Governors from those National Central Banks which are part of the Eurozone are responsible for Euro-zone monetary policy decisions.

To become a member of the "Euro Club" certain conditions apply, I will discuss these conditions further in the next section on the Stability and Growth Pact. However, for now it is important to note that the rules of this club are enforced by the European Commission. It decides whether a country has breached the stability pact and recommends actions to correct the problem. If persistent breaches occur, it can recommend fines to the council of European finance ministers, which in theory can be a significant proportion of government revenue. But the reality has proved that it is impossible to get agreement on such large fines which would further damage the country's economy at the exact moment of its difficulty. This has led to calls for reforming the SGP and the creation of a better mechanism to ensure fiscal responsibility, otherwise some members could "free ride" and gain the benefits of membership of the euro currency zone without paying any costs.

The ECB's primary objective is price stability, with economic growth as a secondary objective. The ECB aims to ensure that annual inflation in consumer prices is anchored at less than 2%. It achieves this in two ways, by controlling the money supply and by monitoring price trends and evaluating the risk they pose to price stability. Controlling the money supply involves, amongst other things setting interest rates for the eurozone area. No provision was included in the Maastricht Treaty for the ECB to act as a lender of last resort in the case of financial crisis, nor does the ECB have supervisory powers over European banks; these roles are still maintained by the member's own national central bank. This fact is very important in the context of this research, because it is the lack of a lender of last resort within the Eurozone that is supposed to remove the risk of moral hazard. If any sovereign government gets itself into financial difficulty, it cannot look to the ECB or other members of the Eurozone to come to its assistance.

Another important function of the ECB that is rarely mentioned in the academic literature is that the ECB manages the foreign reserves for the EMU Area. While the members' national central banks manage their own foreign reserves independently, their operations on the foreign exchange market above a certain limit must be approved by the ECB to ensure a consistency on monetary policy between members. The Treaty provides that further transfers of foreign reserve assets from the NCBs to the ECB may take place should the need arise. The ECB has recently updated its criteria on debt instruments that are eligible for such transfers, the debt instrument's rating must be at least "A-" from Standard & Poor's or Fitch Ratings, or "A3" from Moody's. This creates a floor to the quality of instruments that are required to function as collateral between members national central banks. If a member's credit rating dropped below this level, it would no longer be able to substitute its own debt instruments for cash with the ECB and this would be an enormous penalty for that member.

3.2.2 Stability and Growth Pact

First conceived by Theo Waigel in 1995, the Stability and Growth Pact (SGP) was ratified at the Amsterdam Summit (June 1997) by all Member States. The SGP is important for ensuring sustainable public finances and to prevent high debt countries from further expanding their deficits and debts which may adversely affect all members in the monetary union. In a study prepared by the UK Treasury it stated: "If the costs of unsustainable policies fall entirely within the country that carries them out, they need not be the concern of area-wide rules. However, they can have adverse spillovers in a monetary union and become a concern for other countries." Without the corrective mechanisms of devaluations or significantly higher interest rates for national governments with higher debt or deficit ratios, the cost would be carried by all.

To combat this risk the original 1997 SGP (now called SGP I) set out an Excessive Deficit Procedure. This would be initiated under one of two scenarios: a government deficit exceeds 3 per cent of GDP; or government gross debt exceeds 60 per cent of GDP, unless the level of debt is "sufficiently diminishing and approaching the reference value at a satisfactory pace" (Thus allowing Italy, Greece and Belgium to be part of EMU). However, exceptional circumstances outside the members' control such as a severe economic downturn would be taken into account when deciding if the member had breached the pact. Sanctions were to be imposed in the form of a non-interest-bearing deposit with the Commission. The amount of this deposit contains a fixed component equal to 0.2% of GDP and a variable component linked to the size of the deficit. Each subsequent year the Council could decide to increase the sanctions by requesting an additional deposit, though the annual total of deposits may not surpass the upper limit of 0.5% of GDP. A deposit could be changed into a fine if in the view of the Council, the excessive deficit has not been corrected after two years.

By 2002, only 5 years after agreeing to the SGP, both Germany and France were running deficits of greater than 3 percent of GDP. The original proponents of the SGP now became the first members to breach its limits. In 2004 their deficits rose to be more than 3.5 percent of GDP and were closely followed by Greece, Italy, the Netherlands and Portugal which all stretched to more than 3 percent of GDP. However, instead of imposing the fines as laid out in the treaty, the EU's Council of Ministers voted to suspend enforcement, where upon the European Commission then brought a case before the European Court of Justice requesting it rescind the decision of the Council of Ministers. In July of 2005, the European Court agreed with the Commissions reading of the treaty, that the Council of Ministers did not have the legal right to suspend enforcement. However, even after this judgement no penalty was ever paid by any government for breaking the pact's guidelines.

In order to pre-empt the European Courts decision, the EU Council at a meeting in Brussels in March of 2005 set out a proposal to reform the SGP. The members released an agreement entitled "Improving the Operation of the Stability and Growth Pact" which confirmed that while the core rules of the treaty would be retained (maximum budget deficit of 3% of GDP and maximum debt to GDP ratio of 60%), a number of clauses would be inserted which would take account of exceptional circumstances. First, instead of an annual limit on the deficit, now a country has five years to comply with the rules. Secondly, a country can exceed the three percent rule legitimately if its aim is to "achieve European policy goals" or "foster international solidarity". The agreement explicitly allowed spending on education, research, defence, financial aid as well as unspecified things that might contribute to European unity to fall within the rules.

This "reform" agreement became known as SGP II, and in effect made its rules meaningless and rolled back the recommendations of the Delors Committee. The SGP

no longer contains the necessary support from its members to impose controls which would restrict fiscal deficits. The Economist, in its March edition of that year, concluded that the "rules have been so loosed that they have been rendered almost entirely meaningless". The European Central Bank said it was "seriously concerned" and Mervyn King, Governor of the Bank of England was very critical of the new pact and said other European governors were "dismayed" by this decision. The European Central Bank itself, said they were "seriously concerned" and Standard and Poor warned that French sovereign bonds could be downgraded to "junk" status within 20 years if current deficit and debt trends were to continue.

3.2.3 Free Riding In the EMU – A licence To Run Up Debt

The current European institutional structure with a centralised monetary policy and a decentralised fiscal policies promotes a bias toward continual fiscal deficits and increasing ratios of debt to GDP. Combined with the apparent lack of fiscal discipline by its members, where they set aside the SGP in response to their recent recessions could lead to one or more members free riding. The reason for this bias is because of the single currency and the fact that excessive fiscal deficits will not cause an adjustment in its exchange rate as it would prior to joining the Euro. In effect, the euro has eliminated the immediate market feedback that was required to discipline members who ran large deficits. Deficits are harmful, not only to the countries that incur them but also to the other members of the EMU. As the overall debt within the Eurozone increases, the ECB will be pressurised to allow higher inflation as a way of eroding the real value of the debt. Eventually, the Euro currency exchange rate and the European long-term real interest rates will start to respond to the risk of excessive debt being built-up in the Eurozone.

Each member of the Euro club that runs a budget deficit, contributes negatively to the Eurozone economic performance, but is shielded from its effect in the currency markets by being part of the Euro club. This unwarranted protection is known as the free rider problem, and it becomes increasingly important as the number of countries in the EMU increases. The failure of the SGP to limit its most harmful side-affects may place the entire project and the Eurozone's financial stability at risk. A sovereign may at first justify running a large deficit in response to a cyclical weakness, however once conditions improve they may lack the political willpower to reduce the stimulus. Because member governments can no longer use monetary policy to control their economies, they must now rely on using fiscal policy to counter an economic downturn. The natural decline in interest rates and exchange rates in response to economic weakness that occurred prior to the single currency, now cannot take place unless the economic decline coincides with the majority of member countries. Some critics of the eurozone, go so far as to suggest that interest and currency rates are set to take account of the German economy only, and not the Eurozone as a whole (There is no proof of this, and the ECB does not publish the minutes of its rate setting meetings)

Another danger of this type of free riding behaviour in a monetary union is the risk to fiscal stability. Any kind of fiscal instability in one member country may adversely affect the other members, in particular if capital markets assign some kind of correlation or connection to them (similar to the reasoning for contagion effects, with the additional problem of hope for ECB bailout which will be discussed below). Thus, the cost of debt for one country may be lower than if it still had its own currency, since part of the risk premium is now moved to higher interest rates for the other union members, or a lower common currency value. The result of this is a monetary union-wide "prisoner's dilemma" where all would be better off without additional debt-taking, but individually better off by increasing debt at the expense of the others. In an extreme case, this would

lead to a race to fastest debt accumulation and instability (default or hyperinflation) for all. The institutions of a monetary union do not automatically introduce mechanisms for risk-sharing such as central bank bailouts and fiscal transfers. As such, the key assumption is that a monetary union has a negative impact on the way capital markets function or at best leaves already flawed markets unchanged so that the monetary union will create the spillover effects.

In the Eurozone, we can see this impact in the booming economies of Ireland, Finland and Spain. These countries have enjoyed a massive monetary stimulus from joining the euro, where interest rates have been held down allowing some countries to load up on debt. In countries where the inflation rate is greater than the interest rate, borrowing money is effectively free. However this money is not always channelled into productive investments and speculative bubbles can occur, for example property bubbles have started to appear in these countries. The strain can be seen in the trade deficit which starts to spiral out of control. Because the country cannot produce as much as it consumes it closes the gap by importing more and more. Without the euro, the markets would start taking action to correct imbalances. Investors would sell off the currency, making imports more expensive and exports cheaper. Inside the euro zone, the currencies cannot revalue. The only way for the economy to rebalance is through a long period of slow growth, rising unemployment and depressed demand.

Basically the concerns outlined above, which were first raised in the Delors Report, describe the affects of a slackening of penalties for fiscal misbehaviour brought about by a monetary union. Previously functioning institutions like independent national central banks and flexible exchange rates will lose their disciplining effect (first concern), or the creditors of public debt will fail to correctly price the risk of default (second concern). For both concerns, the key appears to lie not only in the way fiscal authorities could

change their behaviour, but also if such behaviour changes are made more likely by capital markets caught in expectations of bailouts.

3.2.4 The Financial Markets; Enforcers Of Fiscal Discipline?

When EMU began many expected financial markets to punish budget offenders, but this has not occurred. Up until now the markets have applied hardly any risk premium to budget offenders. Even the admission by Greece in 2004 that it had run excessive deficits, and its downgrade by the rating agencies had little impact on its spread to German Bunds (less than 20 basis points). Furthermore, the yields on government bonds of the EMU countries remained relatively low (e.g. a nominal 3.5% as of the end of April 2005 for 10-year Bunds, the Euro land benchmark, and some 1.5% in real terms) while it became clearer that Germany and France would breach the 3% threshold for the third year in succession. This would imply that the market solution to enforcing discipline on governments fiscal policy is not adequate as predicted by the Delores Committee and the "no bailing-out" clause in the Maastricht Treaty is seen as unenforceable, when confronted with debt stricken member state. Another aspect of market discipline was raised by Lamfalussy, who highlighted that the market response to unsustainable policies can be highly non-linear, with yield spreads widening substantially only when debt levels are already high. The reaction of financial markets to chronic deficits acts as a deterrent when countries have their own currencies in a way that no longer happens in the Euro area.

However, it is my belief that it is the structure of the bond market itself which ensures that investors are unable to adequately enforce discipline on the profligate sovereigns. There is a misconception, that with the removal of national currencies, the financial risks and economic feedback mechanisms have transferred seamlessly from the currency

markets to the bond markets, but this is definitely not the case. One of the less publicised political goals of the creators of the single currency was the removal of currency speculators from impacting on their efforts for closer economic integration. An example of this would be the £2 Billion George Soros made when Sterling was forced to withdraw from the ERM. The financial markets, in the opinion of many of the political elite, was an obstruction to the creation of a more integrated Europe, and there was no reason to create a new market that would cause them the same headaches again. An example of the differences is the power the sovereigns wield over the Primary Issues market. They control who receives the new issues and therefore financial institutions that use their bonds to speculate can find themselves excluded from this market. A very good example of this is the Dr Evil trade carried out by Citigroup Global Markets Ltd. I will discuss this in detail in Chapter 5. Not only do the issuers control the release of the bonds on the supply side, but they can pass regulation on the demand side of the equation forcing pension funds, insurers etc. to hold a certain proportion of their portfolios in investment grade instruments, i.e. their bonds. After the "dot-com bubble" of 2001 in the stock market there was a raft of legislation implemented throughout the eurozone to protect investors which resulted in a steady stream of demand for the sovereign's own debt. This helped to reduce the yield issuers had to pay for selling their debt, and highlights the control the issuers have over the market. This control greatly reduces the disciplinary impact of the financial markets as well as the incentives of participants to increase the yield the sovereign must pay.

3.3 European Bond Markets

"In fact, the development of broad, deep and liquid capital markets covering the whole of the euro area is one of the great potentials of European Monetary Union". Dr Jurgen Stark, Deputy of the Bundesbank, addressing the Risk Management Forum of FERMA, 25/10/99.

The history of European sovereign bond market is comparatively short, as most European countries did not have a liquid government bond market until the early 1990s. The introduction of the Euro created one of the world's biggest markets for sovereign bonds. According to BIS data, December 2004, the European government bond market ranks third after the United States (USD 6,150 billion) and Japan (USD 5,022 billion), and the three together account for 84% of all government bonds outstanding. Although the market is similar in size to the US or Japanese markets the array of issuers and differences in creditworthiness differentiate the euro area government bond market from its counterparts. Prior to the Euro, the bond market could not be considered large and deep enough to compete with the US Treasury market as the asset of choice for investors looking for a liquid "risk-free" asset.

The re-denomination of bonds into the Euro from previously national currencies laid the foundation for a European bond market. Bond market conventions were harmonised among the participating Member States, which resulted in a relatively homogenous euro-denominated bond market. That market become much larger and more liquid than the national markets of the participating Member States were in the pre-EMU era. The European bond market has also made distinct progress in terms of competition with markets of other developed countries. The introduction of the Euro and its growing importance as an international currency made a much deeper government bond market possible, significantly widening the bond market's investor base. Efforts to improve

transparency, increase liquidity and cut transaction costs has further increased the attractiveness of the European government bond market to investors. The percentage of non-resident investments in euro-denominated bonds increased from 30.7% in 2000 to 38.6% in 2003. International diversification of EU investors' portfolios has grown also in recent years, whereas for most EU countries the share of foreign euro bond holdings ranged from 19% to 48% (median 37%) in 2000, and this increased to 27% to 79% (median 61%) in 2003.

Despite the multiplicity of Euro sovereign issuers, many investors now take a EU area-wide perspective rather than a national one when deciding their portfolio allocations. Prior to the introduction of the euro, financial regulations restricting currency mismatches had led to a strong national bias in portfolio allocations. With EMU all such restrictions on the flow of capital were relaxed and investors were encouraged to invest across the eurozone allowing them to achieve a greater diversification. This led to increased competition among issuers for both national and international funds as investors were no longer restricted to investing within their own national borders. Monetary union also made obsolete many of the old national benchmark curves, Dunne, Moore and Portes (2006) are amongst the few researchers to try and identify the new benchmark issues in the eurozone; I review their results and develop my own hypothesis in chapter 6.

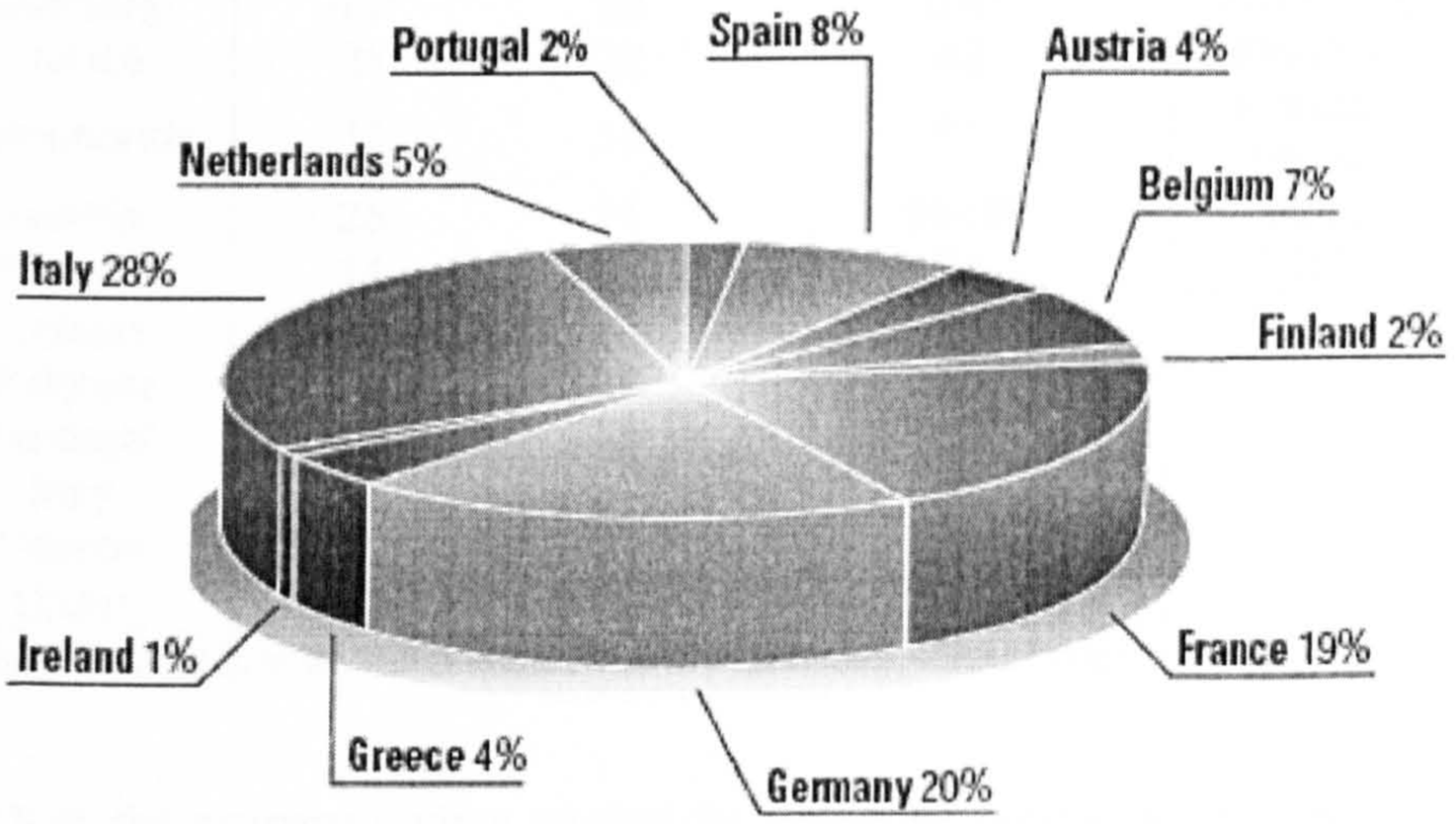
3.3.1 Bond Market Structure

The euro has had an enormous impact on the structure of European government debt markets. In 1995 the EU member governments decided as a consequence of the introduction of the euro that all new sovereign debt would be issued in Euros. The creation almost overnight of one of the worlds largest debt markets enhanced the liquidity and transparency in what had previously been a very illiquid and opaque market. The importance of the sovereign bond market to both the economic and financial stability of the Eurozone is due to the unique characteristics of its bonds. These include the size of the market, the creditworthiness of the borrowers, the availability of a wide range of maturities, the fungibility of issues facilitating trading, the high liquidity (particularly of recently issued securities), the fact of being accepted in open market operations and lending facilities, the existence of a well-developed Repo and Derivatives market and as a result of these features, the coexistence of benchmark yield curves. European bonds have similar coupon types with maturities ranging from 1 to 30 years.

The average issue size of a euro denominated sovereign bond has doubled between 1999 and 2005. The average size of an issue has increased from €5.8 billion to €12 billion. Euro sovereign bonds with a size greater than €20 billion represented more than 80% of the total market of outstanding issues at the end of 2004. While at the other end of the spectrum, bonds with less than €5 billion outstanding represented only 4% of the market. Each country is striving to achieve large liquid benchmark-size issues: recent French and Italian issues have exceeded €20bn, putting them at the level of US Treasury benchmark issues. German issues are in the range of €10-15bn, and even the small countries are now up to €3-5bn. issue size. Secondary markets have become much deeper and more efficient (see Favero, *et al.*, 2000).

As discussed previously just three countries, Italy, German and France account for over two thirds of the total Euro government bond market, and 90% of the total size if the Spanish, Dutch and Belgian markets are also included (see Figure 1). These relative weights have not changed significantly in the last few years although it is worth noticing how the relative weight of those countries following more strictly the Stability and Growth Pact has diminished compared to those whose deficits have remained closer to the 3% threshold. In general terms, the amounts issued by each country are very close to their respective weights, with the total amount of fixed-rate bond supply around €500 billion in both 2001 and 2002.

Figure 1 Composition of the Euro Area Government Bond Market, 2003



Source: MTS Group

In table 1 and 2, we can see the composition of the Euro sovereign broken down by country as well as the percentage of foreign investment for each sovereign's debt. We can compare each issuer's duration and degree of attractiveness to foreign investors and see there is a range of conditions which still separate the individual countries.

Table 1 Composition of Eurozone Debt

Issuer (12/31/03)	Outstanding (€, bln)	Composition of Debt			
		% Euro	No. Of Bonds	Avg Life	Duration
Germany	773.8	100	64	5.6	NA*
France	787.7	100	154	6.3	NA*
Netherlands	180.5	100	31	6	3.8
Austria	146.4	NA*	11	NA*	NA*
Finland	63.3	77	8	3.9	2.3
Ireland	28.1	100	5	6.6	4.9
Belgium	263	99	49	5.9	3.9
Portugal	78.4	100	19	4.3	2.9
Italy	1157.1	98	94	6.1	3.6
Greece	148.3	99	23	6.2	3.7
Spain	309	97	115	6.2	4.7

* Information not available, Source EuroMTS

Table 2 Number of Bonds Market Makers for each Sovereign on EuroMTS

Market Participants	Primary Dealers	MTS Market Makers	Investor Base (% international)
Germany	40*	30	NA*
France	21	22	42
Netherlands	13	13	81
Austria	25	21	90-99
Finland	14	21	77
Ireland	8	10	79
Belgium	16	19	49
Portugal	15	16	85
Italy	22	31	47
Greece	21	21	55
Spain	20	18	38

Type	No. of Bonds Outstanding
Fixed rate	307
Floating	20
Inflation linked	8
Strips	182
T-Bills	84

*Market participants, no official Primary Dealers, Source EuroMTS

MTS is the primary trading market for eurozone bonds and will be discussed in great detail later in this thesis. Along with the Liquidity Pact it helps organise, it has been the cause of the second most dramatic change in the sovereign bond market after monetary union. It has greatly impacted the liquidity and price discovery of sovereign debt in the years since its introduction in 1999. With the continued quotation of 2-way prices throughout the trading day, it has reduced the risk of holding sovereign bonds enormously. Combined with the I.T. changes these have also reduced the transaction costs of trading bonds making them more attractive to investors.

3.3.2 Debt Market Management

European government bond issuers are described as monopolistic demanders of liquidity services. Government issuers depend on primary dealers to take up large risky positions in primary auctions and require them to maintain a strong presence in a secondary market which is often illiquid. Their obligations are quite diffuse across hundreds of bonds with very similar characteristics. Primary dealer status accords certain privileges. In most countries, primary dealers have an exclusive right to make non-competitive bids at or after a debt auction, to participate in bond exchange/reverse offers, to strip and reconstitute bonds and to have exclusive or privileged access to syndicated issues. In some Member States, primary dealers also benefit from privileged access to the Repo market. The precise value of these privileges is unclear for a number of reasons, not least because they come with obligations. It is important to note however, that Member State governments represent an important client-base for international banks.

Dunne, Moore and Portes (2006) in their insightful paper on the transparency, liquidity and efficiency of the European bond market describe how Debt Management Offices (DMO) across Europe guarantee participation in their auctions by employing an auction-syndicate system. This involves a two-stage process where dealers are encouraged to enter the auction by being subsequently rewarded with access to the very profitable syndication process. If they do not enter the auction or enter uncompetitive bids then they will be barred from the subsequent syndication. Indeed these auction-syndicates systems can lead to dealers incurring losses at the auction stage driven on by supernormal syndicate profits at the second stage.

The management of these auctions is often delegated to an independent agency free from government pressure, thus removing the temptation to use insider information to reduce funding costs at the expense of investors. Like independent Central Banks, the independent DMOs have been created to implement a more efficient and transparent debt policy. An example of this is that since the start of EU, debt issuance calendars have been introduced in all EMU member states (see Favero, Missale and Piga 1999). This allows market makers to plan their trading activities and control their risk management more effectively. Another important policy that is managed by the DMOs to ensure the smooth running of the market is the existence of a repurchase agreement facility in the form of a window at the Treasury. The DMO acts as a buyer of last resort and ensures a floor is also available to dealers in periods of market volatility. The active management of the debt markets by the DMOs e.g. buying back old issues, increasing issue size, managing syndications etc. ensures the smooth operation and stability of the debt market. It also reduces the cost and risks to the investors by managing the liquidity risk of the securities in the most efficient manner available. Therefore investors do not have to worry that an issuer will suddenly flood the market with new bonds causing a disruption to the pricing of existing bonds. The efficient and transparent management of the debt markets has been one of the key reasons for the increasing importance of the Euro currency.

3.4 Electronic Bond Trading Systems

The dramatic transformation of trading from open-outcry, where a select number of traders around a "pit" in effect made the market, to computer-screen based systems, where traders from around the world entered bids/offers anonymously, forever changed the market architecture and the way business is conducted. Electronic trading eliminates the geographical constraints and permits continuous pricing transparency for all market participants. A greater volume of trading can be transacted on an electronic trading platform, as risk positions can calculated in real-time, thus allowing immediate hedging or portfolio reallocation. These gains in efficiency have allowed central counterparties to be introduced into the market, thereby eliminating counterparty risk and making the market even more attractive to investors. Clearers and custodians have also embraced the efficiency gains electronic systems offer, reducing their costs and time for settlement. Electronic trading has had a profound impact on trading and the subsequent stability of the financial system.

The adoption of screen based trading in fixed income markets has been sluggish when compared to that of equity markets. The reason for this reflects the distinct characteristics between the two markets. Fixed income products are far from standardized, with varying coupons, maturity and issue size for the same issuer when compared to the single product that is offered in the equity market. The Economist (2000) tells us "there are over 4 million fixed income securities on issue in the United States (varying in coupon, maturity, frequency of interest payments, etc) compared with a few thousand listed shares". This multitude of products has restricted the application of electronic trading due to cost constraints and the difficulty in formulating a price for illiquid products. The difficulties of price formation have until recently been largely ignored in the academic literature; it has only been the recent interest in market microstructure research which has highlighted how different market structures and

imperfections influence trading outcomes, e.g. O'Hara (1995), Madhavan (2000), Bloomfield and O'Hara (2000), Harris (2003) and Hasbrouck (2007).

Dunne, Moore and Portes (2006) carry out a comprehensive analysis on the microstructure of the market and conclude that the structure of the market is particularly important especially when one focuses on transparency, and the advantages and disadvantages of trading in such a market. Their paper investigates a whole range of issues on the microstructure of the European Bond market, and could itself form the basis of a dozen PhD theses. It is one of the first academic papers that truly shows the richness of this field of research, combining academic research with practical market input to advance and influence future research and regulation in the field.

3.4.1 The Secondary Markets

Since the introduction of the Euro, Euro-MTS has been the sole designated electronic trading platform for European cash government bonds as agreed between the sovereign issuers and the Primary dealers (discussed in greater detail in chapter 6). Many academic authors assume that the Euro-MTS market grew organically in a similar way to equity markets, when the reality is the market was created in 1999 to facilitate the diversification of euro denominated debt throughout Europe. At the end of 2000, it handled over 40% of total transactions volume (Galati and Tsatsaronis, 2001) and had grown to 72% by 2006. HDAT, the Bank of Greece's own trading platform for trading Greek bonds, is the second largest electronic platform in Europe with a 19.0% market share. The third largest platform is Senaf, the Bank of Spain's trading platform which has a 5.4% market share. Both these latter trading platforms only allow trading in their national bonds, EurexBonds, owned by Deutsche Börse which initially traded own German bonds but has since expanded to become an international trading platform has a

3.6% market share. BrokerTec and e-Speed bring up the rear with 0.1% market share between them. The removal of Euro-MTS as the sole designated trading platform and the opening of access to non-primary dealers has been a hot topic of debate recently. Many in the industry complain that Euro-MTS is a monopoly that restricts access and inhibits innovation. In the past the justification for this was because of worries about the fragmentation of liquidity across a number of platforms, which may have a negative impact on price discovery. As liquidity risk falls off the radar, this justification no longer holds and going forward certain issuers are expected to remove the specification of the trading platform for market making.

Table 3 Percentage of Bond volumes traded on all major Euro electronic platforms in 2006

	MTS	*HDAT*	*MTS Non-Greece*	*Senaf*	*Eurex*	*BrokerTec & e-Speed*
Feb	66.8	22.0	85.6	7.1	4.0	0.1
Mar	67.4	21.6	85.9	7.3	3.6	0.1
Apr	75.5	16.1	91.2	3.8	3.5	0.1
May	75.2	17.1	90.6	5.2	2.5	0.1
Jun	73.7	17.7	89.5	4.4	4.1	0.1
Jul	71.9	19.5	89.3	4.6	3.9	0.1
Aug	71.8	19.2	88.9	5.4	3.4	0.1
Average	71.9	19.0	88.7	5.4	3.6	0.1

Source iSwap

There are a number of minimum requirements for access and trading on the EuroMTS trading system which minimize liquidity and counterparty risks. First, for a bond to be listed on the platform it must have a minimum issue size of at least €5bn. The minimum requirement for market makers to gain access to EuroMTS system are that they must have a minimum net worth of €39 million and must be an official Market Maker in at least two of the three major European government bond markets (France, Germany and Italy) or by being an official Market Maker in at least one of those markets and having traded in the previous 12 months (or pro rata for the relevant period) Government Bonds

exceeding €150 billion in the three Markets together, with at least €30 Billion in at least one of the markets (see EuroMTS website for further information). Another key market of the Euro-MTS system is the "Repo market" or repurchase market which allows market makers to take larger bond positions and whose introduction has had many positive effects on liquidity.

A key distinction which must be highlighted when comparing the EuroMTS bond market with the US Treasury is the percentage turnover of European bonds pales in comparison to that of the US market. There may be a number of reasons for this; European investors may wish to hold the bond to maturity while US investors may only wish to hold the "on-the-run" bond and therefore they must trade more frequently. Table 4 displays the amount of trading volume in March 2006 for a number of EU members, the whole of the EU and the US for comparison purposes. Trading volumes of European bonds are just 5% of those of US bonds which is a surprisingly low level of market turnover.

Table 4 Average daily turnover in March 2006 on major electronic platforms

Country/ Region	*Volumes Traded (€, Millions)*	*Outstanding Amount (€, Millions)*	*Turnover (volumes /bonds outstanding, %)*
Belgium	9,026	218,120	4.1
Denmark	36,935	486,400	7.6
France	9,520	802,000	1.2
Germany	10,608	869,500	1.2
Holland	3,595	197,190	1.8
Italy	104,163	970,140	10.7
Portugal	9,263	69,780	13.3
Europe	**183,109**	**3,613,130**	**6.1**
US	**3,666,342**	**2,638,680**	**138.9**

Securities with less than 1 year to maturity are excluded, MTS in Europe and e-Speed and BrokerTec in the US; Source ISwap

According to the academic literature this low turnover should be seen as a measure of substantially lower liquidity. However the other measures of liquidity, Width, Immediacy, Depth and Resiliency contradict this conclusion. Codogno, Favero and Missale (2003) and Favero, Pagano and von Thadden (2004) also state that "*liquidity factors play a smaller role*" in bond yields so one possible explanation is that primary dealers are forced to offer the facade of liquidity through tight bid-offer spreads, but because this represents a cost to them, the size of the market is constrained (Liquidity Risk – discussed later in chapter 6). Therefore a market such as this is open to manipulation unless it is heavily regulated. This is exactly what occurred in the Citigroup trade of the 2 August 2004 and the subsequent reaction by the regulators and issuers (discussed in detail in the chapter 5). However, there is another reason that turnover on Euro-MTS is low and that is because most trading is not actually done on the inter-dealer market but rather on the Dealer-to-Client markets (see next section). As information on this segment of the market is difficult to collate, it is often ignored in the academic literature and subsequent research on liquidity risk, but this is where the deepest pool of liquidity resides in the Euro government bond market.

3.4.2 The Dealer-To-Client Markets

The markets discussed above are all inter-dealer, i.e. trading is restricted to only the largest financial institutions, and therefore prohibit trading with clients such as pension funds, insurers, hedge funds etc. Another group of electronic markets have appeared to fill this function; these are called Dealer-To-Client or D2C markets. These markets are not exchanges and have no obligation to publish trade statistics. They are simply a means of distributing prices from a dealer to a client quickly. Generally the prices are not firm but indicative and there is no obligation on the customer to trade on the price sent by the dealer. The purpose of these markets is to replace the tedious process of a customer having to ring around a number of dealers to get a price for a bond. Instead they can send a request to a maximum of 5 dealers simultaneously, hence starting an auction and see what each responds before choosing to trade.

There are 3 main markets; these are in priority Tradeweb, BondVision and Bloomberg. Tradeweb on its website reported that it had a new record turnover in its European Government bond segment of €49.5bn during the week of September 25, 2006. According to Tradeweb nearly 500 institutions traded European Government bonds, with more than a third of the business represented by trades of $50 million or more. Tradeweb was started in 1998 and more than $155 trillion in bond trades have been executed over the Tradeweb network with over $420 billion in securities changing hands on Tradeweb in a single day. According to the BondVision website, which was launched in 2001 in response to continued requests from institutional investors for access to greater liquidity, they achieved a record volume of €57.5bn in March and €155bn. in the first quarter of 2006, up 42% versus the first quarter of 2005. Therefore these markets constitute a significant proportion of the overall trading market; they are in effect the retail side of the government bond market. They are almost completely ignored by the

academic literature on the subject; this is probably because these markets guard their data jealously. These markets are not anonymous, so clients would not be happy to know they got a worse price than another client from the same dealer, therefore no information is ever published.

One should not underestimate the impact of electronic change in the bond market, as Investment Banks strive to be more efficient and maximize profits while faced with the narrowing of Bid/Ask spreads, they invariably have to reduce the cost base, i.e. Number of traders. This means it is not unusual for a trader to find herself quoting firm prices for 150 bonds to 3 separate exchanges. Therefore the reliance on automated pricing systems, automated hedging and the introduction of auto-trading strategies across Futures, Cash and Swaps markets, mean that even if the markets were not integrated before the Euro project, then the sheer weight of trading and the manner of trading has forced the markets to become more integrated over time. On a typical bond desk, the bonds assigned to a particular trader are assigned by maturity, i.e. short, medium and long. Therefore even by construction of the market making desks, it is assumed that the underlying yield curves across the euro zone are similar. I shall discuss this in greater detail in further chapters.

Also with the reduction of costs enforced by greater automation, the experience of traders on the desk is being diluted. With the decrease in volatility over recent years, and the introduction of fixed Bid/Ask spreads for certain sovereigns, the more experienced traders are moving away from the sovereign bond desk to take roles in financially more attractive markets for their skills. Therefore traders with the experience and ability to take an independent view of the market are being removed from the desk, and being replaced much more with trade management specialists, who reply to trade requests from clients and immediately hedge on the futures markets. Therefore they take the minimum

market risk or position and are just as happy to see the market move up or down, as this causes trade activity among their clients.

3.4.3 The Eurex Futures Market

Eurex is the world's leading futures and options market for euro denominated derivative instruments. Its electronic trading platform provides access to a broad range of international benchmark products. With market participants connected from 700 locations worldwide, trading volume at Eurex exceeded 1.07 billion contracts in 2004. A future is a standardised, transferable, exchange-traded contract that requires delivery of a bond at a specified price, on a specified future date. Unlike options, futures convey an obligation to buy. The risk to the holder is unlimited and because the payoff pattern is symmetrical, the risk to the seller is unlimited as well. Dollars lost and gained by each party on a futures contract are equal and opposite. In other words, futures trading is a zero-sum game. Futures contracts are forward contracts, meaning they represent a pledge to make a certain transaction at a future date. The exchange of assets occurs on the date specified in the contract. Futures are distinguished from generic forward contracts in that they contain standardised terms, trade on a formal exchange, are regulated by overseeing agencies and are guaranteed by clearing houses. Also in order to ensure that payment will occur, futures have a margin requirement that must be settled daily. Finally, by making an offsetting trade, taking delivery of goods, or arranging for an exchange of goods, futures contracts can be closed. Hedgers often trade futures for the purpose of keeping price risk in check.

A market maker that sells an asset on the euro cash market can hedge their position almost immediately by buying a future contract on the Eurex Futures Exchanges. However as the cash instrument is almost never the same as the asset underlying the

futures contract, the market maker is exposed to a basis risk. A basis risk results form the possibility of the futures gain being less than the cash market loss, or vice-versa. If the asset to be hedged and the asset underlying the futures contract are the same, the basis should be zero at the expiration of the futures contract. If it was not then there would be a clear arbitrage opportunity, eg. by shorting the futures contract and buying the asset. This would lead to a profit equal to the amount by which the futures price exceeds the spot price.

Eurex Interest rate products cover the German yield curve from one month to thirty years, including Eurex's benchmark contracts, the Euro Bund, Bobl and Schatz Futures. In the Euro area the Bund futures contract has become predominant. German government bonds appear to command a sizeable premium versus other sovereign issues due to this 'derivative factor'. Arguably, the lack of a liquid future contract in all EMU countries but Germany should command a liquidity yield premium on non-German bonds, depending on the size of the basis risk that investors are running by having an imperfect hedge.

The 3 Eurex benchmark futures are:

Bundesanleihen (Bund) issued by the Federal Republic of Germany, having face value of EUR 100,000, with remaining term to maturity of 8 1/2 to 10 1/2 years and coupon of 6% per annum.

Bundesobligationen (Bobl) issued by the Federal Republic of Germany, having face value of EUR 100,000, with remaining term to maturity of 4 1/2 to 5 1/2 years and coupon of 6% per annum.

Bundesschatzanweisungen (Schatz) issued by the Federal Republic of Germany, having face value of EUR 100,000, with remaining term to maturity of 1 3/4 to 2 1/4 years and coupon of 6% per annum.

Settlement: A delivery obligation arising out of a short position in a EUR Fixed Income Futures contract may only be fulfilled by the delivery of certain debt securities issued by the Federal Republic of Germany with a remaining term on the Delivery Day of:

Contract Standard	Remaining Term in Years
Euro-Schatz Futures (FGBS)	1.75 to 2.25
Euro-Bobl Futures (FGBM)	4.5 to 5.5
Euro-Bund Futures (FGBL)	8.5 to 10.5

Such debt securities must have a minimum issue amount of EUR 5 billion.

Most of the time the futures markets operate efficiently, however from time to time an investor group tries to "corner the market". The investor group takes a huge long futures position and tries to exercise some control over the supply of the underlying commodity. As the maturity of the futures contracts is approached, the investor does not close out its position and the number of outstanding futures contracts may exceed the amount of the commodity available for delivery. The holders of short positions realise that they will find it difficult to deliver and become desperate to close out their positions. The result is a large rise in both futures and spot prices. To stop this happening the exchange allows the party with the short position to choose from a basket of bonds which can be delivered in settlement of the bond futures contract. Each German government security in the Eurex futures contract's reference basket has a corresponding conversion factor, representing the price at which that security would yield 6% per annum. The futures contract's final settlement value equals the lowest of all the conversion-factor-weighted prices in the contract's reference basket i.e. the Cheapest-to-Deliver, CTD. This can be calculated from the Basis as:

Basis = Cash Price – (Futures * Conversion Factor)

A number of factors determine the cheapest-to-deliver bond. When yields are in excess of 6%, there is a tendency for the conversion factor system to favour the delivery of low-

coupon long-maturity bonds. When yields are less than 6% there is a tendency to favour the delivery of high coupon, short-maturity bonds. Also, when the yield curve is upward sloping, there is a tendency for bonds with a long time to maturity to be favoured; whereas when it is downward sloping, there is a tendency for bonds with a short time to maturity to be delivered. Finally, some bonds tend to sell for more than their theoretical value. Examples are high-coupon bonds and bonds where the coupons can be stripped from the bond. These bonds are unlikely to prove the cheapest to deliver in any circumstances.

3.5 Methodology and Data

To investigate the dynamics of the Euro bond market and examine its disciplinary effect, I create a number of models which allow me test various hypothesis. In chapter 4 I create a linear regression model similar to Cantor and Packer model (1996) that looks to explain how various economic variables can explain the yield in the secondary bond market. Using this model I test whether free-riding could play a role in the yield spread seen in the market. In Chapter 5, I investigate the market dynamics and look at how integrated the bond market has become since the introduction of the euro. I use a number of common statistical methods to help summarise and describe my data, the first of which is to investigate if a unit root is present, i.e. the time series is said to have a stochastic trend. A number of recent studies have found the bond yields are non-stationary e.g. Cote and Graham (2004), Dunne, Moore and Portes (2006). This may be a surprise to some academics outside the bond market who had assumed that a market which calls itself "Fixed-Income" would not display such a non-fixed element.

When dealing with non-stationary time series data, the standard practice is to employ cointegration. Robert Engle and Clive Granger shared the 2003 Nobel Memorial Prize in Economic Sciences for their work on non-stationary time series. The concept behind this

states that if two or more non-stationary time series are cointegrated then they cannot diverge arbitrarily far from each other, implying that there exists a long-term relationship between these series. By definition, cointegrated markets thus exhibit common stochastic trends. This, in turn, limits the amount of independent variation between these markets and from an investors' standpoint, markets which are cointegrated will present limited diversification opportunities. Chen and Knez (1995) show that economic assets which are integrated, share a common stochastic I(1) factor. This model will be at the core of my research in chapters 5 and 6.

3.5.1 Bond Yield Characteristics

Through out this thesis I employ the bond yield as a proxy or composite for various risk factors. Therefore I take the opportunity to look at my principal source of data in more detail in this section and look at why it would have non-stationary properties. Calculating bond price is relatively simple, as all we are doing is discounting the known future cash flows. But what is the discount factor that we should use? Bonds, like any other commodity face the same trade-off between supply and demand. For the market to clear, buyers and sellers must agree on the discount factor, which in turn becomes the interest rate for the bond. What drives interest rates? Essentially, interest rate levels are affected by movement in price levels or inflation rate, fiscal policy stance, and intermediation cost (cost of funds), how deep and developed are financial markets, level of risks and uncertainty, among other factors. The more the Government spends, the lower must the private sector spend to keep stable prices, Barrowclough (2001). Thus, increased spending (whether by borrowing from market or increased oil price etc.) will drive interest rates up. If riskless Government instruments attract 5%, why would banks lend to risky private sector at lower? The central banks target inflation and the supply of money in the private sector by adjusting the interest rate they are willing to pay.

Interest rates have a number of characteristics, the first is that they exhibit the properties of a random-walk model similar to that of stock-market prices. Contrary to stock-market returns however, first differences of interest rates do contain substantial autocorrelation at shorter and longer lags. It is not always possible to exploit this correlation pattern for reliable prediction. Many authors have found that the explained share of variance (R^2) decreases as the time to maturity increases, such that long-term bond rates come close to pure random walks. The next characteristic is that, in the longer run, interest rates remain in an interval that is approximately determined by the lower bound of zero and the upper bound of around 10%. This fact reflects the economic adjustment mechanism that is primarily enacted by the stabilising influence of central banks. Although the paradox of negative nominal interest rates has been reported for specific episodes in specific countries, the lower bound of zero can be regarded as concrete, as economic agents will not lend money if they are rewarded by a loss. The upper bound is less defined and may be pushed up during phases of high inflation. Because of widespread international agreement about the dangers of high inflation, even these phases will usually be of only limited time span, as other nations try to help.

It appears that the second characteristic seems to contradict the first, as random-walks display non-stationary behaviour due to an ever-increasing variance and an unbounded support. In the literature, the typical way out has been to view the random-walk model as an approximation for a limited time span. Building on the integrated model, researchers such as Campbell and Schiller (1987) and Hall et al. (1992) have gained interesting insights into the joint movements of interest rates at different maturity, which leads to the next characteristic. This is that rates at different maturities exhibit parallel movements as they develop through time. Accepting the integrated model as a working hypothesis, these authors have found that interest rates tend to be cointegrated. Usually, this linear combination has been found to be the difference or yield spread, such that short and long

rates are separated by a stationary term premium with a time-constant mean. Other empirical features of interest rates have been identified, such as evidence on non-normal distributions, highly non-normal kurtosis, conditional hetroskedasticity and long memory.

Interest rates generally change on perceptions of future inflation rates. Inflation is defined as the overall general upward price movement of goods and services in an economy, usually as measured by the Consumer Price Index and the Producer Price Index. Over time, as the cost of goods and services increase, the value of a euro is going to fall because a person won't be able to purchase as much with that euro as he/she previously could. As mentioned previously the ECB specifically targets inflation, which it tries to control and keep at 2%. The long-run characteristics of inflation as we would expect resemble that of interest rates. However, unlike interest rates, neither price nor wage inflation face strict lower bounds. Prolonged periods of deflation, i.e. negative inflation are common. Another distinction to interest rates is that inflation is significantly predictable. There is widespread belief that last years' inflation is a good forecast for this year's inflation. This view is reflected in textbook descriptions of variants of the Phillips curve. Assuming expectations to be rational would imply that inflation obeys a random walk. The fact that changes in inflation are also predictable invalidates the random walk model. In analogy to interest rates, one also observes that a fall in inflation is more probable when inflation is high and a rise in inflation is more probable when inflation is low. One reason for this 'mean reversion at the extremes' is likely to be the policy reaction of monetary authorities.

3.5.2 Cointegration and the Johansen Procedure

The mechanism that ties cointegrated series together is called "causality", not in the sense that if we make a structural change to one series the other will change too, but in the sense that turning points on one series precede turning points in the other. The strength and directions of Granger causality can change over time, there can be bi-directional causality, or the direction of causality can change, e.g. in the relationship between spot and future prices there may be times when futures lead spot, where as at other times spot prices can lead future prices. The process of cointegration is well documented and now appears as standard in almost every recent econometrics textbook, such as Davidson (2000).

The Johansen (1988) procedure allows us to study the relationships between the various variables in a multivariate context and has a number of advantages over the bivariate system approach. Firstly, the Engle and Granger approach requires that the two series are of the same degree of integration; however the Johansen system can consist of I(0) or I(1) variables. Secondly, the Engle and Granger approach restricts one of the coefficients (either one chosen arbitrarily) in the cointegrating vector to be equal to 1 and the results of the procedure are not invariant to this normalisation. The Johansen procedure imposes no restriction. Finally, the null hypothesis for the Engle and Granger (1987) approach is that the variables are not cointegrated; in the Johansen procedure no such prior assumption is required about the number of cointegrating vectors. The procedure itself is organised to estimate the number of cointegrating vectors present in the system.

The Johansen method defines the reduced form error correction model as:

$$\Delta X_t = \alpha\beta' X_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-1} + \Phi D_t + \varepsilon_t \quad t = 1,\ldots,T,$$

where $\mathbf{D}_t$ represents a vector of nonstochastic variables. These may include dummies such as seasonals, but not the intercept, which is included separately, nor trend dummies which require a modified analysis. The joint role of the I(0) regressors is to ensure that ε_t is, at worst, uncorrelated with lagged variables. The advantage of this parameterisation is in the interpretation of the coefficients, where the effect of the levels is isolated in the matrix $\alpha\beta$' and where $\Gamma_1,\ldots,\Gamma_{k-1}$ describe the short-term dynamics of the process. In practice, we can obtain only estimates of $\alpha\beta$' and its characteristic roots. The test for the number of characteristic roots can be conducted using the following test two statistics:

Where λ_i are the estimated values of the characteristic roots (also called eigenvalues) obtained from the estimated Π matrix; and T is the number of usable observations. When the appropriate values of r are clear, these statistics are simply referred to as λ_{trace} and λ_{max}.

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{n}\ln\left(1-\hat{\lambda}_i\right)$$

$$\lambda_{\max}(r, r+1) = -T\ln\left(1-\hat{\lambda}_i\right)$$

The Johansen and Juselius (1990) approach generates two statistics of primary interest. The first is the λ_{trace} statistic, which (in this instance) is a test of the general question of whether there exist one or more cointegrating vectors. An alternative test statistic is the λ_{max} statistic, which allows testing of the precise number of cointegrating vectors. These test statistics can be plotted over time to examine how the nature of market integration is changing over time.[20] This approach is in essence a visual application of the recursive cointegration approach of Hansen and Johansen (1992) that has also been applied in a somewhat different form by Rangvid (2001). The output from the approach which we

[20] Further details regarding the dynamic cointegration approach can be found in Barari and Sengupta (2002). There-in the process is described whereby the investigator can plot over time the values of selected test statistics from the JJ approach. The Barari and Sengupta (2002) paper concentrates on the λ_{trace} statistic.

have taken is twofold: first, the largest value of the λ_{trace} statistic which tests the general hypothesis of no cointegration versus cointegration, and second, the number of cointegrating vectors given by the λ_{max} statistic. A set of series that are in the process of converging should be expected, as in Hansen and Johansen (1992) and Rangvid (2001), to show increasing numbers of cointegrating vectors. Intuitively, this makes sense, consider a set of p series which have n cointegrating vectors, $n<p$. This implies that there are n linear combinations of the p vectors that are stationary. If we later find that we have k vectors, $n<k<p$, there are additional combinations that can be used in the representation of the p data. If we have a static number of cointegrating vectors then recursive estimation will simply lead to an upward trend in the λ_{trace} statistic. It should be noted that in general the λ_{trace} statistic is more powerful and to be preferred to the λ_{max} statistic.

An important issue in econometrics is the need to integrate short-run dynamics with long-run equilibria. The traditional approach to the modeling of short-run disequilibria is the partial adjustment model. An extension to this is the Error Correction Model, which also incorporates past period's disequilibrium. The analysis of short-run dynamics is often done by first eliminating trends in the variables, usually by differencing. This procedure, however throws away potential valuable information about long-run relationships about which economic theories have a lot to say. The theory of cointegration developed by Granger addresses this issue of integrating short-run dynamics with long-run equilibria.

In an economic model containing cointegrating relations, it is normally assumed that the cointegration comes about because a set of long-run linear economic relationships act as 'attractors', drawing the time series together as they evolve through time. The consumption function, investment function, money demand function and other fundamental macroeconomic relationships are often thought of in this way. These are

called structural cointegrating relationships. Johansen's methodology is designed to estimate the space spanned by these relationships, but it does not allow us to observe them individually. An error frequently committed by practitioners is to attempt to give the 'Johansen vectors' a structural interpretation. Cointegration is a purely statistical concept based on properties of the time series considered, it is "a-theoretical econometrics".

However, my mode of research allows me to provide a structural interpretation to my results that other researchers may not have considered. For example, Dunne, Moore and Portes (2007) employ cointegration using 3 time series, Italian, French and German yields, which they then use to test for price discovery. However, in my research I use 2 time series, therefore the 'Johansen vectors' can be interpreted as the yield spread between the two issues, which has a clear structural interpretation. The yield spread in the euro bond market consists of default and liquidity risk, and my research focuses on the interaction of these between issuers. Therefore the long-run relationship between the two series can be clearly identified and discussed from an economic stand-point. Therefore the way I use cointegration allows me to generate a model which better describes my data, and allows me to create tests that are both statistically and economically significant.

3.5.3 Economic Data and Bond Market Sources

There are a number of data sources that I draw on in my research; in chapter 3 I draw on data supplied by EuroMTS on the structure of the Euro sovereign bond market. In chapter 4 I use the data from the Statistical Office of the European Communities (Eurostat) which is the statistical arm of the European Commission, which produces data for the European Union. Two of its roles are particularly significant, producing macroeconomic data which helps guide the European Central Bank in its monetary policy for the euro, and its regional data and classification which guides the EU's structural policies. The data from Eurostat allowed me to compare the data considered important by Cantor and Packer for each of the euro sovereigns in turn. In chapter 5 and 6 the bond yield data came from a variety of sources including EuroMTS, Bloomberg, Reuters and Thomson. This allowed me to view how the bond market developed and how closely integrated the various sovereigns have become since the introduction of the euro.

3.6 CONCLUSION

Once a month the chairman of the ECB in a press conference after the announcement of interest rates, highlights the importance of the eurozone member states controlling their fiscal policies. He highlights the risks from inflation and warns members that in periods of calm they must reduce their debts, and restructure their economies to be in a better position when times are more difficult. He gives a very clear, concise and articulate picture of the global and euro economy as a whole to the financial markets, and the future projections of monetary policy. Yet, when one turns to the fiscal policy of the individual members of the eurozone, one sees a mish-mash of competing and contradictory policies. Reform of our European economies is mired in competing interests without any clear view of the future. Now that the euro exists and it can no

longer be seen as a carrot, governments are understandably reluctant to accept the rigid stick of the Growth and Stability Pact.

In the eurozone, fiscal discipline is based on two mechanisms. The first one is of an institutional nature, the Stability and Growth Pact (SGP). The latest economic slowdown revealed it to be ill-suited (no preventative surveillance, no direct consideration of country-specific circumstances, no importance attached to structural balances, etc.). The second is the discipline imposed by the bond market. The purpose of this thesis is to investigate if the bond market carries out this function, or whether it too is impotent when faced with the power of the sovereigns. The sovereigns are both issuers and regulators of the bond market. They have the power to dictate how much of the investment portfolio must be held in bonds by Pension Funds and Insurers, ensuring a captive market. They also can restrict access to the market itself if they deem their regulations have been broken. This market is a very different proposition to that faced by the currency speculators in the 1980s that were able to force sovereigns to backtrack on political commitments that the market deemed imprudent. There is no George Soros of the bond markets!

Since the euro was introduced, the majority of the member states have repeatedly breached the rules set by the Stability and Growth Pact, causing grave concerns for its survival and its ability to ensure stability of EMU monetary policy. So much so that in June 2005, the Pact had to be "reformed"; this however weakened the institutional disciplinary function of the SGP further. It did not solve the problematic aspect of the monetary integration in EMU concerning the surveillance and co-ordination of member states' budgetary policies. On the other side of the disciplinary equation the Dr. Evil trade carried out by Citigroup showed the control that the Issuers maintain over Primary Dealers, limiting their ability to trade freely on the Secondary bond market. The close

supervision of the Primary Dealers by the Issuers is in stark contrast to their own supervision of the SGP conditions. The current structure and regulatory procedures has weakened the disciplinary aspect of the bond market, in much the same way as the SGP was weakened by the member states.

My main contribution to this subject in this chapter has been bringing both an historical perspective to the evolving European financial integration as well as attention to the impacts of institutional changes in the bond market and in the regulation of the bond market. The development of electronic exchanges has revolutionised the process of trading bonds, and its impact can be considered of equivalent significance to monetary union itself. The increased transparency and guaranteed access to bond markets for investors has been the most important driver of reducing the liquidity premium, which was a very important component of the yield of sovereign bonds and increasing the attractiveness of sovereign bonds to foreign investors. This chapter describes the structure of the bond market and the incentives of its most significant participants; I will draw heavily on this in the chapters going forward.

4. Does The Bond Market Impose Discipline On Governments?

4.1 Introduction

In November 2005 the president of the European Central Bank announced that it would no longer accept government securities as collateral if they were rated below A- by Standard & Poor's and Fitch or A3 by Moody's. The reasoning behind such an act was to allow the Bank to give a clear indication to the markets that they should establish a hierarchy between public debt securities. The Bank was frustrated that the Stability and Growth Pact had not prevented public accounts from deteriorating, and the bond market was not in their eyes carrying out their role of risk assessors adequately. This was an attempt by the Bank to counteract the widely held view within the markets that if a central government of any EMU member country threatened to not pay its debt, it would be bailed out by the collective EMU governments. This implicit bail-out commitment made portfolio holders consider that the debt instruments of all EMU member governments should bear the same default risk.

The credibility of the ban on bail-outs depends on the ability of the financial system to survive the failure of a significant defaulter and on the role played by the government in providing public services and employment. A sovereign borrower may get too big for any market and may be directly responsible for the provision of essential services so that the costs of a bailout may be outweighed by those of its failure. The ECB's mandate of ensuring price stability may, in the eyes of the market, mean that it has to intervene to bail-out an issuer in financial difficulty. Thus, monetary union may have weakened the disciplinary function of credit markets. The theory behind market discipline is that by increasing the default premia or imposing credit constraints could in principle discipline irresponsible sovereign borrowers. Market-based fiscal discipline would take the form of a rising interest premium on the debt of a country running excessive deficits until,

eventually, it would be denied access to additional credit. The increase in the cost of borrowing combined with the threat of reduced availability of credit in the future would provide an incentive to correct irresponsible fiscal behaviour.

Prior to monetary union, it was the currency of the sovereign in distress that bore the brunt of the markets displeasure. As there is now no possibility for a sovereign to adjust its exchange rate within the Euro Zone, a country that has relatively high inflation can quickly lose price and cost competitiveness against fellow members (with consequences for growth and unemployment) unless it takes action to bring inflation under control. In the benign economic environment, that was experienced up to 2007 with low levels of global inflation and interest rates, the Stability and Growth Pact has proved a very poor incentive for fiscal prudence. What would happen then when the members of the monetary union experience less favourable times, access to large pools of debt may prove too difficult to resist. The euro now serves as a shield for member government policies against currency crises. Governments are in a much better position to assert their prerogatives over fiscal policy today than when they faced the threat of market speculation in the currency markets. However, this shield may in the future allow a profligate government to increase the amount of debt that it takes on and may lead if unchecked to the destruction of the union itself. I investigate in this chapter if we can identify the possibility of this free-riding risk component within the euro sovereign yield. To the best of my knowledge there is no empirical research that investigates this issue in the bond market, the de facto replacement for the foreign exchange markets at the inception of the euro.

4.2 The Market's Role as Assessors of Risk

The possible consequence of public debt on government bond yields is an important issue for economists and policy makers alike. As government bond yields contain a risk premium, increasing indebtedness will cause bond yields to rise, thus increasing the cost of borrowing and imposing discipline on governments. In a monetary union such as EMU, the efficient functioning of bond market discipline is especially important as member states can still issue debt independently, but no longer have the option to monetize and inflate away excessive debts. The convergence of Euro bond yields seen with the introduction of EMU has been seen by many as proof that fiscal discipline has been strengthened with the creation of the Stability and Growth pact. They contend that increased integration has not weakened the disciplinary functioning of the bond market and bond yield spreads can be explained by liquidity and differences in perceived credit risks, which in turn reflect the sustainability of the countries' fiscal positions.

This view can be seen to be echoed by Jean-Claude Trichet, President of the ECB in a lecture on the 11th of May 2006. "..the observed convergence in government bond yield spreads mainly reflected the closer coordination of monetary policies across euro area countries – an overall compression of risk premia also observable in other markets and outside the euro area – and the ensuing convergence of inflation expectations across countries, as well as the progressive elimination of uncertainty regarding exchange rate movements and, finally, the disappearance of intra-euro area exchange rate risk by the time the euro was introduced. Since 1999, government bond yield spreads have mainly reflected differences in liquidity and in perceived credit risks, which in turn reflect the sustainability of the countries' fiscal positions."

However, a number of researchers are now starting to question this hypothesis eg. Manganelli and Wolswijk (April 2007) who investigate the relationship between

financial integration, market discipline and fiscal rules in the Euro bond market. In this chapter I will build on their research to investigate if long term interest rates on the government bonds of the Eurozone countries accurately incorporate the probability of default within the yield they return to the investor. The 10-year government bond rates at the end of 2004 were 3.72 percent in France, 3.71 percent in Germany, 3.88 percent in Italy and 3.76 percent in Spain, all essentially the same. Spain received no reward from the bond market for its low deficit (1.1 percent of GDP) or its low debt (less than half of Italy's debt to GDP ratio of 106 percent.). This is not surprising because there is no incentive for markets to penalize individual countries for borrowing excessively. Already five of the 12 euro area countries have deficits that exceed the 3 percent ceiling, with Greece topping 6 percent. Yet the bond market has still shown no tendency to punish those with high deficits or to reward those with low deficits and national debt. The risk looking forward is that each country will find ways to sanction growing fiscal deficits, comfortable in the knowledge that there will be no formal pressure from other EMU countries and that the interest rate effects will be the same for all EMU countries.

Improved risk assessment, via a further widening of spreads, automatically means an increase in the cost of borrowing attached to public debt. As such, there is a major implication for the countries involved. The evaluation of a default risk, which is hypothetical for eurozone countries, is largely based on an analysis of the sustainability of a country's public debt. The latter is directly dependent on the real debt burden and the prospects for potential economic growth. However, will widening the spread by a few basis points be enough of a disincentive for sovereigns to bring their fiscal excesses under control? Since the introduction of the euro, and more importantly the introduction of electronic exchanges, and the associated continuous market making obligations, the pricing of individual euro sovereigns bonds are driven by international factors and the

individual credit component or default risk being almost a constant value added to the regional yield, as will be discussed in the next chapter.

4.3 Eurozone Credit Ratings

Sovereign credit ratings are forward-looking qualitative measures of the relative likelihood that a borrower will default on its obligations. They play an important role in determining a country's access to international capital markets and its cost of capital. As more countries look to access this market, the information on the probability of default inherent in the rating becomes more important to both lenders and borrowers as the cost of gathering this information independently becomes prohibitive. The credit rating is an important part of the overall yield of sovereign bonds[21]. Sovereign borrowers with the low ratings must pay a higher return to lenders to cover the higher probability of default when compared to sovereign with higher ratings as they compete for funds in the capital markets, Cantor and Packer, (1996).

Governments obtain credit ratings to ensure that their debt reaches as wide a pool of lenders as possible, which will help reduce the yield they must pay on the debt. The rating also allows other institutions within the country to issue their own debt and gain access to lenders outside their own national boundaries. The rating the sovereign achieves also affects the ratings assigned to borrowers of the same nationality, e.g. CRAs almost never assign a credit rating to a local municipality, provincial government, or private company that is higher than that of the issuer's home country. Certain investors such as Pension funds are regulated and are restricted to investment grade securities only, therefore many investors favour rated securities over unrated securities of comparable credit risk.

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[21] See, for example, Larraín, Reisen, and von Maltzan (1997), who find evidence that ratings "Granger cause" the yield spreads of sovereign bonds.

4.3.1 Credit Rating Agencies and Their Ratings

Financial markets have an essential function in modern economy, where they direct funds from savers who have no productive use for them to people who do. An essential aspect to consider for savers is the credit risk involved in lending and difficulty in gathering accurate information on the credit worthiness of the borrower. The Credit Rating Agencies solve this problem by providing a credit rating, which is that rating agency's opinion of the creditworthiness of a borrower. The importance of their opinions to investors and other market participants, and the power of these opinions on the financial markets have increased significantly. The central role the CRAs now play in governance and financial regulation means that their opinions can even impact on a borrowers access to capital markets as well as preventing certain lenders from investing in borrowers that the CRAs perceive to be too risky. The activities of CRAs can produce major consequence with a poor rating driving up an issuer's borrowing costs with the possibility of putting companies out of business.

Credit ratings provide a subjective summary evaluation of an issuer's relative creditworthiness. They are not precise measures of default risk but instead make possible comparisons across borrowers by means of standardised risk categories. Each rating agency defines its own categories, the connection between the different agencies' categories is well understood by market participants. Moody's allocates ratings from Aaa for the least risky debt to Baa3 for the most risky investment grade debt; these correspond to ratings from AAA to BBB by Fitch and Standard & Poor. Furthermore the CRAs also announce outlooks, reviews and credit watches. Outlooks reflect rating agencies' projections; positive, negative or stable, regarding the future direction of an issuer's credit quality over the medium term, usually over a 12- to 18-month horizon. They are normally modified when a change in an issuer's risk profile has been observed but it is not yet considered permanent enough to deserve a new credit rating.

Furthermore, a change in outlook will not always lead to a change in rating. "Reviews" and "Credit watches" are indistinguishable; both give a stronger indication than "Outlooks" of future changes in ratings. The rating of an issuer placed on review for an upgrade or downgrade is typically changed within weeks of the review. However, issuers do not need to be on review to be upgraded or downgraded. CRAs can change ratings without any prior announcement of a change in outlook or a review.

Table 5 CRA Rating Categories

Moody's	Standard & Poor's	Fitch	Interpretation
Investment –Grade Ratings			
Aaa	AAA	AAA	Highest Quality
Aa1	AA+	AA+	High Quality
Aa2	AA	AA	
Aa3	AA-	AA-	
A1	A+	A+	Strong payment capacity
A2	A	A	
A3	A-	A-	
Baa1	BBB+	BBB+	Adequate payment capacity
Baa2	BBB	BBB	
Baa3	BBB-	BBB-	
Speculative-Grade Ratings			
Ba1	BB+	BB+	Likely to fulfil obligations,
Ba2	BB	BB	Ongoing uncertainty
Ba3	BB-	BB-	
B1	B+	B+	High-risk obligations
B2	B	B	
B3	B-	B-	
(close to) Default			
Caa	CCC+	CCC+	Lowest Quality
Ca	CC	CC	
C	C	C	
	D	D	

The rating or ranking approach aims at providing an overall view of relative risk when comparing differing investment decisions. Brealey and Myers (2000) have observed that "business people have good intuition about relative risks, at least in industries they are

used to, but not about absolute risk or required rates of return". Thus, the objective of rating methodologies is to grade countries depending on the risks involved and their ability to repay their debts. This allows lenders to compare rates of return between similar investments in other countries. It is much easier to estimate a relative level of risk than an absolute level of risk, and it is not for the CRAs to decide what that rate of return should be.

As mentioned in the Literature Review, there exists no comprehensive theory of country risk, and all approaches are purely empirical. They rely on quantitative evaluations and/or qualitative indicators that provide a more or less explicit score. These scores are then transformed into a rating. Rating methods can be divided into two groups, country risk ratings which cover the full range of foreign investments and incorporate all the possible kinds of risk. Clei (1994), writes "The country risk ranking is necessary both to check the overall consistency of the assessments and to price the guarantees, since the premium rate charged by Coface (French CRA) is a function of several parameters of which the most important is the risk category of the host country". The second group focuses exclusively on debt instruments with Bond investors, Investment banks and Sovereign borrowers in the international capital markets as their main target. It is this second group of ratings that I will be utilising in my research later in this chapter.

4.3.2 The Economic Rationale for the Use of Ratings

The economic rationale for using ratings and their increasing "popularity" arises from their capacity to provide information economies of scale to borrowers and from their contribution to solving principal-agent problems for regulators. Both have found ratings a very powerful tool when analysing the risk involved in various transactions. Because of their unique role in the financial markets, CRAs have access to information on borrowers that investors could not hope to replicate. Also CRAs employ large teams of risk professionals to analyse this information before announcing their ratings opinion, which again could only be justified for the largest investment banks. From the point of view of Regulators, the CRAs increase the stability and efficiency of the financial markets by minimising information asymmetries between investors and the issuers of debt. This transparency has increased the investor pool and provided important impetus to the development of financial markets.

The role of CRA ratings in regulation has been a major topic of debate since the Enron scandal in 2001, where the company held an investment grade rating by all the major CRAs even when it filed for bankruptcy. The widespread corporate fraud that was perpetrated led to accusations that the CRAs were "asleep at the wheel" and calls for reform. However, ratings still remain at the heart of financial regulation, as the CRAs responded to these criticisms with new products such as the market implied rating, which looks to balance the traditional long-term horizon of the CRAs with the short-term horizon of the financial markets. The CRAs previously looked to hold the rating constant through the entire business cycle; over 5 years, which meant that portfolio managers were not forced to chop and change their allocation because of a rating change. The CRAs now give the choice of horizon and leave it to the regulator and investor which method they prefer to follow.

The significance of ratings-based regulations has historically been restricted to the United States, where it can be traced back to the 1930s. However, with the growth of financial debt markets globally in the 1970s the CRAs expanded their offering to include international bonds. With globalisation, the requirement for a "standardised approach to credit risk" led to the Basel II Accord (June 2004) which created an international standard for banking supervision. At the core of this accord was the quantifying of credit risk. This relies explicitly on "external credit assessments", thereby placing CRAs at the heart of global governance. These regulations will affect not only banks, but also pension funds, insurers, mutual funds and broker-dealers, restricting or barring the purchase of debt whose rating is not considered to be investment grade (usually below BBB). This restriction will increase the cost of capital to a borrower depending on the rating he achieves from the CRAs.

The creditworthiness of market participants as judged by the CRAs will also impact on the conditions under which participants access the market. This is particularly true with respect to the short-term management of liquidity (Repo markets) and over-the-counter derivative transactions (Swaps, Options, etc.) where counterparty risk is an important component of the yield. The rating will determine the conditions (costs) under which those investors can access the market (the frequency of margin calls, the amount of collateral required etc). Central banks also depend on the CRAs ratings; indeed for the ECB, the minimum rating for eligible debt assets to be deposited at the European Central Bank is explicitly stated and must be at least "A-" from Standard & Poor's or Fitch Ratings, or "A3" from Moody's. This highlights the importance of credit ratings and the 3 credit rating agencies in particular to the functioning of the European monetary policy.[22]

4.3.3 Euro Sovereign Rating History

When a sovereign retains the right to print its own currency the subject of default is mostly an academic one.[23] The risk instead is that a sovereign may repay its debt through excessive money creation, in effect eroding the cost of its commitments through inflation. However, when a sovereign borrows in a foreign currency there is a greater probability of default, as any increase in the supply of domestic currency will be negated by changes in the exchange rate, thereby maintaining the real cost of the debt. Therefore, the objective of sovereign ratings is "to assess the sovereign's ability and willingness to generate the foreign exchange necessary to meet its obligations" (Fitch, 2002). As the Eurozone countries do not have the right to print money (Euros), although it is their domestic currency, the ratings these countries were assigned at the beginning of the EMU were their former foreign-currency ratings. Table 6 displays the ratings of each eurozone sovereign as assigned by the 3 main rating agencies, Moody's, Standard & Poor and Fitch, as well as a current history of their rating changes.

By eliminating currency risk for European investors, the euro has allowed bond investors to focus on credit risk, while the enlargement of their investment universe has increased their need for simple indicators of this risk. Market participants and financial regulators have therefore turned to the CRAs to supply this information and highlight any issues of financial weakness. The CRAs provide a very important role in the market when it comes to financial discipline as discussed previously. I will be investigating if they apply the same criteria to all euro sovereigns equally or whether there are discrepancies on how different countries are treated.

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[22] "ECB targets its problem Nations" By Ralph Atkins and Mark Schieritz, Financial Times, Nov 10, 2005

[23] This is not always correct as exemplified by the Russian government default on its domestic debt in August 1998.

Table 6 Eurozone Foreign Long-Term Ratings History

Sovereign	MOODY'S		S&P		FITCH	
	Rating	Effective	Rating	Effective	Rating	Effective
Austria	Aaa	26/6/77	AAA	17/3/'95	AAA	10/8/'94
Belgium	Aa1	27/3/'88	AA+	1/7/'92	AA+	5/2/'06
					AA	17/6/'02
					AA-	16/12/'98
Finland	Aaa	4/5/'98	AAA	1/2/'02	AAA	5/8/'98
	Aa1+	18/3/'98	AA+	1/9/'99	AA+	29/4/'97
	Aa1	15/1/'97	AA	17/12/'96		
France	Aaa	25/2/'92	AAA	25/6/'75	AAA	10/8/'94
Germany	Aaa	29/4/'93	AAA	17/8/'83	AAA	10/8/'94
Greece	A1	4/11/'02	A+	10/6/'03	A+	20/10/'03
	A2	14/7/'99	A	13/3/'01	A	20/6/'01
	Baa1	7/5/'98	A-	24/11/'99	A-	27/7/'00
	Baa1-	20/2/'98	BBB	30/11/'98	BBB+	25/10/'99
	Baa1	23/12/'96	BBB-	7/12/'92	BBB	4/6/'97
Ireland	Aaa	4/5/'98	AAA	3/10/'01	AAA	16/12/'98
	Aa1+	18/3/'98	AA+	6/5/'98	AA+	11/11/'94
	Aa1	13/2/'97	AA	3/5/'95		
Italy	Aa2	15/5/'02	A+	19/10/'06	AA-	19/10/'06
	Aa3	3/7/'96	AA-	7/7/'04	AA	17/6/'02
			AA	1/3/'93	AA-	23/2/'95
Netherlands	Aaa	5/5/'98	AAA	7/12/'92	AAA	10/8/'94
Portugal	Aa2	4/5/'98	AA	15/12/'98	AA	4/6/'98
	Aa3+	18/3/'98	AA-	26/5/'93	AA-	10/8/'94
	Aa3	10/2/'97				
Spain	Aaa	13/12/'01	AAA	13/12/'04	AAA	10/12/'03
	Aa2+	19/9/'01	AA+	31/3/'99	AA+	1/9/'99
	Aa2	9/12/'92	AA	1/8/'88	AA	10/8/'94

Source: Bloomberg March 2007

Research into this area is particularly pertinent as according to Moody's "rapidly rising pension and healthcare costs will downgrade the credit ratings of the world's richest industrialised countries to junk within 30 years unless their governments move quickly to balance budgets and reduce outgoings. France will reach this status by the early 2020s,

the US and Germany before 2030 and the UK before 2035". They are currently in the top Triple A category, ensuring they can borrow at low rates. The debt ratios of these countries are "set to reach levels not seen since the second world war" according to S&P.

All the major industrialised nations must confront the problem of rising healthcare costs as their populations age combined with underfunded pension liabilities. Most government have reacted to this changing demography by trying to extend the number of years before retirement and to reduce the generosity of state pensions. But S&P has said that it already takes account of these changes in its projections, and it still "estimates that according to current trends US general government debt will soar to 239 per cent of gross domestic product by 2050, against 65 percent today. France's will reach 235 per cent against 66 per cent, Germany's 221 percent against 68 percent, and the UK's 160 per cent against 42 percent. Japan, the most heavily indebted industrialised country, was set to surpass 700 per cent of GDP by 2050". This will have major implications as to the future path of eurozone ratings.

As mentioned previously, CRAs are financial service firms that determine the 'credit risk' inherent in a specific security. In other words, they provide an investor who wants to buy a government bond with an estimate of the probability with which they are not likely to get the promised return. They are not precise measures of default risk but instead facilitate comparisons across issuers by means of standardised risk categories. Also while each rating agency defines its own categories, the correspondence between the different agencies' categories is well understood by market participants. However, looking again at the table we can see discrepancies between the CRAs for almost every euro sovereign at some point in their history. In the following sections I will investigate the main determinants of these ratings and investigate how the bond market prices these risks.

4.4 Key Economic Components of Ratings

When assigning a rating to a sovereign issuer, CRAs state that they employ both quantitative and qualitative methods of assessment which involve numerous political, economic, and social factors (Moody's 1991; Moody's 1995; Standard and Poor's 1994). However, assessing the relationship between these factors and their actual ratings is quite complex, as the CRAs do not publish their methods and provide scant direction as to the relative weights they assign each factor. However, a number of academic papers have been published on this subject, one of which I will be utilising extensively in my research, namely Cantor and Packer (1996).

4.4.1 Determinants of Sovereign Ratings

Cantor and Packer (1996) examined the determinants of the levels of Moody's and S&P ratings for 49 mature and emerging market economies as of 29 September 1995. After converting these ratings to a numerical scale (with the highest Aaa/AAA=16 and the lowest B3/B-=1), they regressed these ratings on a set of 8 economic variables that had been identified by the agencies as influencing the level of a sovereign's rating. These include:

• *Per capita income.* The greater the potential tax base of the borrowing country, the greater the ability of a government to repay debt. This variable can also serve as a proxy for the level of political stability and other important factors.

• *GDP growth.* A relatively high rate of economic growth suggests that a country's existing debt burden will become easier to service over time.

• *Inflation.* A high rate of inflation points to structural problems in the government's finances. When a government appears unable or unwilling to pay for current budgetary

expenses through taxes or debt issuance, it must resort to inflationary money finance. Public dissatisfaction with inflation may in turn lead to political instability.

• *Fiscal balance.* A large federal deficit absorbs private domestic savings and suggests that a government lacks the ability or will to tax its citizenry to cover current expenses or to service its debt.

• *External debt.* A higher debt burden should correspond to a higher risk of default. The weight of the burden increases as a country's foreign currency debt rises relative to its foreign currency earnings (exports).

• *Economic development.* Although level of development is already measured by our per capita income variable, the rating agencies appear to factor a threshold effect into the relationship between economic development and risk. That is, once countries reach a certain income or level of development, they may be less likely to default. They proxy for this minimum income or development level with a simple indicator variable noting whether or not a country is classified as industrialized by the International Monetary Fund.

• *Default history.* Other things being equal, a country that has defaulted on debt in the recent past is widely perceived as a high credit risk. Both theoretical considerations of the role of reputation in sovereign debt (Eaton 1996) and related empirical evidence indicate that defaulting sovereigns suffer a severe decline in their standing with creditors (Ozler 1991). They factor in credit reputation by using an indicator variable that notes whether or not a country has defaulted on its international bank debt since 1970. This can be summarised in the following table:

Table 7 Description of variables used by Cantor and Packer (1996)

Per capita income	GNP per capita in 1994
GDP growth	Average annual real GDP (1991-1994)
Inflation	Average annual CPI 1992-1994
Fiscal Balance	Avg. gov. budget surplus (%GDP) '92-'94
External Balance	Avg. current account surplus (%GDP) '92-'94
External Debt	Foreign currency debt relative to exports 1994
Indicator for economic development	IMF industrial classification (dummy 0/1)
Indicator for default history	Default on foreign debt since '70 (dummy 0/1)
Source: Cantor and Packer (1996), table 3.	

The reference date of most of the explanatory variables was rather arbitrary. For some variables, a reference value of 1994 was taken, for others an average value of 1991-1994 or 1992-1994. However the results were impressive in terms of explanatory power. On average the variables explain 92.4% of the cross-country variation in ratings, with the explanatory power for S&P being slightly higher than for Moody's, but otherwise very little differences between the two rating agencies. The individual country prediction is consequently very good, with a standard error of only 1.2 notches in ratings. The regression does not lead to any errors exceeding 3 notches in ratings and on average the rating regression predicts broad letter ratings (A, B, etc.) with about 70% accuracy. Cantor and Packer add, however, that the regression achieves its high R^2 through its ability to explain large differences in rating. The model has little to say about small differences in ratings, for example, why Mexico is rated Ba2/BB and South Africa is rated Baa3/BB. These differences, while modest, can cause great controversy in financial markets.

4.4.2 Determinants of Eurozone Sovereign Ratings

While Cantor and Packer compared the sovereign ratings issued by Moody's and Standard and Poor's for 49 Industrialised and developing nations, I concentrate my investigation on those countries that make up the European Monetary Union. As these countries are all linked by a common monetary policy, we would expect therefore that the explanatory power of the Cantor and Packer model would be even greater within this special subset. If we now look at the variables that Cantor and Packer consider significant when assigning a rating and apply them to the euro area we can quickly see some very interesting results. I can remove 2 variables immediately; Economic Development and Default History have never been a determinant since the introduction of the euro. Using data supplied from Eurostat[24] for the variables of each country (Appendix - 1) and the CRAs credit ratings supplied from Bloomberg I create a table containing some very simple statistics.

In Table 8 I calculate the average value of each determinant for each rating category. For example, Germany has a rating of Aaa/AAA so all its data will be entered into the Aaa/AAA column along with all other countries that achieve Aaa/AAA ratings. The differences in the data values are due to the CRAs assigning different ratings to sovereign issuers. There are 7 Aaa/AAA rated countries according to Moody's and Fitch and the average value of their Government Debt is 52.97, while S&P has only given 6 countries its highest rating. We can see that 4 of the six variables are directly correlated with the ratings assigned by the CRAs (Table 8). In particular, just as found by Cantor and Packer, high per capita income appears to be closely related to high ratings. CRAs clearly have a sliding scale, with the highest income countries receiving the highest rating, moving down the scale to the lowest income country receiving the lowest rating.

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[24] Eurostat aim is to provide the European Union with a high-quality statistical information service.

Table 8 Sample statistics by rating category for all eurozone countries, June 2004

Variables	Agency	Aaa/AAA	Aa1/AA+	Aa2/AA	Aa3/AA-	A1/A+
Fiscal Balance	Moody's	-1	0	-3.1		-6.6
	S&P	-1.15	-0.05	-3.1		-6.6
	Fitch	-1		-3.266		-6.6
Government Debt	Moody's	52.97	95.7	82.95		109.3
	S&P	53.97	71.35	82.95		109.3
	Fitch	52.97		77		109.3
Per capita Income	Moody's	116.15	118.5	87.6		81.5
	S&P	119.18	108.1	87.6		81.5
	Fitch	116.15		94.87		81.5
GDP Growth	Moody's	2.74	2.6	1.2		4.7
	S&P	2.68	2.85	1.2		4.7
	Fitch	2.74		1.56		4.7
Inflation	Moody's	1.85	1.9	2.4		3
	S&P	1.65	2.5	2.4		3
	Fitch	1.85		2.36		3
External Balance	Moody's	4.91	4	-3.55		-8.4
	S&P	6.36	0.1	-3.55		-8.4
	Fitch	4.91		-2.26		-8.4
Frequencies: Number Rated	Moody's	7	1	2	0	1
	S&P	6	2	2	0	1
	Fitch	7	0	3	0	1

Source EuroStat, Average or Mean value of each variable for each separate rating category.

But Moody's and Fitch seem to contradict this correlation when it comes to their Aa1/AA+ rating, in this section Moody's have placed Italy and Fitch have placed Belgium and Italy. Both these countries have very wealthy citizens but a very poor state, and therefore proves that no one variable can over-ride another. As discussed previously the CRAs do not use a pure quantative approach to applying ratings, and this seems to be borne out in the eurozone as well.

Another finding in Cantor and Packer is that lower inflation is consistently related to higher ratings. In our data, we are unable to make the same conclusion. As discussed previously, one of the explicit aims of the European Central Bank is to target inflation across the eurozone. As we can see from our data, while there are variations across the zone over time, with countries such as Ireland and the Netherlands experiencing periods

of high inflation, it seems that the bank is doing a very good job, with the inflation rate as a whole for the eurozone remaining around the bank's stated goal of 2%. Also it can be noted that there seems a convergence in the data between the various countries to this common goal. This is a very interesting insight, and may suggest the business cycles within the eurozone are also converging, Artis & Zhang (1997, 1999), Frankel & Rose (1998) and Clark & van Wincoop (2001), Massmann & Mitchell (2003). This is proof of further integration between the eurozone economies.

Cantor and Packer also note that lower Government Debt is consistently related to higher ratings. My data agrees with this view; we can see from Table 8 that for each CRA there is a very clear correlation between the Government Debt and the credit rating, and highlights the burden faced by a sovereign in meeting its financial obligations when heavily indebted. However another interesting item, between Cantor and Packer and my data, is highlighted by the fact that they conclude that – GDP Growth, fiscal balance and external balance – lack a clear bivariate relation to ratings. Except for GDP Growth, where my data also shows no clear relationship, we can clearly see a correlation between ratings and the other two variables. Cantor and Packer suggest that the lack of a relation between GDP Growth and ratings may be because many developing economies tend to grow faster than mature ones. Looking again at table 8, what is interesting to see is not the difference between the various countries GDP Growth, but how they seem to move together over time. If one looks at the GDP Growth of Germany and compare it with France, then one can see that every time the German growth rate increases so does France's, and the same can be seen every time the growth rate decreases. We will look at this further in the following sections. Again, just as in the case of inflation, one can make the case that there has been integration between the eurozone economies.

One cannot fail to recognise the correlation between ratings and the remaining two variables, Fiscal and External Balance. This contradicts the findings of Cantor and Packer, who were themselves surprised by their findings. They suggest that the lack of a relationship between the ratings and these variables may be due to restrictions of international capital for some low-rated countries. This is not the case within the eurozone, where there are almost no restrictions to the transfer of funds between countries. Again one must mention that the Fiscal Balance is supposed to be a key component of the Stability and Growth Pact, so one should not be surprised to see such a clear correlation between the Fiscal Balance and the associated credit rating as found in our data. Again looking at table 8 for both the Fiscal Balance and External Balance data, we can clearly see a progression with the highest rating being applied to countries that run a surplus, and the ratings clearly being downgraded as countries move into deficit. This is not a surprise and demonstrates that the eurozone governments have been running their economies in the same way for a very long period of time. It also highlights how difficult it is for a sovereign that is heavily indebted to turn around its economy.

Another clear progression in table 8 can be seen from the Per Capita Income and the Government Debt. In the Per Capita Income data, countries with the highest values also have the highest ratings. The exact opposite can be seen from the Government Debt data, with those countries carrying the highest debt having the lowest rating. The only discrepancy being Belgium, which even if it has a large debt still has a very high Per Capita Income. The Belgium debt became a political issue in the run-up to entry to the eurozone, as it did not meet the minimum requirements. Therefore various political parties electioneered on the promise to bring the debt down, and this has been the trend now for a number of years as can be seen from the data. This helps to keep its rating higher than otherwise it should possibly be and demonstrates that one cannot judge a rating by one simple statistic.

In conclusion, we can postulate that there are 4 variables that separate the ratings of the eurozone economies. These are Fiscal Balance, Government Debt, Per Capita Income and External Balance. Compared to the 8 variables discussed by Cantor and Packer, the GDP Growth and Inflation are now almost the same within the eurozone economies. This is in part because of the increased integration of their economies, the common interest rate set by the European Central Bank and the subsequent common business cycle. The other 2 variables, the indicators for economic development and default history are common across the eurozone, and are too crude a measure for this dataset. It should also be noted that of the 4 variables we are left with, 2 are explicitly mentioned in the Stability and Growth pact, so it is no surprise that these should be an important part of the rating process.

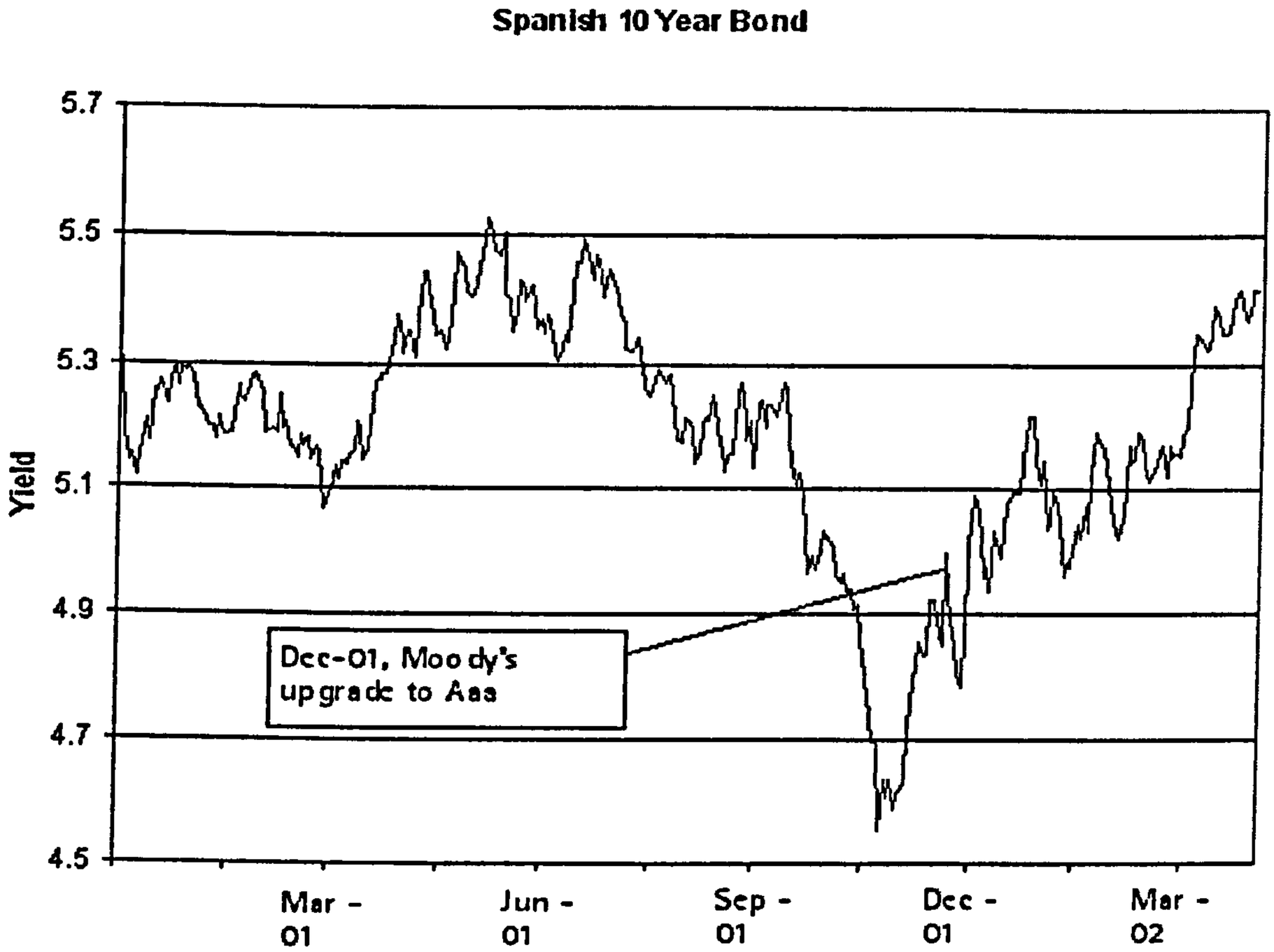
The remaining 2 variables, Per Capita Income and External Balance are implicitly the most important part of the equation. The drive behind the entire Euro project is to increase its population's living standards, i.e. Per Capita Income, and we can see that countries with high ratings generally have all the other variables in place as well, particularly the External Balance. In an open economy such as the Eurozone the main driver of increased living standards is via increased trade. Countries with a competitive advantage, either through natural resources or advanced economic development will under the present system of assessment applied by the CRAs have a substantial lead. However, a simple quantitative model like this cannot explain all variations in ratings across countries: as the agencies often state, qualitative social and political considerations are also important determinants. But until the CRAs publish exactly what variables they study and the weighting supplied to them, then we are left with analysis such as this.

4.5 The Relationship between Euro Bond Yields and Ratings

In addition to the relationship between a country's economic indicators and its sovereign ratings, the effect of ratings on yields is of interest to market practitioners. Although ratings are clearly correlated with yields, it is far from obvious that ratings actually influence yields. The observed correlation could be coincidental if investors and rating agencies share the same interpretation of a body of public information pertaining to sovereign risks. For bond ratings to have a direct, information related impact on the yield, they must contain relevant pricing information that investors cannot obtain from other sources at comparable cost.

Changes in the rating of an EMU sovereign should have a direct impact on the yield of its bonds. Yet most of the time these rating changes have been largely anticipated by the market either due to the improvement in that country's official rating outlook or just based on previous comments or reports from these agencies. A clear example of this relationship between yields and ratings was seen in December 2001, when Moody's upgraded Spain to Aaa. Prior to the announcement, based on the previous comments from this agency, the market was already speculating with the possibility of a rating upgrade. Yet Moody's decided to upgrade the Spanish debt by two notches, taking its rating to the highest category. The extent of the shift surprised the market, which expected just a single notch increase. Most analysis on credit rating changes focuses on the impact to the yield spread; I will investigate this also in the next section. However, if one looks at the absolute impact of the change in ratings instead of the relative impact, one can also see some interesting features.

Figure 2 Spanish Bond before and after rating upgrade



Source Bloomberg

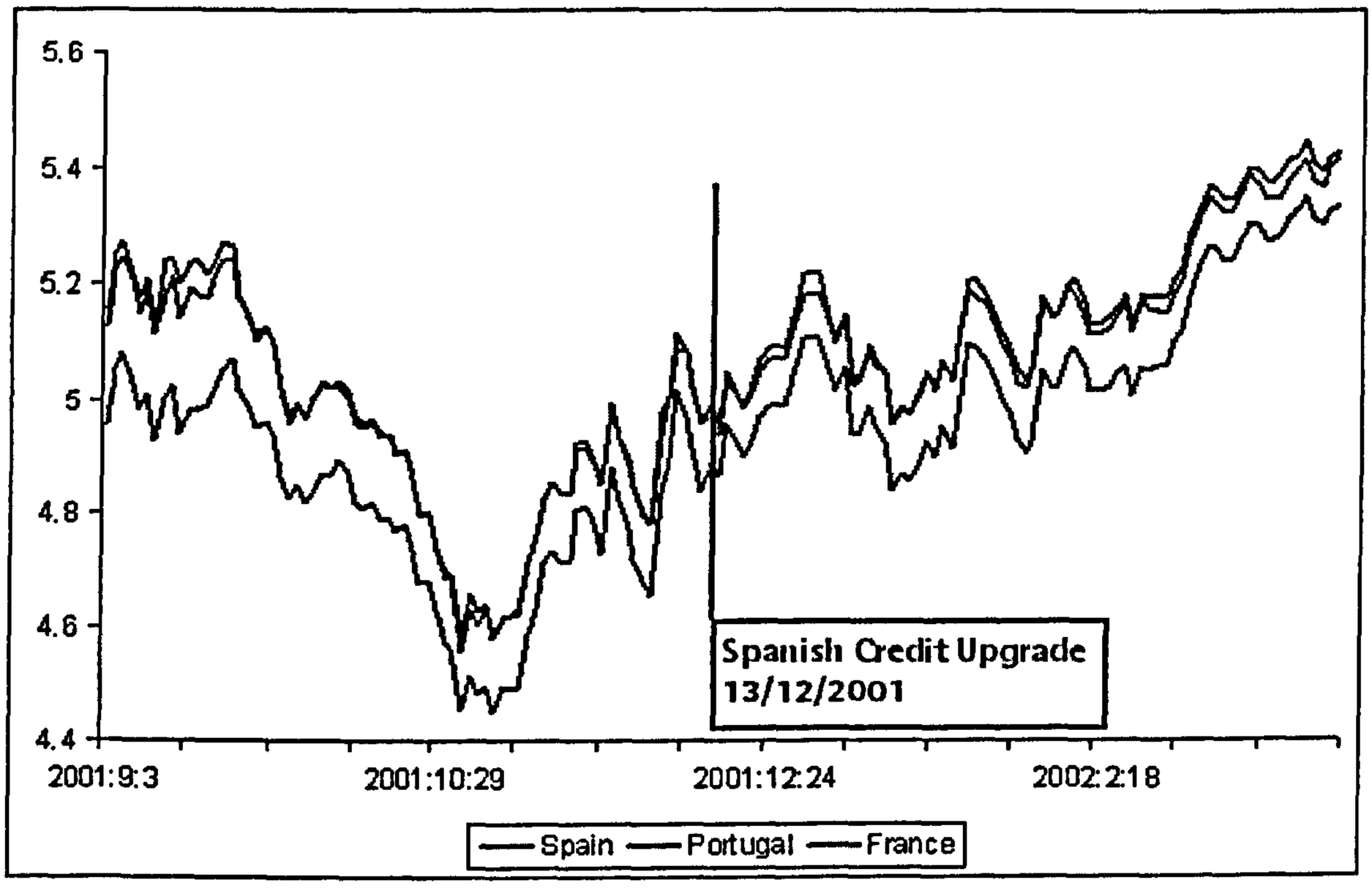
Looking at Figure 2, one can see that the yield on the bond reached its lowest point approximately one month before the announcement took place. This is definite proof of the old trading maxim, "buy the rumour, sell the fact". Obviously it is difficult to analyse the impact of the rating in isolation from this graph, but one must be at least be mildly surprised why a 2 notch rating change has almost no impact if one compares the yield on the 1st Sep 2001 to 1st March 2002. One must conclude that the risk of default is still the same, even with the increased rating. To understand why this is the case, we must look at the world-wide price of risk. If one investigates the yield spread, it is possible to see a more long lasting change versus other countries, but is this of any benefit to the country in question? The above graph highlights what a small part of the overall risk the credit component is, when compared to the total risk of holding the bond.

In this section I will be looking at how a credit event is transmitted through the EMU bond market. This is very similar to the concept of contagion, but instead of just looking

at economic crises and how they spread from one countries bond market to another, I will be looking at other effects as well such as the Spanish credit rating upgrade in December 2001. The first test will be to check how a credit rating upgrade of one country's bonds affects the yields of its neighbouring countries. This will give us a deeper insight into the transmission mechanisms in the EMU bond market. Figure 3 shows the yield of the Spanish, Portuguese and French 10 Year bond yields in the 3 months before and after the Spanish credit rating upgrade by Moody's. From the graph, one can see that the yields for all 3 bonds look to be very closely correlated, but it is difficult to see how the credit rating upgrade affected the yield of the other sovereigns. This is surprising, especially since Spain and Portugal are linked not only geographically, but are also very close economic trading partners. I had expected that any upgrade in Spain's credit rating would have a positive impact on Portugal's yield, similar to a positive contagion effect. However, this does not seem to be the case here.

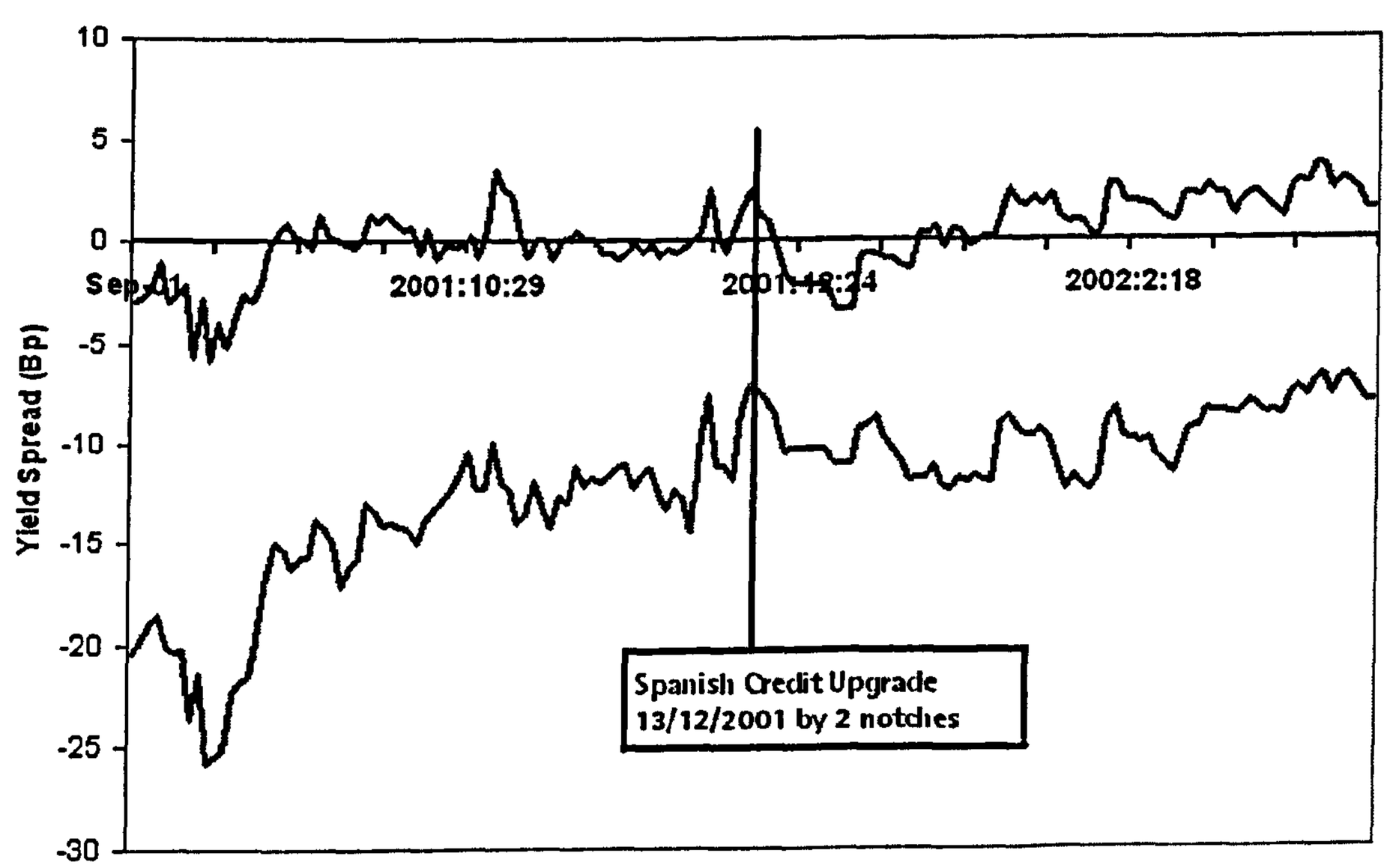
What is very interesting about the above graph is not so much the impact of the credit rating announcement, which seems to have a negligible impact not only on Spain's yield but also its neighbours, but how similar the yields of the various bonds are over time. Returning to the credit announcement, we can examine its impact more closely by comparing the yield spread before the upgrade and afterwards. To do this we examine how the Spanish yield changed relative to the other sovereigns (Figure 4).

Figure 3 Spanish, Portuguese and French 10-Year Government Yields(%)



Source Bloomberg

Figure 4 Portugal and France versus Spain 10-Year Spread



Source Bloomberg

Looking at the above graph we can see that the yield spread actually increased after the announcement. We can see that in the long-run the yield spread between Spain and its neighbours has been decreasing, but the credit upgrade announcement instead of accelerating this, actually caused the spread to go into reverse in the short term. The reason for this could be that the market expected that once the maximum rating had been achieved, the sovereign would slow its rate of fiscal austerity, or issue more bonds to the market in the hope of maximising its new credit rating profile. However the market quickly forgot its concerns and the yields on Spanish bonds have continued to converge to those of other sovereigns in its credit class.

As of May 2006 and since the inception of the Monetary Union only one country has been downgraded. In July 2004 S&P downgraded the rating of the Republic of Italy by one notch to AA- given "the persistence of large structural fiscal deficits and the lack of a well-defined medium-term fiscal strategy." The breach of the Stability and Growth Pact deficit threshold by several countries (Portugal in 2001 and Germany and France in 2002) could also endanger these countries' rating outlooks. The fiscal evolution is therefore being closely watched by the market as they may have an impact on these countries' yields.

4.6 The Disciplinary Function of Euro Sovereign Bond Markets

From the paper by Cantor and Packer (1996), discussed in section 4.4.1, we saw how a few key economic variables influence a sovereigns rating or probability of default, which in turn impacts on the yield the market requires in compensation for holding this sovereign debt. Also as discussed previously in section 2.7.2, the yield differentials across Eurozone countries are determined by credit and liquidity risk. If we use the probability of default as a proxy for the credit risk component then we can develop a relationship between the yield, rating and the liquidity risk. This will allow us to investigate how the euro bond market yields have reacted historically to changes in eurozone sovereign ratings, economic variables and liquidity risk.

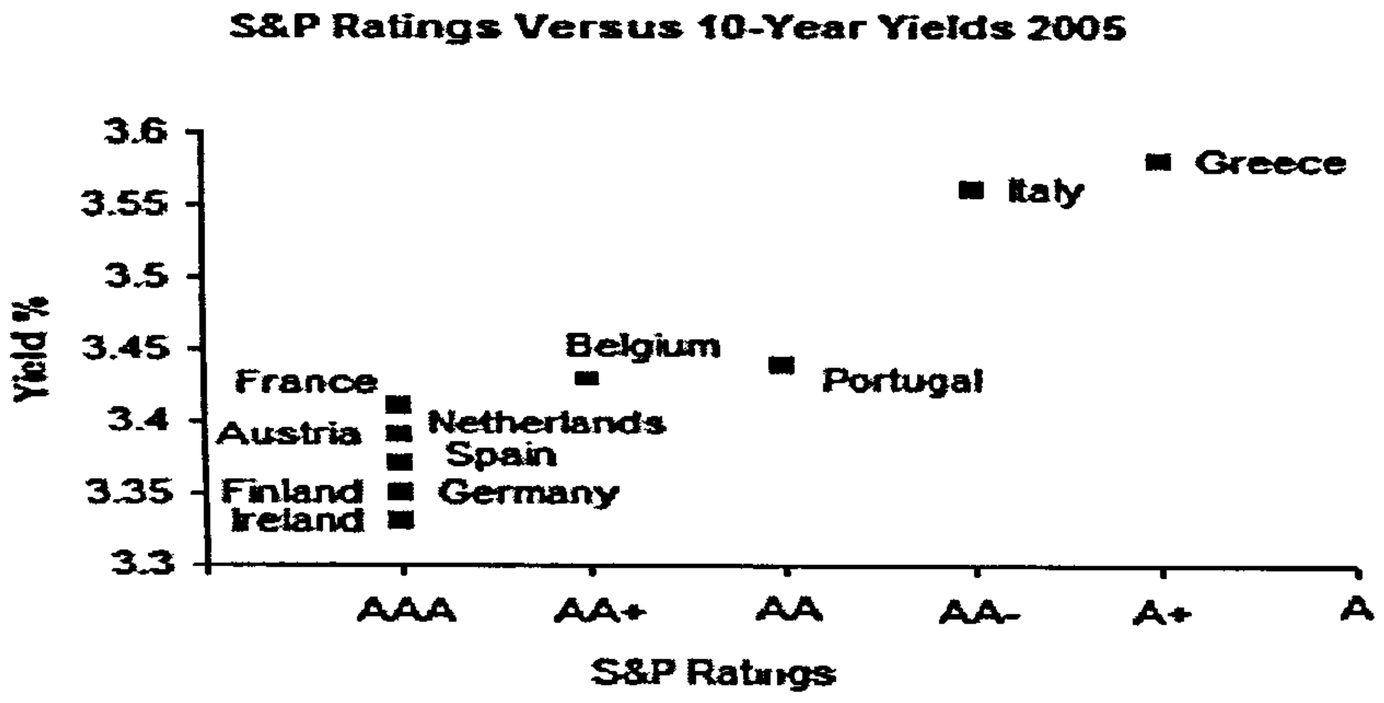
Using this model I show that Liquidity risk, while important in the early years of the euro project, has disappeared in recent years. This is in agreement with Bernoth, von Hagen and Schuknecht (2006) who found that "In the euro-denominated debt market, however, these liquidity risk premiums have vanished with the start of EMU." With the removal of the liquidity premium, I model a direct relationship between euro bond yields and sovereign credit ratings, and by extension their economic variables. This allows me to identify and rank the economic variables which have the most influence of the euro bond yields. This is very important as the SGP explicitly identifies the Deficit and the Debt/GDP ratios. If these are found not to be significant in the bond market, it would signify that the market does not take the SGP seriously and hence will impact on the disciplinary function of the bond market.

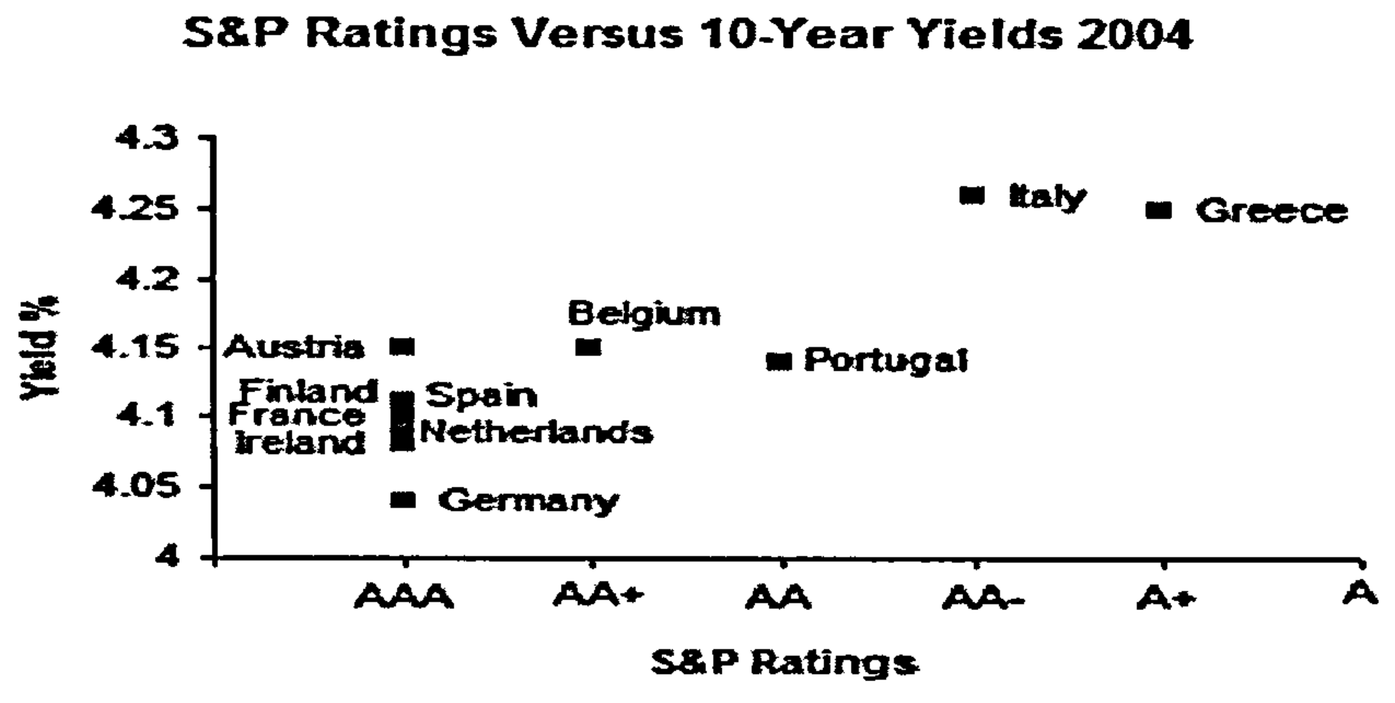
4.6.1 Euro Yields and Ratings over Time

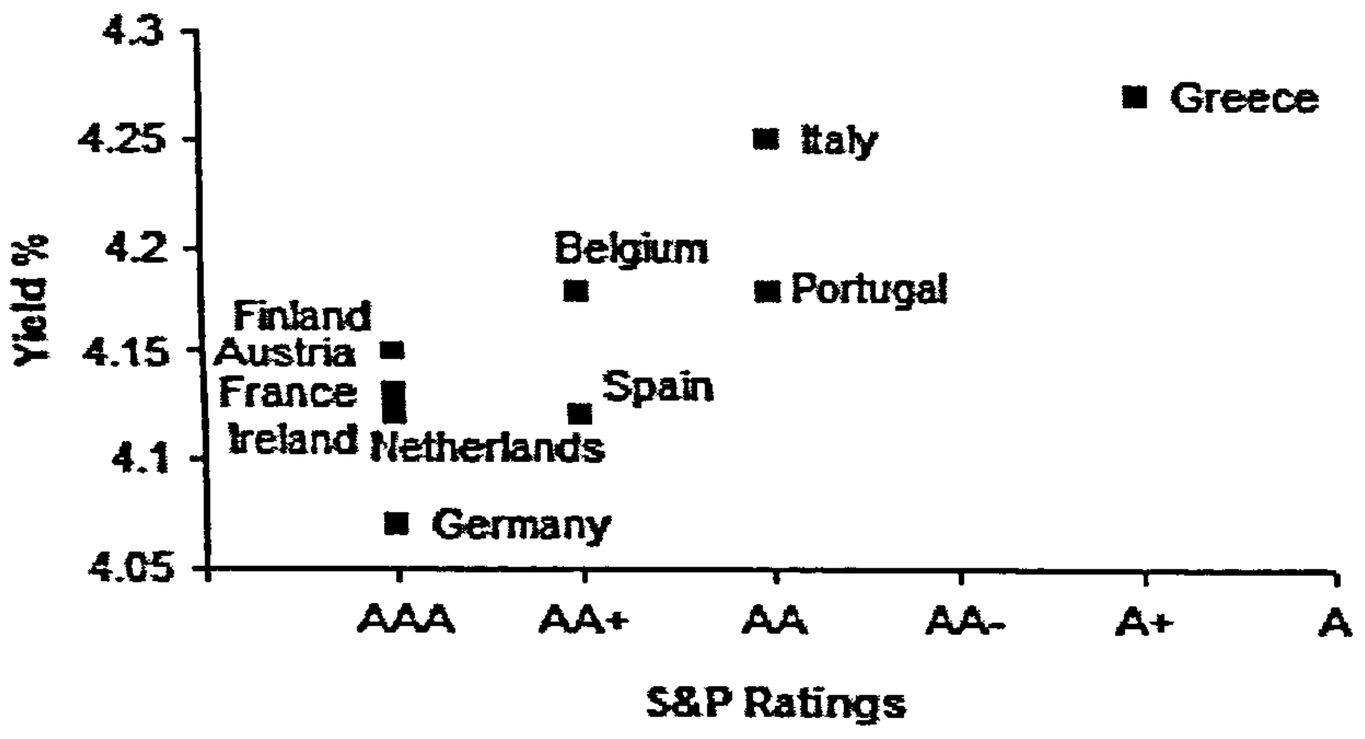
As in the paper by Cantor and Packer (1996), I investigate the relationship between Eurozone sovereign yields and their associated ratings since the beginning of EMU. Figure 5 displays the bond yields (average yearly supplied by Ecofin) versus the S&P rating for each year from 1998 to 2005. As described by Cantor and Packer a pattern is clearly visible, as one moves down the rating scale sovereign bond yields tend to rise. What is interesting is that for sovereigns with the same rating there is a substantial difference in the market yield within the rating class. One interpretation of this finding is that although financial markets generally agree with the agencies' relative ranking of sovereign risk, there is little consensus as to what the yield should be within that rating class. Another interpretation is that while ratings cover a full business-cycle, while yields are more sensitive as to where a particular country is within its business cycle. With closer integration in the eurozone, one would expect to see these cycles becoming similar for each euro member.

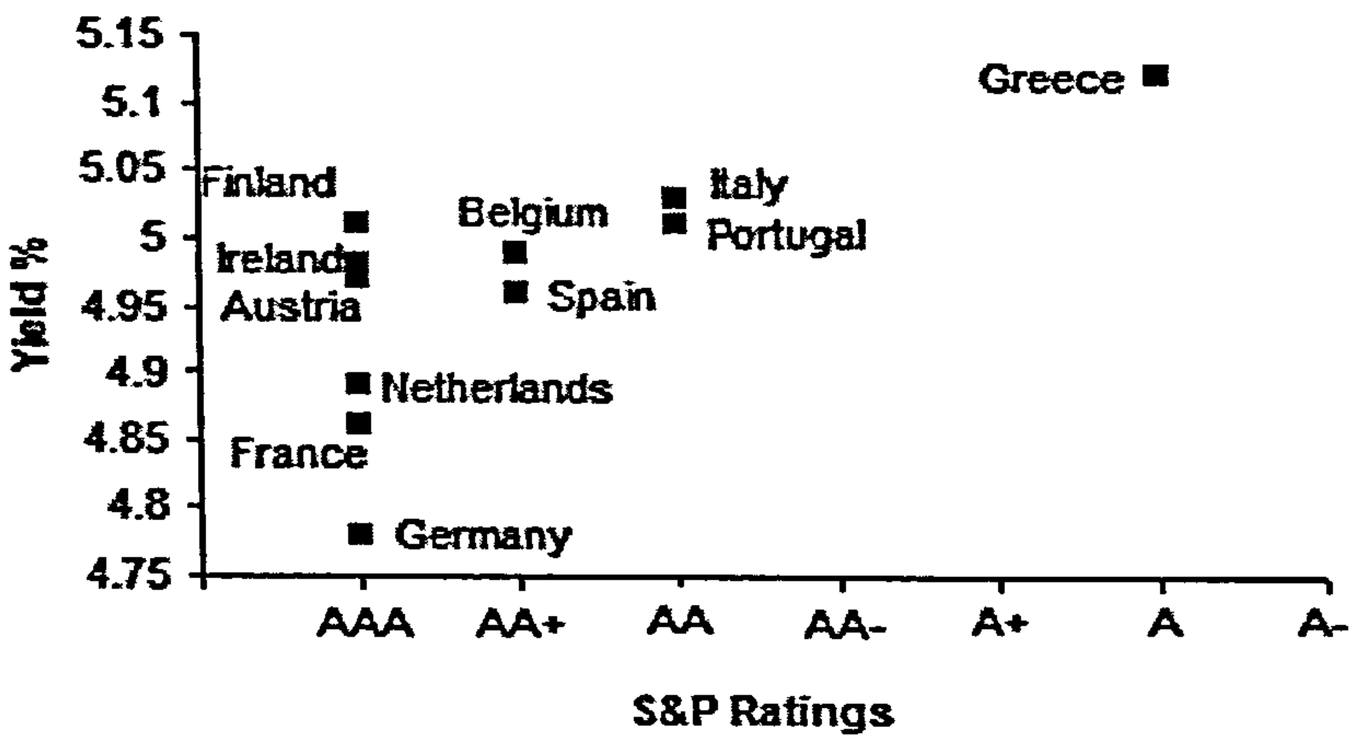
Cantor and Packer went on to investigate the degree to which ratings explain yields. The found "that a regression of the log of bond spreads against their average ratings shows that ratings have considerable power to explain sovereign yields". They found that a "single ratings variable could explain 92 percent of the variation in spreads, with a standard error of 20 basis points". They concluded that "ratings appear to provide additional information beyond that contained in the standard macroeconomic country statistics incorporated in market yields ..... implying that the macroeconomic indicators do not add any statistically significant explanatory power." I replicate their research here by developing a model of ratings versus yields for the Eurozone members for each year from 1998 to 2005; the results are displayed in table 9 below.

Figure 5 History of S&P Rating Vs Yield 1998-2005

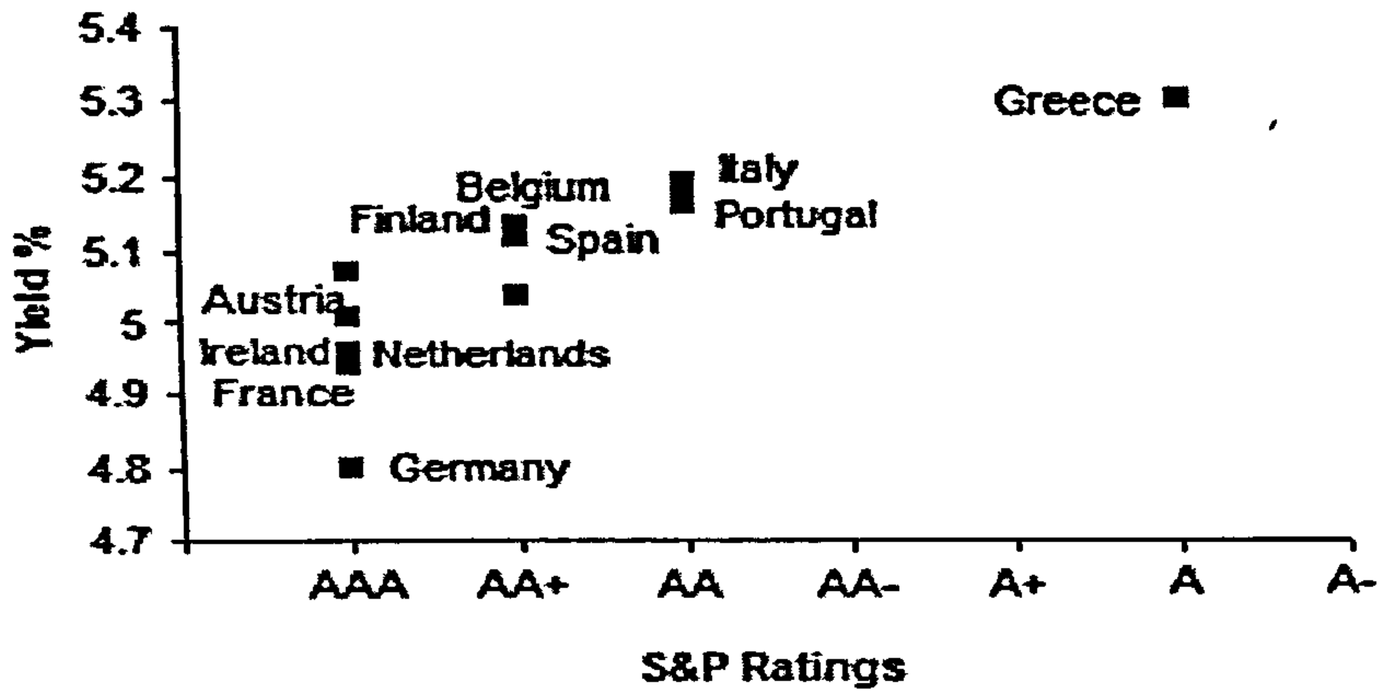




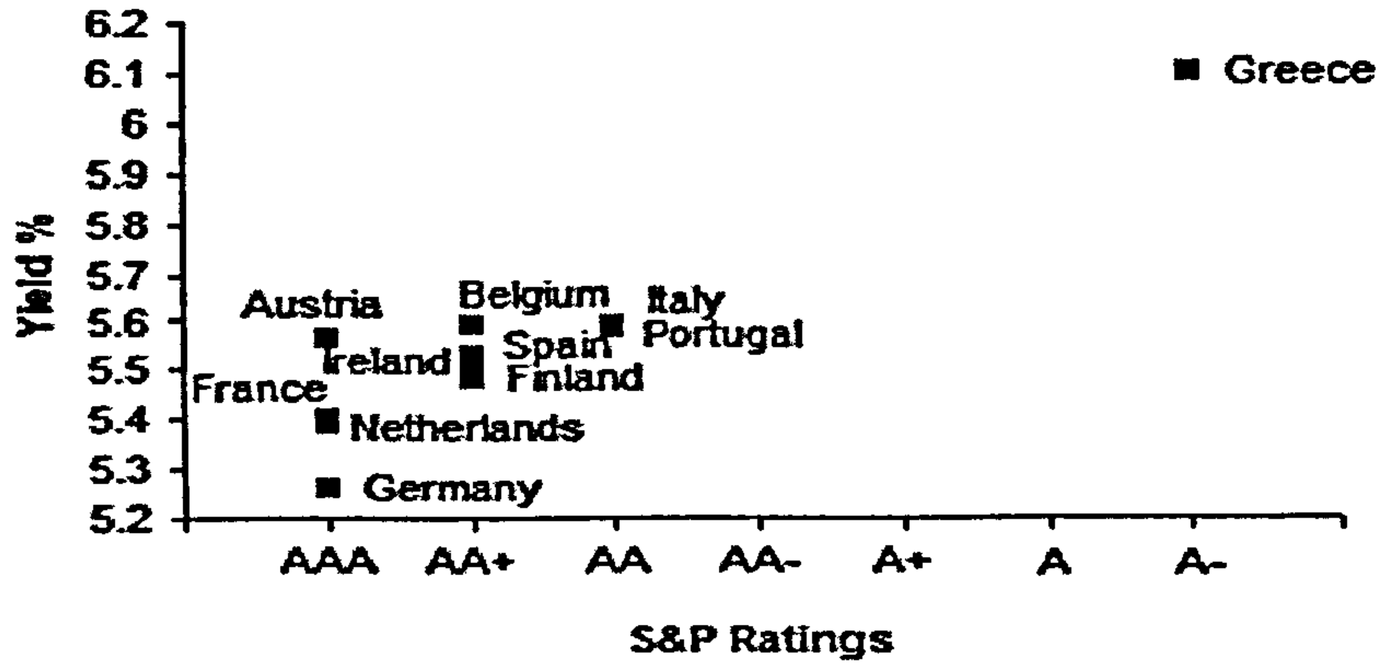




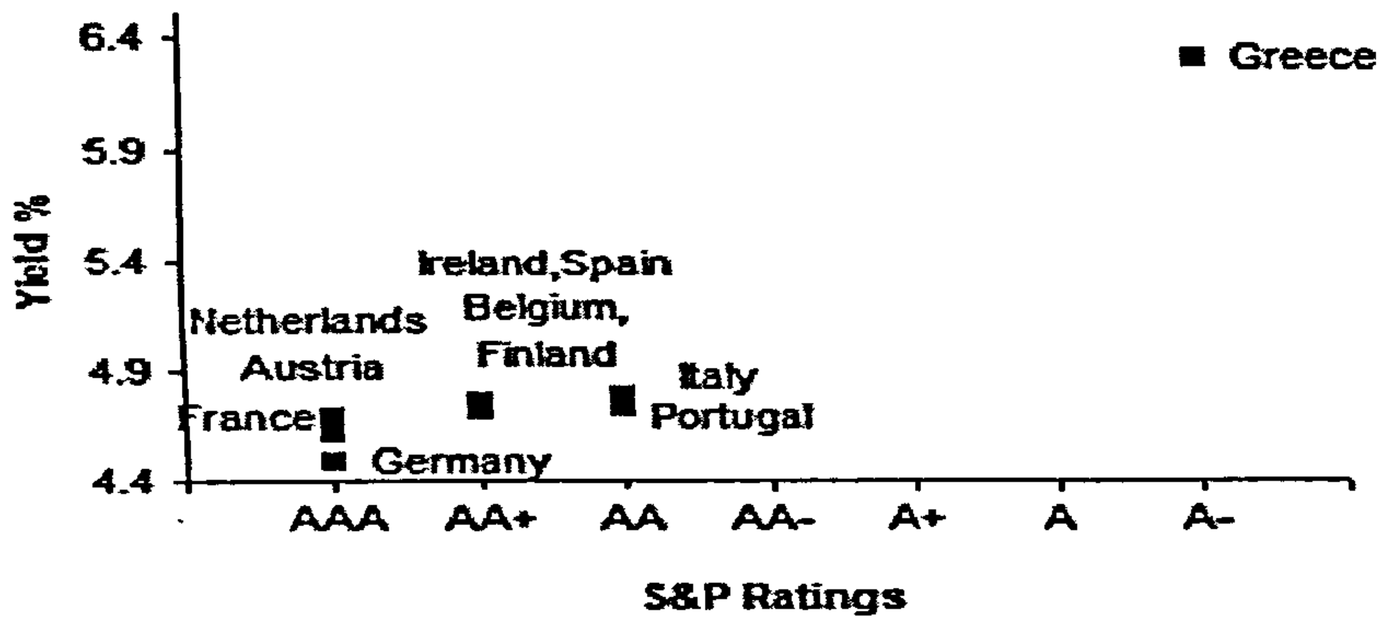
S&P Ratings Versus 10-Year Yields 2001



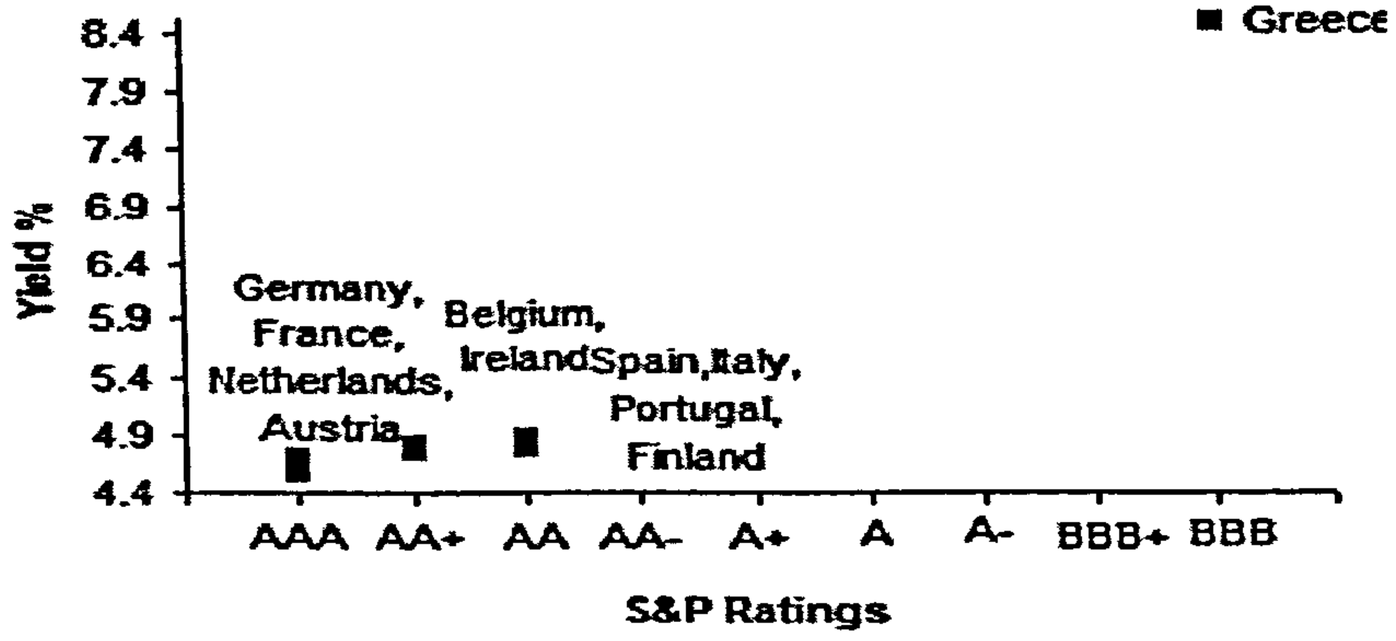
S&P Ratings Versus 10-Year Yields 2000



S&P Ratings Versus 10-Year Yields 1999



S&P Ratings Versus 10-Year Yields 1998



Source EuroStat and S&P

Table 9 Model of Euro Sovereign Long-term Yields 1998 to 2005

	Dependent Variable: Log (Yields)					
	S&P	Moody's	Fitch	S&P	Moody's	Fitch
	2005			2004		
Intercept	1.357*** (22.106)	1.352*** (8.667)	1.208*** (7.315)	1.570*** (58.841)	1.573*** (44.357)	1.565*** (44.810)
Average Rating	-0.015** (3.828)	-0.0135 (-1.314)	-0.0026 (0.275)	-0.0100 (5.693)	-0.010 (4.368)	-0.0097 (4.207)
Adjusted R^2	0.945	0.794	0.684	0.758	0.643	0.625
Standard Error	0.0056	0.0108	0.0133	0.0080	0.0097	0.0100
	2003			2002		
Intercept	1.567 (56.841)	1.569 (64.840)	1.563 (66.613)	1.731 (41.368)	1.727 (41.121)	1.728 (42.682)
Average Rating	-0.0094 (5.177)	-0.0095 (6.006)	-0.0092 (5.933)	-0.0086 (3.099)	-0.0083 (3.001)	-0.0085 (3.148)
Adjusted R^2	0.720	0.778	0.773	0.462	0.444	0.471
Standard Error	0.0074	0.0066	0.0067	0.0136	0.0138	0.0134
	2001			2000		
Intercept	1.839 (35.306)	1.811 (35.190)	1.812 (41.633)	2.0041 (51.351)	1.9931 (34.159)	1.9550 (44.099)
Average Rating	-0.0146 (4.194)	-0.0125 (3.690)	-0.0129 (4.394)	-0.0198 (7.528)	-0.0189 (4.842)	-0.0166 (5.523)
Adjusted R^2	0.623	0.557	0.646	0.847	0.691	0.747
Standard Error	0.0166	0.0180	0.0161	0.0144	0.0205	0.0186
	1999			1998		
Intercept	2.304 (28.140)	2.235 (14.255)	2.099 (21.823)	2.665 (24.773)	2.6910 (15.797)	2.598 (13.055)
Average Rating	-0.0497 (9.013)	-0.0448 (4.262)	-0.0363 (5.552)	-0.0734 (9.920)	-0.0738 (6.407)	-0.0684 (5.0193)
Adjusted R^2	0.889	0.632	0.748	0.906	0.800	0.707
Standard Error	0.0303	0.0553	0.0456	0.0536	0.0786	0.0951

Source S&P, Moody's, Fitch and EuroStat

From Cantor and Packer we would expect to see high adjusted R-squared for each year since 1998 however, we instead see a large variation in the adjusted R-squared reported by the regression, with the value dropping to 0.462 in 2002. From this result we must conclude that the model is a poor fit and the sovereign yields are not dependant on ratings for this year. Therefore another variable e.g. Liquidity risk premium should be included. Looking at the graphs in detail from 1998 in turn we can see substantial changes in the yield and ratings profile. In 1998 we can see 3 major rating blocks, the first centered around Germany and France, the second containing Ireland and Belgium and the next including Italy and Spain, with Greece out on its own. The adjusted R-squared of 0.906 shows that the model is a good fit for explaining the yield of each sovereign and therefore the bond market started with a number of initial conditions that were clearly transparent. Moving on to 1999 we can see that Finland and Spain had their rating increased and now entered the group containing Ireland and Belgium. Greece was upgraded by 2 notches and its yield fell by almost 200 basis points. Again the model provided a good fit with an adjusted R-squared of 0.889 and more noticeably the standard error being reduced by almost half as the yield of the sovereigns continued to converge. In 2000 there were no rating changes and an adjusted R-squared of 0.847 and again the standard deviation halved as the yields converged further.

From 2001 to 2004 the model proved less than a good fit, the adjusted R-squared ranged from a low of 0.464 to 0.765 in this period. Looking at the graph for 2001 we can see that both Ireland and Greece were upgraded by one notch, but with the yields now having being compressed with less than 30 basis points separating Italy from France 2 rating notches apart, the clear correlation between yields and rating was starting to fracture. Austria was now paying 3 basis points more than Finland who was one notch lower, the adjusted R-squared fell to 0.623. However in 2002 the model's adjusted R-squared fell

further to 0.464 with Finland being upgraded by one notch but now Ireland was paying the same yield as Portugal 2 notches below, and Finland and Austria were both paying more than Spain who was one notch below. Why was the bond market no longer pricing yields by the sovereign's rating? At this time the "liquidity risk premium" concept came to the fore as described by Antonio Villarroya in the Literature Review; smaller sovereigns such as Ireland, Finland and Austria may have the highest credit rating but due to their bond market size, it was postulated, their yields would not be able to converge further. It is worth reviewing his conclusion again where he states: "It seems clear from the exhibit that there is an almost linear relationship between spreads and ratings, with the distance between each country's spread to the regression line being a proxy of each country's liquidity premium. This "liquidity premium" is more evident in the AAA rated category, where the market has clearly differentiated between very liquid and deep markets, such as France, versus smaller less liquid countries such as Austria".

In 2003 the adjusted R-squared rose to 0.724 and the standard error halved again. Why the turn around? The big change in 2003 was that Ireland, Finland and Austria's yield fell to that of France! So much for the "liquidity premium" theory, not to say it was incorrect, but the dynamics of the market change continuously. The power of the issuers and the agreement reached with the market makers in the liquidity pact (discussed in the next chapter) convinced the market that the "liquidity premium" was unjustified. This, combined with weak fiscal policies of the big two, made some of the smaller sovereigns bonds look good value to investors. Hence 2003 was the year of the big break-through for the smaller issuers and now Germany itself was no longer guaranteed its benchmark status (benchmark as defined by lowest yield).

In 2004 Spain was upgraded and Italy was downgraded, and the adjusted R-squared rose again to 0.758. However, Austria still paid more than Portugal 2 rating notches below it and Italy paid more than Greece a rating notch below it. Yet the entire range between Ireland and Greece was 16 basis points and that covered 4 credit rating notches. Since the beginning in 1998 we can clearly see that Germany has the lowest yield within its rating class by on average 10bp. In 2005, that is no longer the case and Ireland now has the distinction of having the lowest yield in the eurozone. The adjusted R-squared now reaches its highest level 0.945 with the lowest standard error of just 10 basis points.

We have seen the explanatory power of the model vary since the introduction of the bond market in 1998. This shows the bond market evolving over time, a process that is still ongoing. The continuing convergence of yields within credit rating categories shows that while bond market discipline may be affected in the short-run, especially over issues like the "liquidity risk premium", in the long-run the market will return to its economic fundamentals and the model will hold. The failure of the model in 2002 to demonstrate the relationship between yields and ratings (probability of default), places the Liquidity Risk premium in its historical context. I discuss Liquidity risk in greater detail in section 6.3 and the reasons behind its disappearance.

A number of criticisms of the above model must be highlighted however, one being the lack of data points, while another is the impact that Greece has on the R^2. On the first point, Pagano and von Thadden (2004) use an even smaller dataset, average yield between January 2001 to July 2004, for their research into euro bond yield differentials and they also included Greece in their model. Any study of the Euro bond market, which was only created in 1998, will be constrained by the amount of available data. Economic indicators and ratings by their very nature are slow-moving, and generating a

large dataset will take time, but this should not stop research in this important field. Also a monetary union on this scale has not happened before, so any inferences from other studies such as Cantor and Packer will always be subjective. On the 2nd point, an outlier in regression analysis is generally considered due to a possible observation error. The Greek yield and rating have no such error assigned to them and therefore omitting Greece from the regression would remove a very important information about the market yield required at that rating. This is the reason Pagano and von Thadden (2004) include Greece in their study.

In response to the first criticism I have expanded my analysis by employing a time-series cross-sectional analysis (Panel data), which allows me to compare how the sovereigns yields and ratings changed over time. Panel analysis uses panel data to examine changes in variables over time and differences in variables between subjects. Fixed effects regression methods are used to analyze longitudinal data with repeated measures on both independent and dependent variables. They have the attractive feature of controlling for all stable characteristics of the individuals, whether measured or not. This is accomplished by using only within-individual variation to estimate the regression coefficients. My panel data consists of ratings and yields for the 11 sovereigns over the period 1998 to 2005; this pooled data set contains a total 88 observations. Using this data set I re-run the above regression of yields versus ratings using the Fixed Effects model, the results of which are summarised in table 10 below. The table shows that the estimation coefficient has the expected sign, negative, being consistent with lower yield on higher ratings. The coefficient is significant and the F-test for the equality of the Fixed Effects model rejects the null hypothesis of homogeneity across time periods. This supports my previous results and demonstrates that comparing results on a year by year basis is reasonable and consistent with the previous research discussed above. Running a

Random Effects model gave consistent coefficients and sign to that of the Fixed Effects model.

Table 10 Sovereign Yields vs Ratings – A Panel Data Analysis

Dependent Variable: YIELD?
Method: Pooled Least Squares
Date: 12/10/08 Time: 15:52
Sample: 1998 2005
Included observations: 8
Cross-sections included: 11
Total pool (balanced) observations: 88

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	7.471496	0.324884	22.99744	0.0000
RATING?	-0.189688	0.021719	-8.733583	0.0000
Fixed Effects (Period)				
1998--C	0.339478			
1999--C	0.152092			
2000--C	0.866637			
2001--C	0.422035			
2002--C	0.337461			
2003--C	-0.451658			
2004--C	-0.475295			
2005--C	-1.190749			

Effects Specification

Period fixed (dummy variables)

R-squared	0.844975	Mean dependent var	4.649886
Adjusted R-squared	0.829277	S.D. dependent var	0.777091
S.E. of regression	0.321084	Akaike info criterion	0.662427
Sum squared resid	8.144488	Schwarz criterion	0.915791
Log likelihood	-20.14679	Hannan-Quinn criter.	0.764501
F-statistic	53.82451	Durbin-Watson stat	0.565215
Prob(F-statistic)	0.000000		

Redundant Fixed Effects Tests
Pool: SOVPOOL
Test period fixed effects

Effects Test	Statistic	d.f.	Prob.
Period F	45.779147	(7,79)	0.0000
Period Chi-square	142.617274	7	0.0000

Period fixed effects test equation:
Dependent Variable: YIELD?
Method: Panel Least Squares
Date: 12/10/08 Time: 15:27
Sample: 1998 2005
Included observations: 8
Cross-sections included: 11
Total pool (balanced) observations: 88

	Coefficient	Std. Error	t-Statistic	Prob.
C	8.001792	0.692276	11.55868	0.0000
RATING?	-0.225338	0.046275	-4.869590	0.0000

R-squared	0.216136	Mean dependent var	4.649886
Adjusted R-squared	0.207021	S.D. dependent var	0.777091
S.E. of regression	0.691994	Akaike info criterion	2.123987
Sum squared resid	41.18163	Schwarz criterion	2.180290
Log likelihood	-91.45543	Hannan-Quinn criter.	2.146670
F-statistic	23.71291	Durbin-Watson stat	0.671712
Prob(F-statistic)	0.000005		

Dependent Variable: YIELD?
Method: Pooled EGLS (Period random effects)
Date: 12/10/08 Time: 15:53
Sample: 1998 2005
Included observations: 8
Cross-sections included: 11
Total pool (balanced) observations: 88
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	7.487614	0.379100	19.75102	0.0000
RATING?	-0.190772	0.021712	-8.786509	0.0000
Random Effects (Period)				
1998--C	0.328849			
1999--C	0.147415			
2000--C	0.840720			
2001--C	0.409525			
2002--C	0.327561			
2003--C	-0.438005			
2004--C	-0.460939			
2005--C	-1.155126			

Effects Specification

	S.D.	Rho
Period random	0.553096	0.7479
Idiosyncratic random	0.321084	0.2521

Weighted Statistics

R-squared	0.465615	Mean dependent var	0.801698
Adjusted R-squared	0.459401	S.D. dependent var	0.443263
S.E. of regression	0.325911	Sum squared resid	9.134742
F-statistic	74.93272	Durbin-Watson stat	0.579552
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.211050	Mean dependent var	4.649886
Sum squared resid	41.44882	Durbin-Watson stat	0.675386

Correlated Random Effects - Hausman Test
Pool: SOVPOOL
Test period random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Period random	3.605278	1	0.0576

Period random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
RATING?	-0.189688	-0.190772	0.000000	0.0576

Period random effects test equation:
Dependent Variable: YIELD?
Method: Panel Least Squares
Date: 12/10/08 Time: 15:51
Sample: 1998 2005
Included observations: 8
Cross-sections included: 11
Total pool (balanced) observations: 88

	Coefficient	Std. Error	t-Statistic	Prob.
C	7.471496	0.324884	22.99744	0.0000
RATING?	-0.189688	0.021719	-8.733583	0.0000

Effects Specification

Period fixed (dummy variables)

R-squared	0.844975	Mean dependent var	4.649886
Adjusted R-squared	0.829277	S.D. dependent var	0.777091
S.E. of regression	0.321084	Akaike info criterion	0.662427
Sum squared resid	8.144488	Schwarz criterion	0.915791
Log likelihood	-20.14679	Hannan-Quinn criter.	0.764501
F-statistic	53.82451	Durbin-Watson stat	0.565215
Prob(F-statistic)	0.000000		

4.6.2 Relating Eurozone Economic Data to Bond Yields

Cantor and Packer showed how ratings (probability of default) explain yields, and they also showed how ratings could be explained by a select number of economic variables, see section 4.4.1 and with reference to the Eurozone these variables can be further reduced, see section 4.4.2. In the previous section we have shown that for 2005 the Eurozone bond yields could be explained solely by their ratings (credit risk), without having to take account of the liquidity risk premium. Therefore we can conclude the euro market bond yields for 2005 can be adequately modelled by the economic variables discussed in section 4.4.2 i.e. there is a direct relationship between the credit risk (probability of default) as measured by the 6 economic variables for a particular sovereign and its respective bond yield. Cantor and Packer (1996) also carried out a similar test to investigate if the publicly available data (8 Economic variables) could explain bond yields and found that they explain 86% of the sample variation. This is worse than the rating on its own, and the reason they give is that the rating is forward looking like the yield, while the economic data is historical data.

Continuing the Cantor and Packer analysis I regress the euro yields against the 6 variables that I identified in section 4.4.2. These are Per Capita Income, GDP Growth, Inflation Experience, Fiscal Balance, External Balance, and Government Debt Burden. Two of these variables have special significance in the context of the eurozone; these variables are explicitly mentioned in the Maastricht Treaty for entry and membership of the euro currency. These are the Debt/GDP ratio (Government Debt) and the Deficit/GDP ratio (Fiscal Balance), and each sovereign is constrained by the treaty to operate with a maximum budget deficit of 3% of GDP and maximum debt to GDP ratio of 60%. We would expect to see that these variables to play a very prominent role in the

explanation of the yield. A regression of euro bond yields against the six economic variables explains 90% of the sample variation (Table 11). This is less than the ratings model which explained over 94% of the variation for that year, but is still a good fit.

Table 11 Regression of Euro Yields Versus Economic Variables for 2005

Variables	Dependent Variable: Log (Yields) for 2005				
	(1)	(2)	(3)	(4)	(5)
Intercept	3.221*** (22.106)	3.229*** (60.8)	3.229*** (67.01)	3.216*** (73.54)	3.269*** (89)
Government Deficit	-0.00077 (0.081)	-0.00063 (0.083)			
Government Gross Debt - % of GDP	0.00294** (3.50)	0.00294** (3.92)	0.00297** (4.909)	0.0027** (5.51)	0.0023** (4.61)
GDP per Capita in PPS Standard	0.000189 (0.032)				
External balance of goods and services - % of GDP	-0.0051 (0.556)	-0.00485* (1.822)	-0.0049* (2.13)	-0.0038* (2.17)	-0.00367* (1.84)
Real GDP Growth	0.019* (1.287)	0.019* (1.587)	0.0189* (1.83)	0.0132* (1.82)	
Inflation Rate	-0.01972 (0.0397)	-0.01885 (0.716)	-0.0186 (0.7784)		
R^2	0.902	0.901	0.901	0.892	0.84
Standard Error	0.0408	0.0365	0.033	0.032	0.036

Sources: EuroStat; Notes: The sample size is 11.
Absolute t-statistics are in parentheses
* Significant at the 10 percent level
** Significant at the 5 percent level
*** Significant at the 1 percent level

Looking at the results of the regression we see that the Intercept is the most significant variable in the model. The next variable of importance is the Government Debt variable. The coefficient is positive as expected and shows that an increasing debt adds to the yield that each sovereign must pay, this supports the 'credit punishing' hypothesis of market discipline. Looking at the significance level for each independent variable we can see that the GDP per Capita variable coefficient is not very different from zero. I re-run

the regression without this variable and find that the R^2 is almost identical without the variable, therefore I can conclude I can delete it from my model as it has very low explanatory power. Looking again at my results I see that the Government Deficit variable coefficient is also not very different from zero. This is a very surprising result given that the Government Deficit is a key component of the SGP. It would signify that the bond market either does not consider the Government Deficit as an important part of the SGP or the SGP is not important to the Bond Market. This should signify to policy-makers that they can run high deficits without being penalised significantly in the short-run. This result is in agreement with Bernoth, von Hagen and Schuknecht (2006) who found that "... results show that yield spreads respond significantly to measures of government indebtedness both before and after the start of EMU. Interestingly, after the start of EMU, markets seem to have shifted their attention from government debts and deficits as indicators of creditworthiness to debt-service ratios, perhaps reflecting the fact that the former have become very politicized in the debates over the fiscal framework of EMU."

Rerunning the regression without Per Capita Income, GDP Growth, Inflation Experience, Fiscal Balance we get a model that explains 84% of the variation in yields. We are left with 2 variables, these are the Government Debt and the External Balance of goods and services. These are the 2 variables that make up the Debt Service Ratio as mentioned by Bernoth et al. (2006) above. The coefficient is positive for Government Debt, signifying that the yield will increase as the Government Debt grows, while the coefficient is negative for External balance of goods and services which means that as exports increase the yield will decrease. This variable as discussed previously is very important because it is the main variable as to how a country increases its wealth in the long-run.

The above results are very significant for the following section which investigates free-riding within the bond market. Most papers state that the above finding of increasing debt leading to increasing yields shows that market discipline is still operating efficiently in the bond market. Manganelli and Wolswijk (2007) for example report that "...we find that sovereigns with lower credit ratings are forced to pay a higher credit risk premium, which is confirmed by various robustness checks. Thus, we find evidence of market discipline still operating in EMU". However, what I am proposing in the next section is not that this statement is incorrect, but that the credit risk premium is not proportional to the economic data available. For example, Ireland has a lower Government Debt and exports more goods than Germany and yet still pays a yield equivalent to Germany. While I agree with the conclusions of Manganelli and Wolswijk, I look to quantify their "higher credit risk premium" and see whether it is applied evenly throughout the eurozone.

4.7 Is Free Riding An Issue In the Euro Bond Market?

The convergence of nominal long rates has been quite significant and, more than anything has benefited countries with high public debt. For example, the spread between Italian and German 10yr government bond yields averaged 570 basis points between 1980 and 1996. Since 1997, it has averaged 30bp, even though Italian public debt reached 106% of GDP in 2004, compared with 60% under the Maastricht Treaty and 66% in Germany. The Greek 10yr benchmark rate has followed the same trend. In 1997, it was still 480bp higher than the German benchmark but by March 2006 the differential was down to just 33bp, virtually unaffected by revelations about Greek public accounts. In September 2004, we learnt that, if the Greek national accounts were drawn up according to Eurostat standards, the budget deficit had reached 4.0% of GDP between 2000 and 2003 and not 1.6%, and it would reach 5.3% in 2004 according to initial estimates (ultimately 6.6%), yields rose only slightly (the spread to the Bund was of 20bp at end-September 2004 versus 18bp at end-August).

Of course, the convergence of long rates is largely attributable to the disappearance of foreign exchange risks and the fiscal discipline by the SGP, but can the low market price of credit risk be justified by fundamentals? The reason for the creation of the SGP was to prevent members of the Eurozone accumulating excessive debts and deficits, the economic costs of which all the members of the Eurozone would have to bear, not just the member whose borrowing increases. The concern was that member states would face smaller market disincentives to public borrowing and so would run larger deficits. As a consequence, total EU government debt would increase and the interest rate paid on it would in fact be higher. The outcome of one government over-borrowing would be "adverse for the fiscally virtuous as well as the sinners." Begg (2003). In the next

section we will investigate why free-riding is such a risk within the eurozone and why the bond market fails to "adequately" discipline the sovereign members.

4.7.1 EMU as an Optimum Currency Area

"A monetary zone is optimal if the loss of control tools, i.e. exchange rates and autonomous policy, does not cause a decline in well-being. First of all, this means that, overall, member states must be exposed to comparable shocks. In addition, the perfect mobility of production factors - capital and labour - must guarantee adjustments to asymmetric shocks. Where the EMU is concerned, the flexibility of the goods and labour markets is far from ideal. As such, macroeconomic stabilisation policies remain necessary at a national level. However, they must be supervised, as any discretionary expansionist fiscal policy - obviously implemented locally, but pushing up average inflation in the zone as a whole - may result in a tighter monetary stance, which would, in turn, affect all member states. Fiscal discipline is needed if the monetary union is to function effectively. But who can guarantee it?" (Florance Barjou, May 2006)

The credit risk premium is a very slow moving variable and cannot compare to a flexible exchange rate in disciplining governments that embark down questionable economic paths. When money is not channelled into productive investments, speculative bubbles can occur, for example property bubbles have started to appear in a number of European countries such as Ireland and Spain. The strain can be seen in the trade deficit which starts to spiral out of control. Because the country cannot produce as much as it consumes it closes the gap by importing more and more. For countries outside the currency area, the markets would begin taking action to correct imbalances. Investors would start to sell off the currency, making imports more expensive and exports cheaper. Inside the euro zone, the currencies cannot revalue. The only way for the economy to

rebalance is through a long period of slow growth, rising unemployment and depressed demand.

Therefore compared to the Forex market, the market discipline applied by the bond market would take a long time to change the behaviour of a sovereign in a substantial way. Ireland and Spain who both currently have almost the same yield as Germany, demonstrate the unresponsiveness of this market. In effect the individual sovereigns have become disassociated from their own bonds. The globalised risks, as priced through the Eurex Futures contracts, drives all the Euro sovereign prices. I will discuss the role of the Eurex Futures in more detail in section 5.4.2. When compared to it, the sovereign risk premium is almost negligible and therefore how the market is expected to instil discipline in governments is very much open for debate.

4.7.2 Moral Hazard and the "No-Bailout Clause"

The Delors Committee acknowledged "... that market forces can exert a disciplinary influence but noted that the constraints imposed by market forces might either be too slow and weak or too sudden and disruptive" (Committee for the Study of Economic and Monetary Union, 1989, page 24). The Committee concluded that countries in EMU should accept some constraints on their fiscal policy. Lamfalussy, 1989 pointed out that "closer economic integration might generate expectations that a country in critical conditions would in the end be bailed out by the other countries. For this reason the fiscal stance of governments might have not been fully embedded in credit risk premia". The European Commission (1990) took a similar view: financial markets differentiate among sovereign borrowers, but "it cannot be taken for granted that market discipline would be sufficient, due to expectations of Community assistance and/or inadequate

response of governments to market signals". It concluded that there was a need for rules and procedures at the Community level.

These views should be considered in the context of the time period. Many of the original members of the EMU had a history of poor fiscal control. Increasing government deficits and rising debt levels were common in many member states in the early 1990s. Between 1989 and 1993 public deficits in the EU increased by 3.8 percentage points to 6.0 per cent of GDP. For the EU as a whole, the Debt to GDP ratio rose from 54 per cent in 1989 to 72 per cent in 1996. Some countries had two-digit deficit ratios and debt ratios above 100 per cent. This situation did not advocate that market discipline had been especially effective in Europe. Moreover, accounting practices were not homogeneous across Europe, even for national accounts, thus providing further obstacles to effective risk assessment by market agencies and investors. In the end, regulation was seen as a necessary supplement to market forces.

In order to tackle this 'the free-rider problem', Member States decided that rules were needed to co-ordinate and restrict Member States' fiscal policies. Otherwise all Member States could be worse off in the end with higher interest rates, and possibly with higher inflation also. Many authors cited the free-rider problem as one of the main reasons behind the creation of the Stability and Growth Pact and the Commission confirmed that this was the case, stressing that every country in the Eurozone still had "an obligation to watch out" for what its deficit situation meant for other countries in the monetary union and for the ECB. A key point in the Delors report raised the issue that being a part of the Eurozone could give Member States motivation for extreme borrowing, the effects of which would 'spill over' onto other Member States. This is especially relevant for the emerging economies of the former Soviet Bloc who could over-extend in the race to

catch-up with the living standards of the western Europe. Professor Charles Goodhart of the LSE and formerly of the Bank of England, in a report to the House of Lords raised the issue that "if a government chronically over-borrowed, in due course it might face problems in meeting interest payments on existing debt, and being able to refinance maturing debt, resulting in default." He argued that "the risks of default were further increased in the Eurozone, because Member States would not be able to monetise their debt when default threatened, as they could have done when they had their own monies".

The report went on to state "Government default within the Eurozone would threaten the stability of the financial system of the country in question and the effects would possibly spread more widely. This raises the possibility that the ECB would have to bail out the financial system of some or possibly all Eurozone members, in order to prevent systemic collapse; and witnesses agreed that bailout would impose costs on all Eurozone members. The so-called 'no-bail out' clause (Article 103) of the EC Treaty is supposed to prevent the ECB being forced to bail out an insolvent Member State and to ensure that Member States are not liable for the commitments of other Member States. But some witnesses questioned whether, in this crisis situation, the ECB would be able to resist the pressures to monetise the defaulting country's debt." Many respected academics, such as Professor David Begg (2003) think that it will be "difficult to imagine the ECB would be able to stand entirely aside [...] the political pressure for some pooling of the cost of the default would be very hard to resist". For Professor Begg, the "ECB's credibility rests in part on its ability to resist these pressures; but if the central bank's credibility was damaged, then the whole Euro area would be the loser".

While the record of the SGP has been mixed, on the whole it has contributed to greater fiscal discipline among its members. The SGP has been beneficial to fiscal discipline,

reducing past predispositions towards running large fiscal deficits. By the commencement of EMU in 1999, all of the present EMU member states (except Greece) had succeeded in reducing their deficits to under 3 percent of GDP, and for some this required substantial adjustment. The average EMU zone deficit over the period 1999-03 was 1½ percent of GDP, a full 3 percentage points below the earlier post-Maastricht era (1992- 98) average. The area's disciplined fiscal performance during this time is in stark contrast to other industrialised countries e.g. US and Japan. Fiscal policy also seems to have become less procyclical under the SGP (Gali and Perotti, 2003) especially after the emphasis shifted from nominal to structural balances (Fatas and others, 2003).

But once the single currency came into existence, countries started to return to their original character. For several countries, including the largest members, fiscal deficits were not reduced during economic upturns. These countries failed to take advantage of favourable economic circumstances during the upturn to put their finances in good shape to weather an economic downturn. Therefore when the downturn arrived, their fiscal balances worsened substantially. Meanwhile, the high-debt countries such as Greece and Italy, made little progress in tackling their high debt ratios. Also, very few countries have started to implement unpopular policies to tackle future liabilities such as reducing State Pension contributions. According to the European Commission 2004, at least 8 of the 12 member states face substantial risks to their long-term sustainability unless they reform their economies. More immediately, a number of states have breached the 3 percent ceiling set down by the SGP, and the list of aberrant countries is growing.

This inherent conflict between the simultaneous existence of a single currency and the independent fiscal policies of the member countries of the EMU has not been reconciled by the SGP. In effect the inability of the Commission to enforce the fines has led EMU

governments to ignore the Stability Pact's constraint on budget deficits and they effectively undermined the treaty by changing its rules when it suited them to do so. The agreement reached at the end of March 2005 by the European Council effectively abandons the Stability Pact and many fear leaves the way open for states to run much larger deficits in the future.

4.7.3 Free-riding in the Euro Bond Market

As discussed previously the Delors Committee recognized that the constraints imposed by market forces alone cannot be guaranteed to ensure the sustainability of public finances. They therefore created the SGP, but as we have seen the pact could not be enforced. Therefore we must assume that either the Delors Committee were incorrect in their conclusion that market forces could not discipline issuers or they were correct and free-riding is currently at play within the bond market. Bernoth, Von Hagen and Schuknecht (June 2004) found that "EMU members enjoy a lower default risk premium than before, ... this is consistent with the view that markets may anticipate fiscal support for EMU countries in financial distress". This view seems to be widely accepted in the academic literature, but there is very little research into this issue. The probable reason for this is the enormous number of variables that come into play in analysing free-riding, e.g. business cycles, various macroeconomic data.

If one takes a more innovative approach to the concept of sovereign risk and look at it from what happens if the sovereign has already completely defaulted, then what is the probability of all the investors getting their investment returned? This would be rather dramatic event, but if one looks at the risk from that of a liquidator, then there is no need to look at future money streams or worry about past trade history. This idea comes from

the sovereign debt literature discussed in chapter 2, where organised debt workouts are an important concept in preventing self-fulfilling debt crises. The concept of liquidation or bankruptcy is particularly suitable for investigating free-riding as the success of any "bailout" would depend on an assessment by the member states very similar to the decisions of the US courts under Chapter 11 bankruptcy laws.[25]

If we take the measure of debt as Government Gross Debt as a % of GDP and the measure of assets as the GDP per Capita in PPS Standard [26](GDP per head is an effective way of comparing the relative wealth of two countries). Then to a liquidator, a sovereign is a "going concern" if the assets are greater than the debts. The ratio of the measure of assets to the measure of debts allows us to compare between sovereigns, with the higher ratios signifying greater probability of the sovereign finding itself in difficulty and unable to meet its obligations. Because of the unique construction of both variables by Ecofin, debt and assets, the unit of measurement cancels out (which are in effect indices, see Appendix 1). If we graph the results of this ratio, which I will call the Liquidation Risk, against the market yield we can see an almost linear relationship.

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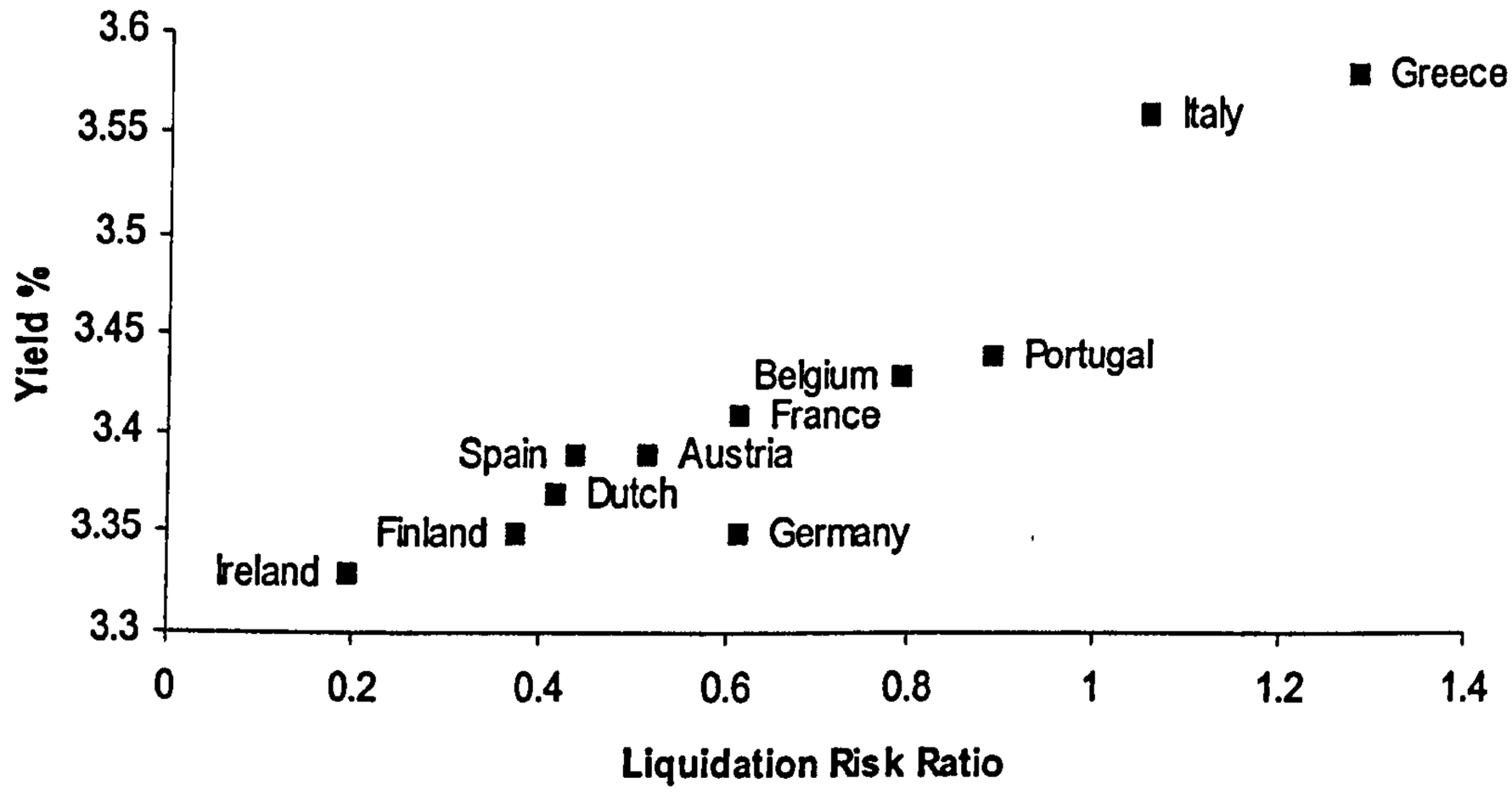
[25] Chapter 11 permits reorganisation under the bankruptcy laws of the United States allowing the company to stay in business.

[26] GDP per head in terms of PPS is the key indicator for assessing levels of economic development in regions and disparities in this. Its position is enshrined in the Structural Funds regulations and in Article 87(3)a of the Treaty on competition policy, both of which have been unanimously approved by the Member States. It is also conventionally used by numerous international institutions (including the World Bank, IMF, OECD and UN) as well as universities and research institutes, central banks and private enterprises as the single most useful measure of economic performance.

http://ec.europa.eu/regional_policy/sources/docoffic/official/reports/p11_box2_en.htm

Figure 6 Liquidation Risk Ratio Vs Yield for the year 2005



We can see a clear relationship between the Liquidation risk faced by an investor and the yield they require for holding such a bond. We can draw an almost straight line from Greece to Ireland connecting almost all the countries in-between. There is one outlier in this graph - Germany, whose government bonds appear to command a sizeable premium versus other sovereign issues. Running a simple regression on the above data gives us a model that explains 87% of the variation in yields, see table 12. Removing Germany from the model and this increase to almost 93% of the variation in the yield. The slope of this graph is almost a horizontal line at 0.24 with an intercept at 3.27% on the y-axis. The analysis shows that the market only marginal increases the yield while the debt/assets levels increase substantially. This raises further questions on the effectiveness of market discipline.

Table 12 Regression of Euro Yields Versus Liquidation Risk ratio for 2005

Variables	Dependent Variable: Yields for 2005	
	Including Germany	Excluding Germany
Intercept	3.265*** (157)	3.272*** (201)
Liquidation Risk	0.236*** (8.34)	0.233 (10.71)
R^2	0.886	0.935
Standard Error	0.029	0.023

Sources: EuroStat; Notes: The sample size is 11. Absolute t-statistics are in parentheses
* Significant at the 10 percent level
** Significant at the 5 percent level
*** Significant at the 1 percent level

Because of the compressed spreads, reflected in the almost horizontal slope, the effects of free-riding have not been adequately researched. Figure 6 clearly demonstrates that there seems to be a floor under which the bond market is not prepared to pay based on Germany's yield. Spain, Holland, Austria and Finland all carry much lower debt/assets and yet all are forced to pay a higher yield than Germany. Ireland has a liquidation risk ratio that is a third of Germany, yet it is rewarded with a yield only 2bp less than that of Germany. This artificial floor means that the credit risk premium are not being adequately priced to reflect the economic data. This confirms another conclusion by Bernoth, Von Hagen and Schuknecht (June 2004) that the "risk premium benefit declines with the size of public debt compared to Germany".

Returning to our definition of free-riding; "The free rider seeks to benefit by the efforts of others, the foul dealer to benefit at their expense" (Pettit, 1986, p 374). The group of sovereigns with liquidation risk lower than Germany are gaining no benefit in the bond market, and instead are discriminated against when compared to Germany. Those sovereigns whose liquidation risk is higher than Germany are benefiting from the other sovereigns as the slope is so small. They are in effect free-riding on the market's

perception that the no "bail-out clause" will not withstand a sovereign running into difficulty servicing its debt otherwise the slope would be steeper. Ireland and Italy are almost equidistant on either side of Germany in Figure 6. Ireland has a yield spread of -2bp while Italy has a yield spread of 21bp. This is a clear example of the 'disconnect' within the market around Germany.

Just as in section 4.6.1, Germany could be considered an outlier and removed from the model, but as Germany is considered by many to be a benchmark for the whole eurozone (Codogno et al 2003 explain the reasons behind the German yield premium, and I will discuss this further in section 6.5.1) and its value cannot be considered an observation error, so its values cannot be excluded. The above results show that Free-riding is a major issue in Euro government bond markets and this research brings some methodology to the investigation of the market's presumption that the "No bail-out clause" cannot be implemented in the real world and that monetary union has reduced the perceived credit risk, and the markets anticipate that member governments in fiscal trouble will be bailed out by other governments or by the central bank. I will investigate how free-riding affect the dynamics of the bond market in the following chapters.

4.8 Conclusion

The president of ECB warned market participants that they may be under-valuing the default premia in the bond market. In this chapter I have investigated whether there is any justification to this warning. We can see within the eurozone that we have a diverse range of economic conditions, yet the yields have converged to a narrow range, with just 30 basis points separating sovereigns with the highest credit rating score as defined by Moody's and Standard and Poor and sovereigns with substantially lower credit rating scores. By investigating the determinants of yields along the lines already explored by Cantor and Packer (1996), but restricting the data to only include members of the euro zone, I was able to create a model that explained 95% of the yield variation.

When I back tested this model over the previous 7 years, I found that during 2002 and 2003 it was a particularly bad fit. From this I could conclude that during these years the yield on the various sovereign bonds could not be explained by my economic variables. This is in accordance with Balli (2006) who states "The macroeconomic indicators are not helpful to explain the differentials at this time." From this I concluded the reason was due to the "liquidity premium" discussed by Antonio Villarroya in 2004. However, this effect was reduced in 2004 and disappeared almost completely in 2005. Unfortunately many academic studies still persist with the "liquidity premium" concept as an important identifier of the yield differential. This has led to researchers such as Villarroya stating that smaller issuers of similar credit risk i.e. Aaa/AAA can never expect to have a yield lower than Germany. This is obviously wrong, as both Ireland and Finland have since both achieved yields lower than that of Germany. In my research I place this risk in its historical context and review how a combination of both policy initiatives and technological innovations has impacted on this constituent of the yield differential.

My contribution however in this chapter has been to identify the possibility of a free-riding risk component within the euro sovereign yield. From my research I found that the bond markets have established a hierarchy between public debt securities, with those countries having the lowest Debt/GDP paying the lowest yield. However the second condition set by the SGP, that of the deficit requirement seems to be ignored by the bond market. Sovereigns running large deficits are not seeing their yield increase. However, the fact that this hierarchy exists is enough proof that "monetary union does not seem to have weakened the disciplinary function of credit markets. Indeed, we have found that the market provides the right signals to sovereign borrowers." Bernoth, Von Hagen, Schuknecht (2004).

However, this simplistic view of market discipline ignores the absolute yield premia that a sovereign must pay for increasing its debt. By reducing the number of economic variables in my model, and looking at the data from the point of view of a liquidator instead of an investor. I created a Liquidation Risk Ratio profile which only involved 2 variables, the Debt as a % of GDP and the GDP Per Capita. I then compared the yield for Germany on this measure to that for all other sovereigns and found some very interesting results. Those countries that had a lower Liquidation Risk Ratio than Germany were given a very similar yield to Germany implying that the German yield was a floor to the market. Sovereigns with a worse Liquidation Risk Ratio than Germany were given a higher yield, but this yield was not proportional to the amount of risk that the investor bore. This raises the possibility that Free-riding is a significant component of the yield. However, my model goes on to show by how much a low Liquidation Risk Ratio issuer could increase its debt and the impact that this would have on its yield. This could open up the whole issue of the "foul dealer" in future research on this topic.

4.9 Appendix: Data Supplied from Ecofin

General government deficit (-) / surplus (+) - Percentage of GDP[27]

	1998	1999	2000	2001	2002	2003	2004	2005
Belgium	-0.8	-0.5	0.1	0.6	0.0	0.0	0.0	-2.3
Germany	-2.2	-1.5	1.3	-2.8	-3.7	-4.1	-3.7	-3.2
Greece	-4.2	-3.3	-4.0	-4.9	-5.2	-6.1	-7.8	-5.2
Spain	-3.1	-1.3	-0.9	-0.5	-0.3	0.0	-0.2	1.1
France	-2.6	-1.7	-1.5	-1.6	-3.1	-4.2	-3.7	-2.9
Ireland	2.4	2.7	4.6	0.8	-0.4	0.3	1.5	1.1
Italy	-2.8	-1.7	-0.8	-3.1	-2.9	-3.5	-3.4	-4.1
Holland	-0.9	0.4	2.0	-0.2	-2.0	-3.1	-1.8	-0.3
Austria	-2.3	-2.2	-1.5	0.0	-0.5	-1.6	-1.2	-1.5
Portugal	-3.0	-2.7	-2.9	-4.3	-2.9	-2.9	-3.2	-6.0
Finland	1.7	1.6	6.9	5.0	4.1	2.5	2.3	2.7
Eurozone	-1.7	-0.8	0.5	-1.1	-2.2	-2.9	-2.6	-2.3

General government gross debt - Percentage of GDP[28]

	1998	1999	2000	2001	2002	2003	2004	2005
Belgium	119.6	114.8	109.1	108.0	103.3	98.6	94.3	93.2
Germany	60.9	61.2	60.2	59.6	60.3	63.9	65.7	67.9
Greece	105.8	105.2	114.0	114.4	110.7	107.8	108.5	107.5
Spain	64.6	63.1	61.1	56.3	52.5	48.7	46.2	43.1
France	59.5	58.5	56.8	56.8	58.2	62.4	64.4	66.6
Ireland	53.8	48.6	38.3	35.9	32.2	31.1	29.7	27.4
Italy	116.7	115.5	111.2	110.9	105.6	104.3	103.9	106.6
Holland	66.8	63.1	55.9	51.5	50.5	52.0	52.6	52.7
Austria	64.2	66.5	67.0	67.0	65.8	64.6	63.8	63.4
Portugal	55.0	54.3	53.3	53.6	55.5	57.0	58.6	64.0
Finland	48.6	47.0	44.6	43.6	41.3	44.3	44.3	41.3
Eurozone	68.9	67.9	64.1	63.1	61.5	63.0	63.3	64.5

[27] The general government sector (sector S.13 in ESA 1995, 2.68) comprises central government, state government, local government, and social security funds. Data for the general government sector are consolidated between sub-sectors at the national level. The series are measured in euro (ECU before 1999) and as a percentage of GDP. General government deficit (-) / surplus (+): general government net borrowing (-) / net lending (+) (balancing item B.9 in ESA95). The ESA 95 (European System of Accounts) regulation may be referred to for more specific explanations on methodology.

[28] The general government sector (sector S.13 in ESA 1995, 2.68) comprises central government, state government, local government, and social security funds. Data for the general government sector are consolidated between sub-sectors at the national level. The series are measured in euro (ECU before 1999) and as a percentage of GDP. General government gross debt: general government consolidated gross debt, at end-year nominal value.

GDP per capita in Purchasing Power Standards (EU-25 = 100)[29]

	1998	1999	2000	2001	2002	2003	2004	2005
Belgium	116	115	117	117	118	119	119	118
Germany	115	113	112	110	109	112	111	110
Greece	71	71	73	73	77	80	81	84
Spain	89	92	92	93	95	97	97	98
France	114	113	113	114	112	108	108	108
Ireland	117	122	126	128	132	134	136	139
Italy	115	114	113	112	110	106	103	101
Holland	122	123	124	127	125	124	125	126
Austria	123	125	126	122	120	123	123	123
Portugal	78	80	80	80	79	74	72	72
Finland	113	112	114	115	115	109	111	110
Eurozone	110	110	110	109	109	109	109	108

Real GDP Growth Rate

	1998	1999	2000	2001	2002	2003	2004	2005
Belgium	1.7	3.4	3.7	0.8	1.5	1.0	3.0	1.1
Germany	2.0	2.0	3.2	1.2	0.0	-0.2	1.2	0.9
Greece	3.4	3.4	4.5	5.1	3.8	4.8	4.7	3.7
Spain	4.5	4.7	5.0	3.6	2.7	3.0	3.2	3.5
France	3.5	3.2	4.0	1.9	1.0	1.1	2.3	1.2
Ireland	8.5	10.7	9.4	5.8	6.0	4.3	4.3	5.5
Italy	1.4	1.9	3.6	1.8	0.3	0.0	1.2	0.1
Holland	3.9	4.7	3.9	1.9	0.1	0.3	2.0	1.5
Austria	3.6	3.3	3.4	0.8	0.9	1.1	2.4	2.0
Portugal	4.8	3.9	3.9	2.0	0.8	-0.7	1.3	0.5
Finland	5.2	3.9	5.0	2.6	1.6	1.8	3.7	2.9
Eurozone	2.9	3.0	3.9	1.9	1.1	1.1	2.3	1.5

[29] Gross domestic product (GDP) is a measure for the economic activity. It is defined as the value of all goods and services produced less the value of any goods or services used in their creation. The volume index of GDP per capita in Purchasing Power Standards (PPS) is expressed in relation to the European Union (EU-25) average set to equal 100. If the index of a country is higher than 100, this country's level of GDP per head is higher than the EU average and vice versa. Basic figures are expressed in PPS, I.e. a common currency that eliminates the differences in price levels between countries allowing meaningful volume comparisons of GDP between countries. Please note that the index, calculated from PPS figures and expressed with respect to EU25 = 100, is intended for cross-country comparisons rather than for temporal comparisons.

Inflation Rate - Annual average rate of change in Harmonized Indices of Consumer Prices[30]

	1998	1999	2000	2001	2002	2003	2004	2005
Belgium	0.9	1.1	2.7	2.4	1.6	1.5	1.9	2.5
Germany	0.6	0.6	1.4	1.9	1.4	1.0	1.8	1.9
Greece	4.5	2.1	2.9	3.7	3.9	3.4	3.0	3.5
Spain	1.8	2.2	3.5	2.8	3.6	3.1	3.1	3.4
France	0.7	0.6	1.8	1.8	1.9	2.2	2.3	1.9
Ireland	2.1	2.5	5.3	4.0	4.7	4.0	2.3	2.2
Italy	2.0	1.7	2.6	2.3	2.6	2.8	2.3	2.2
Holland	1.8	2.0	2.3	5.1	3.9	2.2	1.4	1.5
Austria	0.8	0.5	2.0	2.3	1.7	1.3	2.0	2.1
Portugal	2.2	2.2	2.8	4.4	3.7	3.3	2.5	2.1
Finland	1.3	1.3	3.0	2.7	2.0	1.3	0.1	0.8
Eurozone	1.1	1.1	2.1	2.3	2.3	2.1	2.1	2.2

External balance of goods and services (Percentage of GDP)[31]

	1998	1999	2000	2001	2002	2003	2004	2005
Belgium	4.3	4.3	2.9	3.5	4.7	4.4	4.1	3.0
Germany	1.4	0.9	0.4	2.0	4.6	4.0	5.0	5.2
Greece	-8.3	-8.5	-10.9	-9.7	-9.7	-9.6	-8.9	-7.2
Spain	-0.2	-1.9	-3.1	-2.5	-2.1	-2.4	-4.0	-5.4
France	2.6	2.1	0.9	1.1	1.7	1.0	0.2	-1.0
Ireland	11.9	14.1	13.6	15.7	17.1	16.0	14.9	12.7
Italy	3.1	1.9	0.9	1.4	1.0	0.6	0.7	-0.1
Holland	4.7	4.2	5.5	5.8	6.5	6.3	7.2	7.7
Austria	1.4	1.7	1.4	2.5	4.7	3.6	4.3	4.8
Portugal	-8.9	-10.2	-10.9	-10.0	-8.3	-6.6	-7.7	-8.6
Finland	8.8	10.1	10.1	10.6	10.6	8.3	8.1	5.6
Eurozone	2.1	1.5	0.7	1.6	2.6	2.1	2.1	1.5

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[30] Harmonised Indices of Consumer Prices (HICPs) are designed for international comparisons of consumer price inflation. HICP is used for example by the European Central Bank for monitoring of inflation in the Economic and Monetary Union and for the assessment of inflation convergence as required under Article 121 of the Treaty of Amsterdam.

[31] The external balance is defined as the difference between exports and imports, which in turn measure the value of exchanges of goods and services between residents and non-residents

Long-term interest rates

10-year government bond yields, secondary market. Annual average (%)

	1998	1999	2000	2001	2002	2003	2004	2005
Belgium	4.75	4.75	5.59	5.13	4.99	4.18	4.15	3.43
Germany	4.57	4.49	5.26	4.80	4.78	4.07	4.04	3.35
Greece	8.47	6.30	6.10	5.30	5.12	4.27	4.25	3.58
Spain	4.83	4.73	5.53	5.12	4.96	4.12	4.10	3.39
France	4.64	4.61	5.39	4.94	4.86	4.13	4.10	3.41
Ireland	4.80	4.71	5.51	5.01	5.01	4.13	4.08	3.33
Italy	4.88	4.73	5.58	5.19	5.03	4.25	4.26	3.56
Holland	4.63	4.63	5.40	4.96	4.89	4.12	4.09	3.37
Austria	4.71	4.68	5.56	5.07	4.97	4.15	4.15	3.39
Portugal	4.88	4.78	5.59	5.16	5.01	4.18	4.14	3.44
Finland	4.79	4.72	5.48	5.04	4.98	4.13	4.11	3.35
Eurozone	4.71	4.66	5.44	5.03	4.91	4.14	4.12	3.42

5. Euro Bond Market Integration

5.1 Introduction

As discussed in the previous chapter, there is a high probability that free-riding is a significant component of the yield of a sovereign bond. To analyse the impact that this has on bond market discipline, I now continue my research by looking at how closely integrated the bond market has become since the introduction of the single currency. Lamfalussy (1989) pointed out that closer economic integration might generate expectations that a country in critical conditions would in the end be bailed out by the other countries. If bond markets are very closely integrated i.e. they share the same stochastic process, then individual changes to the economic fundamentals of a sovereign may be regarded as negligible when compared to the regional changes. Therefore a build-up of debt for one particular sovereign may not have an immediate impact on its yield. The Delors Committee accepted that market forces can exert a disciplinary influence but noted that the "constraints imposed by market forces might either be too slow and weak or too sudden and disruptive".

Dunne, Moore and Portes (2006) is one of the few studies to have tested for cointegration in government bond markets. However, they give no theoretical background as to what is the common stochastic force that drives all the euro government bond yields. My own theory stems from a market event, in August 2005, when Citigroup stunned the bond market when it traded €11.3bn of cash bonds in a matter of seconds after first buying an undisclosed number of Futures Contracts and driving the cash prices up. About 30 minutes later, the bank bought back €4bn of the bonds at lower prices, making a profit of about €18.2m. The theory behind the trade was that "...German government bond futures are used to price all Euro zone government debt", note ALL and not just German

debt. In my research I investigate if the Citigroup analysis of the dynamics of the bond market can be justified empirically.

I expand on the work of Dunne, Moore and Portes (2006) who only look at France, Germany and Italy to include all eurozone sovereigns. While their research focused on the "price discovery" mechanism of the bond market, I employ my research to highlight some important implications for bond market discipline, because now regional effects have become dominant over own country effects in EU bond markets and the ability of the bond market to discipline finance ministers by increasing the credit spread is no longer being employed by the market. Using cointegration I show that the all the bond markets are driven by a single stochastic common trend based on long-run cointegrating coefficients, i.e. a regional effect. If the bond market reacted to an individual sovereign then we would expect to see multiple stochastic trends driving that particular sovereign's bond yields. This is further evidence that bond market participants are viewing the "no bail out rule" as meaningless.

5.2 Financial Integration

As part of the Maastricht Treaty, one of the main objectives of the ECB is the promotion of European financial integration. The ECB mission statement reads: "... We in the Euro system have as our primary objective the maintenance of price stability for the common good. Acting also as a leading financial authority, we aim to safeguard financial stability and promote European financial integration." Financial integration is a major part of the development and modernisation of the European financial system, which increases the possibility for greater and more sustainable non-inflationary economic growth. In a speech by Jean-Claude Trichet[32] he noted: "The integration of the financial system plays an important role in the transmission and implementation of the single monetary policy for the euro area. A well-integrated financial system is essential for the implementation of the single monetary policy, as it enhances the smooth and effective transmission of monetary policy impulses throughout the euro area. The degree of financial integration is therefore important in determining the effectiveness of the monetary policy transmission throughout the euro area: the higher the degree of financial integration, the more effectively the transmission will work in practice".

The theory of financial market integration is central to international finance and at its core is the idea that the degree of integration changes with economic conditions. This is due to investors' changing level of risk aversion over time, and the subsequent varying level of return required for holding that asset. Therefore, the vast proportion of new research allows financial integration to vary over time. For government bonds, Ilmanen (1995) presented one of the first assessments on the time varying returns using an asset pricing model. Barr and Priestley (2004) applied a similar framework to Ilmanen to

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[32] President of the ECB, in the Mais Lecture, Cass Business School, London, 11 May 2006

investigate the degree of international bond market integration, and whether yields are determined by world risk factors rather than by domestic risk factors. Clare and Lekkos (2000) and Cappiello et al. (2003) have found considerable variations in international bond market return comovements. Driessen, Melenberg and Nijman (2003) find evidence that issues relating to the term structure explain most of the variations in international excess bond returns and note "it is conceivable that economic convergence required as part of EU membership has inevitably led to higher levels of bond market convergence".

If assets with the same risk have identical returns, markets are said to be completely integrated; the converse is true for segmented markets. It is generally accepted that capital mobility restrictions and foreign entry barriers to markets, in the form of limits to ownership and taxes on dividends and capital gains, serve to segment markets. Blackman et al. (1994) have found that "the stock indices of 18 countries show no evidence of integration for the period 1970-1979, but that there is evidence of integration for the period 1984-1989. The 1984-1989 period of integration coincided with developments in financial deregulation and advances in communications". This has led Blackman et al. (1994) to conclude that, "as a result of the abolition of exchange controls, the easing of capital gains tax on foreign investors and developments in global communications, markets have become increasingly integrated". Rogers (1994) studied the relationship between entry barriers and price movements in emerging stock markets and has concluded "that countries with a relatively greater number of restrictive entry barriers are less responsive to global shocks than countries with fewer restrictive entry barriers". Othchere and Lamba (2001), using cointegration methodology, find that the South African stock market "has become increasingly more integrated with its major trading partners after the fall of Apartheid and the relaxation of entry barriers. Thus far, the

evidence presented on the relationship between market integration and entry barriers points to a significant relationship between the two".

Another interesting consequence of market integration is the degree of contagion, i.e. how quickly a shock in one country flows into the financial markets of a neighbouring country. Forbes and Rigobon (1997) give a lucid explanation of the mechanisms through which contagion propagates, and distinguish between three, namely: aggregate shocks, country-specific shocks and pure contagion. Aggregate shocks such as the rise in the price of Oil, the war in Iraq can have serious consequences on investors' appetite for risk. Explanations of the causes of pure contagion are deeply rooted in multiple equilibria (sunspots), investor psychology, political economy and capital market liquidity (Forbes and Rigobon: 1999). Co-movements caused by contagion are driven by a change in investor expectations, without any underlying economic fundamentals. On the other hand, co-movement in markets that are driven by capital market liquidity is determined by investor liquidity needs, and of particular interest here is investor psychology. While economic theory assumes that investors act rationally, in reality this is almost certainly not the case. It has been argued in the academic literature that investors recall past events imperfectly and a crisis in one country could cause investors to change their expectations which could lead to a downward co-movement in markets that is governed by investor sentiment and imperfect memory, rather than economic fundamentals. Whether in the long or short term, it is evident that the factors and mechanisms discussed above serve as a possible impetus for the comovements of markets.

5.3 Monetary Union but No Fiscal Convergence

In the transition to the European Monetary Union a lot of emphasis has been give to monetary convergence and the definition of the common monetary policy. Since then, fiscal discipline has received most of the academic attention, with the functioning of the SGP coming under heavy criticism and its subsequent reform. However, there has been very little academic research concerning convergence of key fiscal variables within the eurozone. The main reason given for this lack of research on fiscal policy within the EU is the close correlation between business cycles of member states. Hence, it is difficult to distinguish which economic variables impact on the behaviour of the economy. The only papers I am aware of that develops a theory on fiscal convergence are Skidmore et al. (2004) and Onorante (2004) and Kocenda et al. (2006). In these papers the main question that they investigate is whether economic, financial and monetary integration have led to convergence in key fiscal variables across the euro area, or if the euro zone is still characterised by largely idiosyncratic national fiscal policies.

Skidmore et al. (2004) developed a theory around on fiscal expenditure convergence. Their model indicated that "nations with lower levels of government spending experience rapid government growth while those with higher initial levels of government spending experience lower spending growth rates; hence government spending tends to converge over time". Onorante (2004) shows that "fiscal constraints lead to implicit coordination characterized by lower deficits, low interest rates and controlled inflation". She goes on to say "a strategy of convergence in public finances prior to entry in a monetary union may be preferable both for acceding country and the stability of the existing monetary union". This warning is an echo of those raised by Trichet in a number of his monthly press conferences and speeches on monetary policy.

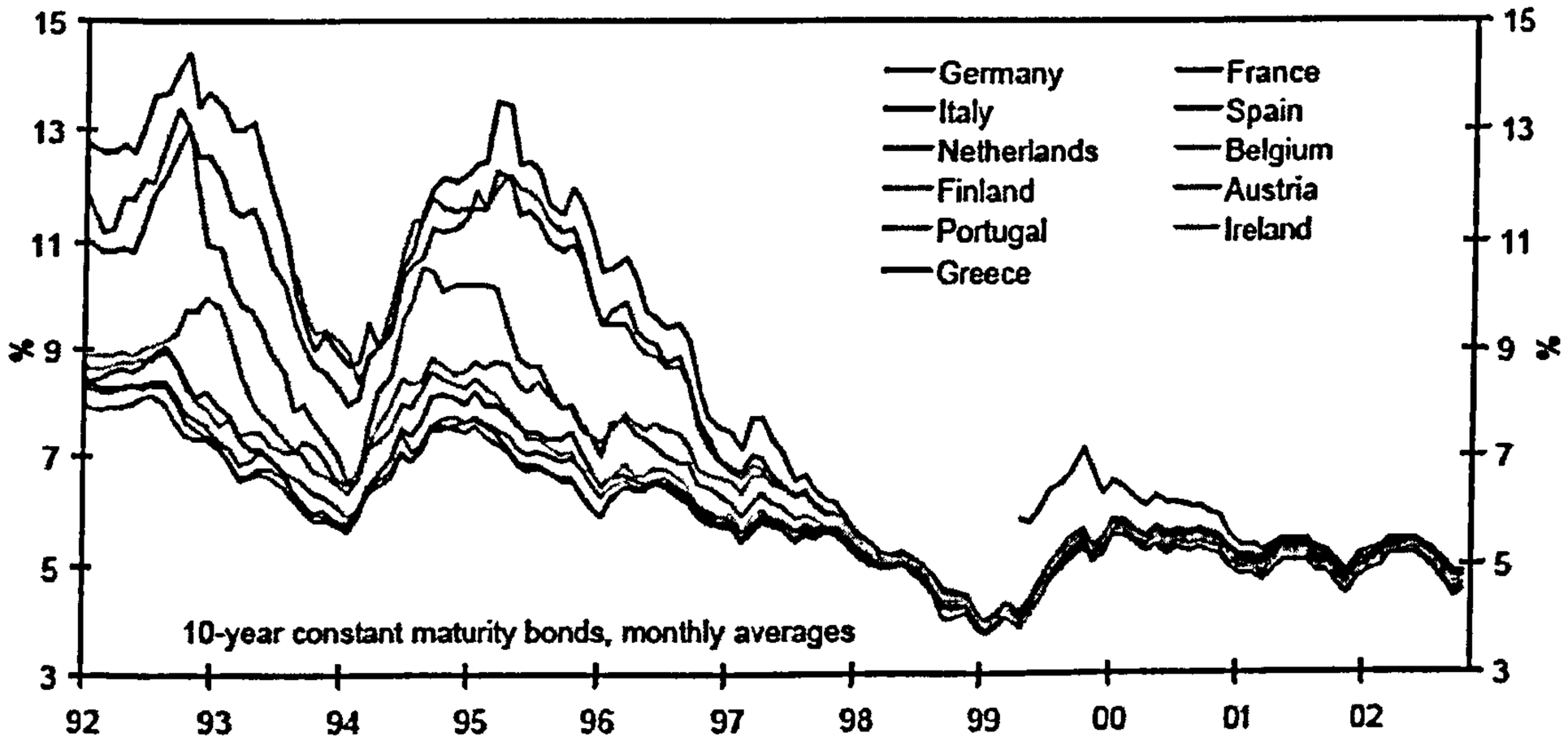
In the research carried out by Kocenda et al. (2006) they find evidence that the 10 new members of the EU are fiscally more disciplined than current EU member states. In their conclusion they state that "this finding raises concerns about the ability of monetary unions to provide a credible signal for fiscal discipline for its new and old members"; they continue "It appears that EMU has not yet become a union in the fiscal aspect and the individual members have neglected the necessary measures of fiscal prudence in their attempt of balancing the EMU criteria with their national interests. Hence, along with new fiscal reforms, establishing fiscal discipline is essential towards achieving a credible and strong fiscal union in Europe. Otherwise, current fiscal practices may destabilize the economic activity in the entire EU25 and delay the entry of the new EU member states to the ERM 2 and hence their adoption of the Euro".

The contrast between the centralized fiscal system in the United States and the decentralized fiscal system in Europe is also very important in this context. A decline of economic activity in a single US state automatically causes a substantial decline in the flow of taxes to Washington from residents and businesses in that state and an increase in transfer payments from Washington. The magnitude is roughly equal to 40 percent of the local decline in GDP. This net fiscal swing constitutes a significant external fiscal stimulus to the local economy. In contrast, with the decentralized European fiscal system, a fall of GDP in any country causes a contraction in tax revenue in that country but very little net transfer from outside. This means that any downturn could be prolonged in the EU because of the fear of free-riding and moral hazard issues. Large scale intra-European transfers from richer countries to poorer countries to develop their local infra-structure is a fraught political issue in many EU countries and is a risk to future coordination.

5.4 Convergence of Euro Sovereign Bond Yields

On the run-up to the introduction of the Euro currency, long-term government bond yields converged among its members to historically low values. The reduction of yields on government debt has been of the great successes of the single currency and EMU. According to the academic literature "... the convergence of national yields to a stable level with reduced risk aids the overall economy, by allowing cheaper access to debt financing with less uncertainty regarding the value of such funds over time. This, in turn, stimulates investment and production output within converging countries. The recent expansion of the eurozone bond market is one beneficial outcome of this process" (Hartmann, Maddaloni, and Manganelli 2003). Given the positive effects of this convergence on the financial system, it is important to identify the factors that will maintain it over the long term.

Figure 7 Government Bond Yields In The Euro Area



Source: Datastream/Thomson Financial

Figure 7 shows a history of bond yields and the extraordinary degree of convergence prior to EMU. The average yield spread for long-term bond yields between Germany and

the other members of the EMU has declined from a high of 646 basis points in the second quarter of 1983 to a low of 12 basis points in the same quarter of 1998. From the graph we can also see that the trend for all member states' yield is down, with the yield required by investors being halved over this timeframe. The reason for this change given in the academic literature is due to the conditions agreed between prospective governments for membership of the EMU alongside the new institutional structures.

Cote and Graham (2004), in their investigation of the reasons behind convergence state "Monetary policy in the future euro-zone countries independently achieved a notable disinflation beginning in the early 1980s". They go on to say that the "extent that movements in inflation are reflected in nominal interest rates, national 10-year government bond yields would have declined as well, contributing to their convergence across countries". They highlight that on the fiscal side, government balance and debt levels began to improve following the initiation of the Maastricht Treaty. Euro governments reduced the supply of sovereign bonds and hence lowered the possibility of default. Cote and Graham (2004) note that "such progress in fiscal positions could be expected to lower the equilibrium yield and the risk premium attached to long-term government bond yields. Indeed, euro-zone national sovereign credit ratings have, on the whole, improved over this period, reflecting lower default risk". They conclude that changes to fiscal policy also appeared "... to have contributed to the convergence of long-term government bond yields across the euro-zone countries".

Cote and Graham (2004) also reported that "Regulatory changes, mark the more rapid periods of convergence in government bond yields. For instance, the decline during the mid- to late 1980s coincides with the signing of the Single European Act (SEA) in February of 1986, and its entrance into force the following July". The purpose of this act

was to attain a single market for goods and services, labour, and capital within the Eurozone. This act signalled a renewed push towards economic and financial integration between members states. The bond market reacted to this act by reducing the yield spread between sovereign issuers. According to Cote and Graham (2004) the next push towards convergence came after the September 1992 ERM crisis, in the lead up to the Maastricht Treaty's entrance into force in November of 1993. Investors began to take account of the low inflation, improved fiscal position, and lower risk premia inherent in the convergence criteria. Cote and Graham (2004) note that the "mid-1990s were, however, an uncertain period in terms of compliance with the Maastricht Treaty. Nonetheless, as the national governments acted to satisfy the necessary criteria, relative long-term yields entered one final period of rapid convergence during the second half of the 1990s".

Table 13 Correlation Of Long-Term Government Bond Yields with Germany

	1980-1991	1991-2002
Austria	0.924	0.996
Belgium	0.796	0.986
Finland	0.540	0.967
France	0.730	0.989
Italy	0.795	0.955
The Netherlands	0.963	0.994
Portugal	0.100	0.890
Spain	0.686	0.952
Average	0.692	0.966

Source: Cote and Graham 2004

In the paper by Cote and Graha (2004) they report that "the convergence of long-term government bond yields since 1980 is also characterized by increased co-movement between national yields". Table 13 illustrates the rise in correlation between the

individual national long-term government bond yields and the German yields over the two halves of their sample. Having divided the sample in half around 1991/1992, which corresponded to the signing of the Maastricht Treaty (draft signed 10 December 1991 and final treaty signed 7 February 1992). The correlation, on average, increased from 0.69 over the period 1980 to 1991 to 0.97 over 1991 to 2002, with all countries showing an increase in correlation between the two periods. Cote and Graham (2004) note "... Austria and the Netherlands maintained very high correlations with the German yield throughout the entire sample due, in part, to the fact that both countries had pegged their currencies to the Deutsche Mark and were effectively subject to German monetary policy[33]. Simple correlations help provide preliminary evidence of how the harmonization of monetary and fiscal policies contributed to the convergence of euro zone long-term government bond yields to that of Germany".

5.4.1 Dr. Evil; the Trade That Shook the Bond Market

As I mentioned previously in the introduction to this chapter the Delors Committee highlighted the possibility that market forces might be "...too sudden and disruptive". Such an event occurred on the 2nd August 2005 which electrified the normally calm and sedate bond market, when Citigroup sold €11.3bn of cash bonds of no fewer than 200 different bonds in 18 seconds after first buying an undisclosed number of Futures Contracts and driving the cash prices up. About 30 minutes later, the bank bought back €4bn of the bonds at lower prices, making a profit of about €18.2m. This caused a panic in the marketplace: how had Citigroup so successfully manipulated the market and made a stunning profit in just one hour?

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[33] Austria's currency was pegged to the Deutsche Mark starting in 1974, whereas the Netherlands' peg began in 1983. Both currencies continued to trade tightly with the Deutsche Mark while in the ERM.

To understand why the manipulation was able to take place, we can turn to the memo published in the Financial Times apparently written by Simon Wivell of Citigroup's European government bond trading desk in London, and addressed to Daniel Leadbetter, another member of the same team, discussing a plan to take advantage of liquidity differentials between the Eurex futures market and cash bonds traded on EuroMTS electronic system.

"Eurex, the Frankfurt-based derivatives exchange, is the most important trading venue for eurozone government bonds, because its German government bond futures are used to price all eurozone government debt. While trading activity on Eurex fluctuates because of seasonal factors and economic conditions, liquidity on MTS (main cash market) is much more constant because the platform obliges its dealers to provide continuous price quotes. Eurex bond futures have become both the primary pricing source and hedging tool of the dealer community. This has led to a large decrease both of the bid-offer spread available on individual bonds and also a decrease in inter bond volatility. Additionally, at the same time as the volatility and bid-offer spread has decreased, the number of dealers has increased and the liquidity available in individual bonds has increased dramatically. This has led to a potentially unstable situation where the liquidity being offered in the bonds is far greater than that offered in the bund future. We should be able to exploit this situation in a profitable way when there is a liquidity imbalance . . . we drive up the Bund future [and] then hit out all the cash [bids] on MTS"

The explicit intention to destabilise the Eurex futures market by continually doing the same kind of trades, which would reduce the attractiveness of using the Bund future as a hedging tool, widen the bid-offer spreads, and of course result in vital flow information

being lost. This could be achieved by exploiting a weakness in the structure of the EuroMTS electronic system, in which market-makers had to commit themselves to quote prices for bonds for at least 5 hours a day for minimum amounts. The Dr. Evil trade was equivalent to a full average day's trading volume on EuroMTS and cost Citigroup's competitors between €1m to €2m apiece. To prevent a repetition EuroMTS restricted trading and many banks refused to honour their commitment to make a market for fear of another mass order. Trading volume on MTS declined by more than 30 percent in the 3 months afterwards, causing European governments to worry about a rise in the cost of servicing their debt due to increasing liquidity risk.

Citigroup argued that this was a market for professional traders who knew how to look after themselves. In its view, exploiting a structural weakness in the EuroMTS market was fair game. Others felt Citigroup had cynically breached a gentleman's agreement central to the workings of the market. However, from a business perspective the trade was a disaster. Angry European governments withdrew business from Citigroup. Any profit they made in the trade were quickly lost, as their lucrative Primary Auction business in new sovereign issues dried up overnight as the eurozone governments punished Citigroup for trying to reduce the liquidity and increase the yields. Britain's Financial Services Authority imposed a fine of £14m for a failure to exercise due skill, care and diligence, together with failures of internal control and risk management – its highest ever fine. An investigation by EuroMTS own independent appeals board found that Citigroup had prejudiced the smooth operation of the market in the long run; shown a lack of professionalism in its disregard of how the trade would affect MTS.

The above sequence of trades shows clearly how closely the Eurozone Bond Futures and Cash markets are integrated. Unlike investors who calculate their yield curve from the

cash markets, market makers must use the Futures market to construct their yield curves. In effect they are calculating a non-arbitrage price from the Eurex Futures market for the underlying cash contract and using various mathematical methods, to interpolate the spot price for all cash instruments. However, it also highlights the weakness in regulation; if Citigroup picked on a single country and sold off its bonds aggressively, building up large short position in say Greek bonds and hence driving the Greek yield up, would it again be penalised if it closed its position with a substantial profit? The regulators are there to enforce a "smooth operating" trading environment, but if that means telling financial institutions what and how to trade, then the concept of an independent financial market is fundamentally flawed. The ambiguous way the charges against Citigroup were handled left the financial markets with one clear insight: anything that would increase the costs of sovereign's debt payments would be punished.

The investigations and reprimand by all the euro regulators against Citigroup after it carried out the "Dr Evil" trade highlight the dual role the sovereigns play of both being issuer and regulator of the same market. The obvious moral hazard implications of such a role seem not to have raised many concerns within the market. This may be because no-one knows of a better solution as to how to separate the roles, so we are left with a very "European" solution, similar to the Stability and Growth Pact mentioned above, which everyone also ignores! The tables have now been firmly turned; the European governments, having so long had their policy goals frustrated by currency speculators, are now themselves in a position to deter what they consider irresponsible trading policies. So where does this leave the role of market discipline as a counter-measure against inappropriate fiscal policies?

What can be seen from the above discussion is that the current system is not operating in its optimum state. There are a number of restrictions and/or regulations in place that limit the effectiveness of the euro sovereign bond market. The purpose of this research is not to offer solutions to these problems, though one need only look to the US bond market to see a much more efficient system, but to investigate how the current restrictions affect how the bond markets operate now. This event was very fortuitous for my investigation; though I started my research before this event took place, I could already see how the various pressures were sculpting the landscape around this issue. This set of trades however brought all the participants that I was studying together in one mixture and crystallised some of the ideas I was exploring, especially around the issue of regulation and market discipline. One should note that no changes of substance were made after this trade; therefore it is still possible for another sequence of trades similar to the Dr. Evil to be carried out. There was no formal reason given by the market why the trades were harmful to the smooth operation of the market. Instead, if an institution passed the management regulations and informed other market makers that it MAY carry-out similar sequences of trades, then what sanctions would it face? It is entirely possible that one of the smaller institutions who can trade on the inter-dealer market but are not market-makers could copy the above trade, knowing that it has very little to lose in the primary dealer market. What happens then?

5.4.2 The Eurex Futures Market Drives All the Bond Cash Markets

A proper functioning of associated derivatives markets facilitates the active trading and management of interest rate risk. Where a well-developed futures market exists, market makers can manage their positions using futures, thereby enhancing their ability to carry out inventory-risk management in the cash market, which in turn, promotes better liquidity. Trading activity in the futures markets may also increase activity in the cash markets due to arbitrage activity on the basis.[34] Equally, a well-developed futures market depends on a deep underlying cash market. This mutually reinforcing process results in large liquid issues, which are deliverable into an actively traded futures contract, commanding a price premium. In the Euro area the Bund futures contract has become predominant. Therefore it is assumed in much of the academic literature that German government bonds, which have became the de-facto benchmark in the 10-year sector, appear to command a sizeable premium versus other sovereign issues due to this 'derivative factor'. Arguably, the lack of a liquid futures contract in all EMU countries but Germany should command a yield premium on non-German bonds, depending on the size of the basis risk that investors are running by having an imperfect hedge.

However returning to the Wivell statement "...its German government bond futures are used to price all eurozone government debt." He states that the futures market is used to price ALL and not just German bonds. This is a substantial difference from that of the academic literature, and remember that Wivell backed-up his hypothesis by selling €11.3bn of bonds, and there is no way any academics could test their hypothesis in quite the same way. Wivell also made his employer a profit of €18.2m so we can take it that

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[34] There appears to be different positions on this issue. Some believe a liquid futures market can withdraw liquidity from the underlying cash market, as speculative traders would find trading in the futures market cheaper.

his hypothesis worked well for him. If the Eurex Futures now prices all bonds and is no longer seen by the market as specific to Germany, then this 'derivative factor' must have been greatly reduced over the years. Christiansen (2003) has also found some changes in European bond markets since the introduction of the Euro. She provides empirical evidence that regional effects have become dominant over both own country and global effects in EMU bond markets with the introduction of the Euro but not in non-EMU countries where country effect remains strong. Such academic research sits very comfortably with Wivell's view of the market, where Eurex Futures simulate the regional role and affect each sovereign's bonds more that "own country" effects.

Taking the view of Simon Wivell and Citigroup, my hypothesis is that once the news/economic data is distributed by Bloomberg/Reuters etc., the Futures Price changes immediately depending on the market's view and the cash market's update reflecting the new futures level. This is not a new insight, as there are a myriad of papers that investigate the relationship between Futures and their underlying Cash markets, Garbade & Sibler (1983), Schroeder & Goodwin (1991), Witherspoon (1993), Zapata, Fortenbery & Armstrong (2005). However, the view of Wivell is that the Eurex Futures market leads not only its underlying German cash, but also leads the Non-German cash markets as well. This is a new insight into the functioning of the bond market and this leads me to investigate how the various sovereigns interact with each other in the following sections.

Wivell hypothesis that the 3 Eurex Future contracts; Bund, Bobl and Schatz, which correspond to 3 distinct maturity segments that drive the Euro Government Bond Market. After each economic announcement, the market responds to reflect this new piece of information and in turn the yield curve changes, the curve may flatten or steepen; it may

experience a parallel shift up or down. As each of the 3 futures prices tick, the bonds in their respective maturity buckets are recalculated immediately. Bonds in the 8.5 to 10.5 year range that use the Bund to calculate their price will only change when the Bund ticks, not when the Bobl or Schatz tick. Bonds in the 1.75 to 2.25 year range that use the Schatz to calculate their price will only change when the Schatz ticks, not when the Bund or Bobl ticks. Bonds that have a maturity which falls between the maturity buckets will blend the 2 nearest futures prices. The coefficients for the futures are computed by a simple linear calculation.

The flow of data is almost instantaneous after the economic data or news is announced to the markets, and the future prices are immediately impacted. The cash traders withdraw their prices prior to an expected announcement, or immediately after an unexpected event. They then wait for the future price to settle down after the announcement, to allow the market to come to some sort of consensus of the direction of prices, the price adjustment of the cash bonds is almost immediate.

Economic announcements (1) → Eurex Futures (2) → All Eurozone Bonds

The market makers then start to quote the more liquid instruments first, i.e. Germany, France and Italy, and once they have cleared the backlog of trades and client requests on these markets, they quote on the remaining bonds, i.e. Illiquid bonds and all other sovereign issues. The sequence is as follows: Cheapest-to-Deliver Bonds (1)→ Core Bonds & Italy (2) → Non-Core Bonds. In this research I will expand on the work by Dunne, Moore and Portes (2006) who demonstrated that Germany, France and Italy were cointegrated to show that all the other euro sovereigns are cointegrated. This will allow me to investigate the impact on market discipline and allow me to create an Error Correction Model to research further the dynamics of the bond market.

5.5 Granger Causality and Information Flow in EMU Bond Market

For a description around Granger Causality, there is no better summary than that supplied by G.S. Maddala in his book, Econometrics. In it he explains that the mechanism that ties cointegrated series together is "causality", not in the sense that if we make a structural change to one series the other will change too, but in the sense that turning points on one series precede turning points in the other. The strength and directions of Granger causality can change over time, there can be bi-directional causality, or the direction of causality can change, e.g. the relationship between spot and future prices there may be times when futures lead spot, where as at other times spot prices can lead future prices. Granger starts from the premise that the future cannot cause the present or the past. If event A occurs after event B, we know that A cannot cause B. At the same time, if A occurs before B, it does not necessarily imply that A causes B. For instance, the weatherman's prediction occurs before the rain. This does not mean that the weatherman causes the rain. In practice, we observe A and B as time series and we would like to know whether A precedes B, or B precedes A, or they are contemporaneous. For instance, do movements in prices precede movements in interest rates, or is it the opposite, or are the movements contemporaneous? This is the purpose of Granger causality. It is not causality as it is usually understood.

Granger devised some tests for causality (in the limited sense discussed above) which proceed as follows. Consider two time series, $\{y_t\}$ and $\{x_t\}$. The series x_t fails to Granger cause y_t if in a regression of y_t on lagged y's and lagged x's, the coefficients of the latter are zero. That is, consider

$$y_t = \sum_{i=1}^{k} \alpha_i y_{t-i} + \sum_{i=1}^{k} \beta_i x_{t-i} + u_t$$

Then if $\beta_i = 0$ (i = 1,2, ..., k), x_t fails to cause y_t. The lag length k is, to some extent, arbitrary. The word "precedence" would be more applicable than Granger causality since in effect we are testing if a certain variable precedes another and we are not testing causality as it is usually understood. The necessity for causality between cointegrated series is revealed by the Error Correction Model (ECM), which is a dynamic model of returns where deviations from the long-run equilibrium are corrected. The practical way to determine Granger causality is to consider whether the lags of one variable enter into the equation for another variable. In terms of the VAR, y_1 does not Granger-cause y_2 if $\alpha_{21} = 0$. To determine if y_1 Granger-causes y_2, use a standard F-test to test the restriction: $\alpha_{21}(1) = \alpha_{21}(2) = \alpha_{21}(3) = ... = 0$.

Continuing with the German and Austrian bonds described previously I construct a two-variable Vector Auto Regression (VAR). I use a lag of 1, as stated previously a lag length of 1 day is a very long time in financial markets. The results show some strong lead-lag interactions between the series. The Austrian yields are significantly affected by the previous day's German yields. The results can also be interpreted as Granger-causality tests, since if variable y_1 causes y_2, lags of y_1 should be significant in the equation for y_2. If this were the case, we would say y_1 'Granger-causes' y_2, and so on. In the present context, consider the F-test p-value of the joint test is 0.036 on the German variable in the regression equation for Austria as dependent variable and the p-value of 0.334 on the Austrian variable in the German equation. The results show that that the German Yield Granger-causes the Austrian Yield, but not the other way around.

Table 14 Granger Causality F-Tests

Variable	Dependent Variable Austria		Dependent Variable Germany	
Austria (-1)	546.2897	0.0000000	0.9342	0.3339925
Germany (-1)	4.4185	0.0357832	648.4560	0.0000000

The Granger-causality analysis is simple but perhaps rather crude. It ignores long-run relationships. An important issue in econometrics is the need to integrate short-run dynamics with long-run equilibria. The traditional approach to the modelling of short-run disequilibria is the partial adjustment model. An extension to this is the ECM (Error Correction Model), which also incorporates past period's disequilibrium. The analysis of short-run dynamics is often done by first eliminating trends in the variables, usually by differencing. This procedure, however throws away potential valuable information about long-run relationships about which economic theories have a lot to say. The theory of cointegration developed by Granger addressees this issue of integrating short-run dynamics with long-run equilibria. Therefore instead of analysing all our bonds for Granger-causality, I progress to using cointegration in the next sections.

We start our investigation of integration in the Euro Sovereign market by analysing the interdependency between Germany and Austria. Germany and Austria are neighbouring countries, which have close cultural and economic ties; they are the only 2 countries that have the same single official language in the Eurozone. However the German economy dwarfs that of its neighbour, and therefore we would expect that any impact on the German economy, and therefore its bond yield, to quickly flow into the Austrian yield, but not vice versa. The correlation between the German and Austrian yields was the highest at 0.996 of all euro sovereign yields and these countries had the same credit rating throughout the time of my investigation. As one can see from Figure 8 the yield of the Austrian bond follows an almost identical path to that of Germany. The German yield was lower than Austria, which reflected the perceived lower riskiness of German government bonds relative to the bonds of the other EMU member countries as discussed in the previous chapter before and after the introduction of the currency.

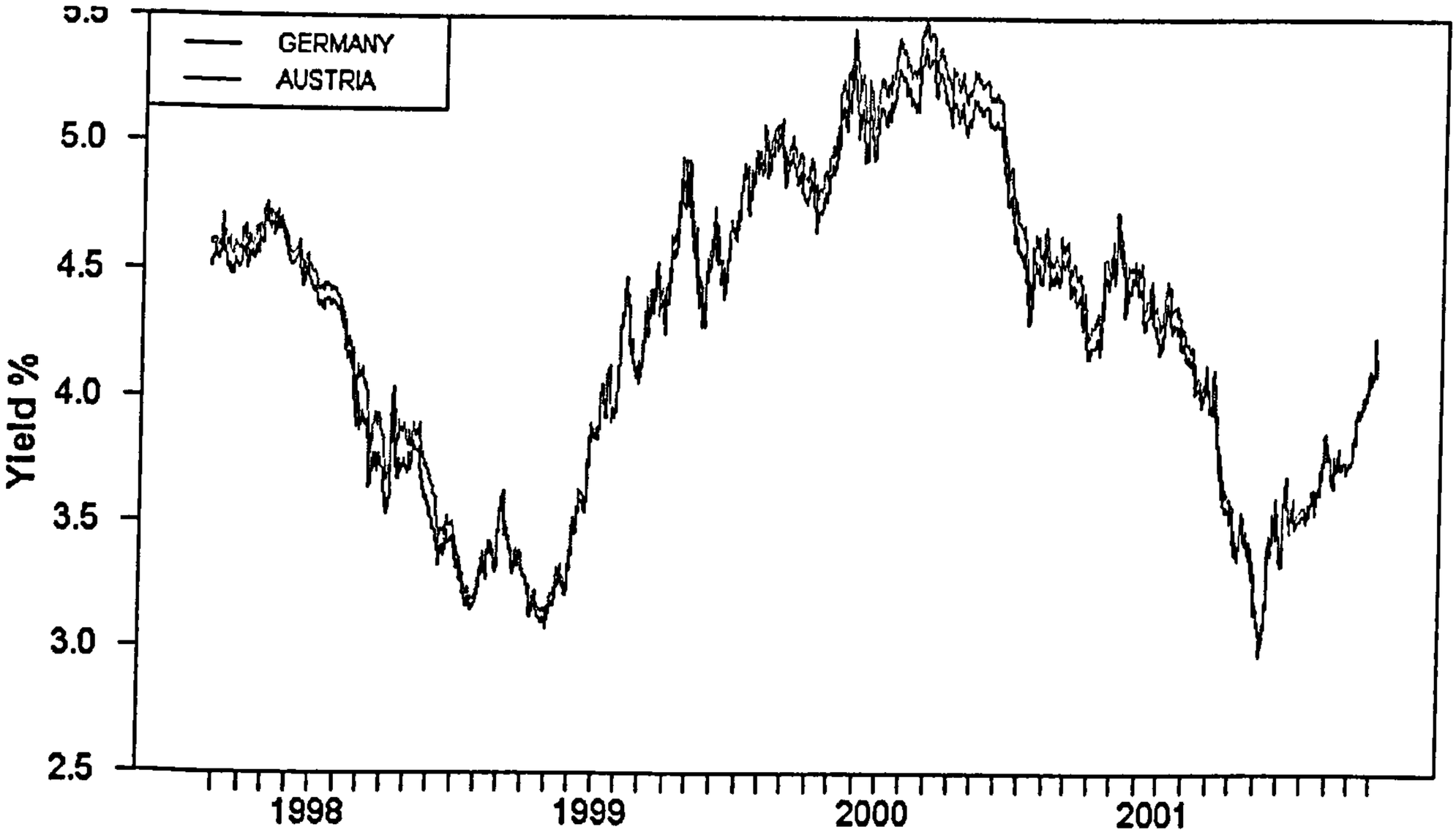
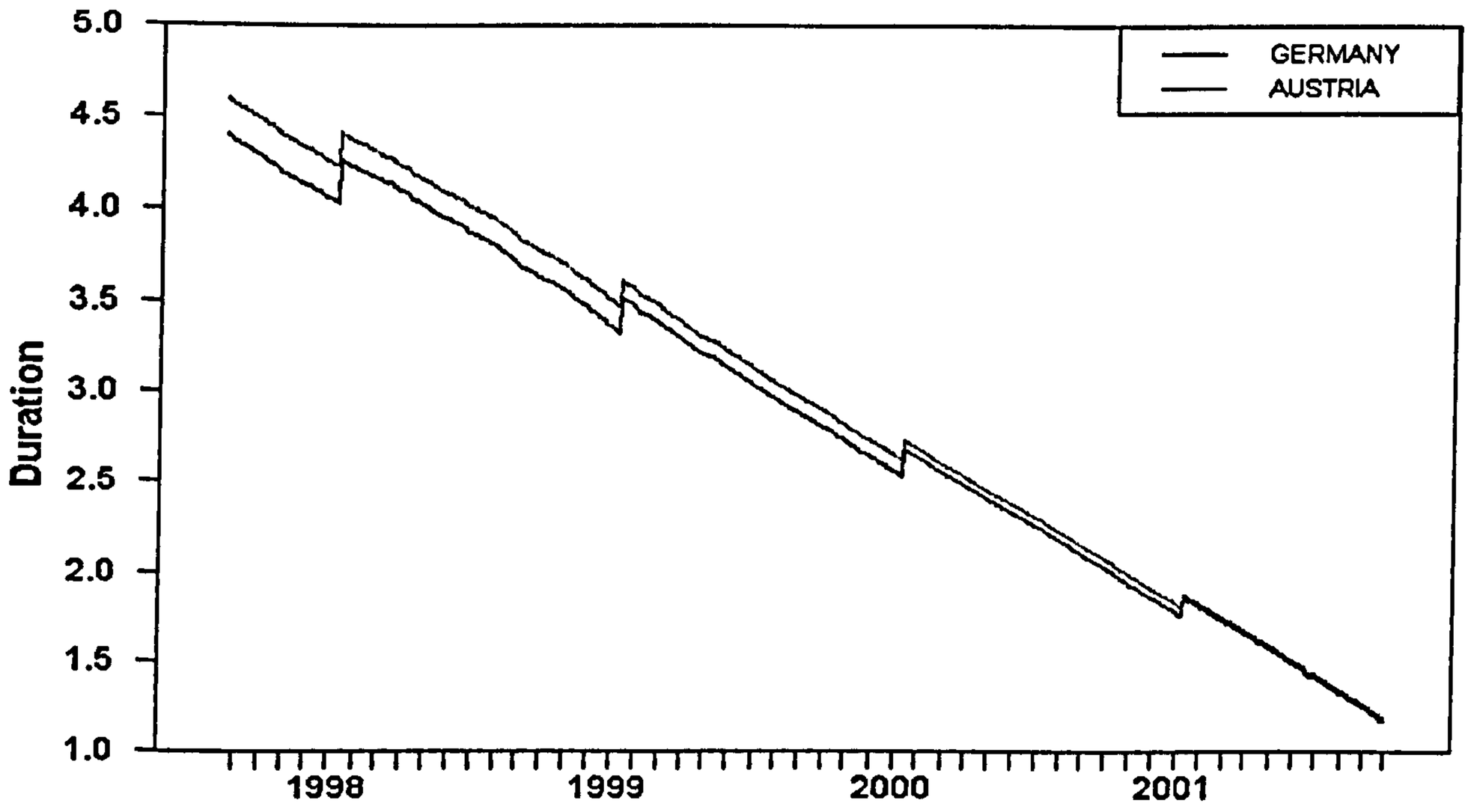


Figure 8 Yield of German and Austrian bonds over time

Figure 8 above shows how bonds of similar duration move together over time, if I had chosen 2 bonds of different durations then the graph would be very different. This is because the Interest Rate risk would far outweigh any other risk incorporated in the yield. Selecting an Austrian bond that had a modified duration similar to that of the German bond previously analysed we reduce the interest rate risk component, when comparing the yields on the bonds. As a reminder, the modified duration measures the proportional sensitivity of a bonds price to a small change in its yield. For a bond with a modified duration of 3.5, a 1 basis point change in the yield will cause a 0.035 percent change in the price. Figure 9 shows how the duration of the bonds changes with time, each time a coupon is paid there is a jagged edge displayed in the duration. Notice how the duration of the bond and hence its sensitivity to interest rate risk is reduced as the bond moves closer to its maturity date.

Figure 9 Modified Duration of German and Austrian bonds over time



If we now reduce the entire bond market down to 2 securities, then an investor would be looking at the relative value of the 2 securities, especially if he had the ability to short one against the other. We can continue our analysis by investigating the Credit Spread between the 2 securities, as this would have a significant impact on which security an investor would select. As with the yield, we start by investigating if the credit spread is a stationary or a non-stationary process. If we assume that the bond markets have a causal long-term relationship, then what does this mean for an investor when it comes to choosing in which country to invest? Are the impacts of economic announcements felt in equal measure by each country? Is there one sovereign issuer that leads the rest i.e. the benchmark for the Eurobond market? What impact does this have for diversification? There are a multitude of questions that this raises, and I will be investigating these issues in the following sections.

5.6 Modelling EMU Sovereign Yields

As discussed in the previous sections the eurozone government bond yields have converged to an extraordinary degree over the course of the last 20 years. This convergence is also characterised by increased co-movement between national yields. Utilising time series analysis on the yield values by country allows us to investigate the inter-dependence of the bond market. Specifically, measures of dispersion and co-movement of yields can shed light on the extent to which shocks are common, or not, across European sovereign markets; and analysis of sovereign bond yields can provide an indication of the time profile of risks. We will begin by testing our time series for stationarity and nonstationarity, and this has importance consequences for how we model our process. Shocks to a stationary time series are necessarily temporary; over time the effects of the shocks will dissipate and the series will revert to its long-run mean level. On the other hand, a nonstationary series necessarily has permanent components. The mean and/or variance of a nonstationary series are time-dependent.

5.6.1 Selection Criteria of Bonds for Analysis

While Euro Sovereign Bond yields have converged significantly, they have not gone so far as to give identical yields on different countries' securities with similar characteristics. The problem when it comes to comparing bonds lies in the fact that in the Euro Government bond market, no two bonds are identical. They either have different coupons or different maturity dates. Each country, or rather each country's debt instruments have varying degrees of liquidity, and various degrees of attractiveness to investors, i.e. On-the-run bonds, liquidity, convexity, special-in-repo etc. Almost every study of any bond market, involves some calculation or manipulation of the data. They invariably try to calculate yields by using a bootstrapping method whereby the zero-

coupon bonds spot rates are determined from the available redemption yields of shorter maturities. This eliminates the coupon effect, which refers to the phenomenon observed in markets that the yield to maturity of bonds with the same maturity but different coupons may vary considerably. They also generally fix the term, again using the bootstrapping method to generate an ideal 10-year bond for example, by using the yield of the bond closest to this maturity, therefore the individual bond will change over the sample many times. In my research, I will not manipulate the data in this way; I will be making no assumptions or attempting to calculate an idealised yield curve. As my data is taken directly from prices quoted on the electronic exchanges, I therefore presume that all the instruments' individual characteristics are already priced in by the market; if the instruments were mispriced then they would be quickly lifted by arbitrage traders. This reasoning is based on theories of Commodity Market Arbitrage which suggest that in the short run, prices of similar products in varied markets might differ; however, arbitrageurs will prevent the various prices from moving too far apart.

My analysis will include all EU countries, except Luxembourg which has negligible government debt. For each country we sub-divide the market by maturity, i.e. Short, Medium and Long. Specifically for the European Bond Market this division is particularly apt as it also corresponds to the Futures Market divisions, where the Schatz, Bobl and Bund are the corresponding hedging instruments for these maturities. For each country and each maturity I select an instrument for analysis; if there are a number of instruments available at a particular maturity, I pick the instrument with the closest duration profile to that of a corresponding German instrument. This minimises the interest rate risk component of the yield spread between the two instruments. No other reason is used for selection purposes, the differences between On-the-run, Off-the-run bonds, Basis risk etc. are not incorporated in the selection process. Again it is the

relative value between the two instruments that is the object of the investigation. Table 15 contains a bond for each maturity of each country that will be analysed. The amount of data available is not the same for each instrument and depends on when the instrument was created.

My data was generated by a batch process whereby all the calculated yield values for all tradable European Government Bonds were written to a database at 12.00 pm (BST) every trading day from various electronic trading platforms including Euro-MTS, Bloomberg, Reuters, and Datastream. Selecting to take a snapshot of the data at 12:00pm reduces a significant proportion of the volatility in the market, as it is approximately 2 hours after most of the European data has been released, usually between 8 am and 10 am every morning, and before the US data is released at 1:30pm, which has a substantial impact on the Euro yield curve. Therefore as the US Markets are closed and as it is lunch-time throughout Europe, the yield will be quite stable at this time.

We will start our analysis with a short yield German bond DBR 6,500% 15/07/03, and use this as a template for our analysis of the other countries tabulated in Table 15. Figure 10 shows the history of the Yield return for the German Bond DBR 6,500% 15/07/03 over a period of almost 5 years. We can see that the yield of the bond dropped prior to the introduction of the Euro, while it breached 5% in 2000. The series autocorrelations and partial autocorrelations help determine whether the series is level and variance stationary, or if we need to apply differencing or other transformations to produce a stationary time series. The plot of the Auto-Correlation Function (ACF) or correlogram should converge to zero geometrically if the series is stationary. From the graphs we can see that the correlogram for the undifferenced data does not converge while first

differences converge quickly to zero. Therefore from our first investigations we hypothesise that the yield process is a non-stationary time-series of order 1, i.e. I(1).

Table 15 Government Bond Instruments under Investigation by Maturity Baskets

Short*	Medium*	Long*
German		
DBR 6.5% 15/7/03	DBR 5.25% 4/1/08	DBR 6.5% 4/7/27
France		
BTAN 3.5% 12/07/04	OAT 5.250% 25/04/08	OAT 8.5% 26/12/12
Austria		
RAGB 4.3% 15/07/03	RAGB 4.0% 15/07/09	RAGB 5.25% 4/01/11
Holland		
DSL 5.75% 15/01/04	DSL 8.25% 15/09/07	DSL 5.50% 15/01/28
Belgium		
OLO 14 7.25% 04/04	OLO 26 6.25% 03/07	OLO 35 5.75% 03/10
Spain		
BONO 3.25% 31/01/05	OBLE 6.00% 31/01/08	OBLE 8.70% 28/02/12
Finland		
RFGB 3.75% 12/11/03	RFGB 5.00% 25/04/09	RFGB 5.75% 23/02/11
Greece		
GGB 8.7% 8/04/05	GGB 8.8% 19/06/07	GGB 5.35% 18/05/11
Ireland		
N/A	IRISH 4.25% 18/10/07	IRISH 4.6% 18/04/16
Italy		
BTP 4.0% 15/07/04	BTP 4.5% 1/05/09	BTP 6.5% 1/11/27
Portugal		
OT 3.625% 19/08/04	OT 3.95% 15/07/09	OT 5.15% 15/06/11

* Short corresponds to 1.25 – 3.5 years, Medium 3.5 – 6.5 years and Long 6.5 – 13.5 years

Figure 10 Graphs of German I(0) and I(1) processes

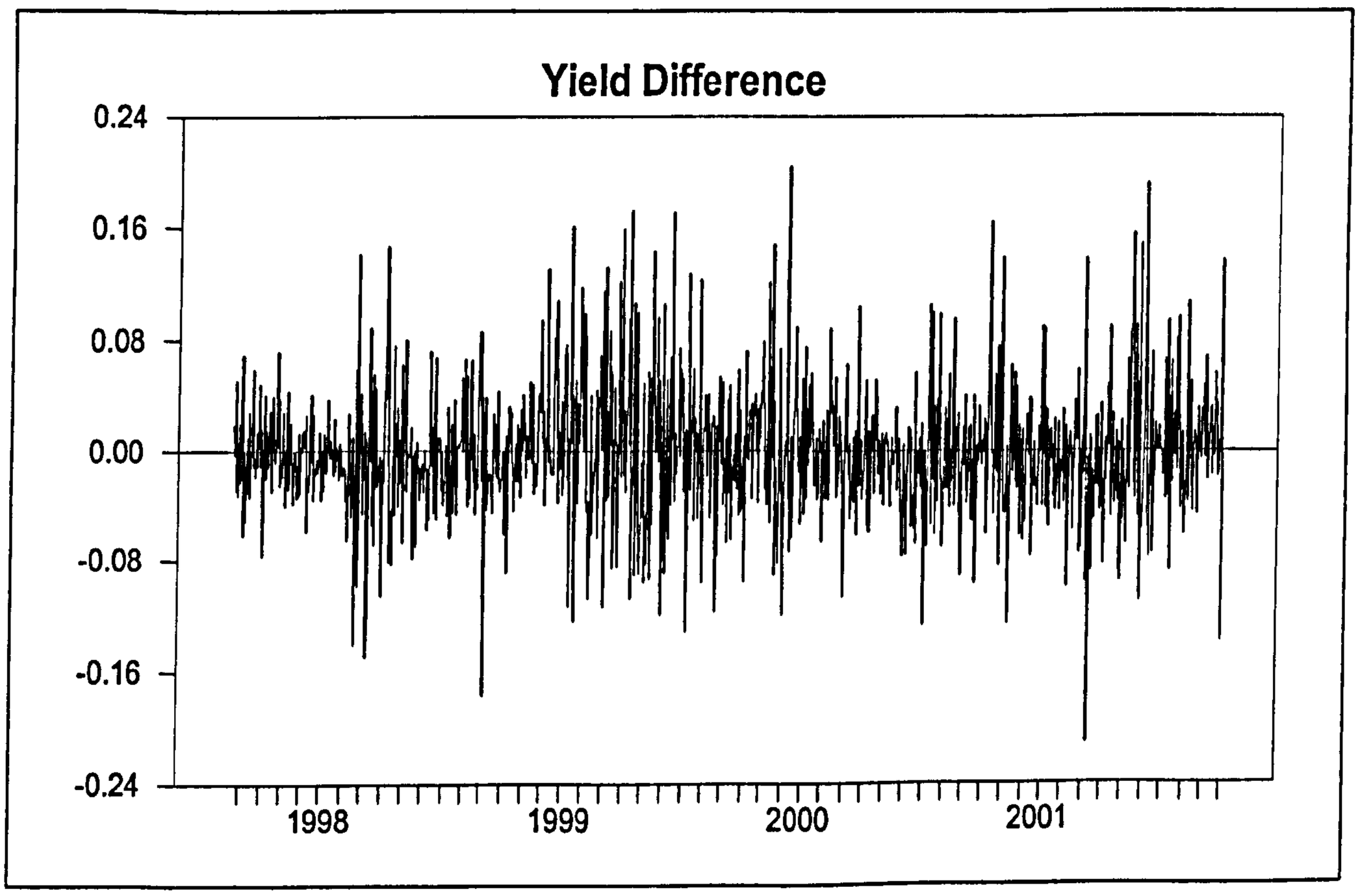
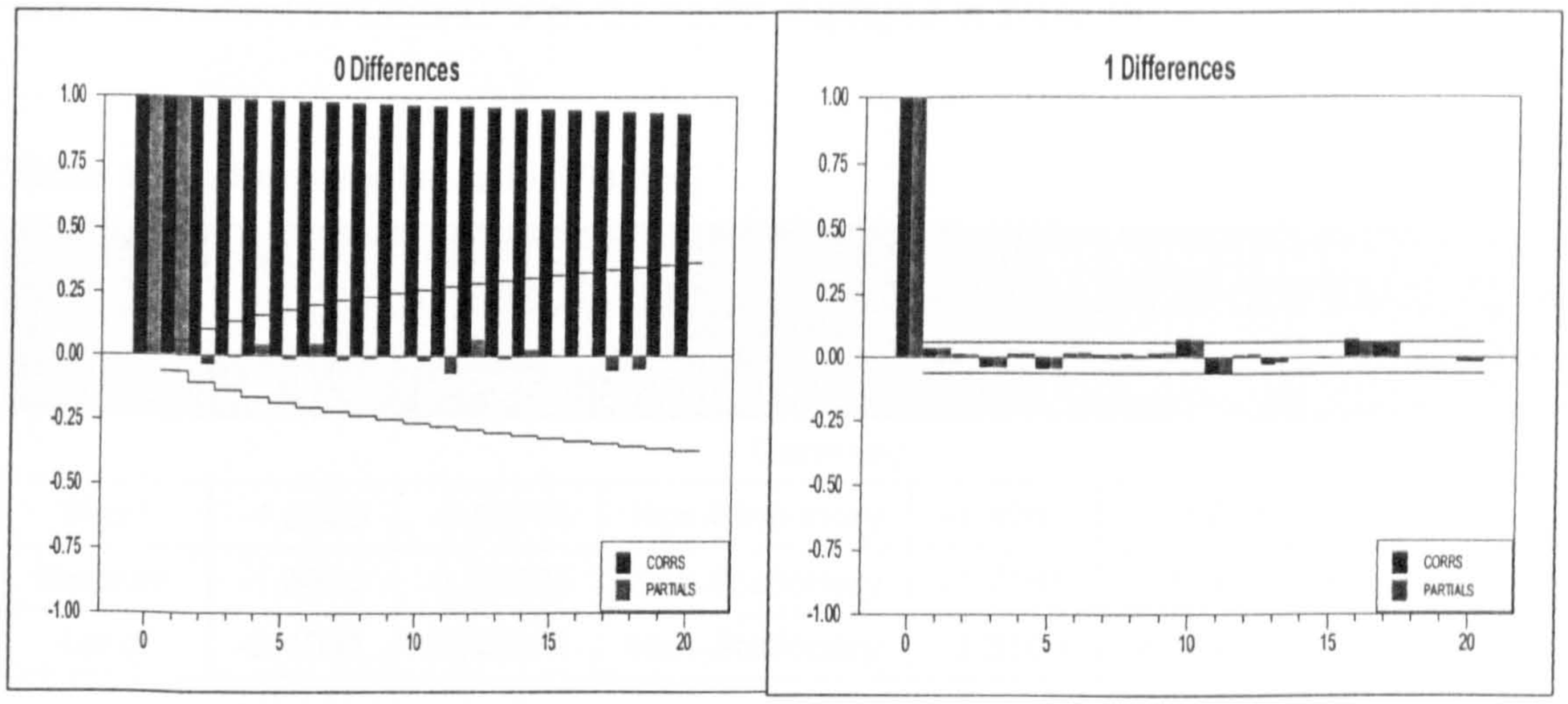


Figure 11 The plot of the Auto-Correlation Function for Short Term German Bond



We continue our investigation of the yield process by using the Dickey-Fuller test procedure to check for a unit root. If the value is greater than the Dickey-Fuller Test Statistic, the series contains a unit root process, i.e. it is a non-stationary process. The ADF selects the lag optimal lag length using the AIC/BIC criterion and reports the t-statistic and the critical value of the intercept and y. We also use the Phillips-Perron test procedure to double-check the results.

We first run the ADF procedure without drift

Augmented Dickey-Fuller test for y with 0 lags:	-1.3005
Phillips-Perron test with 0 lags including intercept	-1.30168
At level 0.05 the tabulated critical value:	-2.8647

We then run the ADF procedure taking drift into account

Augmented Dickey-Fuller test for y with 0 lags:	-1.3265
Phillips-Perron test with 0 lags including intercept and trend	-1.30817
At level 0.05 the tabulated critical value:	-3.4164

We can see that the critical value is more negative than the test statistic and hence the null hypothesis of a unit root cannot be rejected. The same procedure is carried out for every instrument in Table 15 with the results displayed in Table 16.

Table 16 Stationarity Tests for Yields

Maturity	Tests in the absence of drift[a] Unit-root tests[b]			Tests in the presence of drift Unit-root tests		
	ADF: t_μ	PP:Z(α)	Conclusion	ADF: t_μ	PP:Z(α)	Conclusion
Germany						
Short	-1.3005	-1.30168	Non-Stationary	-1.3265	-1.30817	Non-Stationary
Medium	-1.5836	-1.58508	Non-Stationary	-1.7165	-1.72450	Non-Stationary
Long	-2.4937	-2.49574	Non-Stationary	-2.3100	-2.34443	Non-Stationary
France						
Short	-1.9949	-1.99734	Non-Stationary	-2.0115	-1.93925	Non-Stationary
Medium	-1.6267	-1.62823	Non-Stationary	-1.7665	-1.80287	Non-Stationary
Long	-2.5097	-2.51115	Non-Stationary	-1.8014	-1.66969	Non-Stationary
Italy						
Short	-1.4850	-1.48709	Non-Stationary	-2.6919	-2.63993	Non-Stationary
Medium	-2.1293	-2.13175	Non-Stationary	-2.2800	-2.00129	Non-Stationary
Long	-3.5097	-3.29958	Stationary	-3.4435	-3.64018	Stationary
Austria						
Short	-1.2465	-1.24764	Non-Stationary	-1.2541	-1.25078	Non-Stationary
Medium	-2.4274	-2.43046	Non-Stationary	-2.8497	-2.49208	Non-Stationary
Long	-1.5601	-1.56508	Non-Stationary	-1.3673	-1.45277	Non-Stationary
Belgium						
Short	-2.2649	-2.26627	Non-Stationary	-1.9097	-1.62215	Non-Stationary
Medium	-2.2390	-2.24066	Non-Stationary	-1.9219	-1.84957	Non-Stationary
Long	-1.2827	-1.29048	Non-Stationary	-1.7533	-1.88653	Non-Stationary
Finland						
Short	-1.8765	-2.28562	Non-Stationary	-1.9354	-2.22489	Non-Stationary
Medium	-2.5159	-2.53174	Non-Stationary	-2.4449	-2.34783	Non-Stationary

[a] In the absence of drift, the ADF and PP tests include a constant term but do not include a linear time trend, whereas in the presence of drift they include a constant term as well as a linear time trend.

[b] The ADF and PP normalised bias statistics test the null hypothesis of non-stationarity (i.e., H_0: is I(1)) against the alternative hypothesis of stationarity (i.e., H_1: is I(0)). P-values for the ADF t-statistics and the PP normalised bias statistics (reported in square brackets) are obtained from the critical values reported by Davidson and MacKinnon (1993, Table 20.1).

Long	-1.3714	-1.37629	Non-Stationary	-1.6774	-1.56913	Non-Stationary

The Netherlands

Short	-1.8506	-1.85165	Non-Stationary	-1.7705	-1.65013	Non-Stationary
Medium	-1.9946	-1.99581	Non-Stationary	-1.7195	-1.57479	Non-Stationary
Long	-2.5154	-2.18071	Non-Stationary	-2.6588	-2.36222	Non-Stationary

Portugal

Short	-1.2082	-1.21003	Non-Stationary	-2.1226	-2.50774	Non-Stationary
Medium	-2.4865	-2.48967	Non-Stationary	-3.0265	-2.62409	Non-Stationary
Long	-1.3727	-1.37769	Non-Stationary	-1.3049	-1.25395	Non-Stationary

Spain

Short	-1.4595	-1.46216	Non-Stationary	-1.1433	-1.14506	Non-Stationary
Medium	-2.5042	-2.50624	Non-Stationary	-2.2171	-2.24841	Non-Stationary
Long	-4.3736	-4.37667	Stationary	-2.8786	-3.09629	Non-Stationary

Ireland

Short	N/A	N/A	N/A	N/A	N/A	N/A
Medium	-0.7786	-0.79534	Non-Stationary	-1.8935	-2.12347	Non-Stationary
Long	-2.7052	-2.70897	Non-Stationary	-3.2569	-3.74582	Non-Stationary

Greece

Short	-1.4350	-1.43944	Non-Stationary	-1.0557	-1.14872	Non-Stationary
Medium	-1.6754	-1.68066	Non-Stationary	-1.5779	-1.66242	Non-Stationary
Long	-1.6936	1.69911	Non-Stationary	-1.5051	-1.51241	Non-Stationary

The results show that almost all government bond yields are non-stationary. The 2 instruments that are stationary i.e. long Italy and Spain, when graphed as shown below have periods of high volatility, and it is very difficult to argue that there is a mean. The yield of both countries fell as both governments strove to meet the conditions of the Growth and Stability pact for entry into the single currency. However once accepted for entry the austerity measures imposed by these countries were relaxed, and therefore the yield increased.

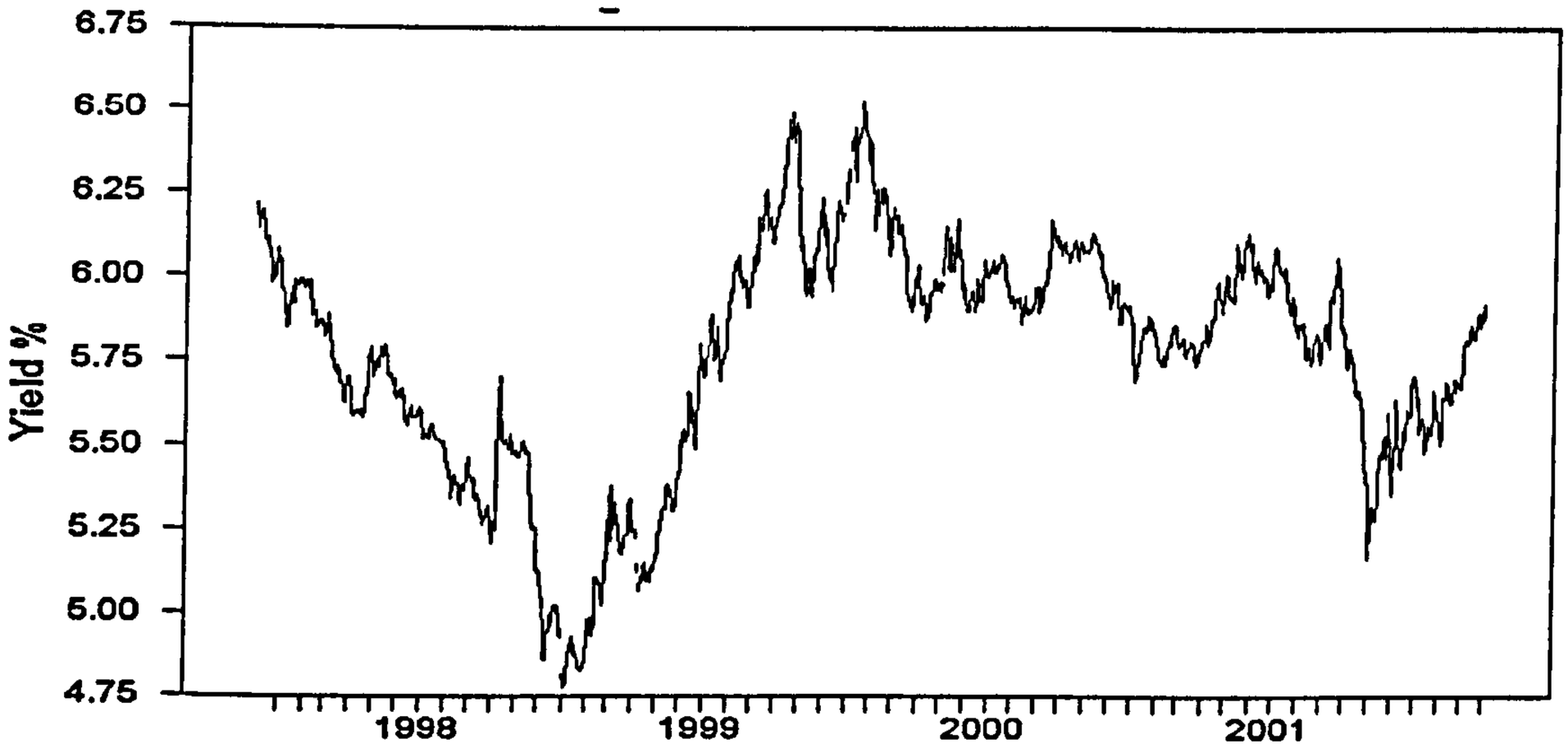


Figure 12 Yield of long term Italian bond over time

Having established that all our Government yields are non-stationary, we must ask why are the yields so highly correlated? As they are stochastic we would expect to see the yields drift further apart over time, and not as has been the case that the yields are actually converging. We must hypothesise that the bonds share a common stochastic process and are therefore integrated. Engle and Granger (1987) state that if a linear relationship exists between two non-stationary time series, and their residuals are stationary, these variables share a long-term relationship. That is, a linear combination of two non-stationary variables may be stationary, implying that the variables share a long-term equilibrium relationship.

5.6.2 Cointegration Analysis

The concept of cointegration applies to a wide variety of economic models. Any equilibrium relationship among a set of nonstationary variables implies that their stochastic trends must be linked. After all, the equilibrium relationship means that the variables cannot move independently of each other. The linkage among the stochastic trends necessitates that the variables be cointegrated. Since the trends of cointegrated variables are linked, the dynamic paths of such variables must bear some relation to the current deviation from the equilibrium relationship. This is exactly what we have discussed above i.e. the Eurex Futures market is the common stochastic process for yields of European Government bonds. There are many examples in finance of areas where cointegration might be expected to hold, including:

1. Spot and futures prices for a given commodity or asset.
2. Ratio of relative prices and an exchange rate.
3. Equity prices and dividends

In all there cases, market forces arising from no-arbitrage conditions suggest that there should be an equilibrium relationship between the series concerned. The easiest way to understand this notion is perhaps to consider what would be the effect if the series were not cointegrated. If there were no cointegration, there would be no long-run relationship binding the series together, so that the series could wander apart without bound. Such an effect would arise since all linear combinations of the series would be non-stationary, and hence would not have a constant mean that would be returned to frequently. Spot and futures prices may be expect to be cointegrated since they are obviously prices for the same asset at different points in time, and hence will be affected in very similar ways by given pieces of information. The long-run relationship between spot and futures prices would be given by the cost of carry.

A principal feature of cointegrated variables is that their time paths are influenced by the extent of any deviation from long-run equilibrium. Thus, the short-run dynamics must be influenced by the deviation from the long-run relationship. It can also be shown that cointegration implies error correction. This result is called the Granger representation theorem stating that for any set of I(1) variables, error correction and cointegration are equivalent representations, which was discussed fully in chapter 4. To elaborate, consider the simple case of a first-order VAR:

$$x_t = A_1 x_{t-1} + \epsilon_t \qquad \text{eqn. 1}$$

where x_t is the (n x 1) vector $(x_{1t}, x_{2t}, \dots, x_{nt})'$; ϵ_t is the (n x 1) vector $(\epsilon_{1t}, \epsilon_{2t}, \dots, \epsilon_{nt})'$; A_1 is an (n x n) matrix. Subtracting x_{t-1} from each side and letting I be an (n x n) identity matrix, we get:

$$\begin{aligned} \Delta x_t &= -(I - A_1)x_{t-1} + \epsilon_t \\ &= \Pi x_{t-1} + \epsilon_t \end{aligned}$$

where Π is the (n x n) matrix ($A_1 - I$). How do we find the cointegrating relationship from this VAR model? There is a simple relationship between vector autoregressions and cointegration. In the two-variable case, if the characteristic roots of the matrix of coefficients in the VAR model, in eqn 1, are both equal to unity, the series are both I(1) but not cointegrated; if precisely one of the roots is unity, the series are cointegrated. If neither of the roots is unity, the series are stationary, and so they are neither integrated nor cointegrated. In the two variable case, the relative values of the cointegration coefficients are uniquely determined. Also in this case, the matrix Π for the VAR model has rank 1.

A cointegrating relationship may also be seen as a long-term or equilibrium phenomenon, since it is possible that cointegrating variables may deviate from their relationship in the short run, but their association would return in the long run. In such an equilibrium model, the short-term dynamics of the variables in the system are influenced by the deviation from equilibrium. In general, all variables in a cointegrated system will respond to a deviation from the long-run equilibrium, however it is possible that some of the adjustment parameters are zero so that only some of the variables respond to the discrepancy from long-run equilibrium. This is exactly how I envisage the Euro government bond market to function, as new information is supplied to the market the Eurex Futures Price changes, the euro-wide bond term structure updates to reflect the new market consensus, i.e. the new equilibrium value. Then the individual sovereign yields will update to encompass the new credit risk component. They will not update immediately, therefore we see compression\widening of the spreads which I investigate in the next chapter.

I calculate the yields directly from the bond market using bonds of similar duration. If the durations are similar then both instruments carry a comparable interest-rate risk and any difference in yields must then be assumed to be due to other factors, e.g. Default Risk, Liquidity, Convexity etc. However, if the durations are not equal then a proportion of interest-rate risk will be included in the spread between the bonds. The proportion of the interest-rate risk within the spread is incorporated in the selection, and this risk should not alter greatly over time. This would have an effect on my results if I looked at one pair of bonds in isolation, but as my research entails a large number of pairs, the effect of the interest-rate risk component is negligible on my overall results. I will produce a history of the spread over the entire life of the bond, and will investigate how the spread changes over time. If I do this for the entire set of an individual sovereign

debt instruments, I should remove or reduce the impact of individual characteristics of a bond from the spread and glean a deeper insight into the credit component for that issuer. I propose that this method of analysis is far superior, when compared to the stylised bonds of previous studies. The reason is that actual prices on quoted bonds encompass all the nuances and risks experienced in the bond market e.g. Economic Announcements, Large Trades, Herd Mentality, Changes in Supply and Demand etc. and are a truer indication of what the market maker or investor face when deciding the price of a bond over a number of economic cycles. By not using the bootstrap method to compensate for bonds of differing maturity dates and coupons, I keep all the nuances of my bond market data intact which is very important when looking at "appetite for risk".

The CATS program of Hansen and Juselius allows us control of the deterministic component in the model. There are a number of options:

- NONE specifies a model without any deterministic components
- CIMEAN restricts the 'constant' to the cointegration space
- DRIFT includes a 'constant' in the unrestricted model but not in the cointegration relations.
- CIDRIFT specifies a model with linear trends in the variables and in the cointegration space

The CATS program also allows us to determine the lag of the model. I will investigate how changing the lag affects our model. Continuing with the German and Austrian bonds described previously and utilising the Johansen procedure as described in the Appendix I test for cointegration between the yields using CATS. The analysis here is empirical, by creating various models I can compare which one best describes my data.

Table 17 Eigenvalues for variable lag and Deterministic Component

No Deterministic Component and 1 Lag					
Eigenvalue	λ_{max}	λ_{trace}	H_0: r	$\lambda_{max}90$	$\lambda_{trace}90$
0.0248	26.98	27.15	0	7.37	10.35
0.0001	0.17	0.17	1	2.98	2.98
2 Lags					
0.0173	18.75	18.89	0	7.37	10.35
0.0001	0.14	0.14	1	2.98	2.98
3 lags					
0.0173	18.67	18.84	0	7.37	10.35
0.0002	0.17	0.17	1	2.98	2.98

Deterministic Component is CIMEAN and 1 Lag					
Eigenvalue	λ_{max}	λ_{trace}	H_0: r	$\lambda_{max}90$	$\lambda_{trace}90$
0.0273	29.72	31.74	0	10.29	17.79
0.0019	2.02	2.02	1	7.50	7.50
2 Lags					
0.0194	20.95	23.36	0	10.29	17.79
0.0023	2.41	2.41	1	7.50	7.50
3 lags					
0.0196	21.06	23.65	0	10.29	17.79
0.0024	2.58	2.58	1	7.50	7.50

Deterministic Component is DRIFT and 1 Lag					
Eigenvalue	λ_{max}	λ_{trace}	H_0: r	$\lambda_{max}90$	$\lambda_{trace}90$
0.0272	29.66	31.60	0	10.60	13.31
0.0018	1.94	1.94	1	2.71	2.71
2 Lags					
0.0191	20.56	22.98	0	10.60	13.31
0.0023	2.42	2.42	1	2.71	2.71
3 lags					
0.0194	20.87	23.32	0	10.60	13.31
0.0023	2.45	2.45	1	2.71	2.71

Deterministic Component is CIDRIFT and 1 Lag					
Eigenvalue	λ_{max}	λ_{trace}	H_0: r	$\lambda_{max}90$	$\lambda_{trace}90$
0.0283	30.88	32.85	0	12.39	22.95
0.0018	1.97	1.97	1	10.56	10.56
2 Lags					
0.0202	21.51	23.83	0	12.39	22.95
0.0022	2.32	2.32	1	10.56	10.56
3 lags					
0.0205	21.81	24.27	0	12.39	22.95
0.0023	2.47	2.47	1	10.56	10.56

Since most financial time series demonstrate a drift over time, and from the graphs above we can see that the Austrian and German yields exhibit a tendency to drift or trend. This may be because of interest rate changes by the ECB, business cycles or changes in investor's appetite for risk over time. Therefore in my cointegration testing, I have

restricted the model to include a drift term, which will affect the critical values. The first result that I highlight is that the eigenvalues for all the models with a deterministic component are very similar. If we analyse the model where the deterministic component is set to CIDRIFT, i.e. with linear trends in the variables and in the cointegration space; we find that CATS reports the estimated values of the eigenvalue as $\lambda_1 = 0.0283$ and $\lambda_2 = 0.0018$. The λ_{max} and λ_{trace} statistics are displayed in the next column and the 90% critical values are displayed in the last two columns. As discussed above, these statistics are calculated such that:

$$\lambda_{trace}(0) = -T\,[\,\ln(1-\lambda_1) + \ln(1-\lambda_2)\,]$$

$$= -1076\,[\,\ln(1-0.0283) + \ln(1-0.0018)\,] = 32.85$$

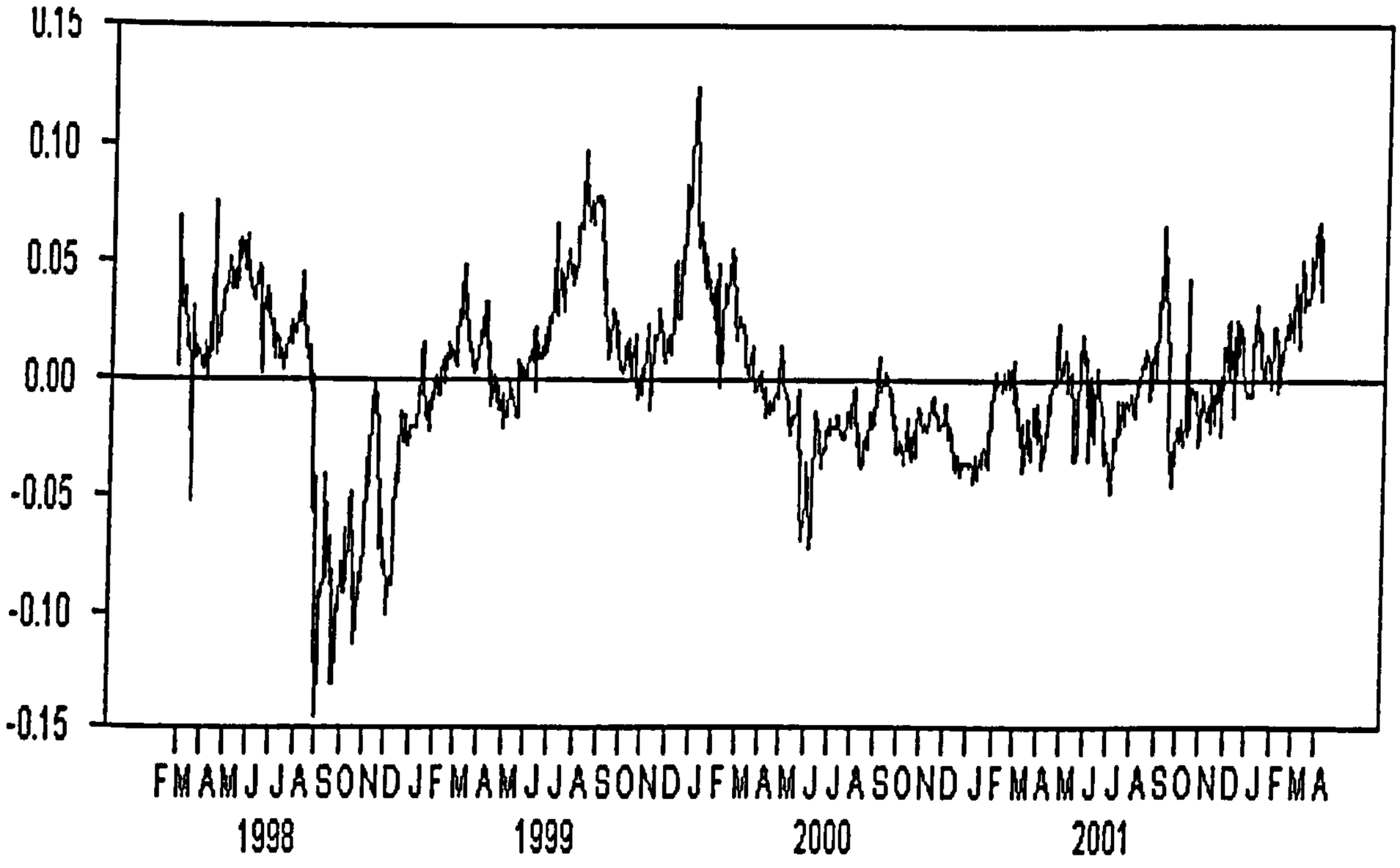
Consider the hypothesis that the variables are not cointegrated (so the rank $\Pi = 0$). Depending on the alternative hypothesis, there are two possible test statistics to use. If we are simply interested in the hypothesis that the variables are not cointegrated ($r = 0$) against the alternative of one cointegrating vector ($r > 0$), use the $\lambda_{trace}(0)$ statistic. Since 32.85 exceeds the 90% critical value of the λ_{trace} statistic, it is possible to reject the null hypothesis of no cointegrating vectors and accept the alternative of one cointegrating vector.

Next we can use the $\lambda_{trace}(1)$ statistic to test the null of $r \leq 1$ against the alternative of two or more cointegrating vectors. In this case, the $\lambda_{trace}(1)$ statistic is 1.97 which does not exceed the 90% critical value of the λ_{trace} statistic, therefore it is not possible to reject the null hypothesis of one cointegrating vector. If we use the λ_{max} statistic, the null hypothesis of no cointegrating vectors ($r = 0$) against the specific alternative $r = 1$ is clearly rejected. The calculated value $\lambda_{max}(0, 1) = 30.88$ exceeds the 90% critical value 12.39. The test of the null hypothesis $r = 1$ against the specific alternative $r = 2$ cannot be rejected at the 90% level. The calculated value of $\lambda_{max}(1, 2) = 1.97$ whereas the

critical value at the 90% significance level is 10.56. In a 2 variable model such as this, there can only be one cointegrating vector, therefore once the first test is rejected, the second test must accept the null hypothesis, however it is still worth noting the results. Based on these tests, the rank of Π should be set equal to 1, i.e. the variables are cointegrated.

Hendry and Juselius (2000) and Harris and Sollis (2003) recommend that one should examine other indicators of possible rank of the matrix Π to complement the trace statistics. One indicator is the t-values of the coefficients of α's in the initial estimated model: if these are small in a given column, then that relation is likely to be unimportant and not cointegrated. A plot of all possible cointegration relations is another indicator. The number of mean-reverting cointegration vectors is indicative of the number of cointegrating vectors in the model as opposed to those that are not mean-reverting. Finally, one should consider the theoretical basis of the model and judge the economic interpretability of the results. However, in my research I generally focus on pairs of bonds, therefore these added tests are not required. Figure 13 graphs the cointegration relation $\beta' y_t$, which shows the actual disequilibrium as a function of all short-run dynamics. It is this series that is actually tested for stationarity and thus determines r in the maximum likelihood procedure.

Figure 13 Graph of the Cointegration Relation



5.6.3 Determining the Rank and Testing for Restrictions

Using the λ_{max} and λ_{trace} statistics we have chosen a rank of 1 from our unrestricted model. CATS allows me to carry-out a number of tests to check the consistency of this selection. The possibility to impose restrictions on the cointegration vectors is crucial in the modelling of cointegrated variables. Continuing on with our Austrian and German pair, I select a rank of 1 and CATS produces the following eigenvectors:

EIGENVECTOR(S) (transposed)

Austria	Germany
26.8293	-27.7304

After normalising the eigenvectors, the vectors appear as β', with the corresponding loadings α', as shown below:

β (transposed)

Austria	Germany
1.000	-1.034

α		T-value for α
DAustria	-0.081	-2.083
DGermany	-0.034	-0.867

Π

	Austria	Germany
DAustria	-0.081	0.084
DGermany	-0.034	0.035

T-value for Π

-2.083	2.083
-0.867	0.867

The t-values indicate that the cointegration relation is significant, I therefore continue my analysis by fixing the β vectors of (1, -1) and test whether this restriction holds. CATS allows us to quickly select this restriction, and generates the value of the likelihood ratio statistic and the p-value, with the restricted β and α matrices and their associated t-values. According to CATS our hypothesis is accepted at the 1% significance level.

The LR test, CHISQ(1) = 7.07 , p-value = 0.01

β (transposed)

Austria	Germany
1.000	-1.000

α		T-value for α
DAustria	-0.086	-2.447
DGermany	-0.051	-1.438

Π

	Austria	Germany
DAustria	-0.086	0.086
DGermany	-0.051	0.051

T-value for Π

-2.447	2.447
-1.438	1.438

5.6.4 Long-Run Dynamics

In this section I continue the analysis of the previous section and find cointegrating relationships for almost all the bonds in Table 17 with an appropriate German benchmark of similar duration. All the cointegration tests for the bonds in Table 15 are compiled in Table 18 as well as the conclusion as to whether the variable are cointegrated or not.

Table 18 Cointegration Tests for Eurozone Bond Pairings with Germany

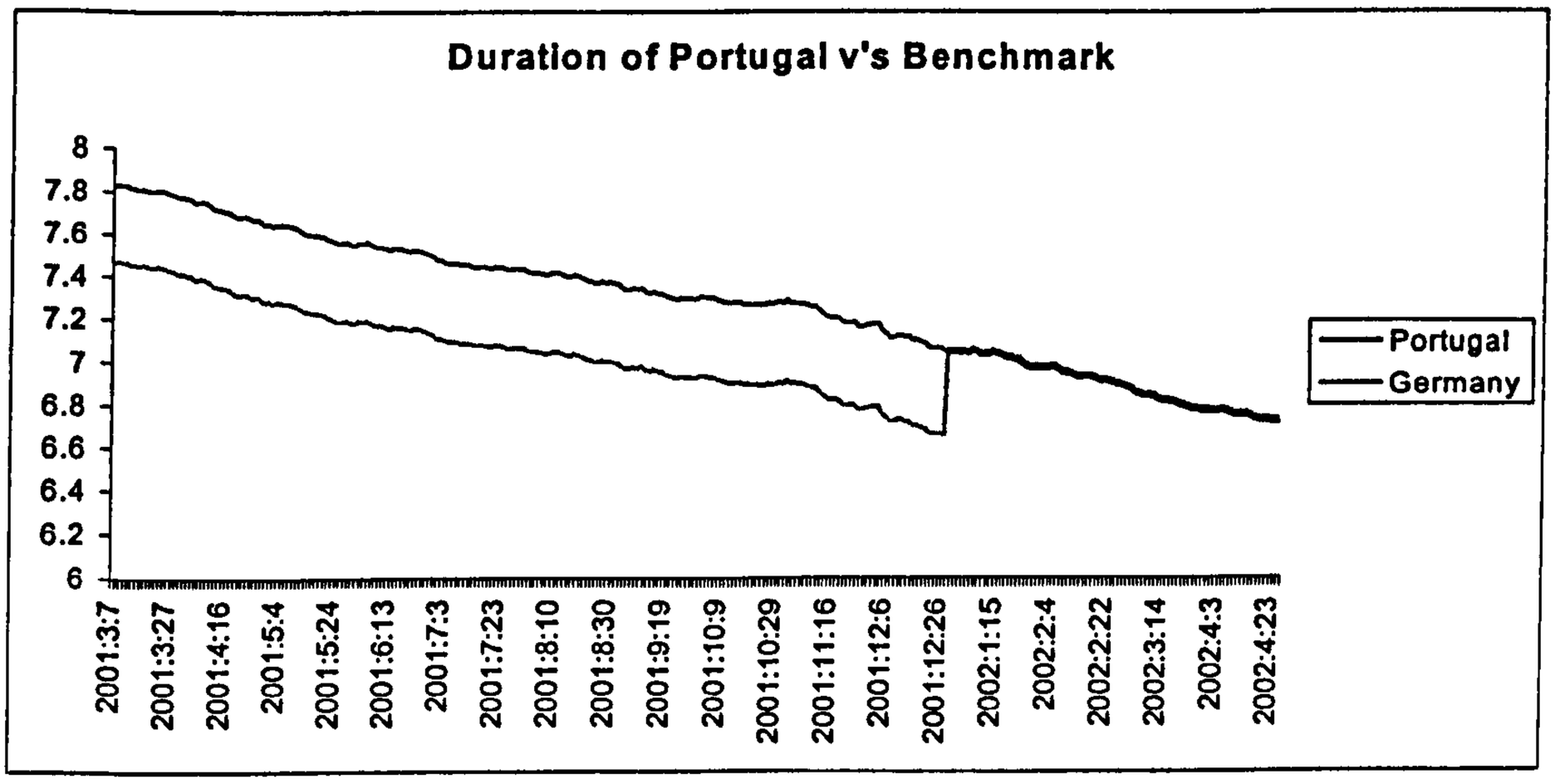
Maturity	Hypothesis	Eigenvalue	Test Statistic λ_{max}	Test Statistic λ_{trace}	Conclusion
France					
Short	$H_0 : r = 0$ $H_0 : r = 1$	0.0274 0.0063	23.22 5.30	28.52 5.30	Cointegrated
Medium	$H_0 : r = 0$ $H_0 : r = 1$	0.0271 0.0034	29.85 3.72	33.56 3.72	Cointegrated
Long	$H_0 : r = 0$ $H_0 : r = 1$	0.1920 0.0205	47.76 4.64	52.40 4.64	Cointegrated
Italy					
Short	$H_0 : r = 0$ $H_0 : r = 1$	0.0652 0.0101	47.84 7.20	55.03 7.20	Cointegrated
Medium	$H_0 : r = 0$ $H_0 : r = 1$	0.0408 0.0100	29.56 7.10	36.66 7.10	Cointegrated
Long	$H_0 : r = 0$ $H_0 : r = 1$	0.0181 0.0060	15.44 5.07	20.51 5.07	Cointegrated
Austria					
Short	$H_0 : r = 0$ $H_0 : r = 1$	0.0283 0.0018	30.88 1.97	32.85 1.97	Cointegrated
Medium	$H_0 : r = 0$ $H_0 : r = 1$	0.0197 0.0074	15.73 5.86	21.60 5.86	Cointegrated
Long	$H_0 : r = 0$ $H_0 : r = 1$	0.0437 0.0066	14.22 2.09	16.32 2.09	Cointegrated
Belgium					
Short	$H_0 : r = 0$ $H_0 : r = 1$	0.0154 0.0024	27.49 4.25	31.73 4.25	Cointegrated
Medium	$H_0 : r = 0$ $H_0 : r = 1$	0.0290 0.0039	37.91 5.06	42.96 5.06	Cointegrated
Long	$H_0 : r = 0$ $H_0 : r = 1$	0.0876 0.0257	15.22 4.31	19.54 4.31	Cointegrated
Finland					
Short	$H_0 : r = 0$ $H_0 : r = 1$	0.0262 0.0054	21.61 4.44	26.05 4.44	Cointegrated
Medium	$H_0 : r = 0$ $H_0 : r = 1$	0.0306 0.0070	26.26 5.95	32.21 5.95	Cointegrated
Long	$H_0 : r = 0$ $H_0 : r = 1$	0.0272 0.0069	7.84 1.95	9.79 1.95	Cointegrated

The Netherlands					
Short	$H_0 : r = 0$ $H_0 : r = 1$	0.1141 0.0020	216.07 3.51	219.58 3.51	Cointegrated
Medium	$H_0 : r = 0$ $H_0 : r = 1$	0.0255 0.0035	33.37 4.56	37.93 4.56	Cointegrated
Long	$H_0 : r = 0$ $H_0 : r = 1$	0.0455 0.0040	49.33 4.28	53.61 4.28	Cointegrated
Portugal					
Short	$H_0 : r = 0$ $H_0 : r = 1$	0.0373 0.0083	25.82 5.68	31.50 5.68	Cointegrated
Medium	$H_0 : r = 0$ $H_0 : r = 1$	0.0174 0.0054	13.87 4.25	18.12 4.25	Cointegrated
Long	$H_0 : r = 0$ $H_0 : r = 1$	0.0254 0.0091	7.17 2.54	9.71 2.54	Not Cointegrated
Spain					
Short	$H_0 : r = 0$ $H_0 : r = 1$	0.0091 0.0029	15.52 4.89	20.41 4.89	Cointegrated
Medium	$H_0 : r = 0$ $H_0 : r = 1$	0.0213 0.0037	23.77 4.14	27.91 4.14	Cointegrated
Long	$H_0 : r = 0$ $H_0 : r = 1$	0.0163 0.0061	3.67 1.37	5.04 1.37	Not Cointegrated
Ireland					
Short	N/A	N/A	N/A	N/A	N/A
Medium	$H_0 : r = 0$ $H_0 : r = 1$	0.1407 0.1019	7.28 5.16	12.44 5.16	Not Cointegrated
Long	$H_0 : r = 0$ $H_0 : r = 1$	0.1504 0.0163	36.50 3.68	40.18 3.68	Cointegrated
Greece					
Short	$H_0 : r = 0$ $H_0 : r = 1$	0.0342 0.0019	2.16 0.12	2.28 0.12	Not Cointegrated
Medium	$H_0 : r = 0$ $H_0 : r = 1$	0.0906 0.0065	30.68 2.09	32.77 2.09	Cointegrated
Long	$H_0 : r = 0$ $H_0 : r = 1$	0.1694 0.0918	8.91 4.62	13.53 4.62	Not Cointegrated

As we can see from Table 18, we can find at least one cointegrating vector for most of the instruments and a German instrument of similar durations. There are however a number of instruments that resulted in no cointegrating vectors been found. Instead of rerunning the tests with another German instrument, I decided to investigate why these instruments failed and found a number of reasons. When I graphed the duration of the Portugal bond with a long maturity and the associated German bonds duration I was surprised to find a step change in the German bond duration that was not replicated by

the Portuguese bond, (this is not a data error, but a mis-specification of the pair selection). However, re-running the analysis before and after the duration change shows that the bonds are cointegrated. Table 18 does not contain a list of cointegrated pairs that are linked for all time; instead it shows that in normal operating conditions bonds of similar risk show a common stochastic force at play.

Figure 14 Duration of Portugal vs Benchmark



I have used German bonds as the benchmark for all issuers, but as cointegration tests indicate that there is a common stochastic trend, I could have equally used French bonds to investigate the relationship and have obtained similar results. As stated previously, European Government Bonds issuers are considered by the market to be either core or non-core issuers. The core issuers are mainly centred on Germany and France, while the non-cores are centred on Italy. Therefore using Germany for the benchmark bond for all issuers, may be a mistaken hypothesis. It seems to be the non-core instruments, especially at the longer maturities, which consistently fail when we look for a cointegrating vector and using Italy as the benchmark may be more appropriate. I will investigate this further in the next chapter. Dunne, Moore and Portes (2006) in their

research found France to be the benchmark in a system containing only France, Germany and Italy. As the bond market evolved since 1999, different countries will have different benchmarks associated with them. Spain in 1999, as we have seen, had a poor credit rating, therefore as a non-core member Italy would have been an expected benchmark for this bond. However as Spain's rating increased rapidly over time, it would be more apt to use Germany or France as its benchmark. I will investigate the changing dynamics over time of the short-term dynamics in the next chapter.

5.6.5 Test for Multiple Stochastic Processes

In the paper by Dunne, Moore and Portes (2006) they state that "all country yields are pairwise cointegrated with the benchmark yield". I do not look to reproduce their results here, but to extend their work to investigate what impact this "pairwise cointegration" has on bond market dynamics and market discipline. While the authors utilise the results to identify the benchmark sovereign, I employ the results to show that bond market integration has now achieved such a high degree of interdependence that an individual sovereign's economic performance has little impact on its own or the regional yield. Therefore a build-up of debt for one particular sovereign may not have an impact on its yield, because investors expect that a country in critical conditions would in the end be bailed out, as highlighted by Lamfalussy (1989).

From the previous section we tested for cointegration using a number of pairs (German yields, French yields) and (German yields, Italian yields) and found that both are cointegrated. According to Dunne et al. it follows necessarily that the pair (French yields, Italian yields) is also cointegrated. If we now increase the number of variables to 3,

(German yields, French yields and Italian yields) and run our test for cointegration again, we find that the cointegrating rank of these three variables is 2, and one of these three irreducibly cointegrated relations necessarily is solved from the other two. Dunne et al use the Davidson (1998) methodology to find the benchmark bond, which they conclude to be France. According to Citigroup it is not an individual sovereign's bond, but the Eurex Futures market that is the benchmark. I will investigate this in the next chapter and the consequences that this has on the dynamics of the bond market.

I carry out my cointegration analysis as in the previous section; however this time instead of having 2 pairs, I have all 11 euro sovereign issuers. The 11 issuers were again broken down by duration, Short, Medium and Long. For the Long and Medium analysis, I found one stochastic process as expected, however among the short dated issuers I found that there are 9 cointegrating vectors among the 11 sovereign yields, when I had expected 10 cointegrating vectors, see Table 19. This meant that there was the possibility of 2 non-cointegrating vectors. In order to identify this 2nd vector, I started to reduce the number of issuers in a systematic manner to identify if a particular issuer impacted my analysis. Once I removed Italy from the analysis I was left with one stochastic process as expected (10 issuers and 9 cointegrating relationships). However, if I reduce the number of issuers to a subset of 7 or 8 (including Italy) then I am always left with one stochastic process irrespective of issuer.

Table 19 Tests for Multiple Stochastic Processes

Hypothesis	Eigenvalue	Test Statistic		Critical Values 90%	
		λ_{max}	λ_{trace}	$\lambda_{max90\%}$	$\lambda_{trace\ 90\%}$
$H_0 : r = 0$	0.3143	290.17	1289.07	44.28	281.63
$H_0 : r = 1$	0.2563	227.69	998.90	40.69	237.35
$H_0 : r = 2$	0.2518	223.03	771.21	36.92	196.66
$H_0 : r = 3$	0.2065	177.87	548.18	33.02	159.74
$H_0 : r = 4$	0.152	126.81	370.31	29.54	126.71
$H_0 : r = 5$	0.1279	105.26	243.50	25.51	97.17
$H_0 : r = 6$	0.0776	62.09	138.24	21.74	71.66
$H_0 : r = 7$	0.0448	35.22	76.15	18.03	49.91
$H_0 : r = 8$	0.0382	29.94	40.93	14.09	31.88
$H_0 : r = 9$	0.0094	7.28	10.99	10.29	17.79
$H_0 : r = 10$	0.0048	3.71	3.71	7.50	7.50

5.7 Conclusion

My research confirms the fears set out by the Delors Committee that "market forces might ... be too slow and weak ...". Expanding on the work of Dunne et al (2006) I found that all euro sovereign bond yields were cointegrated and have a common stochastic force. This shows that the regional effect is now dominant as predicted by Lamfalussy with the increased possibility of free-riding. The fact that the bond yields are cointegrated signifies that the yields will move together in the long-run and while there may be short-run deviations, the disciplinary impact of such changes will be "slow and weak". The increased bond market integration has therefore created expectations of bail-outs for sovereigns that fail to enforce the Stability and Growth Pact and this is why the yields are cointegrated. The convergence in euro sovereign bond yields since Monetary Union is evidence that the process of financial integration has had a detrimental effect on the functioning of market discipline.

My research demonstrates how integrated and interdependent the bond market has become, and to raise the possibility that the price discovery mechanism can be found outside the bond market and in the Eurex Futures market. This has serious implications for market efficiency, transparency and discipline. As Simon Wivell noted in his explanation of the Dr. Evil trade " Eurex bond futures have become both the primary pricing source and hedging tool of the dealer community. ..... This has led to a potentially unstable situation where the liquidity being offered in the bonds is far greater than that offered in the bund future. ... We should be able to exploit this situation in a profitable way...". This highlights the weakness inherent within the current structure of the Euro bond market and has profound implications for the markets ability to enforce discipline. This hypothesis also provides a fresh theoretical explanation as to why the bonds of different issuers exhibit a shared stochastic process.

6. Euro Sovereign Risk Premia

6.1 Introduction

In the previous chapters we saw that we could not rule out the fact that free-riding plays an important role in the yield calculation and that all euro sovereign share a common stochastic force that drives all the euro government bond yields. Both these findings confirm the concerns raised by the Delors Committee on the impact of free-riding on market discipline. However the history of the bond market so far only bears out the first part of their concern, that the "constraints imposed by market forces might ... be too slow and weak", while the second concern was that the market would be "too sudden and disruptive". This condition occurred only once, during the Dr. Evil trade and resulted in many market makers withdrawing from the market. However, the issuers ensured by their actions that such a disruption would not happen again. They may not be able to control the market if a more serious event occurred however, such as a default or a country leaving the Euro. This may cause a total shift in market perceptions of the risk of carrying euro bonds in a sudden and disruptive manner.

In this chapter I look to investigate the short-term dynamics of the sovereign risk premia. This will give us some deeper insight as to how a sharp correction may propagate throughout the euro bond market. While there has been much research on the determinants of the yield spread as discussed in the literature, this is one of the first studies that investigates the yield spread dynamics from the point of view of market discipline. Antzoulatos and Vallianatos (2002) carried out an investigation into the dynamics of the yield spread in which they found that the yield on Non-German bonds exhibits a small but economically and statistically significant undershooting in response to changes in the German yield, as a result of which the yield spread tends to decline

when the latter increases, and vice-versa. They propose that the undershooting is the product of lagged adjustments in the European bond portfolios that is driven by liquidity considerations and in particular by the possibility of excessive price movements in response to changes in the German yield.

Antzoulatos and Vallianatos (2002) carried out their research over the data range January 4 1999 to December 31, 2000. Since then as we have seen, the bond markets dynamics have changed considerably, yet no further research has been carried out that specifically looks at the interaction of yields over a short-term horizon. I intend to re-investigate their theoretical assumptions here with data that represents the new dynamics of the bond market post Dr. Evil, and show that it is not liquidity but credit considerations that currently drive the yield spreads. I extend their results by building on the cointegration results of the previous chapter, which will allow us to carry out a panel analysis to compare how the short-term dynamics have changed over time. However, unlike Antzoulatos and Vallianatos who rank the sovereigns in terms of liquidity, my results show that the speed-of-adjustments rank the sovereigns by credit considerations instead, with highly rated issuers having the greatest speed-of-adjustment and the lower rated issuers having low speed-of-adjustment values. This conclusion is also supported by Beber et al (July 2006) who also find that in "normal market conditions" sovereign yield spreads can be explained by credit considerations.

These results suggest that while all the bond markets are integrated in the long-run, the level of integration between the markets in the short-run varies between issuers. This manifests itself in changing levels of price over/undershooting between bonds and demonstrates that market discipline could be adversely affected during periods of rapid price changes. Because of the regional nature of the market, an increase of the global

risk premia will affect the risk premia of individual issuers by varying degrees. Therefore an accurate assessment of the risk/return profile may be difficult to discover in periods of financial stress. This will all be investigated in the following sections.

6.2 The Cause Of The Outstanding Yield Differential

"Before the introduction of the Euro, yield differentials within Europe had been determined by four main factors: expectations of exchange rate fluctuations, different tax treatment of bonds issued by different countries, credit risk and liquidity. Different tax treatments were eliminated or reduced to a negligible level during the course of the '90s. The introduction of the Euro in January 1999 eliminated the first factor (i.e. expectations on exchange rate fluctuations) creating the conditions for a substantially more integrated public debt market in the Euro area. Hence, the current perceived wisdom is that yield differentials are now mainly determined by the two remaining factors: credit risk and liquidity", (Codogno et al. 2003). I will explore in this chapter the reasoning behind such assumptions and present new ideas as to what really drives the yield differentials.

The fact that each Euro government still holds the right to issue its own debt, and the varying economic impact of meeting its obligations means that yields vary between member states. Some authors such as McCauley (1999) have compared the EMU debt markets to the US municipal bond market. However, the dynamics of yield spreads between EU member states has not been thoroughly explored (see Codogno *et al.* 2003; Portes 2003), and what academic research was carried out in the field occurred shortly after the introduction of the currency and the topic quickly fell out of favour as a topic of research. However, in those first years some very interesting research was carried out, e.g. Blanco (2001) categorised EU members by yield, and noted that there was an inner periphery of countries centred around Germany and France and an outer periphery of

countries focused around Italy. He noted that while yields had converged significantly with EMU, they were far from "perfect substitutes". Because of this research it is widely perceived that sovereign yield spreads reflect differences in liquidity and default risk, which in turn reflect the sustainability of the countries' fiscal positions.

According to Codogno *et al.* 2003 "Understanding the determinants of yield spreads is also crucial in assessing the prospects for the European bonds market. If bonds issued by different member states continue to be perceived as imperfect substitutes, the goal of creating one market for the 'same bond' as large and liquid as the US bond market would be frustrated. However, whether this is a desirable aim depends on the reason for the segmentation. If yield differentials were explained by differences in liquidity, their elimination would certainly be a sign of higher efficiency. If, instead, yield differentials reflected different default risks across states, they would be useful indicators for an efficient allocation of funds and a deterrent for irresponsible fiscal policies. This should be considered as a more important goal than creating a market for the 'same bond' ". However, if the financial markets failed to price the default risks correctly, the growing mountain of debt of profligate countries may become unsustainable and may lead to the destruction of the very market itself.

Codogno *et al.* go on to say "distinguishing between credit risk and liquidity components has important implications for policymaking and for financial markets. If yield spreads reflect differences in credit standings, it would mean that the Stability and Growth Pact and the European fiscal framework *per se* does not ensure the same perceived default risk for all the member states. In other words, the market would perceive that fiscal consolidation is not yet completed and further convergence of debt ratios and in general credit worthiness would be needed in order to see yield differentials disappear. Yield

differentials would be important policy indicators, as they would signal market perception of fiscal vulnerability. On the other hand, if yield spreads mainly reflect differences in liquidity of government bonds, then yield differentials would just be an indicator of the relative effectiveness of debt management policies in improving liquidity and of differences in market microstructures. Policy implications would then depend on the sources of liquidity premiums". The following sections will look into many of these assumptions and see if they still hold and if there may be other causes, not mentioned in the literature such as Free Riding.

6.3 Liquidity Risk

The problem with liquidity is "... its like snow, you never know how deep it is or how long it will last". According to common belief in financial markets, liquidity plays a significant part in the yield differential between various sovereigns since the launch of the Monetary Union. But why this should still be the case after the EuroMTS Liquidity Pact and a raft of other initiatives carried out by both issuers and dealers in the last few years? To answer this question we must first find a set of variables related to liquidity. While there is no generally accepted definition of liquidity, according to the academic literature, there are four dimensions of liquidity (Gravelle (1999a, b) :

1. Immediacy – speed with which a trade of a given size at a given width is completed;
2. Depth – maximum size of a trade for any given bid-ask spread;
3. Width – bid-ask spread, the cost of providing liquidity; and
4. Resiliency – how quickly price movements revert to "normal" levels after a large transaction and how quickly the imbalances in transaction flows dissipate.

Market breadth is also referred to as the market ability to absorb large buy/sell orders without large-scale price movements. All dimensions tend to interact, and there is no single measure of liquidity. It has been argued that, in the context of government bond securities, liquidity may be best thought of in terms of the cost of supplying immediacy. From this description it is no wonder it is almost impossible to identify the liquidity component. There is a limit to the size any market can absorb; even the US dollar currency market moves if any central bank talks about shifting its reserves away from the dollar, and that is the deepest market in the world. No market can handle an infinitely large trade immediately.

As discussed in Chapter 3, Europe's fledgling capital markets struggled to cope with the monumental implications of EMU. In the euro's early days, figuring out a fair price for sovereign debt felt like "running an experiment without a control (FT, 2001)". Investors were wary about stepping outside their comfort zones; they feared being left holding illiquid sovereign debt of smaller countries. However, as the market matured, investors became comfortable with holding a more varied portfolio of bonds. A number of smaller countries' bonds, such as Ireland and Finland, whose economies have done particularly well from eurozone membership soared in value over the last couple of years. While the number of their bonds is still very small, as a percentage of the overall market, investors content with their high credit rating are happy to hold these bonds in their portfolio when they become available. This can be seen by the reduction in their yield spread versus Germany and France since the introduction of the euro.

The increasing automatisation of trading is also a very important factor for liquidity. Since 1999, following the example of Italy and the success of Euro-MTS, electronic transactions are now the principal mode of trading bonds. As a consequence of the

development of the EuroMTS electronic exchange, the number of market-makers trading the same bonds has increased as highlighted in the Dr Evil analysis. This has led to increased trading volumes, transparent pricing which in turn led to reduced yields on EMU bonds. As discussed in chapter 3.4 the development of new electronic exchanges for trading bonds such as TradeWeb, Bloomberg, BrokerTec etc. has changed the entire landscape as to how the world of bonds are traded. In the futures markets, some small and medium exchanges have established alliances to better cope with competition from the biggest exchanges. In the case of settlement systems, there have been initiatives geared to achieving a higher degree of integration. In this regard, the introduction of links between national central securities depositories and the merger of the two international central securities depositories with existing national central depositories should be highlighted.[35] The infrastructure that has been put in place to support the bond market ensures that for the great majority of sovereign debt, liquidity is now only a minor issue.

All studies of liquidity on the EMU bond market have focused only on EuroMTS Market; this is Dealer-to-Dealer system which only lists bonds with an outstanding issue of €5Bn. However, one must look at the motivation for trading on EuroMTS; as an example the Market Makers such as Citigroup, Morgan Stanley & BNP Paribas could be considered the betting world's equivalent of Bookmakers William Hill, Ladbrokes and Paddy Power. Then if one were to consider the 4.30 horse race at Wincanton, then each bookmaker would offer a price on each horse. However due to the liquidity of the market, in this case the small number of "punters", each bookmaker would be happy to hold the entire risk of the race on their own book, thereby maximising their potential

[35] Cedel merged with Deutsche Börse Clearing to form Clearstream International. Euroclear merged with CBISSO and Sicovam to the Euroclear group.

gain. On the other hand, during the Cheltenham festival, where large sums of money are placed on individual races, the bookies would look to lay-off their risks with other bookies, and therefore actively manage their risks. However as far as the punter is concerned, the service is the same for both races.

If one now returns to the bond market and EuroMTS, we can see the same practice in operation. For small sizes, the market makers are happy to keep all the risk on their own books. But for bigger sizes they may need to manage their risk by placing some of the clients business with other institutions. EuroMTS just like bookmakers on the racecourses, allow traders to see prices and quantities that other institutions are willing to trade, i.e. the amount of risk they are willing to take from other Institutions. EuroMTS fulfils an important function in the market; it acts as an insurance policy for institutions, in the fact that traders will be comfortable taking large orders from clients, in the secure knowledge that they can actively manage risks on their own book.

However, like any insurance policy there is a cost involved. Each institution is competing for business from a limited number of clients. Therefore for example in a competitive Bid on TradeWeb, if 5 institutions are involved in the bidding process for a substantial quantity, then the 4 losers will automatically adjust their prices on MTS so as to force the winner to lay-off his business at a disadvantageous price, known as the "winners curse" (Dunne et al 2006). Understanding order flow is a very important part of a modern bond trader's armoury (I discuss this further in section 6.3.3). But just as in the example of the horse races, from the client's perspective the business they wanted to transact has been successfully carried out. Therefore the limited concept of liquidity as discussed in previous research papers that just look at liquidity from a EuroMTS

perspective, and focus on the quantity traded, I believe give a very limited perspective of what is really happening in the market.

The minimum quantity that can be traded on EuroMTS is £2.5 million for Euro sovereign bonds. This is a substantial amount of money to be placed on one bond. If one looks to the Dealer-to-Client markets (D2C), such as TradeWeb, BondVision, Bloomberg and Reuters there is no minimum quantitty, and trades in the region of €100,000 are common. Therefore for €5 million, you can carry-out 2 trades on EuroMTS or 50 on TradeWeb. Therefore the immediacy and depth which a trade can be carried out varies substantially between markets. The width is very different between markets also; the EuroMTS spread is defined by the quoting obligations from the issuer. There are no obligations on the D2C markets, and the price quoted depends on the client. If it is a very valuable client to the dealer and they do a lot of business together, then the spread can be very narrow, and for small quantities, it becomes almost a choice price, i.e No Bid/Ask spread. For less well regarded clients, it can widen substantially. Because of the EuroMTS and Eurex Futures market the resiliency of the D2C clients is very high, with large orders immediately hedged or laid off with other institutions on the EuroMTS market. Except for the Dr. Evil trade, EuroMTS itself has never reported periods where it was unable to operate a smooth and efficient market.

Having gone though all the issues, it is my hypothesis that while liquidity is still a concern, it is no longer of comparable importance when considered alongside default risk for an investor in euro sovereign bonds. This hypothesis is in agreement with Codogno, Favero and Missale (2003), but contradicts that proposed by Antonio Villarroya (2003). In exhibit 5.10, he generates a graph of credit ratings versus the EMU 10-Year Spread to Germany (similar to Figure 15 below), and says "It seems clear from the exhibit that

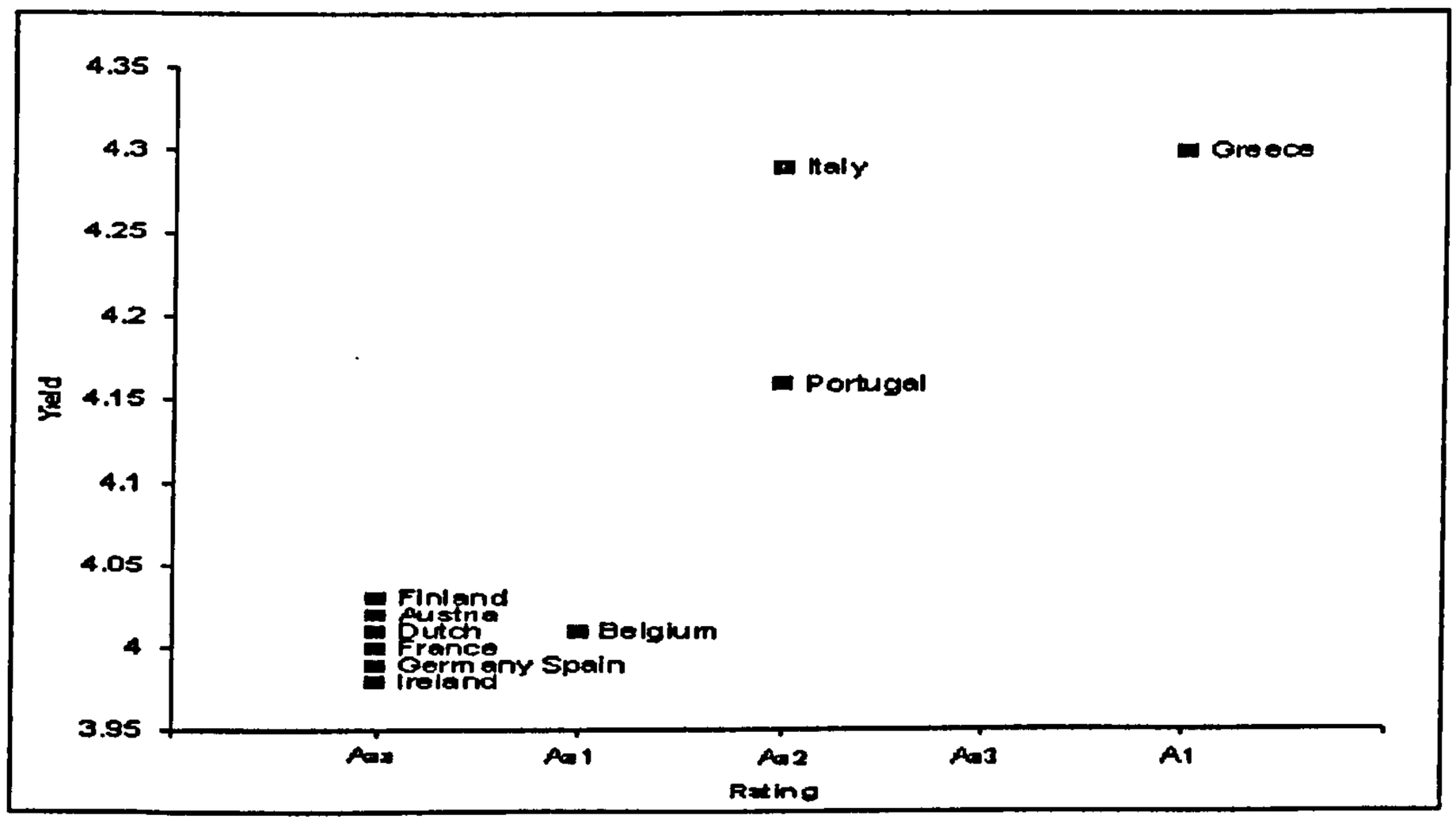
there is an almost linear relationship between spreads and ratings, with the distance between each country's spread to the regression line being a proxy of each country's liquidity premium. This 'liquidity premium' is more evident in the AAA rated category, where the market has clearly differentiated between very liquid and deep markets, such as France, versus smaller less liquid countries such as Austria".

However, if this were the case it would be very difficult to explain why Ireland, one of the smallest countries in the EMU had a negative liquidity premium versus Germany in 2006. If one follows Villarroya's argument to its conclusion, it means that smaller countries yields will always be restricted by the small size of their debt. Therefore there is nothing they can do to reduce their spread vis-à-vis the larger countries. This however is obviously wrong, as the Finnish 10 year yield was 3bp cheaper than the equivalent German bond in May 2006. Indeed, the Austrian bond itself had a lower yield than Germany in those previous 3 months, yet the "liquidity premium" concept still proliferates. The lack of debate on this issue highlights the lack of recent research carried out to date in this area of finance.

Because of the Finnish, Irish and Austrian data it is difficult to make an argument as to why liquidity should explain the differences between the yield spreads for any particular country. Before the introduction of the single currency one can easily see the many obstacles an investor would face when purchasing a bond from a small sovereign such as Ireland. Currency exchange fluctuations, no electronic markets and so no transparency of prices or guarantee of exit from their position, regulations and cross border currency restrictions etc. would mean there was only a small pool of investors who would be willing to hold such a bond. Therefore liquidity would have been a very important issue, but all these restrictions have now been explicitly tackled by the issuing governments in a

concentrated effort to reduce the yield spread each sovereign is forced to pay the market. I will discuss this further in the following sections.

Figure 15 Long-term interest rates (10 Years) at July 2006



(This is just before Italy was downgraded by S&P and Fitch 19/10/'06)

6.3.1 The Impact of Electronic Exchanges on Liquidity

The biggest impact in the Euro bond market is the obligation of market makers to make a market on electronic platforms such as EuroMTS and TradeWeb for as many as 1000 instruments. As these instruments can be traded automatically, it has forced investment banks to invest in high-speed electronic pricing applications. As the spreads narrowed or in some cases are set by the issuers themselves, the number of traders on the desk has been reduced to economise on costs, as these pricing applications took more of the decisions that were formerly made by traders. All the exchanges introduced rules for quoting, and reported directly to the issuer the number of hours each market maker quoted on the exchange.

With the introduction of computation of the bond market it was easier to use an understandable mathematical formula to derive a mid-price for a particular instrument. The debt capital markets and the pricing of debt instruments revolves around the term structure, and for this reason this area has been extensively researched in the academic literature. Each institution has its own methods of calculating its term structure; unlike investors it cannot simply derive it. This is not a simple calculation, but using the hypothesis of no-arbitrage and taking prices from a number of markets e.g. Money, Repos and Futures markets. It is built-up from overnight to 30 years using numerical and econometric techniques: Splines, Ordinary Least Squares etc. Once the term structure is calculated, it can then be applied to calculate the prices of the individual bonds to be quoted on the exchanges. The calculation of the term structure has to a large extent therefore become standardised as far as the market makers are concerned. If the prices they have calculated for the bonds are different from other market makers, they will be immediately displayed via the exchange. The other market participants may then decide that according to their calculations whether the price is rich or cheap and trade it. Therefore a consensus as to the market price of the bond is quickly achieved thanks to the exchanges. This has many benefits for the issuers; it has developed a transparent and controlled market in their bonds. It has increased liquidity dramatically and narrowed the bid/ask spreads demanded by the investment banks.

The method of developing the term structure using the hypothesis of no arbitrage implies that the prices will be integrated, as the price of the one year bond will depend on the 6 month bond, and so on out the maturity range. As far as the European Bond Markets are concerned this integration is further increased by using the same Money markets i.e. The Euro Money Market. However the Repo market uses mainly Italian and German instruments and the Futures market is almost exclusively German. I will cover this in

greater detail in the following sections, but highlight that the term structure that is calculated for the Euro bond market is in effect the German term structure, with a spread added for each country. As the German Futures market is by far the most important in the Eurozone, the term structure must also take into account the yield for the notional instruments (Bund, Bobl and Schatz) and ensure that no arbitrage opportunities are available. I will explore this again in much further detail, but highlight here the impact of electronic trading on the Eurobond market is equivalent to the Big Bang experienced by the City of London.

Besides the aforementioned effects, the introduction of the euro has had other more indirect effects. In particular, the search for market liquidity has fostered competition between issuers to attract investors and has prompted some reorganisation of the market structure. On the side of the issuers, some significant changes have been observed since the start of Monetary Union. In this respect, mention may be made of the efforts by national treasuries to increase market transparency through different means such as the introduction of pre-announced auction calendars. Additionally, issue sizes have generally tended to increase. In some countries, the creation of large issues was facilitated by the introduction of programmes to exchange old illiquid bonds for new bonds and by the concentration of issuance activity in a smaller number of benchmark securities. Some of the smaller issuers, such as Austria, Belgium, the Netherlands and Portugal, have resorted to syndication procedures instead of traditional auctions with the aim of reaching a larger set of investors. Others, such as the French Treasury have introduced new instruments such as constant maturity and inflation-indexed bonds to attract more investors. Other institutional changes introduced were the harmonisation of market conventions such as the computation of yields, and the existence of a single trading calendar.

Interestingly, with the notable exception of Greece, the requirements for becoming market makers do not appear to have changed since the advent of EMU. The number of bond lines to be quoted, the amounts to be traded or the minimum amounts of bidding in auction (if applicable) or qualitative requirements have remained the same. Some countries have changed the requirements in January 1999 but have since left such requirements unaltered. In Greece a number of quantitative and qualitative requirements have been introduced. Only in Finland has a narrower bid-ask spread been introduced for market makers; since January 2001 the bid-ask spreads have been reduced to 4, 6 and 8 cents depending on the maturity of the bond being traded.

6.3.2 The EuroMTS 'Liquidity Pact'

"Within the context of rapid changes in the European bond markets, MTS, the European Bond Exchange, initiated a dialogue with dealers and issuers respectively and facilitated discussions leading to a 'Liquidity Pact'. Dealers committed to becoming Market Makers, adhering to specified criteria, such as quoting a set number of bonds for a given number of hours each day. In turn, this was presented to issuers who adapted their issuance policies accordingly, respecting the minimum issuance size and issuance transparency required by the dealer community.

Respect of the Liquidity Pact is required by both parties - if an issuer does not respect the issuance criteria, its bonds are de-listed by MTS. Likewise, if a bank that agreed to the pact does not respect the market-making obligation, it is sanctioned. In markets where the Liquidity Pact was observed by issuers and dealers, liquidity built up, spreads narrowed, the cost of funding for issuers fell and the investor base broadened. Through these defined commitments, dealers and issuers have developed a deep pool of liquidity

in the European bond markets. MTS is proud to have participated in the birth of such an agreement, which is now a permanent feature of the European bond markets today and which has the potential to be a model of efficiency for the global bond markets."

This is a quote from Gianluca Garbi; Chief Executive Officer of MTS S.p.A. An excerpt from his speech delivered at the MTS Reception during the IMF Annual Meetings, Dubai, September 21, 2003

Garbi goes on to state "... technology changes have dramatically increased the capacity of dealers to provide liquidity across a broad range of bond issues. EuroMTS stepped forward as the exchange of choice for both issuers and dealers to manage and distribute prices on this new market. EuroMTS set minimum standards of size and liquidity commitments for each sovereign bond. To be listed on the exchange a bond must have a minimum listing size of €5 billion. They also allocate randomly the bonds amongst dealers for quoting obligations and agree a minimum number of hours per day that a dealer must make a 2-way price. Also, on a more contentious note, many of the issuers set conditions on the maximum bid/offer spread that dealers could quote. However, these commitments have allowed EuroMTS to become the *de facto* market for trading sovereign bonds, not only within the EMU zone but throughout Europe, now including non-euro currency bonds. The MTS platform is used by both sides of the market to referee and bring transparency to the Liquidity Pact.

There has been an ongoing evolution in relationships between benchmark bond issuers and the investment banks that syndicate and make markets in the bond issues. Since 1999, issuers and investment banks have strengthened their commitments to each other, leading to improved efficiency in the markets. Many issuers, facing competition in a single currency for the first time, have recognised the need to take an active role in

developing their issuance policies and secondary markets. Such issuers, previously active in a wide range of currencies, have concentrated large parts of their funding requirements in the single currency and in so doing have sought to enhance the liquidity of their bonds by encouraging continuous electronic quotation from investment banks. In return, such issuers offer a regular supply of transparent and sizeable primary market activity.

Now issuers that do not respect the Liquidity Pact or insist on dictating their own terms unilaterally in the secondary market, place themselves at a competitive disadvantage to other eurozone sovereign issuers that have embraced common standards. The strength of the Liquidity Pact is illustrated by the fact that on average, market makers commit to quote at least 50% more than their official requirement, with many selecting far more, and all the market makers opt to disclose their quoting and trading performance to the issuers. Typically, market makers select all bonds from their preferred list of issuers, irrespective of whether they belong to all the bond syndicate groups involved. The result is that they sponsor the development of deep pools of liquidity in the interbank markets from which they can supply their buy-side clients, and also can expect steady, large and regular flows in the primary markets.

Enhanced transparency has broadened the dealer community. With the removal of currency risks between eurozone countries, this has allowed unprecedented transparency in the pricing of interest rates and credit in Europe. Issuers previously confined to relatively narrow currency areas were suddenly able to reach investors across the continent and further afield. Fund and asset managers are offered the opportunity to compare liquidity and credit profiles of issuers from Lisbon to Helsinki. In the absence of transparency, only a few multi-national bond dealers would be able to trade across the

range of eurozone bonds. However, the Liquidity Pact has enabled a far greater range of banks to participate in the market, benefiting both diversity and liquidity. Institutional investors are not directly involved in secondary market arrangements, but gain a degree of liquidity and transparency in their investments together with reduced dealing costs passed on from the enhanced efficiency of the interbank market. Issuers developing benchmark programs promote their brands and increase their reach across the investment community, and in sowing liquidity in their consolidated lines, reap liquidity premiums and reduced funding costs."

In this speech Mr Garbi clearly sets out how the bond market has been transformed and the positive impact that this has had on the liquidity premium of the member states. While he does not discuss the credit profile of the members, the conclusions that he draws on the liquidity component part of their yields highlights to the academic world that their preconceptions about structure of the yield spread must be re-investigated.

6.3.3 Market Liquidity; Order vs Quote Driven Exchanges

In the US, investors and banks can trade bonds however they like and competition among dealing platforms is fierce. Moreover, trading is "order driven", meaning that prices are posted only when there is demand to buy or sell a bond - in the same way that equities are traded on exchanges. However, Europe's system is "more controlled", though banks are technically free to trade anywhere, most governments offer strong incentives for them to concentrate their activity on a network of platforms run by MTS. Moreover, MTS uses a so-called market-maker system, which forces member banks to supply continuous price quotes on bonds, irrespective of investor demand. The difference between these two systems has profound implications for the dynamics of the bond market and its price

discovery mechanism. It shapes the way information flows within the market as I describe in the section on benchmarks and the interaction of the yield spreads.

The reason that MTS is a quote driven exchange can be explained by the structure of Europe's bond market. As each sovereign has kept the right to issue debt separately, the euro bond market is very fragmented with a multitude of issuers. "As long as you have fragmented issuance, the interests of the smaller countries require market-making obligations," according to Richard Portes (FT March 13 2007), "You cannot expect it to look like the US Treasuries market." Governments of the smaller member states fear that if market participants are not "incentivised" to make a market in their issues, Investment Banks will not price the issues competitively and Bid/Ask spreads will widen. This could make it more expensive for these smaller sovereigns to raise funds and for retail investors to get bond price information.

A quote driven market overcomes these problems and allows market-making obligations to be implemented easily by Investment Banks and monitored by the Issuers.[36] In turn, those Investment Banks that have fulfilled their market-making obligations gain privileged access to primary auctions as well as developing strong relationships with sovereign governments that can produce more profitable work in the future such as mandates to advice on privatisations. This is the real "incentive" for the Investment Banks to quote on this market. To meet the requirements of these obligations, Investment banks are obliged to quote 2-way prices with a maximum Bid/Ask spreads, Minimum Quantity, Minimum time to be displayed and even minimum percentages on trade turnovers on certain issues.

While the Issuers are happy with the choice of a quote driven market, Investment Banks dislike the market. The obligations have narrowed the Bid/Ask spreads and therefore made the secondary market less profitable. The transparency in prices on the market reduces the value of the informational flow of customer orders for the larger institutions. The fact that market makers must trade at their quoted price, i.e. no negotiation unlike the D2C markets means they are vulnerable to speculators. This issue will be become more problematic as the demand for access to the EuroMTS market grows among Hedge Funds and large non-investment banking institutions. Restricting access to what is in effect a club of banks may become politically sensitive and could be challenged at a future date in the European courts as un-competitive and fall foul of anti-monopoly laws. However, any change in the market micro-structure could be problematic for smaller issuers. One way to compete with the larger issuers would be for the sovereigns to come together and issue joint bonds. "If the system breaks down, you could end up with a situation where all business is focused on, say, French five-year issues and German 10-year and Italian two-year," says Mr. Portes (2007). "That may be the future. But do the European governments or citizens really want that?" It is a question they may soon need to be resolved.

When one compares the *order* driven US bond market to the *quote* driven Euro bond market, we can clearly see how this impacts the dynamics of the entire system. Table 20, shows monthly electronic trading volumes across venues in the US and a number of EU Member States plus the Eurozone as a whole. Electronic volumes of European bonds are 5% of those of US bonds, even though the US bond market is one third smaller in terms of bonds outstanding in 2006. This is a strikingly low level of market turnover.

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[36] For a more indepth analysis of the impact of market structure on price transparency, see "The implications of electronic trading in financial market" (January 2001) by the Bank

Table 20 Average Daily Turnover in march 2006 by Issuer

Country/Region	Volumes Traded[37] (€, Millions)	Outstanding Amount (€, Millions)	Turnover (volume/bonds outstanding, %)
Belgium	9,026	218,120	4.1
Denmark	36,935	486,400	7.6
France	9,520	802,000	1.2
Germany	10,608	869,500	1.2
Holland	3,595	197,190	1.8
Italy	104,163	970,140	10.7
Portugal	9,263	69,780	13.3
Europe	183,109	3,613,130	5.1
US	3,666,342	2,638,680	138.9

Source: Icap

From the above table the European bond market has some way to go to rival the US as a trading venue for bonds. In conclusion, we see that liquidity is a multi-faceted concept and in the eurozone the selection of a quote driven system for EuroMTS is warranted by the low-level of secondary market activity. What I have shown in the previous sections is that the euro bond market cannot be easily compared to either the US bond market or European equity markets when it comes to measuring liquidity. The "controlled" aspect of this market means that it has been designed to fulfil a given requirement, i.e. to allow a wider dissemination of euro sovereign debt. The market did not evolve over time as for example the London Stock Exchange which can trace its history back over 200 years, and whose market goes even further back to the old coffee houses alongside the London docks. The fact that EuroMTS has been running without any significant changes to its business model since the introduction of the Euro signifies that as far as the Issuers are concerned it is successfully achieving its remit of providing liquidity and transparency within the marketplace.

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for International Settlements.

6.4 Credit Risk

Financial market instability has long been at the centre of academic research. Of late, this research has looked at how globalisation has impacted on market volatility, and many argue that its impact is that "highly diversified investors not paying much attention to economic fundamentals and following the herd in the presence of asymmetric information." (See, for example, Calvo and Mendoza (2000)). These conclusions have led to a call for the re-introduction of capital controls, as argued in Krugman (1998) and Stiglitz (2000). Policies that can lead to moral hazard, including bailouts by either governments or central banks have also been blamed for causing financial volatility and financial excesses (See, for example, McKinnon and Pill (1997) and Dooley (1998)). Rating agencies are routinely blamed after every crisis for failing to warn investors in a timely manner. Ferri, Liu, and Stiglitz (1999), argue that their pro-cyclical behaviour, upgrading countries in good times and downgrading them in bad times, could have contributed to amplifying the boom-bust pattern in stock markets. They report "even if rating agencies do not behave pro-cyclically, their announcements may still trigger market jitters". This is because most institutional investors can only hold investment grade instruments (i.e. securities with ratings above a certain threshold). The ECB highlighted this when it said that it would no longer accept government securities as collateral if they were rated below A- by Standard & Poor's and Fitch or A3 by Moody's.

The current setting of the Monetary Union leaves fiscal and budgetary policy mostly in the hands of national governments. This may result in substantial movements in the credit risk component of spreads. In fact the risk of default, though small, remains the most important component explaining yield differentials among Eurozone government bonds. The default risk is currently priced so low by the market, that central bankers and

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[37] Securities with less than one year of original maturity are excluded.

politicians can claim that it is only because of liquidity that the yield they must pay is not the same as Germany, a country with a proud history of fiscal prudence and good management. If one looks at the economic situations between EMU member states for 2005, you could see budget balances stretched from a surplus of 1.1% of GDP in Spain to a deficit of 6.0% for Portugal, while the debt ratio went from 7% for Luxembourg to 107% for Italy. Yet for all these very different budget situations, the maximum risk spread is just 30bp.

To become a member of the eurozone, each sovereign had to fulfil the austerity programme that was the Stability and Growth Package. As each sovereign meets this requirement for membership, its subsequent default risk diminished. In the euphoria after the launch of the euro, default risk almost disappeared from the radar screen, to be replaced by liquidity concerns. However, now that the euro is well established, and the rules for continued membership ignored, the fiscal discipline required seems to be weakening. The seminal paper by Lorenzo Codogno, Carl Favero and Alessandro Missale (2003) on the subject of yield spreads on EMU Government Bonds postulates that the yield differentials seen between Eurozone government bonds can be explained by credit risk-related domestic and international factors, as opposed to liquidity factors. In their conclusion they suggest "that yield differentials mainly reflect the market assessment about the creditworthiness of borrowers and those premiums are a function of international risk-related factors". Codogno et al. conclude that "...further convergence in fundamentals, and especially in debt-to-GDP ratios, would be required to reduce current yield differentials. The presence of yield differentials and their sensitivity to credit-related factors provides an incentive to fiscal discipline."

This is contrary to the view expounded by Villarroya (2003), Gomez-Puig (2006), Manganelli and Wolswijk (2007), and others that liquidity concerns are the reasons that sovereigns of the same credit rating have different yield spreads. From my analysis in chapter 5 I favour the view expounded by Codogno, Favero and Missale (2003), Bernoth, von Hagen and Schuknecht (2006), that the yield spreads can be explained more by the credit risk-related factors faced by each sovereign. However as Codogno et al. make clear, it is almost impossible to decompose the liquidity premium and default risk into separate parts when studying their impact on the yield differential within the Euro area. They explain that "some aspects of both credit risk and liquidity may not change over the period considered, and this may prevent the identification of the determinants of the constant in the model of yield differentials." This is further supported by Beber et al (July 2006) who find investors' risk profiles change during periods of financial stress and liquidity risk then becomes much more significant. Therefore the timeframe of investigation for these 2 components becomes crucial for any conclusion. If the markets operate under "normal market conditions" then liquidity risk will be negligible. In the following sections, I look to build on the work by Codogno et al. and investigate how the yield spread varies between various euro sovereigns. As the yield spread (both credit & liquidity risk) is not likely to change substantially from one day to the other, the yield spread would be expected to remain stable. Yet, we can see substantial changes in the yield spread over time with periods of increased and decreasing volatility.

6.5 Short Run Dynamics of the Yield Spread

In this section I look to investigate the second concern of the Delors Committee that the market would be "too sudden and disruptive". To study this I need to look at the short-term dynamics of the bond market. Antzoulatos and Vallianatos (2002) investigated the yield spread between euro sovereign bonds and Germany and found a small but economically and statistically significant undershooting in response to changes in the German yield, as a result of which the spread tends to decline when the latter increases and vice versa. They conclude that the reason for this undershooting is the product of lagged adjustment in the European bond portfolios that is driven by liquidity considerations and by the possibility of excessive bond price movements in response to changes in the German yield. They suggest the adjustment can last for as long as four days. The sample of data they use is from January 4 1999 to December 31 2000. Unfortunately there has been no academic paper published since looking at the short-term dynamics of the market, so I will re-run their analysis to show how the bond market has developed since 2000. This should allow us to re-evaluate some of their conclusions, in the new environment of reduced liquidity risk.

6.5.1 The Euro Benchmark

Most major research has assumed that the German bond yield fulfils the role of benchmark in the euro sovereign bond market when examining yield differentials. Investigating which country's bonds are the benchmark by which all other countries bonds are judged in the euro area may seem like an exercise in jingoism, but there are a number of benefits in achieving benchmark status. Clearly governments wish to borrow at the lowest possible yields; and there is an obvious welfare consequence when foreigners hold a significant share of domestic government securities. If indeed lowest

yield were all that mattered for benchmark status, then the German market would have provided the benchmark at all maturities up until 2004, but not now. Analysts who take this view accept that the appropriate underlying criterion for benchmark status is that this is the security against which others are priced, and they simply assume that the security with lowest yield takes that role (e.g., Favero et al., 2000, pp. 25-26).

A plausible alternative, however, is to interpret benchmark to mean the most liquid security, which is therefore most capable of providing a reference point for the market. But the Italian market, not the German, is easily the largest and arguably the most liquid for short-dated bonds; and perhaps the French is most liquid at medium maturities according to Dunne et al (2006). A different approach to defining benchmark status focuses directly on the price discovery process and regards price discovery as a purely empirical matter (see Hasbrouck, 1995, for a treatment in the context of equity markets). This perspective is based on recent theoretical developments due to Yuan (2002) in which a benchmark security provides an information externality to the market as a whole due to the fact that it best represents common movements of the entire market. Essentially, the benchmark bond is the instrument to which the prices of other bonds react. Therefore the definition of a benchmark has nothing to do with having the lowest yield. It is purely about the security's information content. Dunne et al (2006) use this concept of benchmark status in their research on price discovery in the bond market. Yuan formalises the concept of a benchmark security as having the following properties:

- It has no sensitivity to country-specific risk,
- It has unit sensitivity to systematic risk.

Antzoulatos and Vallianatos (2002) in their research do not specify why they select Germany as the benchmark issuer, but as their research was published at the same time as

Yuan (2002) we can assume they selected Germany because it had the lowest yield. Dunne, Moore and Portes (2006) as mentioned previously carried out extensive research on identifying the benchmark bond as described by Yuan. In their conclusion the instrument that provides superior information content is the French bond at all maturities except the very long. Obviously this seems to contradict the hypothesis that I have set out above, that it is the Eurex Futures instruments that provide the information component. However, I believe my results do not contradict their findings, but instead advance their hypothesis. Electronic Information flows both instantaneously and extensively in the modern financial world, therefore the concept of an MTS 'quote' driven bond supplying information as to the demand/supply equation is seriously questionable as described previously. Only an 'order' driven market can clearly encapsulate the information component of risk as defined by theoretical economics. However, once the risk is calculated it flows directly into the relevant benchmarks simultaneously and instantaneously, but the adjustment of one bond issuer relative to another issuer is not immediate and takes some time. Therefore, it is this relative adjustment that Dunne et al (2206) investigate in their data and not the price discovery which is formulated outside the MTS market in the Eurex Futures market.

6.5.2 The Yield and the Yield Spread

To investigate how each sovereign adjusts to changes in the regional risk premia we need to re-examine the determinants of the yield as seen by an investor. The real yield of a country specific security is the inflation-adjusted rate of return demanded by the market for holding long-term fixed income instruments whose value can be eroded by sustained increases in inflation. Real yields are impacted by supply and demand for capital as well as inflation expectations. This can be expressed as:

$$y_i = R_f + \alpha_i \tilde{I} + \tilde{S}_i + \tilde{\varepsilon}_i$$

Where y_i is the yield on the i'th country's security, R_f is the eurozone risk-free rate (real) at a specific maturity. I is the euro-zone wide inflation assumption, and α_i is country i's sensitivity to it. S_i is the credit-spread between the country-specific security and the theoretical yield of the euro-curve for that maturity. The risk-free rate differs across countries because of, for example, political factors such as the risk that a country might leave the euro-zone. ϵ is the specific characteristics of the bond that makes it unique such as Coupon, Maturity Date, Convexity, Duration, Special in Repo, On-the-run, Bond Size..... etc. Market participants assume that the first 3 variables account for as much as 90% of the value of the yield.

If we now start to compare yield for various sovereigns we can see the R_f is common to both (i.e. common stochastic force) and therefore can be removed from the equation when examining the yield spread. As the ECB sets out to control inflation for all members of the eurozone, and therefore sets monetary policy to ensure that this is stable throughout the zone, I assume that this variable is also common, or of such a low difference among issuers that it too can be deleted. Also by comparing bonds of similar

duration we can reduce ϵ to be of negligible difference by selection. Therefore by following the market convention, we express the yield spread of country i at period t, $S_{i,t}$, as the difference between the yield of the country's i government bond, $y_{i,t}$, and the benchmark's corresponding yield, $y_{B,t}$. In mathematical terms:

$$S_{i,t} = (y_{i,t} - y_{Bt})*100 \qquad \text{in Basis Points.}$$

To simplify the notation further, the country-subscript i can be dropped. Since there is no currency risk, many studies separate the spread into two distinct parts, the credit risk and the liquidity premium. However, it is impossible to disentangle the two premia as their relative magnitude probably varies across countries and over time. As discussed in the previous section, when it comes to comparing euro sovereign bond yields in the EuroMTS market, it is my opinion that the liquidity risk can be ignored or more correctly be included in the ϵ variable, i.e. the specific characteristics of the bond. This allows me to concentrate on the remaining credit component, and equate the yield spread to the credit or default differential between the 2 issuers.

To investigate the Yield Spread between eurozone bonds for different sovereigns with similar maturity, we must return to chapter 5 and again look at the section on the 'Determinants of Credit Spreads'. This states "that a credit spread is determined by the probability of default, since other risks (interest rate risk, inflation expectations, etc.) should already be reflected in the "risk-free" rate, the difference between the yield of a credit-sensitive bond and a risk-free bond should be determined by the default probability expected by the market." Now, expected default probability is not directly observable. So, in trying to determine credit spreads, we need to look at factors which directly affect investor expectations in the eurozone.

- Country macroeconomic fundamentals

- Sovereign credit rating by S&P, and Moody's
- Liquidity issues in the market for the bonds

All 3 conditions are relatively stable over time: country specific data on the economy are generally slow moving for developed economies, therefore the probability of default should remain constant in the short-run for a particular issuer. Market Makers are obliged by the Issuers of the debt to make a market for the bonds; we would not expect to see liquidity vary substantially in the short-term.

However, as in Antzoulatos and Vallianatos, we see a small yet economically and statistically significant variation in the yield spread over a short horizon. I agree with their arguments, but with a slight alteration, that this is due to the lagged adjustment that is driven by market risk considerations and in particular, by the possibility of excessive bond-price movements in response to changes in the Futures Market, (This is a change from Antzoulatos and Vallianatos, who argued the German Cash bond was the cause of the widening yield). The market makers update their price instantaneously, and this is reflected on the EuroMTS market instantly. However, their clients will not immediately trade on these new prices, until they fully digest the economic reasons behind the change in the Eurex Futures market prices (Regional Risk discussed previously). As highlighted by Antzoulatos and Vallianatos, because of "transaction costs, the prices of financial assets may adjust sluggishly and thus occasionally deviate from their equilibrium values. The deviation may become so large when a series of similar shocks occurs, large amounts of similar information in the terminology of Barberis et al., as to trigger an adjustment that corrects all the accumulated deviations of previous shocks". On top of the regional stochastic risk, is superimposed a country-specific risk, which also impacts on the yield spread as certain issuers experience changes in economic outlook or rating

changes. According to Dunne, Moore and Portes (2006) this country-specific risk can be represented by a simple ARMA model, and I will investigate these issues further in the next sections.

6.5.3 The Speed of Yield Adjustment

In contrast to many other studies on the dynamics of the yield spread that look from the perspective of a single or benchmark issuer, my research looks at the interaction of the bonds to each other and their response to changes in the regional or global price of risk. This is a much richer concept than the benchmark theory where one issuer moves the others. However, I can still compare my results to Antzoulatos and Vallianatos (2002) if I compare Germany to the other issuers. As stated previously there is no explicit reason given by Antzoulatos and Vallianatos as to why they selected Germany as the Benchmark; it may have been that they empirically derived or it may have been selected prior to their tests. Whichever was the case, it is the results that I am most interested in analyzing.

Antzoulatos and Vallianatos drew some interesting conclusions from their research, which I believe were correct for that specific timeframe. However, if they now re-ran their research, they would find it much more difficult to justify "that the undershooting is the product of lagged adjustments in the European bond portfolios that is driven by liquidity considerations and in particular by the possibility of excessive price movements in response to changes in the German yield. The empirical results are consistent with this proposition and additionally suggest that the adjustment can last as long as four days". As discussed throughout this thesis, liquidity seems to be employed whenever a researcher cannot theoretically account for an inefficiency in the market. However, in

this case they are probably correct and the German yield acted as the Benchmark to which all other sovereigns reacted. The Stability and Growth Pact was still fresh in everyone's mind and the Eurex Futures market priced German risk, not all eurozone risk. Therefore a lag of 4 days to re-price the sovereign risk may be justified theoretically. Remember during this timeframe the D2C markets described previously were not in existence and clients could not adjust their portfolio electronically as they do now.

Antzoulatos and Vallianatos carry out 3 tests in order to test their hypothesis on yield undershooting due to changes in the German yield. The first test is to find the conditions for a likely undershooting. The second tests for the lagged speed of adjustment. The final test, the one that I am interested in reproducing, is a consistency check that the "speed of yield adjustment should be faster for countries with higher bond market liquidity and hence lower yield undershooting." Here they tabulate the speed of adjustment for each sovereign in response to changes in the German yield. The model that they use is:

$$S_t = y_t - y_{G,t}$$

$$S_t = \alpha_0 + (\phi\text{-}1)\Delta y_{G,t} + (1\text{-}\phi\text{+}\phi\alpha_1)S_{t\text{-}1} + \phi\alpha_2 S_{t\text{-}2} + \ldots + \phi\alpha_k S_{t\text{-}k} + \epsilon_t$$

in which S is the observed spread, y_G is the yield of the German bond, α_i are unknown non-negative coefficients, ϕ measures the speed of adjustment, with faster yield adjustment associated with higher ϕ. However, it must be noted that the speed of adjustment as set out by Antzoulatos and Vallianatos is one-way i.e. The non-German issuer is assumed to adjust totally to changes in the German yield. This means there is no feedback to Germany, from for example, changes in the French yield. This is a major flaw in their hypothesis, as we have seen in the previous chapter all euro issuers are cointegrated and ignoring the possibility of feedback from other issuers in their model

means we could be significantly under-estimating the speed of adjustment. However, Antzoulatos and Vallianatos were fortunately correct within their timeframe, as I show in the next section; the feedback from non-German issuers could be ignored. This analysis is still significant today for comparison purposes because the change in the German yield due to regional effects will also be reflected in the non-German yield. Therefore the change in the yield spread will be because of the risk interaction between issuers; the speed of adjustment is still telling us how quickly the yields are moving due to changes in the regional rate of risk.

Table 21 displays my results and compares the speed of adjustment that I calculate using my data in 2007 to that calculated by Antzoulatos and Vallianatos using data prior to 2000. It must be noted that in my data, the lag is in hours while in their data the lags are in days. This might be considered by some to negate direct comparison of the results. However, some adjustments need to be included to account for the introduction of electronic D2C markets which transformed the trading landscape. We can see R^2 for this model are still very high, even in this timeframe with that of Italy reaching 0.963 or explaining over 96% of the yield spread. The only sovereign for which the model is a poor fit is Belgium, (If we swapped Germany for France and ran the model again we would still get very good R^2 values for most sovereigns. This highlights the fact that each sovereign moves relative to each other rather than to a benchmark).

Continuing my comparison, we can see that the speed-of-adjustment are all very high across the range of issuers, from a high for Belgium of 0.962 to a low for Portugal of 0.775. My results are consistent with those of Antzoulatos and Vallianatos, who find a similar high of values of speed-of-adjustment, however in a different arrangement. They hypothesized that they could explain the arrangement by liquidity, with the most liquid

issuers having the highest speed-of-adjustment. From my results, I cannot draw the same conclusions. Italy, the most liquid issuer, is only ranked 8th with a speed-of-adjustment of 0.816 while France is ranked 9th with a speed-of-adjustment of 0.8. Therefore it is impossible to rank the sovereigns, either by credit rating or liquidity. This shows that the market dynamics have changed substantially since Antzoulatos and Vallianatos carried out their research. I find that almost all members have experienced fluctuations in the local yields and these fluctuations are not homogenous across the members. When we observe the volatility of yield spreads in the euro area, it is again obviously seen that perfect financial integration is not achieved for these markets, (I will investigate spread volatility further in the next section). While I do not claim that this is evidence of free-riding, it further undermines the importance of liquidity risk in the yield spread and demonstrates that the regional risk is propagated at different speed through the various issuers. It also emphasizes that the interaction of yields between the issuers cannot be easily identified.

The ongoing process of integration of the euro area government bond market may in principle reinforce the market-driven disciplinary effects. Market discipline is most effective in efficient, competitive and well-functioning markets. A necessary condition for financial markets to correctly price sovereign bonds is that each country will ultimately bear the full costs of the credit risk implied in its government debt. If these conditions are satisfied (and there are no market failures), perfectly competitive markets will provide an accurate assessment of the risk/return profile of each bond. What can be concluded from both Antzoulatos and Vallianatos and my research, is that while the process of financial integration may have been achieved in the long-run, there are still inefficiencies in the market in the short-run that can seriously hamper market-driven disciplinary effects.

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Table 21 Speed of Adjustment for 10 Year Bonds Spreads with respect to Germany

$$S_t = \alpha_0 + (\phi\text{-}1)\Delta y_{G,t} + (1\text{-}\phi+\phi\alpha_1)S_{t\text{-}1} + \phi\alpha_2 S_{t\text{-}2} + \ldots + \phi\alpha_k S_{t\text{-}k} + \epsilon_t$$

Estimate Coefficients	Austria	Belgium	Finland	France	Ireland	Italy	Holland	Portugal	Spain	Greece
α_0	0.0 (0.44)	-1.12 (-10.17)***	0.81 (6.64)***	-0.12 (-2.61)**	0.1 (1.4)	0.01 (0.972)	-0.03 (-1.75)*	-0.07 (3.05)***	-0.33 (-5.72)***	-.021 (-1.976)*
$(\phi\text{-}1)$	-0.141 (-8.85)***	-0.038 (-2.38)**	-0.18 (-9.75)***	-0.20 (-10.98)	-0.05 (-3.01)***	-0.184 (-11.97)***	-0.147 (-11.12)***	-0.225 (-12.31)***	-0.145 (-9.55)***	-0.156 (-7.69)***
$(1\text{-}\phi+\phi\alpha_1)$	0.515 (15.1)***	0.416 (11.53)***	0.454 (14..43)***	0.407 (12.29)***	0.466 (13.16)***	0.549 (16.72)***	0.476 (14.4)***	0.454 (14.25)***	0.555 (17.24)***	0.447 (12.82)***
$\phi\alpha_2$	0.191 (5.08)***	0.087 (2.243)**	0.391 (12.46)***	0.221 (6.26)***	0.213 (5.47)***	0.302 (8.48)***	0.204 (5.57)***	0.247 (7.22)***	0.328 (10.19)***	0.265 (7.12)***
$\Phi\,\alpha_3$	0.089 (2.35)**	0.096 (2.676)***		0.163 (4.62)***	0.135 (3.45)***	0.141 (4.28)***	0.119 (3.25)***	0.252 (7.89)***		0.193 (5.18)***
$\Phi\,\alpha_4$	0.178 (5.21)***			0.172 (5.18)***	0.171 (4.83)***		0.181 (5.47)***			0.074 (2.12)*
R^2-bar	0.871 (0.882)	0.257 (0.823)	0.641 (0.581)	0.872 (0.467)	0.939 (0.746)	0.963 (0.829)	0.919 (0.434)	0.843 (0.760)	0.724 (0.623)	0.922
D.W	2.10	1.99	2.13	2.04	2.02	2.08	2.05	2.10	2.09	1.99
Implied ϕ *Speed of Adjustment*	0.859 (0.800)	0.962 (0.777)	0.82 (0.845)	0.8 (0.823)	0.95 (0.712)	0.816 (0.864)	0.853 (0.926)	0.775 (0.729)	0.855 (0.933)	0.844
Implied α_1 *Coefficients*	0.435 (0.179)	0.393 (0.336)	0.334 (0.309)	0.259 (0.230)	0.438 (0.187)	0.447 (0.415)	0.387 (0.304)	0.295 (0.445)	0.479 (0.420)	0.345
Ranking By Issuer	3 (6)	1 (7)	7 (4)	9 (5)	2 (9)	8 (3)	5 (2)	10 (8)	4 (1)	6

Notes: The numbers in parentheses in the final 3 rows are the results from Antzoulatos and Vallianatos research in 2002

6.5.4 Short-Run Dynamics of the Yield Spread

In this section I look to extend the work of Antzoulatos and Vallianatos (2002) on short-run dynamics, to create an Error Correction Model that better describes the interaction of sovereign yields. The hypothesis of cointegration implies that the process y_t is non-stationary, but $\beta' y_t$ is stationary. Thus we can interpret the relations $\beta' y_t$ as stationary relations among nonstationary variables. A characteristic feature of the error-correction formulation is the inclusion of both differences and levels in the same model, allowing us to investigate both short-run and long-run effects in our model. From this, Π can be interpreted as a long-run coefficient matrix, and can be defined as the product of two matrices, α and β', of dimension (n x r) and (r x n), respectively, i.e. $\Pi = \alpha\beta'$ The matrix β gives the cointegrating vectors, while α gives the amount of each cointegrating vector entering each equation of the VECM, also know as the 'adjustment parameters'. In general, all long-run relationships influence all the variables, and since there are cross equation restrictions, information is lost if all equations are not estimated together.

Assuming that the yields are nonstationary, but cointegrated, with one lag and suppressing the error term, this can be represented as follows:

$$\Delta\begin{pmatrix} y_{Austria} \\ y_{Germany} \end{pmatrix}_t = \begin{bmatrix} a_1 \\ a_2 \end{bmatrix}\begin{bmatrix} b_1 & b_2 \end{bmatrix}\begin{pmatrix} y_{Austria} \\ y_{Germany} \end{pmatrix}_{t-1}$$

If $b_1 = -b_2$, the prices will be proportional and basis constant. Normally, b_1 is normalised to be 1, so that one tests whether $b_2 = -1$ (or 1 if the term is moved to the other side of the equality operator). The a's measure the impact of changes in basis on respectively the Austrian and German yields. If $a_1 \neq 0$, a change in basis will be at least partly corrected by a change in the Austrian yield, while if $a_2 \neq 0$, a change in basis will be at least partly

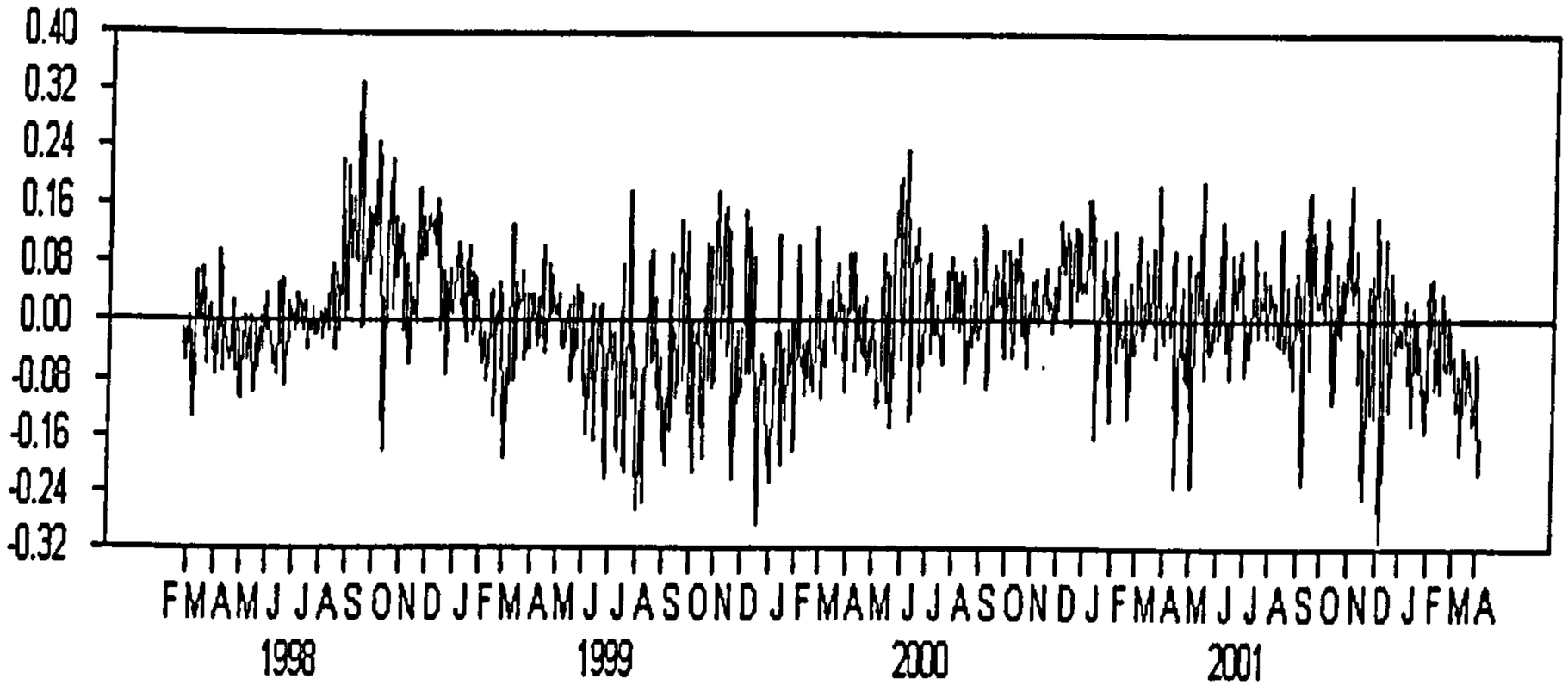
corrected by a change in the German yield. It should then be obvious that if $a_1 = 0$, there are no changes in the Austrian yield due to changes in basis and all corrections will have to made by changes to the German yield, and vice versa if $a_2 = 0$. Hence, if $a_1 = 0$ Austrian yields will lead German yields, if $a_2 = 0$ German yields will lead Austrian yields and if $a_1 \neq a_2 \neq 0$ there will be no yield leadership in this system. Both a's cannot simultaneously be zero, as there will then be no long-run relationship.

Continuing our investigation of the Austrian and German long maturity bonds from the previous chapter, the CATS software produces the following results for short-run dynamics:

	α	t-values for α
ΔAustria	-0.081	-2.083
ΔGermany	-0.034	-0.867

The values of α are such that the coefficients on the error-correction term dAustria and ΔGermany equations are -0.081 and -0.034 respectively. At conventional significance levels only ΔAustria adjusts to a deviation from the long-run equilibrium relationship. Therefore we would expect that changes in the German yield will lead changes to the Austrian yield. This result is in agreement with those of Antzoulatos and Vallianatos, and demonstrates that Germany leads Austria. Figure 16 graphs the actual disequilibrium as a function of all short-run dynamics. Market participants are forcing the system back into its equilibrium state.

Figure 16 Short-run dynamics



Now, if we rerun the same set of tests for all sovereigns versus Germany and investigate how changes in the German yield affect yields of other Non-German bonds and compare how the short-run dynamics have changed in the 5 years, we can explore how short-term integration has varied with time. In Table 22 we tabulate the speed of adjustments for long term maturity bonds over 2 time periods, 04/'01 - 4/'02 and 04/'07 - 06/'07. The bonds will be different, but they had the same durations during the timeframe. Unlike other studies, I am just looking at the interaction of bonds over a specific time period. I am not drawing conclusion as to price discovery or benchmarks. All results should be repeated for each sovereign pair, i.e. France-Belgium, Spain-Portugal, Italy-Greece and all other combinations. This would allow us to create a matrix of short-run dynamics from which we can see how each sovereign relates to changes in another sovereigns yield. From this matrix we can see a complex response mechanism of how sovereigns react to each other; there are differing time lags and varying levels of adjustment. We cannot compare the speed of adjustment from the Error Correction Model with that of Antzoulatos and Vallianatos, as their model did not employ cointegration and the speed of adjustments of the spread is not the same as the speed of adjustment of the

cointegrating force. However, as both our models look at how changes in the German yield affect either the spread or the yield of the Non-German bond, then comparing the rankings of both models raises a number of interesting points.

The speed of adjustment in Belgium versus Germany substantially increased over the two timeframes. In Table 22 it increased from -0.273 to -0.433 and its rank increased from 9th to 4th, which is very similar to what we found in Antzoulatos and Vallianatos where its ranking increased from 7th to 1st. In the above table Italy, Greece and Portugal have among the lowest speed of adjustment values and this is also consistent with the results found by re-running the model of Antzoulatos and Vallianatos. The Netherlands, Ireland and France are those with the highest speed of adjustment in the above table. From these results, we can see that certain issuers respond quicker to changes in the German yield than other issuers. The level of integration and hence the speed of adjustment increases with the credit rating. However, this adjustment is far from uniform throughout the timeframe or even among the issuers. This is in agreement with that of Antzoulatos and Vallianatos who found a yield undershooting in non-German bonds in response to changes in German yields. However, my results show that the undershooting will be greatest for issuers with low credit ratings in contrast to that of Antzoulatos and Vallianatos who claim that it is due to liquidity considerations.

Table 22 Comparison of Speed of Adjustment over time

Country	α or Adjustment Parameters		Ranking	
	Long (1/4/01 – 2/4/'02)	Long (10/4/07 – 7/6/07)	4/01 – 4/'02	4/07 – 6/07
France - Germany	-0.745 (-27.694) -0.050 (-0.849)	-0.609 (-10.037) 0.045 (0.702)	2	3
Italy - Germany	-0.609 (-18.812) -0.009 (-0.175)	-0.098 (-2.910) 0.025 (0.678)	4	10
Austria - Germany	-0.389 (-13.063) -0.052 (-1.358)	-0.378 (-5.065) 0.235 (3.007)	5	6
Belgium - Germany	-0.273 (-10.203) -0.028 (-0.914)	-0.433 (-5.361) 0.178 (2.328)	9	4
Finland - Germany	-0.280 (-10.478) -0.061 (-2.101)	-0.400 (-7.421) 0.071 (1.293)	6	5
The Netherlands - Germany	-0.874 (-40.740) -0.139 (-2.360)	-0.664 (-7.835) -0.065 (-0.702)	1	1
Portugal - Germany	-0.230 (-9.543) -0.040 (-1.385)	-0.324 (-6.487) 0.096 (1.824)	10	7
Spain - Germany	-0.270 (-10.066) -0.027 (-0.798)	-0.319 (-4.845) 0.113 (1.631)	8	8
Ireland - Germany	-0.649 (-23.204) -0.031 (-0.613)	-0.657 (-9.249) -0.037 (-0.554)	3	2
Greece - Germany	-0.273 (-10.469) -0.047 (-1.450)	-0.126 (-4.392) 0.006 (0.228)	7	9

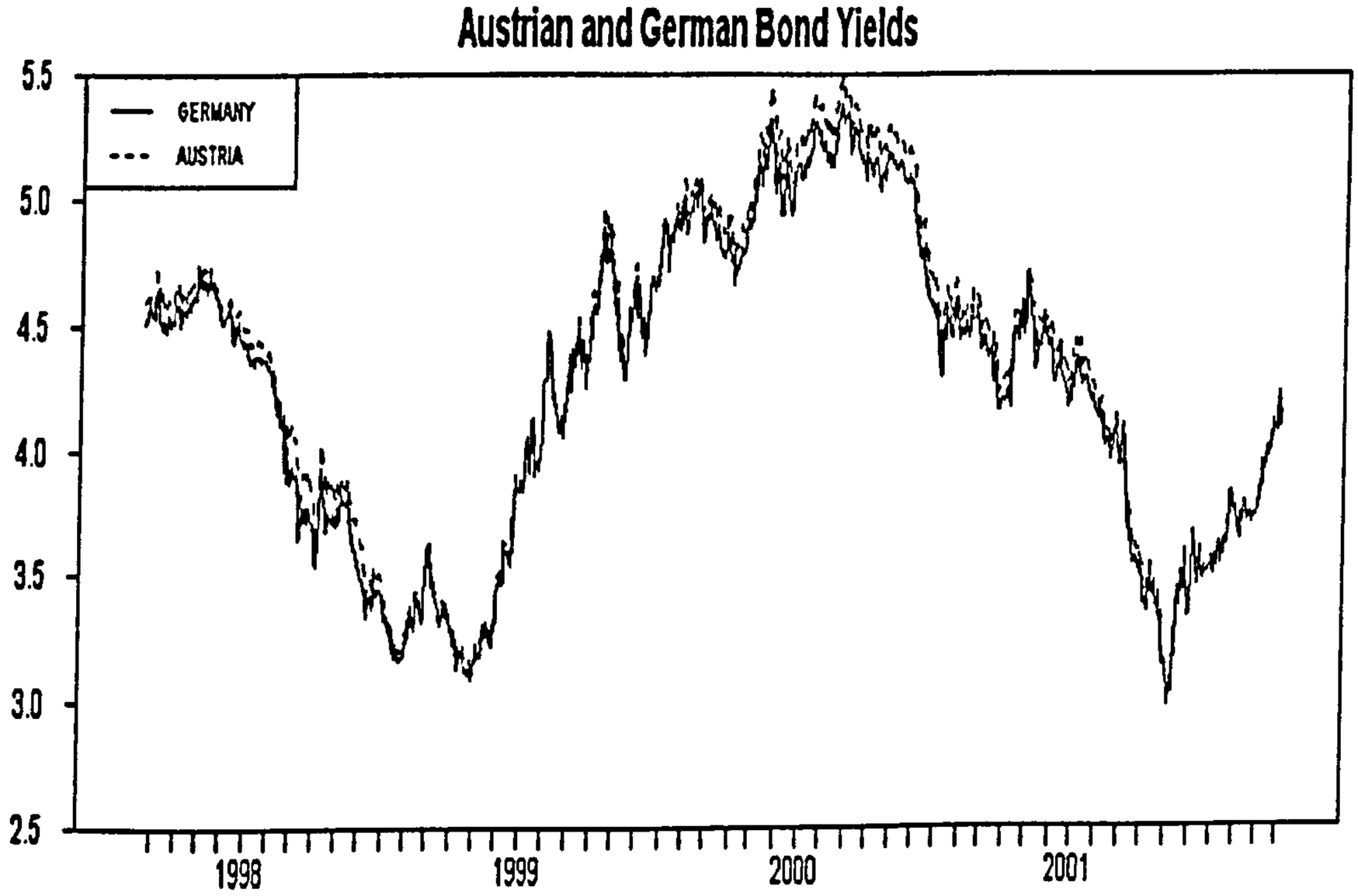
6.5.5 Modelling the Yield Spread

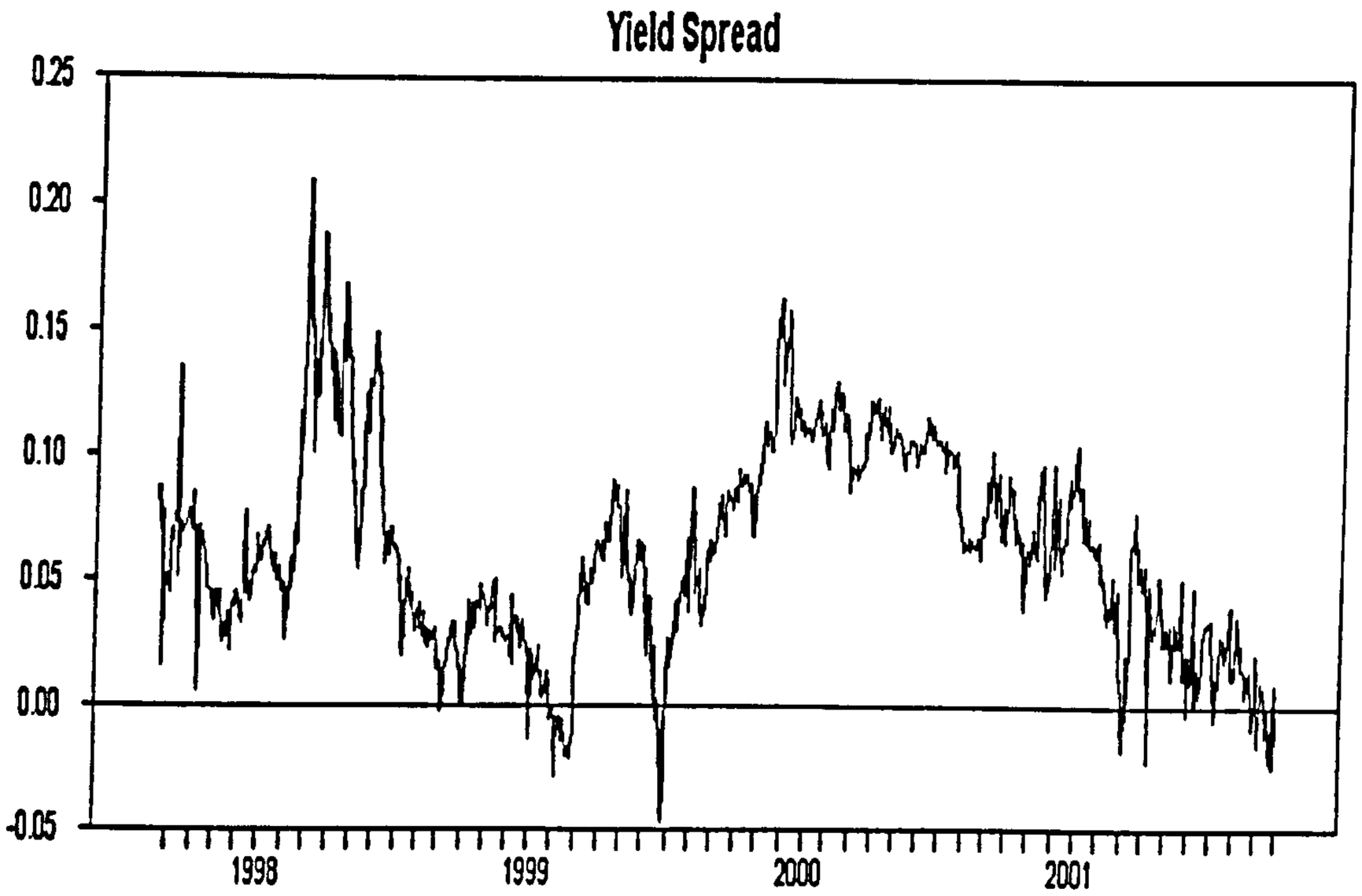
In this section I investigate the stationary process, i.e. the spread that links 2 cointegrated sovereigns yields. In the paper by Dunne, Moore and Portes they state that this process is best represented by a simple ARMA model. However, this seems to reduce our understanding of the dynamics of the yield spread rather than increase it. We have shown in the previous sections the subtle interaction between the spread and the underlying yields, i.e. the spread overshoots/undershoots due to changes in the German yield. This cannot be captured in such a simple ARMA model which only looks at past values of the spread, and does not incorporate the underlying yields of the 2 sovereigns bonds. The fact that each sovereign reacts with a unique "speed-of-adjustment" to changes in its cointegrated pair means that the yield undershooting as reported by Antzoulatos and Vallianatos will be a feature not just of the cointegrated pair including Germany, but of all cointegrated pairs, irrespective of whether Germany is included.

The ARMA model is a univariate time series model, and these models try to predict financial variables using only information contained in their own past values and possibly current and past values of an error term. Such models are usually a-theoretical, implying that their construction and use is not based upon any underlying theoretical model of the behaviour of the variable. Instead time series models are an attempt to capture empirically relevant features of the observed data that may have arisen from a variety of different (but unspecified) structural models. This practice can be contrasted with structural models, which are multivariate in nature, and attempt to explain changes in a variable by reference to the movements in the current or past values of other (explanatory) variables.

In Dunne et al. (2006) state that the "parameters of the ARMA process are country-specific, and are independently distributed with mean zero and constant variance. Any country specific dynamics in the risk-free rate are included here. Specifically, we are modelling country default and credit risk as stationary. If this were not so, the eurozone would not be a credible monetary union. This is what distinguishes the eurozone from a mere system of national currency boards. We also assume that that no country in the union is large enough for its risk factors to become systematic." Again using the data for Austria and Germany, I create such an ARMA process to model the price spread between the 2 issuers. Figure 17 shows the yield and yield spread over almost 4 years.

Figure 17 Yield and Yield Spread between Austrian and German 10 Year bonds





The spiky nature of the yield spread can be explained by overshooting/undershooting, also known as overreaction/underreaction (as described by Antzoulatos and Vallianatos) which is a feature of many financial and economic models, and has been observed in many financial series. Most market practitioners and academics conclude that this occurs because of the changing "appetite for risk" of international investors, or the world price of risk which can change. Markets have driven bond prices too far away from fundamentally justified levels. This seems to happen, because in phases of high market volatility it is too complicated to forecast the future path of various return components. The interplay of monetary policy, bond yields, risk premia and exchange rate devaluations or revaluations is still not fully understood, especially concerning relatively young government bond markets. The result resembles an "overshooting", normally only seen in the foreign exchange markets, rarely in bond markets.

Table 23 displays the output from a Box-Jenkins ARMA model with a reported R^2 of 0.9315 which is only slightly lower than that of the Error Correction Model of 0.9481 in Table 24. This shows that the cointegrated model can produce superior results in modelling the yield spread as it captures both the short-run and long-run dynamics. Re-running the ARMA model with various lags for the autoregressive and moving averrage components from 0 to 10 lags the Akaike Information Criteria (AIC) selects an ARMA(6,4) model while the Schwarz Information Criteria (SIC) selects an ARMA(5,7) model. However, no matter which model is selected the R^2 is always less than the ECM R^2. I re-ran the same experiment with a number of different bond pairs and found similar results.

Table 23 Box-Jenkins Model of the Austrian/German Yield Spread

Box-Jenkins - Estimation by Gauss-Newton
Convergence in 5 Iterations. Final criterion was 0.0000078 < 0.0000100
Daily(5) Data From 1998:02:18 To 2002:04:02

Usable Observations 1075	Degrees of Freedom 1073
Centered R2 0.931518**	R Bar **2 0.931455
Uncentered R**2 0.979066	T x R**2 1052.496
Mean of Dependent Variable	0.0623034957
Std Error of Dependent Variable	0.0413597362
Standard Error of Estimate	0.0108284693
Sum of Squared Residuals	0.1258154166
Durbin-Watson Statistic	2.006946
Q(36-2)	46.621319
Significance Level of Q	0.07316482

Variable	Coeff	Std Error	T-Stat	Signif
1. AR{1}	0.993189679	0.003431719	289.41464	0.00000000
2. MA{1}	-0.232275644	0.029992729	-7.74440	0.00000000

Table 24 Error Correction Model of the Austrian/German Yield

Linear Regression - Estimation by Least Squares
Dependent Variable ΔAustia
Daily(5) Data From 1998:02:18 To 2002:04:02

Usable Observations 1075	Degrees of Freedom 1073
Centered R2 0.948124**	R Bar **2 0.948075
Uncentered R**2 0.948129	T x R**2 1019.239
Mean of Dependent Variable	-0.000479046
Std Error of Dependent Variable	0.047795806
Standard Error of Estimate	0.010891208
Sum of Squared Residuals	0.1272775475
Durbin-Watson Statistic	2.399437

Variable	Coeff	Std Error	T-Stat	Signif
1. ECT	-0.048176261	0.008940995	-5.38824	0.00000009
2. ΔGermany	0.965402050	0.006909406	139.72287	0.00000000

6.6 Conclusion

In this chapter I investigated the short-term dynamics of the sovereign risk premia in the Euro bond market from the point of view of market discipline. Antzoulatos and Vallianatos (2002) in their research found that the yield on Non-German bonds exhibits a small but economically and statistically significant undershooting in response to changes in the German yield, as a result of which the yield spread tends to decline when the latter increases, and vice-versa. They conclude that such undershooting can be explained by the possibility of excessive bond-price movements in response to changes in the German yield or the introduction of a lag due to transaction costs. However, such deviations from equilibrium demonstrate the difficulty in pricing risk over a short horizon.

Antzoulatos and Vallianatos found that they could rank the sovereign issuers speed-of-response to a change in the German yield by liquidity. I re-ran the same experiment, but instead of using data from 2000, I used data from 2007 and found that I was no longer able to rank the issuers either by liquidity or credit risk. However, I extended their research by building on the cointegration results of the previous chapter, to develop an Error Correction Model that allowed for the feedback from one issuer to another which was not incorporated into the experiment of Antzoulatos and Vallianatos. The results of the speed-of-adjustments from this model showed that issuers with high credit ratings had also high speed-of-adjustments, and vice-versa. This is in line with my previous results and highlights the dominant role of credit risk within the short-term dynamics. The fact that issuers with lower rating experience more under and overshooting can be explained by the increased difficulty in re-pricing the relative risk after a rapid change to the benchmark rate and demonstrates that the influence of market discipline may be weakened.

Another area of research that this chapter investigated is how the microstructure of the bond market has changed since the introduction of the Euro. The main events being the creation of an electronic exchange, EuroMTS, and the subsequent development of the Liquidity Pact. The impact of both these events had an enormous impact on the bond market and created a deep pool of liquidity and a continuous market for the trading of sovereign bonds. This increased the numbers of participants in the market and further deepened the pool of liquidity. The improved transparency meant that the price discovery mechanism was easily revealed and the risk of holding a particular issuer relative to another was clear to every investor. The increased efficiency of the debt market means that it should be easier for investors to hold issuers to account and enhances the market discipline effect. However, these technical innovations may instead have led to an over tightening of the yield spread. These events are rarely mentioned in the academic literature as having any impact on the narrowing of yield spreads.

Another major issue investigated here is the role of the benchmark, the common perception being that the benchmark can be found internally, i.e. among the euro bond issuers. My conclusions are based on the premise that the price discovery mechanism is external to the bond market itself, and what papers such as Dunne, Moore and Portes (2006) are instead showing are the complex interlinkages of credit risk among the issuers. By examining the microstructure of the EuroMTS market, I was able to identify the reason behind why the benchmark is external to the market. The fact that EuroMTS is a quote driven market means that prices are quoted *irrespective* of supply and demand factors. Most exchanges are order driven, therefore prices are in the market because an investor wants to buy or sell an instrument. As the liquidity pact was designed to artificially create a market that was not previously liquid, most bonds were and are still bought in the primary market and kept until maturity. This is why only 5% of bonds are

traded on the Euro secondary market in comparison to the order driven US debt markets which have over a 100% turnover. Only an order driven exchange can encompass the supply/demand function as is commonly understood. In the Eurozone, the Eurex Futures market is the only exchange that incorporates this functionality, therefore looking for a benchmark on the EuroMTS market will generate spurious results.

Dunne et al. (2006) report that the yield spread can be modelled as an ARMA process, however I have shown that because the yields are cointegrated an ECM can provide a superior model for investigation. Using my ECM I was able to model the short-run dynamics of the yield spread between 2 cointegrated issuers using not just the yield spread but the 2 underlying yields. This structural model allowed me to model the yield spread to investigate the short-run dynamics of the yield spread. The only other research that I could find that specifically investigated this was by Antzoulatos and Vallianatos (2002) who did not use cointegration in their analysis. Their research found that liquidity played a significant role in the short-term dynamics which is in agreement with research that I carried-out in chapter 5, that in the period directly after the introduction of the Euro, liquidity was an important part of the yield spread. However, as my research was carried out with a more up to date timeframe, we can see that the dynamics have changed over time. My results show that instead of liquidity risk controlling the speed-of-adjustment as reported by Antzoulatos and Vallianatos, that it is now the credit risk component that plays a more significant role in the short-run dynamics. This is particularly relevant for market discipline as highlighted by the Delors Committee when they noted that the market could be "too sudden and disruptive".

7. Concluding remarks and outlook

The Delors Committee acknowledged that market forces can exert a disciplinary influence but noted that the "constraints imposed by market forces might either be too slow and weak or too sudden and disruptive". With the failure to enforce the rules of the SGP, have bond market investors followed the hypothesis suggested by Lamfalussy, and failed to price the credit risk premia sufficiently? Are they now failing in their role of sovereign risk adjudicators as they believe that the "no bail out rule" is meaningless? These questions are at the core of my thesis. To investigate this I carried out a critical analysis of the entire area, starting with a review of the current literature, then bringing together all the variables that could impact the market, from political issues to the bond markets micro-structure, referencing both academic papers and leading economists in the field to support my arguments. I also review the conclusions made in a number of research papers, and place them in their historical context. I show that they no longer hold true due to the continuously changing landscape of this field of research. I then apply econometric theory to this bond market to gain deeper insight into the dynamics of the bond market. These results are particularly relevant not only academically but to policy makers and those whose task is to ensure the smooth running of the European Debt markets.

My research focused on 3 main topics, Market Discipline, Free-Riding and Market Integration and how they interact within the Euro sovereign debt market. I drew on a vast field of academic and market literature to create a theoretical underpinning for my research. My work is one of the first that specifically looks at the yield spread from the point of view of market discipline. Current research focuses on trying to explain the yield differentials with respect to default risk and liquidity premia. However, this ignores completely the possibility of free-riding; to my knowledge, this study is the first

to look at the possibility that free-riding is a significant part of the yield differential in the euro government bond market.

I started my contribution to this area of research by investigating the determinants of yield along the lines already explored by Cantor and Packer but restricted my data to only include members of the euro zone. From this I was able to create a model that explained 95% of the yield variation. When I back tested this model over the previous 7 years I found that during 2002 and 2003 it was a particularly bad fit. I concluded that during these years the yield on the various sovereign bonds could not be explained by the economic variables. I concluded the reason was due to the "liquidity premium" discussed by Antonio Villarroya in 2004. However, this effect was reduced in 2004 and disappeared almost completely in 2005. Unfortunately many academic studies still persist with the "liquidity premium" concept as an important identifier of the yield differential. This has led to researchers such as Villarroya stating that smaller issuers of similar credit risk i.e. Aaa/AAA can never expect to have a yield lower than Germany. This is obviously wrong, as both Ireland and Finland have since both achieved yields lower than that of Germany. In my research I place this risk in its historical context and review how a combination of both policy initiatives and technological innovations has impacted on this constituent of the yield differential.

I then investigated the market discipline effect on the sovereigns, by reducing the number of economic variables in my model, and looking at the data from the point of view of a liquidator instead of an investor. I created a Liquidation Risk Ratio profile which only involved 2 variables, the Debt as a % of GDP and the GDP Per Capita. I then compared the yield for Germany on this measure to that for all other sovereigns and found that countries with a lower Liquidation Risk Ratio than Germany were given a very similar

yield to Germany implying that the German yield was a floor to the market. Sovereigns with a worse Liquidation Risk Ratio than Germany were given a higher yield, but this yield was not proportional to the amount of risk that the investor bore. This shows that Free-riding is a significant component of the yield. I went on to show by how much a low Liquidation Risk Ratio country could increase its debt and the impact that this would have on its yield (the Foul Dealer).

Having found the possibility of Free-riding in the Euro zone, I now investigate whether the concerns raised by Lamfalussy prior to the launch of the euro are materialising and the level of bond market integration that has occurred among European bonds has led to a weakening of market discipline and the possibility of financial bailouts. My research focuses on the fact that all the euro sovereigns yields are cointegrated. The common stochastic force that binds all euro yields is the regional price of risk, i.e. the risk of holding a euro-denominated bond, and as feared by the Delors Committee, this regional effect has become dominant over own country effects in EU bond markets and has greatly reduced the ability of the bond market to discipline finance ministers by increasing the credit spread. This is further evidence that bond market participants are viewing the "no bail out rule" as meaningless. This study is the first to question the disciplinary role of the bond markets and develop economic theories that can be easily constructed and tested.

The focus of my research is always centered on the interaction of economic variables and the creation of testable hypotheses. The final part of my research looks at the short-run dynamics of the cointegrated model. This is again connected to previously raised concerns as to the disciplinary aspects of the bond market, where the Delors Committee noted that the "constraints imposed by market forces might be too sudden and

disruptive". Most research assumes that the yield spread can be modelled by an ARMA process, however I show that while such a model is adequate for data with a long-horizon it has little to say about short-run deviations that are highlighted by Antzoulatos and Vallianatos (2002). Instead I develop a structural error-correction model which incorporates both the underlying bond prices and price spread in modelling the short-term dynamics. However unlike Antzoulatos and Vallianatos, who concluded that undershooting in the yield spread depended on liquidity, I show that the speed-of-adjustments can be ranked by credit considerations. I show that higher speed-of-adjustments correspond with high Liquidation Risk Ratio sovereigns and vice versa. To my knowledge there is no other work that investigates the short-run dynamics of the credit risk premia. With the failure of the SGP there is a gap in the research which I hope this thesis will start to fill.

7.1 Future Work

There are a number of topics which I wanted to research further, the main one being Credit Rating Agencies and their ability to influence the debt markets. However, it was decided that many of my hypotheses were "too journalistic" in nature, therefore it was difficult to create testable experiments which could be referenced to previous academic work. This is a limitation to the PhD process, but is still an area of research which after each financial crash or "credit crunch" there are calls for closer scrutiny. The incorporation of Credit Rating Agencies in both the management and regulation of bond markets is very important to the sovereign debt markets. The fact that Euro governments are both issuers of debt and regulators of their own debt raises serious questions as to transparency of the sovereign debt markets. I wanted to highlight the removal of Citigroup access rights to the Primary Debt market as punishment for the Dr. Evil trade as a heavy-handed regulatory operation that does nothing for market clarity.

Unfortunately, it is almost impossible in an empirical analysis to demonstrate that such market inefficiencies lead to the growing sense of the possibility of a market breakdown and subsequent bail-outs.

The second area of further research, would be an investigation into what a future European bond market similar to the USA would look like, i.e. a single issuing authority similar to the US Fed that is responsible for managing all Euro debt. It is clear that the current yield differentials point to incomplete fiscal consolidation and to the need for further convergence of debt ratios. It has often been hoped that this yield spread can play an important role in debt policy as they should work as a deterrent for irresponsible fiscal policies. However, as this research demonstrates this role no longer works efficiently and more unfortunately there is a complete lack of energy in both the political and economic fields to look at why it is failing and the possibility of creating a new system which is much more efficient. The lack of leadership in these field will lead to reduced market discipline, increased moral hazard and free-riding over time. This will have a negative impact both for investors and fiscally responsible issuers in the long run if there is no reform. A comparison of the US market versus the Euro market in respect to market transparency, regulation and investor protection is long overdue.

However, the area where I have made most progress and hope in the future to continue working on is the short-term dynamics of the market. I would like to further develop this to create cointegrated trading strategies that could be used to model the complex relationships between the issuers. In a perfectly functioning market the law of one price states that assets with identical risks and returns characteristics will be priced identically regardless of where they are transacted. However, from my data I often see example where a country such as Ireland falls 30 cents versus Italy and 20 cents versus France

after a fall in the Eurex Bund Future of 15 cents. This complex interaction is difficult to explain, especially as it can be reversed 20 minutes later after another news announcement. While this research focused on the interaction of bonds amongst themselves, I will now start to introduce the Eurex Futures into the model.

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