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A Theory on European Bond Market Turmoil

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Abstract

This white paper builds a new financial theory of euro area sovereign bond markets under stress. The theory explains the abnormal bond pricing and increasing spreads during the recent market turmoil. We find that the strong disconnect of bond spreads from the respective bonds' underlying fundamental values in 2010 was triggered by an increase in asymmetric information and weak reputation of government policies. Both factors cause a normal bond market to switch into a crisis mode. Finally, those markets are prone to self-fulfilling bubbles in which the economic effects are amplified by herding behaviour arising from animal spirits. Altogether, this produces contagious effects and multiple equilibria. Thus, we argue that government bond markets in a monetary union are more fragile and vulnerable to liquidity and solvency crises. Consequently, the systemic mispricing of sovereign debt creates more macroeconomic instability and bubbles in the euro area than in a single country. In other words, financial markets are partly blind to national default risks in a currency union. Therefore, the current European institutional framework puts the wrong incentives in place and needs structural changes soon. To tackle the root causes we suggest more market incentives via consistent rules, pre-emptive austerity measures in good economic times, and a resolution scheme for heavily indebted countries. In summary, our paper enhances the bond market theory and provides new insights into the recent bond market turmoil in Europe.

Key words: Theory of Sovereign Bond Market, Market Turmoil, Euro Crisis

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1. Introduction

The European sovereign debt crisis poses serious questions for financial theory in general and bond market pricing in particular. According to standard theory, bond yields reflect default risk, and default risk is determined by a number of fundamental variables, such as government debt-to-GDP ratios and the current account balance. The theory states that a higher government debt-to-GDP ratio increases the burden of debt service and thus increases the probability of default. Hence, bond spreads widen because investors demand a higher risk premium to compensate for the default risk in comparison to an alternative bond. A similar effect occurs for a large current account deficit because it can be interpreted as an increase in net foreign debt. As a matter of fact, an increase in net foreign debt affects the default risk of both the private and government sectors.

Since the beginning of the euro crisis in 2010, spreads of government bonds have widened considerably. However, the increase in spreads has been significantly larger than the changes in the underlying fundamentals (De Grauwe and Ji 2012). This raises the question of whether the financial markets may have just mispriced risks or orthodox bond theory is not applicable to a monetary union. The obvious disconnect between the spread and fundamental value is proven for the GIPS states, Greece, Italy, Ireland, Portugal, and Spain. For these countries, financial markets exerted no disciplinary effect on high debt-to-GDP ratios from 1999 to 2010, before the onset of the crisis. This demonstrates the flawed incentives in the European Monetary Union (EMU). It remains a conundrum why bond markets suddenly changed that mindset in 2010. This white paper sheds light on this issue.

Indeed, euro area member states do not have control over their own currency and thus, in contrast to stand-alone countries, they cannot guarantee pay-out to bondholders. Thus, it is not remarkable that stand-alone countries with debt-to-GDP ratios equally high or even higher than the indebted European member states were not affected by a similar debt crisis. This may be evidence that mispricing of sovereign risk is augmented in a currency union. Consequently, government bond markets are more fragile and vulnerable to self-fulfilling crises. Such self-fulfilling crises produce multiple equilibria including a bad, or a kind of trap, equilibrium. The policy lesson is simple: A monetary union only works efficiently if its institutional rules and setup are based on market incentives for fiscal and economic policies. The rules have to imitate the market forces of a stand-alone country. Of course, in case of turmoil, austerity measures and temporary liquidity provisions are reasonable instruments to tackle the problem. However, additional liquidity measures from the central bank alone are insufficient because monetary policy is considerably constrained in the EMU. Moreover, monetary policy does not tackle the root cause of a sovereign debt crisis, in particular the loss of competitiveness and thus the underlying current account imbalances in the eurozone.

The remainder of the paper is structured as follows: Section 2 is a brief introduction to the bond market supply-and-demand model in normal times. In Section 3 we explain the unique characteristics of the European sovereign bond market and develop a new bond pricing theory. We explain our conceptual model and discuss the new determinants in detail: economic fundamentals, asymmetric information, reputation issues, and animal spirits. The new theory provides a straightforward explanation of the sovereign debt crisis in the euro area. Finally, Section 4 concludes the paper.

2. Bond market determinants in normal times

The bond market is the heart of financial economics. Usually we differentiate between corporate and sovereign bonds. This white paper provides an in-depth study of sovereign bonds because of the recent anomalies during the euro crisis (Herzog 2012). The paper focuses mainly on sovereign bonds under stress and offers new insights into and explanations for bond market dynamics.

First consider the bond market in normal times, when the standard supply-and-demand determinants apply. In asset-pricing theory there are at least four factors that determine the demand for assets:

I. The wealth level, which is the total resource/income owned by an individual;
II. The expected return, which is defined over the next period;
III. The risk, which measures the degree of uncertainty;
IV. The liquidity, which expresses the speed with which the asset can be transformed into cash.

All four determinants – wealth, expected return, risk, and liquidity – are evaluated for a given bond relative to an alternative asset. The impact that a change in these determinants has on bond supply and demand is obvious (Table 1).

Holding everything else constant, an increase in wealth or liquidity raises the quantity demanded for a bond. Hence, higher wealth/income implies more resources available to purchase bonds. Liquid markets, characterized by many buyers and sellers, will cause transaction costs to decrease, which increases the demand for those assets in relation to others. However, an increase in the expected interest rate due to higher risk lowers the expected return for bonds; thus, investors are less attracted to purchase. The risk measure and its relationship to the quantity demanded depend on the behaviour or attitude of agents. In standard economics we suppose that agents are risk-averse.[1] Consequently, the higher the degree of risk or uncertainty relative to an alternative, the lower the quantity demanded, assuming that everything else is held constant (especially the expected return).

Similarly, there are three factors that determine the supplied quantity of a bond:

I. The sustainability of public finances, or the public deficit and debt levels;
II. The level of expected inflation;
III. The expected potential growth rate.

Each of these factors changes the position of the supply curve (Table 1). A higher public deficit or debt increases the

Table 1: Standard Factors of Bond Demand & Supply

Demand Factors		Supply Factors	
An Increase in	Caused Effect on Bond Demand	An Increase in	Caused Effect on Bond Supply
Wealth	Rise	Sustainability of public finance (lower defict and debt)	Fall
Expected interest rate	Fall	Expected inflation rate	Rise
Expected inflation rate	Fall	Expected growth rate	Rise
Riskiness of bond	Fall		
Liqudity of bond	Rise		

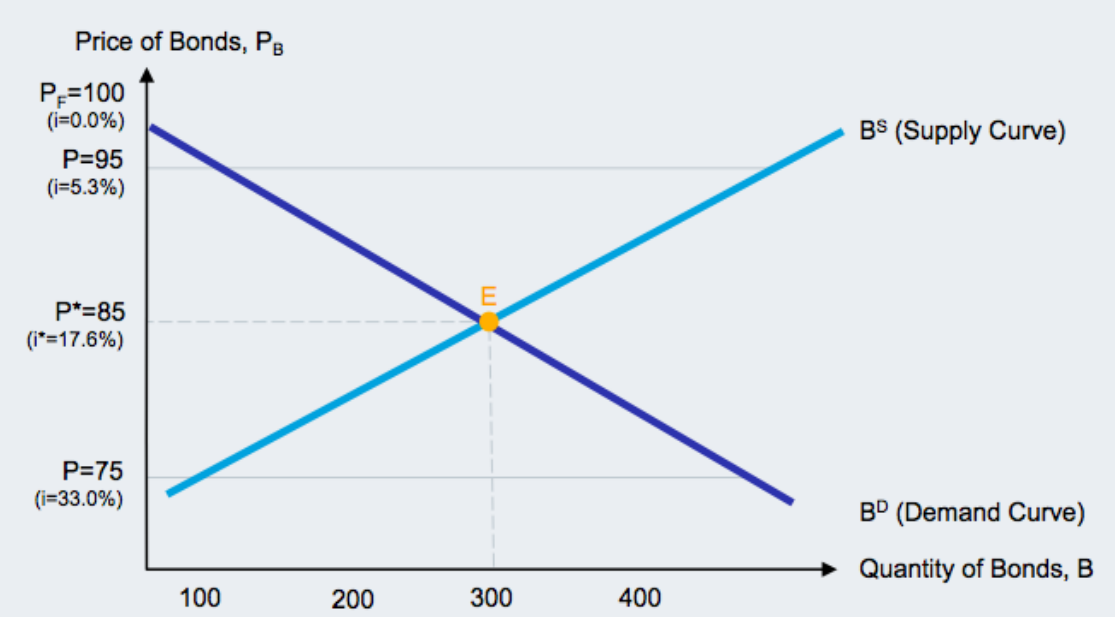
Authors' source.

supply of sovereign bonds and shifts the supply curve to the right. Indeed, the government has to issue treasury bonds to finance a higher government deficit. When the deficit is large, the government sells more bonds and the quantity supplied at each bond price increases. In contrast, a decreasing deficit shifts the supply curve in the other direction, as do sounder public finances. Similarly, an increase in expected inflation reduces the real return (real interest rate), and thus the cost of borrowing falls. The lower the cost of borrowing due to higher expected inflation, the more a government borrows and the higher the quantity supplied. Of course, this channel relies on monetary policy, too. Finally, the higher the expected output growth, the more eager a government will be to borrow in order to finance infrastructure investments. In other words, the government will issue more bonds, which will shift the supply curve to the right.

These determinants of supply and demand contribute to the standard bond market equilibrium illustrated in Figure 1. On the vertical axis we have the interest rate, which is equal to the inverse price of a bond. This is due to the fact that at maturity the bond has a face value of $P_F = 100$, and the price of the bond one year before maturity implicitly defines its one-year interest rate (for instance, a price of $P_B = 95$ implies an interest rate of 5.3%). This fact demonstrates that the lower the price before maturity, the higher the respective interest rate. Hence, there is a negative relationship between the price and the interest rate in bond markets.

Figure 1 depicts the concept of equilibrium price and quantity, indicating where the market is heading – obviously the market always converges towards the equilibrium, *E*. Figure 1 is a conventional supply and demand diagram in normal times. In times of market turmoil or crisis it might look different. We address this issue in the next section. First, we study the specific bond market environment in the EMU. Next, we elucidate the unique supply and demand constellation of sovereign bond markets during market turmoil. Finally, we discuss the implications of bond market turmoil and its new equilibrium.

Figure 1: Standard Equilibrium in the Bond Market



Authors' source.

3. Turmoil in European sovereign bond markets: What's going on?

This section is devoted to analysing the European sovereign bond market under stress. We focus on bond market dynamics in troubled countries such as Greece, Spain, Portugal, and Italy, and compare them with unaffected countries inside and outside the euro area such as Germany, Finland, Austria, the United Kingdom, the United States, and Japan.

European sovereign bond markets are unique due to country-specific characteristics and the supranational framework of the EMU. As a matter of fact, every euro area country still has its own bond market based on the sovereignty of national fiscal policy. Thus, bond pricing is primarily based on domestic fundamentals such as public deficit, debt, current account balance, and growth prospects. However, the institutional linkage to the supranational framework, especially monetary policy, eliminates several important market incentives. The European Central Bank (ECB) sets a common interest rate for all 17 euro area countries and thus triggers either positive or negative stimulus depending on the domestic stage of the business cycle. As opposed to the national central banks, the supranational ECB is the only institution able to guarantee the payout of euro debt obligations. This unique interplay between national fiscal policy and supranational monetary policy characterises the EMU and the sovereign bond markets in Europe. In times of market stress, the divide between domestic fiscal policy and European monetary policy is an important vulnerability.

A comparison to highly indebted G7 member states such as Japan, the UK, and the US reveals that euro area countries are less flexible and more exposed to sudden market reversals. On average, despite high debt-to-GDP and deficit-to-GDP levels, individual euro area countries cannot shape possible bond buying programs or implement public support for a country because of prohibition in European law. In fact, Article 123 of the Treaty on the Functioning of the European Union prohibits monetary financing, while Article 125 (the so-called "no-bailout clause") prohibits any support for or bailout of other countries. This challenge does not exist in Japan, the US, or the UK. In addition, the US benefits from the unique safe haven status of the US dollar.

Consequently, the EMU has fundamentally changed the institutional setup of national and European governance. All member states' debt is denominated in euros without the possibility of a respective central bank to create the means to repay the debt. Of course, the EMU member states suppose that the contagiousness of a sovereign default is eliminated by institutional rules, such as the no-bailout clause or the Stability and Growth Pact (SGP) (Herzog, 2012, 2013a). In theory, these rules force countries to adopt sound fiscal policies. However, in the 1990s economists realized that the no-bailout clause and the SGP are ineffective mechanisms that lack credibility, especially in times of crisis. It was always expected that the rules would be abandoned in situations of severe turmoil. According to Hellwig (2011), the implosion of the EMU's institutional setup was only a matter of time. The existing shortcomings of European governance have been discussed continuously (Fisher et al., 2006; Herzog, 2013b).

Since the tipping point in 2010, financial markets have reassessed the creditworthiness of euro area countries (Herzog, 2012). The relatively abrupt reversal of sovereign yields has produced a situation similar to a bank run, but in the sovereign bond market. Bond spreads have increased considerably and caused unprecedented turmoil in indebted euro area countries. These self-reinforcing effects are highly contagious, creating temporary liquidity problems and evolving into an enduring solvency crisis. To understand this particular tipping point, we establish a new theory of sovereign bond markets in turmoil.

3.1. Conceptual Model Framework

It is obvious that the fundamentals, such as the long-term sustainability of public finances, the current account balance, and economic growth rates, are insufficient ingredients to explain the euro crisis and bond market turmoil in general. In terms of the fundamentals alone, it is difficult to understand why the market reaction was negligible in countries with similar or even higher deficit and debt levels, such as the US, the UK, and Japan. Comparing the US, the UK, and Japan to the indebted countries in the euro area, we see that fundamentals alone do not explain the sudden reassessment of markets. Therefore, we have to take into account further vulnerabilities that trigger significant bond market reversals. We propose that the following three issues characterise these additional vulnerabilities and triggers:

I. High Levels of Asymmetric Information: Countries with weak fundamentals and whose governance and

accounting systems lack transparency and credibility generate high levels of asymmetric information that may trigger market concerns and subsequently market turmoil. The economic mechanism is as follows: an increase in asymmetric information increases the transaction cost and reduces the liquidity effect. Consequently, the bond price drops and the yields rise considerably.

II. Weak Political Reputation: Although the degree of asymmetric information, together with the fundamentals, is decisive in determining reputation, it does not sufficiently explain the sudden market reversals in some euro area countries. The second relevant trigger in bond markets is the degree of political reputation. A country that expresses sufficient willingness to undertake structural reforms, such as those designed to regain competitiveness or fiscal sustainability, has a stronger reputation. Hence, strong reputation helps to diminish market concerns about the respective sovereign bond. However, bad fundamentals, together with no political commitment, lead to weak reputation and self-reinforcing downward spirals. As long as policymakers show no willingness to undertake necessary changes, countries will lose their reputation. The loss of reputation is swift and triggers a tipping point in the bond market.

III. Animal Spirit: Last but not least, both mechanisms generate a vicious circle due to animal spirit. In other words, markets follow trends and new trends are vulnerable to herding behaviour and market exaggerations.

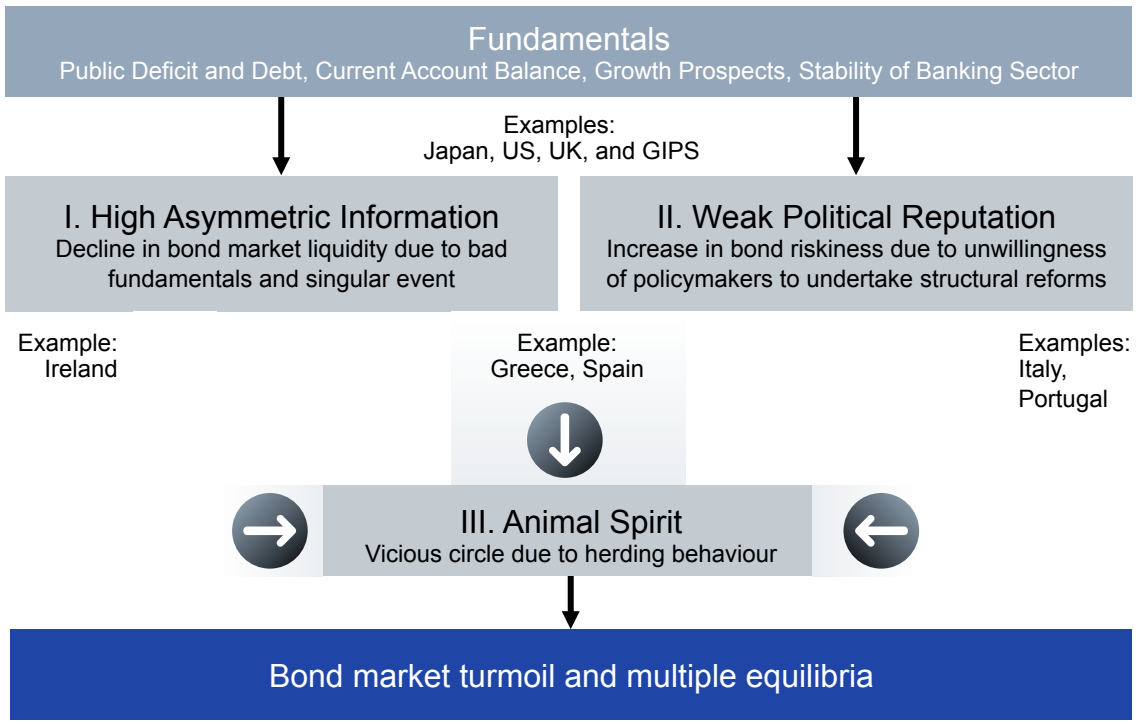
The interplay among these three factors explains the extreme yield dynamic during market turmoil in Europe. Of course, the assessment of fundamentals precedes the three triggers. We will demonstrate that this constellation even leads to multiple equilibria. Figure 2 is a graphical illustration of the conceptual model. This model helps to distinguish stable from unstable bond market conditions.

The following subsections provide an economic discussion about the different elements and their impact on the bond market equilibrium during market turmoil.

3.2. Economic Analysis of Fundamentals

The major fundamentals in sovereign bond markets are the: i) sustainability of public finances; ii) current account balance; iii) expected GDP growth rate; and iv) stability of financial

Figure 2: Model Framework



Own source.

markets, i.e., size and linkage of the government and banking sector. All four elements have typical measures, and they must be assessed for each country.

There is no doubt that apart from the current account balance, the sustainability of public finances is the key prerequisite for solid bond market conditions. There are many examples that show the importance of this element. Bad fundamentals in public finances triggered the recent crisis in Europe, as well as the crisis in Argentina two decades ago. The economic approach to assessing sound public finances utilises the government budget constraint (Herzog 2010):

$$\Delta b_t = \frac{i_t - g_t}{1+g_t} b_{t-1} - p_t + db_t \quad (1)$$

where Δb_t expresses the change in the public debt-to-GDP ratio and db_t is the deficit-debt adjustment-to-GDP ratio, which includes transactions that affect the outstanding stock of debt but not the primary balance. A stable or declining debt ratio (i.e. $\Delta b_t \leq 0$) requires a sufficiently large primary surplus, p_t, and small deficit-debt adjustment, db_t, if the nominal interest rate on outstanding debt is higher than the nominal GDP growth rate. According to Bohn (1995), this approach defines debt sustainability in general.

The government debt level is sustainable if the government is able to generate primary surpluses in the future, which are large enough to accommodate the cost of servicing current and future debt obligations. Thus, the most effective test of sustainability is a positive relationship of primary surpluses to the debt-to-GDP ratio, after controlling for government spending and the business cycle. Table 2 demonstrates the estimated results for Germany and the United States in 2012. We find that German public finances are sustainable with a

Table 2: Estimation of Debt Sustainability in Germany and the United States, 1980 – 2010 (US)

Variable	Germany	US
Constant	-3.7505*	0.0509***
	(1.9409)	(0.0151)
Debt-to-GDP	0.0610**	-0.0017***
	(0.0265)	(0.0002)
GVAR	-1.3354***	-0.01433**
	(0.0793)	(0.0049)
YVAR	-22.4822***	-0.0530
	(4.2545)	(0.2181)
Adj. R-squared	0.8921	0.9298
F-statistic	42.3587	71.6486

Dependent: primary deficit. Regression, Newy-West t-values controlled for autocorrelation and heteroskedasticity. Std. errors in parentheses and * / ** / *** indicate statistical significance at 10% / 5% / 1% level. Source: Own estimation.

Herzog (2012).

positive debt-to-GDP coefficient of 0.061 (significant at the 5% level). On the contrary, public finances in the United States are unsustainable with a negative debt-to-GDP coefficient of -0.001 (significant at the 1% level). However, US public finances benefit from their exceptional status in financial markets due to America's safe haven currency. In general, we argue that this approach is very helpful for informed investors in evaluating the sustainability of public debt (Herzog, 2012).

The positive response of primary surplus to the debt-to-GDP ratio can be understood intuitively. A necessary and sufficient condition for unsustainable debt is the following empirical relationship: High primary deficits (greater negative number) trigger higher debt accumulation (greater positive number), a negative relationship. The primary deficit becomes more negative while the debt level becomes more positive. Thus, a negative relationship indicates unsustainable public debt levels. On the contrary, sustainable finances require a positive relationship in which the higher the debt is, the lower is the primary deficit (or the higher is the primary surplus).

Apart from the assessment of public finances, it is important to consider other macroeconomic variables, such as the current account balance, the GDP, and the stability and shape of the banking sector. All these factors can be evaluated based on independent assessments by central banks, the IMF, or OECD. Altogether the analyses of the macroeconomic and financial fundamentals provide good information about the state of sovereign bonds. Unfortunately this assessment is not sufficient to identify countries exposed to sudden crises or market reversals. The US, UK, and Japan are three examples of exceptions. Despite bad fundamentals, none of these countries displays any bond market turmoil – at least so far. Thus, high debt-to-GDP levels, current account deficits, or systemically important financial institutions (SIFIs) are key vulnerabilities but they do not trigger a sovereign debt crisis. Consequently, bad fundamentals alone do not cause surprising market reversals. Why not?

The US, UK, and Japan do not face the same problematic situation that the EMU does, in which fiscal policy is a national responsibility and monetary policy is a supranational one. Of course, this difference does not explain why some euro area countries are more exposed than others. To answer that question, we have to consider the scale and scope of two key distinguishing and decisive elements: asymmetric information and reputation.

3.3. Economic Analysis of Asymmetric Information and Reputation

Both an increase in asymmetric information and a decrease in reputation have a substantial effect on the bond market environment. These two factors are able to trigger a sudden crisis that leads to a race to the bottom due to herding behaviour. Weak reputation and high levels of information asymmetry impair the liquidity and increase the riskiness of bonds, affecting assessments of the bonds' quality. In other words, during bond market turmoil we observe that a price decline lowers the demand for bonds. This is contrary to normal markets, where demand for bonds increases with lower prices. Consequently, in a crisis the bond demand curve becomes upward-sloping. The phenomenon of an upward-sloping demand curve is not uncommon. In 2001, Akerlof, Spence, and Stiglitz received the Nobel Prize in Economics for the discovery of markets with asymmetric information. They analysed the impact of asymmetric information on special demand curves as well as the equilibrium price. We apply this idea to bond markets in turmoil.

During the sovereign debt crisis, bond yields of countries such as Greece, Italy, Spain, and Portugal increased dramatically, despite other countries having similar or even worse fundamentals. We argue that asymmetric information and reputation problems are responsible for these sudden and intense reversals.

Suppose there are four types of sovereign bonds: Bonds from countries with sound or unsound fundamentals and committed or uncommitted policymakers. Despite the differences that may exist between policymakers, bond investors buy without knowing whether the country is sufficiently sustainable to repay all debt obligations in future. Hence, they do not know the real political commitment to structural reforms or budget consolidation. Thus, the overall quality of the bond is unknown and it depends on the beliefs of others (in some sense, the animal spirit). Of course, even after holding the bond, information asymmetry remains because political administrations may change, casting doubt on the future policy program. Furthermore, investors cannot know whether

policymakers are real reformers or not. Consequently, the bonds of countries with similarly sound fundamentals will sell at the same price, regardless of their proclaimed commitment to reform. However, countries with good reputations are unwilling to accept the same risk premium as offered to non-reform-oriented countries. Thus, the supply of good quality bonds declines. Even more importantly, investors are more attracted to the high yields because they do not know the type of policymakers, but they do know that both countries are financially sound today (or, at least, in line with EMU rules).

In sum, the bonds from unsound countries sell at the same price whether policymakers are reformers or not. But reform-oriented countries are not willing to issue bonds at prices that are too low or at interest rates that are too high. In the end, countries with a credible commitment to reform may exit the market. Either way, they may be willing to consolidate the budget autonomously and balance the budget with less external finances. However, policymakers without a commitment to reform remain in the market. Of course, they are in a strong position to finance public expenditures at relatively low rates. As a result, there are more bonds with bad quality than good quality in the market.

There is anecdotal evidence that the quality of financial assets (bonds) is determined by asymmetric information and political reputation in the eurozone. We design a new index that enables us to measure this new dimension. We argue that a country has high levels of asymmetric information and a weak reputation if the whole political system is more unstable. An unstable political system is characterized by a large number of political parties (coalitions), more frequent elections, and high corruption. These measures will be used to identify countries that are exposed to asymmetric information and reputation issues. In Table 3, we compute the new 'Political Risk Index' (PRI)[2] for sovereign bond markets. This PRI is able to address both factors sufficiently.

Table 3: Political Risk Index (PRI) for Selected Countries

Countries	Number of Nationwide Parties	Number of Elections in past 20 years	Human Development Index (2011)	Corruption Index (2012)	PRI (measurement of asymmetric information & reputation effects)*
Canada	7	7	0.908	84	1.7
Finland	8	6	0.882	90	1.1
France	23	5	0.884	71	2.8
Germany	6	6	0.905	79	2.1
Greece	10	9	0.861	36	6.0
Ireland	11	5	0.908	69	3.0
Italy	6	8	0.874	42	5.5
Portugal	19	7	0.809	63	3.6
Spain	16	6	0.878	65	3.4
Switzerland	17	6	0.903	86	1.5
UK	3	5	0.863	74	2.6
US	5	6	0.910	73	2.7

* On a scale from 1.0 (low risk) to 6.0 (high risk). Index of 4 and higher indicates extremely high risk. Such countries are regularly exposed to bond market crises.

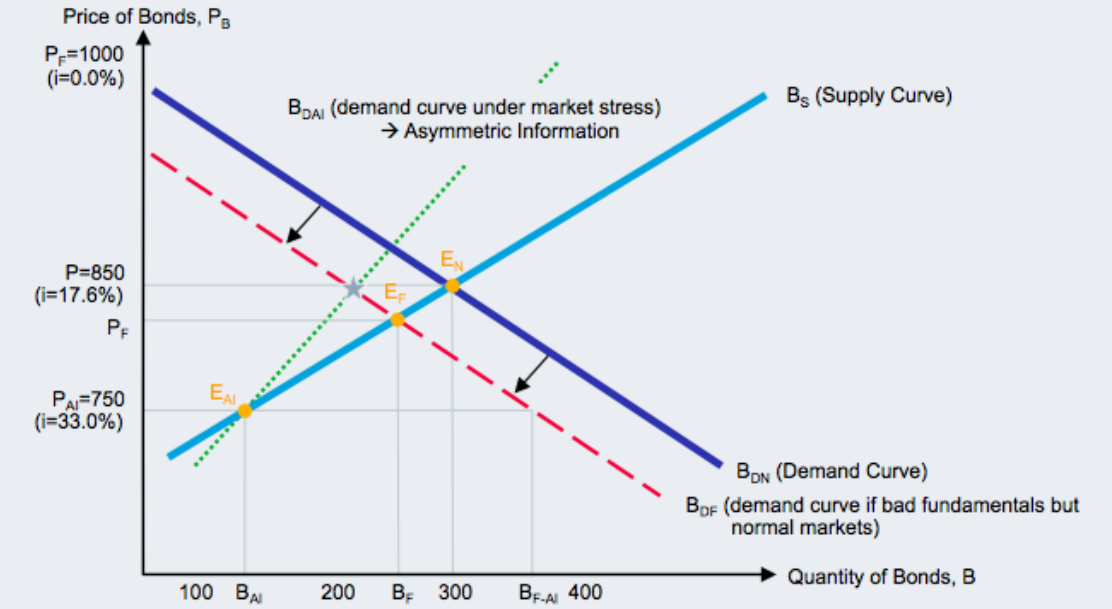
Own calculation.

So far we argue that unsound countries with uncommitted policymakers remain in the market, and even dominate the supply, in relation to other types of countries and policymakers. But in extreme events, it may happen that no market equilibrium for unsound countries exists at all. Suppose the bond demand under market stress depends on two variables: the price p and the average quality z, where $B_D = D(p,z(p))$. In addition, the quality is an increasing function of the price. To put it simply, the higher the price is, the higher is the quality of the asset. Furthermore, the supply S depends on the price p and quality z, as well, such that $B_S = S(p,z(p))$. As long as the price falls, the quality declines. Within this model it is possible to show that under special assumptions, no equilibrium exists (Appendix A). Even more surprisingly, we can show that the likelihood of more than one equilibrium increases when asymmetric information aligns with animal spirits.

In summary, under asymmetric information, where quality is positively related to price, the demand curve slopes upward, as illustrated by the dotted line in Figure 3. If the upward sloping demand curve has a steeper or smaller slope than the supply curve, an equilibrium of market turmoil, E_{AI}, exists at the intersection of the bond supply curve (solid curve) and bond demand curve (dotted curve). But there is a second equilibrium E_F, at the intersection of the downward-sloping demand curve with bad fundamentals and the upward-sloping supply curve. The difference between the equilibria is that the equilibrium E_F captures only markets with bad fundamentals but a credible policymaking environment, while the equilibrium E_{AI} reflects both bad fundamentals and an absence of decisive commitment to reform. Hence, there is a further exogenous event (shock) that questions the fundamentals according to our conceptual model (Figure 3).

The bond market with just bad fundamentals still behaves like a normal bond market. The respective demand curve (${}^{B}D_F$) shifts to the left as indicated by the determinants in Table 1. However, if an additional event or shock occurs that further calls into question the fundamentals because of a lack of reputation or commitment, the demand schedule changes to the

Figure 3: Bond Market In Turmoil



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upward-sloping (dotted) line. Thus, this simple model displays both effects, a bond market with and without market turmoil. The two triggers for the market reversal are asymmetric information and reputation. Both factors change the slope of the demand curve, and probably affect the determinants that shift the new upward-sloping demand curve ($^{B}D_{AI}$). Table 4 summarises the determinants of the bond demand curve during market turmoil. As a consequence, Table 4 helps to make sense of the behaviour of bond markets in turmoil.

In general, there are two solutions for a market with asymmetric information and reputation problems: signalling and/or screening. Both approaches counteract the effects of quality and uncertainty. One obvious institution is a guarantee (good signal). That means governments guarantee that they always repay their debt. This is implicitly the case in Europe today – via the European Financial Stability Facility (EFSF), the European Stability Mechanism (ESM), and outright monetary transactions (OMTs) by the central bank. A second approach is better screening, relying on increased transparency of public finances, policy reforms, and sustainability. In this case, policymakers credibly commit to undertake the needed reforms or budget consolidation. In principle, there are two possibilities for how to achieve credible commitments: (1) an automatic budget rule (for instance, a debt brake) or (2) an independent committee that is responsible for the consolidation process (for instance, the Swedish Fiscal Policy Council). Thus, the prerequisite for a signalling or screening solution is the absolute credibility of either the signal or the action. This can only be achieved via effective rules with automatic enforcement or an independent authority. The last mechanism was tried in Italy via the 'technocratic' government led by Mario Monti.

Since the onset of the euro crisis, there have been several institutional changes on the European level to improve the signalling and screening solution in future. There was a reform of the Stability and Growth Pact in 2011 and an agreement on the fiscal compact in 2012. Both will enhance the signalling and screening mechanisms and finally reduce asymmetric information and increase fiscal reputation. Of course, all this mitigates – but does not solve – the asymmetric information and reputation problems in Europe. We do need far deeper institutional and governance reforms in Europe. These reforms have to tackle the macroeconomic root cause behind the crisis: the

Table 4: Factors of Bond Demand in Normal Markets and Under Stress

Determinants that Shift the Demand Curve			
Market Stress (Upward Sloping Curve)		Normal Markets (Downward Sloping Curve)	
An Increase in	Shifts Demand Curve to the	An Increase in	Shifts Demand Curve to the
Deficit and Debt level (weaker fundamentals)	left and up	Deficit and Debt level (weaker fundamentals)	left and down
Expected inflation rate	left and up	Expected inflation rate	left and down
Riskiness of bond	left and up	Riskiness of bond	left and down

Own source.

poor competitiveness of some countries.

3.4. Construction of the Demand Curve in Market Turmoil

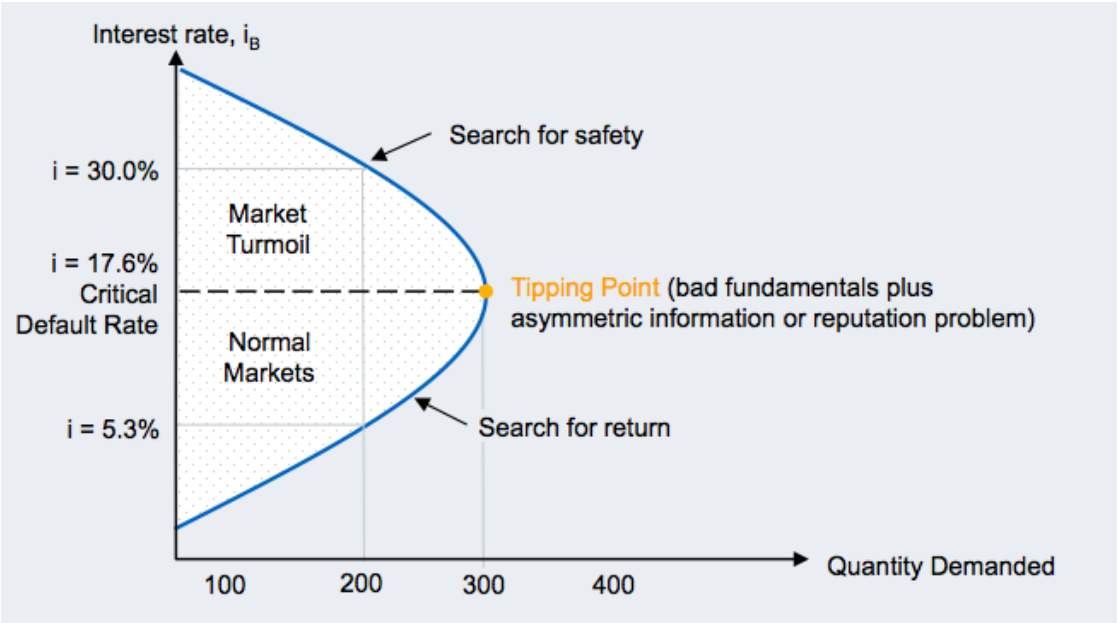
The following subsection provides additional information behind the two different demand curves. Readers just interested in the bottom line of the white paper can omit this subsection.

Here, we describe and derive the upward-sloping demand curve under market stress and provide an intuitive insight into our model. This section is written for financial practitioners who are interested in a more rigorous understanding of the model. We provide the hidden issues behind the uncommon demand schedule but avoid technical details.

We assume that the level of the sovereign yields is characterised by economic and financial fundamentals in the respective country. Higher bond yields indicate higher risk, i.e., lower growth prospects, higher deficits, or higher debts. Altogether, a higher yield describes a less sound situation. However, higher risk, and correspondingly higher return, is only positively linked as long as the country is solvent and able to repay its debt obligations in future. As soon as the high risk increases, the default probability increases, too. Thus, there is a certain point at which the default probability is so high that the higher interest rate is unable to compensate for the prospective default. At that point, bond demand declines despite high yields, i.e., a high rate of return. Figure 4 illustrates this graphically.

The region below the tipping point in Figure 4 depicts the normal market situation. Above the tipping point we have the bond market in turmoil. This market environment reflects a "liquidity aversion" in which bond supply is greater than demand and bond yields are extremely high. In normal

Figure 4: Bond Demand Relation in Different Market Environments



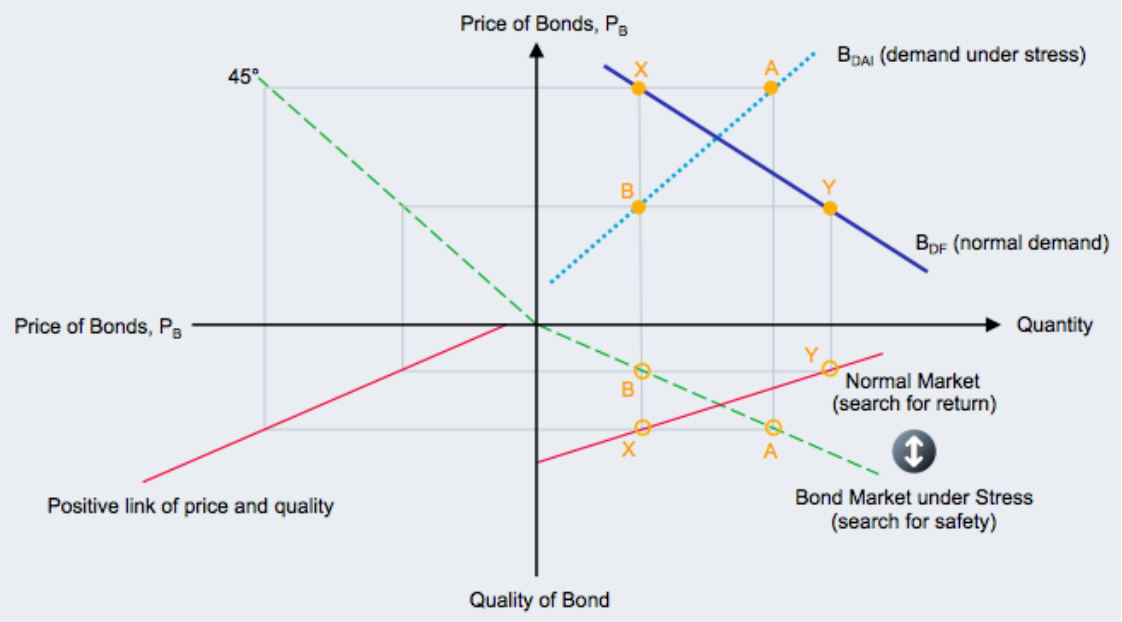
Authors' source.

markets, the investor is in search of yields and purchases bonds that are almost safe assets (low default probability) but offer a relatively high rate of return. Points close but below the tipping point describe such a state. As an unforeseen event occurs or the policymakers lose credibility and reputation, these countries jump to the top segment of the demand schedule (tipping point in Figure 4). This implies that despite higher yields, the demand of assets is equal or lower. Thus, we have a demand shortage or, in terms of the sovereign bond market, a "liquidity aversion." In this market environment investors merely search for safety. This effect is similar to the idea of asymmetric information in financial markets (cf. Stiglitz and Dasgupta 1971; Stiglitz and Weiss 1981).

If we agree on this relationship, it is quite simple to derive the demand curve in normal markets as well as in markets under turmoil. The demand curve in the normal market is characterised by the upward-sloping segment and the demand curve under stress is characterised by the downward-sloping part in Figure 4. Although this is an intuitive argument, it does not take the pricing signal into account. Therefore, we will assume that in all market environments a higher price always indicates higher quality – and vice versa. It remains to be shown that the demand curve is downward-sloping in a normal market and upward-sloping in bond markets under stress. We illustrate this feature in Figure 5. Here, we construct the respective demand curves within the 4-quadrant system.

The first quadrant on the top-right side illustrates the two constructed demand curves. The downward-sloping curve depicts bond demand in normal markets. The upward-sloping curve demonstrates the bond demand under market turmoil. In the second quadrant on the top-left we have a 45°-line that is needed for construction purposes only. The third quadrant on the bottom-left illustrates the assumed positive relation between the price and quality. The most important feature is depicted in the fourth quadrant on the bottom-right side. Here we have the essential ingredients for the construction process of the two different demand curves. The dotted curve depicts the situation of the bond market under stress. This situation is characterised by the search for safety (Figures 4). Thus, during market turmoil the demand for bonds increases with higher quality. Indeed, this pattern – the flight to safety in assets such as German Bunds – has appeared in the European

Figure 5: Construction of Demand Curves



Authors' source.

sovereign debt crisis. Given this relationship, one can see how the upward-sloping dotted demand curve (through points A and B) results by construction. The solid curve, however, depicts the situation of normal markets. In normal markets, investors have confidence and they are in search of returns. Hence, there is high demand for assets with a high rate of return and lower quality. This linkage results in the common downward-sloping demand curve (through points X and Y). It is noteworthy that both lines in the bottom-right quadrant follow immediately from the intuitive idea in Figure 4. The upward-sloping line reflects the normal market and the downward-sloping line the market turmoil. The graphical construction of the demand curve is convincing and intuitive.

3.5. The Role of Animal Spirit

The final force in our conceptual model is animal spirit – in other words, the herding behaviour of investors. Suppose we have a bond market with bad fundamentals and, in addition, an asymmetric information and/or reputation problem. Consequently, the bond market switches from normal into crisis mode. Commonly, a country in market turmoil displays high volatility in bond prices and interest rates due to a different assessment of the quality of the assets. In such a situation some investors lose confidence in the underlying assets, which reduces prices; others are more reluctant to reassess the fundamentals. Thus, the pricing effects are asymmetric and amplified either positively or negatively, due to herding behaviour. According to the literature on behavioural macroeconomics by De Grauwe (2012), we call this "animal spirit."
Next we build a model and demonstrate its impact with a simple numerical simulation. Suppose there are two types of traders, optimists and pessimists. Optimists systematically overestimate and pessimists underestimate the bond price and quality respectively. Thus, the market price, b_t that reflects the bond quality as well is different in both groups. The optimists believe that $b_{opt} = b^* + x$, and the pessimists believe $b_{pes} = b^* - x$, where $x > 0$ and b^* is the true, but unobserved, fundamental value. The bond demand functions are

$$D_{opt,t} = a(b_{opt} - b_t) \qquad D_{opt,t} = a(b_{pes} - b_t)$$

(1a, 1b)

where $a>0$. Assume that a market-maker collects the individual orders of the two types of traders $w_{i,t}$, where i is the type of trader (either 1 = optimist or 2 = pessimist) and t is the time. The market value of the bond price is computed by the following forward equation

$$b_{t+1} = b_t + \gamma \sum_i w_{i,t} D_{i,t} \quad (2)$$

where $\gamma>0$ measures the speed with which the market-maker adjusts the bond value. Moreover, by defining $z_t = w_{(opt,t)} - w_{(pes,t)}$, with $\sum_i w_{(i,t)} = 1$ we are able to rewrite the weights with simple algebra, such that $w_{(opt,t)} = (1+z_t)/2$ and $w_{(pes,t)} = (1-z_t)/2$. After substituting these definitions and the equations (1a, 1b) into equation (2), we obtain the equation

$$b_{t+1} = b_t + a\gamma[b^* - b_t + xz_t]. \quad (3)$$

This equation has an intuitive interpretation. The change of the bond price between two time periods is determined by two factors: (1) the gap between the fundamental value and today's value, $(b^* - b_t)$, and (2) the fraction of pessimists and optimists, z_t. The bond price tomorrow, $b_{(t+1)}$, increases (decreases) if its fundamental value b^* is above (below) the bond price b_t today. Moreover, it increases if $z_t>0$, i.e. the number of optimists is greater than the number of pessimists, and vice versa for $z_t<0$. In addition, the impact on the future bond price is dependent on the size and difference in price expectations x. Under the assumption of rational expectations (RE), pricing equation (3) simplifies to the typical benchmark equation of bond markets: $b_t = b^*$; in which the bond price in period t equals the fundamental value.

Lastly, we use the same assumption to describe the dynamics of traders. Traders do not choose their trading strategy randomly, but rather on the basis of rational and evolutionary criteria. Traders utilise a certain rule and if it turns out to be beneficial – by maximising profits best – they stick to it. If not, they adopt a new rule and depart from the old one. Thus we have to formulate the profit function of the optimist $\pi_{(opt,t)}$ and pessimist $\pi_{(pes,t)}$. The profit or loss function is defined as the price change $(b_t - b_{(t-1)})$ times the quantity $D_{(i,t)}$ for each type of trader, i.e. $\pi_{(i,t)} = D_{(i,t)} * (b_t - b_{(t-1)})$. Following the literature by Brock and Hommes (1997), the fraction of optimists and pessimists is distributed according to

$$w_{i,t} = \frac{exp(\beta \pi_{i,t})}{Z_t}$$

where $Z_t = exp(\beta \pi_{(opt,t)}) + exp(\beta \pi_{pes,t})$ and $\beta > 0$ is a parameter measuring the intensity of choice. For $\beta = 0$, traders are randomly optimists or pessimists, which means a pure stochastic distribution of traders. For $\beta \to \infty$ all traders are either optimistic ($z_t \to 1$) or pessimistic ($z_t \to 0$).

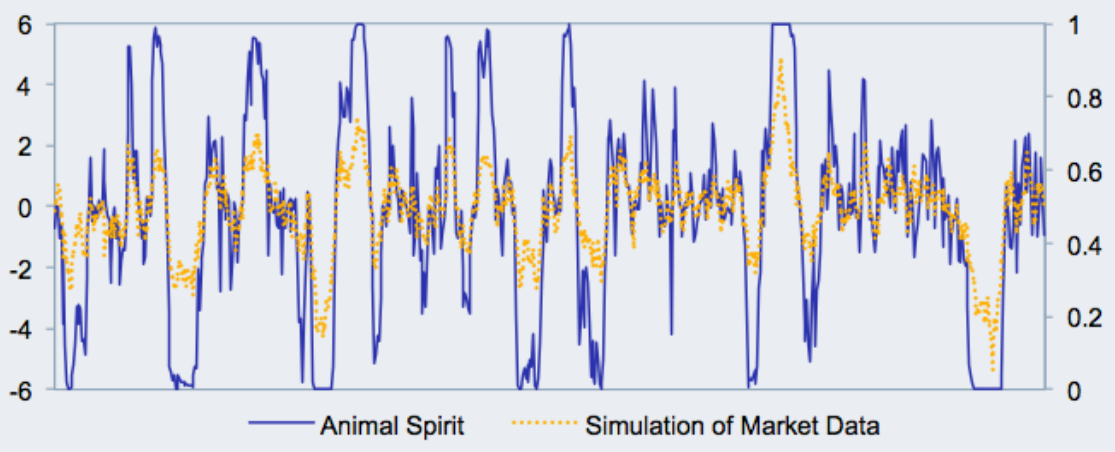
The simulation of this behavioural model illustrates two important insights:

1) During booms or busts there is animal spirit, which means there are either more optimists or pessimists. This imbalance will cause the markets to overreact either positively or negatively (Figure 6).

2) If there is sufficient disagreement about the fundamental value (if there is a large x), we get multiple equilibria (Figure 7).

Both phenomena are common in bond markets under turmoil. The following numerical simulation illustrates these points in detail. Figure 6 demonstrates the effect of animal spirit on bond markets. The dotted curve is the simulation of the rate of change in market data – that is, either price growth or price decline. However, in all periods of abnormal changes, either positive or negative, the market automatically experiences animal spirit (solid curve). The black solid curve jumps between zero and one and indicates a typical regime switch.

Figure 6: Market Data (dotted line) vs. Animal Spirit (solid line)



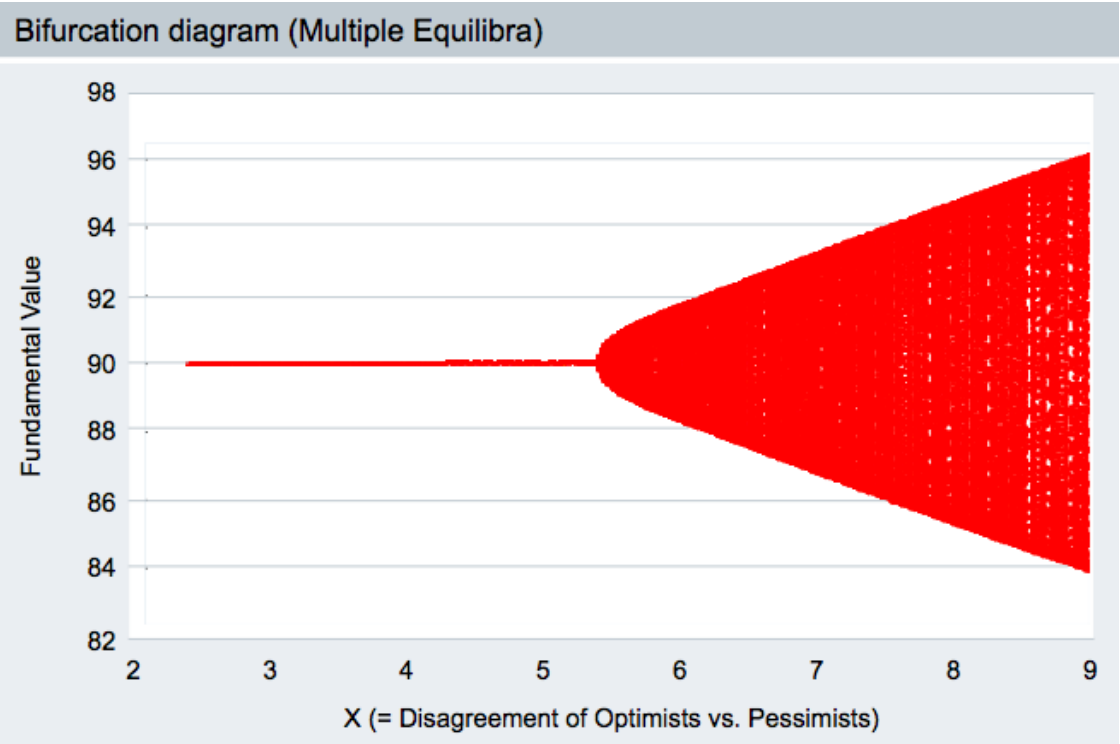
Own simulation.

During market exaggeration the solid curve jumps up or down. This jump phenomenon illustrates the amplification effect and is typical of herding behaviour. Thus, our simulation captures the last element of bond market turmoil in our conceptual model. The bond market anomalies in Greece and Italy displayed exactly this feature during the European sovereign debt crisis.

The next Figure 7 is a simulation of the relationship between the bond price b_t and the parameter x. A greater x, meaning a wider disagreement between optimists and pessimists about the fair bond value, results in multiple equilibria. Figure 7 indicates an equilibrium space for numbers bigger than 5.5.

The lesson here is that animal spirit leads to large fluctuations and multiple equilibria even if the fundamental value has not been changed by any exogenous shock. However, notice that the trigger of animal spirit is either asymmetric information or weak reputation. Therefore, investors have to study these two issues in advance and in detail. In addition, they have to understand and know that in crises, markets suddenly experience animal spirit. In summary, our model explains the entire and sophisticated pricing dynamics of bond markets. Fortunately, this model provides informed investors a certain equilibrium price range.

Figure 7: Bifurcation Diagram



Own simulation.

4. Conclusion

In this white paper we develop a new bond market theory for euro area sovereign debt markets under stress. We find that bond markets are different in the euro area because of the institutional issues of the EMU. First, member countries have fiscal authority without monetary authority. Thus, eurozone member states cannot guarantee payment of bondholders in all cases. Second, a monetary union reduces the incentive to maintain sustainable finances despite the existence of the no-bailout clause and the Stability and Growth Pact. Consequently, there is a disconnect between bond market fundamentals and the respective bond yield, which measures the default probability. We identify the trigger mechanism from normal pricing to turmoil by two factors: asymmetric information and/or political reputation. Both issues trigger negative sentiments and change market expectations suddenly. Finally, these negative pricing effects are amplified by animal spirits, which lead to self-reinforcing bubbles and/or herding behaviour.

The model offers a reasonable explanation of the recent events during the sovereign debt crisis in the euro area. We present the linkages with a graphical approach and analyse the pricing effects. We identified the key determinants that trigger the switch of bond markets to both crises mode and animal spirits. First, we find that three key variables, such as economic fundamentals, asymmetric information, and political reputation determine the move of bond markets into market turmoil. In addition, we show that the occurrence of animal spirits and multiple equilibria rest on the relative number of optimists and pessimists as well as the disagreement in the fundamental value. Altogether the erosion of these factors triggers a sudden switch of the bond demand with severe negative effects on bond yields. Thus, the model provides useful insight for all bond investors in times of bond market panics in the eurozone.

The policy lesson is simple: Countries that display bad or multiple equilibria have not only bad fundamentals, but they have an asymmetric information and/or overall reputation problem aligned with animal spirit. Only in this case does the market face turmoil and multiple equilibria. To tackle the root causes, governments have to restore confidence by implementing structural reforms, austerity measures, transparency, and strong commitments to sustainable policy in the future. At the same time, central banks have to provide liquidity provisions to mitigate a liquidity crisis and smooth the transition process towards the new equilibrium. However, countries that display a solvency problem should not get further support according to the Maastricht rules and economic wisdom – even in a monetary union. Otherwise, we generate more moral hazard and even weaker disciplinary incentives that will further erode the EMU's institutional framework. Consequently, it would be reasonable to develop an efficient resolution scheme or exit strategy for eurozone countries that display sustained economic or financial problems. The EMU without such a mechanism is exposed to the same risk that systemic financial institutions still pose to the financial system: "too big to fail." The necessary institutional changes must be made before it is too late. In the absence of a resolution scheme, the next eurozone crisis is just a matter of time.

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Appendix A

Suppose there are two groups of traders: group one and group two. The utility is assumed to be a linear function where M is the consumption of goods other than bonds B_i. The quality z_i denotes the quality of bonds i, and n is the number of bonds. The utility function yields

$$U_1(M, z_i) = M + \sum_{i=1}^{n} v_i$$

and

$$U_2(M, z_i) = M + \sum_{i=1}^{n} \frac{3}{2} v_i$$

Assume that both groups of traders maximise von Neumann-Morgenstern expected utility functions. Moreover, group one holds n bonds with uniformly distributed quality v_i, $0 \leq v_i \leq 2$, and group two holds none. Without loss of generality we assume that the price for other goods M is one. The income of all type one traders is Y_1 and all type two traders Y_2. This implies the following demand and supply functions:

$$B_{D_1} = \begin{cases} \frac{Y_1}{p} & if \quad z > p \\ 0 & if \quad otherwise \end{cases}$$

and the supply S, for $p \leq 2$: $S_1 = z * n = (p/2)*n$. Supply of groups is per definition zero $S_2 = 0$. The demand is:

$$B_{D_2} cs = \begin{cases} \frac{Y_2}{p} & if \quad \frac{3}{2} z > p \\ 0 & if \quad otherwise \end{cases}$$

Consequently, total demand D(p,z) is:

$$B_T = B_{D_1} + B_{D_2} = \begin{cases} \frac{Y_1 + Y_2}{p} & if \quad z > p \\ \frac{Y_2}{p} & if \quad \frac{3}{2} z > p > z \\ 0 & if \quad p > \frac{3}{2} z \end{cases}$$

However, in case of average quality, defined as z = p/2, there is no demand in any market condition. Thus, the market mechanism – normal equilibrium, E_N – breaks down under asymmetric information.

Endnotes

[1] Other assumptions are risk-neutral agents or risk lovers.

[2] The PRI is newly developed by Professor Herzog, the Director of the 'Institute of Finance and Economics' (IFE) at ESB Business School, Germany. Investors can ask the IFE Reutlingen for a PRI update and country specific evaluations of default risk.

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