The fragility of two monetary regimes: The European Monetary System and the Eurozone

by Paul De Grauwe and Yuemei Ji

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Abstract

We analyze the similarities and the differences in the fragility of the European Monetary System (EMS) and the Eurozone. We test the hypothesis that in the EMS the fragility arose from the absence of a credible lender of last resort in the foreign exchange markets while in the Eurozone it was the absence of a lender of last resort in the long-term government bond markets that caused the fragility. We conclude that in the EMS the national central banks were weak and fragile, and the national governments were insulated from this weakness by the fact that they kept their own national currencies. In the Eurozone the roles were reversed. The national central banks that became part of the Eurosystem were strengthened.

JEL classification: E42, E52, E58, F33

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TABLE OF CONTENTS

1. Introduction

The European Monetary System (EMS) and the Eurozone are monetary regimes that exhibit some similarities. The most important one derives from their fragility. The EMS that existed between 1979 and 1999 was a pegged exchange rate arrangement in which central banks promised to convert their liabilities into a foreign currency, the German mark, at a fixed price. The problem of this promise was that the central banks did not have these marks. As a result, when investors had doubts that the central bank may be unable to make this conversion because of a lack of marks, there would be a run on the central bank that in a self-fulfilling way would generate the crisis (i.e. an inability to make the conversion).

In the Eurozone national governments made a similar promise, i.e. to convert their liabilities (government bonds) into a "foreign" currency (the euro) i.e. a currency over which they had no control. This generated a similar fragility as in the EMS: when investors feared that the government would lack the euros to pay out at maturity there would be a run on the government, i.e. a sale of bonds that in a self-fulfilling way would generate the liquidity crisis that was so much feared (De Grauwe(2011)).

In the EMS this problem was initially solved by a commitment of the Bundesbank with some central banks to lend them unlimited amounts of marks when their currency came under market pressure. This commitment arose from the fact that when a currency, say the lira, reached its lower limit against the mark, the Banca d'Italia was obliged to intervene, i.e. to buy liras in exchange for German marks. Since the Banca d'italia typically did not have German marks, it had to borrow these from the Bundesbank. The agreement implied that the Bundesbank was obliged to lend these marks to the Banca d'Italia[1]. Thus it can be said that the Bundesbank was the "backstop" of the system, or put differently, the lender of last resort that would provide the liquidity in times of market pressure so as to avoid self-fulfilling liquidity crises. It turned out that this commitment had a weak credibility.

There was the so-called Emminger letter to Helmut Schmidt, the German Chancelor, in which Emminger, the then president of the Bundesbank, stressed that the intervention

1 See the Resolution of the European Council of 5 December 1978 on the establishment of the European Monetary System (EMS). See also De Grauwe (2012), p.106 and Gros and Thygesen, (1998).

commitment of the Bundesbank would be limited. This letter was leaked to the public in 1978 and thus was publicly known information (see James(2012)). In 1992, fearing the inflationary consequences of its interventions, the Bundesbank withdrew its commitment to lend German marks to Italy, thereby precipitating the demise of the system[2].

The designers of the Eurozone were very hostile to the idea that the ECB should be the lender of last resort in the government bond markets. As a result, the fragility of the governments' promises to convert their liabilities into euros was left unresolved until the liquidity crises erupted in 2010 and 2011.

In this paper we compare the fragility of these two monetary regimes. We will do this mainly by analyzing the behavior of the interest rate spreads (both in the money market and government bond markets). We will use existing theories to explain these spreads. It will be shown that in both monetary regimes during crises periods the movements of some spreads tend to be dominated by self-fulfilling market sentiments that lead to deviations of the spreads from their underlying fundamentals.

An additional objective of this paper is to test the hypothesis that these self-fulfilling crises, as exemplified by deviating spreads, are focused in that part of the financial system where there is an absence of a credible lender of last resort. In the EMS this absence of a credible lender of last resort was in the foreign exchange market, while in the Eurozone it was in the government bond markets.

2. The theory

The spread between the interest rates on two government bonds reflects the relative risk of holding these two bonds in the portfolios of investors. Assuming that one of the two bonds is a benchmark bond with zero risk (e.g. the German government bond) then the

[2] It should be noted that interventions by NCBs in stressed foreign exchange markets were often financed in the EMS not only through exchange reserves but also by requesting the Treasury or the domestic public companies to borrow in foreign currencies, mostly German marks. This, however, amounted to delaying using the ultimate backstop provided by the Bundesbank.

spread between the interest rate of country i and the interest rate on the benchmark bond reflects the risk of holding the bond issued by country i.

This risk can be decomposed in different sources. The first source of risk is a devaluation risk. This risk occurs when governments issue debt in their own currencies, as in that case they can decide to devalue the national currency. A second source of risk is a default risk. This risk occurs independently of whether countries issue debt in their own currency or in a different one. It is the risk that the government will fail in servicing the debt. Thus one can write:

$$S_{it} = R(devaluation)_{it} + R(default)_{it} \qquad (1)$$

where S_{it} is the interest rate spread of country i in period t, R(.) is the risk of devaluation and default respectively.

When countries issue debt in a currency, which is not their own (the member countries in the Eurozone) there is only a default risk. When countries issue debt in their own currencies (e.g. the EMS-countries) both devaluation and default risks exist.

In principle one should be able to relate devaluation and default risks to observable variables. For example the devaluation risk is related to variables such as inflation differentials. The theory of purchasing power parity tells us that systematic inflation differentials between two countries that peg their currencies to each other will lead to a devaluation of the currency experiencing the higher rate of inflation. Thus, observable inflation differentials will lead to an increase in the spread reflecting a risk of future devaluation. (In the next section, we discuss other relevant fundamental variables such as the growth rate, the debt to GDP ratio, etc.).

The trouble with this view is that it is incomplete. Devaluations and defaults can also be triggered by self-fulfilling expectations (Obstfeld(1986) and De Grauwe and Ji(2012))[3]. These self-fulfilling expectations can force a country to devalue the currency or to default

[3] There exist many formal theoretical models that create self-fulfilling liquidity crises. Many of these have been developed for explaining crises in the foreign exchange markets (see Obstfeld(1986)). Other models have been applied to the government debt (Calvo(1988), Gros(2011), Corsetti and Dedola(2011)).

even if at the time of the crisis no deteriorating movement in the fundamental variables is observed. Thus, one should expect that when we relate the spreads to observed fundamentals, there can be periods during which the spreads are deviating systematically from these fundamentals (see De Grauwe and Ji(2012)).

We show an example of such a mechanism in a simplified version of the Obstfeld model. Figure 1 shows the costs (C) and benefits (B) of devaluation in a given country. On the horizontal axis we represent a current account shock (deficit). On the vertical axis the cost and benefit of devaluing the currency. We draw two benefit curves. Take the B_U first. This is the benefit of a devaluation that is unexpected. This benefit increases with the size of the current account deficit. The benefit arises from the fact that restoring current account equilibrium after the shock is costly. The government will have to reduce spending and raise taxes, which is politically costly. Devaluation can help in restoring equilibrium with lesser costs and creates benefits that increase with the size of the current account deficit.

The B_E line is the benefit of devaluation when the market expects such a devaluation. The B_E line is located above the B_U line because when the market expects a devaluation it forces the central bank to defend the fixed rate by raising the domestic interest rate. This defence is costly and raises the benefits from a devaluation. Finally the cost curve is assumed to be a fixed, i.e. a devaluation leads to a loss of reputation that is assumed to be a fixed cost.

It can now be seen that different types of equilibria can arise. First, when the shock is small, i.e. $\varepsilon < \varepsilon_1$, the costs always exceed the benefits of a devaluation. As a result, the government has no incentive to devalue, and thus there will be no devaluation. Rational agents know this and thus the no-devaluation solution is model consistent.

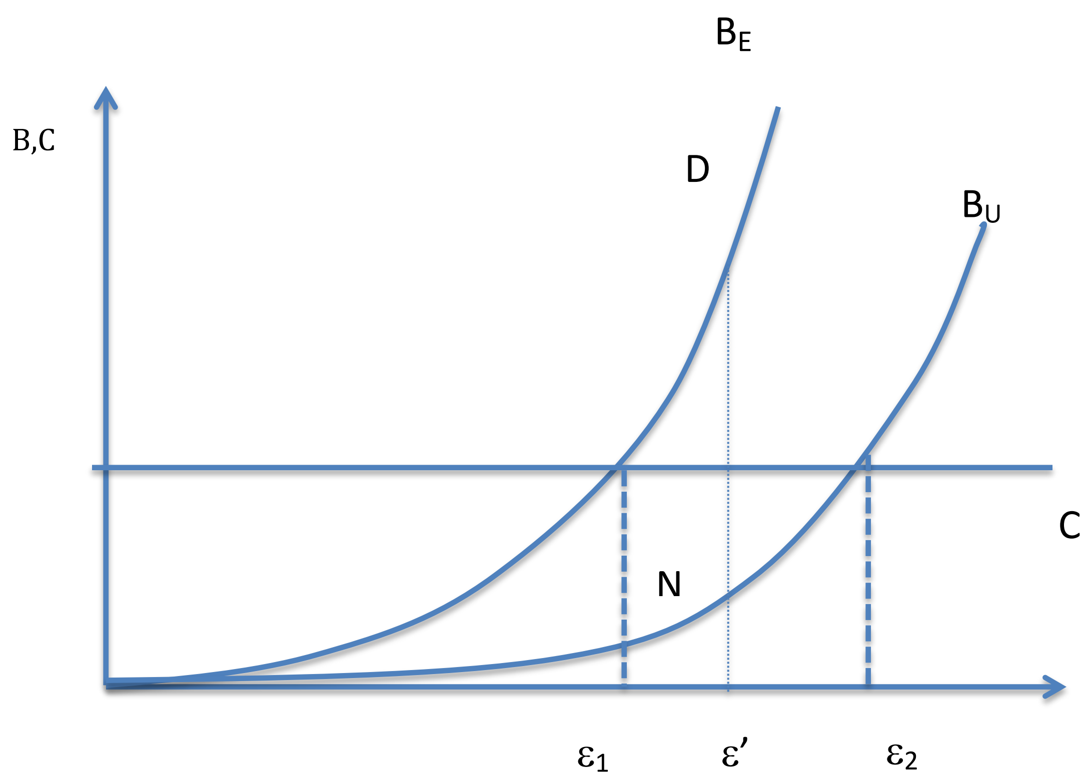
Second, when the shock is large, i.e. $\varepsilon > \varepsilon_2$, the benefits of devaluing always exceed the cost. The government will devalue and rational agents know this. A devaluation is the only possible (model consistent) equilibrium.

Third, when the shocks is intermediate, i.e. $\varepsilon_1 < \varepsilon < \varepsilon_2$, we obtain two possible equilibria. Take the shock ε'. We obtain a good (no-devaluation) and a bad (devaluation) equilibrium. In N we have a no-devaluation equilibrium. In N the market does not expect a devaluation.

As a result the cost of a devaluation is lower than the benefit. The government will not devalue. In D we have a devaluation equilibrium because in D the market expects a devaluation. As a result the cost of devaluation will now be lower than the benefit and the government will devalue.

Thus, in the range of intermediate shocks two equilibria are possible that only depend on the state of expectations in the market. If investors expect a devaluation the devaluation will occur in a self-fulfilling way. We move to D. If investors do not expect a devaluation, it will not occur. We move to N. This dependence of the devaluation outcome on expectations is the result of the fact that these expectations affect the cost benefit calculus of the government.

Figure 1 : Self-fulfilling equilibria in fixed exchange rate system and in monetary union



The decision to default by a government in a monetary union can be modeled in a similar way as the decision to devalue in a fixed exchange rate system. We developed such a model in De Grauwe and Ji(2012). We can in fact use the same Figure 1 and just reinterpret the variables on the axes. On the horizontal axis we now define ε as a solvency shock, i.e. an increase in the government budget deficit (produced e.g. by a recession). On the vertical axis C and B represent the costs and the benefits of a default by the government. The benefit of a default arises from the fact that by defaulting the government can avoid costly austerity measures (e.g. increased taxation). The benefit increases with the size of the solvency shock. As in the fixed exchange rate system there are two benefit lines, an expected and an unexpected one. The expected benefit line is above the unexpected one because when a default is expected the interest rate on the government debt is raised, thereby increasing the debt burden of the government and increasing its incentive to default.

We obtain the same structure of equilibria as in the fixed exchange rate system. For intermediate shocks, there are two equilibria, a good one in which the government has no incentive to default, and thus will not do so (point N), and a bad one in which the government has an incentive to default, and thus will default. The outcome only depends on the state of expectations as in the fixed exchange rate system. This feature will also allow us to design empirical tests as in the fixed exchange rate system.

It is important to realize that the existence of two equilibria ultimately depends on the existence of liquidity backstops[4].. Take the case of the fixed exchange rate system. Suppose the central bank had an unlimited stock of international reserves. In that case, when a speculative attack occurs (speculators expect a devaluation), the central bank would always be able to counter the speculators by selling an unlimited amount of foreign exchange. The central bank would always beat the speculators. The latter would know this and would not start a speculative attack. In other words they would not expect devaluation. In terms of Figure 1, the B_E curve would coincide with the B_U- curve. There would be no scope for multiple equilibria (see Obstfeld(1986) where this is proven formally)).

As in the case of the fixed exchange rate regime, the existence of two equilibria in a monetary union is the result of the liquidity constraint faced by the national governments. In order to see this, suppose that these governments would not face a liquidity constraint,

[4] This is what makes the model similar to models of bank runs. See the classic Diamond and Dybvig(1983) model.

i.e. they could like “stand-alone” countries be sure that the central bank (in this case the European Central Bank) would always provide the liquidity to pay out the bondholders at maturity. In that case, the government could always guarantee that the cash would be available. Bondholders would not be able to force a default, if the government did not want to default. The B_E-curve would coincide with the B_U-curve. There would be no scope for multiple equilibria. Put differently, a speculative selling of government bonds out of fear that the government may have insufficient cash would not be possible, if the government could guarantee that the cash would always be available[5].

The theory presented in the previous section leads to some testable propositions. We have seen that in a fixed exchange rate system and in a monetary union, movements of distrust vis-à-vis one country lead to an increase in the spreads (money market or government bonds) of that country. When such movements of distrust occur these spreads are likely to increase significantly without much movement of the underlying fundamentals. More precisely when market sentiments turn against a country the spreads are likely to exhibit the following features:

- Large movements in the spreads occur over short periods.
- Changes in the fundamental variables cannot account for the total change in the spreads[6]. Movements in the spreads appear to be dissociated from the fundamentals.

Our aim is not to test the particular prototype model shown here. It is too simple for that. For example, the model does not describe the dynamics of the movements from one equilibrium to the other. It just shows that these different equilibria exist and that therefore sudden movements in the spreads driven by changes in belief can occur.

Our model does not exclude the correlation of spreads and forward-looking variables or other risk relevant ratings. There has been a tendency to add lots of such variables and improve the fit dramatically in some empirical studies. The problem of using these

[5] Note that the role of the lender of last resort is to deal with liquidity crises by buying government bonds in the secondary markets. It has nothing to do with creating inflation as a substiute for taxation when a fiscal shock occurs. See Sims(2012) who discusses this.

[6] Note that we are not implying that fundamentals do not matter; in fact small movements of fundamentals can trigger large movements in spreads, because they trigger the fear factor (like in a bank run).

variables is that it may increase the explanatory power, but it has serious endogeneity problems. Expectations, ratings and forecasts are very much scenario dependent. In the case of Eurozone when the sovereign debt crisis erupts 2010-2012, all these forward-looking variables are also likely to be influenced by the negative market sentiments towards the periphery Eurozone countries due to lack of lender of last resort, and therefore it is hard to establish precisely a causal relationship. We will not do that and instead we will try to account for unexplained part by introducing time variables (time dummies).

The way we will design empirical tests of this theory is to first identify the fundamental variables that affect the interest rate spreads in a fixed exchange rate regime and in a monetary union. We will use standard theories to identify these fundamental variables. In a second stage we will identify periods during which the spreads systematically and in a serially correlated way deviate from the underlying fundamentals and relate these to market sentiments. Third, we will perform this analysis both at the short and the long end of the interest rate spreads to analyze the difference between the EMS and the Eurozone. As argued earlier, our hypothesis is that in the EMS the deviations in the spreads are concentrated at the short end that was dominated by movements in the foreign exchange market and an absence of a lender of last resort; in the Eurozone these deviations are concentrated at the long end (government bond market) where the lender of last resort was absent.

3. Data and Econometric Model

3.1 Data

To test our theory on the similarities and the differences between the EMS and the Eurozone, we will study two samples of quarterly observations. The EMS-period is from 1981Q1 to 1993Q4, and the Eurozone period is from 2000Q1 to 2012Q2. The countries included in the EMS-period are Italy, Denmark, Belgium, Ireland, Austria, France and the

Netherlands[7]. The countries included in the Eurozone are Greece, Portugal, Ireland, Spain, Italy, Belgium, France, Austria, the Netherlands and Finland[8].

We are interested in both the short-term money market and the long-term government bond interest rates. The long-term interest is selected from the 10-year government bond market. The short-term money market interest rates (annualized) include the average interest rate of less than 1 year maturity, of three month maturity and of day-to-day maturity. We calculate the spreads of these interest rates at different maturities. These spreads are defined as the difference between the national and the German interest rates.

Figures 2 and 3 present the long term government bond spreads and the short-term (less than one year) money market spreads of the countries participating in the EMS. A comparison of Figures 2 and 3 leads to the following observations. First, the money market spreads are much more volatile than the government bond spreads (the standard deviation is 3.85% versus 2.60%). In addition, on average the money market spreads (3.48%) are higher than the government bond spreads (2.61%). Figures 4 and 5 provide spreads with three-month and day-to-day maturities.

Second, there is a gradual decline in these spreads during the EMS-period. In the first half these spreads are significantly higher than in the second half of the period. This trend is probably relevant to the fact that in the late 1980s European countries gradually abolished capital controls and managed to reduce inflation rates (and the differentials in inflation). This difference in spreads is more pronounced for the money market spreads than for the government bond spreads. At the end of the period (from September 1992) the money market spreads surge again, but do not reach the levels reached during the first part of the period (except for Ireland in the day-to-day spreads). This is paradoxical. The EMS collapsed when the spreads were significantly lower than in the beginning of the period.

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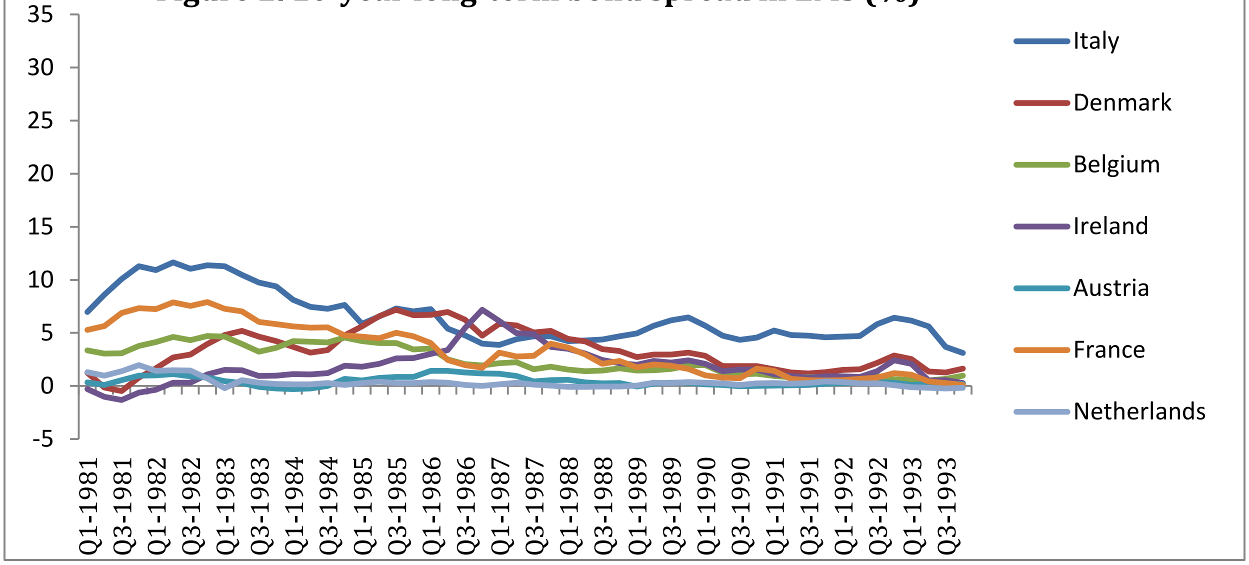
[7] UK, Portugal and Spain were in the EMS for a much shorter period, therefore they are not included in the EMS sample.

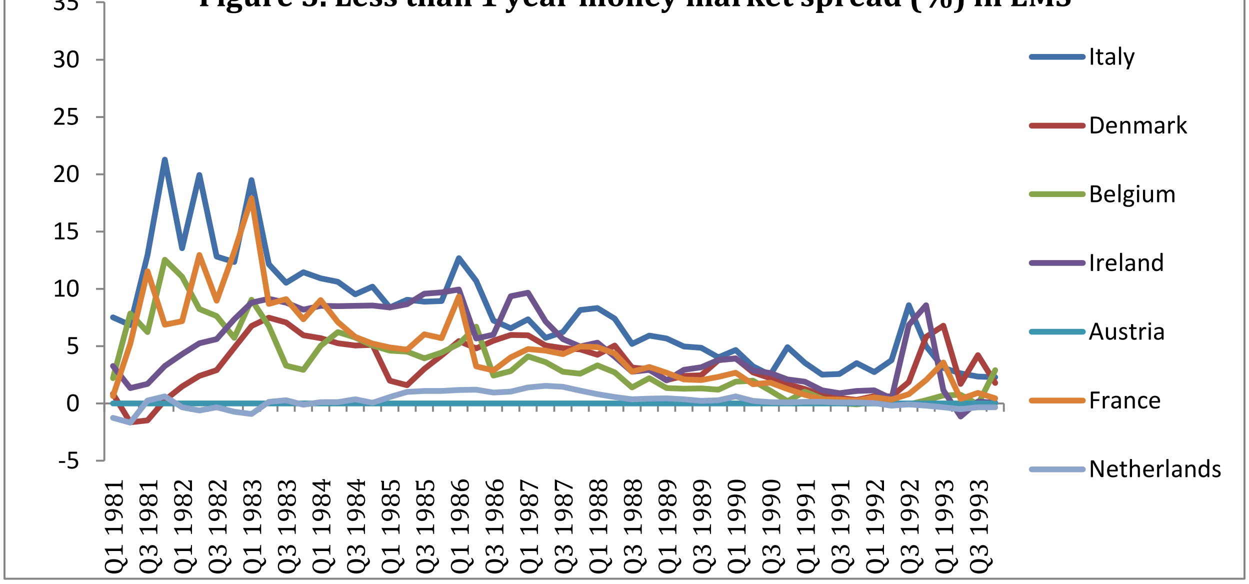
[8] Cyprus, Estonia, Luxemburg, Malta, Slovakia and Slovenia are not included in the Eurozone sample. The sizes of these economies are small and some of them have been in the Eurozone for quite short period.

Figure 2. 10-year long-term bond spread in EMS (%)



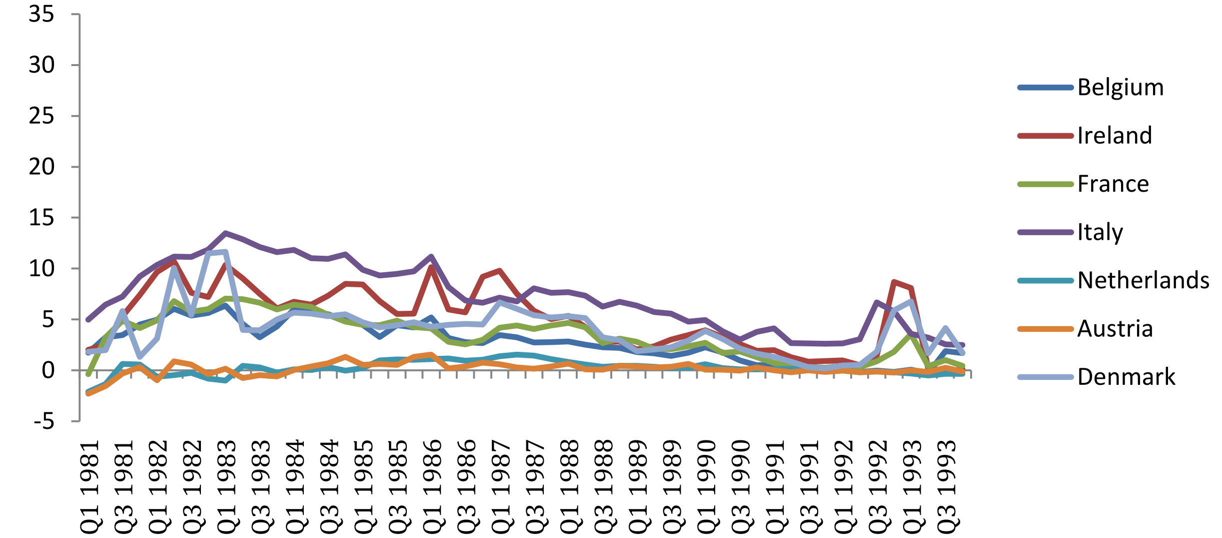
Data source: Datastream (Oxford Economics)

Figure 3. Less than 1 year money market spread (%) in EMS



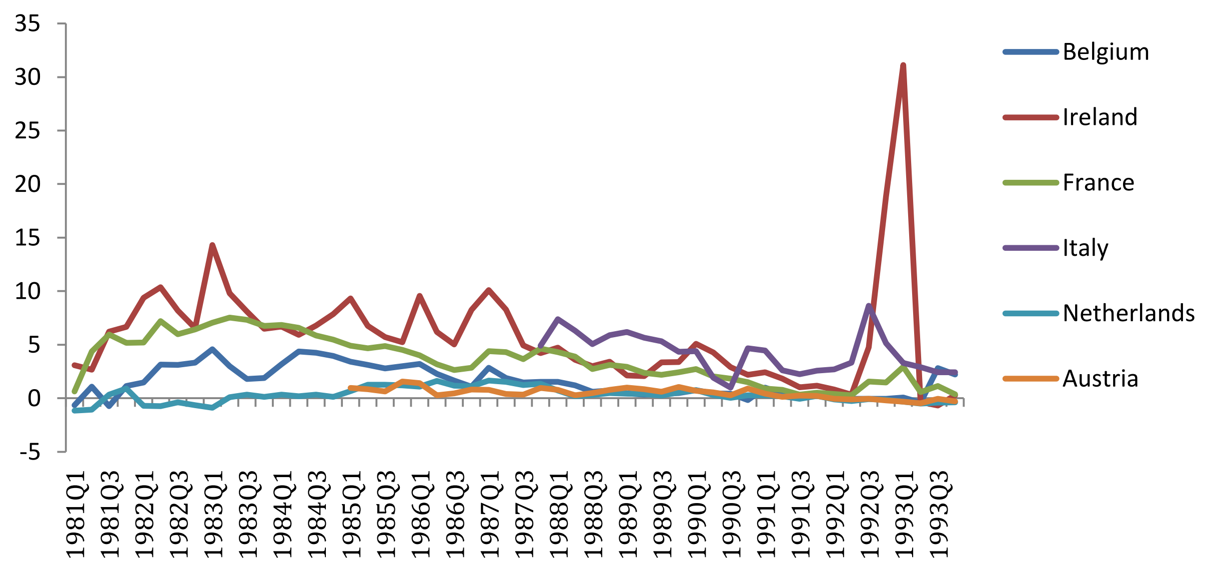
Data source: Datastream (Oxford Economics)

Figure 4. Three-month money market spread (%) in EMS



Data source: Datastream (Oxford Economics)

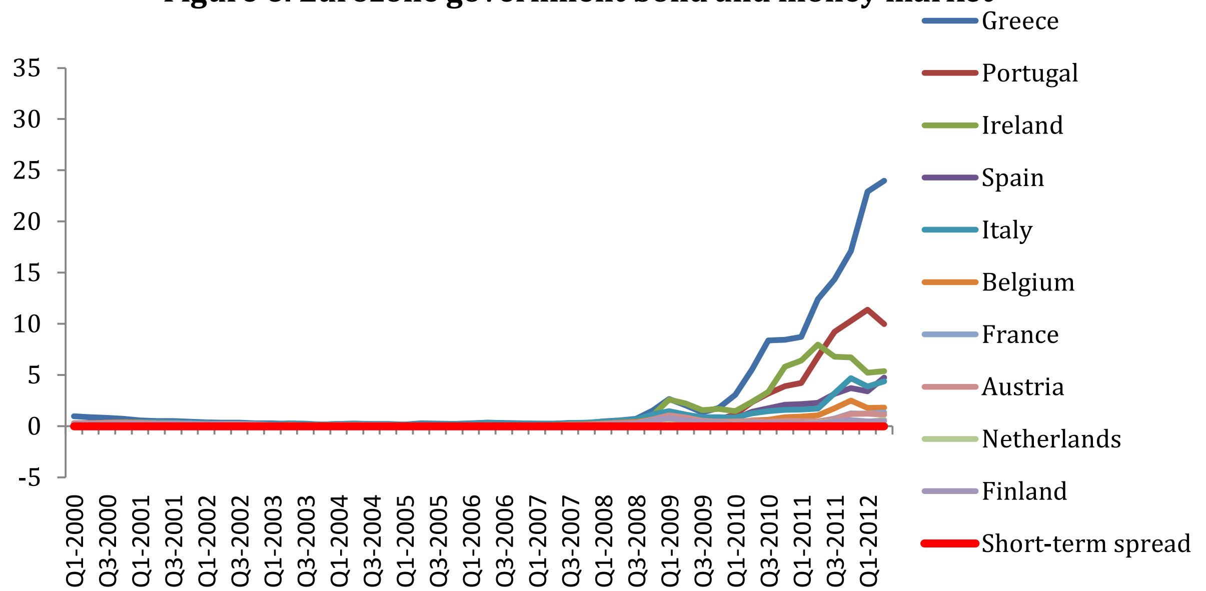
Figure 5. Day-to-day mone market spread in EMS (%)



Data source: Datastream (Oxford Economics)

The money market and government bond spreads during the Eurozone period are shown in Figure 6. The contrast with the EMS is striking. First, the volatility of the long-term government bond spreads is much higher than the volatility of the money market spreads. The latter have remained close to zero throughout the period, while the former became extremely volatile since 2008. Second, in contrast with the EMS-period, the spreads were very stable (and close to zero) in the first part of the period. Only in the second part do we observe strong volatility of the government bond spreads while the money market spreads remain stable.

Figure 6. Eurozone government bond and money market



Data source: Datastream (Oxford Economics)

3.2 Econometric Model

To analyze the determinants of the interest rate spreads in the EMS and the Eurozone. We specify the following fixed-effect econometric model.

$$S_{it} = \alpha + \delta * F_{it} + \alpha_i + u_{it} \qquad (1)$$

where S_{it} is the interest rate spread of country i in period t, α is the constant term and α_i is country i's fixed effect. The latter variable measures the idiosyncrasies of a country that affect its spread and that are not time dependent. For example, the efficiency of the tax system, the quality of the governance, the population structure and many other variables that are country-specific are captured by the fixed effect. F_{it} is a set of fundamental variables that are specific to the two different monetary regimes. A fixed effect model helps to control for unobserved time-invariant variables and produces unbiased estimates of the "interested variables".

In the second step, following De Grauwe and Ji (2012), we introduce time dummies into the basic model and the specification is as follows:

$$S_{it} = \alpha + \beta * F_{it} + \alpha_i + \gamma_t + u_{it} \qquad (2)$$

where γ_t is the time dummy variable. This measures the time effects that are unrelated to the fundamentals of the model or (by definition) to the fixed effects. If significant, it shows that the spreads move in time unrelated to the fundamentals forces driving the yields. It will allow us to evaluate the importance of fundamental economic factors and time effects.

3.3 Fundamental variables

We first identify the fundamental variables that according to prevailing exchange rate theories affect the spreads in a fixed exchange rate system. We then turn to the fundamentals model in a monetary union----the Eurozone.

Fundamentals determinants in fixed exchange rate system (EMS)

The oldest theory about the fundamental value of the exchange rate is the purchasing power parity theory. Although the empirical evidence for this theory remains surprisingly weak, especially as a theory describing the short and medium run behavior of the exchange rate, it has remained one of the fundamental cornerstones of the determination of the exchange rate (Obstfeld and Rogoff(2000)). In a nutshell it says that if a country experiences systematically more inflation than the country with which it pegs its currency, this country will have to devalue the currency to reflect this inflation differential. Rational agents who observe this systematic inflation differential will start anticipating the future devaluation. As a result the spread will be pushed up.

Modern theories of the exchange rate have expanded on the list of fundamental variables that affect the exchange rate. In these modern theories the exchange rate is a variable that will have to adjust so as to achieve external equilibrium (current account equilibrium), see Williamson(1985).

As fundamental variables we select the following quarterly data:

- The *inflation differential* between country i and Germany.
- The *current account* position of country i. When country i experiences systematic current account deficits these will have to be corrected. This can be achieved by costly general expenditure reducing policies or by a devaluation. The risk that such a devaluation may occur will then affect the spread. This variable is calculated as the ratio between the accumulated current account since 1981Q1 and the GDP level of country i.
- The *real growth rate* of country i. Both the monetary theory of the exchange rate (see Sarno and Taylor(2002)) and the open economy macroeconomic models (Obstfeld and Rogoff(1996)) stress the importance of long term economic growth on the exchange rate. In general countries experiencing high growth rates will tend to have an appreciating currency, *ceteris paribus*. This effect is also akin to the Balassa-Samuelson effect.
- The *real effective exchange rate* (CPI based) as a measure of competitiveness. This variable can be seen as an early indicator of future current account imbalances.
- The *debt GDP ratio*: as there is a possible risk of default in the EMS, we selected the debt to GDP ratio as the variable that best measures this risk of future default (see next section where we discuss the importance if this fundamental variable as a measure of default risk)
- The *exchange rate change* (%): The EMS was characterized by frequent but relatively small realignments, especially in the first half of the period. These frequent realignments are likely to affect expectations of future realignments. This variable aims to measure the importance of this effect.

Fundamentals determinants in monetary union (Eurozone)

The set of economic and monetary variables F_{it} include the most common fundamental variables found in the *sovereign bond* literature[9] are: variables measuring the sustainability of government debt. We will use the debt to GDP ratio. In addition, we use the current account position, the real effective exchange rate and the rate of economic growth as fundamental variables affecting the spreads. The effects of these fundamental variables on the spreads can be described as follows.

- When the *government debt to GDP ratio* increases the burden of the debt service increases leading to an increasing probability of default. This then in turn leads to an increase in the spread, which is a risk premium investors demand to compensate them for the increased default risk. We also add debt to GDP ratio squared. The reason of focusing on the non-linear relationship comes from the fact that every decision to default is a discontinuous one, and leads to high potential losses. Thus, as the debt to GDP ratio increases, investors realize that they come closer to the default decision, making them more sensitive to a given increase in the debt to GDP ratio (Giavazzi and Pagano(1990)).
- The *current account* has a similar effect on the spreads. Current account deficits should be interpreted as increases in the net foreign debt of the country as a whole (private and official residents). This is also likely to increase the default risk of the government for the following reason. If the increase in net foreign debt arises from the private sector's overspending it will lead to default risk of the private sector. However, the government is likely to be affected because such defaults lead to a negative effect on economic activity, inducing a decline in government revenues and an increase in government budget deficits. If the increase in net foreign indebtedness arises from government overspending, it directly increases the government's debt service, and thus the default risk. To capture net foreign debt position of a country, we use the

[9] Attinasi, M., et al. (2009), Arghyrou and Kontonikas(2010), Gerlach, et al.(2010), Schuknecht, et al.(2010), Caceres, et al.(2010), Caporale, and Girardi (2011), Gibson, et al. (2011), De Grauwe and Ji (2012), Aizenman and Hutchinson(2012), Beirne and Fratzscher(2012). There is of course a vast literature on the spreads in the government bond markets in general. See for example the classic Eaton, Gersovitz and Stiglitz(1986) and Eichengreen and Mody(2000). Much of this literature has been influenced by the debt problems of emerging economies. See for example, Edwards(1984), Edwards(1986) and Min(1998).

accumulated current account GDP ratio of that country. It is computed as the current account accumulated since 2000Q1 divided by its GDP level.

- The *real effective exchange rate* as a measure of competitiveness can be considered as an early warning variable indicating that a country that experiences a real appreciation will run into problems of competitiveness which in turn will lead to future current account deficits, and future debt problems. Investors may then demand an additional risk premium.
- *Economic growth* affects the ease with which a government is capable of servicing its debt. The lower the growth rate the more difficult it is to raise tax revenues. As a result a decline of economic growth will increase the incentive of the government to default, raising the default risk and the spread.

4. Econometric Results

4.1 EMS: *Long-term government bond spreads*

We start with the econometric analysis of the long-term government bond spreads in the EMS. A Hausman test confirms that a fixed effect model is more appropriate than a random effect model. The results are shown in Table 1. As shown in the column (1), most economic fundamental variables are not significantly associated with the spread. The only significant variable is the change in exchange rate. It indicates that the spreads in the long-term bond market was influenced by the regular realignments that created and endemic expectation of further realignments.

It is likely that there is a structural break in the EMS period due to the fact that European countries decided to give up capital controls and free the capital movement across Europe around 1987. A Chow test confirms this view and therefore we also run separate regressions on the pre-1987 and post-1987 periods in Table 1. The results suggest that during the pre-1987 period, the debt GDP ratio, the current account position and changes in exchange rate are significant variables associated with the spread; during the post-1987 period, the inflation differential becomes a significant variable.

Were the long-term government bond markets in the EMS exposed to time-dependent market sentiment? To test this, we perform an F test of the time dummies and the result is shown in Table 1. The hypothesis that there is no time effect cannot be rejected. This test is illuminating and is consistent with our theory. In the EMS, each government issued debt in its own currency and was fully backed by the lender of last resort guarantee in the government bond markets. This guarantee prevented market fears of imminent defaults from destabilizing the national bond markets.

Table 1. Long-term government bond spread (%) in EMS period (1981Q1-1993Q4)

	(1) Pooled	(2) Pre-1987	(3) Post-1987
Debt/GDP ratio	0.0292	0.0834*	0.0415***
	[0.0252]	[0.0370]	[0.0077]
Accumulated current account/GDP ratio	-0.0853	-0.2330***	-0.0337
	[0.0482]	[0.0478]	[0.0384]
Real effective exchange rate	-0.0128	0.0180	0.0467*
	[0.0478]	[0.0714]	[0.0191]
Growth rate	0.0991	0.0365	0.0017
	[0.0665]	[0.1178]	[0.0341]
Inflation differences	0.2431	0.2213	0.3086***
	[0.1754]	[0.1718]	[0.0780]
Change in exchange rate	0.2448*	0.2787***	0.1326***
	[0.1165]	[0.0479]	[0.0339]
Observations	364	168	196
R^2	0.6974	0.8226	0.8748
Hausman test for fixed effect model		Prob>chi2 = 0.0000	
Chow test for structural break		Prob > F = 0.0000	
Time fixed effect F test		Prob > F=0.4808	

Cluster at country level and robust standard error is shown in brackets. * p < 0.1, ** p < 0.05, *** p < 0.01

4.2 EMS: Short-term money market spreads

The analysis in the previous section has shown that the long-term government bonds in the EMS were sensitive to the development of economic and monetary variables, but were not exposed to market sentiments like those that countries experienced in the Eurozone. In the end, the EMS collapsed, however, despite the fact that the long-term government bond spread for all the participant countries had been declining (see Figure 2). What triggered this breakup? We answer this question by studying the short-term money market spread and its determinants.

Table 2 presents the result of the estimation of the econometric model using the short-term money market spreads of less than 1 year. The regression using the pooled sample in Column (1) suggests that the debt to GDP ratio, the current account position and the real effective exchange rate are not significant explanatory variables.

The growth rate, the inflation differentials and the change in the exchange rate are significant. It is noticeable that the spread is positively associated with the growth rate of GDP. The Balassa-Samuelson effect does not hold. The reason is likely to be that higher growth is related to stronger demand for liquidity and this tends to push up the short-term spread.

Table 2. Money market (less than 1 year) spreads of EMS (%) (1981Q1-1993Q4)

	(1) Pooled	(2) Pre-1987	(3) Post-1987
Debt/GDP ratio	0.0306	0.0640	0.0519**
	[0.0511]	[0.0700]	[0.0209]
Accumulated current account/GDP ratio	-0.0972	-0.1836	-0.0127
	[0.1075]	[0.1486]	[0.0653]
Real effective exchange rate	0.0070	-0.0305	0.1418
	[0.0604]	[0.1055]	[0.0760]
Growth rate	0.1214***	0.1243	0.0746
	[0.0139]	[0.2041]	[0.0701]
Inflation differences	0.4947**	0.0044	0.4206***
	[0.1448]	[0.2067]	[0.0789]
Change in exchange rate	0.3374**	0.4215*	0.2039***
	[0.1252]	[0.1824]	[0.0406]
Observations	364	168	196
R^2	0.6196	0.7164	0.7004
Hausman test	Prob>chi2 = 0.0000		
Chow test	Prob > F = 0.0000		

Cluster at country level and robust standard error is shown in brackets. * p < 0.1, ** p < 0.05, *** p < 0.01

The Chow test confirms a structural break in 1987. In Table 2 (2) and (3), it indicates that prior to 1987 the exchange rate change is the only significant variable while during the post-1987, the debt to GDP ratio, inflation differences and exchange rate changes are significant variables.

The regressions described in Table 2 may not be appropriate as our F-tests suggest that the spreads are significantly related to the time dummies. We study the short-term money market spreads of three different maturities (less than one year, three month, day-to-day) using the fixed effect model with time dummies and the results are shown in Table 3. After controlling for time dummies, we find that the three-month and day-to-day spreads are significantly related to the growth rate and the inflation differentials. The latter corroborates the empirical results of Andrew Rose and Svesson (1994). The fundamental variables cease to be significant in the regression of the less than one year spread.

Table 3. Regression of money market spreads with time dummies in EMS

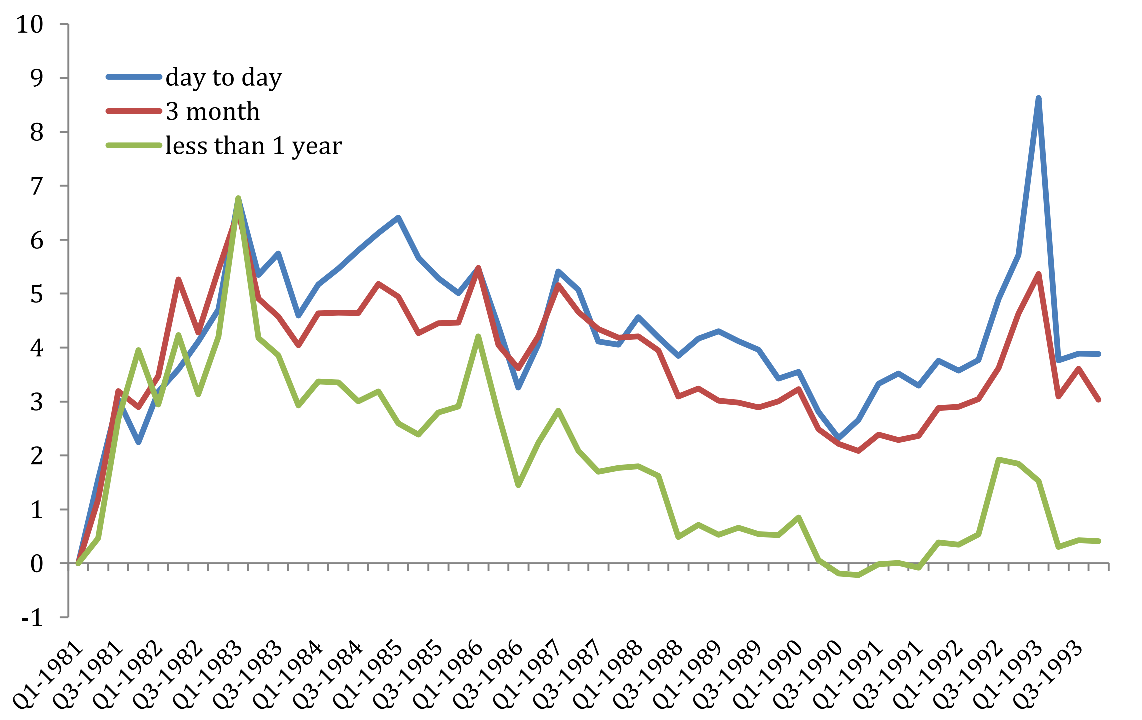
	(1) Less than one year	(2) Three month	(3) Day-to-day
Debt/GDP ratio	0.0224	-0.0044	-0.0220
	[0.0580]	[0.0436]	[0.0255]
Accumulated current account/GDP ratio	0.0093	0.0064	0.0461
	[0.0920]	[0.0569]	[0.0372]
Real effective exchange rate	0.0525	0.0242	0.1368
	[0.1241]	[0.0535]	[0.1187]
Growth rate	0.1590	0.1390*	0.1474**
	[0.1205]	[0.0692]	[0.0498]
Inflation differences	0.2878	0.3913***	0.3576**
	[0.2468]	[0.0836]	[0.1075]
Change in exchange rate	0.2156	0.1178	0.3933
	[0.1926]	[0.1323]	[0.3212]
Control for time dummies	Yes	Yes	Yes
Observations	364	364	269
R^2	0.7138	0.8499	0.6373
F test for no time effect hypothesis: p-value	0.0004	0.0000	0.0409

Cluster at country level and robust standard error is shown in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Note: the day-to-day regression using an unbalanced sample.

More importantly, we detect significant time dummies, which provide empirical evidence that a common time component affected the money market spreads across the EMS countries. The time dummies are plotted in Figure 7. We detect the following features of the time dummies. First, significant time dummies influence the short-term money market spreads. This is the case in the first part of the sample period and at the very end. Thus during these periods the money market spreads were regularly dissociated from the fundamental variables. Second, the time dummies from different maturities seem to have some co-movement. Third, the time dummies of the short maturity spreads (day-to-day and 3-month) are significantly higher than those associated with the spreads of less than 1 year. A striking example is to be found during the final crisis period from 1992Q2 to 1993 Q1. One observes that the common time dummies for the day-to-day spread increases from 3.77% to 8.63%.

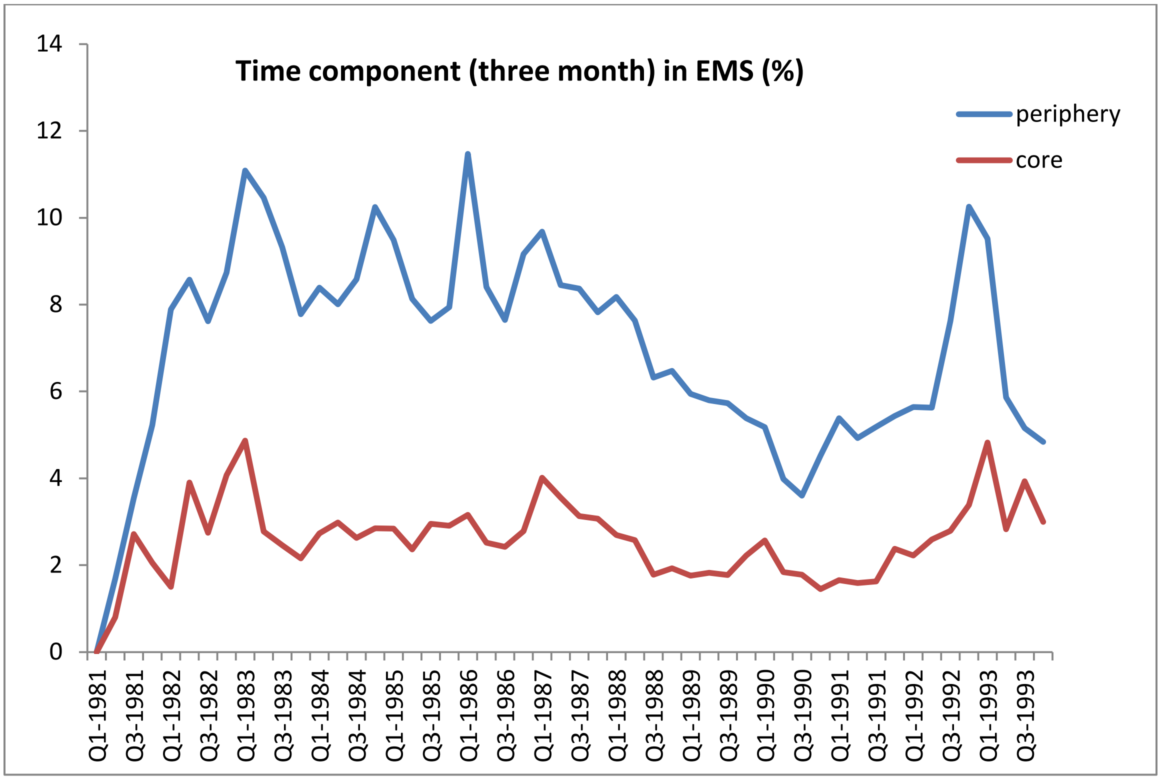
Fourth, the time dummies prior to the crisis of 1992-1993 were actually declining. Thus financial markets seem to have been lulled into a belief of stability. In September 1992 a new speculative attack erupted, and when the Bundesbank refused to lend marks to the Banca d'Italia this crisis turned out to be the fatal one for the EMS. In appendix we present a numerical example illustrating the central position of the Bundesbank in providing the necessary liquidity (German marks) allowing capital flows to occur.

Figure 7. Time dummies in EMS (%) (1981Q1-1993Q4)



Source: authors' own calculations from regressions in Table 3.

Fifth, we also allow for different common time components in the core and the periphery countries of the EMS. The time components in the periphery countries are significantly higher than the time components of the core countries. However, the time components appear to have some co-movement. For example, both time components surged in the crisis time of 1992-1993. These features are illustrated in Figure xx on the three-month spreads.



Source: authors' own calculations from regressions in Table 3(2) which allows for different time components in the core and the periphery countries. The core countries of EMS are Austria, Belgium, France, the Netherlands and Denmark; the periphery countries of EMS are Ireland and Italy.

4.3 Eurozone: *long-term government bond spreads*

To compare the long-term government bond spreads in the Eurozone with those in the EMS, we again run regressions using a fixed effect model. After having established by a Hausman test that the random effect model is inappropriate, we used a fixed effect model to analyze the long-term bond spreads in the Eurozone. Table 4 presents regressions of the Eurozone countries using the proposed fixed effect model. Column (1) shows the regression without the time dummies using the pooled sample. The debt to GDP ratio is a significant variable and the relationship between the spread and the debt to GDP ratio is non-linear. Additionally, we find that the growth rate is negatively associated with the spread.

Table 4. Long-term government bond spreads (%) of Eurozone (2000Q1-2012Q2)

	(1) Pooled	(2) Pre-crisis	(3) Post-crisis	(4) FT model
Debt/GDP ratio	-0.0901***	-0.0114	-0.0892**	-0.0968**
	[0.0254]	[0.0066]	[0.0387]	[0.0379]
Debt/GDP ratio squared	0.0011***	0.0001	0.0008**	0.0007**
	[0.0002]	[0.0001]	[0.0003]	[0.0003]
Real effective exchange rate	-0.0185	-0.0149***	-0.2156	0.0293
	[0.0466]	[0.0024]	[0.2331]	[0.0361]
Growth rate	-0.1070*	-0.0008	-0.1145	-0.2058**
	[0.0511]	[0.0037]	[0.0853]	[0.0873]
Accumulated current account/GDP ratio	-0.0192	0.0003	-0.1845*	-0.0301
	[0.0122]	[0.0016]	[0.0834]	[0.0186]
Observations	500	320	180	500
R^2	0.7193	0.7088	0.8297	0.8724
Hausman test	Prob>chi2 =0.0000			
Chow test	Prob > F = 0.0000			
Time fixed effect F test	Prob > F=0, "no time effect" hypothesis is rejected			

Cluster at country level and robust standard error is shown in brackets. * p < 0.1, ** p < 0.05, *** p < 0.01

Figure 6 suggests that a structural break occurs at the time of the financial crisis. A Chow test revealed that a structural break occurred in the Eurozone around the year 2008. This allows us to treat the pre- and post-crisis periods as separate and we show the results in Table 4(2) and (3). In general, the results confirm that since 2008 the markets become more cautious towards some key economic fundamentals which are associated with higher spreads. To be specific, the coefficients of the debt to GDP ratio and accumulated current account GDP ratio are low and insignificant prior to the crisis. In the post-crisis period these coefficients become larger and are statistically significant[10]. Moreover, the coefficient of the real effective exchange rate is negative prior to the crisis and this negative effect does not last any more.

Finally, the results of the time dummy model are shown in Table 4(4). An F test confirms that there are significant time components in the regression. In order to differentiate the core (Austria, Belgium, France, Finland, the Netherlands and Italy) and periphery (Spain, Ireland, Portugal and Greece) Eurozone groups, we assume that the time components of

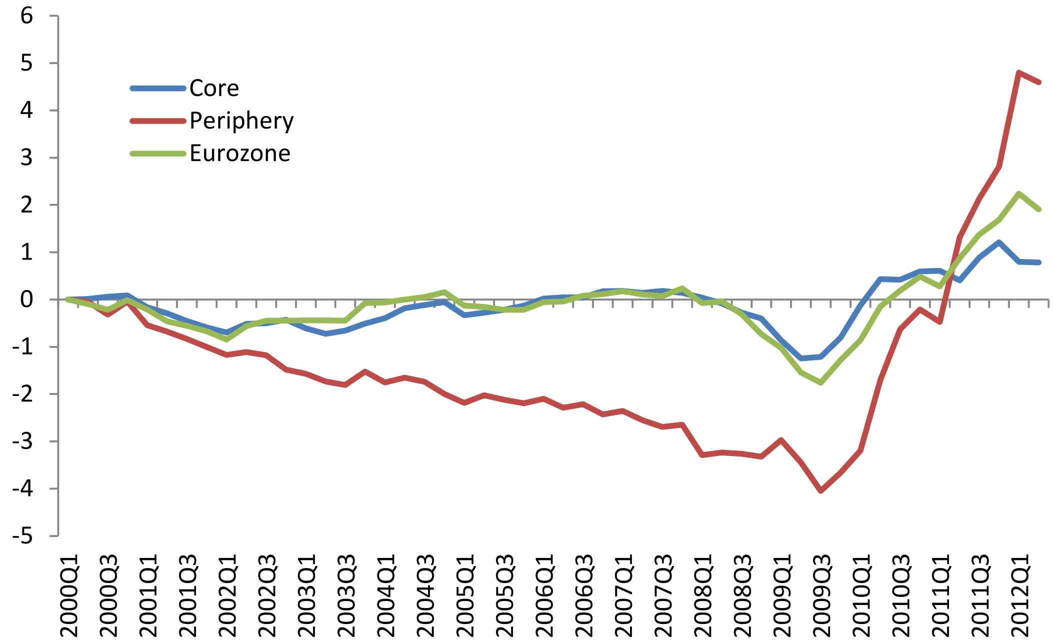
[10] Similar results are obtained by Schuknecht et al. (2010), Arghyrou and Kontonikas(2010), Borgy, et al., (2011), Gibson, et al. (2011), Beirne and Fratzscher(2012) and Ghosh and Ostry(2012).

the two groups can be different. We show the estimated time components (associated with the regression results in Table 4(4)) in Figure 8. It confirms the existence of significant time components that led to deviations of the spreads from the underlying fundamentals. This time effect is especially pronounced in the peripheral countries. This result in the Eurozone contrasts a great deal with the one in the EMS. In the EMS, there is always a national bank acting as a lender of last result in the government bond market, while in the Eurozone where the absence of a credible lender of last resort lead to scenarios in which the government bond markets can be gripped by market fear and panic. This leads to large spreads that cannot be justified by the economic fundamentals.

Another noticeable result is the dynamics of the time dummies. Prior to the crisis we observe increasing negative time dummies in the periphery countries. The time component of the periphery Eurozone countries was negative and declining until 2009Q3 and when the crisis erupts there is a quick increase of the time dummies and these become significantly positive and hit 4.79% in 2012. This result suggests that prior to the crisis the fundamentals increasingly pointed towards the need to increase the spreads. Financial markets however, did not recognize this, until market sentiments abruptly changed. These market sentiments then overreacted and produced spreads that far exceeded those predicted by the deteriorating fundamentals. Thus in a way it can be said that the markets were wrong much of the time. Prior to the crisis they disregarded the deteriorating fundamentals in the periphery when pricing the government bonds. After the crisis they overreacted and applied spreads that were too high when compared to the underlying fundamentals.

It should be noted that as the short-term money market spreads in the Eurozone (shown in Figure 6) were close to zero during the whole sample period there is nothing to explain. Thus we arrive at the conclusion that in the Eurozone the phenomenon of spreads that are driven away from their underlying fundamentals occurs only in the government bond markets . This is also where a lender of last resort was conspicuously absent, allowing fear and panic to dominate the government bond markets after 2010. At the short end, the interbank market, the ECB stood ready to intervene massively and to provide the necessary liquidity so as to avoid self-fulfilling crises. In appendix we present an analysis of how the existence of a liquidity backstop in the money market allowed stabilizing the short-term spreads in the Eurozone.

Figure 8. Time component in Eurozone from 2000Q1-2012Q2(%)



Source: authors' own calculations from regressions in Table 4(4).

4.4 Robustness check on the specification of debt to GDP ratio

We also include squared debt to GDP ratio in the regressions of the EMS. However, in contrast to the regressions of the Eurozone, the non-linear relationship of debt to GDP ratio with the spreads does not significantly exist. This result may relate to the fact that in the EMS debt level and default risk are not the main concern of investors, compared to inflation and depreciation risk. Therefore, in the regressions of Table 1, 2 and 3, it is safe to just use debt to GDP ratio as a measure of default risk.

Apart from the debt to GDP ratio variables, we also experiment with different specifications about a country's government debt situation. In the Eurozone regressions, instead of using debt to GDP ratio and its non-linear form, we also use the government deficit to GDP ratio or the year-on-year change of the debt to GDP ratio. Neither variable is found to be significant. The major results (including the time effects) in the Table 4 don't change significantly.

Additionally we also replace the debt to GDP ratio with the variable "fiscal space". The latter is defined as the ratio of the government debt to total tax revenues. Aizenman and Hutchinson(2012) argue that this is a better measure of debt sustainability than the debt to GDP ratio. A country may have a low debt to GDP ratio, yet find it difficult to service its debt because of a low capacity of raising taxes. In this case the ratio of government debt to tax revenues will be high, i.e. it takes a lot of years to generate the tax revenues necessary to service the debt. We find evidence that there is a significant non-linear relationship (i.e. "fiscal space" and "squared fiscal space") with the spreads. The results are consistent with the results in Table 4 and we still detect significant time components which are surging radically in 2010-2012. These details can be found in the empirical study of De Grauwe, P and Ji Y, (2012).

5. Conclusion

Our empirical results support the theory we developed about the different nature of the fragility of two monetary regimes, the EMS and the Eurozone. In the EMS-regime governments issued debt in their own currencies. Therefore, they could and did guarantee that the liquidity was always available to stabilize the government bond markets in times of crisis. This was not the case in the money markets (short end). The short-term interest rates (interbank interest rates) were dominated by the need to keep the exchange rate fixed. In times of crises (i.e. expectations of a devaluation) the exchange rate system relied on the intervention capacity of the central bank concerned, i.e. its capacity to convert its own liabilities into marks at a fixed price. This capacity in turn was limited by the willingness of the Bundesbank to provide the marks necessary to do the interventions. As argued earlier, the commitment of the Bundesbank to be a lender of last resort to the other central banks of the system was not fully credible, thereby triggering self-fulfilling crises that led to regular devaluations. In the end when in September 1992 the Bundesbank refused to continue to be the liquidity backstop of the system, the EMS broke up[11]..

In the Eurozone, the situation was exactly the reverse. The absence of a devaluation risk had the effect that spreads could only reflect default (credit risks). In the money market the ECB was willing to provide all the necessary liquidity to prevent major counterparty credit risks in the interbank market from leading to a liquidity crisis. At some point during the debt crisis this led to massive accumulation of Target2 liabilities in the Southern European countries matched by large claims in Northern Eurozone countries, which sustained the banking systems in these countries (see Figure 9). In the government bond market there was no such commitment of the ECB. As a result, fears of payment difficulties could easily lead to a liquidity crisis and large volatilities of the long-term bond rates.

Thus the difference in the money market and government bond markets' volatilities can be attributed to the differences in the role of the central banks in both regimes. In the EMS there was no credible lender of last resort in the foreign exchange markets while there was a lender of last resort one in each of the national government bond markets. In the Eurozone, there was a lender of last resort in the interbank market while there was none in the government bond markets.

[11] It is clear that in its refusal to be the backstop of the system in 1992 the Bundesbank was very much motivated by a fear that its interventions would make it impossible to control the German money stock.

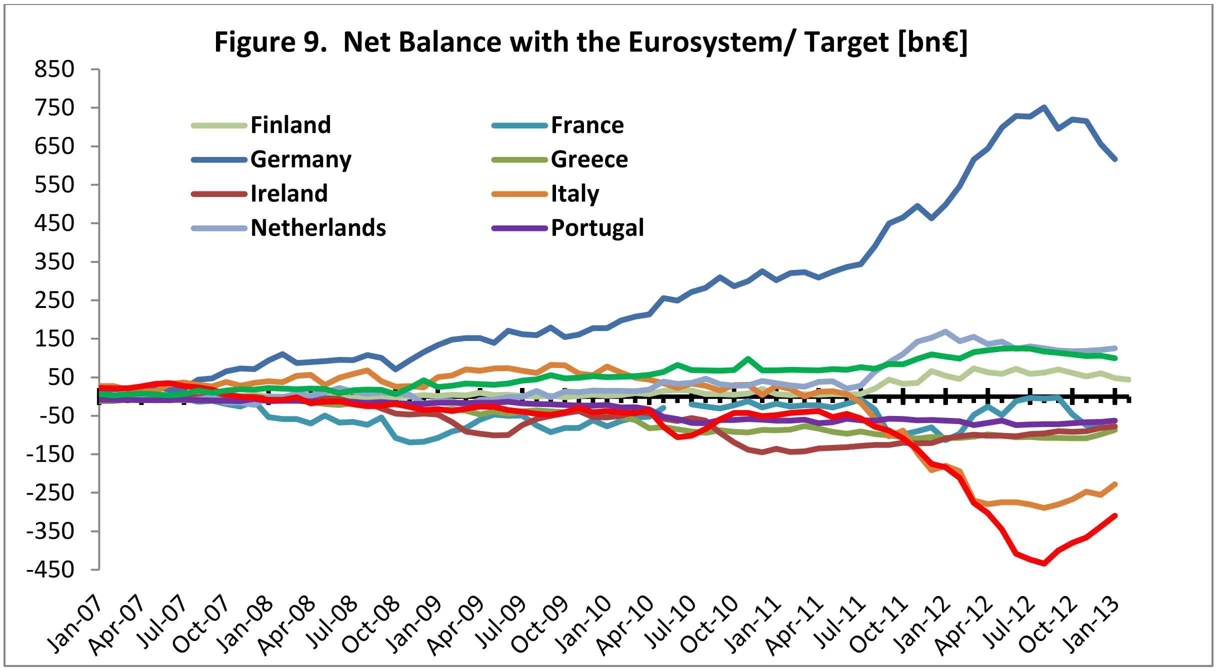


Figure 9. Net Balance with the Eurosystem/ Target [bn€]

Data source: Euro Crisis Monitor, Institute of Empirical Economic Research, Osnabrück University

Another way to interpret these results is the following. The EMS fragility arose from the fact that the commitment to convert national currencies into the German mark at a fixed price could not be made credible for the following reason. Fundamentals (e.g. inflation differentials) were not in line with each other necessitating regular devaluations. These devaluations were triggered by speculative crises when investors suspected that the national central banks would not have enough liquidity support from the central bank that mattered, the Bundesbank.

The designers of the Eurozone thought they could solve this credibility problem by abolishing the national currencies thereby eliminating a commitment to convert national currencies into marks that could not be made credible. In doing so, however, they shifted this credibility problem to the government bond markets. In the Eurozone, the national governments faced the same problem of the national central banks in the EMS, i.e. they made a commitment to convert their liabilities into a currency they do not have. In the absence of a liquidity backstop in the government bond markets this turned out to create a similar problem of fragility as the one that existed in the EMS. The only change that occurred was that the fragility was shifted from the foreign exchange markets to the government bond markets.

In a way it can be said that in the EMS the national central banks were weak and fragile, and the national governments were insulated from this weakness by the fact that they kept their own national currencies. In the Eurozone the roles were reversed. The national central banks that became part of the Eurosystem and supported each other unconditionally were strengthened.

In 2012 the ECB decided to become the lender of last resort in the government bond markets, in the context of its "Outright Monetary Transactions' (OMT) program. This had an immediate stabilizing effect and led to rapid declines in the government bond spreads in the Eurozone (see De Grauwe and Ji(2013)). Thus, the power of the ECB to counter market sentiments of fear and panic is great. This is good news for the future of the Eurozone. However, up to now the power of the ECB has been exerted only by announcement. It is clear that if market sentiments were to turn around again, the ECB would be forced to intervene. Intervention will be necessary if the ECB wants to avoid losing its credibility and its power.

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Appendix: The mechanics of lenders of last resort in EMS and Eurozone

In this appendix we present a numerical example of how a given capital outflow from one country (Italy) to another country (Germany) is processed in the EMS and in the Eurozone. We will show that in the EMS, the position of the Bundesbank is key as it provides the necessary liquidity (German marks) to make this capital flow possible. In the Eurozone, this strategic position of the Bundesbank is eliminated. In contrast, through the Target2 payment system these capital flows are made possible without any restriction.

We start by presenting a very simple set of balance sheets of an Italian and a German bank together with their respective central banks. It presents the situation before the capital flow from Italy to Germany occurs.

EMS and Eurozone: initial position

Banca d'Italia

DA 300	Reserve 100
FA 200	Currency 400

Bundesbank

DA 300	Reserve 100
FA 200	Currency 400

Banco di Roma

Reserve 100	Deposit 1000
Loans 900	

Commerzbank

Reserve 100	Deposit 1000
Loans 900	

EMS: Speculative flow of 100 from Italy to Germany

Banca d'Italia

DA 300	Reserve 0
FA 200	Currency 400
	Debt BB 100

Bundesbank

DA 300	Reserve 200
FA 200	Currency 400
Claim BI 100	

Banco di Roma

Reserve 0	Deposit 900
Loans 900	

Commerzbank

Reserve 200	Deposit 1100
Loans 900	

Banco di Roma makes transfer of 100 to Commerzbank. This is done through drawing down of reserves held by Banco di Roma at Banca d'Italia. In exchange Banco di Roma obtains marks from Banca d'italia. The latter has borrowed these from Bundesbank and now has a debt of 100 vis a vis Bundesbank (Debt BB). Banco di Roma delivers these marks to its customer who deposits these at Commerzbank. Commerzbank obtains reserves at the Bundesbank.

This transaction is only possible because the Bundesbank is willing to lend marks to the Banca d'Italia. But the Bundesbank is coming into conflict with its money targeting as this whole operation increases the money base and potentially the money stock in Germany. If the Bundesbank refuses to lend marks, the Banca d'italia has to stop intervening and cannot keep lira/mark rate fixed. Thus the Bundesbank is lender of last resort in the foreign exchange market.

Note also that the Banca d'Italia will have to act as lender of last resort for Banco di Roma which experiences a liquidity crisis. It will do this by open market operations, providing reserves and taking loans of Banco di Roma as collateral. But all this creates liquidity in the Italian banking system that can be used for further speculative activities, forcing the Bundesbank to lend additional marks. So the ultimate backstop is the Bundesbank.

EMS: Sterilization policies by Banca d'Italia

Banca d'Italia

DA 390	Reserve 90
FA 200	Currency 400
	Debt BB 100

Bundesbank

DA 300	Reserve 200
FA 200	Currency 400
Claim BI 100	

Banco di Roma

Reserve 90	Deposit 900
Loans 810	

Commerzbank

Reserve 200	Deposit 1100

Eurozone: Flow of 100 from Italy to Germany

Banca d'Italia

DA 300	Reserve 0
FA 200	Currency 400
	Target2 100

Bundesbank

DA 300	Reserve 200
FA 200	Currency 400
Target2 100	

Banco di Roma

Reserve 0	Dep 900
Loans 900	

Commerzbank

Reserve 200	Deposit 1100
Loans 900	

The movement of 100 deposits from Italy to Germany has the same balance sheet effects. However, no transactions in foreign exchange market occur. It is a transfer through the Target payment system that is achieved automatically. Banco di Roma makes a transfer of euros to Commerzbank by drawing down its euro reserve position at the Banca d'Italia. Commerzbank increases its reserve position at the Bundesbank by 100. The Banca d'Italia has Target2 liability of 100 and Bundesbank Target claim. These target claims and liabilities are vis-à-vis the Eurosystem. It is not a loan that Bundesbank provides to Banca d'Italia. There is no limit to the size of these claims and liabilities. There is also no way the Bundesbank can refuse these claims. The lender of last resort by the Eurosystem is unlimited and unconditional. It is the Eurosystem that is lender of last resort. This lender of last resort occurs automatically.

The latter is the big difference with the EMS where the liquidity backstop was conditional on the Bundesbank's continued willingness to provide this facility. However, this could not be unlimited because it conflicted with the Bundesbank's money targeting.

Note that in the Eurozone the Eurosystem (through Banca d'Italia) will have to provide further liquidity support to Banco di Roma that is short of liquidity. It will do it the same way (sterilization policies) as in EMS. This may also lead to further capital flows from Italy to Germany, thereby increasing Target2 claims and liabilities.

Eurozone: Sterilization policies by Banca d'Italia

Banca d'Italia

DA 390	Reserve 90
FA 200	Currency 400
	Target2 100

Bundesbank

DA 300	Reserve 200
FA 200	Currency 400
Target2 100	

Banco di Roma

Reserve 90	Deposit 900
Loans 810	

Commerzbank

Reserve 200	Deposit 1100
Loans 900	

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