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► **To cite this version:**

Gilles Dufrénot, Fredj Jawadi, Zied Ftiti. Sovereign bond market integration in the euro area: a new empirical conceptualization. *Annals of Operations Research*, 2022, 318 (1), pp.147-161. 10.1007/s10479-022-04847-5 . hal-03740521

HAL Id: hal-03740521

<https://amu.hal.science/hal-03740521>

Submitted on 28 Feb 2023

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Sovereign Bond Market Integration in the Euro Area: a New Empirical Conceptualization

Gilles Dufrénot¹, Fredj Jawadi², Zied Ftiti³

Abstract

This paper proposes a new empirical conceptualization of financial integration of sovereign bond markets in the euro area. We introduce a methodology based on the joint testing of the assumptions of efficient market and convergence/divergence of the yield spreads. We test these assumptions by proposing parametric and non-parametric techniques. We find that markets have been more fragmented than usually advocated in the literature. We also show that the information contained in the fundamentals are not always fully reflected in the spreads, which suggests that either they have insignificant effects, or that their coefficients in the spread equations appear with the wrong sign.

Keywords: Financial integration; Euro area; sovereign bonds; fundamentals.

JEL Classification: E43, G01, G10.

The project leading to this publication has received funding from the French government under the “France 2030” investment plan managed by the French National Research Agency (reference: ANR-17-EURE-0020) and from Excellence Initiative of Aix-Marseille University - A*MIDEX

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1.- Introduction

This paper focuses on the Euro area bond markets and investigates whether, sovereign bond markets have been integrated since the beginning of the Euro area, and whether debt crises have contributed to their fragmentation. This question is relevant because the observed divergence in the sovereign bond spreads in 2010 casted some doubts, in the academic literature and policymakers' circles, about the integration process that is supposed to have been at play since the launch of the Single Currency.

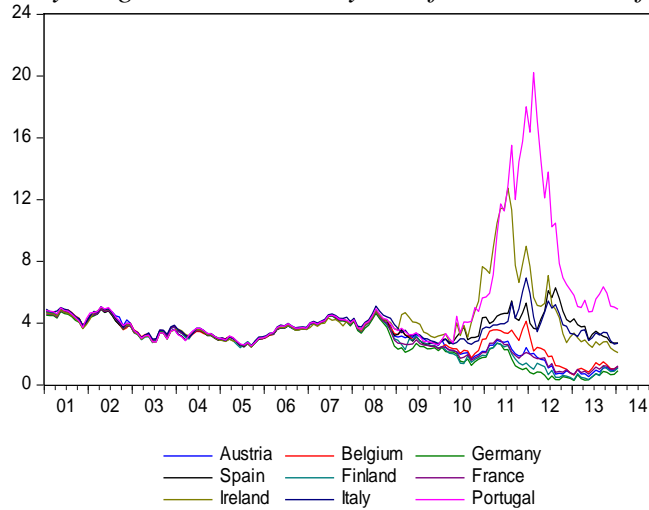
Traditionally, the literature relates the assumption of financial integration to the law of one price in asset markets⁴. Indeed, when there are no financial frictions, such as imperfect capital mobility or asymmetric information, the financial spreads reflect all available information related to their fundamental determinants, show an independent structure and approaches a random walk. A consequence is that markets are efficient. Markets where spreads are diverging are therefore considered to be integrated, if the divergence is caused by differences in macro-financial fundamentals among countries. Conversely, markets where interest rates converge are not necessarily integrated, if the convergence stems from factors other than the convergence of macroeconomic fundamentals between countries. For example, markets might converge because of contagion effects across markets.

The question as whether the macroeconomic variables have been significant in driving the sovereign bonds spreads in the euro area has been addressed in a vast empirical literature⁵. However, the sovereign debt crises marked a renewed interest in this issue as we observed spectacular rises in the peripheral countries' sovereign bond yields (Greece, Ireland, Italy, Portugal, Spain), and at the same time, a flattening of the yield spreads in the core countries (see Figure 1). Was this a sign of a market fragmentation? Or is it simply an illustration that markets have been correctly pricing differences among countries with heterogeneous fiscal policies and economic situations?

⁴ For a survey, see Ben Ameer et al. (2018), Jawadi et al. (2018).

⁵ See section 2 for more details.

Figure 1. 5-year government bond yields for a selection of countries



We identify here a financial policy issue. Indeed, if the weight of fundamentals in the determination of sovereign spreads is overestimated, this would imply that they are not good advanced indicators of risk premiums and that surveys about investors' expectations of growth rates, inflation rates, debt ratios, etc, are not the determining factors of the spreads. This issue is crucial for investors as well for policymakers for monitoring financial markets.

In this paper we propose two simple methods to test whether investors have discriminated among the Euro area sovereign debt issuers according to their macroeconomic fundamentals and policies, or whether changes in the interest rates have been driven by non-fundamental factors. The central difficulty to tackle this issue is that the "non-fundamental factors" are unobserved, and we cannot retrieve them from the residuals of the regressions linking spreads to macroeconomic fundamentals. Indeed, these residuals incorporates several elements: the role of non-fundamental factors, but also measurement errors on the variables, mis-specification errors, and various shocks affecting the returns and the volatility of the bond assets.

The purpose of this paper is to provide a unified approach to the joint testing of the convergence of sovereign spreads and the efficiency of sovereign bond markets (by efficiency, we mean informational efficiency). Usually, these issues are investigated in separate frameworks. On the one side, many papers proposed several measures of convergence/divergence of sovereign spread by borrowing concepts from beta-convergence growth empirics. On the other side, many connectedness measures between bond yield and some macro determinants exist, and the concept

of “connection” uncovers several aspects like contagion, causal links, networks etc. Here, we associate significant causal link to informational efficiency.

Our proposal to associate both approaches relies on three motivations. First, it seems straightforward to test the outcome that the causal link between yield spreads and their determinants has some impact on the convergence dynamics of the spreads. Equivalently, significant coefficients of the macro-financial fundamentals in a conditional beta-convergence equation, is not enough to conclude in favor of or against financial integration. We need to be sure that, convergence is occurring, because the significant causal links between the spreads and their determinants are interpreted correctly by market participants. Secondly, we do not consider the notion of “market integration” by any empirical characterization of distribution of the spreads (random walk). As we shall see in the next sections, significant causal link between the spreads and some of their fundamentals are indeed potentially consistent with the presence of locally non-stationary or nonlinear dynamics, sometimes implying persistent divergence of the spreads over time. Thirdly, we test the assumption of financial integration as reflecting the fact that the convergence, or divergence, of spreads are reflecting fundamentals. We therefore make the situation of divergence of spreads – the inverse of the law of one price – compatible with the assumption of financial integration.

The method we propose is based on the study of the dynamics of convergence/divergence of spreads by connecting the autoregressive coefficient of a beta-convergence model with those of the coefficients of the macroeconomic variables that are assumed to influence the spreads. Unlike the usual literature, our specification combines beta- and -sigma convergence of the spread dynamics. More specifically, we question whether the following macroeconomic fundamentals have been key drivers in influencing or not the bond yield spreads current account balance, inflation, real GDP growth, country-level index of financial stress and the debt ratio.

Our approach has several advantages compared to the methodologies used so far in the existing literature. First, the methodology is simple to apply and requires no specific assumptions about unobservable components of spreads. The second advantage is that the sensitivity of spreads to macroeconomic fundamentals is assumed to vary across countries and over time and may change when the spreads diverge or converge. Third, unlike the bulk of the literature our methods are robust to extreme changes in the spreads, notably during turbulent time.

Our results suggest that markets are not fully integrated in the short-term and that the information content of macroeconomic variables varies across time and countries, thereby casting doubt on the view according to which bond markets have been integrated since the beginning of the 2008 financial crisis and then started to be fragmented during the surge of the 2010 sovereign debt crises.

The remainder of the paper is organized as follows. Section 2 provides a brief literature review of bond market integration in Europe. Section 3 proposes a joint test of convergence of spreads and significance of the informational content of macro-financial fundamentals to explain the yield spreads. Section 4 concludes.

2. Brief literature overview

Whether or not sovereign bond markets have been more integrated since the launch of the Single currency has always been controversial in the literature. Doubts have re-emerged since the recent 2008 financial crisis and 2010 debt crises which have been viewed as adverse unexpected shocks that have threatened this integration. Important issues have centered on two questions i) whether European bond markets have become more integrated or more fragmented, and ii) whether one can identify the drivers of this integration/fragmentation phenomenon (institutional reforms, fiscal and monetary policies, etc).

Is it true that the adoption of the Single Currency brought together previously fragmented sovereign bond markets in the EU? And can we consider that the large and persistent yield spreads observed in some countries was a sign of a fragmentation? During the decades that followed the launch of the Single Currency, many studies have supported the view that the harmonization of fiscal, monetary and structural policies would help market investors to correctly price sovereign risks. Many researchers argued that lower government bond yields observed after 1999 were caused by market expectations of forthcoming macroeconomic convergence between the Euro area members, through the convergence of the national macro-financial policies. For instance, Côté and Graham (2004) show that a gradual downward trend in the bond yield spread occurred in three steps: mid-1980s, early 1990s and the third mid-1990s. And they conclude that “in the context of integrated financial markets, harmonization of sound monetary and fiscal policies across countries

will cause national long-term bond yield to converge”. Many economists agreed that a key explanation of the yield convergence was progress towards financial integration of the sovereign bond markets (see, for instance, Hartmann et al. 2003).

The literature of the 1990s and 2000s, up until the sovereign debt crises, was predominantly “biased” in favor of the view that sovereign spreads were “fundamentally” driven by macro-financial factors and policy actions. Supporters pointed to the empirical evidence of the causal statistically significant relationship between such variables and the yield spreads. Just to mention a few papers in an abundant literature, Correia-Nunes and Stemitsiotis (1995) find a strong significant relationship between nominal long-term interest rates and budget deficits. Orr et al. (1995) show that the trend of bond yields is driven by some structural factors, like the rate of return on capital, the risk-premium related to inflation credibility, the current account balances and government deficits. Brook (2003) finds a significant relationship between the bond yields and fiscal balances. Even during the year of the 2008 financial crisis, some authors like Pozzi and Wolswijk (2009) showed that fundamentals were significantly driving sovereign bond yields in the euro area and concluded that sovereign bond markets were efficient. This point is important to understand. For the “fundamentalist” literature, the preponderance of influence of macro-financial, institutional or economic policy variables was crucial, if the European countries were to come anywhere close to achieving their objective of being an integrated sovereign debt securities market. And one must keep in mind that this was viewed as a step towards future fiscal union.

The “fundamentalist” view has continued to prevail, after the financial and sovereign debt shocks. Some authors still relate changes in the sovereign yields to differences in competitiveness, fiscal and external imbalances, public and private debt ratios. For instance, Aizenmann et al. (2013) find that macroeconomic factors were significant determinants of sovereign spreads in South-West Eurozone (Greece, Italy, Ireland, Portugal and Spain). More recently, Arakelian et al. (2019) show that some key macroeconomic fundamentals, like debt/GDP ratio, have been useful during the period 2008-2017 to assign specific risk thresholds in CDS. Beetsma et al. (2017) find that more news reduces the volatility of yields of financially-distressed countries with German yields. Antonakis et al. (2017) find that, while there may be short-run divergence, the yield spread in the EU 17 convergence in the long-run. Göld and Kleiner (2016) find that yield spreads react to news on growth and deficit forecasts, but not on fiscal bailouts and fiscal retrenchments. For other

examples of papers, the reader can refer to Attinasi et al., 2009; Ben Salem and Castelletti, 2016; Constantini et al., 2014; Laubach, 2009; Von Hagen et al., 2011).

This literature has been challenged by an alternative one pointing that the indicators used by creditors are not always precise, thereby implying cognitive biases and being therefore useless for sovereign risk pricing. For instance, Blommestein et al. (2012) find that the hypothesis of “animal spirits” in the Euro area CDS bond markets provide a good fit of the data. De Grauwe and Ji (2013) argue for example that the spreads were not justified for some countries such as Portugal and Spain, with regards to their fundamentals compared with other countries that benefited from lower premiums. From the authors, rather some subjective factors (self-fulfilling prophecies driven by a greater aversion to the overall risk, or a fear of a contagion effects of the debt crises in the peripheral countries) have driven these spreads. In the same context, some authors analyzed the widening spreads as a sign of fragmentation of the sovereign bond markets in the Euro area. de Sola Perea and Van Nieuwenhuyze (2014) suggest that a financial segmentation has started in 2007 and intensified after 2011, thereby revealing the unstable nature of the financial integration in times of crises. Battistini et al. (2014) explain the phenomenon of financial segmentation by changes in investors’ expectations of sovereign default risks. Other authors point out to a negative influence redenomination of debt (Aizenman et al., 2013; Di Cesare et al, 2013), contagion behaviors (Giordano et al., 2012), changes in the degree of risk aversion (Abad et al., 2014), and changes in the rating of bonds (Christiansen, 2014). Other papers find that creditors discriminate between sovereign borrowers using subjective judgments. For instance, Broner et al. (2014) argue that, during crises, investors are more inclined to buy domestic (rather than foreign) bonds because they have higher returns. This increases crowding-out effects on the private sector, thereby impacting private investment. Since this affects growth, such behaviors can be a cause of self-fulfilling expectations. D’Agostino and Erhmann (2014) find that, during the years preceding the financial crises – e.g. in normal times – there has been a mispricing of risk of euro area bonds, a feature that does not apply to non-Euro area G7 bonds. Using a network approach, Glover and Richards-Shubik (2014) conclude that the “balance sheet” channel usually evoked to explain the divergence of spreads through contagion effects did not have any economically significant effects on the Euro area CDS spreads between 2005 and 2011.

3.- A joint test of convergence of spreads and informational content of fundamentals

3.1.- The empirical methodology

In this section, we propose a methodology that modifies the standard framework based on the law of one price usually considered in the literature to investigate financial integration in sovereign bond markets.

Let us start with a standard β -convergence equation. We compare the yield in country i , y_{it} , with the yield of a benchmark country f , y_{ft} , (in our case, Germany). The convergence coefficient is estimated using the following equation:

$$\ln\left(\frac{y_{it}}{y_{ft}}\right) = \alpha + \beta \ln\left(\frac{y_{it-1}}{y_{ft-1}}\right) + X'_{it}\gamma + \varepsilon_{it}, i = 1, \dots, N, t = 1, \dots, T. \quad (1)$$

X_{it} is a vector of macroeconomic fundamentals influencing the spread. β is a coefficient measuring the convergence of country i 's yield to the benchmark country's. α is an intercept and $\varepsilon_{it} \sim iid(0, \sigma_\varepsilon^2)$ is a residual term. The ratio $\frac{y_{it}}{y_{ft}}$ is the spread and the coefficient γ measures the influence of *differences* of macro-financial fundamentals (between country i and country f) on the spread. A negative β usually signals that spreads are narrowing, while a positive β suggests widening spreads. In the literature, it is common wisdom to consider that when $|\beta| < 1$ (resp. $|\beta| \geq 1$), sovereign debt markets should be considered as integrated (resp. fragmented). This means that after a shock, the mean-reverting dynamics of spreads leads them to stabilize to a certain level in the medium/long-run. We propose an alternative interpretation based on the testing of two hypotheses.

3.1.1- Testing the convergence of yield spreads

A general formulation for testing the convergence of yield spreads is:

Hypothesis 1 : H_0^1 : the yields are converging versus H_1^1 : the yields are diverging.

We define $sp_{it} = \ln\left(\frac{y_{it}}{y_{ft}}\right)$. The conditions $|\beta| < 1$ and $|\beta| \geq 1$ alone are not sufficient to see whether the yields are on a converging or diverging path.

Indeed, there are several conceptualization of convergence. The first kind refers to conditional β -convergence. $|\beta| < 1$ is a sufficient condition for Equation (1) to be stable, i.e. for the sequence (sp_{it}) , $t = 1, \dots, T$, to reach stochastic trajectories defined by sequences of values (sp_{it}^*) , $t = 1, \dots, T$, where

$$sp_{it}^* = \lim_{t \rightarrow +\infty} \frac{X'_{it}\gamma + \varepsilon_{it}}{1-\beta}, \quad |\beta| < 1. \quad (2)$$

In other words, this first notion of convergence implies that, in the long-run, spreads are determined by the macroeconomic fundamentals defined by the vector X and by non-fundamental variables represented ε_{it} . This definition of convergence is sufficient, only if we study the dynamics of spreads on a country-by-country basis. When capital markets are interconnected, it is more interesting to study the dynamics of spreads based on country panels. The investors' arbitrage behaviors is then reflected by in the variability of spreads from one country to another. In this case, a second interpretation of convergence is the following. The inter-individual variability of spreads must not be "too wide". We therefore add to Equation (1) another equation describing the temporal dynamics of the sample variance of spreads.

Denoting σ_{spt}^2 and σ_{Xt}^2 the empirical variances of the spreads and macroeconomic differentials (the annual country average), Equation (1) implies

$$\sigma_{spt}^2 = \beta^2 \sigma_{spt-1}^2 + \gamma^2 \sigma_{Xt}^2 + \sigma_{\varepsilon t}^2, \quad t = 1, \dots, T. \quad (3)$$

where $\sigma_{\varepsilon t}^2$ is the variance of ε_{it} . A general solution of this equation is

$$\sigma_{spt}^2 = \sigma_{spt}^{2*} + \beta^{2t} [\sigma_{sp0}^2 - \sigma_{sp0}^{2*}] + \lambda \beta^{2t}, \quad \sigma_{spt}^{2*} = \frac{\sigma_{\varepsilon t}^2 + \gamma^2 \sigma_{Xt}^2}{1-\beta^2}, \quad t = 1, \dots, T. \quad (4)$$

λ is an arbitrary constant. σ_{spt}^{2*} is the stochastic steady state path (bassin of attraction) of σ_{spt}^2 .

The steady state variance depends on the sample variance of the macroeconomic fundamentals and on the variance of the shocks ε_{it} . From Equation (4), we see that, if $|\beta| < 1$, then

$$\lim_{t \rightarrow +\infty} \sigma_{spt}^2 = \sigma_{spt}^{2*}. \quad (5)$$

Spreads can be β -converging towards zero, while at the same time, non-fundamental variables (the random shocks ε_{it}) are pushing them away from zero. An important feature here, seen in Equation (4), is the initial dispersion of spreads σ_{sp0}^2 . It must be small compared to the volatility of non-fundamental and fundamental variables. The expression of σ_{spt}^{2*} can be interpreted as representing the respective influence on spread dispersion of the volatility due to noisy traders $\sigma_{\varepsilon t}^2$ and the volatility stemming from the actions of fundamentalists $\gamma^2 \sigma_{Xt}^2$. A sufficient condition to avoid that spreads diverge (strong σ -divergence) in spite of β -convergence (when $|\beta| < 1$) is $\sigma_{sp0}^2 - \sigma_{sp0}^{2*}$ (the initial dispersion must be “weak enough”).

In conclusion, Hypothesis 1 can be formulated as follows:

$$H_0^1: |\beta| < 1 \text{ and } \sigma_{sp0}^2 \leq \sigma_{sp0}^{2*}$$

versus

$$H_1^1: |\beta| \geq 1 \text{ and/or } \sigma_{sp0}^2 > \sigma_{sp0}^{2*}$$

3.1.2- Combining the sample variability and β -convergence : quantile regressions

Taking into account the variability of spread dynamics when considering a panel of countries has two consequences.

First, there is no reason for fundamentals to influence spreads in the same way across countries and time. Similarly, the persistence of the shocks ε_{it} is not necessarily similar in all countries. Otherwise, this would mean that investors are short-sighted and do not discriminate between countries' risks. This assumption does not hold in real life, as shown by Figure 1 in the introductory section.

Second, the speed of convergence of countries' yields towards the risk-free rate is not necessarily similar across countries and time.

To take both considerations into account, we estimate β and σ using quantile regressions.

The conditional quantile function of the random variable sp (denoted \widetilde{sp}_θ) is defined by

$$F^{-1}(\theta/X) = \inf\{\widetilde{sp}_\theta: F(\widetilde{sp}_\theta/X) \geq \theta\}, F(\widetilde{sp}_\theta/X) = \Pr(sp \leq \widetilde{sp}_\theta), \quad (6)$$

for any $0 \leq \theta \leq 1$. θ is the θ^{th} conditional quantile of sp . Quantile regression estimates of the parameters of interest are obtained by the solution of the minimizing program:

$$\{\hat{\beta}, \hat{\gamma}\} = \operatorname{argmin}_{\beta, \gamma} \sum_{i=1}^N \sum_{t=1}^T \rho_\theta(sp_{it} - \beta(\theta)sp_{it} - X'_{it}\gamma(\theta)) \quad (5)$$

for given θ . ρ_θ is the check function defined by $\rho_\theta(\epsilon) = \epsilon(\theta - 1\{\epsilon < 0\})$. The literature on quantile regressions has attracted considerable attention. The interested reader can refer to Koenker et al. (2017). β and γ are estimated by applying a quantile estimator to Equation 1 at the different percentiles of the conditional distribution of spreads. We thus obtain a vector of $\hat{\beta}(\theta)$ and a vector of $\hat{\gamma}(\theta)$. Then, for each percentile θ , we compute $\sigma_{sp0}^{2*}(\theta)$ defined in Equation (3) and we test:

$$H_0^1: |\beta(\theta)| < 1 \text{ and } \sigma_{sp0}^2(\theta) \leq \sigma_{sp0}^{2*}(\theta)$$

versus

$$H_1^1: |\beta(\theta)| \geq 1 \text{ and/or } \sigma_{sp0}^2(\theta) > \sigma_{sp0}^{2*}(\theta)$$

This test leads two possible conclusions. On the one side, if H_0^1 is rejected, we conclude that the sovereign bond markets, some years and in some countries (located at the percentile θ), exhibit a divergent dynamic. It may be the case because some shocks in the market produce large initial deviations between the yields ($\sigma_{sp0}^2(\theta) > \sigma_{sp0}^{2*}(\theta)$), and/or because the spread dynamics is temporarily non mean-reverting (locally unstable: $|\beta(\theta)| \geq 1$). On the other side, if H_0^1 cannot be rejected, we conclude that the spread dynamics leads to a convergence of the sovereign yields.

We then compute \bar{P}_0^1 the percentage of θ s for which H_0^1 is *not* rejected. And choosing a cut-off of 0.5, we conclude that the spreads are, on average, converging if $\bar{P}_0^1 \geq 0.5$ and diverging otherwise.

3.1.3- Investing the sources of convergence/divergence of the spreads

Hypothesis 2. In a second step, we investigate whether H_0^1 is rejected - or not rejected - because of the links that exist between the macroeconomic fundamentals – their differences across countries and time – and the dynamics of the spreads. Let us define X_k as the the k^{th} explanatory variable in the vector X . Several conditions are worthy to check:

- a) $\hat{\gamma}_k(\theta)$ must be statistically significant: differences in macroeconomic fundamentals modify the risk premium in the sovereign bond markets. We test:

$$H_0^{2a}: |\gamma_k(\theta)| = 0 \text{ versus } H_1^{2a}: |\gamma_k(\theta)| \neq 0$$

For each k , we compute P_{0k}^{2a} the percentage of θ s for which H_0^{2a} is *not* rejected. And then, we calculate the average \bar{P}_0^{2a} over the k s. This measures the “probability” that differences in the macroeconomic fundamentals imply changes in the risk premium. Choosing a cut-off value of 0.5, we conclude that, on average, the macroeconomic fundamentals do not influence the spread if $\bar{P}_0^{2a} < 0.5$ and that the influence is significant if $\bar{P}_0^{2a} \geq 0.5$.

- b) $\hat{\gamma}_k(\theta)$ must carry the expected sign. For purpose of illustration, let us assume that X_k is the difference between countries' i and f primary balances. Referring to theory, we expect $\hat{\gamma}_k(\theta)$ to carry a negative sign, because investors asked for a higher risk premium when the fiscal balance in country i deteriorates compared with the fiscal balance in country f ($\Delta X_k < 0$). We test

$$H_0^{2b}: \gamma_k(\theta) < 0 \text{ or } \gamma_k(\theta) < 0$$

versus

$$H_1^{2b}: \gamma_k(\theta) < 0 \text{ or } \gamma_k(\theta) > 0$$

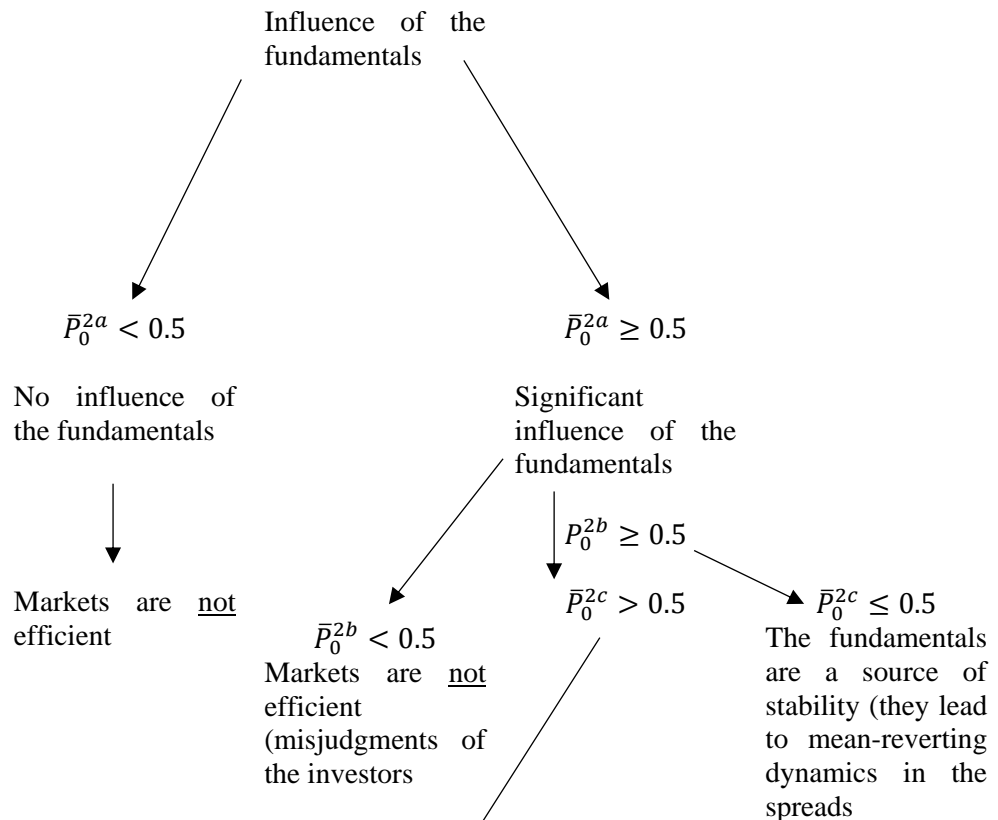
For each k , we calculate P_{0k}^{2b} the percentage of θ s for which $\gamma_k(\theta)$ carries the expected sign. We then compute the average \bar{P}_0^{2b} over the k s and choose a cut-off of 0.5 to conclude whether, on

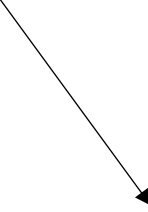
average, differences in the macroeconomic fundamentals are influencing the spread in the “right” direction ($\bar{P}_0^{2b} \geq 0.5$), or in the “wrong” direction ($\bar{P}_0^{2b} < 0.5$).

c) Let us assume a mapping between the vector $\hat{\delta}(\theta) = |\hat{\beta}(\theta) - 1|$ and $\hat{\gamma}_k(\theta)$, for instance $\hat{\delta}(\theta) = m_k[\hat{\gamma}_k(\theta)]$. We investigate the relationship between $\delta(\theta)$ and the *marginal* effects of X_k on the spread. m is estimated using a non-parametric model. For each explanatory variable k , we want to know whether m'_k (the derivative of $\hat{\delta}(\theta)$ with respect to $\hat{\gamma}(\theta)$) is positive or negative. In the first case, the correlation between the spreads and the fundamentals reduces the persistence of the spreads and of their volatility, or said equivalently, when the market participants price the risk by taking into account the information in the fundamentals, this has a stabilizing effects on the spreads. Conversely, if $m'_k < 0$, the value of $\hat{\beta}(\theta)$ becomes closer to 1, thereby implying that any initial gap (in the spreads, but also in their variance) has a de-stabilizing effect on the spreads.

The above tests lead to the following decision tree shown in Figure 2.

Figure 2. Decision tree





$m'_k \geq 0$. The fundamentals are a source of stability in the market (tend to reduce the spread)

$m'_k < 0$. The fundamentals are a source of instability in the market (tends to increase the spread)

3.2.- Data

The endogenous variable is defined by the difference in bond yields of 5-year maturity relative to the German (we take the first difference). The explanatory variables, all measured in terms of difference with Germany, are the following: (i) the spread with one lag, (ii) a public finance variable: sovereign debt ratio (iii) current account balance as a percentage of GDP and the real GDP growth rate; (iv) a financial stress indicator: each country's CLIFFS index- country level index of financial stress; (VI) inflation rate. These variables are selected with regards to the literature on the determinants of yield spreads⁶.

The frequency of the data is quarterly. Macroeconomic variables (public finances, current account, growth) are constructed from data collected in the Eurostat database. The 5-year bond yield rates were collected from Datastream. The original data frequency was daily, and we calculated the quarterly average. The CLIFFS is a composite index of financial system stress taken from the ECB (for a detailed presentation see Hollo et al., 2012). For each explanatory variable, we take the average over 3 consecutive quarters.

3.3.- Results

Table 1 contains the results of the tests and Figures 3a and 3b shows the quantile estimates (blue line) and confidence intervals (red line) for both sub-periods 2003-2009 and 2010-2017. The key variable that accounts for the influence of fundamentals on sovereign spreads is the current account.

⁶ See for instance, Afonso et al. (2015, 2020), Afonso et Nunes (2015), Aizenman et al. (2013), Beirne et Fratzscher (2013), Bernoth et Ergodan (2012), De Santis (2014), Erce (2015), Chaieb et al. (2014), Heinz et Sun (2014), Mink et de Haan (2013), Maltriz (2012).

For this variable, we obtain a probability \bar{P}_0^{2a} higher than 50% (above 70%). In Figure 3, when zero crosses the confidence interval, the coefficients are insignificant. This is the case for all the variables, except for the current account balance where the estimated coefficient is statistically significant at almost all quantiles. This variable is a source of market (informational) efficiency, in the sense that market participants correctly extract information from this variable to price the risk premium (the probability P_0^{2b} , indicates that the coefficient of this variable is always correctly signed in the quantile regressions: an increase in the current account balance leads a reduction of the yield spreads). Table 1 also indicates that the influence of countries' financial stress has become more important after 2010, though the influence was not very significant (\bar{P}_0^{2a} remains lower than 50%).

Figure 3a. Quantile estimates: 2003-2009

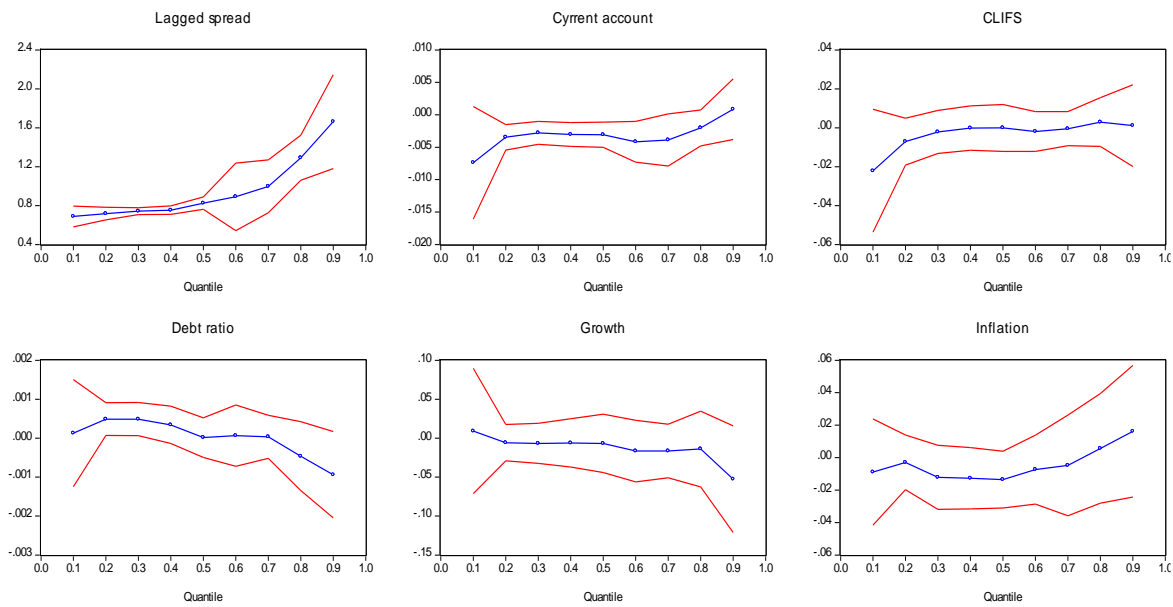


Figure 3b. Quantile estimates: 2010-2017

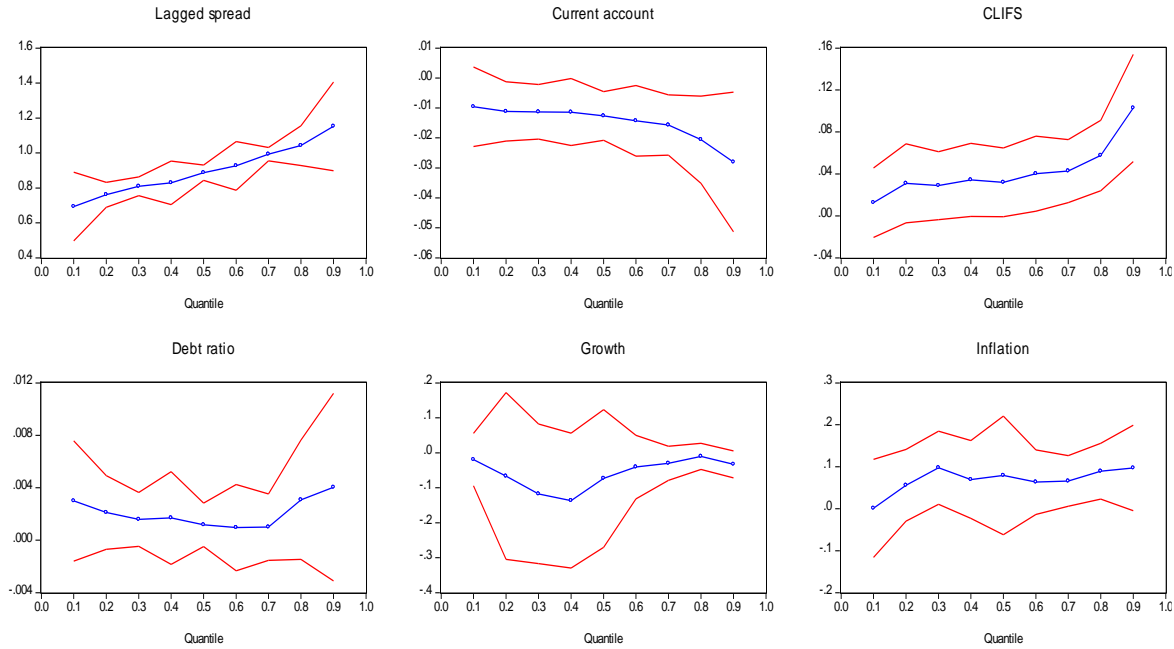


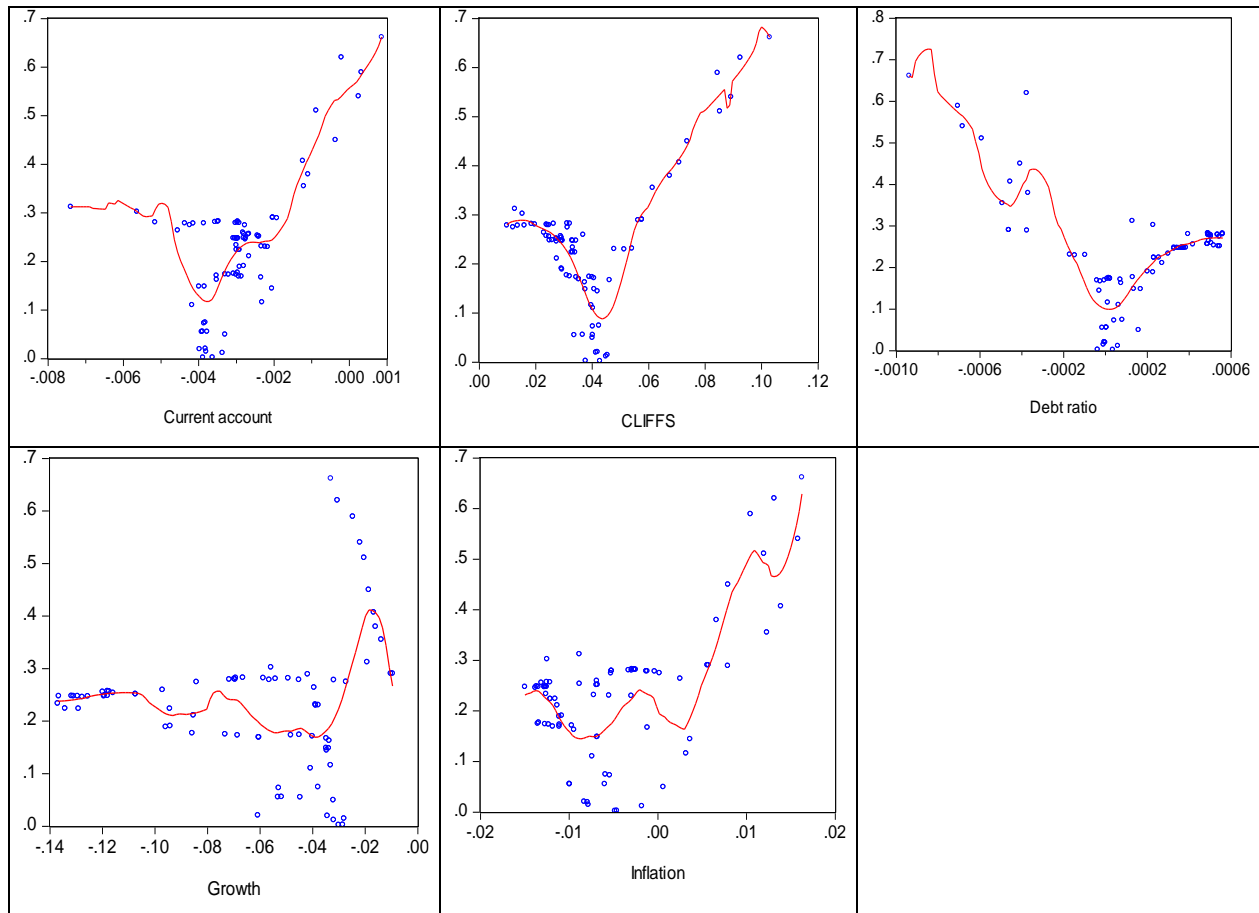
Table 1. Results of the tests

| | 2003-2009 | | 2010-2017 | |
|-----------------|------------------|------------|------------------|------------|
| | \bar{P}_0^{2a} | P_0^{2b} | \bar{P}_0^{2a} | P_0^{2b} |
| current account | 0.70 | 1.0 | 0.78 | 1.0 |
| CLIFFS | 0.0 | 0.98 | 0.46 | 1.0 |
| Debt ratio | 0.23 | 0.87 | 0.04 | 1.0 |
| Growth | 0.0 | 0.0 | 0.0 | 0.0 |
| Inflation | 0.0 | 1.0 | 0.26 | 1.0 |
| \bar{P}_0^1 | 0.49 | | 0.42 | |

Whether the dynamics of spreads is mean-reverting (stabilizing) is still a topic for debate. Indeed, the probability \bar{P}_0^1 is lower than 50%. This comes from the fact that, $|\hat{\beta}(\theta)| \geq 1$ above the median (see Figure 3, the coefficient of lagged spread). This illustrates the role of threshold -or nonlinear – effects in the dynamics of the yield spreads. Below a certain level of gap, any shocks to the spreads is rapidly absorbed by the markets. But, above this threshold, widening gaps tend to persist over time. Such nonlinear – or nonstationary- effects call for cautious when interpreting the significance of the explanatory variables within a linear context, as in Table 1. We therefore need to investigate further the presence of “local” nonlinearities and non-stationarity and we do this through wavelet analysis in the next section.

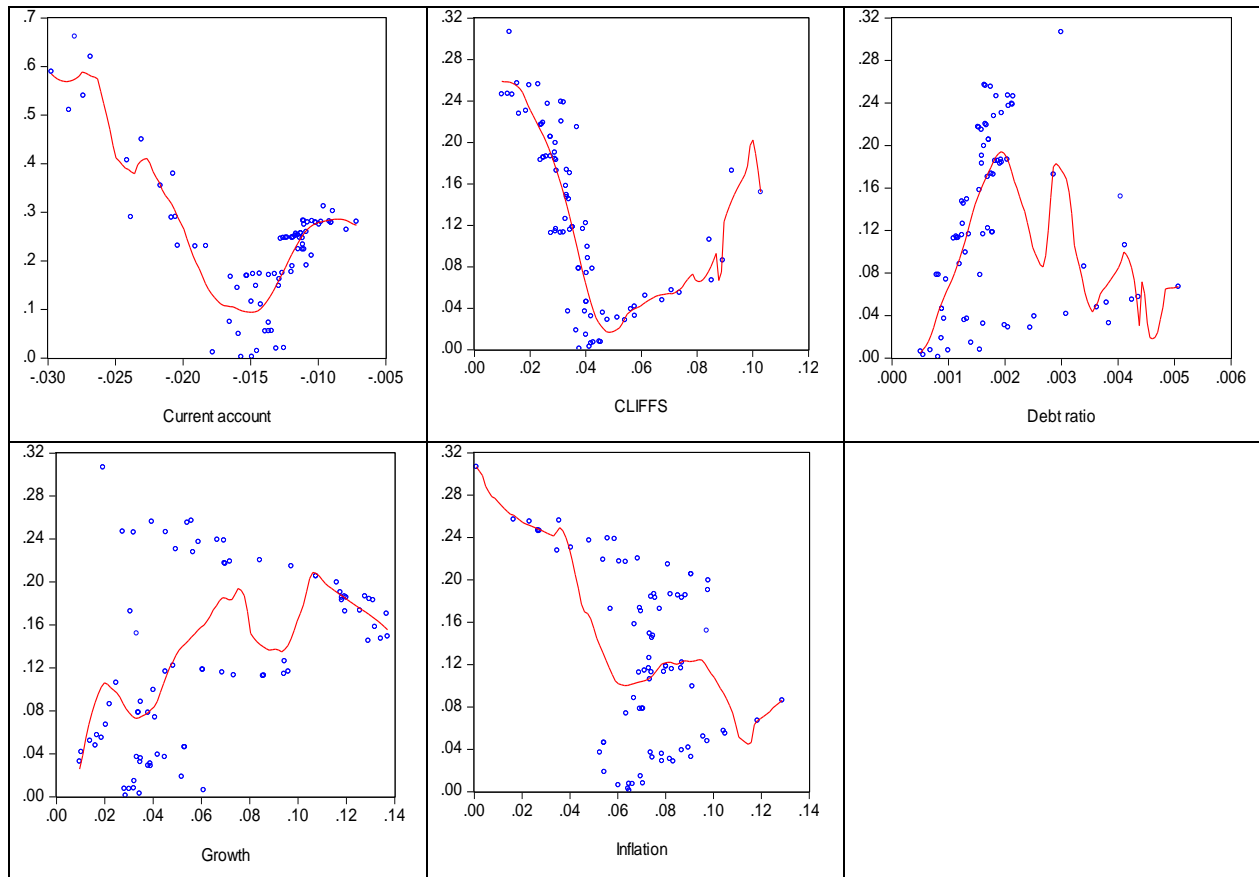
Before this, we compute m'_k , in order to investigate whether the correlation between the spreads and their determinants has a stabilizing or de-stabilizing effects on their influence the nature of their dynamics (stabilizing or de-stabilizing). We do a local polynomial regression by considering couples of coefficients $(\hat{\delta}(\theta), \hat{\gamma}_k(\theta))$. Figures 4a and 4b show scatterplots corresponding to these couples and a curve corresponding to the kernel fit. We want to know whether, when the correlation between fundamentals and spreads becomes stronger, the spread dynamics is more persistent, or whether it is less persistent. In the first case, following a shock, it takes time for yield gaps to close. The fundamentals therefore have a destabilizing effect on the spreads: $\hat{\delta}(\theta)$ and $\hat{\gamma}_k(\theta)$ are negatively correlated. In the second case, yield spreads are quickly absorbed following a shock, because the fundamentals have a stabilizing effect on spreads: $\hat{\delta}(\theta)$ and $\hat{\gamma}_k(\theta)$ are positively correlated.

Figure 4a. Local polynomial regression of $\hat{\delta}(\theta)$ on $\hat{\gamma}_k(\theta)$ for the period 2003-2009



Figures 4a and 4b show that the effects can go in either direction for the same variable. This calls into question the assumption that sovereign bond markets are informatively efficient, whether during calm periods (before the 2010 debt crises) or during more turbulent episodes (after 2010). In this context, it seems difficult to conclude that sovereign bonds markets have always been integrated in the euro area. Indeed, the law of one price cannot be satisfied when $\hat{\delta}(\theta)$ and $\hat{\gamma}_k(\theta)$ are negatively correlated. The fundamentals do not act as “attractors” for the spreads. The figures suggest that, sometimes investors can become “irrational” or use the information in the macro-financial fundamental in an inappropriate manner. These figures can also be explained by the fact that the interplay between fundamentalists and noise traders in the euro area sovereign bond markets have led to “out-of-equilibrium states” of the yield spreads.

Figure 4b. Local polynomial regression of $\hat{\delta}(\theta)$ on $\hat{\gamma}_k(\theta)$ for the period 2010-2017



5. Conclusion

This paper gives a new interpretation of the hypothesis of financial integration and fragmentation with an illustration to the euro area. In the usual approach, integration is seen as a natural state, a consequence of the assumption of informational efficiency. This state can then be disrupted by large financial shocks and lead to the onset of market fragmentation. But once the effects of the shocks dissipate, there is a return to integration. Our work suggests another alternative, at least with respect to sovereign bond markets. The notion of equilibrium is compatible with situations of price convergence or divergence. Moreover, informational efficiency is not a permanent phenomenon, as evidenced by the alternation of periods during which the links with fundamentals can be significant and go in the right direction, and then be misinterpreted by investors (the coefficients then have opposite signs in the regressions).

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