
DOCUMENT
DE TRAVAIL
N° 582

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Measuring Financial Fragmentation in the Euro Area
Corporate Bond Market

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We would like to thank Bo Becker, Ralph Koijen, Philippe Mueller, Jean-Paul Renne, Martin Wagner, Andrea Zaghini and participants in Banque de France seminar, Asymmetries in the European Union workshop, European Economic Association (EEA) conference, International Association for Applied Econometrics (IAAE) conference, European Central Banking Network policy research conference, for detailed and helpful suggestions. The views expressed in this article are those of the authors and do not necessarily reflect the views of ECB or Banque de France.

Résumé – Cet article porte sur l'évolution des déterminants, au cours de la dernière décennie, des rendements des obligations émises par les sociétés non financières de la zone euro. Nous décomposons l'écart entre le rendement des obligations de sociétés allemandes, françaises, italiennes et espagnoles vis-à-vis du Bund de même maturité, en des primes de risque pays, de risque de crédit et de risque de maturité au moyen de régressions avec des indicatrices. Nous soulignons trois principales conclusions. Tout d'abord, la phase initiale de la crise financière (2008-2009) a provoqué une augmentation globale des primes de risque de crédit. Depuis le début de 2013, les primes de risque de crédit sont de retour à des niveaux comparables à ceux précédant la crise financière. Deuxièmement, lors de la phase aiguë de la crise des dettes souveraine européennes (2011-2012), les primes de risque de crédit élevées ont été accompagnées par des signes forts et persistants de fragmentation financière en Italie et en Espagne (mais pas en France). Cette fragmentation a atteint son apogée dans la seconde moitié de 2012 et a commencé à reculer seulement après l'annonce de l'OMT. Troisièmement, nous fournissons une simple mesure de l'intégration financière entre les 4 grands États membres de la zone euro.

Mots-clés : intégration financière, risque de crédit, primes pays, indicateur de fragmentation

Codes JEL: E43, G12, G24, C23.

Annexe en ligne : <https://www.banque-france.fr/economie-et-statistiques/la-recherche/documents-de-travail/document/582.html>

Abstract – This paper analyses the determinants of euro area non-financial corporate bonds over the last decade. We decompose the spread between the yield of German, French, Italian and Spanish corporate bonds vis-à-vis the German Bund of similar maturity into country, credit and duration risk premia components via dummy regressions. We highlight three main findings. First, the initial phase of the financial crisis (2008-2009) caused an overall increase in credit risk premia. Since the beginning of 2013 credit risk premia are back to levels comparable to those preceding the financial crisis. Second, at the height of the euro area sovereign crisis (2011-2012), high credit risk premia were accompanied by strong and persistent signs of market fragmentation in Italy and Spain (but not in France). This fragmentation has reached its peak in the second half of 2012 and has started to recede only after the announcement of the OMT. Third, we provide a simple measure of financial integration across the big 4 member states of the euro area.

Keywords: financial integration, credit risk, country premia, fragmentation index

JEL codes: E43, G12, G24, C23.

Online appendix : <https://www.banque-france.fr/en/economics-statistics/research/working-paper-series/document/582-1.html>

Non-technical summary

The 2008 financial crisis and the ensuing recession triggered deterioration in the public finances of most economies. Some governments hence have to manage simultaneously bleak activity prospects, a high debt burden and the need to help their banking system. Investors therefore conceived doubts on the ability of the agents, whether firms or governments, to repay their debts. The interest rates asked by investors sharply increased, especially for agents located in countries such as Italy or Spain.

The aim of this paper is to build price indicators of deviation from the law of one price for corporate bonds within the euro area.¹ To this end, we estimate national risk premia in the yields of non-financial corporate bonds while controlling for their underlying credit and maturity risks. We estimate these indicators on a panel of 735 individual bonds issued by 157 non-financial corporates.

Our main contribution is to measure the part of corporate spreads vis-à-vis the bund which is due to financial fragmentation, that we define as differences in spreads between two securities, these assets are otherwise similar in terms of their risk characteristics. In particular, we control for differences in both credit risk and maturity risk.

The paper is related to at least three strands of empirical finance literature: credit risks of sovereigns, credit risk on corporate and the measurement of financial fragmentation in the euro area.

The first one is devoted to the determinants of sovereign interest rates and allows for relating interest rates on sovereign debt to macroeconomic fundamentals. Analyses of the European sovereign debt crisis show a sharp break in the relation between sovereign yields and “fundamentals” (Aizenman, (2013)²). Other factors not directly connected to “fundamentals” may be considered: change in risk aversion over the business cycle; spillover from other countries; and more, generally, turbulences on the financial markets, but also redenomination risk.

Second, regarding the literature on the credit spread, we can notice that, in studies using either reduced form models or calibrated models obtain, default probabilities explain only one third of the variations in credit spreads for investment grade bonds (Collin-Dufresne et al., (2001)³, Huang and Huang, (2012)⁴). The remaining part of the spread can include tax asymmetries or dispersed information. However, a large body of the literature focuses on credit risk premia and liquidity premia.⁵ A credit risk premium is asked by the investors because of the tendency for defaults to cluster in bad states of the economy and the ensuing difficulty to hedge against such risk. Liquidity premia are asked for bonds that, in some state of the economy, are not fully liquid and therefore costly to sell. The role of the corporate bond illiquidity on corporate bond prices is emphasized in both theoretical (Acharya and Pedersen (2005)⁶) and empirical analyses emphasize (Dick-Nielsen et al.,

¹ In the paper we will describe this deviation from the law of one price either as financial fragmentation or lack of financial integration.

² Aizenman, J., M. Hutchison, et Y. Jinjarak. «What is the risk of European sovereign debt defaults? Fiscal space, CDS spreads and market pricing of risk.» *Journal of International Money and Finance* 34 (2013): 37-59.

³ Collin-Dufresne, Pierre, Robert Goldstein, et J. Spencer Martin. «The Determinants of Credit Spread Changes.» *The Journal of Finance* 56, n° 6 (2001): 2177-2207.

⁴ Huang, Jing-Zhi, et Ming Huang. «How much of the corporate-treasury yield spread is due to credit risk?» *Review of Asset Pricing Studies* 2, n° 2 (2012): 153-202.

⁵ The credit risk and liquidity premia can be interconnected. He and Milbradt (2014) model the endogenous interplay between default and liquidity: liquidity dries up when solvency becomes a concern, which amplifies issuers' defaults.

⁶ Acharya, V., et L. Pedersen. «Asset pricing with liquidity risk.» *Journal of Financial Economics* 77 (2005): 375-410.

(2012)⁷). Our results highlight that both credit risk and liquidity premia peaked during the sovereign debt crisis for Italy and Spain.

Third, a growing literature investigates financial fragmentation in the euro area and their impact on the business cycle. Gilchrist and Mojon (2014)⁸ compute credit risk indices for the euro area banks and non-financial corporate issuers following the methodology of Gilchrist and Zakrajsek (2012)⁹. They show instead that their aggregate, security-specific measure of credit risk is a useful leading indicator of real activity. Bleaney et al. (2012)¹⁰ extend Gilchrist and Zakrajsek (2012) for non-financial corporate bonds issued in 8 European countries. They also estimate excess bond premia defined as the difference between the credit spread and a Merton based measure of credit risk proxied by distance to default. Pianeselli and Zaghini (2014)¹¹ estimate the risk premia of non-financial long-term corporate bonds, using prices at issuance for a sample of euro area, US and UK bonds, over the 2005-2012 period. Unlike our paper, they focus on the primary market and use coarser time dummies to identify the financial crisis period (2008-2009) and the euro area sovereign debt crisis (2010-2012). They find that the financial crisis increases the costs of funding for all corporate bonds, while the sovereign debt crisis creates a wedge between peripheral countries corporations and their German counterparts.

Our results show that while financial fragmentation has remained fairly limited during the post Lehman Great Recession, from 2008 to 2009, it reaches very high levels at the heights of the euro area sovereign crisis in 2011 and 2012. Corporate bonds issued in Italy and Spain bear higher yields than similar bonds issued in France and Germany. Fragmentation has receded gradually since the announcement of the Outright Monetary Transaction (OMT thereafter) program that the ECB announced in September 2012. However, it remains around 50 basis points as of June 2015. Hence, during the most acute periods of the sovereign debt crisis, corporate bondholders have required higher yields to hold corporate bonds issued in Italy and Spain. To the extent that this increased the cost of funding for firms in these countries, it is likely to have dampened the effectiveness of the accommodative stance pursued by the ECB.

These country premia appear to be correlated with the credit premia of their respective sovereign. Such correlations show that corporate issuers are not fully insulated from the domestic economy and financial turmoils associated with a sovereign default. This can be due to several reasons including the difficulty to diversify portfolio against a sovereign default in Italy or Spain, risks of financial repression, redenomination risk or concerns on the funding of a public bailout of the finance industry.

These results are useful for the analysis and implementation of monetary policy. Since 2010, the European Central Bank (ECB) has frequently referred to the financial fragmentation within the euro area as an impediment to the transmission of its monetary policy to bank lending rates and thus a

⁷ Dick-Nielsen, Jens, Peter Feldhütter, et David Lando. «Corporate bond liquidity before and after the onset of the.» *Journal of Financial Economics* 103 (2012): 471-492.

⁸ Gilchrist, Simon, et Benoît Mojon. *Credit risk in the Euro area*. NBER Working Paper Series, Cambridge: NBER, 2014.

⁹ Gilchrist, Simon, et Egon Zakrajsek. «Credit Spreads and Business Cycle Fluctuations.» *American Economic Review* 102, n° 4 (2012): 1692-1720.

¹⁰ Bleaney, M., P. Mizen, et V. Veleanu. *Bond spreads as predictors of economic activity in eight european economies*. Working Paper, University of Nottingham, 2012.

¹¹ Pianeselli, Daniele, et Andrea Zaghini. «The cost of firms' debt financing and the global financial crisis.» *Finance Research Letter* 11 (2014): 74-83.

major obstacle to the conduct of monetary policy (see for instance ECB, (2013)¹² and Coeuré, (2014)¹³).

Our measure of financial fragmentation, which we update on a quarterly frequency and publish on an online appendix, can be used to assess this impediment to the transmission of the ECB monetary policy.

¹² ECB. *Annual Report 2012*. Frankfurt: European Central Bank, 2013.

¹³ Coeuré, B. «Current challenges for the conduct of monetary policy in the euro area.» *Speech at the Conference ECB and its Watchers*. Frankfurt, 12 March 2014.

1. Introduction

The purpose of this paper is to build price indicators of deviation from the law of one price for corporate bonds within the euro area.¹⁴ To this end, we estimate national risk premia in the yields of non-financial corporate bonds while controlling for their underlying credit and maturity risks. We estimate these indicators on a panel of 735 individual bonds issued by 157 non-financial corporates.

Our main contribution is to measure the part of corporate spreads vis-à-vis the bund which is due to financial fragmentation, which we define as differences in spreads between two securities which are otherwise similar in terms of their risk characteristics. In particular, we control for differences in both credit risk and maturity risk.

Our results show that while financial fragmentation has remained fairly limited during the post Lehman Great Recession, from 2008 to 2009, it reaches very high levels at the heights of the euro area sovereign crisis in 2011 and 2012. Corporate bonds issued in Italy and Spain bear higher yields than similar bonds issued in France and Germany. Fragmentation has receded gradually since the announcement of the Outright Monetary Transaction (OMT thereafter) program that the ECB announced in September 2012. However, it remains around 50 basis points as of June 2015. Hence, during the most acute periods of the sovereign debt crisis, corporate bondholders have required higher yields to hold corporate bonds issued in Italy and Spain. To the extent that this increased the cost of funding for firms in these countries, it is likely to have dampened the effectiveness of the accommodative stance pursued by the ECB.

These country premia appear to be correlated with the credit premia of their respective sovereign. Such correlations show that corporate issuers are not fully insulated from the domestic economy and financial turmoils associated with a sovereign default. This can be due to several reasons including the difficulty to diversify portfolio against a sovereign default in Italy or Spain, risks of financial repression (Becker and Ivashina, (2014)), redenomination risk (De Santis, (2015)) or concerns on the funding of a public bailout of the finance industry (Acharya et al., (2014), Bofondi et al (2013)).

These results are useful for the analysis and implementation of monetary policy. Since 2010, the European Central Bank (ECB) has frequently referred to the financial fragmentation within the euro area as an impediment to the transmission of its monetary policy to bank lending rates and thus a major obstacle to the conduct of monetary policy (see for instance ECB, (2013) and Coeuré, (2014)). Our measure of financial fragmentation, which we update on a quarterly frequency and publish on an online appendix, can be used to assess this impediment to the transmission of the ECB monetary policy.

Our results relate to at least three strands of empirical finance: credit risks of sovereigns, credit risk on corporate and the measurement of financial fragmentation in the euro area.

The first one is on the determinants of sovereign interest rates. This literature relates interest rates on sovereign debt to macroeconomic fundamentals (Bayoumi et al., (1995), Bernoth, (2012), Faini, (2006)). Analyses of the European sovereign debt crisis show a sharp break in the relation between sovereign yields and “fundamentals” (Borgy et al., (2011), Aizenman, (2013), Dewachter et al., (2015)). Other factors not directly connected to “fundamentals” may be at play, including change in risk aversion over the business cycle (Manganelli and Wolswijk, (2009)), spillover from other

¹⁴ In the paper we will describe this deviation from the law of one price either as financial fragmentation or lack of financial integration.

countries (De Santis, (2012), Ehrmann and Fratzscher, (2015), Giordano, (2013)) and more generally on turbulences on the financial markets (Ang and Longstaff, (2013)), but also redenomination risk (De Santis, (2015)) or political risk (Manzo, (2013)).

Second, this paper is related to the literature on the credit spread. Studies using either reduced form models or calibrated models obtain that default probabilities explain only one third of the variations in credit spreads for investment grade bonds (Collin-Dufresne et al., (2001), Duffie et al., (2007), Giesecke et al., (2011), Huang and Huang, (2012)). The remaining part of the spread can include tax asymmetries (Elton et al., (2001)) or dispersed information (Albagli et al., (2014)). Most of the literature focuses however on credit risk premia and liquidity premia.¹⁵ A credit risk premium is asked by the investors because of the tendency for defaults to cluster in bad states of the economy and the ensuing difficulty to hedge against such risk. Liquidity premia are asked for bonds that, in some state of the economy, are not fully liquid and therefore costly to sell. The role of the corporate bond illiquidity on corporate bond prices is emphasized in both theoretical (Lo et al. (2004), Acharya and Pedersen (2005), Garleanu and Pedersen (2013)) and empirical analyses emphasize (Bao et al., (2011), Dick-Nielsen et al., (2012), Friewald et al., (2012)). Our results highlights that both credit risk and liquidity premia peaked during the sovereign debt crisis for Italy and Spain.

Third, a growing literature investigates financial fragmentation in the euro area and their impact on the business cycle. Gilchrist and Mojon (2014) compute credit risk indices for the euro area banks and non-financial corporate issuers following the methodology of Gilchrist and Zakrajsek (2012). They show instead that their aggregate, security-specific measure of credit risk is a useful leading indicator of real activity. Bleaney et al. (2012) extend Gilchrist and Zakrajsek (2012) for non-financial corporate bonds issued in 8 European countries. They also estimate excess bond premia defined as the difference between the credit spread and a Merton based measure of credit risk proxied by distance to default. Pianeselli and Zaghini (2014) estimate the risk premia of non-financial long-term corporate bonds, using prices at issuance for a sample of euro area, US and UK bonds, over the 2005-2012 period. Unlike our paper, they focus on the primary market and use coarser time dummies to identify the financial crisis period (2008-2009) and the euro area sovereign debt crisis (2010-2012). They find that the financial crisis increases the costs of funding for all corporate bonds, while the sovereign debt crisis creates a wedge between peripheral countries corporations and their German counterparts.

Our approach is closely related to the one of Baele et al. (2004). They estimate a series of cross-sectional regressions of corporate bond yield spreads against bond specific characteristics (coupon, liquidity, time to maturity) and a set of dummies proxying for rating and sectors. Next they test for integration by checking whether the residuals from these regressions still contain systematic country components.

The paper proceeds as follows. Section 2 is devoted to the data, corporate bond main characteristics as well as the computation of the spreads. Section 3 presents the reduced-form model for panel data. Results of the benchmark model are reported in Section 4. Section 5 presents a series of robustness checks. Section 6 concludes.

¹⁵ The credit risk and liquidity premia can be interconnected. He and Milbradt (2014) model the endogenous interplay between default and liquidity: liquidity dries up when solvency becomes a concern, which amplifies issuers' defaults.

2. Data

Our empirical analysis builds on a new database of comparable interest rates on corporate bonds. In this section, we first describe the source of our data and next we discuss in detail the summary statistics of our key variables.

2.1 Source

We collect data on individual corporate bonds over the period from January 2004 to June 2015. The dataset has been constructed at the security level from Datastream, Bloomberg and Dealogic. We impose several restrictions to ensure the data are homogeneous. The sample is restricted to fixed coupon, non-callable securities issued by non-financial corporations, for which Moody's rating is available at all dates. We observe the yield of each bond, which we measure with the yield to maturity, on the last day of the month. We follow bonds from their issuance to their maturity. However, since the market price is volatile for bonds close to their maturity, we discard bonds with a residual maturity less than eighteen months.

The identification of a firm's country requires special care, as the location of a firm does not necessarily match the nationality of its' owner.¹⁶ Furthermore, large firms sometime hold finance vehicle in charge of corporate debt issuance and these branches can be located in other countries. The location of the issuer, namely the branch, should not be confused with the location of its' parent company. The country we will refer to hereafter is the location of the parent company, since it reflects the market in which the firm evolves and the sovereign to which it is mostly related to. Our sample contains data on securities whose issuer parent company are located either in Germany, France, Italy or Spain.

We complement the data on yields with the ratings of the parent company as provided by Moodys'.

2.2 Descriptive statistics

The key variable we use in our empirical analysis is the corporate bond spread over the German government bond with similar maturity. More precisely, let the i index denote a corporate bond. The corresponding spread S_{it} is the difference between the yield R_{it} of the corporate debt security and the German Bund zero coupon of a similar duration $ZCR_t^{DE}(Dur(i, t))$. Hence:

$$S_{it} = R_{it} - ZCR_t^{DE}(Dur(i, t)).$$

These spreads are by construction free of term risk premia and should therefore capture credit risk premia vis-à-vis the German Bund (see also Gilchrist and Zakrajsek, (2012); and Gilchrist and Mojon, (2014)).

The sample is of about 32,000 monthly observations, relative to 735 corporate securities and 157 issuers. Details on the number of observations along with summary statistics on their main characteristics, including the size of the issuance, maturity and durations, are in Table 1. About two

¹⁶ For instance, if a company owned by a German car manufacturer issue bonds in Italy, we relate these bonds to Germany.

third of the observations come from issuers located in France or Germany. Nonetheless, the average issuances, close to 1 billion dollars, and the maturities, around 8 years, are quite similar across countries. The most noticeable difference is that Italian yields 50 basis points higher than their counterparts in Germany or France, which is partly explained by the slightly longer maturity of Italian bonds.

Figure 1 provides further information on the depth of the markets. The relative proportions of bonds issued in each country are quite stable over time. Germany and France have about twice more bonds on the market than Italy and Spain. However, the gap in outstanding amounts get narrower over time.

Figure 2 displays the evolution of the average spread in the countries under review. They co-move remarkably up to 2010 and split into two groups afterwards. For France and Germany, they stabilise at levels which are about 50 to 100 basis points above those observed before 2008. For Italy and Spain, they increase first mildly and temporarily in 2010 and then sharply from early 2011 to mid-2012. After that, they decrease progressively and reach at the end of the period levels similar to those observed for France and Germany.

2.3 Rating dynamics

Differences in the cross country averages could be explained by differences in firms' characteristics. The widening in spreads observed between 2011 and 2014 for Italian and Spanish firms could be due to a composition effect, triggered for instance by an increase in the firms' risk of default relative to their German and French counterparts. We control for individual default risks using the security credit ratings from Moodys'.¹⁷

While ratings are only an imperfect measure of default risks, they remain the most widely used measures of credit risk. In addition, recent papers have showed that the accuracy of ratings improves in periods of financial stress like the one we consider in our sample (Baar-Isaac and Shapiro (2013), Koopman *et al.* (2009) and Broto and Molina (2014)). One additional concern for our analysis is that the ratings of corporates are dominated by the ratings of their sovereign (Almeida *et al.* (2014) and Adelino and Ferreira (2015)). Figure 3 shows that this is unlikely to be the case in our sample. Clearly, whereas both series display a tendency toward more default risk, sovereign ratings deteriorate much more than security ratings. The Spanish sovereign was downgraded 8 notches, from Aaa to Baa2, over the period from 2010 to 2015, while securities issued by Spanish firms were on average downgraded by only 1 notch, from Baa1 to Baa2. A similar phenomenon can be observed in Italy. The so called diabolic loop between sovereign and corporates seems therefore fairly weak in our sample. This may be due to our focus on non-financial corporates.

Ratings in our sample are stable not only at the aggregate level but also at the security level. We show in Table 2a that transition intensities from the current rating to another never exceed 5%.

To ensure that we have a sufficient number of observations within each rating category at every point in time, we aggregated the ratings in two broad categories: a highly rated group, including all

¹⁷ Alternatives measures of credit rating could be used, such as CDS spreads or accounting based measures. We do not use these variables as they are available for only a small subsample of bonds that, furthermore, are presumably very liquid. We should thus correct such variables from the effect of liquidity, rendering the analysis much more complicated and less convincing.

companies rated between Aaa and A3, and a lower rated group, including ratings between Baa and B3.¹⁸ Figure 4 reports the evolution of the number of observations within each rating category. For Italy, the number of observations belonging to the group with the best rating dropped sharply just after 2012, which is mirrored by an increase in the group with the lowest ratings. Something similar occurred in France at the end of 2014. Even with these broad groups, there are no observations relative to Spain in the safest group at the end of the period. The developments in 2012 notwithstanding, the transitions in and out of our two rating categories are rare (see Table 2B). Downgrades are more likely than upgrades for bonds whose issuer parent is located in Italy (probability of an upgrade about 0.002, of a downgrade of 0.010) or Spain (probability of an upgrade lesser than 0.001, of a downgrade of 0.012).

Altogether, the rating structure is fairly stable throughout our sample.

3. Empirical strategy

Our goal is to identify whether similar issuers in terms of risk and maturity but located in different member states pay similar or different premia. The most general specification would allow credit and term premia to vary with countries:

$$S_{it} = \delta_i + \delta_t + \delta_{C,R,M,t} + e_{it}$$

where S_{it} is the difference between the yield to maturity of corporate bond i and the zero coupon German Bund of equivalent maturity, as explained in the preceding section, δ_i is the bond fixed effect, δ_t is a monthly time dummy, and $\delta_{C,R,M,t}$ are dummies which identify each possible country-rating-maturity combination. In our sample we have:

- i. four different countries: $C=\{DE, FR, IT, ES\}$;
- ii. two broad rating categories: high if the bond is rated A3 or higher and low if it is rated between Baa1 and Baa3, $R=\{HR, LR\}$;
- iii. three types of maturities: short if the maturity of the bond is between 1.5 and 3 years, medium if it is between 3 and 6 years and long if it is more than 6 years, $M=\{ST, MT, LT\}$.

Taking a German bond with high rating and short maturity as reference, there would be a total of 23 possible combinations: $\{DE, FR, IT, ES\} \times \{HR, LR\} \times \{ST, MT, LT\} \setminus \{DE, HR, ST\}$. However, as discussed in the previous section and reported in Table A.1, many of these combinations involve only a few observations and sometimes no observation at all. This implies that the coefficients of some of the dummies would be at best poorly identified.

We therefore impose the following identification assumptions:

1. credit risk premia are identical across countries;

¹⁸ We discarded bonds with junk rating because they were too few.

2. durations risk premia are identical across countries;
3. credit, country and durations risk premia are separable.

The resulting specification becomes:

$$S_{it} = \delta_t + \delta_{c,t} + \delta_{r,t} + \delta_{m,t} + \delta_i + e_{it}, \quad [1]$$

where $\delta_{c,t}$ is associated to a set of country dummies identifying bonds issued by corporates residing in France, Italy or Spain ($c \in \{FR, IT, SP\}$), $\delta_{r,t}$ to dummies identifying lower rated bonds ($r \in \{LR\}$) and $\delta_{m,t}$ to dummies for bonds with medium or long durations ($m \in \{MD, LD\}$). The reference bond spread estimated by the intercept δ_t is a German bond with high rating and short maturity. Fixed effects capture bond characteristics that are constant over time. This includes characteristics such as the amount issued or the coupon rate, which are often used as liquidity proxies in the cross-section.

It is easy to see that the default risk of a bond in this specification is independent of the country. For instance, the spread of an Italian medium-term bond i with a low rating would be

$$\delta_t + \delta_{IT,t} + \delta_{LR,t} + \delta_{MD,t} + \delta_i$$

while a high rating bond i' would instead be

$$\delta_t + \delta_{IT,t} + \delta_{MD,t} + \delta_{i'}$$

The difference in yields between the two bonds:

$$\delta_{LR,t} + (\delta_i - \delta_{i'})$$

is not country-specific.

Our main object of interest is the estimated coefficient $\hat{\delta}_{c,t}$, which can be interpreted as the additional cost that non-German corporations have to pay compared to their German counterparts with similar risk profiles. Risk profiles are characterized here by both the observed and unobserved characteristics. In an integrated euro area wide financial market, and provided our risk controls are comprehensive, the country specific time fixed effects should not be significantly different from zero.

We estimate the above panel regression with the within estimator, that uses variations in the explanatory variables over time. Standard errors are clustered at the issuer level.

4. Main results

This section presents the estimates of our main model and introduces our index of financial fragmentation in the euro area. We report in the figures the estimated quantities at monthly frequency, together with the associated 95% confidence intervals derived from standard errors clustered at the level of the issuer. We first report three main sets of results, the credit risk premia, the term spread and the country risk premia. We then introduce our euro area index of financial fragmentation.

4.1 Credit Risk Premia

Given bonds i with a low rating and bond i' with a high rating, credit risk premia are measured by $\delta_{LR,t}^+ (\delta_i - \delta_{i'})$. Figure 5, panel A, plots their evolutions.

Credit risk premia started to increase in the first months of 2008, suggesting that a substantial re-pricing of risk was already under way before the Lehman default. Credit risk premia reached their peak in the aftermath of the Lehman bankruptcy, at more than 170 basis points above their level of January 2004. There was a second peak at the end of 2011, associated with the euro area sovereign debt crisis. However, this second peak is, at about 110 basis points more than the level of January 2004, much smaller than the one observed at the end of 2008. The decrease in the risk premia since summer 2012 indicates that the yields on securities rated from Aaa to A3 gets closer to those on bonds rated from Baa1 to Baa3. The risk premia are only weakly positive in June 2015. This could be driven by another wave of “search for yield” inducing, in the current context of very low interest rates, an excess demand for assets with relatively high default probability. No specific variations are observed in January or March 2015, dates at which the European QE has been announced and implemented.

4.2 Maturity structure

We now turn to the maturity structure of credit risk¹⁹. We divide bonds in three categories with maturity of, 1.5 to 3 years, 3 to 6 years and more than 6 years. Figure 5, panel B, plots the evolution of difference in yields with respect to the 1.5 to 3 years, that is specific to corporate bonds term structure. These differences have remained relatively stable around zero well into the crisis. The striking development revealed by the estimation is the substantial increases during the first half of 2012, especially for bonds of maturity superior to 6 years. Since the yield curve of the German sovereign remain quite stable at that time, this result indicates a steepening in the yield curve of credit risk. It may in particular reflect the impact of 3 years Long Term Refinancing Operations (LTROs thereafter)²⁰ put in place the first quarter of 2012 and the Outright Monetary Transactions (OMTs thereafter)²¹, which would target bonds with maturity up to 3 years, announced in September 2012. It seems that Italian and Spanish corporate bonds of maturity inferior to 3 years have benefited from these programs more than their counterparts of longer maturity.

4.3 Country Risk Premia

The coefficient associated with the country dummy represents our main measure of financial fragmentation. Fragmentation was not an issue in 2004 and we set January 2004 as a reference for financial integration in our estimates. The charts in Figure 5, panel C, show that country risk premia

¹⁹ Given that our yields are already defined as differences between corporate bonds and Bunds of similar maturity (see Definition in section 2), the term structure we analyse here is one of the credit risk which may arise in addition to the term structure of the Bund, our benchmark which we assume to be free of credit risk.

²⁰ The 3-years LTROs are announced in December 2011 (ECB, (2011)).

²¹ The modalities for the OMTs are described in ECB (2012).

did not differ from zero until 2010. That is, even after the start of the financial crisis, following the Lehman Brothers default in September 2008. Sizable country risk premia started to be priced for Italy and Spain (but not for France), only at the start of the euro area sovereign debt crisis in 2010. The observed country risk premia peaked at more than 300 basis points at the end of 2011 for Italy, and at 400 basis points for Spain during Summer 2012. There is a noticeable decline after the famous “whatever it takes” speech by Mario Draghi on July 2012 and the following announcement of the OMT program by the ECB in September 2012. It is also interesting to notice that according to our measure, there was no major sign of fragmentation for French non-financial corporate bonds. Finally, it is the country risk premia, and not the credit risk that dominate spread during sovereign debt crisis. At that time, Italian and Spanish corporates were penalized by the rising defiance of investors toward their sovereign if compared to German and French firms of similar risk characteristics.²²

Towards the end of the sample, in June 2015, the country coefficients for Italy and Spain have dropped close to but slightly above pre-sovereign crisis level. Issuers located in Italy face a premia of about 70bp and issuer located in Spain face a premia of about 50bp. These estimates are statistically different from zero only in Italy. Altogether, financial fragmentation has receded substantially with respect to 2012 and 2013.

4.4 A corporate bond market fragmentation index

We derive a synthetic index of corporate bond market fragmentation as the sum of the country premia described in section 4.3. Figure 6 shows the index with its confidence bands (Panel A) and compares it to an alternative measure of fragmentation which is constructed by the ECB (Panel B).

Financial fragmentation has remained negligible until 2010 when the sovereign debt crisis began. The Greek budget deficit was subject to large corrections in October 2009 and the Greek sovereign bonds were downgraded to “junk” status in April 2010. By early 2010, corporate bond markets in Italy and Spain showed signs of contagion that ultimately peaked in summer 2012. It is only after the announcement of the OMTs that fragmentation receded. Still, the fragmentation index remains higher in mid-2015 than prior to the European debt crisis level.

Figure 6 also reports the dispersion of bank interest rates on new loans to NFCs (Panel B). It is the ratio of the cross-country standard deviation of bank interest rates on new loans divided by their average level.²³

Both fragmentation indices highlight the increase in the heterogeneity across funding costs from mid-2011. However, our measure which directly reflects market sentiment, peaked in mid-2012 and decrease afterward. The ECB indicator, which reflects self-reported interest rates bank loans, peaked in 2013 and showed a much more gradual decline. This suggests at least that the effects of fragmentation on the cost of issuing corporate debt securities receded much faster. It also indicates

²² Another dire consequence of the crisis on corporate funding costs was channelled through the banking system. Bofondi et al. (2013) show that the increase in Italian sovereign debt risk in 2011 led Italian banks to tighten credit supply.

²³ Decomposition of the coefficient of variation according to various dimensions, including loan maturity and borrowers type, can be found at: <https://www.ecb.europa.eu/stats/money/interest/coeff/html/index.en.html>

that Italian and Spanish firms that are too small to issue bonds are more likely to have suffered from financial fragmentation much longer.

5. Further analyses of the country risk premia

5.1 The informational content of the country premia

Positive country premia reveal the pricing of characteristics that are not measured by default risk or duration risk. In this section, we assess whether these deviations are associated to sovereign credit risk.

We measure the sovereign credit risk premia with the estimates derived from the affine term structure model in Monfort and Renne (2014).

Stationarity tests reject the assumption of unit root in the $\hat{\delta}_{C,t}$ before 2010.²⁴ It is only after 2010 that the estimated country premia $\hat{\delta}_{C,t}$ become positive and show signs of autocorrelation.²⁵ ²⁶ Distributed lag models relating changes in the country premia to changes in the sovereign credit risk have stationary residuals. We therefore turn to cointegration analyses, using Seemingly Unrelated Regressions (SUR) and the Pooled Mean Group estimator (PMG, Pesaran et al. (1999)).²⁷ The SUR allows for separate dynamics across countries, both in the short and long-run. Shocks are correlated cross-sectionally but not longitudinally. The PMG estimator assumes on the contrary that short-run dynamics are country specific, but all countries share a common long-run relationship.

The estimates show a cointegration between the country premia and sovereign credit risk premia (Table 3). From January 2010 to June 2015, about two third of the sovereign risk is passed through to the Italian and Spanish country premia.

5.2 Robustness

We examine the sensitivity of our results to the measurement of default risk, its endogeneity, the liquidity of each bond.

²⁴ The assumption of non-stationarity for Italy and Spain prior to 2010 is rejected by Augmented Dickey-Fuller tests and Phillips-Perron tests respectively, with p-values always below 1%.

²⁵ Augmented Dickey-Fuller tests and Phillips-Perron tests cannot reject autocorrelation in the country premia for Italy and Spain at level below 35% after January 2010. The series in difference are however stationary at the usual levels. We therefore consider the country premia are $I(1)$ since the sovereign debt crisis.

²⁶ We use the within estimator in our main specification. It is equivalent to the OLS estimator applied to a model in first difference. Therefore, estimates of the model for corporate spreads are not affected by first order integration.

²⁷ The European sovereign debt crisis involves further risks, such as liquidity risk for each specific sovereign and redenomination risk. Usual measures for both risks, such as bid-ask spreads for the liquidity risk or quanto CDS for the redenomination risk (De Santis, 2007), seem to be stationary according to standard unit-root tests. It is therefore not possible to assess cointegration relationships. The assumption of non-stationarity in the credit risk premia is accepted by ADF and Phillips-Perron tests with p -values greater than 0.60.

5.2.1 *Finer rating grids*

A too coarse rating scale can erroneously lead us to conclude to the existence of country risk premia. A first risk is that the crises induced downgrades of a too limited magnitude to be discernible on a broad rating grid. This occurs for instance if many bonds would be downgraded within the broad rating categories used thus far. The increase in spreads could thus be erroneously attributed to country premia. We address this issue in three ways: first, we use a more detailed set of rating dummies, second, we use all the different ratings and assume the yields are linear in the ratings and third, we use cubic splines.

We measure the rating at a finer level and distinguish now three categories: bonds rated from Aaa to Aa3, those rated from A1 to A3 and those rated from Baa1 to Baa3. Figure 7, panel A, shows the estimated risk premia and Panel B the associated country premia. The latter is consistent with the estimates reported in Figure 5.

In the same spirit, we estimate the model with a continuous rating grid. We therefore assign numeric values to each rating category, from 1 for Aaa to 10 for Baa3. The ensuing variable is assumed to influence corporate spreads in a linear way. The estimated credits risk effects are reported in Figure 8. Again, the country risk premia are very similar to their estimates in reported above. The stability of the results are in line with the design of the two rating categories, which induces transition intensities similar to the one obtained with Moodys' ratings.

Finally, we estimate a semi-parametric model where the spreads depend on the qualitative information represented by the rating categories through cubic splines. This accrued flexibility comes at the cost of restricting the influence of the ratings on the spread to be constant over time. A cubic spline is a function that is defined by 3-order polynomials over rating categories. Intuitively, fitting a spline function is like outlining the shape of a scatter plot painted on a wooden panel by placing a few nails and connecting them with a flexible metal strip. Figure 9, panel A, represents the scatter plot of our data along with the spreads, averaged over time, predicted either under our benchmark model with two rating categories or under a spline function. We can see that the two modelling strategy provide a very similar estimates of the country premia.

5.2.2 *The role of liquidity*

One important determinant of yields is the liquidity of the bond. In principle, this is controlled for by a bond fixed effect. However, the latter is, by definition fixed throughout the sample. We therefore re-estimate model [1] including as additional control for the time varying depth of market for each bond, measured by the amount outstanding not yet repaid. Figure 10 reports the estimated country premia, that are globally unaffected by the proxy for liquidity.

5.2.3 *Endogeneity of the default probability*

Changes in the rating can be correlated with shocks on the spread. For instance, this occurs if the ratings are revised due to changes in the bond market value. It raises a potential endogeneity concern

that we assess by retaining the first observed rating for each bond. The ensuing variable is constant over time and thus uncorrelated with the errors.²⁸

The coefficients on credit risk premia reported in Figures 11 are very similar to the baseline estimates. Again, the credit risk premia increase mostly during the 2008 crisis and to a lesser extent in 2012. Country premia are reported in Figure 11, panel B. They are close to the estimates obtained under the benchmark model.

5.2.4 Sensitivity to transitions from one dummy variable to another

Parameters $\delta_{R,t}$ and $\delta_{M,t}$ measure changes in the spread when: i) time passes from $t-1$ to t for bonds with same rating or maturity class at both dates, ii) a bond is downgrade or its' class of residual maturity decreases at time t . We ensure now the estimated parameters measure solely the effect of time and are not driven by transitions from a rating or maturity category to another. To this aim, we drop the observations where a transition occurs. Again, Figure 12 shows that the results are very similar to those obtained with our baseline specification.

5.2.5 Selection biases

One can wonder whether the increase in the country during the sovereign debt crisis and then its decrease documented in the previous part of the paper is an artifact driven by a tightening in the access to the financial markets. If the only corporate able to issue bonds after the sovereign debt crisis are those in a very good financial situation, a decrease in the premia could indicate only an increase in the quality of the new issuers.

We therefore estimate the main specification using a subsample restricted to bonds issued before December 2007. Intuitively, if the access to the bond market was easier before the crisis, we would expect these bonds to still face a higher risk premia than bonds issued after 2008. Their impact on the estimates obtained with the full sample could nonetheless be negligible if their influence is outweighed by the influence of bonds issued since the crisis by firms with better financial statements.

The country risk premia estimated for bonds issued before the crisis (Figure 13) have the same profile than those obtained with the full sample. The confidence intervals estimated over 2014 widen vastly for issuers located in Spain. It highlights that there are very few bonds issued in Spain prior to 2008 with a maturity of more than 6 years.

Conclusion

This article uses corporate bond markets to assess the fragmentation of the euro area financial markets. We decompose yields of non-financial corporate bonds to disentangle country-specific premia from other observable determinants of risk. We examine the performance of our approach under various changes in the modeling strategy and provide simple measure of financial fragmentation.

²⁸ The rating variable does not vary over time for a given bond. Nonetheless, since the corresponding dummies are monthly; they take different values from one month to the other. The within estimator can thus estimate the corresponding coefficients, despite the underlying variable is constant.

Financial fragmentation in the corporate bond market began in the first half of 2010 at the start of the sovereign debt crisis. The fragmentation peaked in 2011 and 2012. It receded gradually following the OMT in September 2012.

These results show clear evidence that the European sovereign debt crisis has reversed the process of financial integration in the Euro area. Bondholders asked the Italian and Spanish issuer to pay a significant premium with respect to their German (and to a lesser extent French) counterparts to hold their bonds, even if they display similar risk profiles (including default probability). Issuers located in Italy still pay a significant premia around 70 basis points as of June 2015.

Our results confirm that the sovereign debt crisis has introduced heterogeneity in the transmission of monetary policy in the euro area. The adoption and the implementation of non-standard monetary policy measures in the euro area could take this additional piece of information into account. Our synthetic indicator can also be used to monitor the effectiveness of the non-standard measures in addressing the heterogeneity on funding conditions in the various countries of the euro area.

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Figure 1: Main features of the sample of corporate bonds

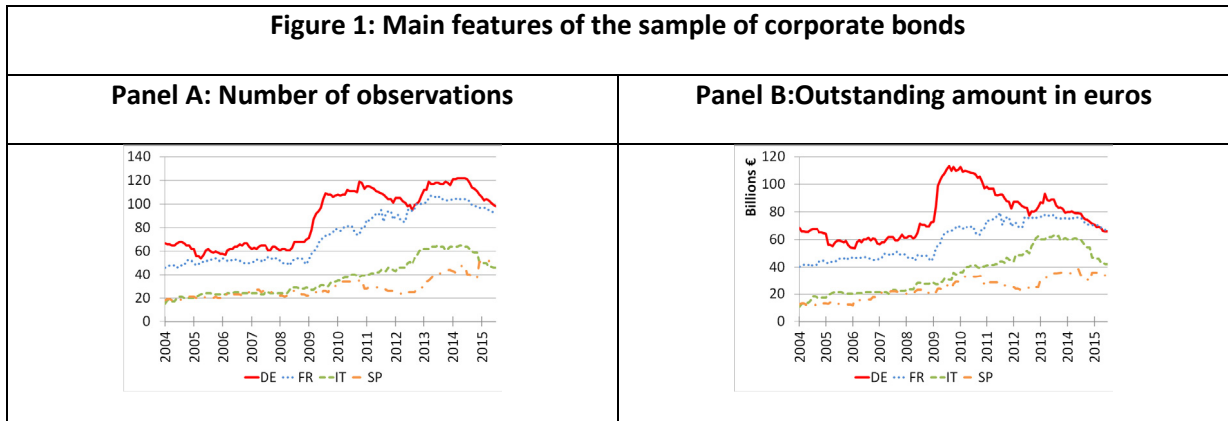


Figure 2: Average spread by country

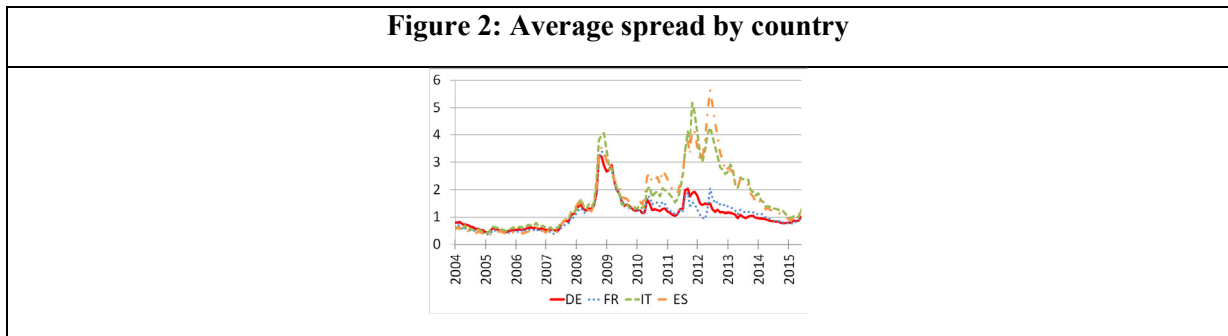


Figure 3: Developments in Moody's ratings

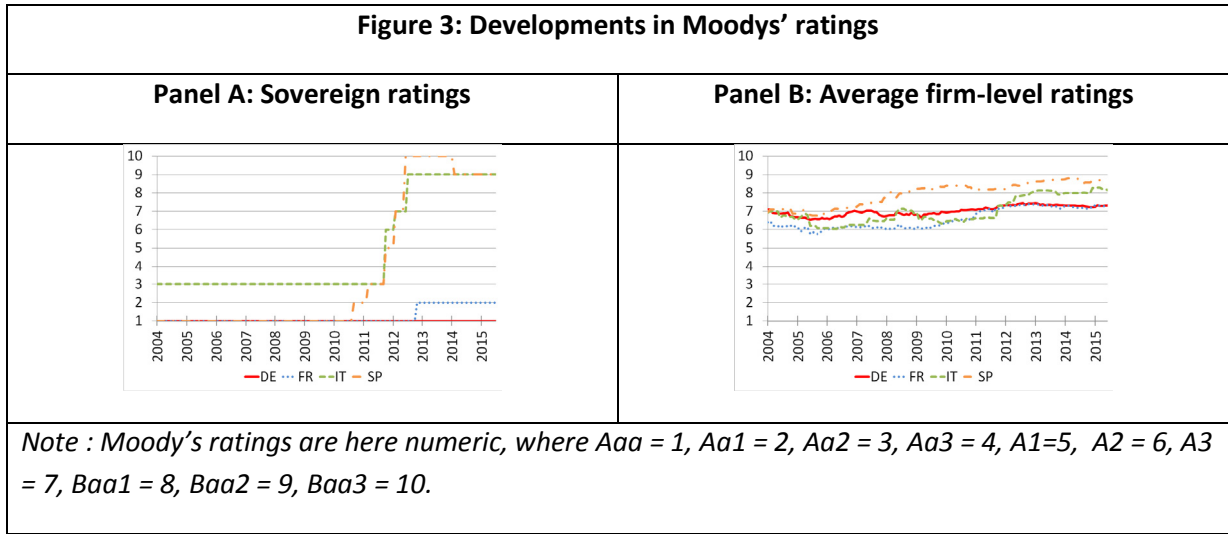


Figure 4: Number of observations by rating categories

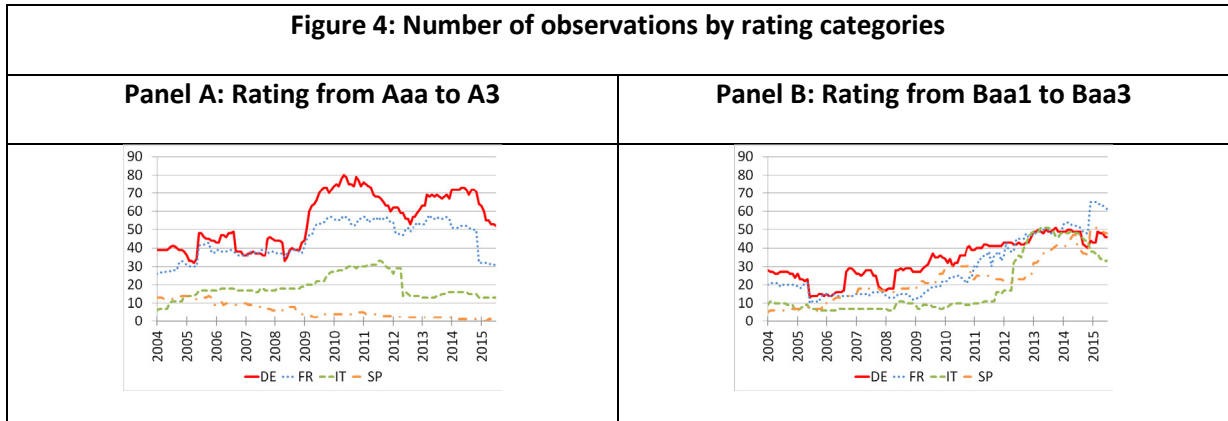
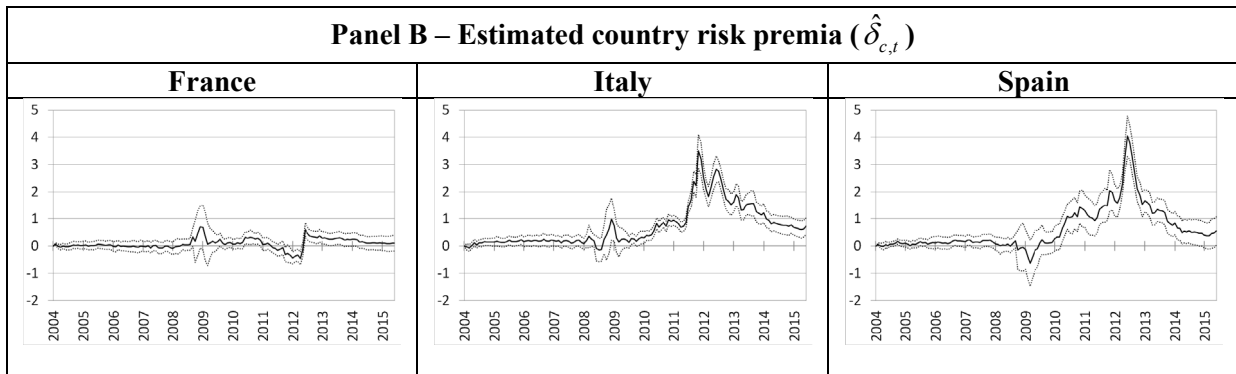
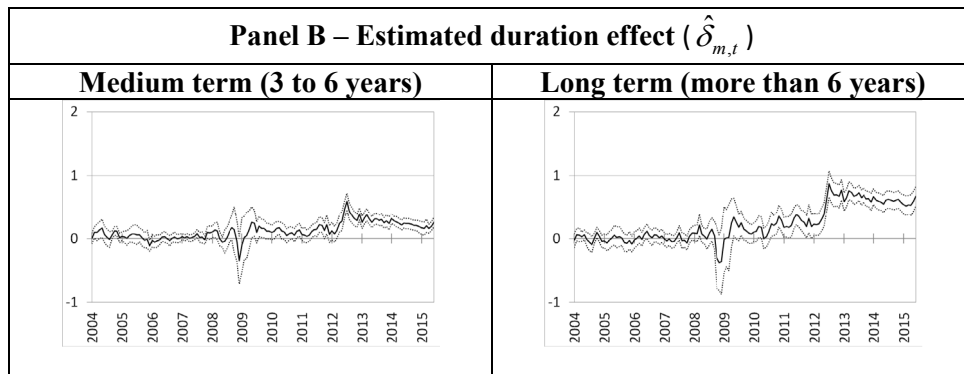
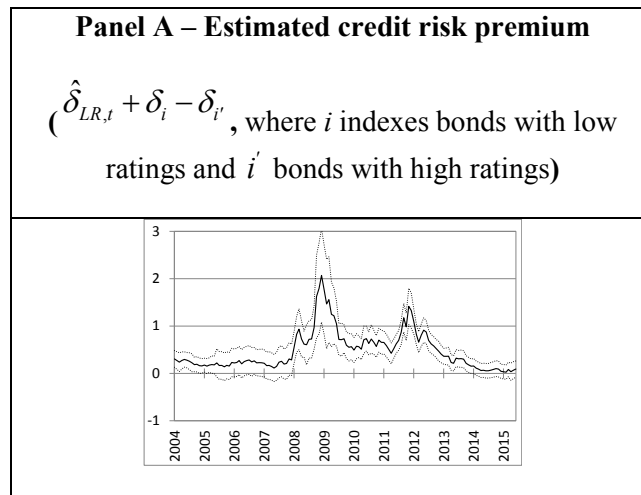
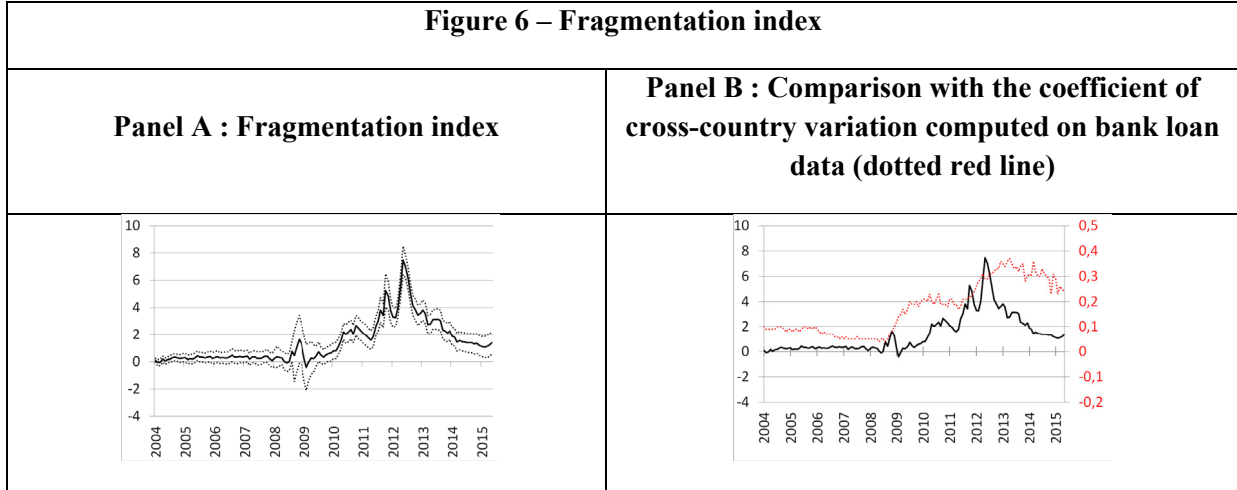


Figure 5: main results



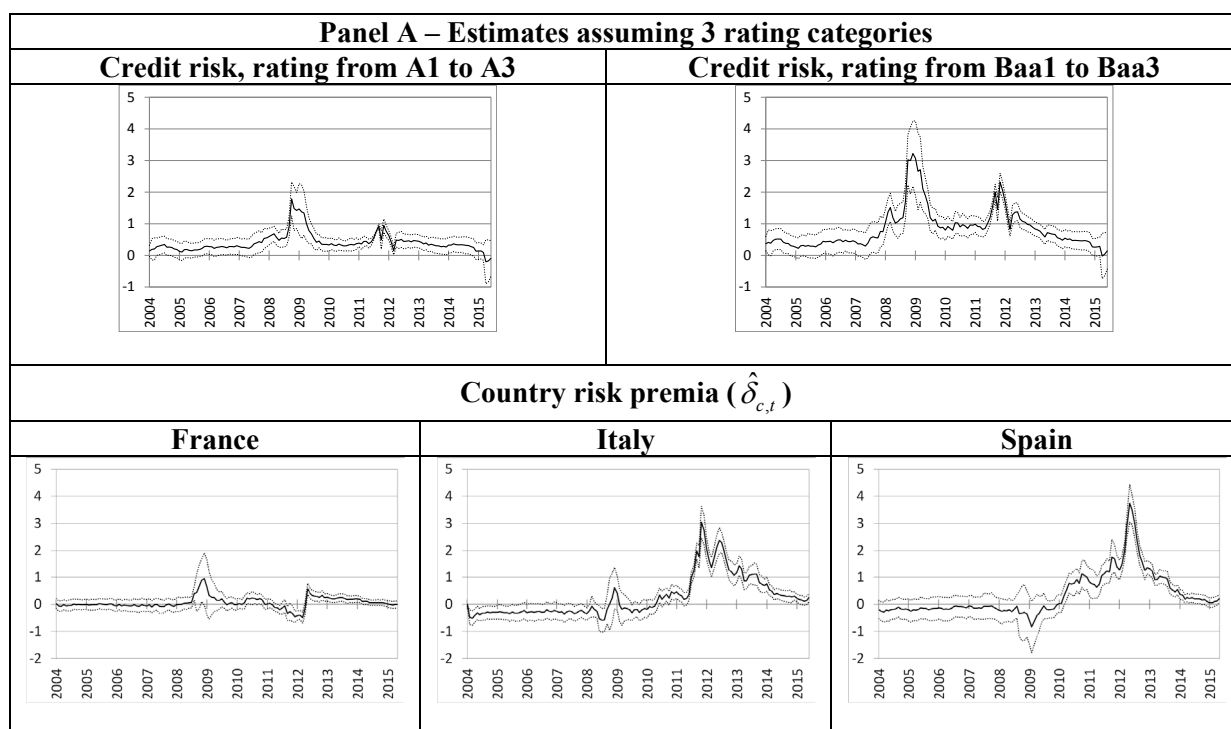
Note: The estimated credit risk premium is based on bonds rated from Baa1 to Baa3 relative to those rated from Aaa to A3. The estimated duration effect is to be interpreted for bonds of maturity longer than 6 years relative to those with maturity less than 3 years. Estimated standard errors are clustered at the issuer level. Dotted lines represent the confidence intervals at the 5% level.

Figure 6 – Fragmentation index



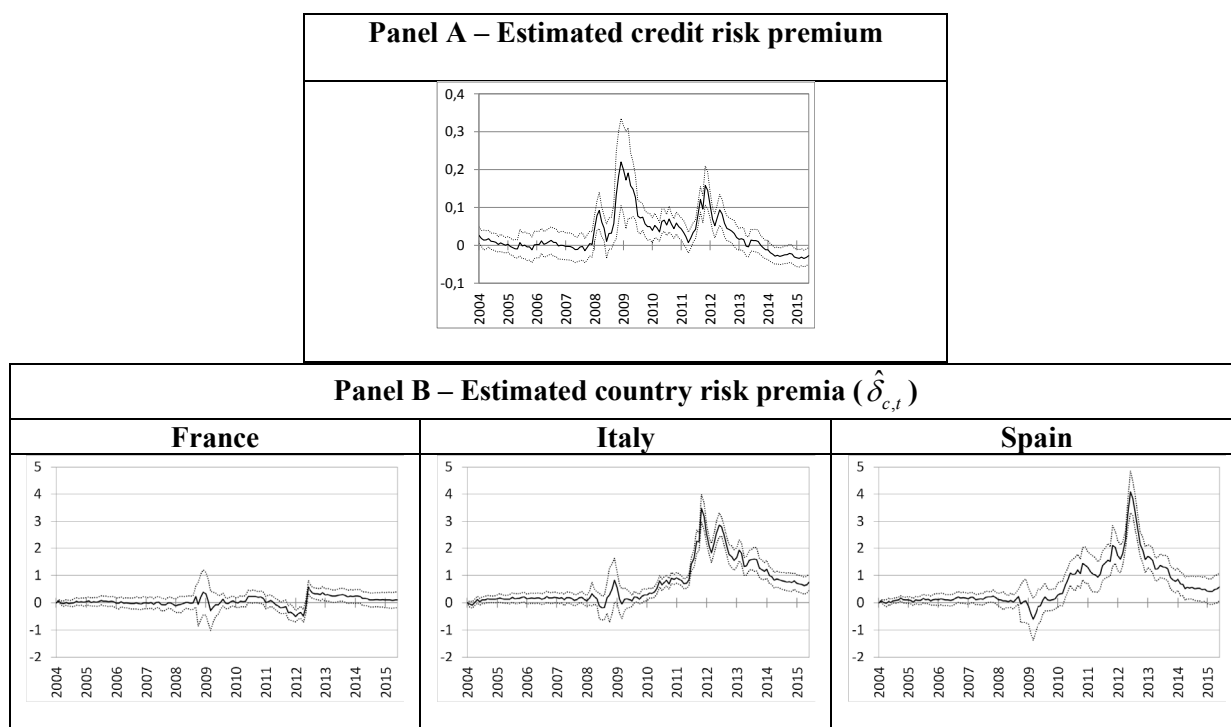
Note: The fragmentation index is the sum of country risk premia. In panel B, we compare it with the coefficient of cross-country variations computed by the ECB using interest rates on new bank loans: <https://www.ecb.europa.eu/stats/money/interest/coeff/html/index.en.html>.

Figure 7: Results with a finer rating grid



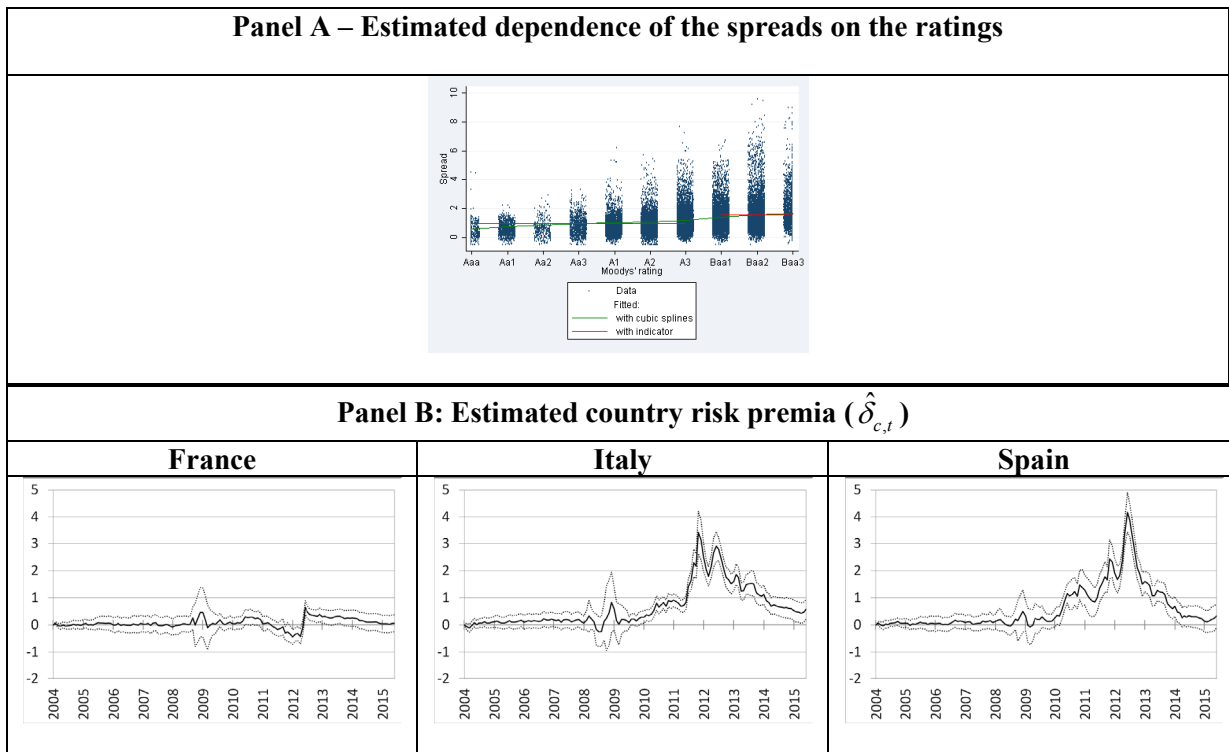
Note: The estimated credit risk premium relative to those rated from Aaa to Aa3. Estimated standard errors are clustered at the issuer level. Dotted lines represent the confidence intervals at the 5% level.

Figure 8: Results with a continuous rating scale

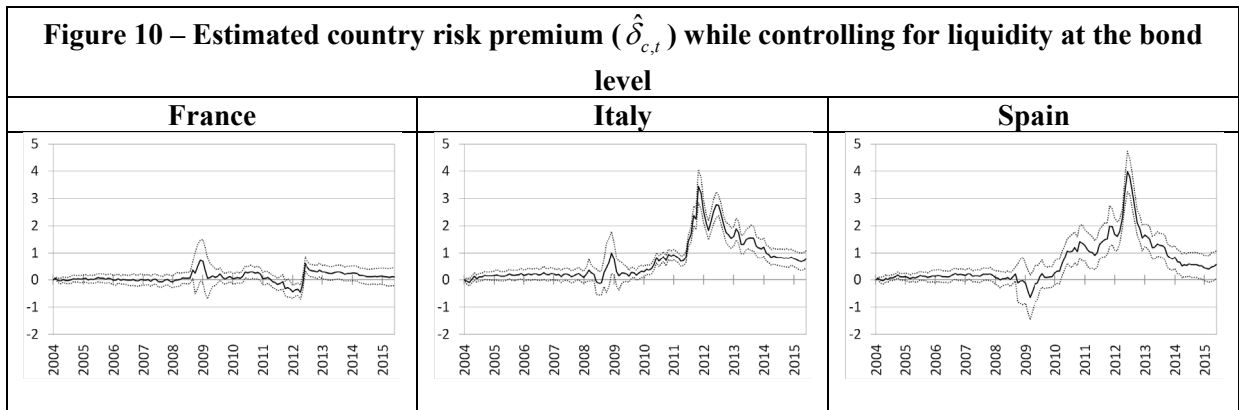


Note: Moody's ratings are here numeric, where Aaa = 1, Aa1 = 2, Aa2 = 3, Aa3 = 4, A1 = 5, A2 = 6, A3 = 7, Baa1 = 8, Baa2 = 9, Baa3 = 10. Estimated standard errors are clustered at the issuer level. Dotted lines represent the confidence intervals at the 5% level.

Figure 9: Semiparametric influence of the ratings

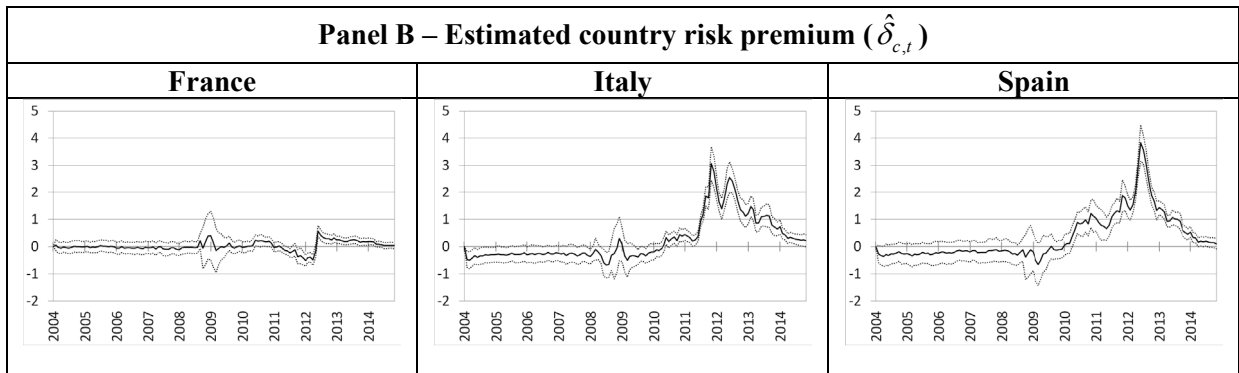
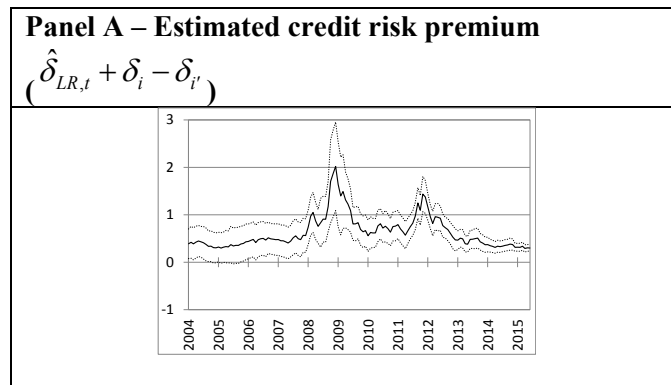


Note: Spreads depend on the ratings through a cubic spline function, with knots at Aa2, A2 and Baa2. Estimated standard errors are clustered at the issuer level. Dotted lines represent the confidence intervals at the 5% level.

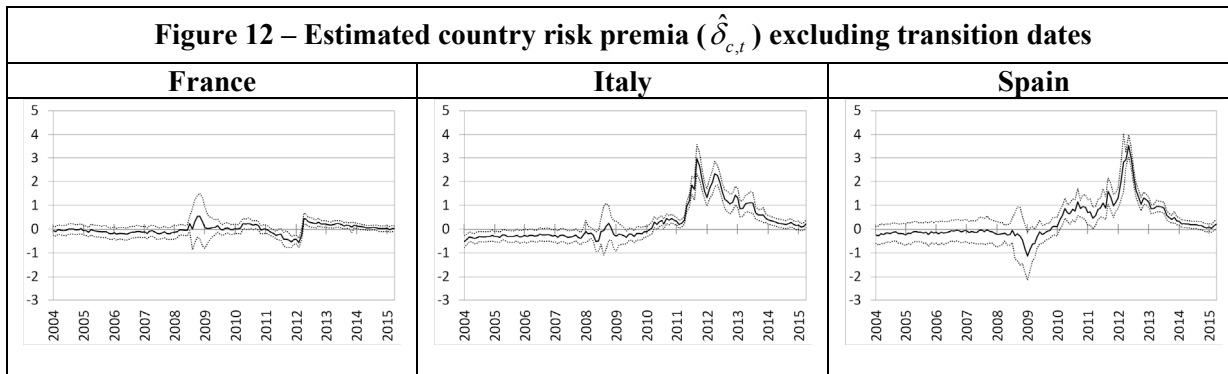


Note: Estimated standard errors are clustered at the issuer level. Dotted lines represent the confidence intervals at the 5% level.

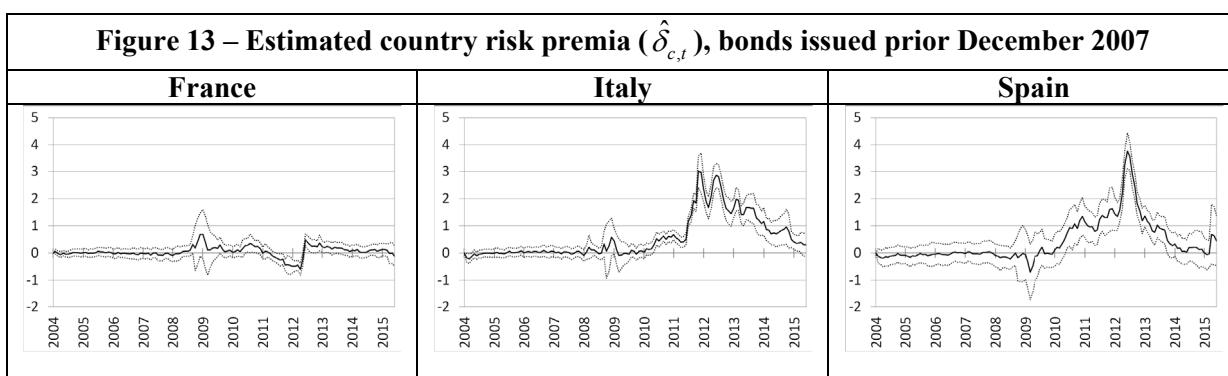
Figure 11: Results controlling for endogeneity in the default probability



Note: We retain the first observed rating for each bond so as to control for the endogeneity of the rating. Estimated standard errors are clustered at the issuer level. Dotted lines represent the confidence intervals at the 5% level.



Note: Subsample excluding rating or maturity migrations. Estimated standard errors are clustered at issuer level. Dotted lines represent the confidence intervals at the 5% level.



Note: Subsample of bonds issued prior December 2007. Estimated standard errors are clustered at issuer level. Dotted lines represent the confidence intervals at the 5% level.

Table 1: Descriptive statistics of the micro data

The sample is of about 32,000 monthly observations, relative to 735 corporate securities and 157 issuers. It runs from January 2004 to June 2015. The table reports the number of observations, securities and issuer by country, along with the amount issued and the maturity at the issuance. We also provide information on residual maturity, yields and spreads, computed using the full trajectories and not only information at the issuance.

	DE		FR		IT		SP	
Number of observations	12,344		10,174		5,177		4,024	
Number of securities	310		214		104		107	
Number of issuers	64		49		24		20	
Characteristics of the securities								
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Market value at the issuance (millions €)	798	750	758	750	924	850	766	750
Maturity at issuance	7,5	7,0	8,3	7,3	9,3	7,5	7,9	7,0
Residual maturity	6,0	4,6	6,5	5,2	8,0	6,0	6,8	5,3
Nominal yield	2,95	2,95	3,07	3,05	3,67	3,78	3,58	3,63
Spread	1,14	1,00	1,14	0,97	1,85	1,49	1,68	1,34

Table 2: Transition intensities

We report the transition intensities across ratings, from one month to the other, at the security-level. Overall, we observe 55 upgrades and 100 downgrades on 744 securities.

Table 2A: Transitions intensities across Moodys' ratings

	Aaa	Aa1	Aa2	Aa3	A1	A2	A3	Baa1	Baa2	Baa3
Aaa	99,5	0,0	0,0	0,3	0,0	0,0	0,3	0,0	0,0	0,0
Aa1	0,0	99,8	0,0	0,2	0,0	0,0	0,0	0,0	0,0	0,0
Aa2	0,0	1,5	96,0	2,5	0,0	0,0	0,0	0,0	0,0	0,0
Aa3	0,0	0,2	0,3	95,7	3,7	0,0	0,0	0,1	0,0	0,0
A1	0,0	0,0	0,0	0,3	98,1	1,6	0,0	0,0	0,0	0,0
A2	0,0	0,0	0,0	0,1	0,1	97,7	2,0	0,1	0,1	0,0
A3	0,0	0,0	0,0	0,0	0,0	0,4	98,4	1,1	0,1	0,0
Baa1	0,0	0,0	0,0	0,0	0,0	0,0	0,8	98,5	0,7	0,1
Baa2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,9	98,5	0,6
Baa3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,2	1,5	98,4

Table 2B: Transition intensities across broad rating categories

	DE		FR		IT		ES	
	Aaa-A3	Baa1-Baa3	Aaa-A3	Baa1-Baa3	Aaa-A3	Baa1-Baa3	Aaa-A3	Baa1-Baa3
Aaa-A3	99,3	0,7	99,7	0,3	99,8	0,2	99,9	0,1
Baa1-Baa3	0,5	99,5	0,5	99,5	0,9	99,1	1,2	98,8

Table 3: Long-run coefficients estimated in error-correction models

Estimator	Country-specific long-run dynamics		Common long-run dynamic
	SUR	SUR	PMG
	IT	SP	IT and SP
Credit risk			
Credit risk premia	0.68 (30.79)	0.79 (8.56)	0.69 (32.65)
N	128		128

Note: We analyse the cointegration between the country premia and sovereign characteristics from January 2010 to June 2015. The PMG estimator restricts the long-run coefficients of the error-correction model to be common to all countries (Pesaran et al. (1999)). It is not consistent in case of cross-sectional dependence in the errors. We therefore complement the results above with the G_{τ} and G_{α} tests by Westerlund (2007). They tackle the issue of cross-sectional dependence but require the covariates to be integrated at order 1, an assumption that we cannot reject at usual confidence levels. The tests by Westerlund (2007) lead us to reject the assumption of no cointegration with p -values below 0.01.

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