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Abstract

This paper investigates the relationship between sovereign and bank CDS spreads with reference to their ability to convey timely signals on the default risk of European sovereign countries and their banking systems. For a sample including six major European economies, we find that sovereign and bank CDS spreads are cointegrated variables at the country level. We then perform a more in-depth investigation of the underlying price discovery mechanisms, and find that both variables have an important price discovery role in the period preceding the financial crisis of 2007-2009. However, during the global financial crisis and the subsequent European sovereign debt crisis, sovereign CDS spreads dominate the price discovery process. Our findings strongly suggest that, especially during crisis periods, sovereign CDS spreads incorporate more timely information on the default probability of European banks than their corresponding bank CDS spreads. Price discovery measures based on CDS prices could be used as market triggers to increase equity levels at financial institutions and in the various forms of contingent capital.

JEL classification: G01; G12; G14; G20; D8

Keywords: Credit default swap spreads; price discovery; information flow; financial crisis; banks; sovereign risk; bank capital; contingent capital

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1. Introduction

The study of the interlinkages between sovereigns and banking systems has drawn great attention since the outbreak of the global financial crisis in mid-2007. Acharya et al. (2011) describe a two-way feedback effect between sovereign risk and banking risk, where bank bailouts by governments produce a negative effect on the sovereign's public finances which, in turn, reduce the value of the implicit government guarantees for bank debt. This process generates a strong co-movement between the CDS spreads of sovereign countries and financial companies. Kallestrup et al. (2012) also show that the size of the implicit guarantees that the sovereign may extend to the domestic banking system has a strong effect on sovereign CDS spreads. Gerlach et al. (2010) indicate that the size of the banking sector is an important determinant of European sovereign risk spreads. Sgherri and Zoli (2009) find that solvency concerns of the national banking systems have become an important determinant of sovereign credit spreads during the financial crisis of 2007-2009.

However, as the main findings of this paper confirm, the interconnectedness of banks and sovereigns has existed since before the start of the sub-prime crisis, and the successive European sovereign debt crisis. Since their introduction in 1988, Basel rules on banks' capital requirements have certainly favoured the development of these links, which, in the past 5 years, have appeared to be particularly strong. According to the first Basel accord (Basel I), government bonds are given a zero risk weight. Basel II rules, introduced in 2004 to remediate some of the pitfalls existing in the previous accord (in particular the poor risk sensitivity for a bank's capital allocation decisions), rely upon a ratings-based system (the standardised approach).[1] According to this latter approach, AAA-rated and AA-rated government debt are assigned a zero risk weight. Furthermore, relative to the computation of the risk weight for banks' exposures, a bank is given the option to classify its loans based on the rating assigned to the borrowing bank and the rating of the country where the borrowing bank operates (Resti and Sironi, 2007).

Hence, based on the existing capital adequacy rules, government debt represents a cheap way for a bank to get a financial instrument which can be widely used for risk and liquidity management purposes. In particular, government bonds can be used as collateral for interbank loans, for repo transactions and to access central bank liquidity through the discount window. According to Bolton and Jeanne (2011), data on the 2010 European banks stress test show that, as of March 2010, on average, about 30% of government debt was held by the banking sector. Higher shares (of about 50%) were observed for Spain

[1] Basel II rules allow banks to choose among two main methods for computing capital requirements for credit risk. The first one is the standardised approach, which is based on credit ratings provided by external rating agencies. The second one is the internal ratings based (IRB) approach, which allows banks the use of their internal estimates of the loss given default, expected and unexpected losses to calculate the capital required for a given exposure (Basel Committee on Banking Supervision, 2005).

and Germany. Given the above evidence, it is then not surprising that a shock to a country's banking system may have sizeable effects on its sovereign (and vice versa).

In order to describe the linkages between European sovereigns and their respective banking systems, we focus on sovereign and bank CDS spreads for six major European economies during the period 2004-2013. The objective of this paper is the study of the credit risk price discovery process implied by bank and sovereign CDS spreads. As the CDS spreads are cointegrated variables, they share the same stochastic trend (or common factor). We find that, while both bank and sovereign CDS spreads contribute to the price discovery of this common factor in the period preceding the financial crisis, sovereign CDS spreads lead the price discovery during the sub-prime crisis and the subsequent sovereign debt crisis.

The study of these interconnections also allows us to investigate whether the price discovery implied by market CDS prices could have given timely signals about the financial risks of the European banking systems, which have subsequently become the main subject of costly resolution mechanisms and endangered the solvency of various European sovereigns. The recent examples of sovereign-funded bank bailout packages adopted by a group of European Union countries have shown how governments' attempts at restructuring their countries' banking system have generated huge costs for the taxpayers, which in turn have exacerbated recessionary spirals across European economies.

Our results show that sovereign CDS spreads contain important credit risk information on a country's banking system. This is especially true during recent crisis periods, whereby an investor would have obtained a more timely indication of a bank's default risk from the CDS spreads of the sovereign country (where the bank operates) than the bank CDS spread itself. While the latter result can be explained, in part, by the extensive programmes of bank bailouts undertaken by European governments that have shifted the credit risk from the banking sector to the sovereigns, it is notable that sovereign CDS spreads lead the price discovery in France, Italy and Spain during the relatively stable period of 2004-2007, which certainly did not involve any bank bailout or financial transfer from governments to banks.

Based on the cointegration between bank and sovereign CDS spreads, price discovery triggers for bank resolution mechanisms could be used in the future to raise banks' equity buffers and their contingent capital. In retrospect, our findings show that, at the end of 2009, these triggers would have suggested the need for capital buffers for most European banks. As documented by Hart and Zingales (2011), CDS spreads capture the downside risk better than equity prices (which are subject to limited liability), are more liquid than bond issues and lead the price discovery process.

Our findings also contribute to the recent debate on the negative effect that speculation can have on the sovereign CDS market and the regulators' decisions in 2010 to ban naked CDS trading. Indeed, our results show that the information flow and the price discovery of sovereign CDS markets, for a set of countries concerned by these restrictive policy decisions, are not negatively affected, as confirmed by the leading role of the sovereign CDS market documented for that period for all countries but Portugal.

Our conclusions are important for bank regulators. Information about the credit risk of a country's banking sector can be retrieved by analysing the sovereign credit risk. The latter could provide extra information that can be used by bank supervisors to improve banking rules on capital requirements. The early signals of a banking crisis could be obtained by observing sovereign credit spreads and this information could be used to take more timely policy actions in order to prevent a country-specific banking crisis from becoming systemic and affecting the whole European banking sector. In particular, the early signals implied by the price discovery process of bank and sovereign CDS spreads could be used as timely market triggers for a more efficient and effective implementation of resolution mechanisms for banks. Our findings also suggest that policymakers should adopt coordinated actions, especially in crisis periods when European banking sectors are similarly affected by negative shocks. With regard to that, recent proposals for the establishment of a banking union (Goyal et al., 2013) could help speed up the decision process at times when timely decisions are much needed.

The rest of the paper is as follows: Section 2 reviews some of the literature on the determinants of sovereign and bank credit spreads, the price discovery of credit spreads and the various proposals of contingent capital for banks. Section 3 describes the dataset. Section 4 presents the methodology. Section 5 analyses the main results of our study and Section 6 concludes.

2. Related work

Recent studies on the determinants of bank and sovereign CDS spreads show that these two time series of CDS spreads are driven by the same risk factors. Annaert et al. (2013) and Fontana and Scheicher (2010) analyse the determinants of Euro area bank CDS spread changes and sovereign CDS spread changes, respectively. Both studies are inspired by the theoretical credit risk models, introduced by the seminal work of Merton (1974), in the selection of the possible determinants of CDS spreads. Following Collin-Dufresne et al. (2001) and Ericsson et al. (2009), which focussed on the determinants of credit spread changes for corporates, Annaert et al. (2013) use both firm-specific variables (such as bank financial leverage, asset volatility and liquidity) and market-wide variables (such as the risk free interest rate, the

slope of the yield curve, a stock index return, an implied volatility index, corporate bond risk premium) to explain the changes of bank CDS spreads. Likewise, Fontana and Scheicher (2010) use a very similar set of independent variables to explain sovereign CDS spread changes.

Based on this evidence, the evolution of bank and sovereign CDS spreads should be driven by the same common factor at any point in time. Indeed, some other recent studies on the determinants of sovereign CDS spreads have investigated whether this common factor is related to fundamental macroeconomic risk or to financial risk. For instance, Longstaff et al. (2011) find that most of the sovereign CDS spread variation can be explained by US equity, volatility and bond market risk premia. In another study, Ang and Longstaff (2011) find evidence that a systemic common factor drives CDS spreads written on sovereign states in the US and European countries. They also show that this systemic risk factor is affected by global financial factors rather than macroeconomic factors.

Over the last decade, several papers have analysed the price discovery of corporate credit spreads. For instance, Zhu (2004) and Blanco et al. (2005) find that CDS spreads have a greater price discovery role than bond credit spreads. Longstaff et al. (2003), Norden and Weber (2009) and Forte and Peña (2009) also show that equity-implied spreads and CDS spreads have a leading role over bond credit spreads. Acharya and Johnson (2007) show that the CDS market leads the equity market. More recently, there has been a proliferation of studies on the price discovery of European sovereign CDS and bond spreads. Varga (2009) and Palladini and Portes (2011) find a leading role of sovereign CDS spreads over bond spreads. Delatte et al. (2012), O'Kane (2012), Arce et al. (2011), Fontana and Scheicher (2010) find that CDS spreads lead in some countries, whereas bond credit spreads lead in others.

Following a similar methodology to these price discovery studies, our paper aims to analyse the price discovery of bank and sovereign CDS spreads to the revelation of the common factor (or efficient price) which previous research has identified as the main driver of the two series of CDS spreads. Our decision to focus on CDS spreads rather than bond credit spreads derives from a greater evidence of a leading role of CDS spreads for both corporates and sovereigns.

More recently, academics, regulators and policymakers have focussed on the need to find more effective and less costly resolution mechanisms for banks in financial distress. The main goal of a successful resolution policy is to achieve the necessary rebuilding of banks' balance sheets at the lowest costs (in terms of taxpayers' transfer of wealth) and the worsening of incentives in the financial system. A great deal of attention has been given to the concept of "contingent capital". Contingent capital allows banks to issue debt claims which convert to equity during crisis periods, generating capital buffers at times when it is paramount and hard for banks to raise new capital. Previous studies which have suggested the use of

contingent capital are by Flannery (2009), Squam Lake Working Group (2010), Pennacchi et al. (2010), McDonald (2013), Hart and Zingales (2011) and Sundaresan and Wang (2013).

Flannery (2009) suggests that systemically important banks issue contingent capital certificates (CCC). When asset values fall significantly, some of the CCC would be converted into equity to restore capital to a target level. Squam Lake Working Group (2010) proposes a dual trigger for conversion. In particular, a declaration by the regulators that there is a systemic crisis (regulatory trigger) and violations of covenants indicated in the debt claim (accounting trigger) would determine debt conversion into equity. Pennacchi et al. (2011) introduce the Call Option Enhanced Reverse Convertible (COERC). When a market value trigger is reached, debt is converted into equity at a deep discount and shareholders have the right to purchase the shares at the conversion price. McDonald (2013) also proposes a dual trigger which converts debt into equity when both the bank's stock price and the value of a financial institution's index reach a trigger value. Sundaresan and Wang (2013) perform a theoretical analysis on the design of contingent capital with a market trigger based on equity prices. They show that, if used as a regulatory tool, contingent capital with market triggers can be problematic. In particular, at the time of conversion, the existence of multiple equilibria can lead to potential manipulation of equity prices when the latter approach the trigger levels. Contrary to previous studies, which used equity prices as triggers, Hart and Zingales (2011) suggest the use of CDS spreads as market triggers to decide when debt claims have to be converted into equity.

3. Data

We download sovereign CDS and bank CDS daily mid-quotes from CMA (provided by Datastream) for six major European economies, namely France, Germany, Italy, Portugal, Sweden and Spain. CMA data from Datastream are available from January 2004 until September 2010. Starting from October 2010 until March 2013, Datastream provides CDS quotes obtained from Thomson Reuters.[2] In accordance with previous studies, we focus on the 5-year maturity for senior unsecured debt, as these contracts are regarded as the most liquid in the market. The time series of bank CDS spreads for each country was created by averaging individual bank CDS spreads at the country level.

Figure 1 and Figure 2 show the time series of CDS spreads both for the six countries and on aggregate, respectively, over the whole sample period from January 2004 until March 2013. It is evident how the level of both bank and sovereign CDS spreads started to rise dramatically since mid-2007, in

[2] CDS spreads for Sweden and Spain are only available starting from March 2004 and July 2004, respectively.

correspondence with the outbreak of the financial crisis. Clearly, the pair of spreads for each country are very much interlinked over the whole sample period. We compute Pearson's correlations (unreported) at the country level and find that they range from about 0.90 to 0.98. However, the correlation between sovereign and bank CDS spreads is 0.66 in Sweden, and an explanation for this lower value could derive from the higher illiquidity of the sovereign CDS market in the early part of the sample.

Table 1 presents the summary statistics for the levels of bank CDS spreads (Panel A) and sovereign CDS spreads (Panel B). We can note how bank CDS spreads show a higher mean and volatility than sovereign CDS spreads. Median values are consistently lower than mean values, highlighting the presence of non-normality features such as positive skewness. The range of values for the bank and sovereign CDS spreads is very wide and this is reflected by the fact that the first part of our sample coincides with a very tranquil period, whereas the second part includes both the global financial crisis and the European sovereign debt crisis. As can be seen from the last row of the two panels, aggregate results show a similar picture to the country-level summary statistics. With regard to the bank CDS spreads, we have an overall sample of 28 banks spread across the six countries. The minimum number of banks is found in Portugal (only 2), whereas the maximum number of banks is in Italy and Spain (7 banks for each country).

According to the Augmented Dickey Fuller (ADF) test[3], both bank and sovereign CDS spreads are non-stationary at the 5% significance level for France, Germany, Italy, Portugal and Spain. The sovereign CDS spreads for Sweden are non-stationary at the 10% significance level. Instead, CDS changes result to be stationary.

4. Methodology

The first step of our analysis is to check whether bank and sovereign CDS spreads are cointegrated at the country-level. Two non-stationary variables are cointegrated if there exists a linear combination of them which is stationary. In this case, both variables share the same stochastic trend. The literature review and the evidence found in section 2 hint at the existence of a long-run relationship between the two variables under investigation, as they both are driven by the same risk drivers and graphically share common patterns over the whole sample period.

In order to test for cointegration, we implement the Johansen (1991) test for each country's pair of sovereign and bank CDS spreads. Indeed, as discussed in the next section, cointegration is found for all

[3] See Dickey and Fuller (1981). Results on the ADF test are available on request.

six countries. This finding is very important for the choice of the appropriate econometric model to be used to describe the time series behaviour of the bank and sovereign CDS spreads. In particular, the following analysis is based on the vector error correction model (VECM). The latter model is best suited to represent the dynamic interactions of cointegrated variables. Our general model is applied separately for each country and is given below:

$$\Delta Bank_t = \alpha_1 + \lambda_1 CE + \sum_{j=1}^{p} \beta_{1j} \Delta Bank_{t-j} + \sum_{j=1}^{p} \delta_{1j} \Delta Sovereign_{t-j} + \varepsilon_{1t} \quad (1)$$

$$\Delta Sovereign_t = \alpha_2 + \lambda_2 CE + \sum_{j=1}^{p} \beta_{1j} \Delta Bank_{t-j} + \sum_{j=1}^{p} \delta_{1j} \Delta Sovereign_{t-j} + \varepsilon_{2t} \quad (2)$$

where ε_{1t} and ε_{2t} are i.i.d. error terms. We define the cointegrating equation as follows:

$$CE = Bank_{t-1} - \phi_0 - \phi_1 Sovereign_{t-1} \quad (3)$$

Bank and *Sovereign* represent bank CDS mid-quote and sovereign CDS mid-quote, respectively. This general representation allows us to investigate the price discovery process between bank and sovereign CDS spreads. In order to do so, we study the statistical significance of the error correction coefficients, namely λ_1 and λ_2. For example, for the bank CDS spreads to be leading the price discovery process λ_2 has to be positive and statistically significant and, at the same time, λ_1 has to be statistically insignificant. This would mean that sovereign CDS spreads have to adjust when they deviate from bank CDS spreads in order to meet the long-run equilibrium defined in equation (3). As bank CDS spreads would not be responsible for the latter adjustment, they would be leading the price discovery process. On the other hand, bank CDS spreads would not lead the price discovery if λ_1 is negative and statistically significant and λ_2 is not statistically different from zero. If both λ_1 and λ_2 are correctly signed (as indicated above) and statistically significant, then both bank and sovereign CDS spreads would contribute to the price discovery process. Another way to quantify which market leads the price discovery is via the implementation of common factor models. The latter are used to generate a price discovery measure for each market. For our purposes, we use the Gonzalo and Granger (1995) measure of price discovery. According to Gonzalo and Granger (1995), the contribution of bank CDS spreads to the price discovery can be defined by the following expression:

$$GG_{Bank} = \frac{\lambda_2}{\lambda_2 - \lambda_1} \quad (4)$$

where GG_{Bank} stands for the Gonzalo and Granger measure for bank CDS spreads. $(1-GG_{Bank})$ would define the contribution to the price discovery of sovereign CDS spreads. For instance, a GG_{Bank} value of 0.80 can be interpreted as evidence that 80% of the price discovery takes place in bank CDS spreads, whereas the remaining 20% of price discovery is attributed to sovereign CDS spreads.

5. Results

The results of the Johansen cointegration test are reported in Table 2. Trace test statistics show that one cointegrating equation is found for each of the six countries under analysis. Hence, a long-run relationship exists between bank and sovereign CDS spreads in each country. Cointegration is also found on aggregate between the mean sovereign CDS spreads and the mean bank CDS spreads.

Based on this finding, we estimate both a country-level and an aggregate VECM – as defined in equations (1) to (3) – which is used to study the price discovery process between bank and sovereign CDS spreads. In Table 3, we report the estimated error correction coefficients, their significance and the GG measure of price discovery for different sample periods.[4] Panel A describes results for the whole sample period. If we focus our attention on the error correction coefficients, we can note that λ_1 is highly significant in 5 out of 6 cases, whereas λ_2 is significant 3 out 6 cases. Hence, there is greater evidence that sovereign CDS spreads lead bank CDS spreads than vice versa. This finding is confirmed by the GG values, reported in the last column of the table. Indeed, sovereign CDS spreads dominate the price discovery in 4 countries (France, Germany, Italy, and Spain), whereas bank CDS spreads have a leading role in Portugal and Sweden only.

In order to better capture the time variation of the price discovery, we split the sample into 3 sub-periods: a pre-crisis period (January 2004 to July 2007), a sub-prime crisis period (August 2007 to December 2009) and a sovereign debt crisis period (January 2010 to March 2013). The splitting points for the sub-periods are selected based on the fact that the cost of insurance against corporate defaults doubled in August and we take this as a strong signal for the start of the sub-prime crisis. We also choose January 2010 as the starting point of the sovereign debt crisis as on January, 12th Eurostat reported that Greek debt

[4] In some cases, we find that GG values are lower than zero or higher than 1. We follow Blanco et al. (2005) and replace these numbers with zero and one, respectively.

data could not be relied upon, causing concerns among financial market participants, of a possible Greek default on its foreign borrowing.[5]

Panel B of Table 3 shows results for the pre-crisis period. We can observe that λ_1 is significant in 2 cases (for France and Italy), whereas λ_2 is highly significant in 5 out of 6 cases. This would suggest a greater leading role for bank CDS spreads. The GG measure shows that a clear leading role of bank CDS spreads occurs in Germany, Portugal and Sweden, whereas in the other countries sovereign CDS spreads lead the price discovery. These findings support the fact that both bank and sovereign CDS spreads have had a significant price discovery role in the period preceding the start of the financial crisis.

Panel C analyses the sub-prime crisis period, for which λ_1 is negative and significant for 5 countries out of 6, while λ_2 is positive and significant in the case of Germany only. Hence, we find overwhelming evidence of the leading role of sovereign CDS spreads, and this is confirmed also by the values assumed by the GG measure, which are close to zero for bank CDS spreads.

Finally, Panel D summarizes estimation results for the sovereign debt crisis period. Similar to the sub-prime crisis results, λ_1 is negative and significant in 5 cases out of 6, whereas λ_2 is never significant at the 5% significance level. Again, these findings support a leading role of sovereign CDS spreads over bank CDS spreads. The latter is also confirmed by the bank GG values which are always lower than 0.50 except for the case of Portugal (GG of 0.66).

Overall, our results show that the period preceding the start of the financial crisis of 2007-2009 was characterized by a joint contribution of both bank and sovereign CDS spreads to the price discovery. However, during both the sub-prime crisis and the sovereign debt crisis, sovereign CDS spreads have taken the lead over bank CDS spreads.

Our findings relative to the crisis periods (Panel C and D) can be explained by (1) the presence of a potential illiquidity premium existing in the CDS market for financial companies, as documented by Annaert et al. (2013), according to whom CDS protection sellers raised the ask price in order to balance the increased hedging difficulties. Evidence of illiquidity is found for their regression of bank CDS spreads on liquidity proxies, whereas Fontana and Scheicher (2010) find that liquidity proxies are insignificant to explain changes in sovereign CDS spreads. This finding could hint at the fact that the sovereign CDS market was more liquid than the bank CDS market and, hence, preferred by credit

[5] Note that for the estimation of the VECM for the different sub-periods, we impose the cointegration equations obtained from the VECM implemented over the whole sample period.

traders;[6] (2) the emergence of counterparty risk in the settlement of CDS contracts during the crisis periods may have affected more the CDS market for banks than for sovereigns. This may clearly have kept investors from trading bank CDS spreads and favoured sovereign CDS trading;[7] (3) the existence of explicit and implicit guarantees has taken attention away from banks and directed it to sovereigns, which took on full responsibility for the survival of a country's banking system and burdened their public finances with excessive debt. Hence, investors willing to bet on bank credit risk have done so by trading sovereign CDS spreads as the latter were seen as the main source of banking risk; (4) linked to point (3), possible speculative attacks on sovereign CDS markets may have been at play, as evidenced by the decisions taken by some European governments which banned naked sovereign CDS positions.[8] Interestingly, these decisions do not seem to have affected the price discovery process of sovereign CDS spreads, which, except the case of Portugal, lead bank CDS spreads in the period interested by these policy actions. The latter finding is in contrast with Duffie (2010), according to whom banning sovereign CDS would have negatively affected the public information flow about a borrower's credit quality. Portes (2010) instead expressed positive views on a ban on naked CDS as buying naked sovereign CDS would drive up prices and increase a country's borrowing costs.

Table 3 also shows average (based on country-level estimates) and aggregate bank GG measures for each sample period. While 57% (93% based on aggregate results) of the price discovery occurs in bank CDS spreads before the start of the financial crisis, consistent with the theoretical evidence discussed in section 2, according to which both bank and sovereign CDS spreads are driven by the same fundamental factors and hence are both expected to contribute significantly, to a greater or lesser extent, to the price discovery of the common factor, only 6% (0% based on aggregate results) of the price discovery is due to bank CDS spreads during the financial crisis of 2007-2009. The share of bank CDS spreads' price discovery is equal

[6] We find that bid-ask spreads (often used as a liquidity proxy) are much higher for bank CDS contracts. In particular, they are about 1.3 basis points (bp) higher than sovereign CDS contracts in the pre-crisis period, but they significantly increase during the sub-prime crisis and the sovereign debt crisis, where they exceed sovereign CDS bid-ask spreads by 4.3 bp and 7.4 bp, respectively.

[7] What is special about bank CDS contracts is the fact that banks may constitute the buyers, the sellers and the reference entities of the contract, such that if a credit event occurs (e.g., bank default) there is a high probability that other banks (which could be protection sellers) may default as well. This circumstance is especially possible in times of distress (such as the recent financial crisis) if banks are highly interconnected (and they were) because of financial innovation and globalization, the extensive use of securitization and substantial use of the interbank market for funding purposes. Hence, from this point of view, bank CDS contracts bear higher systemic risk than sovereign CDS contracts. In the latter, banks still appear as buyers and sellers but the reference entity is a sovereign. The failure of a sovereign is less likely to spill over to banks unless several banks hold substantial holdings of government debt of the defaulted country. The CDS settlement in case of the Greek default was smooth (see Coudert and Gex, 2013) as the Greek debt was not considered as systemic, but the question is whether the sovereign CDS market would have functioned as smoothly in case of a German default.

[8] In May 2010, the German financial regulator banned naked sovereign CDS positions (Augustin, 2012). In the same period, similar decisions were taken by the financial regulators of the other European countries.

to 18% (0% based on aggregate results) during the sovereign debt crisis period. The massive drop in the price discovery of bank CDS spreads that occurred during the financial crisis shows how traders had already factored in the credit risk transfer from banks to sovereigns in the period 2007-2009, that is well in advance of the actual government bailouts that occurred in May 2011 for Portugal and July 2012 for Spain. Very low values of price discovery for bank CDS spreads indicate a sign of inefficiency in the price formation of the "true" CDS spreads inherent in bank CDS spreads. In this very moment, it would have been necessary for regulators and policymakers to affect the bank CDS market's expectations in order to re-establish markets' efficiency and efficient capital allocation. In line with Hart and Zingales (2011), a price discovery measure (such as the GG measure) could be either used as a new market trigger for banks' contingent capital purposes or to simply signal to the supervisory bodies that banks should increase their equity funding. Such a measure could be used both at the country level and at the aggregate level. The latter application would be particularly interesting as it would deal with situations (such as the current one) where many financial institutions within Europe are in distress at the same time and decrease lending to comply with regulation rather than raising new equity, generating recession mechanisms (*credit crunch*). For example, a centralized regulatory body could enforce banks to issue new equity or convert debt claims into equity if the average price discovery of European bank CDS spreads was less than 5% (and the price discovery of sovereign CDS spreads was more than 95%). At the country level, as of March 2013 (Panel D of Table 3), it would be advisable that Spanish, French and German banks increase their capital buffers, in order to avoid future costly government bailouts.[9]

The use of price discovery triggers for contingent capital is particularly interesting, as it could partly deal with the concerns of market manipulation raised in the literature on banks' contingent capital for the use of stock prices as market triggers for conversion of debt into equity. As discussed previously in section 2, McDonald (2013) suggested the use of a dual price trigger to attenuate these concerns. On the same line as McDonald (2013), a feasible alternative could be to base the conversion on both a stock price trigger and a price discovery trigger. The latter trigger would make manipulation harder as it would not be observable in the market but would require the use of an econometric model such as the VECM.

[9] We also run the analysis assuming the German sovereign CDS spreads as a benchmark. In fact, German government bonds have been a target investment among investors all over Europe during the recent years as they were regarded as the safest market for government bonds. Hence, German sovereign CDS spreads and bank CDS spreads for each of the six countries are used for the VECM analysis in equations (1)-(3). Results (available on request) are very similar to those presented in Table 3. However, we do not find cointegration between the German sovereign CDS spreads and the Italian bank CDS spreads.

6. Conclusions

Based on the evidence provided by previous research on the existence of a common factor responsible for the time variation of both bank and sovereign CDS spreads, this paper investigates the price discovery process to this common factor of bank and sovereign CDS spreads for six major European economies during the 2004-2013 period.

Our results show substantial evidence of the leading role of sovereign CDS spreads over bank CDS spreads during the sub-prime crisis and the successive sovereign debt crisis. This finding can partly be motivated by the credit risk transfer from the banking sector to the sovereigns that occurred in the European countries either through bank bailouts or implicit guarantees provided by the European governments. This credit risk transfer was anticipated by credit traders in 2009, as shown by the overwhelming and striking price discovery dominance of sovereign CDS spreads over bank CDS spreads. Additional explanations of these findings stem from greater illiquidity concerns and counterparty risk inherent in bank CDS contracts.

Our conclusions support the idea that bank and sovereign CDS markets have been interconnected since the start of their CDS trading and that sovereign CDS spreads should be considered by both bank regulators and monetary authorities to provide early signals on the default risk of a country's banking system. Furthermore, price discovery information could be used to generate market triggers for banks' contingent capital. Our results show that price discovery signals would have triggered an early intervention to bolster banks' capital buffers in 2009. This would have favoured the option of banks' restructuring to the more costly one of a government bailout.

Banks' recapitalization, at times when investors believe that, according to the price discovery mechanisms, banks are more likely to be bailed out by governments, would be beneficial for banks themselves as they would be seen as less risky, much safer and more able to face the occurrence of credit events and ensure an orderly and successful settlement of CDS contracts. Higher levels of capital for banks would improve the trading activity, liquidity and efficiency of the bank CDS market and reduce the concerns on banks' counterparty risk. In turn, this should increase the price discovery for bank CDS spreads relative to sovereign CDS spreads and, hence, rebalance the share of price discovery of both bank and sovereign CDS markets to their common factor. At last, higher levels of bank capital could bring huge benefits to the society as a whole because the likelihood of government bailouts would be reduced and financial resources could be allocated more efficiently to sustain a country's economic growth.

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Table 1 – Summary Statistics

This table reports, for each country, summary statistics (expressed in basis points) for the time series of bank CDS spreads (Panel A) and sovereign CDS spreads (Panel B) over the whole sample period, which starts from January 2004 until March 2013.

	N. Banks	Mean	Median	Minimum	Maximum	Std Deviation
Panel A: Summary statistics for bank CDS spreads						
France	5	94.10	88.37	5.88	366.3	89.46
Germany	3	87.44	76.75	7.88	364.3	79.52
Italy	7	140.8	71.39	8.33	691.8	167.7
Portugal	2	282.1	95.76	8.43	1485	382.3
Sweden	4	70.69	70.34	8.25	238.7	54.78
Spain	7	150.9	106.9	5.39	644.4	149.2
ALL	28	135.9	97.11	8.18	549.8	139.4
Panel B: Summary statistics for sovereign CDS spreads						
France	-	49.06	14.75	1.50	249.6	61.04
Germany	-	27.05	9.50	0.60	119.2	29.56
Italy	-	123.6	43.85	5.30	591.5	150.7
Portugal	-	240.0	40.50	1.90	1527	357.5
Sweden	-	33.34	29.52	1.40	160.8	29.46
Spain	-	134.4	65.77	2.55	641.0	159.8
ALL	-	99.11	26.09	3.29	457.4	125.3

Table 2 – Johansen Cointegration Test

This table reports Johansen trace test statistics for the existence of a cointegrating vector relating bank CDS spreads and sovereign CDS spreads. A constant is included in both the cointegrating equation and the VAR. The number of lags is optimized according to the Akaike criterion. *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively.

	Number of Cointegrating Equations	
	None	At Most 1
France	17.44**	2.52
Germany	24.09***	2.93*
Italy	38.52***	2.00
Portugal	20.60***	1.20
Sweden	53.47***	3.09*
Spain	37.18***	2.63
Aggregate	29.60***	2.46

Table 3 – Price Discovery Contributions

Error correction coefficients (λ_i) estimates, their t-statistic and the Gonzalo and Granger (1995) measure of price discovery are reported for the whole sample period (Panel A), the pre-crisis period (Panel B), the sub-prime crisis period (Panel C) and the sovereign debt crisis period (Panel D).

	λ_1	t-stat	λ_2	t-stat	GG_{Bank}
Panel A: Whole Sample (January 2004 – March 2013)					
Aggregate	-0.02	-4.72	-0.00	-0.23	0.00
France	-0.01	-3.35	-0.00	-0.41	0.00
Germany	-0.01	-3.69	0.00	0.39	0.03
Italy	-0.01	-4.10	0.00	0.51	0.13
Portugal	-0.01	-1.84	0.01	2.63	0.63
Sweden	-0.00	-2.44	0.02	6.50	0.86
Spain	-0.03	-5.89	-0.00	-1.34	0.00
Mean					0.28
Panel B: Pre-crisis period (January 2004 – July 2007)					
Aggregate	-0.01	-1.56	0.11	6.28	0.93
France	0.02	2.71	0.01	2.59	0.00
Germany	0.00	0.11	0.02	4.07	1.00
Italy	-0.05	-4.20	0.01	2.48	0.12
Portugal	0.00	0.33	0.00	1.23	1.00
Sweden	-0.00	-0.43	0.08	7.94	1.00
Spain	-0.05	-1.51	0.02	3.77	0.30
Mean					0.57
Panel C: Sub-prime crisis period (August 2007 – December 2009)					
Aggregate	-0.03	-3.37	-0.00	-1.02	0.00
France	-0.03	-3.04	-0.00	-0.04	0.00
Germany	-0.01	-1.82	0.00	0.46	0.00
Italy	-0.01	-2.04	-0.00	-0.23	0.00
Portugal	-0.02	-2.98	-0.01	-1.11	0.00
Sweden	-0.00	-1.43	0.00	1.34	0.37
Spain	-0.03	-2.72	-0.00	-0.71	0.00
Mean					0.06
Panel D: Sovereign debt crisis period (January 2010 – March 2013)					
Aggregate	-0.02	-3.02	-0.00	-0.12	0.00
France	-0.03	-2.91	-0.01	-0.73	0.00
Germany	-0.02	-2.72	-0.00	-0.11	0.00
Italy	-0.02	-2.33	0.00	0.44	0.20
Portugal	-0.00	-1.02	0.01	1.61	0.66
Sweden	-0.01	-2.57	0.00	1.71	0.22
Spain	-0.04	-4.60	-0.01	-1.16	0.00
Mean					0.18

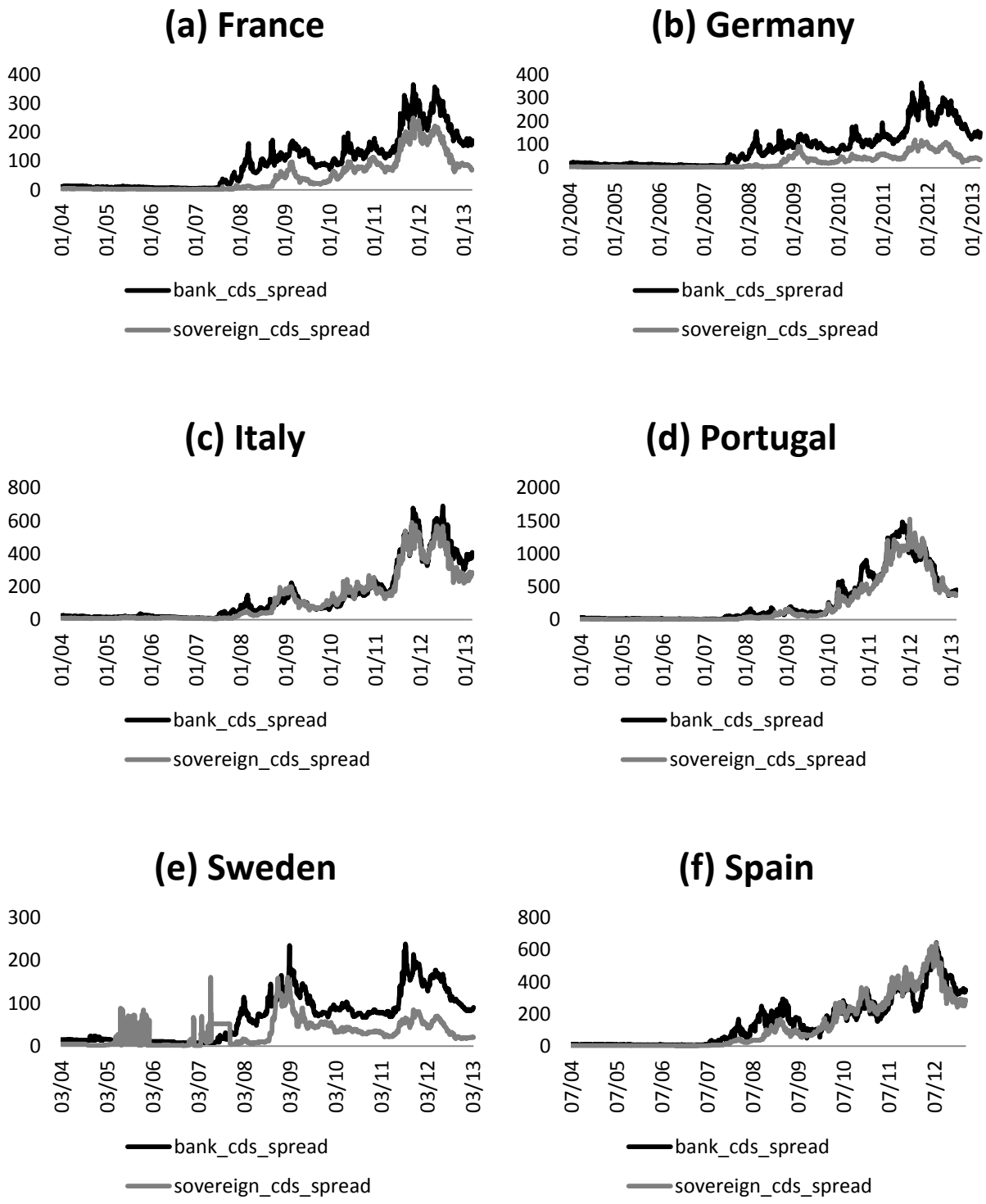

Figure 1 – Time series of bank and sovereign CDS spreads

This figure shows the evolution of the time series of bank and sovereign CDS spreads (in basis points) for the six European economies under analysis, namely France, Germany, Italy, Portugal, Sweden and Spain.

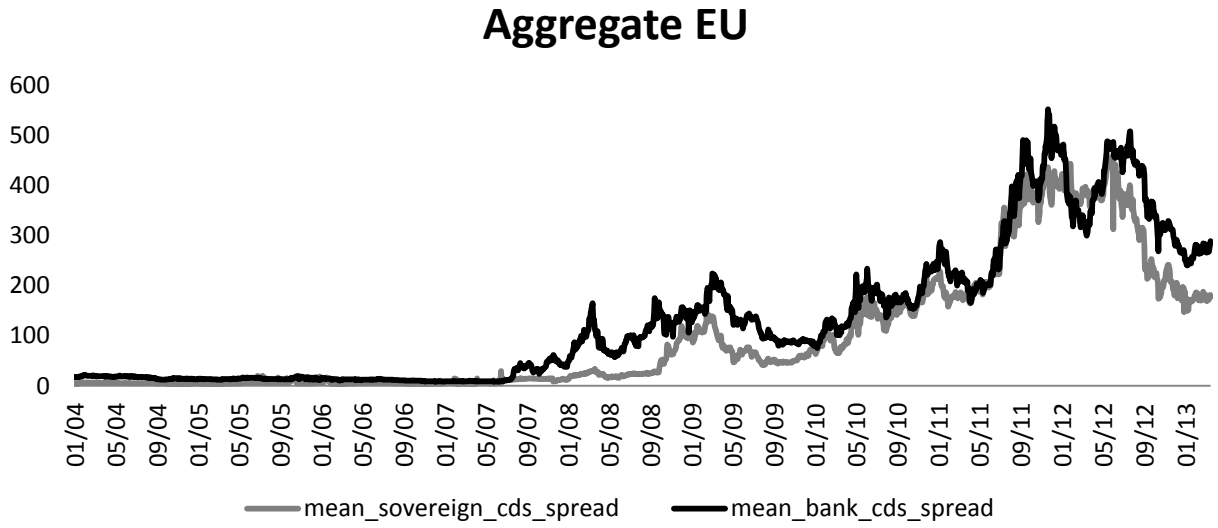

Figure 2 – Time series of average bank and sovereign CDS spreads across the six European economies

This figure shows the evolution of the time series of average bank and sovereign CDS spreads (in basis points). Data from the six European economies have been aggregated.