EUROPEAN FINANCIAL MARKETS CONNECTEDNESS AND MONETARY POLICY COMMUNICATION STRATEGY: SPILLOVER EFFECTS FOR CENTRAL AND EASTERN EUROPE

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Abstract: This study evaluates the impact of unconventional policy announcements by the European Central Bank (ECB) on the interconnectedness of sovereign credit default swaps (SCDS) markets in the European Union (EU) from 2009 to 2014. The findings suggest that ECB's unconventional policy measures reduced sovereign default risk not only in Eurozone nations but also in Central and Eastern European countries. To investigate the transmission of monetary policy effects across European countries, we employ the Diebold & Yilmaz connectedness framework along with an event-study approach. Our analysis reveals robust evidence of substantial positive spillovers from ECB monetary policy measures to all EU countries, effectively shielding the SCDS market from adverse shocks. Among various policy tools, we observe that asset purchase programs enhance overall connectedness, while mixed policy measures bolster within-cluster connectedness. Furthermore, our results highlight the efficacy of specific monetary policy instruments, indicating that asset purchase programs and quantitative easing are particularly effective in reducing sovereign risk.
Keywords: communication strategy, financial markets, monetary policy, sovereign risk, Central and Eastern Europe

Introduction

Since the beginning of the financial crisis in 2007, major central banks have implemented both conventional and unconventional monetary policy measures to control the spread of financial instability. Central banks around the world struggled to tackle economic negative consequences not only by lowering key interest rates, but also by designing innovative programs and tools to ease the flow of credit. For the European Central Bank (ECB), the sovereign debt crisis added an extra layer of responsibility testing its capacity to contain financial instability through non-conventional policy measures. Confronted with the

possibility of multiple debt crises, ECB engaged in targeted sovereign debt purchases exercising its lender-of-last-resort capacity. Between 2009-2014 the shift from its traditional operating framework included even more new policy measures. However, their impact on Central and Eastern European (CEE) markets has rarely been assessed.

While the literature investigated cross-border spillover transmission channels of unconventional monetary policy focusing on various financial variables (Georgidas & Grab, 2015; Apostolou & Beirne, 2017), only a few studies focused on spillover transmission from European Monetary Union (EMU) member states to six Central and Eastern European economies (Falagiarda et. al., 2015; Ciarlone & Colabella, 2016) . Moreover, a vast literature investigated how sovereign credit risk changes spillover transmission depending on global factors (Ang & Longstaff, 2013; Pan & Singleton, 2008) or country-specific domestic fundamentals (Aizenman & Park, 2013; Beirne & Fratzscher, 2013; Jeanneret, 2018). Investigating sovereign market connectedness in an intended integrated monetary union by taking into account the impact of unconventional monetary policy measures proves to be valuable not only for measuring credit risk magnitude in the European Union but also for designing monetary policy programs aimed at containing financial distress.

Thus, our paper stands between two research fields: one exploring unconventional monetary policies' impact on financial markets and one exploring spillover transmission. First, this paper aims to investigate how monetary policy announcements increase or decrease spillover transmission between Eurozone and Central and Eastern European countries during turbulent times (more specifically, during sovereign debt crisis). Second, we examine the short-term impact of monetary policy announcements on the European Sovereign Credit Default Swap (SCDS) market.

We contribute to the literature in at least two ways. First, we explore EU sovereign market connectedness through the application of Diebold & Yilmaz (DY) methodology to SCDS which represent a measure for sovereign default probabilities. This provides an undetermined estimation of country-specific sovereign risk. In addition, to account for the influence of global or domestic factors in spillover transmission, we compare two different measures: SCDS returns and SCDS idiosyncratic returns. Second, through an event study methodology, we explore the unconventional monetary policy announcements' impact on SCDS market while other studies focused exclusively on bond or equity markets. This supports other empirical findings about the importance of spillover transmission within an increasing sovereign risk environment. Overall, studies about spillovers triggered by unconventional monetary policy measures in the EU are insufficient and limited by the impossibility of designing a model that takes into account all the factors that impact financial assets. Exploring spillovers transmission through the application of two separated methodologies may be the most effective way to describe the impact of specific policy events on sovereign connectedness and risk.

The results indicate that ECB unconventional policy measures contained financial distress not only for Eurozone countries but also for the CEE region. We find evidence of strong spillovers from ECB's monetary policy measures to all countries, including CEE countries. Among different types of monetary policy measures, we find that spillovers from asset purchases programs were the most noticeable, while spillovers from mixed unconventional measures are rather unclear: spillovers from asset purchases programs increase all-in-all connectedness and spillovers from mixed measures increase within-cluster connectedness.

The results also shed light on the effectiveness of several monetary policy instruments: asset purchases programs and quantitative easing are the most effective policy instruments for decreasing sovereign default risk.
The paper is structured as follows. Section 2 presents briefly the literature related to spillover transmission from advanced economies to emerging markets, from Eurozone countries to CEE. It simultaneously considers the influence of domestic and global factors on spillover transmission. Section 3 presents data and methodological elements. Section 4 presents the results, while conclusions are drawn in Section 5.

Literature Review

Financial market connectedness and the impact of unconventional monetary policies have recently dominated academic research, as well as policy debates. The impact of unconventional monetary policy in spillover transmission from advanced economies to emerging markets has not been directly assessed through econometric techniques. However, empirical studies related either to market connectedness or to unconventional monetary policies on financial assets observed the presence of spillover transmission across countries. To what extent spillover transmission impacts economic performance, especially within systems oriented towards monetary integration, remains understudied. Two research directions have a direct connection with our paper. On the one hand, studies focus on the impact of unconventional monetary policy on financial assets prices. On the other hand, authors discuss spillover effects from unconventional measures to emerging economies. While exploring both issues within the same methodology to observe a direct impact of policy in spillover transmission encounters econometric difficulties, both directions point out implications of monetary policy actions for emerging economies.
A large proportion of the literature focusses on the impact of FED's policies spillover transmission to emerging markets. Aizenman et al. (2014) assess the impact of Fed's tapering monetary policy on financial markets in emerging economies arguing that countries with weaker domestic fundamentals experience a smaller depreciation of exchange rate, a less significant fall in stock prices and a less significant increase in CDS spreads than countries with stronger domestic fundamentals. Fratzscher et.al. (2013) finds that FED's measures since the implementation of the second round of quantitative easing policies (2010) globally increased equities, while their impact on yields is rather unobservable. They conclude that US's unconventional monetary policy triggered portfolio rebalancing and acted in a pro-cyclical manner for capital flows to emerging markets. Similar to Aizenman et al. (2014) who describe the importance of domestic fundamentals in spillover transmission, Georgiadis and Gräb (2015) show that the magnitude of spillover effects across economies depend on countries' financial openness, exchange rate regimes, trade and the integration with the Eurozone. Apostolou and Beirne (2017) study changes in the ECB and FED's balance sheets examining how much volatility in emerging markets financial variables can be explained by these changes. They find that bond markets are more responsive to positive volatility spillovers while FED has the most significant impact. They also find that EMs' stock markets are subject to negative volatility spillovers. We contribute to the European literature by comparing two SCDS returns and SCDS idiosyncratic returns. The comparison accounts for the influence of global and domestic factors in spillover transmission.

Moreover, several studies focused on the global impact of unconventional monetary policies. Lim et. al. (2014) find that quantitative easing policies have been transmitted globally through liquidity, portfolio balancing, and confidence channels arguing that these effects cannot be attributed to market expectations of country-specific domestic fundamentals. Fic (2013) examines unconventional policies' impact on BRIC countries (Brazil, China, India and Russia). They find that unconventional policies undertaken by major central banks (FED, BoE, ECB and BoJ) lead to lower yields, higher equity prices, and lower investment premia. Chinn (2013) discusses the impact of unconventional monetary policies on exchange rate and asset prices in emerging economies concluding that more volatility is introduced into global markets while supporting global rebalancing through emerging countries' motivation for market currency revaluation.
Two main conclusions are clearly visible from the above literature review. Firstly, there is a consensus regarding spillover effects from advanced economies' monetary policy measures. Secondly, most of the studies focused on spillover effects from FED's policies to emerging markets. We contribute to the literature regarding the impact of ECB's unconventional policy measures to emerging markets by exploring system-wide connectedness in the EU. This allows us to conclude on the magnitude of country-specific sovereign default risk.

Methodology and data

Data
Daily 5Y sovereign CDS data is used in both parts of our empirical analysis. We chose SCDS spreads to offer a good illustration of default risk. Compared to its corresponding market, the bond market, the SCDS market is more liquid enabling better estimates for default risk. SCDS spreads are quoted in basis points. Higher spreads indicate increasing market expectations about the possibility of a default, while lower spreads indicate diminishing market expectations about a default. The dataset comprises the daily exchanges on the 5-year credit risk representing the average premium (average between demand and supply) from 1st of January 2009 to 31st of December 2014 quantifying a total of 1565 observations. The selected sample comprises 23 EU member states. The data is extracted from DataStream being fully denominated in Euro to ensure the comparability of time series. Missing segments of the price series are interpolated through previous-day price repetition.
In the implementation of the DYCI model, both SCDS returns and SCDS idiosyncratic returns measures are chosen as variables of interest, rather than the SCDS spreads themselves. SCDS returns reflect to a certain extent systemic sovereign credit risk since it captures the influence of global financial market variables, while the idiosyncratic measure is more sensitive to countries' economic fundamentals capturing sovereign domestic risk and highlights the pure contagion component of the systemic risk.
To extract the idiosyncratic returns measures, we use the generalized dynamic factor model proposed by Forni et al. (2000) and adapted by Barigozzi and Hallin (2016). For our $N \times T$ panel dataset, we have $Y=\{Yit;\ i=1,\ldots,N;\ t=1,\ldots,T\}$ of CDS returns. The generalized dynamic factor model decomposes Yit into a common component, Xit, driven by q factors, and an idiosyncratic component, Zit, as follows:

$$Y_{it} = X_{it} + Z_{it}$$

The common component takes the form of an auto-regressive representation as:

$$X_{it} = \sum_{k=1}^{q} b_{ik}(L)u_{kt}$$

where L is the lag operator, the q factors are defined as an orthonormal zero-mean white noise vector process ut=$\{u1t,\ldots,uqt\}'$, and the filters $bik(L)$ are one-sided and square-summable. We choose the number of factors by applying the Hallin and Liška (2011) criterion, which indicates one common factor.

Diebold-Yilmaz connectedness measures and graphical representations

Diebold-Yilmaz Connectedness Index (DYCI) methodology is based on generalized variance decompositions of a vector autoregressive (VAR) model. DYCI association with network graphical display results in a powerful spillover representation across countries connecting forecast error variance decompositions matrices with network edge weights. The measure reveals how much SCDS i's variable future uncertainty results from shocks in variable j. DYCI methodology starts with the implementation of a covariance-stationary VAR model with N variables is defined as follows:

$$Y_t = \sum_{i=1}^{p} \emptyset_i \, x_{t-i} + \varepsilon_t$$

with $\varepsilon_t \sim (0, \Sigma)$. The moving average representation of VAR takes the following form: $Y_t = \sum_{i=0}^{\infty} A_i \varepsilon_{t-i}$

where N*N is a coefficient matrix. Ai follows recursive pattern as Ai = ∅1 Ai-1 +∅2 Ai2+…+∅p Ai-p. A0 is an identity matrix and Aj = 0 for i<0. Because the number of estimated parameters increases quadratically with the number of variables, the VAR estimation adopts Dermirer et. al. (2018) approach to estimate sparse VAR of SCDS idiosyncratic and returns measures using an elastic net estimator. The estimator minimizes the sum of squared errors and shrinks coefficients to zero if estimating them does not substantially reduce prediction error. We calculate the decomposition of the variance of the forecast error at h steps ahead:

$$\varphi_{ij}(H) = \frac{\gamma_{jj}^{-1} \Sigma_{h=0}^{H-1} \left(e_i' A_h \Sigma e_j\right)^2}{\Sigma_{h=0}^{H-1} (e_i' A_h \Sigma A_h' e_i)}$$

The decomposition records how much variance of the forecast error of SCDS idiosyncratic or returns measures at h steps ahead is due to the shocks in another variable included in the VAR model. Each matrix element is normalized by summing the row so that the decomposition including shocks in each market equals the total decomposition of all variables sums to N:

$$\tilde{\varphi}_{ij}(H) = \frac{\varphi_{ij}(H)}{\Sigma_{j=1}^{N} \varphi_{ij}(H)}$$

For our graphical representation, it represents the estimated size of the edge from node j to node i. Similarly, directional spillovers received/ transmitted can also be decomposed:

$$DS_{i\leftarrow \cdot}^{H} = \frac{\Sigma_{j=1, j\neq i}^{N} \tilde{\varphi}_{ij}(H)}{\Sigma_{i,j=1}^{N} \tilde{\varphi}_{ij}(H)} \, x \, 100 = \frac{\Sigma_{j=1, j\neq i}^{N} \tilde{\varphi}_{ij}(H)}{N} \, x \, 100$$

$$DS_{\leftarrow i}^{H} = \frac{\Sigma_{j=1, j\neq i}^{N} \tilde{\varphi}_{ji}(H)}{\Sigma_{i,j=1,}^{N} \tilde{\varphi}_{ji}(H)} \; x\; 100 = \frac{\Sigma_{j=1, j\neq i}^{N} \tilde{\varphi}_{ji}(H)}{N}$$

These measures denote the spillover level received or transmitted by variable i within the system. Finally, the total spillover index is calculated as:

$$S(H) = \frac{\Sigma_{i,j=1, i\neq j}^{N} \tilde{\varphi}_{ij}(H)}{N} \; x\; 100$$

denoting the overall spillover significance that originates in other countries on the determination of SCDS measures. This measure is called "system-wide connectedness" or "dynamic connectedness index".

The graphical display of our empirical analysis follows the results obtained from DYCI presenting estimated connectedness measures. Corresponding to our sample, we have 23 nodes and as many as 232 edges. Presented shortly, networks graphical representations follow three simple rules: node size is a linear function of total directional connectedness "to others" representing a direct measure of default risk; node location is determined by the directional spillovers "to" and "from " (Nodes with many strong links to other nodes are located at the network's center, while nodes with weak links are located close to the sidelines); edge thickness indicates a strong pairwise connectedness (Presenting whole network structure with all the resulting edges would hide the basic patterns in spillover transmission. Therefore, only the thickest edges are shown in our graphs).

High-Frequency Event Study

To quantify country-specific changes in SCDS spreads around monetary policy announcements we apply a high-frequency event-study initially proposed by Fama et. al. (1969). Changes in SCDS markets are measured in a narrow window of time to shortly measure the effects of policy announcements. Considering rational expectations theory's implications for financial markets, SCDS pricing should promptly change after policy announcements. More specifically, one-day or two-day changes in SCDS spreads are sufficient in estimating an unbiased effect of monetary policy announcements. (The high-frequency event study methodology operates under several assumptions: (i) markets are efficient and rational, (ii) the lack of confounding factors impacting asset prices and (iii) events are unexpected. However, our event sample encompasses several monetary policy announcements aimed at re-orienting market expectations (more specifically, forward guidance - FG - discourses presented in Table 1) violating the third assumption. Moreover, the issue of cofounding factors driven by the simultaneous implementation of monetary policy actions including changes in interest rates could also be a valuable concern. However, we keep all monetary policy events (incl. FG discourses and other unconventional monetary policy actions) since we used multiple -day event windows. Using more than one-day window allows for the possibility that SDSC may not react immediately to monetary policy announcements. Additionally, to consider this market inefficiency, for DYCI dynamic estimation we consider connectedness matrices 14 days before/ after a monetary policy announcement.). Thus, we can test our two null hypotheses presented under section 4.4. The statistic that we use is each event change divided by the unconditional standard deviation for the one/ two-days CDS change rate before the announcement date. We compute unconditional standard deviation using data from 14th of January 2008 to 8th of October 2008, a sample period that is not contaminated by

unconventional policy announcements. Similar methodologies are performed by Rebucci et. al. (2021) and Swanson et. al. (2011).

Results

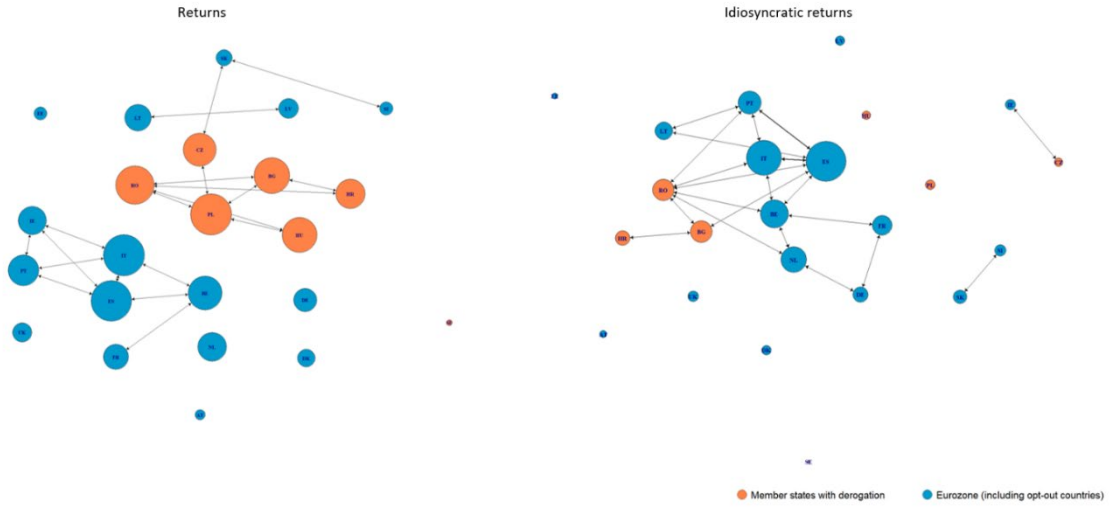
Static network structures: idiosyncratic vs returns

This section presents the static sovereign CDS network estimating the average measure of connectedness among markets over the full sample period. Figure 1 presents sovereign CDS connectedness for returns and idiosyncratic measures. Both figures reveal sovereigns' connectedness is transmitted through three groups of countries: GIIPS countries (Italy, Spain, Portugal), CEE countries (Bulgaria, Croatia, Romania, Poland, Hungary), and Core Eurozone countries (excl. GIIPS). The multivariate cluster analysis performed on the correlation matrix displayed a strong connectedness measure among sovereigns based on their geographical distribution. The cluster algorithm attempts to sort the states into groups with similar characteristics. Following the literature, we assumed the existence of three clusters (GIIPS countries, Core Eurozone and CEE). Thus, the number of k-medoids equalled 3. The results showed a high degree of connectedness among neighbouring countries: an Eastern European cluster (EE, LV, CZ, PL, HU, LT, RO, BG, HR, SI, SK), a Western European cluster (AT, UK, NL, PT, IT, ES, BE, DK, DE, SE, FR) and a third cluster only with Ireland suggesting that Ireland risk is distinct from other states. Overall, these results show a strong regional component of sovereign credit risk supporting (Ang & Longstaff, 2013) findings about Europe.

The sovereigns' connectedness reported through edges' intensity is quite weak for both the idiosyncratic component and returns measures. These results are in line with Heinz & Sun (2014) that find that during the European sovereign debt crisis spillovers between Central, Eastern, and South-Eastern European countries were relatively small. Moreover, these results indicating weakness of spillovers intensity are compatible with Aizenman & Park's (2013) findings that observe a constant degree of spillover propagation suggesting a controlled contagion risk and a stable integration for different eurozone countries.

Credit risk magnitude determined by the node size shows that high credit-risk countries are strongly interconnected. While for the returns measures there is a clear distinction between the main GIIPS and CEE countries with all CEE countries being located at the center of the network, for the idiosyncratic component almost all countries transmit spillovers being all connected at the network's center. Even though the idiosyncratic network shows a slightly higher degree of connectedness between several Core Eurozone countries and GIIPS countries (Italy and Spain registering highest credit risk), Core Eurozone countries are weakly connected to high-risk countries. CEE countries also show a low degree of connectedness being located at the network's peripheries signaling a low credit risk. In addition, two bilateral linkages occur (Ireland – Czech Republic, Slovenia – Slovakia), but with no connection with the most- tightly connected countries within the network.

Figure 1. Static network structures during sovereign debt crisis for both returns and idiosyncratic returns



Dynamic index estimation

The dynamic index estimation provides an assessment of the average network during 2009-2014. The sample period starts on 30 January 2009 when a group of 10 Central and Eastern European banks requested bailouts and it covers the peaks of the European sovereign debt crisis. The sample ends two months after 4 September 2014 when ECB decided to cut interest rates to new record levels. However, financial linkages between countries vary over time and are influenced by specific economic, financial, and political events. To capture over-time connectedness dynamics, we use a rolling window analysis of 250 days, roughly 8 months. We connect the over-time connectedness index with important economic events to obtain an understanding of what type of events encourage or offset spillover transmission. Figure 1 presents the over-time connectedness measure for both the idiosyncratic component and returns. Comparing over-time connectedness between the two measures we make several observations.

First, the idiosyncratic index is significantly less high than the returns measure until the end of 2014 indicating a lower level of financial integration among sovereigns: while returns measures reach a spillover connectedness of 80% during turbulent times, the idiosyncratic index only reaches 60%. However, the half-year 2014 when interest rates hit the zero lower bound signals the occurrence of a convergence trend between the two both connectedness measures showing a high degree of financial integration.

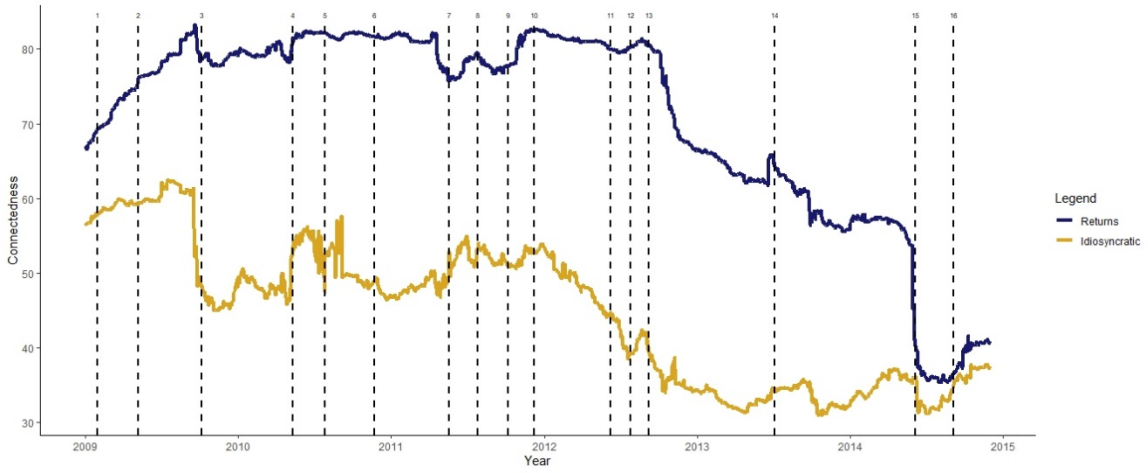
Second, the idiosyncratic connectedness index is more unstable with frequency highs and lows over shorter periods. For instance, the period between May 2010 and May 2011 is characterized by more than four highs and lows for the idiosyncratic index, while the returns index remains stable.

Third, there is a similar evolution pattern between the two measures allowing us to indirectly infer that the idiosyncratic index is mainly driven by global credit events, rather than by local events. The Granger Causality test was applied to check whether total spillovers obtained for returns can predict the total spillover for the idiosyncratic component (p-value = 0.04823). The significance test revealed that total connectedness on returns is useful in predicting the evolution of idiosyncratic connectedness. There is no

problem with reverse causation. There are only three time periods when the two indexes follow opposite directions: returns index increases while idiosyncratic index decreases. The first one corresponds occurs in the second half of 2011 during the implementation of SMP (10th of May 2010) and after the first Greek Austerity Plan (3rd of May 2010). The second one corresponds to the announcement of the Second Greek Economic Adjustment Programme (2011-July-21). The third one corresponds to the date when Portugal received financial assistance from the EU and the IMF.

Finally, while there are several indexes increases over time, we identify several juncture points corresponding to two types of events: monetary policy announcements and unexpected events announcements. These junctures show a significant increase or decrease in both returns and idiosyncratic indices. On the one hand, there are several sudden changes caused by unexpected events. For instance, after Greece revealed that its unprecedented budget deficit, the index decreased with approximately 10 percentage points for the idiosyncratic component and approximately 5 percentage points for the return measures in less than 30 working days. Moreover, when seven banks failed the stress tests performed by the Committee of European Banking Supervisors the idiosyncratic index with approximatively 7 percentage points in less than 5 working days. On the other hand, unconventional monetary policy announcements have also a significant impact on sovereign market connectedness. For instance, when ECB announced SMP the idiosyncratic index increased by approximately 10 percentage points, and the returns index increased by approximately 4 percentage points in less than one week. Moreover, when ECB announced its decision to impose negative interest rates on banks' overnight deposits, the return index decreases by approximately 18 percentage points and the idiosyncratic index by approximately 5 percentage points.

Figure 2. Dynamic sovereign CDS market connectedness during Sovereign Debt Crisis (correlation with ECB's unconventional monetary policy announcement and unexpected events)



Events:

A group of 10 central and eastern European banks had already asked for a bailout (30th of January 2009)

Covered bond purchase program (CBPP1) and ECB reduced rates with 25 basis points (7th of May 2009)

Greece revealed that its budget deficit was 12.7% of gross domestic product (5th of November 2009)
A three-year program for Greece and Securities Market Program (SMP) announcement (10th of May 2010)
Seven EU banks fail stress tests (26th of July 2010)
Irish authorities request financial assistance (22nd of November 2010)
Portugal receives financial assistance from the EU and the IMF (18th of May 2011)
Second Greek Economic Adjustment Programme (21st of July 2011)
Covered Bond Purchase Program 2 (6th of October 2011)
LTROs expansion announcement and the reduction of ECB main policy rate by 0.25 basis points (8th of December 2011)
Spain requests financial assistance (8th of June 2012)
"Whatever it takes" speech (26th of July 2012)
Outright Monetary Transactions (OMT) announced (6th of September 2012)
"Keeping interest rates unchanged" Speech (4th of July 2013)
ECB policy rate breaking through the zero lower bound for the first time and imposed negative interest rates on banks' overnight deposits. TLTROs announced (5th of June 2014)
ECB's QE announcement (4th of September 2014)
Since we want to capture the impact of monetary policy announcements on spillover transmission during turbulent economic times in the European Union, we exclude unexpected events to focus on nine ECB's monetary policy announcements. All of them signal highs or lows of spillover index in both returns and idiosyncratic measures and they indicate either lender-of-last-resort program other unconventional monetary policy tools.

Dynamic network structures around monetary policy announcements
To assess the time-varying characteristics of the CDS network and the impact of monetary policy announcements, we look at the evolution of connectedness across time; more specifically 14 days before and after each event. Assessing connectedness around specific events allows us to observe whether spillovers propagation intensified or diminished. For better visualization, this sections only presents specific network structures, but we stress that our results follow the same patterns, as described in the following sections. Moreover, to assess the effectiveness of monetary policy actions on spillover transmission, we divide monetary policy announcements depending on the type of policy action managed by the ECB: asset purchase program (APP), interest rates changes (IR), targeted lending (TL), lending operations (LO) and forward guidance (FG).

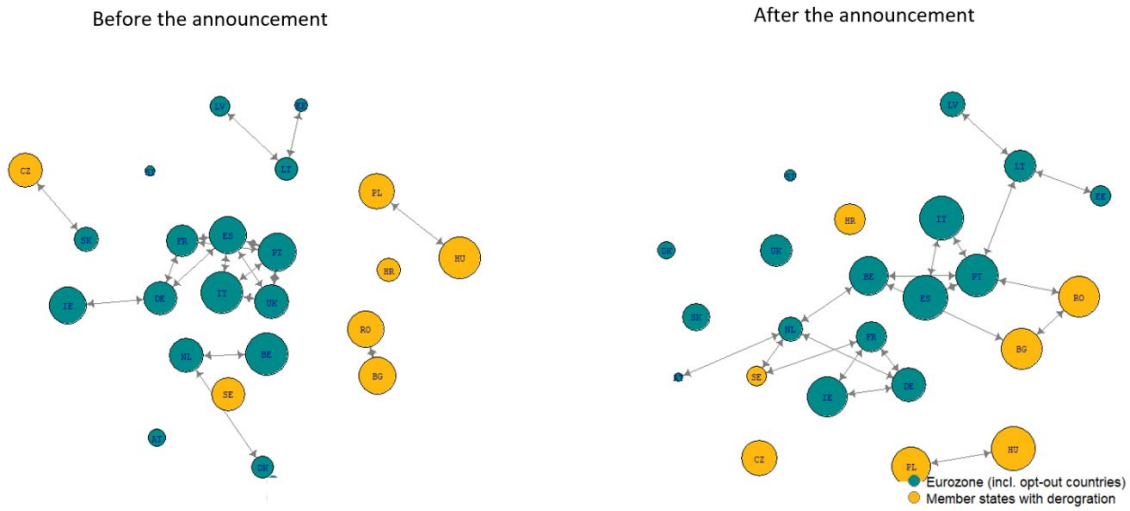
Event Number and Event Date	Type of policy action	Event description
7th of May 2009	APP	Covered bond purchase program (CBPP1)
	IR	Reduction of main policy rate by 0.25 basis points
	LO	12-month LTROs announcement
10th of May 2010	APP	Securities Markets Program (SMP)
6th of October 2011	APP	Covered bond purchase program (CBPP2)
8th of December 2011	LO	36-month LTROs expansion announcement; enlarging the pool of eligible assets as collaterals
	IR	Reduction of main policy rate by 0.25 basis points

26th of July 2012	FG	Mario Draghi's "Whatever it takes" Speech and the indication of expending sovereign debt purchases
6th of September 2012	APP	Outright Monetary Transactions (OMT) program
4th of July 2013	FG	"Keeping interest rates unchanged" Speech
5th of June 2014	IR	The decision to impose negative interest rates by reducing banks' overnight deposit rate by 10 basis points to -0.10%.
	TL	TLTRO I announced
4th of September 2014	IR	Reduction of the policy rate to 0.05 from 0.15; reduction of deposit facility rate by 10 basis points to -0.20%
	APP	ABSPP programme (Asset-Backed Securities' Programme)
	APP	CBPP3

Asset purchases programs increasing all-in-all market connectedness

APPs gained significance at the beginning of the sovereign debt crisis. First, in May 2010, ECB announced direct purchases of government bonds in secondary markets under the SMP. The program aimed to restore trust levels in sovereign bond markets which threatened to escalate several debt crises. Second, in September 2012, to calm market fears about the dissolution of the monetary union, ECB announced the introduction of OMT. The program follows the same pattern as SMP encompassing the possibility of purchases of government bonds issued by countries under the European Stability Mechanism. While the first two programs are categorized under the umbrella of "lender-of-last-resort programs", the third program ABSPP (4th of September 2014) is part of larger quantitative easing tools implemented after the fall below the Zero Lower Bound for interest rates. The dynamic network structures indicate a high degree of connectedness among the CEE region and Eurozone after each monetary policy announcement. All three programs increase spillover transmission among European sovereigns without intensifying the default risk. Additionally, strong bilateral spillovers occur for both idiosyncratic and return measures suggesting a stable and moderated monetary integration. Figure 3 presents sovereign connectedness after the SMP announcement for the returns index.

Figure 3. Sovereign CDS market connectedness 14 days before and after the announcement of the Securities Market program (10th of May 2010)



Forward-guidance

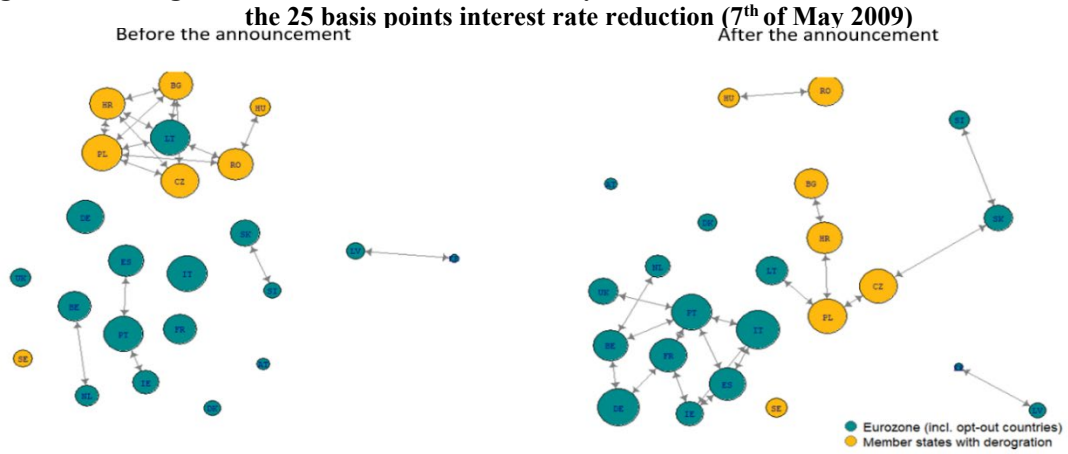
Among the toolkit for unconventional monetary policy tools, forward guidance corresponds to a communication strategy delivering a commitment to future interest rate decisions. Forward guidance aim is to influence long-term interest rates, rather than short-term interest rates which are, in turn, affected by market expectations on future short-term rates. While there is an increasing academic and policy attention on forward-guidance actions, our empirical results shed little light on its impact on financial markets. Mario Draghi's "Whatever it takes", a pure forward-guidance action followed by the announcement of OMT, as well as his speech notifying his intention of "Keeping interest rates unchanged" (26th of July 2012) have an insignificant impact on spillover transmission across European CDS markets. Indeed, "Whatever it takes speech" seems to have a slightly increased impact on the idiosyncratic measure connecting Eurozone CDS markets. Figure 4 describes this impact.

Mixed unconventional policy measures to increase geographical cluster-within connectedness

During the early sovereign debt crisis, ECB shifted its policy actions from traditional to unconventional monetary tools. During 2009 and early 2010, to support the flow of credit and increase public trust in the banking system, ECB conducted direct purchases of covered bonds and reduced its main policy rate by 0.25 basis points. In addition, ECB programs included LTROs (Long-Term Refinancing Operations) – time-limited loans to banks partially used for buying government debt. The connectedness impact on CEE countries of these measures was quite limited: Figure 5 presents the network structure on returns measure 14 days before and after the day of announcement of all the above-mentioned policy actions. It reveals an intensified spillover transmission for Eurozone countries but decreased connectedness within CEE. Similar results can also be observed for events 3 and 4 when the same mix of policy actions was deployed only 2 months apart. Increased connectedness is observed only depending on geographical clusters for most of the networks in our sample.

Overall, our empirical results show two important factors that contribute to sovereign risk connectedness: the over-time spillover unpredictability and monetary policy announcements' influence on spillover transmission. On the one side, over-time

Figure 4. Sovereign CDS market connectedness 14 days before and after the announcement of CBPP1 and the 25 basis points interest rate reduction (7th of May 2009)



unpredictability is determined by the fact that connectedness among SCDS markets changes over time. While we can identify an increase in bilateral/group spillovers between certain countries at certain moments in time, these patterns change substantially over time. An interesting finding is that both idiosyncratic and returns measures, as well as the spillover index evolution, generate similar results across the EU suggesting that sovereign risk is rather driven by global market factors such as risk premium or investment flows rather than by domestic fundamentals (Longstaff et al. 2011).

On the other side, the results shed light on the impact of unconventional monetary policy toolkit in spillover transmission across European Union member states. While FG actions do not seem to have a specific impact on spillover transmission, APPs increase all-in-all market connectedness generating spillovers from Eurozone to CEE (and vice versa), and mixed unconventional policy measures increase spillover transmission among geographical clusters. Particular attention needs to be paid to pure quantitative easing policy packages implemented after the fall of interest rate below the zero lower bound.

Event study results

The application of DYCI provides an understanding of the short-term impact of monetary policy announcements on the European CDS market. Given our previous results regarding spillover transmission around announcements about APPs and mixed-unconventional policy actions, we formulate our event study null hypothesis: monetary policy announcements do not affect European SCDS markets. The alternative hypothesis is that monetary policy announcements should produce an increase or decrease in SCDS basis points indicating growing or diminishing market expectations of default. Table 1 presents our results based on the geographical clusters.

Table 1. Event study results on geographical clusters

		Eurozone														Member states with derogation					
		Core Eurozone					GIIPS				Eastern Eurozone					CEE					
		AT	NL	BE	DE	FR	IT	ES	PT	IE	EE	LV	LT	SI	SK	CZ	BG	HR	PL	RO	HU
Event 1 (7th of May 2009)	One-day market response	-15***	-6***	-7***	-1.5***	-4***	-9***	-13***	-5***	-15***	-15	-50***	0	-3	-5***	0	-8*	-13***	5*	15***	-12**
	Two-days market response	-15***	-4*	-9***	-2***	-4***	-9***	-14.5***	-5*	-15***	-15	-50***	0	-3	-5	5*	-8	-13***	5	-1	-5
Event 2 (10th	One-day market	-7.9***	-8.9*	4.9*	0	2.9***	-10*	-5***	-10*	10*	0	21	10*	0	1	11*	5	4	0	2	-4

of May 2010)	respo nse		***	**			**		***	***		***	***			***				
	Two-days mark et respo nse	-7.9***	-8.9***	0.9	-2.9***	-3*	-27***	-27***	-61***	-155***	-10	1	-20***	-5	-2	-4	-26***	-111*	-133*	-255***	-188***
Event 3 (6th of Octobe r 2011)	One-day mark et respo nse	0.06	2.43	0.38	2.3	-1.3	-4***	6***	-8***	-3***	-13	0	-4***	2	2	0	-9**	-5	-4*	-9	6
	Two-days mark et respo nse	-6.9***	-0.49	1.3	0***	-4.4***	-33*****	-2	-36***	-255***	-13	-2	-6***	2	2	-2	-13*	-9	-8*	-13	1
Event 4 (8th of Decem ber 2011)	One-day mark et respo nse	0.04	2.9*	-2.2*	-2.8*****	-2.4**	10*****	-7***	-1	6***	0	1	3***	0	1	1	4	2	1	2	2
	Two-days mark et respo nse	7.47***	6.3*****	9.7*****	0.22	14.7*****	39*****	10*****	2	13*****	0	12	18*****	4	6*	3	13*	8	11***	5	17*
Event 5 (26th of July 2012)	One-day mark et respo nse	-2.1**	-4.2***	-5.3*****	-3.4*****	-4.3	-21*****	-26*****	-39*****	-255*****	0	-4	-4*****	0	0	-2	-4	-21*****	-5***	-188***	-8
	Two-days mark et respo nse	-3.6**	-5.5*****	-8.1*****	-3.4*****	-8.5*****	-38*****	-47*****	-48*****	-34*****	0	-10	-18*****	-3	-2	-8*****	-9	-21*****	-11***	-266***	-20***

Before discussing the impact of the different types of policy events on the SCDS market, we make two general observations. First, there is a geographical distribution of default risk among sovereigns determined by country-specific common elements captured previously by dynamic network structures on both idiosyncratic and returns measures: approximately all policy announcements produce a decrease in SCDS basis points in highly-indebted GIIPS countries; policy announcements have a significant decreasing impact on the Baltic

states, especially Latvia and Lithuania which are the most responsive countries; policy announcements impact on CEE countries is geographically unequally distributed due to the country-specific dissimilarities. Second, a chronological view on table 1 indicates some form of incremental effects for monetary policy announcements. Without a doubt, policy actions are gradually incorporated into financial prices through a slow-moving adjustment process, whereas FG might play a role in the incremental process of building market expectations (Rostagno et. al., 2021). Moreover, compared to our previous results about FG where spillover transmission is negligible, event study results indicate significant SCDS decreases at least for Mario Draghi's "Whatever it takes speech". However, our empirical results concerning the impact of FG remain debatable and problematic since our "pure FG" control measure - Keeping interest rates unchanged" Speech - does not shed the same impact as the "Whatever it takes speech" followed only two months after by the OMT announcement.

Event 6 (6th of September 2012)	One-day market response	-3.5***	-0.39	6.8***	0.3	-4.3***	-7****	-7****	-26*****	-5*	0	-11	-2*	-13*****	0	1	14****	-13*****	0	-9	-1
	Two-days market response	-6.7***	-4.9***	-6.7***	-0.3	-1.6	-21*****	-25*****	-32*****	-37*****	0	-16	-7*****	-53*****	-8	-2	-18	-29*****	-6	-26***	-9
Event 7 (4th of July 2013)	One-day market response	-0.6	0.5	-1.9	-0.9***	-0.7	-2*	-3***	-2	-1	4	3	3***	4	0	-4***	2	-7*	-3	0	0
	Two-days market response	-0.5	-0.7	-2.3	-1.4***	-1.2	-8*****	-6*****	-7*****	-2	4	3	3	4	0	-4	6	-7	-3	0	0
Event 8 (5th of June 2014)	One-day market response	-0.9	0	-1.5	0	-3***	-13******	-8*****	0	-8*****	0	0	0	0	0	0	0	0	0	0	-9
	Two-days market response	-1	-0.9	-2.2	-1.2***	-4.8***	-20******	-12******	0	-11******	-2	0	-23******	-10******	0	0	0	0	0	-7	-9

Event 9 (4th of September 2014)	One-day market response	-1.5	-0.9	-1	-0.3	0	-5***	-1	-8***	0	0	0	0	0	0	0	0	0	0	-1
	Two-days market response	-1.6	-0.9	-1	-0.6	0	-5***	-1	-6***	0	-2	0	0	-1	0	0	0	-3	0	0	-8

Compared to mixed unconventional policy actions, APPs alone substantially decrease SCDS spreads diminishing default risk. After the SMP announcement, SCDS spreads fell by 3 to 9 basis points in Core Eurozone countries, by approximately 20 basis points in GIIPS countries with the highest decrease of 61 basis points registered in Portugal, by 20 basis points in Lithuania, and by approximately 20 basis points in CEE region. Surprisingly, while for most countries the two days market change in SCDS spreads is negative, one-day market change is positive for some countries: Belgium, Ireland, Latvia, Lithuania, Czech Republic. After the OMT announcement both one-day and two-day results, SCDS changes fell for almost all countries (only one-day SCDS change is positive for Belgium). GIIPS countries registered the highest average decline of 20 basis points, followed by the Eastern Eurozone cluster with an average decline of approximately 18 basis points and by the CEE region with an average decline of 13.5 basis points.

Mixed unconventional measures have mixed results especially if they are dispersed in time: while the introduction of CBPP1, the announcement of 12-month LTROs, and the reduction of policy rate (Event 1) determined a decline in SCDS spreads for all countries, only the announcement about LTROs expansion and interest reduction (even though preceded by CBPP2 two months before) determined a rise in SCDS spreads. More specifically, around event 4 SCDS spreads increased by approximately 13 basis points in all countries but with little impact on the Eastern European cluster, while event 1 determined a decline of approximately 11 basis points. While we would expect to observe increases in SCDS basis points determined the be TLTRO I announcement, we noticed several declines. However, this situation occurs in a negative interest rate environment with a specific change in strategy for lending operations: compared to previous LTRO operations, TLTRO operations are „targeted" allowing banks to receive capital only if it is disbursed towards private clients. The 2014 policy actions form a quantitative easing package with a targeted impact on GIIPS countries. For instance, a fall of approximately 12 basis points occurs after the announcement of TLTRO I in Italy, Spain, and Ireland. Moreover, the announcement of CBPP3 and ABSPP, a program conflicting with TLTRO I, determined falls between 5 and 8 basis points in SCDS.

Conclusions

In this paper, we provide some insights into spillover transmission among EU member states. We find evidence of strong spillovers from ECB's monetary policy measures to all countries, including GIIPS and CEE countries. Among ECB's monetary policy measures, we find that spillovers from asset purchases programs were the most noticeable, while spillovers from mixed unconventional measures are rather unclear: spillovers from asset

purchases programs increase all-in-all connectedness and spillovers from mixed measures increase within-cluster connectedness. The results also shed light on the effectiveness of several monetary policy measures: asset purchases programs and quantitative easing policy measures are the most effective policy instruments for decreasing default risk. The results suggest that sovereign default risk decreases over time with the implementation of APPs. They are in line with Ciarlone & Colabella's (2016) findings indicating that the implementation of ECB's APPs was able to protect EU-6 financial markets from negative shocks. The results about Forward Guidance and the effectiveness of targeted lending operations below the zero lower bound need further study through different methodologies since event study application resulted in conflicting observations. In addition, we find strong evidence that SCDS market connectedness is subject to a high degree of market unpredictability since spillover transmission constantly changes over time. This finding reflects Apostolou and Beirne's (2017) observation that volatility proportion in emerging countries modifies over time along with changes in FED and ECB's balance sheets.

This paper has several limitations. One limitation of this paper is its limited lack of focus on CEE countries. To address this problem, we plan to restrict our sample even more. This will allow us to explore spillovers only among EU member states (excluding Sweden, Denmark, and United Kingdom) resulting in more clear conclusions about the effectiveness of policy instruments for European monetary integration. A second limitation is related to event studies methodologies: the impact of a policy actions gets perceived slowly and gradually by the market, and then, adjusted in prices. In this sense, event study methodologies have a build-in lack of memory which is a disadvantage in assessing spillover transmission even though our results show these incremental effects of monetary policy actions. A third limitation is the lack of connection between spillover transmission magnitude and monetary policy transmission channels. To solve this challenge, we plan to analysis ECB's programs specific objectives with regards to our event study results. Adopting another econometric estimation strategy for assessing monetary policy transmission channels and their impact on spillover transmission may result into a more complex analysis about the pricing of different financial assets. In conclusion, our results shed light on the ECB's effectiveness in transmitting positive spillovers over the entire European SCDS market. There is a clear suggestion that portfolio rebalancing channel played an important role in spillover transmission across EU. Through this channel, ECB's policy measures decreased sovereign risk protecting all economies from negative shocks determined by international' investors risk aversion.

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