The bank-sovereign nexus across borders

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Abstract

We quantify the transmission of risk from the banking to the sovereign sector within and across borders in the euro area. Our empirical findings are based on difference and difference-in-differences specifications around the European Central Bank's (ECB) release of the outcome of its Comprehensive Assessment (CA) of the 130 most significant banks in the euro area, on 26 October 2014. An associated information shock in stressed countries led to a reassessment of bank risk and, as a consequence, of sovereign risk. Surprisingly, we find that there is no risk transmission from domestic banks to their respective sovereign in stressed countries. Instead, non-stressed countries bear the risk by providing guarantees to banks in stressed countries. This implies that the well-known bank-sovereign nexus has an important cross-border component.

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1 Introduction

The sovereign debt crisis that erupted in the euro area highlighted that bank credit risk and sovereign credit risk are connected through several important links. First, a growing literature points towards a close connection between domestic banks and their respective sovereigns; see, for example, Cooper and Nikolov (2014), Acharya et al. (2014), Farhi and Tirole (2014), and Acharya and Steffen (2015). This strong relation may cause, through multiple feedback loops, a 'deadly embrace', or 'doom loop', as a result of which both banks and their sovereigns can end up in crisis simultaneously. Second, there may be a link between banks across countries, for example due to counterparty credit risk and information contagion, as documented by Lang and Stulz (1992), Jorion and Zhang (2007, 2009), and Helwege and Zhang (2012).[1] Third, risk interdependence may occur across sovereigns as well, and was arguably present during the most severe phases of the euro area sovereign debt crisis; see, for instance, Augustin et al. (2015), Kallestrup et al. (2013), Lucas et al. (2014), and Benzoni et al. (2015).

In this paper, we show that there is an important fourth channel. There is a cross-sector cross-border dimension through which *bank risk* surprises in one country affect the credit risk and refinancing of *other sovereigns*. We quantify these risk transmissions and discuss the relevant transmission channels.

Our study exploits exogenous variation from a negative information shock associated with the publication of the European Central Bank's (ECB) Comprehensive Assessment (CA) results on 26 October 2014. This release led to a substantial reassessment of banking sector risks within a subset of euro area countries, which allows us to estimate the causal effect of bank credit risk on sovereign risk both *within* and *across* countries. Bank equity prices declined sharply after the arrival of adverse news of bank risk in euro area countries

[1] When companies file for bankruptcy, other firms in the same industry often suffer as a result. Lang and Stulz (1992) conclude that rivals' stocks drop in response to the news because investors learn about future industry cash flows from the filing. Consistent with this result, Jorion and Zhang (2007) report that credit default swap (CDS) premiums typically rise for firms in an industry after a default in that industry. Theocharides (2007), Hertzel and Officer (2012), and Boissay and Gropp (2012) present evidence of similar patterns for corporate bonds, bank loans, and trade credit, respectively. In addition, Helwege and Zhang (2012) find that both counterparty risk transmission and information transmission have significant effects on other financial firms' stock prices.

facing sovereign distress. More precisely, Italian bank equity prices declined by about 12 percent and Greek, Irish, Portuguese, and Spanish bank equity prices by an average of about 10 percent. At the same time, bank equity values did not change in other euro area countries that were less affected by the European sovereign debt crisis (non-stressed countries). Strikingly, this adverse news was only priced in bank equities and not in bank credit default swap (CDS) premia.[2] We show that a country with a sovereign in distress absorbs (guarantees) less or even none of its banking sector risk. The bank-sovereign nexus is broken, which suggests that institutions other than the local sovereign of the stressed country provide insurance for bank debt through explicit guarantees (e.g., the European Stability Mechanism (ESM)) or implicit guarantees (e.g., strong political will to ensure the success of the monetary union). Consistent with this interpretation, we find that countries without sovereign distress faced an increase in the risk transmission between sovereign and banks after the CA release. Consequently, we find that the bank risk from stressed countries spills over onto sovereigns that are unlikely to face sovereign distress. Bank risk in stressed countries appears to be shared within the euro area.

The CA was a year-long examination of the resilience of the 130 largest banks in the euro area, and consisted of a backward-looking Asset Quality Review (AQR) and a forward-looking supervisory stress test (ST) of the examined banks. The CA covered bank assets of €22 trillion, which represented more than 80% of total banking assets in the euro area. It was carried out by the ECB together with the 26 national supervisors from November 2013 to October 2014, and involved a total of approximately 6000 people. The completion of the CA on 26 October 2014 was a major milestone in the ECB's preparation for the Single Supervisory Mechanism (SSM), the newly created cross-border banking supervisor within the euro area. The SSM became operational on 4 November 2014, two weeks after the release of the CA results. In turn, the SSM is a key pillar of the European 'Banking Union', which is a set of legislation that was ratified by the European Council and the European Parliament in successive steps between 2012 and 2014, with the main objective of breaking, or at least

[2]Throughout the paper, we refer to Greece, Ireland, Italy, Portugal, and Spain as stressed countries, and to other euro area countries such as Austria, Belgium, Finland, France, Germany, and the Netherlands as non-stressed countries. Cyprus and Slovenia are stressed countries, but do not have banks that are referenced by a liquid CDS contract. For a similar grouping of countries see, for example, Acharya and Steffen (2015) and Eser and Schwaab (2015).

minimizing, the 'deadly embrace' between the credit risk of national banking sectors and that of the respective sovereigns; see, for instance, EC (2012) and Constâncio (2014).

Establishing a causal link from bank risk to sovereigns is challenging given the strong risk dependence between the two sectors. Banks depend on their own sovereigns because they hold large amounts of sovereign debt for investment and liquidity insurance purposes. On the other hand, sovereigns provide a fiscal backstop, in particular in times of crisis, to their banking sectors. In addition, bank lending matters for economic growth and thus for future sovereign tax revenue; see, for instance, Farhi and Tirole (2014), Acharya et al. (2014), and Fratzscher and Rieth (2015). Fortunately, the announcement of the CA results can serve as a quasi-experimental setup that allows us to identify the risk spillovers from banks to sovereigns. Changes in sovereign CDS premia after the announcement of the CA results are plausibly due to the arrival of adverse news about banks' risk, and not due to new information about sovereign risk.

Our main empirical approach relies on cross-sectional differences and difference-in-differences estimates to test and quantify the risk transmissions from banks to sovereigns. We use these panel data regression results, first, to investigate how bank-sovereign risk sensitivities change within countries from before to after the ECB's announcement of the CA results, second, to study the cross-sectional differences in the risk transmission within countries, and finally, to relate sovereign risk to the risk of both domestic and foreign banks. As a complementary approach, we use a time-varying parameter model in state space form to estimate the time variation in risk sensitivity parameters directly. This approach allows us to cover a longer period of time, particularly focusing on market developments that occurred between the start of the CA in late 2013 and its conclusion in October 2014. Both the regression and state space modeling approaches provide similar estimates of the differential effects around the time of the CA.

Having established that the arrival of adverse news about the risk of the banking sector was located in stressed countries and not non-stressed countries, we first examine the bank-sovereign nexus within countries. Even though the information shock was located in stressed countries, the bank-sovereign nexus in stressed countries was not affected. Putting it differ-

ently, there is no transmission of risk from banks to their sovereigns in stressed countries. Clearly, the local sovereign of a stressed country does not or cannot provide guarantees to its banking sector. Looking at non-stressed countries, we would not have expected there to be any effect on the bank-sovereign nexus, given that there was no adverse news released about their banking sectors. Surprisingly, though, the bank-sovereign nexus in non-stressed countries becomes significant. With an increase in banking sector risk of 10 percent, the risk transmissions from banks to sovereigns increase by about 3 percent. This figure is about 2.6 percent higher than the figure for stressed countries excluding Italy, and about 4.2 percent higher than the figure for the transmission of banking sector risk to the Italian sovereign.

This strongly suggests that there are guarantees provided by non-stressed countries to the banking sectors of stressed countries. These guarantees could be either explicit or implicit. Explicit guarantees are, for instance, provided by new institutions that were created during the course of the euro area sovereign debt crisis from 2010 to 2012, such as the ESM, with a total size of more than €700 billion. The funding structure of the ESM resembles that of the ECB, implying that two large euro area countries (Germany and France) contribute approximately half of the equity. In addition, a subset of central bank non-standard monetary policy measures include features of partial and conditional insurance, such as the ECB's Outright Monetary Transactions program (OMT), and also its private sector securities' purchase program (PSPP), as announced in January 2015. Implicit guarantees consist particularly of the strong political will to ensure the success of the single currency and the integrity of the euro area.

To quantify and test for the cross-border risk transmission from the banking sectors of stressed countries to non-stressed countries, we use the simple average of bank equities of banks located in stressed countries in our baseline model. The decline of average bank equity prices in stressed countries leads to an increase in the sovereign CDS of non-stressed countries. A 10 percent drop in banks' equities increases the risk transmission to non-stressed countries by about 7 percent. Note that there is no significant connection between stressed countries' equities and non-stressed countries' sovereign risk prior to this arrival of adverse news.

While changes arguably best capture the dynamics of risk transmissions between banks and sovereigns, we show that the evidence derived from levels of equity and CDS prices confirm these dynamics fully and provide additional support for our results. Given the adverse information shock about bank risk in stressed countries, the CDS premia show surprisingly little if any effect. The level of Italian bank CDS did not change, on average, after the release of the CA results, compared to pre-CA levels, despite a large drop in equity prices. Even more starkly, an average Italian bank was suddenly perceived as less risky than the Italian sovereign. Even though other stressed countries exhibit an increase in bank CDS premia, there was a partial decoupling from sovereigns after the release of the CA results. As we argued before, other institutions provided guarantees to the banking sectors of stressed countries, which led to there being no risk transmission from banks to their sovereign. In non-stressed countries, however, only sovereign CDS spreads increased, while, surprisingly, bank CDS spreads remained approximately flat. Implicit and explicit guarantees led to an increase in all euro area sovereign CDS premia. The increase in sovereign CDS premia is about 10 basis points on average (from about 52 basis points to about 62 basis points) and economically significant given the substantial amounts of sovereign debt that are refinanced each year in the euro area.

Our findings have very apparent policy implications, in particular given that risk transmission across borders occurs through explicit and implicit public guarantees. Shortly after the results of the CA were announced, the president of the ECB observed that "... when a shock hits ..., we need other ways to help spread those costs. In a monetary union like ours, there is a particular onus on private risk-sharing to play this role. Indeed, the less public sector risk sharing we want, the more private sector risk sharing we need." (Draghi (2014)). Our results suggest that public sector risk sharing in the euro area is present and significant. In late 2014, sovereigns were still being affected by banking sector woes, both domestically and across national borders. This transfer of bank risk across borders is potentially problematic owing to its effects on risk-taking incentives and moral hazard. In this regard, we conjecture that endowing the euro area banking supervisor with a sizable bank resolution fund, funded by risk-sensitive contributions from banks, would support a shift in risk dependence away from the public sector to the private sector (i.e., banks). According to

current plans, the bank resolution fund is scheduled to achieve a total size of approximately €55 billion, eight years after its inception in 2014.[3] Instead, the size and leverage capabilities of the bank resolution fund could be made more similar to the ESM, a rescue facility that is backed by European sovereigns.

We proceed as follows. Section 2 explains why the setting is a valid quasi-natural experiment in which to study risk transfers from banks to sovereigns. It also discusses the main aims, outcomes, and communication timeline of the ECB's CA. Section 3 explains the empirical methodology. Our data are presented in Section 4. We present the main empirical findings in Section 5. Section 6 concludes.

2 The ECB's Comprehensive Assessment

2.1 Aims and results of the CA

The CA was a financial health check of 130 banks in the euro area, covering bank assets of €22 trillion and representing 82 percent of the total banking assets in the euro area. It was carried out by the ECB together with the national supervisors during the 12 months between October 2013 and October 2014. 26 national supervisors were involved, with approximately 6000 people active during its course. The CA concluded with an aggregate disclosure of the overall outcomes, bank-level balance sheet data, and recommendations for subsequent supervisory measures. All results were published on the ECB's website on 26 October 2014.

The CA started in October 2013 as a way to ensure that, when the ECB became the euro area's single supervisor (SSM), banks' risk across all countries would be evaluated and audited according to the same rules and regulations. It consisted of a backward-looking AQR and a forward-looking supervisory ST of the banks. The stated objectives of the three elements were to strengthen banks' balance sheets by repairing any problems uncovered, enhance transparency by improving the quality of information available on the health of the banks, and build confidence by assuring that, on completion of the required remedial actions,

[3] To put this into perspective, the 2012 losses of a single Spanish bank (Bankia) alone amounted to approximately €19 billion; see WSJ (2013).

all banks would be soundly capitalized; see ECB (2014).

As the ECB CA's main result, a total capital shortfall of €25 billion was identified at 25 tested banks. 12 of these 25 banks had already covered their capital shortfall by increasing their capital by €15 billion during 2014, leaving 13 banks that fell short and failed the CA. These 13 banks were required to prepare capital plans within two weeks of the announcement of the results, and were given up to nine months to cover their capital shortfall. Importantly, if the required new equity could not be raised in private markets, the respective sovereign would be called upon to provide a fiscal backstop by purchasing the remaining number of shares.

The AQR revealed substantial new bank risks in the euro area. First, the 2013Q4 book values of banks' assets needed to be adjusted downwards by a total of €48 billion. In addition, banks' non-performing exposures needed to be adjusted upwards by €136 billion, to a total of €879 billion. Based on the AQR outcomes, the subsequent stress test found that a severe macro-financial stress scenario would deplete the banks' top-quality, loss-absorbing Common Equity Tier 1 (CET 1) capital – the measure of a bank's financial strength – by about €263 billion. If the severe stress scenario were to realize, the median CET1 ratio taken over all participating banks was predicted to decrease by 4 percentage points from 12.4% to 8.3%. This reduction was substantially higher than those found in similar exercises, such as the stress tests previously undertaken by the European Banking Authority (EBA) between 2010–2013. This approach may have been seen as harsher than earlier stress tests, which may have contributed to a perception that, this time, the results were credible.

2.2 The ECB's CA as a quasi-natural experiment

We argue that the CA offers a promising quasi-experimental setup through which to identify the spillover effects from bank risk to the risk of sovereigns. For this to be the case we need to establish that (*i*) the CA involved a genuine and significant shock to investors' information sets, leading to a substantial reassessment of banks' risk, and (*ii*) banks subject to this shock were located in stressed countries (i.e., the ex-ante criterion is satisfied). The latter condition holds as banks' headquarter locations are difficult to change, and in any case did not change

for the banks in our sample during the CA. We establish the former condition in Sections 2.3 and 2.4 below.

Importantly, in addition to the bank-level AQR and ST outcomes, market participants also learned from the announcement of the CA results what kind of supervisor the ECB was likely going to be in the future. Specifically, the CA revealed which stance the ECB would take towards weak banks in stressed countries, and whether the ECB would be relatively more or less lenient towards these banks than the respective national supervisors that had been in charge earlier. Mitigating the extent of regulatory capture was a key motivation for the move towards establishing a single European bank supervisor; see EC (2012). The negative equity surprises in stressed countries following the CA announcement, as documented in Section 2, are in line with the notion that the ECB was expected to be a potentially more lenient supervisor for troubled banks in stressed countries before the CA, but not afterwards.

We distinguish between three periods throughout our analysis: (*i*) a pre-announcement period (Pre-CA, 29 Sep – 10 Oct), (*ii*) a soft information period in which rumors and mostly speculative information were released to the news media and financial markets (Soft Info, 13 – 24 Oct), and (*iii*) a post-announcement period during which the hard information about the CA results was available to all market participants (Post-CA, 27 Oct – 04 Nov).

Figure 1 plots the chronology of the ECB communication up to the announcement of the CA results. The ECB announced on 10 October 2014 that the final CA results would be published in about two weeks' time, on 26 October 2014. After that initial announcement, media attention began to focus on the CA. News coverage of the upcoming CA was fairly intense during the Soft Info period. Indeed, news reports and rumors were so frequent, and the resulting market movements so volatile, that the ECB offered a press release on 22 October stating that "any media reports on the outcome of the tests are ... highly speculative". Arguably, three key news announcements stand out. First, a Bloomberg News report on Tuesday 14 November appears to have had a significant impact on financial (particularly CDS) markets. The report quoted from a leaked confidential document, dated 6 October, that some banks "need to fail" to prove the exam's credibility; see Bloomberg (2014). A pressing worry was that the exam would not "reveal big enough capital shortfalls

to prove its rigor", according to the leaked document. Second, a Bloomberg News report on Thursday 23 November named a few banks that had failed the ST, and also some that had not failed. Finally, a third Bloomberg News report appeared on Friday 24 November, again based on a leaked document, stating that exactly 25 banks had failed the ST (the correct number), but not providing their names. All this news had a significant impact on the financial markets. However, the news was always perceived as market-wide news and not to be reflecting any bank-level information.

To ensure a reliable quantification of the different effects over time, we take the Soft Info period as starting on Monday 13 October. This was after the ECB's initial announcement on Friday 10 October that the final CA results would be communicated on 26 October.

2.3 Bank-level impact

Table 1 lists the banks for which we observe either liquid CDS data or equity data, and which we use in our empirical analysis. For details on the data sources, please refer to Section 4. Banks are sorted according to their equity market change from the pre-CA to the post-CA period. For banks that do not have a stock listing, we sort according to CDS changes, with the largest increase first.

A vast majority of the banks that did badly in the CA were located in countries that were in sovereign distress during the euro area sovereign debt crisis. According to Table 1, of the top 20 worst performers in terms of changes in equity market valuation, 18 were located in stressed countries. The top 15 in terms of the most positive surprises, by contrast, contain 9 out of the 11 banks that are located in non-stressed countries. Banks that were located in countries that experienced less stress during the euro area sovereign debt crisis, and hence to a lesser extent the associated economic woes, received a relatively clean bill of health. Looking at the actual CA results, out of the 25 banks that failed (or near-failed), 9 were located in Italy; see ECB (2014). Other banks with significant regulatory capital shortfalls were located in Spain, Portugal, and Greece. The final column of Table 1 indicates whether a listed bank failed (F) or near-failed (NF) the CA. However, note that the outcome of the CA is not necessarily surprising. Banks were evaluated based on data upto December 2013,

and also had the chance, in the course of the year, to anticipate and correct a potentially weak capital ratio. Therefore, much more informative is the unexpected change in equity prices in stressed countries after the release of the CA results.

2.4 Impact on bank equity at the country level

This section documents the impact of the release of the CA outcome on equity markets at the country level. We argue that the information provided by the CA led to a substantial re-assessment of banks' risks in stressed countries. This reassessment in turn affected investors' perceptions of sovereign risk throughout the euro area.

Equity prices for banks located in stressed countries dropped sharply after the CA, by approximately 12 percent, compared to the pre-CA period. Italian banks' equity suffered the most, followed by that of banks located in Spain, Ireland, Portugal, and Greece. Figure 2 plots the cumulative log changes in equity prices on average over the period from 29 September 2014 to 7 November 2014. The dashed vertical line marks the beginning of the Soft Info period, while the solid vertical line marks the announcement of the actual results on 26 October 2014. The figure distinguishes between non-stressed countries (solid line), stressed countries excluding Italy (dashed line), and Italy (dotted line). By contrast with the results for stressed countries, bank equity prices remained approximately unchanged in non-stressed countries. Also, Figure 2 depicts the parallel trend in equity prices before the release of the CA results. In the bottom panel, we relate equity price changes in stressed countries, both Italy and the others, to equity price changes in non-stressed countries. In sum, bank risk surprises were located in stressed countries and were only revealed with the announcement of the CA results. Before this, equity prices across the euro area were driven by common factors.

2.5 Impact on bank and sovereign CDS at the country level

Having established that there was a substantial increase in banking risk in stressed countries, we also consider claims that are more senior than equity. Figure 3 plots CDS premia for

both banks and sovereigns from 29 September 2014 to 7 November 2014. Again, the dashed vertical line marks the Soft Info period, while the solid vertical line marks the announcement of the CA results on 26 October 2014. The top panel plots average CDS levels for banks (solid line) and sovereigns (dashed line), for stressed countries other than Italy. The bottom panel refers to non-stressed countries, including Austria, Belgium, France, Germany, and the Netherlands. While both bank and sovereign CDS increased in most stressed countries (top panel), only sovereign risk increased in non-stressed countries. Bank CDS in non-stressed countries remained approximately flat, in line with the equity developments from Figure 2.

The bottom panel of Figure 3 plots the development of Italian bank and sovereign CDS. Strikingly, Italian banks' average CDS premia were approximately unchanged post-CA compared to their pre-CA values, despite the stark 13 percent drop in equity prices post-CA, and the observation that 9 out of 25 failed banks were headquartered there. Italian sovereign CDS increased in line with that of other euro area sovereigns, indicating that overall bank risk perceptions in the euro area had increased. Average bank CDS were below the sovereign CDS after the CA announcement, indicating a violation of the sovereign ceiling. This is surprising, since any set of banks is unlikely to 'survive' the default of their own sovereign. We take it as a strong indication that (i) Italian bank debt is insured, and (ii) it is not the Italian sovereign that serves as the 'guarantor-of-last-resort'.

For more reliable results, we conduct a cross-sectional analysis to analyze the differences in the CDS-equity sensitivities. Usually, equity price changes and changes in CDS have a negative relationship. Falling equity values imply rising credit default probabilities and thus increasing CDS. Table 3 gives the estimation results for the differential effects of CDS-equity sensitivities between stressed and non-stressed countries. Column 2 depicts the results when we control for daily and bank-specific common factors. We find that, in non-stressed countries, there is a negative relationship between a bank's equity and CDS of -.29. However, this relationship is .22 higher in stressed countries and therefore small in magnitude and insignificant. This suggests that in stressed countries equities shocks have indeed no or very little impact on a bank's CDS.

3 Panel Regression Specifications

3.1 Sovereign-bank risk sensitivities within countries

This section relates the variation in sovereigns' credit risk to the credit risk of their own domestic banks. We thus focus on the within-country bank-sovereign nexus, and examine how the risk sensitivity parameters change from before to after the announcement of the CA results for both the stressed and the non-stressed countries. To this end, we consider the panel regression

$$\begin{aligned} \Delta\texttt{cds}^{s}_{j,t} &= \alpha_0 + \alpha_1 \times \texttt{S}_j \times \Delta\texttt{cds}^{b}_{i,j,t} + \alpha_2 \times \Delta\texttt{cds}^{b}_{i,j,t} \\ &+ \alpha_3 \times \texttt{S}_j + \gamma_t + \delta_i + \varepsilon_{i,j,t}, \end{aligned} \tag{1}$$

where $\Delta\texttt{cds}^{b}_{i,j,t}$ is the daily log change in CDS spread for bank i in country j at time t, $\Delta\texttt{cds}^{s}_{j,t}$ is the daily log change in CDS spread for sovereign j, $\texttt{S}$ is a dummy variable that takes the value of one for stressed countries and zero for non-stressed countries. Bank fixed effects δ_i eliminate the influence of unobserved bank-specific characteristics on the bank-sovereign risk sensitivity. γ_t controls for all common daily time factors. The main coefficient of interest is α_1, and is expected to be positive if the perception of additional bank risk moves sovereign risk perceptions as well. As a first step, we estimate these correlations for all three periods separately.

Regression specification (1) contains repeated CDS values on the left-hand side for country j if there is more than one bank i located in that country. Repeating CDS on the left-hand side does not affect the moment-based estimation. Importantly, it allows us to control for bank-specific fixed effects. Doing so increases the robustness of the parameter estimates, and controls for bank-specific unobserved heterogeneity when estimating the risk sensitivity coefficient. As a downside, repeated left-hand-side values affect inference due to potentially cross-sectionally dependent error terms $\varepsilon_{i,j,t}$ at the country level. We take this issue into account by bootstrapping all parameter standard errors.

We estimate the causal effect of the information shock in stressed countries using a

difference-in-differences specification. This allows us to study cross-sectional differences in sovereign-bank risk sensitivities before and after the ECB's CA announcement.

The specification is

$$\begin{aligned}\Delta\texttt{cds}^{s}_{j,t} &= \alpha_0 + \alpha_1 \times \texttt{P}_t \times \Delta\texttt{cds}^{b}_{i,j,t} \times \texttt{S}_j + \alpha_2 \times \texttt{P}_t \times \Delta\texttt{cds}^{b}_{i,j,t} \\ &+ \alpha_3 \times \texttt{P}_t \times \texttt{S}_j + \alpha_4 \times \Delta\texttt{cds}^{b}_{i,j,t} \times \texttt{S}_j \\ &+ \alpha_5 \times \Delta\texttt{cds}^{b}_{i,j,t} + \delta_i + \gamma_t + \varepsilon_{i,j,t}, \end{aligned} \tag{2}$$

where $\Delta\texttt{cds}^{s}_{j,t}$, $\Delta\texttt{cds}^{b}_{i,j,t}$, and $\texttt{P}_t$ are as in (1), $\texttt{S}_j$ is a cross-sectional dummy variable that distinguishes between banks in stressed and non-stressed countries. Bank and time fixed effects are given by δ_i and γ_t, respectively. Daily time fixed effects are a strong set of controls that absorb the influence of any common macroeconomic and financial factors. In addition, the bank fixed effects eliminate the impact of unobserved bank heterogeneity.

3.2 Risk sensitivities across countries

This section explains how we test for cross-border risk transfers from banks in stressed countries to non-stressed sovereigns by relating sovereign risk to the risk of both domestic and foreign banks. To do so, we relate sovereign risk in non-stressed (ns) countries to both domestic and foreign bank risk, according to

$$\begin{aligned}\Delta\texttt{cds}^{s,ns}_{j,t} &= \alpha_0 + \alpha_1 \times \texttt{P}_t \times \Delta\texttt{equity}^{b,st}_{t} + \alpha_2 \times \Delta\texttt{equity}^{b,st}_{t} \\ &+ \alpha_3 \times \Delta\texttt{cds}^{b}_{i,j,t} + \kappa' X_{(i),j,t} + \delta_i + \gamma_{t,week} + \varepsilon_{i,j,t}, \end{aligned} \tag{3}$$

where $\Delta\texttt{cds}^{s,ns}_{j,t}$ refers to the daily log change in the CDS of a non-stressed sovereign j at time t, $\Delta\texttt{equity}^{b,st}_{t}$ is the average daily equity return of banks located in stressed countries, $\Delta\texttt{cds}^{b}_{i,j,t}$ are daily log changes in the CDS of domestic banks in non-stressed countries, $\kappa' X_{(i),j,t}$ are additional control variables, and $\gamma_{t,week}$ are weekly time fixed effects.[4]

[4]Note that daily time fixed effects in this setup would absorb $\Delta\texttt{equity}^{b,st}_{t}$ due to colinearities.

As an additional check, we use a regression specification that allows for both equity and CDS measures of banks in stressed countries. Given that the adverse news about bank risks in stressed countries is not reflected in the respective bank CDS, a natural extension of our baseline model is

$$\begin{aligned}\Delta\texttt{cds}_{j,t}^{s,ns} &= \alpha_0 + \alpha_1 \times \texttt{P}_t \times \Delta\texttt{equity}_t^{b,st} + \alpha_2 \times \Delta\texttt{equity}_t^{b,st} \\ &+ \alpha_3 \times \texttt{P}_t \times \Delta\texttt{cds}_t^{b,st} + \alpha_4 \times \Delta\texttt{cds}_t^{b,st} \\ &+ \alpha_5 \times \Delta\texttt{cds}_{i,j,t}^{b} + \kappa' X_{(i),j,t} + \delta_i + \gamma_{t,week} + \varepsilon_{i,j,t}, \end{aligned} \tag{4}$$

where the equity and CDS covariates are defined as in (3). Since the increased bank risk is only reflected in the equity prices and not in the CDS spreads, we conjecture that there is little bank risk transmission through the CDS.

3.3 A medium-term perspective

This section presents a time-varying parameter model that allows us to efficiently estimate the time variation in cross-country risk sensitivities directly and over longer periods of time. This allows us to study medium-term developments around the ECB's CA announcement, rather than focusing exclusively on six weeks of daily data.

We consider the following panel regression model with time-varying parameters:

$$\Delta\texttt{cds}_{j,t}^{s,ns} = \gamma_t + \delta_i + \beta_t \Delta\texttt{cds}_{i,j,t}^{b,ns} + \kappa_t \Delta\texttt{equity}_t^{b,st} + \epsilon_{it}, \tag{5}$$

where $\Delta\texttt{cds}_{it}^{s,ns}$ denotes the weekly difference in the log CDS of non-stressed sovereigns, $\gamma_t \sim \text{NID}(0, \sigma_\gamma^2)$ is a serially uncorrelated time effect, δ_i is a bank fixed effect, $\Delta\texttt{cds}_{it}^{b,ns}$ is the difference in the log CDS of banks located in non-stressed countries, $\Delta\texttt{equity}_t^{b,st}$ are the average weekly returns of banks located in stressed countries, and ϵ_{it} is an idiosyncratic error term. Indexes i, j, and t are as before. We are most interested in estimating the time-varying cross-country effect κ_t, controlling for domestic banks' risks β_t.

We fit the model to weekly panel data from January 2009 to November 2014, and focus

on a significantly wider window around the ECB's CA. To allow for time-variation in the measurement error over extended periods of time, we specify

$$\epsilon_t = (\epsilon_{1t}, \ldots, \epsilon_{Nt}) \sim \text{NID}\,(0, H_t)\,, \tag{6}$$

where the covariance matrix is specified as $H_t = \text{diag}\,(h_{1t}, \ldots, h_{Nt})$, where $h_{it} = \sigma_\epsilon^2 \cdot \text{CDS}_{i,t-1}^{s,ns} \geq 0$, σ_ϵ^2 is a parameter to be estimated, and $\text{CDS}_{i,t-1}^{s,ns}$ is the lagged CDS spread of the respective non-stressed sovereign. As a result, error variances are serially correlated and higher during more stressful times; see Feldhütter and Lando (2008) and Krishnamurthy et al. (2014) who point out the connection with a square-root interest rate process. While somewhat restrictive, the volatility specification (6) is parsimonious and sufficiently flexible to allow us to estimate the time-varying parameters and test the key economic hypotheses at hand. For a similar specification of time-varying measurement error volatility see Eser and Schwaab (2015).

In addition to panel specification (5), we also consider the alternative specification

$$\Delta\texttt{cds}_{j,t}^{s,ns} = \gamma_t + \delta_i + \beta_t \Delta\texttt{cds}_{i,j,t}^{b,ns} + \kappa_t \Delta\texttt{cds}_{i,j,t}^{b,st} + \epsilon_{it}, \tag{5'}$$

which uses solely changes in CDS spreads as a proxy for bank risk.

The time-varying within-country effect β_t and cross-country effect κ_t capture the elasticity of sovereign CDS in non-stressed countries in the euro area with respect to risks to domestic and foreign banks, respectively. The time-varying parameters evolve over time as

$$\alpha_t = (\beta_t, \kappa_t)' = \alpha_{t-1} + \eta_t; \qquad \eta_t \sim \text{NID}\,(0, Q)\,, \tag{7}$$

where η_t is a two-dimensional state equation error term, and Q a positive definite covariance matrix. The off-diagonal elements of Q are not necessarily zero, which allows the two time-varying parameters to be correlated. The time-varying coefficients are initialized as uninformative $\alpha_1 \sim \text{N}(0, \kappa I)$, with $\kappa \to \infty$; see Durbin and Koopman (2012, Chapter 5).

Model (5) – (7), together with its initial condition, is a linear Gaussian model in state

space form. The log-likelihood is easily obtained from a single run of the Kalman Filter; see Hamilton (1994). Filtered estimates of the time-varying parameters along with their standard errors are also provided by the Kalman Filter. Drawing inferences on the model parameters is straightforward as a result.

4 Data

We mainly consider CDS data and bank equity data at the daily frequency for our study of the impact of the ECB's CA on the financial markets and the bank-sovereign nexus.

CDS spreads are obtained from the Credit Market Analysis (CMA) database through Thomson/Reuters Datastream. All CDS are at the 5-year maturity. We choose the full-restructuring credit event clause, as this is the standard contract documentation for Western European sovereign reference entities. Unlike sovereign bonds and bank bonds, CDS are standardized products with pre-determined and comparable contractual agreements, allowing for a consistent comparison of credit risk across banks and sovereigns.

Bank equity data are taken from Bloomberg for all listed CA banks. Bank stock returns are based on daily closing prices. In addition, we match our data with the ECB's CA outcomes. Data on the CA outcomes are also available from the ECB's public website, and from ECB (2014).

Descriptive summary statistics for the Pre-CA, Soft Info and Post-CA event windows are reported in Table 2. There is substantial heterogeneity in the sample, both across time and across countries. The average bank CDS spread remained constant at around 104 bps in non-stressed countries, declined from 140 bps to 138 bps in Italy, and increased from 229 bps to 251 bps in other stressed countries, from the Pre-CA to the Post-CA period. The sovereign CDS spreads went up in all countries of the euro area. Non-stressed countries' CDS increased from 31 bps to 36 bps, stressed countries other than Italy show an increase from 208 bps to 282 bps, and Italian CDS increased from 112 bps to an average of 139 bps after the publication of the CA results. Interestingly, the volatility index (VIX) did in fact decline from about 17 to about 14.

5 Main Empirical Results

5.1 The bank-sovereign nexus within countries

This section presents our empirical findings on the risk transmission from banks to their sovereign, the bank-sovereign nexus within countries. Given that the bank risk surprises appeared among banks located in stressed countries but not among banks located in non-stressed countries, we would expect there to have been an increase in the risk transmission within stressed countries and not within others. Surprisingly, it is the other way round. Stressed countries appear to have been unaffected by the adverse news, but non-stressed countries on the other hand faced a significant increase in risk transmission despite there having been no additional banking sector risk within the country.

Table 4 presents the results of relating the log changes in the sovereign CDS spreads in country j, $\Delta\texttt{cds}^s_{j,t}$, to the log changes in the CDS of their respective domestic banks, $\Delta\texttt{cds}^b_{i,j,t}$. This table focuses on the differential effects between stressed and non-stressed countries. To ensure the most transparent representation, we first provide cross-sectional evidence within each sample period, Pre-CA (columns 1 and 2), Soft Info (columns 3 and 4), and Post-CA (columns 5 and 6), before estimating the causal change in the differential impacts (columns 7 and 8). In all three sample periods, the risk transmission in stressed countries remained unaffected. Note that the risk transmission from the banks located in stressed countries to their sovereigns is the sum of the coefficient estimates for all banks (ΔLog(Bank CDS)) plus the estimate for the cross-sectional differences (Stressed x ΔLog(Bank CDS)), i.e. in the Post-CA period the risk transmission from banks to sovereigns in stressed countries was -.001 (.289 - .290) and non-significant. On the other hand, the results for the non-stressed countries differ over time. While there was no significant effect in the Pre-CA period (column 2) and no significant change from the Soft Info period (column 7), there was a significant increase in the risk transmission from the Pre-CA period to the Post-CA period (column 8). With a 1 percent increase in bank risk in non-stressed countries, the sovereign risk increases by .34 percent. The cross-sectional difference in the change for stressed countries is -.40 and thus again close to zero in magnitude and statistically insignificant. Note that we have

strong controls such as daily time fixed effects and bank fixed effects to capture all potential common factors. Also, we capture a significant fraction of over 9 percent of the variation when simply looking at the cross-sectional differences without additional controls within the Post-CA period. R2 increases to 55 percent when we use controls. Note further that all standard errors are bootstrapped. In sum, our regression analysis uncovers that there is no risk transmission in stressed countries from the banks to their sovereigns, despite these countries' exposure to adverse news about bank risk. Instead, risk transmission causally increases in non-stressed countries.[5]

Table 4 separates not only stressed from non-stressed countries, but also individual stressed countries. We compare non-stressed countries with four stressed countries in the euro area (i.e., Spain, Portugal, Ireland, and Greece, but not Italy), and also separate out the distinct effect for Italy. It is instructive to study Italy in isolation, for several reasons. First, 9 out of 25 failures (or near-failures) were located in Italy. Second, CDS and equity prices decoupled around the announcement of the CA results, and to a larger extent than in the other four countries. Third, the violation of the sovereign ceiling in Italy on the day after the CA suggests (see Figure 3) that risk transfers play a particularly important role in this case. Finally, Italy is the largest of the five stressed countries, and potentially systemically important for the euro area as a whole.

In the Pre-CA period, we observe no differences in risk transmission between the three groups of countries. In the Soft Info period, however, the risk sensitivity coefficient increases by .37 percent (.57 - .20) for stressed countries compared to non-stressed countries (column 7), while that for Italy remains small in magnitude and insignificant. In the Post-CA period, the sensitivity coefficient in stressed countries is insignificant, but significantly different from the coefficient estimate in non-stressed countries, for which there is an increase of .27 percent (column 8). Overall, our results suggest that the effects are stronger for Italy, but also significant for the remaining stressed countries.

The uncovered pattern is consistent with the expectation that, if banking risk were to materialize on a large scale in Italy, it would be ESM funds (or the bank resolution fund) that

[5]The finding that bank and sovereign risk are significantly related, on average, in the euro area is in line with Leonello (2014), Farhi and Tirole (2014), and Acharya et al. (2014).

would be used for bank equity recapitalization. This cross-border cross-sector risk transfer also explains the violation of the sovereign ceiling in Italy, observed post-CA, as well as the higher risk sensitivities observed in non-stressed countries.

5.2 The bank-sovereign nexus across borders

This section formally tests for the presence of cross-country cross-sector risk spillovers in the euro area around the time of the ECB's CA. We find that risk transfers across borders and sectors are statistically and economically significant. As a result, they can explain the at-first-glance counter-intuitive finding that the bank-to-sovereign risk transfers appear to be strongest in precisely those countries for which no additional banking sector risks were uncovered by the ECB's CA.

Table 6 reports the results of estimating the panel data regression (3). Coefficient α_3 is always positive across specifications, suggesting that controlling for changes in the risk of a country's own banks is important. Controlling for the direct effect, we find significantly negative loadings on foreign banks' equity returns. This suggests that a decline in the market value of banks located in stressed countries increases the sovereign risk of non-stressed countries. The final column reports the effect on cross-country and sector risk transfer from before to after the ECB's CA.

Both the loading on the CDS of domestic banks and the equity returns of foreign banks are significant and economically large. Our estimates suggest that an exogenous decrease of 10 percent in average bank equity prices in stressed countries would lead to an average increase in the sovereign CDS of non-stressed countries, with an elasticity of up to 7 percent.

Table 7 reports the results of estimating the panel data regression (4). The cross-sectional differences in risk sensitivities come from the change in the banking sector risk in stressed countries, as measured by drops in market equity. The respective coefficient is robust to including the CDS data as an additional risk control and remains at approximately .6 percent. Interestingly, as the arrival of adverse news is only exhibited in the equity prices, we also find that there is indeed no risk transfer from bank CDS in stressed countries (column 7).

5.3 Medium-term developments

This section discusses our main results, obtained by applying a time-varying parameter approach.

The top panel of Figure 4 plots estimates of the time-varying coefficients β_t and κ_t, measuring the elasticity of sovereign CDS in non-stressed euro area countries with respect to changes in their own banks' CDS and the mean equity returns of foreign banks, respectively; see (5). The bottom panel of Figure 4 plots the same time-varying estimates, but now with the foreign banks' mean equity returns replaced with the corresponding CDS measure, average weekly differences in log CDS. The top and bottom panels plot the weekly time-series variation from 1 January 2014 to 30 November 2014, five weeks after the end of the CA.

We formulate three findings from the medium-term analysis. First, the time variation in both parameters is approximately stable during almost all weeks of 2014, and usually not statistically different from zero. Importantly, our two-week Pre-CA period appears to be approximately representative of the medium-term bank-sovereign relationship, for both domestic and foreign banks, during 2014.

Second, the risk sensitivity parameters change significantly during our Soft Info period, and stay approximately unchanged thereafter. The changes effects in the (maximum likelihood, weekly) time-series estimates of elasticities are in line with the (moment-based, daily) difference-in-differences estimates around the CA.Our main findings are robust to very different econometric approaches, as well as to variations in the data sample. The (time difference in) cross-elasticity of non-stressed sovereigns with respect to the average equity returns of banks in non-stressed countries increases in absolute value to about -.5 percent during the Post-CA period, controlling for bank CDS in non-stressed countries as well as additional effects. Our finding implies that an unexpected 10 percent decline in the market value of bank equity in stressed countries would raise the sovereign CDS in non-stressed countries by about 5 percent.

Third, the cross-elasticity estimate differs substantially depending on whether relative changes in bank CDS or bank equity returns are used to approximate banking sector risk.

This is intuitive, as the two instruments respond differently to different economic risks. Bank CDS respond to the probability of a default on bank debt, while equity returns primarily reflect the risk of a bank's (equity) recapitalization under stress and the accompanying dilution of existing shareholders. Given the current bail-in rules in the EU, as stipulated by the EU Bank Recovery and Resolution Directive (BRRD) from December 2013, bank "risk" in stressed countries appears to be better captured by developments in equity prices, at least in our sample, than by changes in CDS.

6 Conclusion

We have documented the extent of cross-border risk sharing between the banking and sovereign sectors in the euro area. Based on difference and difference-in-differences estimates around the ECB's announcement of the outcome of its Comprehensive Assessment on 26 October 2014, we have demonstrated that the information shock to bank risk in stressed countries did not affect the domestic sovereigns. Instead, this banking sector risk propagated across borders to impact sovereigns in non-stressed countries. This means that the often mentioned bank-sovereign nexus, which is commonly understood as within-country risk sharing, in fact contains an important cross-border component in the euro area.

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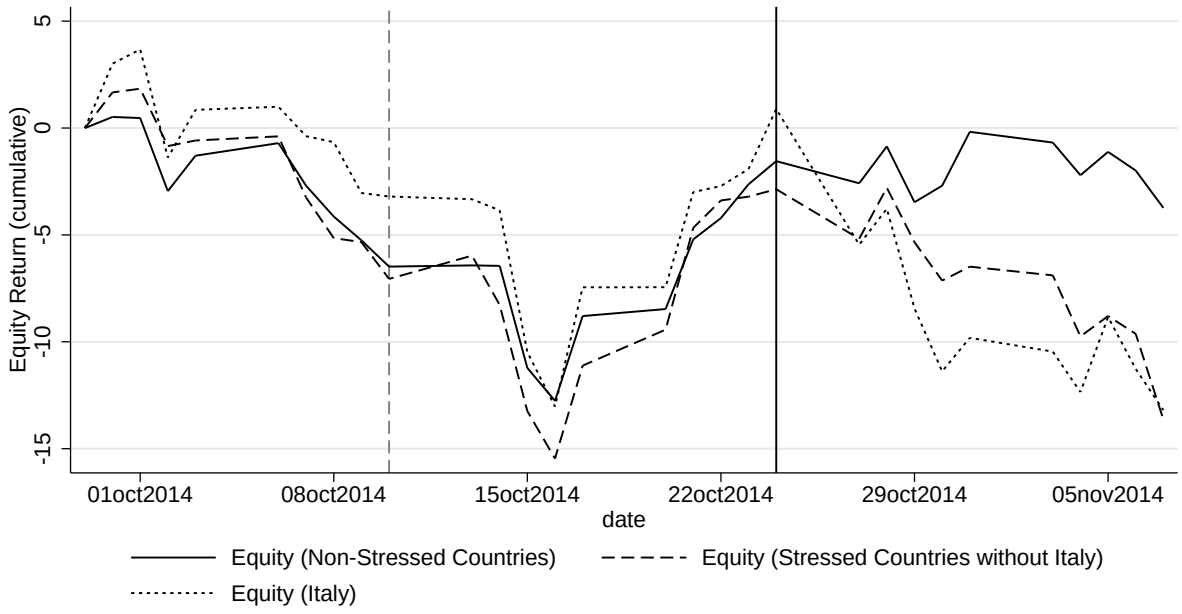
Figure 1: Timeline of news around the ECB's Comprehensive Assessment

A summary of major news about the CA from 29 September 2014 to 7 November 2014. The period between the two dashed vertical lines denotes the Soft Info period, which commences two weeks prior to the announcement of the CA results on 26 October 2014.

Figure 2: Cumulative bank equity returns in the euro area

Equity prices are from 29 September 2014 to 7 November 2014. In each panel, the dashed vertical line marks the beginning of the Soft Info period, while the solid vertical line marks the release of the CA results. The top panel plots the cumulative log changes in equity closing prices for non-stressed countries' bank equities (solid line), the bank equities of stressed countries excluding Italy (dashed line), and Italian bank equities (dotted line). The bottom panel plots the cumulative log changes in the equity of banks located in stressed countries, relative to the cumulative log changes in the equity of banks located in non-stressed countries.



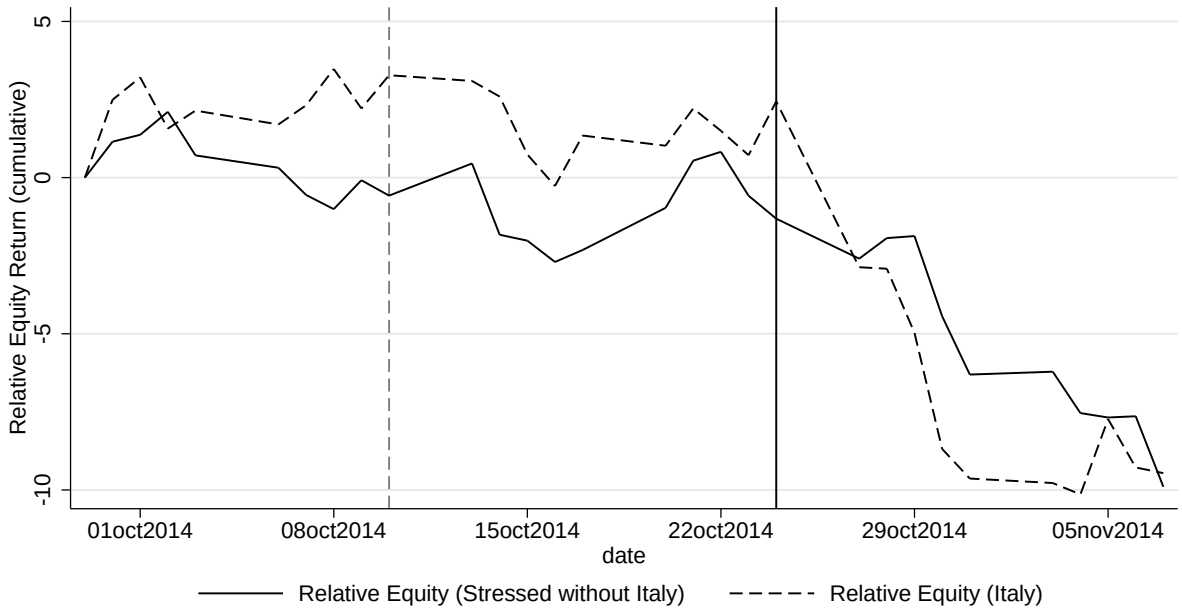


Figure 3: Bank CDS and sovereign CDS in the euro area

CDS levels for both banks and sovereigns within the euro area (except Italy) from 29 September 2014 to 7 November 2014. In each panel the dashed vertical line marks the start of the Soft Info period, while the solid vertical line marks the announcement of the CA results on 26 October 2014. The top panel plots average CDS levels for stressed countries' banks' CDS (solid line), and stressed countries' sovereign CDS (dashed line), excluding Italy. The middle panel plots average CDS levels for non-stressed countries' banks' CDS (solid line) and non-stressed countries' sovereign CDS (dashed line). The bottom panel refers to Italy.

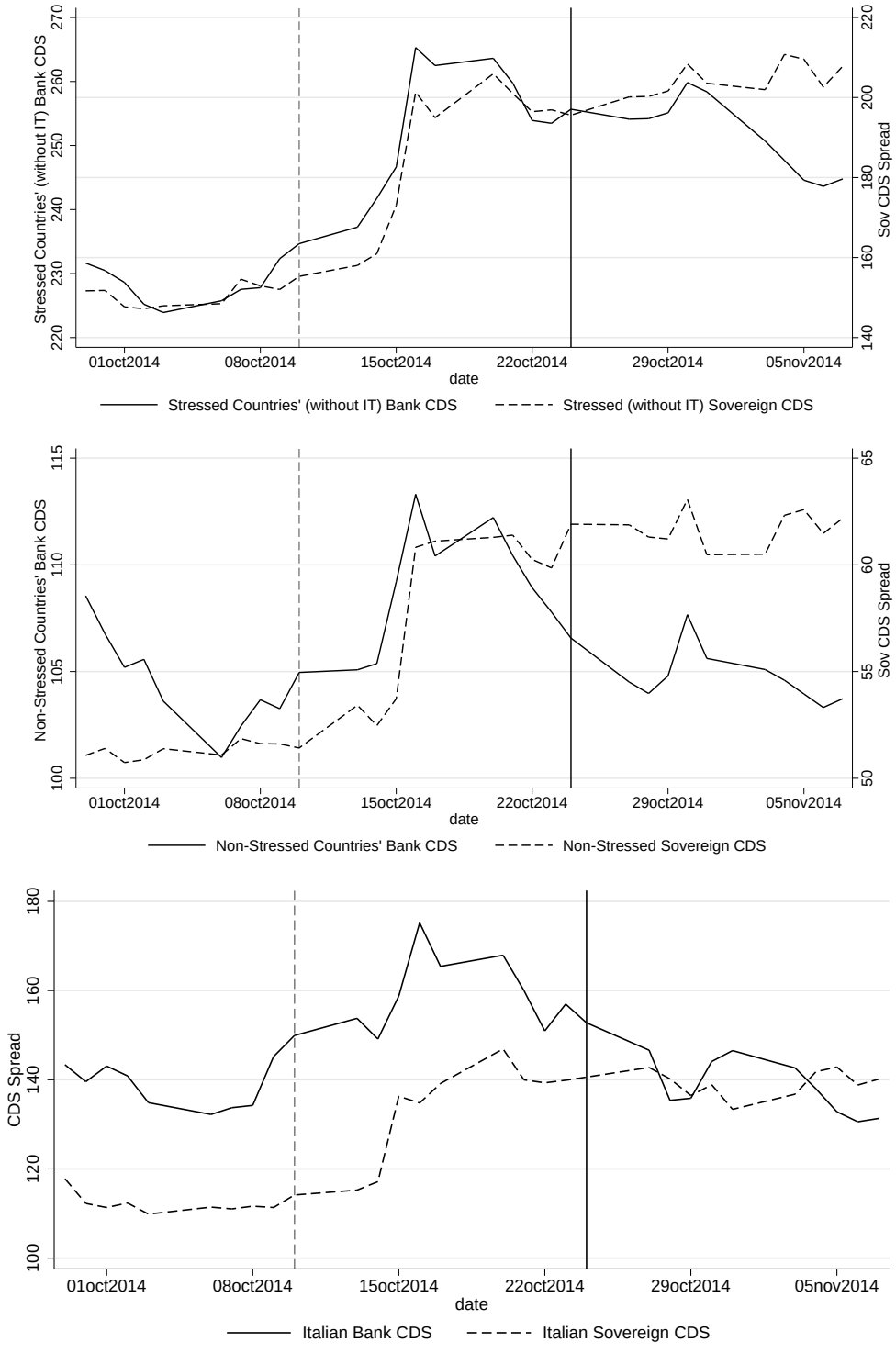


Table 1: Bank equity surprises

Banks are sorted by Equity Surprise (in ascending order), or, when the latter is missing, by CDS Change (in descending order). Stressed countries are highlighted. Equity Surprise and CDS Change are defined as the log-return between the two-week average price preceding 10 October 2014 and the two-week average price following 27 October 2014. Beta is the coefficient obtained by regressing the daily CDS log-return on the daily equity log-return. The CA outcomes are codified as follows: P (Pass) if the bank meets the 5.5% CET1 ratio requirement under the adverse scenario and meets the 8% ratio under the baseline scenario; NP (Near-pass) if the bank does not meet either of the required ratios, but has already covered its capital shortfall; NF (Near-fail) if the bank does not meet the ratios and has not covered the shortfall, but its plans to raise capital have been deemed adequate; F (Fail) if the capital ratios are not met and none of the repairing measures has been implemented.

Bank Name	Country	Equity Surprise	CDS Change	Beta	CA Outcome
Banca Monte dei Paschi di Siena SpA	IT	-38.60%	3.79%	-0.34	F
Banca Carige SpA	IT	-35.23%			F
Permanent TSB plc	IE	-15.30%	-1.44%	0.02	F
Alpha Bank SA	GR	-13.33%	20.98%	-0.23	P
Banco Comercial Português SA	PT	-12.22%	6.89%	-0.52	F
National Bank of Greece SA	GR	-12.13%	20.98%	-0.08	NF
Eurobank Ergasias SA	GR	-10.90%	20.96%	-0.11	NF
Piraeus Bank SA	GR	-8.59%	11.33%	-0.02	NP
Deutsche Bank AG	DE	-8.21%	10.67%	-1.43	P
Liberbank SA	ES	-8.18%			NP
Banca Popolare Di Milano Scarl	IT	-7.14%	-4.03%	-0.25	F
Banco Santander SA	ES	-7.03%	6.85%	-1.56	P
UniCredit SpA	IT	-6.77%	4.78%	-1.17	P
Unione Di Banche Italiane Scpa	IT	-6.33%	2.24%	-0.34	P
Banco Bilbao Vizcaya Argentaria SA	ES	-5.62%	6.78%	-1.93	P
Banca Popolare di Sondrio Scpa	IT	-4.77%			NP
Société Générale	FR	-3.78%	6.20%	-1.03	P
Banca Popolare Dell'Emilia Romagna SC	IT	-3.60%			NP
Banca Piccolo Credito Valtellinese SC	IT	-3.47%			NP
Banco de Sabadell SA	ES	-3.36%	-12.70%	-0.03	P
Banco Popular Español SA	ES	-3.14%	-16.70%	0.06	P
BNP Paribas	FR	-2.96%	7.66%	-1.42	P
Bankinter SA	ES	-2.83%	-9.85%	-0.02	P
Intesa Sanpaolo SpA	IT	-1.93%	0.09%	-1.13	P
KBC Group NV	BE	-1.05%	5.59%	-0.35	P
Banco BPI SA	PT	-0.77%	14.78%	-0.05	P
Groupe Crédit Agricole	FR	-0.19%	8.16%	-0.78	P
Raiffeisen Zentralbank AG	AT	0.61%	-11.67%	-0.61	P
Banco Popolare SC	IT	0.73%	-13.13%	-0.52	NP
IKB Deutsche Industriebank AG	DE	0.76%	-7.28%	0.05	P
ING Bank NV	NL	0.88%	-3.58%	-0.69	P
Aareal Bank AG	DE	1.62%			P
The Governor and Company of the Bank of Ireland	IE	2.09%	-4.68%	-0.03	P
Mediobanca - Banca di Credito Finanziario SpA	IT	2.80%	4.50%	-1.43	P
Commerzbank AG	DE	5.93%	-2.39%	-0.90	P
Erste Group Bank AG	AT	10.07%	-13.95%	-0.69	P
Dexia NV	BE		13.01%		NF
Caixa Geral de Depósitos SA	PT		6.79%		P
C.R.H.	FR		0.19%		NP
Allied Irish Banks plc	IE		-1.04%		P
Banque PSA Finance	FR		-1.46%		P
Landesbank Baden-Württemberg	DE		-1.94%		P
ABN AMRO Bank NV	NL		-2.07%		P
Coöperatieve Centrale Raiffeisen-Boerenleenbank B.A.	NL		-2.10%		P
Landesbank Hessen-Thüringen Girozentrale	DE		-2.14%		P
Bayerische Landesbank	DE		-2.61%		P
Norddeutsche Landesbank Girozentrale	DE		-2.83%		P
BAWAG P.S.K.	AT		-2.84%		P
RCI Banque	FR		-2.86%		P
HSH Nordbank AG	DE		-2.89%		P
SNS Bank NV	NL		-2.95%		P
AXA Bank Europe SA	BE		-3.72%		NP
The Royal Bank of Scotland NV	NL		-14.24%		P
DZ Bank AG	DE		-16.46%		P

Table 2: Summary statistics

We report summary statistics for bank CDS, sovereign CDS, equity data, and a control covariate. For each group we report the mean, standard deviation, the 5th and 95th percentiles, and the total number of observations. Horizontally the table is divided according to the three time periods Pre-CA, Soft Info, and Post-CA, as explained in Section 2. For each data panel, we distinguish between banks from non-stressed countries, those from stressed countries excluding Italy, and those from Italy.

	Pre-CA					**Soft Info**					**Post-CA**				
	Mean	5p	95p	Std Dev	N	Mean	5p	95p	Std Dev	N	Mean	5p	95p	Std Dev	N
Bank CDS															
Non-stressed	104.50	48.31	188.26	54.86	270	108.93	52.33	205.31	55.13	265	104.73	52.45	207.40	54.56	260
Stressed (no IT)	228.80	72.69	390.30	112.25	150	253.99	79.00	469.95	130.67	150	251.30	77.36	489.31	147.17	150
IT	139.70	79.72	238.59	55.71	70	159.09	84.20	273.84	67.42	70	138.38	81.66	250.06	54.62	70
All	147.58	54.03	388.49	94.82	490	161.03	55.81	425.89	108.29	485	155.44	54.22	470.03	114.42	480
Sovereign CDS															
Non-stressed	30.69	18.28	45.99	11.65	50	35.58	19.32	57.31	15.08	50	36.15	19.48	56.69	15.48	50
Stressed (no IT)	208.38	52.38	539.50	193.15	40	259.25	58.36	730.49	251.84	40	281.97	61.78	757.71	276.97	40
IT	112.33	109.88	117.80	2.22	10	134.93	115.26	146.91	10.37	10	139.21	133.37	142.86	3.03	10
All	109.93	18.38	531.11	147.83	100	134.98	20.03	713.18	190.62	100	144.78	19.94	747.17	209.54	100
Equity															
Non-stressed	23.72	0.92	50.53	15.16	107	22.55	0.85	48.29	14.11	110	23.51	0.93	48.89	14.47	110
Stressed (no IT)	2.68	0.09	9.17	2.96	140	2.58	0.07	8.79	2.86	140	2.58	0.07	8.69	2.84	136
IT	4.07	0.11	11.23	3.37	110	3.96	0.09	11.50	3.38	110	3.95	0.08	11.33	3.40	110
All	9.41	0.10	41.44	12.79	357	9.10	0.09	39.24	12.13	360	9.47	0.08	41.09	12.63	356
VIX	16.75	14.55	21.24	1.96	10	20.60	16.08	26.25	4.01	10	14.47	13.12	16.04	0.81	10

Table 3: Bank equity and CDS sensitivities in stressed and non-stressed countries

This table reports the differences between stressed and non-stressed countries in terms of bank equity and CDS sensitivities. Columns 1 reports the difference estimators without controls. Columns 2 refers to the cross-sectional differences between stressed and non-stressed countries, with time fixed effects and bank fixed effects. Standard errors are bootstrapped. Each column indicates whether the regression contains time (Time FE) and firm (Firm FE) fixed effects.

	(1)	(2)
VARIABLES	bank_change1	bank_change1
Stressed x ΔLog(Bank Equity)	0.393***	0.216*
	(0.152)	(0.129)
Stressed Country FE	0.000	
	(0.003)	
ΔLog(Stock Price)	-0.701***	-0.288**
	(0.131)	(0.140)
Observations	858	858
R-squared	0.0669	0.2797
-	-	-
Bank FE	NO	YES
daily Time FE	NO	YES
-	-	-
Bootstrapped SE	YES	YES

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4: Risk transmission from banks to sovereigns within stressed and non-stressed countries

This table reports the results from difference-in-differences regressions (2) that allow for country differences in the risk transmission from banks to their respective sovereigns. The table compares non-stressed countries with stressed countries in the euro area. Columns 1–2, 3–4, and 5–6 include only those observations from the Pre-CA (29 September to 12 October 2014), Soft Info (13 to 26 October 2014), and Post-CA (27 October to 7 November 2014) periods, respectively. Columns 7 and 8 report the difference-in-differences estimators. Columns 7 and 8 refer to time differences between the Pre-CA on the one hand, and the Soft Info and Post-CA periods, respectively, on the other hand. Soft Info FE and Post-CA FE are dummy variables that take the value one in the respective period, and zero in the Pre-CA period. Standard errors are bootstrapped. Each column indicates whether the regression contains time (Time FE) and firm (Firm FE) fixed effects.

Dependent Variable:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔLog(Sovereign CDS)	Pre-CA	Pre-CA	Soft Info	Soft Info	Post-CA	Post-CA	Diff-Diff (4)-(2)	Diff-Diff (6)-(2)
Stressed x Post x ΔLog(Bank CDS)							0.184	-0.397***
							(0.148)	(0.113)
Stressed x ΔLog(Bank CDS)	-0.009	0.112	0.129	0.289**	-0.524***	-0.290**	0.099	0.108
	(0.064)	(0.074)	(0.165)	(0.132)	(0.137)	(0.113)	(0.069)	(0.080)
Post x ΔLog(Bank CDS)							-0.159	0.339***
							(0.119)	(0.108)
Stressed x Post							0.001	-0.001
							(0.005)	(0.004)
ΔLog(Bank CDS)	0.063	-0.050	0.315***	-0.211**	0.593***	0.289***	-0.038	-0.049
	(0.059)	(0.070)	(0.120)	(0.103)	(0.129)	(0.111)	(0.064)	(0.075)
Stressed Country FE	0.003		0.002		0.002			
	(0.003)		(0.005)		(0.004)			
Observations	441	441	485	485	480	480	926	921
R-squared	0.0100	0.2163	0.0941	0.4433	0.0923	0.5489	0.4165	0.4361
-	-	-	-	-	-	-	-	-
Bank FE	NO	YES	NO	YES	NO	YES	YES	YES
daily Time FE	NO	YES	NO	YES	NO	YES	YES	YES
-	-	-	-	-	-	-	-	-
Bootstrapped SE	YES	YES	YES	YES	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Risk transmission from banks to sovereigns and Italy

This table reports the results from difference-in-differences regressions (2) that allow for country differences in the risk transmission from banks to their respective sovereigns. The table compares non-stressed countries with four stressed countries in the euro area (excluding Italy), and Italy, respectively. Columns 1–2, 3–4, and 5–6 include only those observations from the Pre-CA (29 September to 12 October 2014), Soft Info (13 to 26 October 2014), and Post-CA (27 October to 7 November 2014) periods, respectively. Columns 7 and 8 report the difference-in-differences estimators. Columns 7 and 8 refer to time differences between the Pre-CA on the one hand, and the Soft Info and Post-CA periods, respectively, on the other hand. Soft Info FE and Post-CA FE are dummy variables that take the value one in the respective period, and zero in the Pre-CA period. Standard errors are bootstrapped. Each column indicates whether the regression contains time (Time FE) and firm (Firm FE) fixed effects.

Dependent Variable:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔLog(Sovereign CDS)	Pre-CA	Pre-CA	Soft Info	Soft Info	Post-CA	Post-CA	Diff-Diff (4)-(2)	Diff-Diff (6)-(2)
Italy x Post x ΔLog(Bank CDS)							0.105	-0.343***
							(0.167)	(0.104)
Stressed (other) x Post x ΔLog(Bank CDS)							0.570***	-0.198*
							(0.116)	(0.114)
Post x ΔLog(Bank CDS)							-0.202*	0.267**
							(0.119)	(0.108)
Italy FE x Post							0.008	-0.000
							(0.008)	(0.004)
Stressed (no IT) x Post							-0.004	-0.001
							(0.005)	(0.005)
ΔLog(Bank CDS)	0.063	-0.050	0.315***	-0.183	0.593***	0.292***	0.032	0.027
	(0.057)	(0.070)	(0.111)	(0.117)	(0.119)	(0.094)	(0.032)	(0.026)
Italy x ΔLog(Bank CDS)	-0.002	0.128*	-0.131	0.116	-0.582***	-0.340***		
	(0.071)	(0.073)	(0.183)	(0.173)	(0.131)	(0.095)		
Stressed (no IT) x ΔLog(Bank CDS)	-0.015	0.092	0.570***	0.565***	-0.428***	-0.204**		
	(0.085)	(0.085)	(0.161)	(0.126)	(0.153)	(0.102)		
Italy FE	-0.002		0.005		-0.002			
	(0.003)		(0.007)		(0.004)			
Stressed (no IT) FE	0.006*		-0.001		0.005			
	(0.003)		(0.006)		(0.005)			
Observations	441	441	485	485	480	480	926	921
R-squared	0.0163	0.2167	0.1363	0.4594	0.0963	0.5510	0.4308	0.4365
-	-	-	-	-	-	-	-	-
Bank FE	NO	YES	NO	YES	NO	YES	YES	YES
daily Time FE	NO	YES	NO	YES	NO	YES	YES	YES
-	-	-	-	-	-	-	-	-
Bootstrapped SE	YES	YES	YES	YES	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Changes in sensitivities from bank equity to sovereign CDS across countries

This table reports the results from regressing log changes in the sovereign CDS spreads in country j, $\Delta\texttt{cds}^{s}_{j,t}$, on log changes in the average bank equity prices of stressed countries, $\Delta\texttt{equity}^{b,st}_{t}$, controlling for domestic banks' log changes in CDS, $\Delta\texttt{cds}^{b}_{i,j,t}$. Columns 1–3, 4–6, and 7–9 include only those observations from the Pre-CA (29 September to 12 October 2014), Soft Info (13 to 26 October 2014), and Post-CA (27 October to 7 November 2014) periods, respectively. Columns 10 and 11 report the difference estimators that compare the Pre-CA to the Soft Info period, and the Pre-CA to the Post-CA period, respectively. Standard errors are bootstrapped. Each column indicates whether the regression contains time (Time FE) and bank (Bank FE) fixed effects.

VARIABLES	(1) Pre-CA	(2) Pre-CA	(3) Pre-CA	(4) Soft Info	(5) Soft Info	(6) Soft Info	(7) Post-CA	(8) Post-CA	(9) Post-CA	(10) Diff-Diff (6)-(3)	(11) Diff-Diff (9)-(3)
ΔLog Stressed Equity x Post										0.590	-0.472**
										(0.379)	(0.227)
ΔLog(Stressed Equity)	-0.087	-0.157	-0.161	0.444*	0.682**	0.681**	-0.478***	-0.568***	-0.564***	-0.243	-0.185
	(0.160)	(0.160)	(0.170)	(0.257)	(0.329)	(0.345)	(0.142)	(0.153)	(0.178)	(0.218)	(0.170)
ΔLog(Bank CDS)	0.028	0.026	0.020	0.364***	0.380***	0.379***	0.562***	0.552***	0.566***	0.199***	0.275***
	(0.072)	(0.068)	(0.081)	(0.082)	(0.065)	(0.073)	(0.105)	(0.124)	(0.129)	(0.048)	(0.068)
ΔLog(VIX (US))		-0.074***	-0.074***		0.114***	0.114***		-0.074	-0.073	0.010	-0.102***
		(0.018)	(0.019)		(0.044)	(0.044)		(0.075)	(0.083)	(0.036)	(0.023)
Observations	243	243	243	265	265	265	260	260	260	508	503
R-squared	0.0974	0.1537	0.1878	0.1086	0.1338	0.1464	0.2090	0.2117	0.2289	0.1236	0.1593
-	-	-	-	-	-	-	-	-	-	-	-
Bank FE	NO	NO	YES	NO	NO	YES	NO	NO	YES	YES	YES
Weekly Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
-	-	-	-	-	-	-	-	-	-	-	-
Bootstrapped SE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 7: Changes in sensitivities from bank equity to sovereign CDS across countries
This table reports the results from regressing the log changes in the sovereign CDS spreads in country j, $\Delta\texttt{cds}^{s}_{j,t}$, on the log changes in the average bank equity prices, $\Delta\texttt{equity}^{b,st}_{t}$, and average CDS prices, $\Delta\texttt{cds}^{b,st}_{t}$, of stressed countries, and on the log changes in the bank CDS spread of the same country, $\Delta\texttt{cds}^{b}_{i,j,t}$. Columns 1–3, and 4–6 include only those observations from the Pre-CA (29 September to 12 October 2014) and Post-CA (27 October to 7 November 2014) periods, respectively. Columns 7 reports the difference estimators that compare the Pre-CA to the Pre-CA to the Post-CA period. Standard errors are bootstrapped. Each column indicates whether the regression contains time (Time FE) and bank (Bank FE) fixed effects.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	Pre-CA	Pre-CA	Pre-CA	Post-CA	Post-CA	Post-CA	Diff (6)-(3)
ΔLog Stressed Equity x Post							-0.639***
							(0.203)
ΔLog Stressed CDS x Post							-0.177
							(0.253)
ΔLog(Stressed Equity)	-0.094	-0.175	-0.180	-0.434**	-0.606***	-0.608***	0.019
	(0.191)	(0.175)	(0.146)	(0.175)	(0.196)	(0.220)	(0.158)
ΔLog(Stressed CDS)	-0.388***	0.459*	0.460**	0.195	0.028	0.018	0.352
	(0.067)	(0.239)	(0.229)	(0.127)	(0.238)	(0.261)	(0.255)
ΔLog(Bank CDS)	0.033	0.025	0.019	0.498***	0.500***	0.513***	0.261***
	(0.086)	(0.064)	(0.068)	(0.084)	(0.092)	(0.099)	(0.064)
ΔLog(VIX (US))		-0.140***	-0.140***		-0.098	-0.099	-0.122**
		(0.046)	(0.046)		(0.191)	(0.198)	(0.052)
Observations	243	243	243	260	260	260	503
R-squared	0.1325	0.1596	0.1937	0.1609	0.1622	0.1790	0.1412
-	-	-	-	-	-	-	-
Bank FE	NO	NO	YES	NO	NO	YES	YES
Weekly Time FE	YES	YES	YES	YES	YES	YES	YES
-	-	-	-	-	-	-	-
Bootstrapped SE	YES	YES	YES	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 4: Time-varying parameter estimates

The top and bottom panels plot filtered estimates of the time-varying parameters β_t and κ_t in panel regression equations (5) and (5′), respectively. Standard error bands are reported at a 95% confidence level. The estimation sample consists of weekly data from January 2009 to November 2014. Reported values are from March 2014 to November 2014. Vertical lines mark the boundaries of the Pre-CA, Soft Info, and Post-CA periods, respectively.