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by

Carlo Altavilla

(European Central Bank)

Marco Pagano

(University of Naples Federico II and EIEF)

Saverio Simonelli

(University of Naples Federico II)

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Carlo Altavilla   Marco Pagano   Saverio Simonelli

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Abstract

Using novel monthly data for 226 euro-area banks from 2007 to 2015, we investigate the determinants of changes in banks' sovereign exposures and their effects during and after the crisis. First, public, bailed out and poorly capitalized banks responded to sovereign stress by purchasing domestic public debt more than other banks, with public banks' purchases growing especially in coincidence with the largest ECB liquidity injections. Second, bank exposures significantly amplified the transmission of risk from the sovereign and its impact on lending. This amplification of the impact on lending does not appear to arise from spurious correlation or reverse causality.

JEL classification: E44, F3, G01, G21, H63.

Keywords: sovereign exposures, sovereign risk, bank lending, credit risk, euro, crisis.

Authors' affiliations: Altavilla, European Central Bank; Pagano and Simonelli, Università di Napoli Federico II.

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1 Introduction

This paper analyses the role of banks' sovereign exposures in the transmission of sovereign stress to the credit market, using the euro-area debt crisis and its aftermath as testing ground. Specifically, we address two closely related questions: first, how did banks change their public debt holdings in response to sovereign stress, and why? Second, did their sovereign exposures amplify the transmission of stress to lending and bank risk? To answer these questions, we draw on a unique data set covering 226 euro-area banks at monthly frequency from 2007 to 2015. We establish three main results.

First, the buildup of banks' sovereign holdings in stressed countries was driven by the sovereign's moral suasion as much as by search for yield. Consistently with moral suasion, publicly-owned and recently bailed-out banks reacted to sovereign stress by purchasing significantly more domestic public debt than other banks – public banks boosting their purchases especially at the time of the two large liquidity injections by the ECB in December 2011 and March 2012.[1] Moreover, in stressed countries banks with low regulatory capital increased their holdings of domestic public debt more than others, in line with the view that they engaged in carry trades to gamble for resurrection (Acharya and Steffen, 2015).

Second, the stressed-country banks that took larger sovereign exposures featured sharper reductions in loans and increased loan rates by more than less exposed banks. We estimate precisely the amplification effect associated with sovereign exposures: a 1-standard-deviation drop in the price of government bonds reduced the loan growth of the median domestic bank by 1.4 percentage points, which is 20% of the standard deviation of loan growth. Since in principle causality could run from bank loans to their sovereign holdings rather than the opposite, we address endogeneity issues in several ways. First, we analyze the correlation between banks' losses on their sovereign holdings and the riskiness of their loan portfolios – to assess whether a bank's riskiness is systematically linked to its sovereign exposure. Second, we investigate

[1] Uhlig (2013) shows that fiscally vulnerable governments have an incentive to allow domestic banks to hold home risky bonds, in order to borrow more cheaply, while non-vulnerable governments will impose tighter regulation. Battistini, Pagano and Simonelli (2014) argue that sovereign stress heightens this incentive, generating a positive relationship between sovereign yields and banks' holdings of domestic debt, and refer to this prediction as the "moral suasion" hypothesis, a label also used in subsequent work.

the lending behavior of foreign subsidiaries of stressed countries' banks – to assess whether lower demand for loans might have driven the drop in lending. Finally, we instrument sovereign exposures in our lending regressions with public share ownership and bailout events – to reduce simultaneity concerns. Results are confirmed.

Third, we document that domestic sovereign exposures amplified the transmission of risk from governments to banks, besides affecting their lending policies: a 100-basis-point increase in the domestic sovereign CDS premium translated into a rise of 31.5 basis points in the CDS premium of the bank with median exposure.

Our paper is related to a large literature on the drivers of domestic sovereign exposures during sovereign crises. Indirect evidence on such drivers was first provided by Acharya and Steffen (2015), who document that the loadings of bank stock returns on sovereign debt returns are higher for low-capitalized and recently bailed-out banks. They interpret these findings as evidence for the carry trade and moral suasion hypotheses, respectively. This interpretation is warranted if factor loadings proxy for banks' sovereign exposures, but neglects that they may also reflect banks' dependence on public bail-out guarantees: the stocks of less capitalized banks and recently bail-out banks may be more sensitive to public debt returns simply because they depend more on the domestic government as backstop. Instead, our month-by-month observations of banks' sovereign holdings enable us to directly estimate the impact of sovereign stress on the portfolios of banks with different characteristics.

Most contributions to this literature focus alternatively on the moral suasion or carry trade hypothesis, while we allow for both drivers of banks' portfolio choices. Ongena, Popov and van Horen (2016) find that, consistently with the moral suasion hypothesis, in stressed countries domestic banks bought more sovereign debt than foreign banks when the domestic government's financing needs were particularly high. Similarly, De Marco and Macchiavelli (2016) report that banks with sizeable government ownership or politically appointed directors feature more home-biased sovereign portfolios than privately-owned and managed banks. Instead, Buch, Koetter and Ohls (2016) report evidence only in support of the carry trade hypothesis using granular information on German banks. Finally, Horváth, Huizinga and Ioannidou (2015) test both hypotheses, but in separate regressions, so that from their estimates it is unclear whether both would have explanatory power in a nested specification. In contrast, we show both moral suasion and carry trade motives were at work simultaneously, and resulted in quantitatively similar effects.

Other papers investigate whether central bank liquidity fueled the purchase of sovereign debt by banks, and whether it amplified moral suasion or carry trade behavior. Drechsler, Drechsel, Marques-Ibanez and Schnabl (2016) document that less capitalized banks bought more domestic sovereign debt after the extraordinary liquidity provision by the ECB in December 2011 and February 2012. Ongena, Popov and van Horen (2016) find that the larger sovereign debt purchases by domestic and public banks were not fueled by the ECB liquidity injections. In contrast with both papers, we find that the ECB liquidity injections on 2011 and 2012 amplified the moral suasion channel, since they appear to have enabled public banks to buy more sovereign debt, while this does not apply to poorly capitalized banks. Importantly, these two subsets of banks are almost completely disjoint in the data.

Our paper is also related to the literature on the transmission of sovereign stress to lending activity. Gennaioli, Martin and Rossi (2014a) present a model in which sovereign defaults reduce private lending by undermining the balance sheets of domestic banks, the more so the larger their holdings of government debt, and test these predictions on cross-country evidence; in a companion paper (Gennaioli, Martin and Rossi, 2014b) they also test them on bank-level data. Becker and Ivashina (2014) use company data on bank borrowing and bond issuance to show that European companies were more likely to replace bank loans with bond issues when banks in their country held more domestic sovereign debt and when that debt was risky. De Marco (2014) and Popov and van Horen (2014) show that the euro-area banks that turned out to have larger sovereign exposures in the EBA stress tests participated less than less exposed banks in the syndicated loan market, and raised their lending rates more sharply.[2] All these studies suffer from the lack of accurate time series of bank-level data for banks' sovereign exposures. Gennaioli, Martin and Rossi (2014b) rely on banks' total bond holdings, which lump domestic government bonds together with non-domestic bonds. The other three studies use data on sovereign exposures drawn from the EBA stress tests, and thus refer only to (at most) four dates and to a small sample of systemically important banks.

To identify the impact of sovereign stress on the lending policies of banks that travels via their sovereign exposures, it is important control for the demand for loans by firms. The recent contributions by Acharya, Eisert, Eufinger and Hirsch (2015,

[2] De Marco (2014) documents this finding also using yearly balance-sheet data on bank loans, besides syndicated loan data.

2016) and Carpinelli and Crosignani (2015) achieve such identification following the methodology proposed by Khwaja and Mian (2008): they analyze the change in loans issued to the same firm by banks with different exposures to sovereign risk. In our study, we try to control for loan demand in other ways, since we do not have bank-firm matched loan data. However, our data are more complete in terms of coverage of banks, countries and time, as they refer to a sample of banks providing about 70% of total euro-area lending, and track bank-level sovereign exposures and lending policies continuously throughout the crisis and after its abatement, rather than at specific dates and for a segment of the credit market. In contrast, Acharya, Eisert, Eufinger and Hirsch (2015, 2016) measure bank lending with data on syndicated loans, which account for just 10% of total euro-area lending and cater mostly to large, established corporations, while Carpinelli and Crosignani (2015) focus only on Italian banks.

Finally, our paper is related to the literature on the bank-sovereign feedback loop. We find that the domestic sovereign exposures of banks in stressed countries accentuated both the impact of sovereign stress until mid-2012 and its abatement subsequently. In this way, they significantly exacerbated the volatility of bank risk and lending in the euro-area periphery from 2008 to 2015. This evidence accords with the sovereign-debt feedback loop models of Acharya et al. (2014), Brunnermeier et al. (2016), Cooper and Nikolov (2013), Farhi and Tirole (2014) and Leonello (2014), which show that the larger are banks' sovereign exposures, the more extensive is the parameter region in which pessimistic beliefs about government solvency result in sovereign default and collapse in bank lending.

The structure of the paper is as follows. Section 2 describes the data, illustrating the variation in bank-level exposures and presenting some stylized facts. Section 3 analyzes the determinants of banks' domestic sovereign exposures. Section 4 examines whether these exposures influenced the impact on bank lending and loan rates, and Section 5 whether they affected risk transmission from the sovereign to banks. Section 6 concludes.

2 Data and Stylized Facts

This section describes our data and sets out some stylized facts about euro-area banks' holdings of domestic sovereign bonds and their relationship with bank lending. These not only help to gauge the correlations in the data at aggregate level but also point

to the additional insights that can be gleaned from bank-level data.

Our analysis is based on a unique, proprietary data set of balance sheet items at bank level (Individual Balance Sheet Items, or IBSI), which is regularly updated by the ECB. We use monthly observations on the main balance-sheet indicators (assets and liabilities) from June 2007 to February 2015. The sample contains a total of 226 unconsolidated banks in 18 euro-area countries (Table 1), the highest coverage being in the largest countries: Germany (60), France (32), Italy (24) and Spain (23). The banks are observed at unconsolidated level: 119 group head banks, 49 domestic subsidiaries, and 59 foreign subsidiaries (some affiliated to UK or Danish groups).[3] For all these banks, balance-sheet variables are supplemented by bank-level lending rate data drawn from another ECB proprietary data set (Individual MFI Interest Rates, or IMIR), measured as the average rate on new loans granted to non-financial corporations in a given month, weighted by the corresponding new business volumes.

[Insert Table 1]

These data are merged with data on bank share ownership from Bankscope and hand-collected data about bailout dates from the EU Commission state aid database. For the subset of banks with traded credit default swaps (CDS), we take monthly CDS premia from Datastream. The data include monthly observations of the benchmark 10-year and 5-year sovereign yields, survey-based consensus yield forecasts at 3-month and 12-month horizons, and 5-year CDS (monthly averages). Yields and CDS premia for euro-area countries are drawn from Datastream; survey-based forecasts are from Consensus Economics and are available only for France, Germany, Italy, the Netherlands and Spain. For details on data definitions and sources, see the Appendix. We apply the following screens to deal with outliers: we remove data for loans and/or exposures in periods where these are continuously zero with rare spikes (which occurs for 5 banks), data for CDS premia if these are constant for more than three months (3 banks), loan interest rates if their values are missing for more

[3] Our analysis is based on the IBSI data release of 15 April 2015, which contained data for 252 banks. Of these, we removed 26 banks featuring one or more of the following: (i) less than 12 months of observations were available for loans and exposures; (ii) loans equal to zero for the entire sample (with at most sparse spikes); (iii) frequent and extreme jumps in exposures or loans. Of the removed banks, 2 are Finnish, 5 French, 5 German, 2 Irish, 2 Italian, 5 Latvian, 1 is from Luxembourg, 1 Slovenian, and 3 are Spanish.

than 50% of the observations for a given bank (7 banks), and all negative values of domestic sovereign holdings, equity, main assets and lending.

The representativeness of the sample is shown in Table 2, which reports main assets (defined as total assets less derivatives), loans to non-financial corporations and holdings of government bonds for the banks in our data set as a fraction of the national aggregate, drawn from the ECB Balance Sheet Items (BSI) database. On average, for the main variables our data cover about 70% of the corresponding country aggregate. The bottom row of the table shows that weighting country coverage by GDP does not change the results.

[Insert Table 2]

Our data are far more representative of the euro-area banking system than those used in previous studies, along several dimensions. First, our sample has data for the sovereign exposures of 226 banks, compared with at most 91 banks in the pre-2014 EBA stress test data, and for 93 months, compared with the 2 or 3 snapshots of the EBA stress tests. Second, as illustrated by Table 2, our bank loan data cover almost 70% of the corresponding national lending aggregates, compared with the 10% coverage of the syndicated loan data used by Popov and van Horen (2014) De Marco (2014) and Acharya, Eisert, Eufinger and Hirsch (2015).

Descriptive statistics for the main variables are shown in Panel A of Table 3, and for bank characteristics in Panel B. As in the subsequent analysis, the statistics are computed separately for two groups of countries: "stressed" (Cyprus, Greece, Ireland, Italy, Portugal, Slovenia and Spain) and "non-stressed" (Austria, Belgium, Estonia, Finland, France, Germany, Luxembourg, Malta, the Netherlands, and Slovakia). We define as "stressed" – i.e. subject to high sovereign stress – countries whose 10-year sovereign yield exceeded 6% (or, equivalently, 4 points above the German yield) for at least one quarter in our sample period.

[Insert Table 3]

Table 3 reveals that banks in these two groups of countries behaved quite differently in several respects. First, their domestic sovereign exposures (the ratio of government debt holdings to main assets) are greater in stressed countries (4.9%)

than in non-stressed ones (3.8%), while the opposite applies to non-domestic euro-area exposures (1% versus 2.2%).[4] Hence, in stressed countries the sovereign debt portfolios of banks are more "home-biased" than in non-stressed countries. (Unfortunately, we cannot measure the diversification of sovereign debt portfolios more precisely, because our data do not break non-domestic exposures down by sovereign issuer.) Second, banks accumulated domestic sovereign debt twice as fast in stressed as in non-stressed countries (2% versus 1% on a quarterly basis). Third, in stressed countries loans to firms are a larger fraction of bank assets than in non-stressed countries but grow less, and corporate lending rates are higher.

However, in both groups of countries there is considerable dispersion in the sovereign exposures of banks, as well as in the growth of bank sovereign holdings and corporate lending. Sovereign exposures feature substantial variation both over time and cross-sectionally: in the stressed countries, their within and between standard deviations are 3.09 and 3.83 respectively, compared with a mean of 4.9 percent; in the non-stressed countries, 1.85 and 6.42, with a mean of 3.8 percent. The growth rate of domestic sovereign holdings is more volatile, and its within standard deviation is four times higher than the between: 19.45 versus 5.16 in stressed countries and 22.48 versus 5.41 in non-stressed ones. Both values are very large compared to the respective means of -0.4 and 0.2. Both between-bank and within-bank variation in these variables is central to our empirical strategy.

Panel B shows that the characteristics of the average bank in the two groups of countries are similar: quite large, highly leveraged (more so in the non-stressed countries), yet with high regulatory capital ratios (9.4% in the stressed and 9.9% in the non-stressed countries), and mainly reliant on deposit funding (about 2/3 in both sets of countries). Also, government intervention in the banks of the two groups is similar, with average public stakes of 24% and 23% respectively (public ownership being defined as shareholding of local or national government and of publicly controlled institutions); and the frequency of observations referring to bailed-out banks is 10% for both sets of countries (the bailout being a dummy equal to 1 during and

[4] Banks' sovereign holdings are partly at market prices and partly at book values. They are marked to market if the bank classes them in its "trading book" (i.e., either "available for sale" or "held for trading"). They are at book values if the bank classes them in its "banking book" (i.e., "held to maturity"). Our data do not contain the breakdown between these two components. In the 45 euro-area banks present in the EBA stress test data, trading-book sovereigns account for 59% of the total for banks in stressed and 48% in non-stressed countries.

after a bailout, and 0 otherwise).

Figures 1, 2 and 3 add a dramatic time dimension to two of the stylized facts that emerge from Table 3, namely the rapid growth of banks' domestic sovereign exposures and the sharp decline in the loan-to-asset ratio in stressed countries, in striking contrast with the experience of non-stressed countries. Figure 1 shows that the different pattern of sovereign exposures between the two groups of countries is driven by the exposures of the head banks: the median domestic subsidiary in the stressed countries and the median foreign subsidiary in both groups have virtually no sovereign exposures, reflecting the fact that a banking group's securities portfolio is typically managed by the head bank.[5]

[Insert Figure 1]

Figure 2 shows the pattern of median domestic sovereign exposures and loan-asset ratios for stressed countries from July 2007 to February 2015; Figure 3, for non-stressed countries. Besides confirming that domestic sovereign exposures increased much more sharply in the former, the figures illustrate the completely different dynamics of the median bank's loan-to-asset ratio. Figure 2 shows that in the stressed countries, loans to non-financial corporations are correlated negatively with sovereign exposures: over the sample period, the median bank's domestic exposure increases from 1% to 6% of assets, while its corporate lending falls from 28% under 20% of main assets, the sharpest drop coming in the second half of 2012. In late 2014 the loan-asset ratio begins to stabilize, in line with the improvement in aggregate lending in the stressed countries. Figure 3 shows a completely different picture for the non-stressed countries: except for the first two years of the sample, the loan-asset ratio of the median bank is positively correlated with its domestic sovereign exposures, and both variables have a distinct positive trend.

[Insert Figures 2 and 3]

Of course, these different correlations between sovereign exposures and bank lending at the time-series, aggregate level cannot, as such, establish causation: in principle, the negative correlation in stressed countries could reflect either the "crowding

[5] We are grateful to Rony Hamaui (Head of Financial Institutions of Banca Intesa) for pointing out this fact to us, based on his experience.

out" of private lending by sovereign debt in banks' balance sheets or diminished demand for loans leading banks to substitute them with sovereign debt. However, as we shall see, bank-level data can reveal the direction of causality, as we can exploit heterogeneity among banks in the response to sovereign stress of sovereign exposures (Section 3) and of corporate loans (Section 4).

3 Determinants of Banks' Sovereign Exposures

The descriptive evidence set out above highlights the cross-sectional and time-series variation in banks' domestic sovereign exposures. Some of this variation is accounted for by three characteristics of the banks: fraction of public share ownership, government-bailout history, and regulatory capital ratio. This section documents that these three characteristics correlate not only with differences in sovereign exposure, but also with the way banks vary such exposure when faced with domestic sovereign stress: public ownership, previous occurrence of a bailout and low capitalization are associated with a greater tendency to increase holdings of distressed government debt in the face of price declines.

As observed in Section 1, according to the "moral suasion" hypothesis publicly owned banks should be more willing than private ones to surrender to government influence and purchase domestic debt at times of sovereign stress, and foreign banks should be less willing than domestic ones to do so. By the same token, recently bailed-out banks should be more sensitive to government pressure, their management being typically government-appointed and keenly aware that survival hinged on a public capital infusion. According to the "carry trade" hypothesis, poorly capitalized banks should purchase more high-yield public debt, in order to gamble for resurrection. Hence, heterogeneity across banks helps to distinguish between the two hypotheses, which cannot be done in aggregate data (see Battistini et al., 2014). In this section we show that each of these hypotheses accounts for some of the variation of bank sovereign exposures in stressed countries, and that the two groups of banks to which each hypothesis applies are distinct and largely non-overlapping. Before turning to regression analysis, let us examine some graphic evidence to explore how changes in domestic sovereign exposures correlate with bank characteristics.

Figure 4 shows banks' domestic sovereign exposure according to the type of ownership: the lines labeled "public" and "private" respectively plot the average exposure

of banks above and below the average fraction of public ownership of shares in the relevant country in 2008. The two vertical dashed lines in both panels of Figure 4 mark the timing of the two largest injections of liquidity effected by the ECB during the sovereign crisis, the 3-year Very Long-term Refinancing Operations (VLTROs) of December 2011 and March 2012, which provided loans for €489bn and €529bn respectively to euro-area banks.[6] In the left panel, which refers to the stressed countries, domestic sovereign exposures are very similar until late 2011, but afterwards the banks with more public ownership increase their domestic sovereign exposures at a much faster pace than the other group, the difference between them growing from nil in 2011 to over 6 percentage points in 2015. The largest increase in public banks' sovereign exposures occurs in coincidence with the two VLTROs, suggesting that these banks used the liquidity provided by the ECB to fund their purchases of domestic public debt and/or bought such debt to pledge it as collateral to obtain liquidity, as found by Crosignani, Faria-e-Castro and Fonseca (2016) for Portuguese banks. The right panel shows a qualitatively similar pattern in the domestic exposures of non-stressed countries' banks as well, but with a much smaller difference between public and private banks – between 1 and 2 percentage points.

[Insert Figure 4]

Figure 5 shows that in the stressed countries, banks that benefited from a bailout purchased substantially more domestic government debt in the month before and the year after it. The line plotted in the two panels is the difference between the average domestic sovereign exposure of the bailed-out and the other banks, measured in the same month and group of countries, over a 2-year window centered on the bailout date (month 0). In the stressed countries, the exposure of the bailed-out banks rises on average 3 percentage points above that of the control group over the 12 subsequent months. No such pattern is detectable in the non-stressed countries.

[Insert Figure 5]

Figure 6 explores whether banks with different regulatory capital ratios (Tier-1 capital scaled by risk-weighted assets, or $T1/RWA$) changed their domestic sovereign

[6] More precisely, the settlement dates of the two operations were 22 December 2011 and 1 March 2012, respectively.

exposures differently. The left panel refers to stressed countries, the right panel to non-stressed ones. The figure is based on the subsample of banks for which $T1/RWA$ data are available in the SNL database: between 30 and 40 banks in each group, depending on month. In each panel, the lines labeled "high $T1/RWA$" and "low $T1/RWA$" refer to the average domestic sovereign exposure of banks with above-median and below-median $T1/RWA$. After the 2010 Greek bail-out, the stressed-country banks with low capital ratios increased their sovereign exposures more than their better-capitalized counterparts. Some difference, albeit smaller, is also observable in the non-stressed countries.

[Insert Figure 6]

Taken together, the three figures suggest that in stressed countries banks with higher public ownership and less regulatory capital increased their sovereign holdings more than other banks at times of sovereign stress, and recently bailed-out banks bought more stressed domestic debt than other banks. That is, this graphic evidence already suggests that both the "moral suasion" and the "carry trade" hypotheses have explanatory power. Interestingly, the two hypotheses appear to apply to two quite different groups of stressed-country banks: as of the end of 2008, only one of the "low $T1/RWA$" banks in Figure 6 – Monte dei Paschi di Siena – also features public ownership above its country median, and therefore belongs to the group of "public" banks in Figure 4.

To test these two hypotheses with regression analysis, we proceed in two steps. Since the SNL data on $T1/RWA$ – needed to test the carry trade hypothesis – are only available for a small subsample of banks, we first use the full sample to test the moral suasion hypothesis only. Next, we restrict the estimation to the subsample for which we have SNL data and test both hypotheses on this smaller sample.

In Table 4, we estimate the following specification:

$$\begin{aligned}\frac{\Delta H_{ijt}}{H_{ijt-1}} = {} & \alpha_{jt} + \gamma_i + \phi_1 Public_{ijt} \times \frac{\Delta P_{jt}}{P_{jt-1}} + \phi_2 Public_{ijt} \times VLTRO_t + \phi_3 Public_{ijt} \\ & + \phi_4 Bailout_{ijt} \times VLTRO_t + \phi_5 Bailout_{ijt} + \phi_6 F_{ij} \times \frac{\Delta P_{jt}}{P_{jt-1}} \\ & + \phi_7 F_{ij} \times VLTRO_t + \theta X_{ijt-1} + \eta_{ijt}, \qquad (1)\end{aligned}$$

where the dependent variable is the quarterly percentage change in domestic sovereign holdings H_{ijt} of bank i in country j and quarter t. (Holdings H_{ijt} of debt issued by country j's government differ from exposure, which is defined as the ratio of holdings to main assets, i.e. H_{ijt}/A_{ijt}.) In equation (1), $Public_{it}$ is the time-varying fraction of the bank's shares owned directly or indirectly by local or national government or publicly controlled institutions (*Fondazioni* in Italy, *Fundaciones* and *Cajas* in Spain, and *Sparkasse* and *Landesbank* in Germany); $\Delta P_{jt}/P_{jt-1}$ is the percentage change in the price of sovereign j's debt in the previous quarter (computed as the product of the change in the relevant 10-year yield from $t-1$ to t by the corresponding duration as in De Marco (2015)); $VLTRO_t$ equals 1 in coincidence with the the two ECB liquidity injections of December 2011 and March 2012, and 0 otherwise; $Bailout_{ijt}$ equals 1 from the quarter in which bank i was bailed out (unless acquired by another bank in the two subsequent quarters), and 0 otherwise; F_{ij} equals 1 if bank i is the subsidiary of a foreign bank operating in country j and 0 if it is a domestic head bank or subsidiary. The specification also includes bank fixed effects γ_i to control for unobserved heterogeneity at bank level and time-country effects α_{jt} to control for country-level factors that may affect bank purchases of sovereign debt, including government debt repricing: the latter enters the specification only via its differential effect on banks with different characteristics. Finally, we include the (lagged) deposit-liability ratio X_{ijt-1} as a further bank-level control. In estimating specification (1), errors are clustered at the bank level, and the quarterly growth rates of sovereign holdings are trimmed at $\pm 100\%$ to avoid outliers.

At times of sovereign stress, the price of domestic public debt prices falls; that is, the variable $\Delta P_{jt}/P_{jt-1}$ is negative. The moral suasion hypothesis holds that at those times public banks should buy more domestic debt than private ones, and foreign subsidiaries less than domestic banks, so that $\phi_1 < 0$ and $\phi_6 > 0$. Insofar as the ECB liquidity injections facilitated the purchase of domestic public debt by public banks rather than by private and foreign ones, one would also expect $\phi_2 > 0$ and $\phi_7 < 0$. The moral suasion hypothesis does not necessarily imply a positive direct effect of public ownership, ϕ_3: public banks are supposed to be more pliant at times of sovereign stress, not to increase their public debt holdings more than other banks at all times. Instead, the moral suasion hypothesis requires bailed-out banks to buy more sovereign debt during and after the salvage, compared with other banks in the same country and quarter: $\phi_5 > 0$. Moreover, if ECB liquidity injections also contributed to domestic public debt purchases by bailed-out banks, one should find

$\phi_4 > 0$. The specification (1) merges elements from the models of "moral suasion" estimated by De Marco and Macchiavelli (2014), Acharya et al. (2015), Horváth et al. (2015) and Ongena et al. (2015): the first three studies estimate regressions of sovereign exposures on indicators of political control and government support using EBA stress test data; the third focuses on measures of foreign ownership using IBSI data for stressed countries.[7]

The estimates in Table 4 show that for stressed countries the coefficient of the interaction between public ownership and the change of sovereign debt prices (ϕ_1) is negative and significant, and the coefficients of the bailout variable (ϕ_5) and of the interaction between foreign ownership and sovereign price changes (ϕ_6) are both positive, although the latter is imprecisely estimated: all these estimates conform to the predictions of the moral suasion hypothesis. The estimate of ϕ_1 in column 3 implies that, in response to a 1% decrease in domestic sovereign debt prices, a 100% publicly-owned bank ($Public_{ijt} = 1$) increased its domestic sovereign holdings by 0.35% more than a 100% private bank ($Public_{ijt} = 0$); the estimate of ϕ_5 instead implies that bailed-out banks increase their public debt holdings by 6.44% more than other banks. Moreover, the interaction of the $VLTRO_t$ dummy with public ownership has a positive and significant coefficient (ϕ_2), and that with foreign ownership has a negative and significant one (ϕ_7): the 3-year ECB loans in 2011-12 allowed domestic public banks of stressed countries to purchase sovereign debt far in excess of private and foreign banks. The estimates in column 2 imply that in the two months of the liquidity injections a 100% publicly-owned bank increased its domestic debt holdings by 16.52% more than those of a 100% privately-owned bank, in stressed countries. By contrast, none of the coefficients is significantly different from zero in the non-stressed countries, except for ϕ_7, which is also negative and marginally significant. Since sovereign solvency was seriously questioned by investors only for stressed countries, the results support the moral suasion hypothesis. They broadly agree with the results of De Marco and Macchiavelli (2014) and Horváth et al. (2015), but not with those of Acharya et al. (2015), who find no evidence of moral suasion, nor with Ongena et al. (2015), who find no interaction between the VLTRO and moral suasion.

In Table 5, we expand specification (1) to jointly test the moral suasion and

[7] The specification used by Ongena et al. (2015) also relies on a different variable to gauge sovereign stress, namely a measure of abnormally large domestic sovereign issuance ("high needs"), which may induce the government to pressure domestic banks to underwrite larger amounts of its debt.

the carry trade hypothesis, allowing for their respective interactions with the ECB liquidity injections:

$$
\begin{aligned}
\frac{\Delta H_{ijt}}{H_{ijt-1}} = {} & \alpha_{jt} + \gamma_i + \delta_1 \frac{T1}{RWA_{ijt-1}} \times \frac{\Delta P_{jt}}{P_{jt-1}} + \delta_2 \frac{T1}{RWA_{ijt-1}} \times VLTRO_t + \delta_3 \frac{T1}{RWA_{ijt-1}} + \\
& + \delta_4 Public_{ijt} \times \frac{\Delta P_{jt}}{P_{jt-1}} + \delta_5 Public_{ijt} \times VLTRO_t + \delta_6 Public_{ijt} \\
& + \delta_7 Bailout_{ijt} \times VLTRO_t + \delta_8 Bailout_{ijt}. \qquad (2)
\end{aligned}
$$

According to the carry trade hypothesis, weakly capitalized banks (low $T1/RWA_{ijt-1}$) should increase their sovereign holdings more than better capitalized ones when government debt becomes cheaper ($\Delta P_{jt}/P_{jt-1} < 0$), and resell it more aggressively if and when prices recover ($\Delta P_{jt}/P_{jt-1} > 0$) to realize their profits. Hence, the coefficient of the interaction between $T1/RWA_{ijt-1}$ and $\Delta P_{jt}/P_{jt-1}$ should be positive: $\delta_1 > 0$. Interestingly, the $T1/RWA_{ijt-1}$ variable has low correlation with $Public_{ijt}$ and $Bailout_{ijt}$ (0.15 and 0.18 respectively), confirming that the group of poorly capitalized banks is quite distinct from the groups of public and recently bailed-out banks. Specification (1) also allows us to test whether weakly capitalized banks borrowed more from the ECB and used these loans to buy risky sovereign debt, as found by Drechsler, Drechsel, Marquez-Ibanez and Schnabl (2016): this would require the coefficient of the interaction between bank capitalization ($T1/RWA_{ijt-1}$) and the $VLTRO_t$ to be negative, i.e. $\delta_2 < 0$.

It is worth noticing that the carry trade hypothesis does not imply that poorly capitalized banks invariably purchase more domestic public debt (i.e., $\delta_3 < 0$): if the price of domestic sovereign debt is stable while that of distressed foreign sovereign debt declines, a bank wishing to engage in a carry trade will bet on foreign sovereign debt, and divest domestic debt. In other words, the hypothesis predicts an increasing home bias in sovereign debt portfolios only for banks in stressed countries, not in non-stressed ones: during the crisis, a yield-seeking German bank would not have invested in German but in Italian or Spanish public debt. But since our data only provide a breakdown between domestic and foreign euro-area sovereign debt holdings, they allow us to test the carry trade hypothesis only for stressed countries: for the banks in non-stressed countries, such testing would require the complete breakdown of their foreign debt portfolio (as in the studies of Buch et al. (2016) on German banks and

Peydrò, Polo and Sette (2016) on Italian banks). Hence, we estimate specification (2) only for stressed countries, where our data allow meaningful estimation of the carry-trade coefficients δ_1, δ_2 and δ_3.

Specification (2) also includes the variables present in specification (1) to capture moral suasion, except for the interaction between foreign ownership and sovereign debt repricing, since we have no data on the regulatory capital of foreign subsidiaries. The sample includes only the bank-quarter observations for which the SNL database supplies regulatory capital data. The panel is unbalanced, since there are data gaps even for some of the 41 banks included in the sample.

The estimates of specification (2) are shown in Table 5. The first two columns are for the carry-trade variables only: the sample used in column 1 includes all domestic banks, while that in column 2 includes head banks only (that hold most of their groups' sovereign debt). The estimate of δ_1 is positive and significant in both columns. Its estimate in column 2 implies that a 1% decrease in the price of domestic sovereign debt is associated with an increase in sovereign holdings of about 1% for the median bank (which has a regulatory capital ratio of 10%). The estimate of δ_3 is negative and marginally significant in columns 2 and 3, implying that in stressed countries less capitalized banks increased their domestic sovereign holdings more than better capitalized ones. Both estimated coefficients are thus in agreement with the carry trade hypothesis. The estimate of δ_2 is negative but not significantly different from zero in columns 2 and 3, implying that in our data the ECB liquidity injections do not appear to have exacerbated carry trades by poorly capitalized banks.

[Insert Table 5]

Column 3 shows the estimates for the complete specification (2), comprising both the carry trade and the moral suasion terms, as well as the corresponding interactions with the ECB liquidity injections of 2011-12, including only group head banks. Both hypotheses are seen to have explanatory power, despite the limited size of this subsample. The carry-trade coefficients δ_1 and δ_3 are virtually the same as in column 2, and the coefficient δ_8 of the bailout variable and the coefficient δ_5 of the interaction between public ownership and the $VLTRO_t$ both remain positive and significant, and of similar magnitude to the corresponding estimates in column 3 of Table 4 – the only difference being that the coefficient of the interaction between public ownership and sovereign debt repricing is no longer significant, though positive. Indeed, a formal

test shows that on the whole the carry trade and the moral suasion variables have the same explanatory power.[8] The main difference between them lies in their interaction with monetary policy: the ECB liquidity injection appears to have facilitated sovereign debt purchases by public banks rather than by undercapitalized ones, i.e. to have fed more into the moral suasion than the carry trade channel – a finding that no previous study had uncovered.

This novel finding is corroborated by the correlation between the change in banks' domestic sovereign holdings around the VLTRO dates and their liquidity take-up in the VLTROs. As shown by Figure 7, in stressed countries this correlation was larger for public banks than for private ones, the difference being statistically significant at the 2.8 percent level. This confirms that sovereign debt purchases by public banks were fuelled by the 3-year ECB loans of the VLTROs more than those of private banks, in contrast with the findings of Ongena, Popov and van Horen (2016). Instead, no significant difference in this correlation exists between banks with low and high $T1/RWA$ ratio, as shown by Figure 8: in our data the ECB's liquidity injections do not appear to have exacerbated carry trades by poorly capitalized banks compared to better capitalized ones, in contrast with the results reported by Drechsler, Drechsel, Marques-Ibanez and Schnabl (2016).

[Insert Figures 7 and 8]

To sum up the evidence so far, the descriptive statistics in Section 2 show great heterogeneity in banks' sovereign exposure and its changes over time; this section shows that sovereign stress tends to increase this heterogeneity, eliciting different responses from banks with different characteristics. Next, we investigate whether such heterogeneity is associated with differing responses of banks' solvency risk (Section 5) and lending policies (Section 4).

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[8] To test whether there has been a predominance of one of the two hypotheses, we estimate specification (1) – for the banks for which SNL data on capital are available – first retaining only the carry-trade variables and then retaining only the moral suasion ones. We then perform the likelihood ratio test proposed by Vuong (1989) and find that the null hypothesis that the two models have the same predictive power cannot be rejected (p-value = 0.8).

4 Sovereign Stress, Bank Lending and Loan Rates

In this section we investigate whether the domestic sovereign exposures of euro-area banks affected the lending policies of euro-area banks through an "exposure channel". As noted in the introduction, an increase in sovereign risk may induce the more highly exposed banks to reduce lending, owing to the capital losses from the repricing of their sovereign holdings. The resulting loss of equity increases banks' default risk and pushes them closer to the minimum prudential capital ratio, forcing the weakest to deleverage. An increase in sovereign risk may also raise the funding costs of the more exposed banks disproportionately. These banks have less collateral to pledge to their creditors given capital losses, which also forces them to contract lending. And they tend to face higher funding rates and haircuts, which they may try to pass on to customers via higher lending rates. Conversely, of course, one would expect symmetric effects when banks' sovereign holdings appreciate, as they did in the stressed countries in 2012-13: in that case, the capital gains on sovereign holdings should amplify the expansion of lending and the decrease in loan rates.

Of course, sovereign stress may also affect banks' loans directly, for instance by inducing banks to change their lending policies or by inducing firms to reduce their demand for credit, quite apart from banks' exposure to government debt: indeed, our specification will control for this "direct channel". But this baseline effect will be amplified for banks that are heavily exposed. Our analysis focuses precisely on this amplification effect of sovereign exposures: that is, we seek to estimate the strength of the "exposure channel".

4.1 Bank Lending Regressions

To evaluate the impact of sovereign stress on bank lending, we estimate the following specification:

$$\frac{\Delta L_{ijt}}{L_{ijt}} = \alpha_{jt} + \gamma_i + \left[\left(\beta_1 + \beta_2 \frac{\Delta P_{jt-1}}{P_{jt-2}} \right) D_{ij} + \left(\beta_3 + \beta_4 \frac{\Delta P_{jt-1}}{P_{jt-2}} \right) F_{ij} \right] Exp_{ijt-1} + \boldsymbol{\theta}' \mathbf{X}_{ijt-1} + \nu_{ijt}, \quad (3)$$

where the dependent variable $\Delta L_{ijt}/L_{ijt}$ is the quarterly growth of the loans granted by bank i to non-financial corporations in country j and quarter t, and $\Delta P_{jt-1}/P_{jt-2}$ is the percentage change in the price of sovereign j's debt in the previous quarter. The

reason for lagging the price change in (6) is to allow for a gradual response of lending to capital gains or losses on the sovereign portfolio (although similar estimates are obtained using the contemporaneous price change). The price P_{jt} of the sovereign debt of country j is alternatively the price of 10-year and of 5-year government bonds, computed as the product of the change in the relevant yield from $t-1$ to t and the corresponding duration, as in De Marco (2015). As in the credit risk regression in (6), in specification (3) too the loans of domestic and foreign banks are allowed to respond differently to sovereign exposures and capital gains or losses. The bank-level controls $\mathbf{X}_{ijt-1}$ in (3) are the lagged leverage ratio and deposit-liability ratio, and their interactions with the sovereign debt repricing $\Delta P_{jt-1}/P_{jt-2}$, to control for the differential effect that such repricing may have on banks differing in solvency risk. In estimating specification (3), errors are clustered at the bank level, and the quarterly growth rates of loans are trimmed at $\pm 100\%$ to eliminate outliers.[9]

Table 6 shows the estimates of specification (3) for the stressed countries. In panel A, columns 1 to 3 show the estimates obtained when sovereign debt repricing is computed from the yields of 10-year benchmark bonds; columns 4 to 6 relate to 5-year yields. In each case, we start from a specification where domestic and foreign banks are constrained to have the same coefficients (columns 1 and 4), then expand that specification with bank-level controls (columns 2 and 5), and finally estimate a specification where domestic and foreign banks are allowed to have different coefficients and bank-level controls are included.

In all these specifications, the estimate of β_2 is positive and significantly different from zero, indicating that in stressed countries the domestic banks more highly exposed to the sovereign responded to public debt price drops by cutting lending more sharply than the less exposed; and conversely they expanded their lending more in response to a rise in public debt prices. In contrast, the estimate of β_4 is small and not significantly different from zero, implying that foreign banks with different expo-

[9] In the estimation of this specification, we also take into account two breaks in the time series of loans of four Spanish banks (BFA-Bankia, Catalunya Banc, NGC Banco-Banco Gallego and Banco de Valencia), in November 2012 and January 2013. These breaks are due to restructuring and recapitalization by SAREB, the "bad bank" set up by the government to manage the assets transferred by these four banks. To remove the breaks, we regress the loans for these banks on dummy variables corresponding to the two breaks and replace the actual values with the residuals obtained from this regression. We use the same approach to deal with a break for the Slovenian bank Nova Kreditna Banka Maribor in December 2013, when it transferred its bad loans to the Slovenian bad bank.

sures to their host country's debt did not respond differently to its repricing, probably because typically the subsidiaries of foreign banks operating in stressed countries had very little exposure to the host country sovereign debt (see Figure 1).

[Insert Table 6]

As in stressed countries both domestic and foreign subsidiaries hold little sovereign debt (Figure 1), the sovereign portfolio of domestic banking groups is likely to be concentrated at the group head. In this case lending should react only to the value of sovereign debt holdings of the head bank. Panel B of Table 6 inquires into this in two different ways. First, column 1 estimates a specification similar to (3) using only data for heads of domestic groups, with sovereign repricing based on 10-year yields; column 3 repeats the estimation using 5-year yields. In both cases, the estimate of the interaction coefficient β_2 using only data for head banks is considerably higher than that obtained in Panel A using all banks. The coefficient is rises from 1.40 to 2.48 using 10-year debt repricing, and from 0.97 to 1.96 using 5-year debt repricing, and the explanatory power of the regression increases slightly even though the number of observations is reduced by 42%. Next, in columns 2 and 4 of Panel B, instead of dropping subsidiaries from the sample, we re-estimate the regression by imputing to domestic subsidiaries the sovereign exposures of their respective head banks, since subsidiaries' lending decisions may be affected by the capital gains or losses on the securities held by their head banks. Again the estimate of β_2 exceeds that obtained in Panel A: 2.08 using 10-year debt repricing, and 1.96 using 5-year debt repricing. This suggests that the amplification effect is indeed associated with the sovereign exposures of the head bank.

The economic relevance of the estimates in Table 6 is considerable: they imply that in the stressed countries a 1-standard-deviation drop in the price of 10-year government bonds (−17%) reduces the loan growth of the median domestic bank by 0.7 percentage points and that of the median domestic head bank by 1.4 percentage points . These account respectively for 9.7% and 20% of the standard deviation of loan growth (12.7% and 12.2%). Comparable figures are obtained for the effect of the repricing of 5-year government bonds: in that case the amplification effect accounts for 10.1% of the standard deviation of the loan growth of domestic banks and for 23.3% of that of domestic head banks.[10]

[10] The effect of a 1-standard-deviation rise in the price of 10-year bonds on domestic bank lending is

Another way to assess the economic significance of this amplification mechanism, is to compute the loan growth associated with the change in the value of banks' sovereign holdings in the sample period. Figure 9 plots the cumulated component (dashed line) of the loan growth rate predicted by the interaction term (relying on the estimated coefficient of 2.45, reported in column 1 of Table 9, Panel B), averaged across the banks operating in stressed countries. The figure also plots actual average loans (solid line) as a benchmark to gauge how far the interaction of bank exposures and sovereign stress helps explain the actual dynamics of lending. The interaction effect is virtually nil until mid-2010, goes negative and increasingly large after the Greek bailout in that year (marked by the first vertical line), and then turns positive and rising after Draghi's "whatever-it-takes" speech in 2012 (the second vertical line): hence, the interaction effect due to sovereign exposures considerably amplified the fluctuations in loan growth during most of the crisis and post-crisis period.

[Insert Figure 9]

The results reported in Table 6 are qualitatively confirmed also when the same specifications are re-estimated for household loans (not reported for brevity). But in the case of household loans the amplification effect of sovereign exposures is considerably smaller than for loans to firms: typically, the estimate of the interaction coefficient β_2 is one-third of the size reported in Table 6. Hence, banks suffering larger losses on their public debt holdings cut back their household loans considerably less than their loans to firms. This "pecking order" may reflect the lower riskiness of household loans, which are generally collateralized by real estate and carry lower prudential risk weights; but it may also reflect the fact that housing mortgages have typically longer maturities than loans to firms, which can therefore be more easily reduced by not rolling them over.

In Table 7 the specifications of Table 6 are re-estimated for the non-stressed countries: the amplification coefficient β_2 is not significantly different from zero for

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obtained by multiplying its standard deviation (0.17) by the estimate of β_2 in column 3 of Panel A of Table 7 (1.46) and by the median domestic bank's sovereign exposure (0.05), i.e., $0.17 \times 1.46 \times 0.05 = 0.012$. Similarly, for domestic head banks we multiply the estimate of β_2 in column 1 of Panel B of Table 7 (2.48) by the median domestic head bank's exposure (5.8%), i.e., $0.17 \times 2.48 \times 0.058 = 0.024$. The calculation can be repeated for 5-year bonds taking into account that the standard deviation of their price changes is 0.25, and using the estimates of β_2 in column 6 of Panel A (1.03) for all domestic banks and in column 3 of Panel B (1.96) for domestic head banks.

domestic banks, whereas it is positive and significant for foreign banks (columns 3 and 6 of Panel A); this also explains why it is weakly significant when domestic and foreign banks are pooled (columns 4 and 5 of Panel A). Hence the lending of foreign subsidiaries responds to capital gains or losses on their holdings of their host government's debt. Since these foreign banks include subsidiaries of head banks located in the stressed countries, the loans of stressed-country banks are presumably sensitive to the valuation of their sovereign debt holdings, whether issued by their home or by their host government – possibly because they are more severely equity-constrained than the banks of the non-stressed countries.

[Insert Table 7]

4.1.1 Endogeneity

The estimates in Tables 6 and 7 might be biased and inconsistent due to endogeneity problems. That is, at times of sovereign stress firms may curtail their investments, and thus loan demand, which could engender spurious correlation or reverse causality. Spurious correlation can occur if banks with larger sovereign exposures happen to have customers whose business is more sensitive to sovereign stress, so that when public debt prices fall sharply they suffer a larger drop in loan demand by their (solvent) customers. Reverse causality may occur if the banks that face a larger drop in loan demand (due to the composition of their customer base) substitute public debt for loan assets: if so, causality would run from change in corporate loan demand to banks' sovereign debt holdings.

To address the issue of spurious correlation, we investigate how lending by foreign subsidiaries of stressed-country banks operating in non-stressed countries responds to the repricing of the sovereign portfolio of their head bank. The idea is that the repricing of sovereign debt in the stressed countries was external to the credit markets of the non-stressed countries, it can be viewed as an exogenous shock to loan supply in the latter, along the lines of Peek and Rosengreen (2000), Klein, Peek and Rosengren (2002) and Puri, Rocholl and Steffen (2011). The domestic sovereign exposures of head banks in stressed countries should amplify the magnitude of this shock: for example, the loans granted by Italian banks operating in Germany should respond to the depreciation of Italian sovereign debt to an extent that depends on the amount of Italian sovereign debt owned by their head bank in Italy. This change in lending

should not be affected by spurious correlation, as loan demand in Germany should not respond to sovereign stress in Italy.[11]

Hence, we estimate the following specification:

$$\frac{\Delta L_{ijt}}{L_{ijt}} = \alpha_{jt} + \gamma_i + \left(\beta_1 + \beta_2 \frac{\Delta P_{ht-1}}{P_{ht-2}}\right) Exp.Head_{ijt-1} + \boldsymbol{\theta}' \mathbf{X}_{ijt-1} + \nu_{ijt}, \quad (4)$$

where the dependent variable is the growth rate of loans by bank i to non-financial corporations in non-stressed country j. The index h denotes the bank's "home" country: bank i may be either a domestic country-j bank (in which case $h = j$) or the foreign subsidiary of a bank based in stressed country h (in which case $h \neq j$). The sample comprises subsidiaries of banks based in Italy and Spain that operate in Austria, Belgium, Germany, Luxembourg, and Slovakia, as well as domestic banks based in these countries. $\Delta P_{ht-1}/P_{ht-1}$ measures the repricing of the sovereign debt of the home country $h \neq j$ in quarter $t-1$. $Exp.Head_{iht}$ is the indirect exposure of subsidiary i operating in country j to the sovereign risk of its *home* country $h \neq j$, and is set to zero if bank i is a domestic bank of country j, i.e. if $h = j$. The bank-level controls $\mathbf{X}_{ijt-1}$ are Exp_{ijt-1} and $\Delta P_{jt-1}/P_{jt-2} \times Exp_{ijt-1}$, where Exp_{ijt-1} is the direct exposure of bank i (whether domestic or the subsidiary of a foreign bank) operating in country j to the sovereign debt of country j in quarter $t-1$: these variables control for the effect of exposure to the *host* country's sovereign risk and the effect of its repricing on bank i's lending.

The results for this specification are shown in Table 8, where columns 1-2 are based on repricing of 10-year debt and columns 3-4 on 5-year debt, either without or with bank-level controls. In all cases, the estimate of the amplification coefficient β_2 is positive, significant and comparable to that estimated in Panel B of Table 6 for the loan growth of the head banks: when repricing refers to 10-year debt, β_2 is estimated to be 3.26 for "lending abroad" by stressed-country subsidiaries in Table 8, and 2.48 for "lending at home" by the corresponding head banks in Table 6; the estimates are even closer for 5-year debt, β_2 being 1.71 for "lending abroad" by subsidiaries in Table 8, and 1.96 for "lending at home" by head banks in Table 6.

[11] Bofondi, Carpinelli and Sette (2013) adopt a symmetric strategy to identify the effect of sovereign stress on the supply of loans in Italy: they compare the loans extended by Italian and foreign banks to the same customers in Italy, and show that during the sovereign crisis Italian banks reduced their lending by more than foreign ones.

[Insert Table 8]

Hence, the response of loans granted abroad by subsidiaries of stressed-country banks to the repricing of the home country debt held by their head banks in very similar to the response of the domestic loans of those head banks themselves. This suggests that the amplification coefficients estimated in Table 6 do capture a shift in bank loan supply and not a shift in firms' loan demand.

A second endogeneity concern is that lending itself may affect the size of lagged sovereign exposures, generating reverse causality: if sovereign stress affects lending differently across banks, it may induce them to vary their sovereign exposures differentially – increasing them more in banks that suffer a greater loan shortfall, less in the others. This concern should be attenuated by the fact that in our specification the sovereign exposure of bank i is measured one quarter before its loan growth. But in principle banks could change their sovereign holdings in anticipation of future changes in loan growth. In this case, rather than measuring the impact on lending of losses or gains on sovereign holdings, the estimates might be capturing the impact on sovereign exposures of expected changes in lending.

To address this potential reverse causality, recall the evidence in Section 3 that publicly-owned banks increase their domestic sovereign holdings more than privately-owned banks in response to sovereign stress, and that bailouts are followed by increases in domestic sovereign holdings. Hence, in our specification these two variables – public ownership and occurrence of a bank bailout, both interacted with sovereign repricing – are used as instruments of the interaction term $Exp_{ijt-1} \times \Delta P_{jt-1}/P_{jt-2}$. Table 9 shows the instrumental variable estimates of specification (3), restricted to domestic banks (i.e., setting $D_{ij} = 1$ and $F_{ij} = 0$), as obviously there are no domestic bailouts of foreign banks. For the stressed countries the estimate of β_2 is still positive and significant: indeed it increases in value compared to its OLS counterpart, while for non-stressed countries it is still not significantly different from zero.

[Insert Table 9]

For the variables $Public_{ijt-1} \times \Delta P_{jt-1}/P_{jt-2}$ and $Bailout_{ijt-1} \times \Delta P_{jt-1}/P_{jt-2}$ to be valid instruments, our assumed exclusion restriction is that the lending of publicly-owned and bailed-out banks does not react differently to sovereign stress from that of other banks, unless they have different domestic sovereign exposures. In other words,

their exposure is the only factor determining their differential response to sovereign stress. This exclusion restriction would be violated if at times of sovereign stress the customers of public and recently bailed-out banks were to become comparatively riskier, so that these banks would want to cut on lending to them. To verify whether this is the case, we estimate an auxiliary regression whose dependent variable is the ratio of impaired loans to gross loans, based on SNL data for 35 banks in stressed countries and 43 banks in non-stressed ones. The explanatory variables include the $Bailout_{ijt-1}$ and $Public_{ijt-1}$ variables, and their interactions with $\Delta P_{jt-1}/P_{jt-2}$. The estimates (shown in Table A2 in the Appendix) indicate that the coefficients of the two instruments ($Public_{ijt-1} \times \Delta P_{jt-1}/P_{jt-2}$ and $Bailout_{ijt-1} \times \Delta P_{jt-1}/P_{jt-2}$) are not significantly different from zero: at times of sovereign stress, the fraction of impaired loans does not tend to increase more for public and recently bailed-out banks, which lends credibility to the exclusion restriction made in Table 9.

In short, neither spurious correlation nor reverse causality is a serious problem for the estimates shown in previous tables. Admittedly, this still does not preclude potential reverse causality from banks' loans to sovereign debt repricing: if sovereign stress triggers a contraction in lending, the resulting slowdown in economic activity could trigger a drop in tax revenue, which may in turn reinforce sovereign stress – what Brunnermeier et al. (2016) label the "real diabolic loop". But this loop requires a considerable amount of time to operate: the slowdown in lending growth is unlikely feed back onto sovereign debt repricing in the *previous* quarter. And, even if such feedback did exacerbate sovereign stress, it would also aggravate the cutback in lending by the more exposed banks.

4.1.2 Unexpected sovereign repricing

The foregoing estimates show that in the stressed countries bank loans dropped in response to the depreciation of sovereign debt and rose in response to its appreciation, in proportion to the relevant bank's exposure. Insofar as the price changes are anticipated, however, banks will switch in advance from corporate loans to sovereign debt assets; that is, they can be expected to buy sovereign debt when its price is unusually low – an effect that is indeed documented in Section 3. In this case the estimate of β_2 would conflate the impact of the appreciation of given sovereign exposures and that of the concomitant response of exposures to the expected appreciation. In order to study the first of these two effects by itself, the previous specification is re-estimated

replacing sovereign debt repricing with its unexpected component.

As noted in Section 5, we have data on survey-based consensus forecasts of 10-year yields (Y^E_{jt}) for Germany, France, the Netherlands, Italy and Spain, so for these five countries we can compute time series of "yield surprises", $(Y_{jt} - Y^E_{jt})/Y_{jt-1}$. Since these surprises cannot be transformed into unexpected price changes owing to the non-linearity of the price-yield relationship, in Table 10 we estimate a variant of specification (3) in which the change in the price of sovereign debt $\Delta P_{jt-1}/P_{jt-2}$ is replaced by yield surprises. The interaction between domestic yield surprises $(Y_{jt} - Y^E_{jt})/Y_{jt-1}$ and a bank's domestic exposure Exp_{ijt} measures the bank's capital loss from the unexpected repricing of its domestic sovereign holdings. Notice that as the repricing is unanticipated, the bank cannot have modified its sovereign holdings to take advantage of it. To take into account that banks may adjust their lending policy to such an unexpected capital loss with a delay, in the regression this interaction variable is lagged by one quarter with respect to the bank's loan growth, as with the analogous interaction variables in previous specifications.

[Insert Table 10]

The estimates in the first three columns of Table 10 refer to stressed countries. In columns 1 and 2, domestic and foreign banks are pooled: the two specifications differ by the absence or presence of bank-level controls, which are the (lagged) capital-asset ratio, the lagged deposit-liability ratio, and their interactions with sovereign yield surprises. In column 3, as in the previous tables, the estimates are allowed to differ between domestic and foreign banks. Columns 4-6 show the estimates of the same specifications for banks operating in non-stressed countries. On the whole, the results confirm those of the previous tables, based on the realized repricing of domestic sovereign debt: the estimated coefficient of the interaction term is negative (as expected) and significant for the stressed but not for the non-stressed countries. Further, it is considerably larger and more precisely estimated for domestic banks than for foreign ones operating in stressed countries. The main difference with respect to the previous results is that in any case the coefficient estimate is non-negligible and significantly different from zero at the 10 percent level also for foreign banks operating in stressed countries: despite their limited exposure to their host countries' sovereign risk, these banks too appear to have reacted to unexpected losses and gains on their holdings of local sovereign debt.

4.2 Lending Rate Regressions

This subsection considers another dimension of banks' lending policies, namely the interest rates charged on new loans to non-financial corporations: as with lending, the question is not whether sovereign stress (and its subsequent abatement) affected the interest rates but whether the response was amplified by sovereign exposures. The hypothesis is that the banks hit by greater losses during the sovereign crisis were faced with higher funding costs (due to reduced creditworthiness) and tried to pass them onto borrowers via higher lending rates, and conversely when sovereign stress abated after 2012. To this purpose, we estimate the following specification:

$$\Delta R_{ijt} = \alpha_{jt} + \gamma_i + \left(\beta_1 + \beta_2 \frac{\Delta P_{jt}}{P_{jt-1}}\right) \times Exp_{ijt-1} + \boldsymbol{\theta}'\mathbf{X}_{ijt-1} + u_{ijt}, \qquad (5)$$

where ΔR_{ijt} is the change in the average rate charged by bank i in country j on new loans granted to non-financial corporations in quarter t, the rate R_{ijt} being the average of loan rates for different maturities and loan sizes, weighted by their respective new business volumes. The coefficient β_2 measures the amplification effect associated with sovereign exposures; it is expected to be negative, as a decline in government bond prices ($\Delta P_{jt}/P_{jt-1} < 0$) induces the banks with larger exposures Exp_{ijt-1} to increase their loan rates ($\Delta R_{ijt} > 0$) more than other banks, to offset their higher funding costs.

Tables 11 and 12 report the estimates of specification (5), respectively for stressed and non-stressed countries. In each table, the repricing refers to the 10-year benchmark bond yield in the first two columns, and the 5-year yield in the last two. Columns 1 and 4 show the OLS estimates without bank-level controls, columns 2 and 5 those with bank-level controls. As expected, the OLS estimates of coefficient β_2 are negative and significant for stressed countries but not for non-stressed ones.

[Insert Tables 11 and 12]

However, these estimates too may be affected by reverse causality: insofar as sovereign stress lowered average loan quality, it may have led banks to charge higher rates while reducing their loan exposure and at the same time increasing sovereign debt holdings. As for bank lending, we address this concern by IV estimation: columns 3 and 6 of Tables 11 and 12 show the IV estimates obtained using $Bailout_{it} \times \Delta P_{jt}/P_{jt-1}$

as instrument for $Exp_{ijt-1} \times \Delta P_{jt}/P_{jt-1}$. However, unlike the results on loans in Table 12, the IV estimate of the amplification coefficient β_2 is much lower than the OLS estimate and not significantly different from zero, even though the coefficient of the instrument is strongly significant in the first-stage regression. Hence, in contrast to our findings for lending in Table 9, we cannot be sure of the direction of causality between banks' loan rates and sovereign exposures in the presence of sovereign stress.

5 Sovereign Stress and Bank Default Risk

In this section we investigate whether, beside affecting banks' lending policies, the domestic sovereign exposures of euro-area banks amplified the transmission of risk from governments to banks. As already noted, the thesis is that as sovereign stress inflicted greater losses on the banks that held more domestic sovereign debt, it undermined their creditworthiness more severely. In principle, sovereign stress may be transmitted to banks even if they hold no domestic sovereign debt, since it saps the credibility of public bailout guarantees; it may also impact directly on the solvency of domestic firms, and hence on their creditor banks. So, just as for lending policies, sovereign stress may also be transmitted to banks directly, apart from their sovereign exposures. But this baseline effect will be amplified for heavily exposed banks, and we investigate precisely the strength of this amplification effect.

Figures 10 and 11 offer graphical evidence, showing how the nexus between government and bank default risk differs between high-exposure and low-exposure banks. Figure 10 plots monthly observations of the average 5-year CDS premium of banks against the corresponding sovereign premium in stressed countries, distinguishing between low-exposure and high-exposure banks, defined respectively as those whose domestic sovereign exposure in 2009 was in the bottom or the top quartile of the distribution. Figure 11 does the same for non-stressed countries.

[Insert Figures 10 and 11]

In both figures bank default risk appears to be positively correlated with sovereign risk for both groups of banks. But in the stressed countries, the correlation is much stronger for high-exposure than for low-exposure banks, whereas in non-stressed countries the intensity of the sovereign-bank nexus does not vary with exposure. Even though sovereign risk may influence bank default risk via many channels

(for instance because government is the ultimate backstop for banks or by reason of rating agencies' policies), this is *prima facie* evidence that at least part of the effect comes by way of banks' government bond holdings.

5.1 Bank Risk Regressions

In testing the "exposure channel" by panel regressions, we allow the response of foreign banks' solvency risk to their host country's sovereign risk to differ from that of domestic banks. This is because foreign banks may face different prudential regulations and supervision, or enjoy different implicit bailout guarantees from their governments. Moreover, as subsidiaries their exposure to the sovereign risk of the host country is determined mainly by the portfolio of their foreign group head bank: the subsidiary's exposure to host-country sovereign risk is likely to be underestimated, as is suggested by the minuscule exposures of foreign subsidiaries (Figure 1).

To capture the exposure channel, we regress quarterly changes of the five-year CDS premium of bank i in country j and quarter t (ΔCDS^{B}_{ijt}) on quarterly changes of the domestic sovereign CDS (ΔCDS^{S}_{jt}) interacted with the domestic sovereign exposure of bank i (Exp_{ijt}), defined as the average ratio of sovereign debt holdings to assets in quarter t, allowing this interaction to differ between domestic and foreign banks (respectively identified by the D_{ij} and F_{ij} dummy variables):

$$\Delta CDS^{B}_{ijt} = \alpha_{jt}+\gamma_i+\left[(\beta_1 + \beta_2 \Delta CDS^{S}_{jt})D_{ij} + (\beta_3 + \beta_4 \Delta CDS^{S}_{jt})F_{ij}\right] Exp_{ijt}+\boldsymbol{\theta}'\mathbf{X}_{ijt}+\epsilon_{ijt}. \tag{6}$$

The coefficient β_2 of the interaction variable $\Delta CDS^{S}_{jt} \times Exp_{ijt} \times D_{ij}$ measures the amplification associated with the exposure of domestic banks to the home-country sovereign, β_4 that associated with foreign banks' exposure to that same host-country sovereign. The country-time fixed effects α_{jt} capture all country-specific macroeconomic factors affecting bank credit risk, including the default risk of the domestic sovereign (such as ΔCDS^{S}_{jt}): hence, they control for the "direct channel" component of the sovereign-bank nexus. Moreover, the bank fixed effects γ_i control for time-invariant bank characteristics. Finally, the bank-level variables $\mathbf{X}_{ijt}$, namely leverage ratio and deposit-liability ratio, control for time-varying bank default risk.

The estimates of specification (6) are shown in Table 13, separately for 44 banks in 5 stressed countries (columns 1 and 2) and 61 banks in 6 non-stressed countries

(columns 3 and 4), first omitting and then including the bank-level controls $\mathbf{X}_{ijt}$. In all regressions, errors are clustered at bank level. The sample is dictated by the availability of CDS data; moreover, it does not include observations of stale CDS prices and those for Greek and Cypriot banks, on account of the extreme volatility and low liquidity of their markets.

[Insert Table 13]

The estimate of β_2 indicates that in the stressed countries the amplification associated with the sovereign exposures of domestic banks is positive and statistically significant, but it is not for foreign ones, as β_4 is not significantly different from zero. Conversely, in the non-stressed countries there is no amplification for either domestic or foreign banks. Since the median bank in stressed countries has a 4.5% domestic sovereign exposure, the 6.98 estimate of β_2 in columns 1 and 2 implies that a 100-basis-point increase in the sovereign CDS premium translates into an increase of 31.4 basis points in the CDS premium of the median domestic bank ($6.98 \times 0.045 = 0.314$). This increase in the CDS premium for banks comes on top of the baseline change associated with the change in the sovereign CDS premium, which is controlled for by the country-time effect included in the regression.

5.2 Endogeneity

In principle, the estimate of coefficient β_2 may be biased by spurious correlation, error-in-variables or reverse causality. Spurious corelation may arise if the more exposed banks have loan portfolios that are more sensitive to sovereign stress, e.g. lend disproportionately to state-owned firms. If so, sovereign stress would hit these banks harder not because of larger sovereign exposures, but because of a sharper rise in non-performing loans (NPL). One way to address this concern is to lag banks' sovereign exposures in equation (6). If exposures are lagged by one to four quarters, the results shown in Table 13 are unaffected. A more direct method is to verify whether at times of sovereign stress the fraction of NPLs increases more for banks with larger sovereign exposures. Hence, we estimate a regression whose dependent variable is the ratio of impaired loans to gross loans, based on the same data used in Table A2. The specification is otherwise the same as in (6). The estimates (shown in Table A3 in the Appendix) indicate that the coefficient of the variable $\Delta CDS^S_{jt} \times Exp_{ijt} \times D_{ij}$

is not significantly different from zero, in both stressed and non-stressed countries: at times of sovereign stress, the fraction of impaired loans does not increase more in banks with larger domestic sovereign exposures. Hence the estimates of β_2 in Table 6 reflect the increased riskiness of banks' sovereign holdings, not that of their loan portfolios.

Another possible problem with the estimates in Table 13 is that the CDS market may misprice sovereign risk, especially in turbulent times like that of the euro-area crisis, introducing an error-in-variables problem. Therefore, we re-estimate specification (1) replacing the change in the sovereign CDS premium ΔCDS^S_{jt} with an alternative measure of sovereign stress, namely the surprise component of the change in the yield of domestic 10-year sovereign debt, computed as the percentage difference between the realized yield and the consensus prediction of professional forecasters three months earlier, $(Y_{jt} - Y^E_{jt})/Y_{jt-1}$. This new specification is estimated using only data for France, Germany, the Netherlands, Italy and Spain, the only countries for which such forecasts are available. Due to the limited number of observations, this specification is estimated by pooling the observations for foreign and domestic banks. The resulting estimates are presented in Table 14.

[Insert Table 14]

The coefficient of the new interacted variable is again positive and statistically significant for the stressed countries, i.e., for banks in Italy and Spain (columns 1 and 2), but not for banks in France, Germany and the Netherlands (columns 3 and 4). Since the median domestic Italian or Spanish bank in this sample had a 5.5% exposure to domestic sovereign debt, the coefficient of 9.62 obtained in column 2 implies that an unexpected 100-basis-point rise in the sovereign yield in Italy or Spain translated into a 53-basis-point increase in the CDS premium of the median bank of those countries ($9.62 \times 0.055 = 0.529$). This estimate is comparable to that given in Table 13, if a bit higher. That is, whether sovereign stress is measured by changes in CDS premia or unanticipated yield changes, the estimate of the amplification of the bank-sovereign nexus attributable to domestic sovereign exposures is similar.

Finally, there may be reverse causality from bank CDS (ΔCDS^B_{ijt}) to sovereign CDS premia (ΔCDS^S_{jt}). This possibility is actually inherent in the feedback loop: bank distress may feed back to sovereign risk, due to the increased risk of bailouts. Indeed in the model of the "diabolic loop" by Brunnermeier et al. (2016), domestic

sovereign exposures reinforce not only the transmission of stress from the sovereign to domestic banks but also the feedback from banks to the sovereign. Hence, what is economically relevant is the extent to which banks' sovereign exposures strengthen the correlation between government and bank solvency, irrespective of the direction of stress transmission – which is what the coefficient β_2 measures in specification (6).

6 Conclusions

Exploiting the substantial cross-sectional and time-series variation in individual banks' domestic sovereign exposures, this paper jointly addresses two questions that various recent studies of the euro-area crisis have attacked separately. First, did banks with different characteristics change their public debt holdings differently in response to sovereign stress and to its abatement after 2012? Second, were larger sovereign exposures associated with more forceful transmission of sovereign stress to banks' lending policies and risk, and was such an amplification causally related to banks' sovereign exposures?

Our findings answer both questions affirmatively. First, in stressed euro-area countries, publicly owned and less strongly capitalized banks reacted to sovereign stress by increasing their holdings of domestic public debt more than other banks, which suggests that portfolio choices were influenced both by government moral suasion and by the search for yield. Domestic public debt purchases by public banks in stressed countries were also facilitated by the ECB's 3-year refinancing operations of 2011-12. Second, banks' domestic sovereign exposures in the stressed countries were indeed associated with a statistically significant and economically relevant amplification of sovereign risk transmission, and the resulting amplification of bank lending cannot be attributed to spurious correlation or reverse causality.

The importance of these findings for banking regulation can hardly be overstated, considering that euro-area prudential regulation currently gives strong preferential treatment to sovereign debt over bank loans, treating it as risk-free for purposes of capital charges and imposing no concentration limit on holdings. To make matters worse, in the stressed euro-area countries, banks' domestic sovereign exposures are considerably larger now than in 2010-12, so that a future resurgence of sovereign stress would trigger proportionately larger effects on bank lending.

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Table 1: Distribution of the Banks by Country and Ownership

For each country, the table reports the total number of individual banks and their breakdown according to the country in which they operate and domestic or foreign ownership.

	Total	Domestic banks		Foreign banks
		Head banks	Subsidiaries	
Austria	9	6	2	1
Belgium	10	3	0	7
Cyprus	5	4	0	1
Estonia	4	1	0	3
Finland	5	3	0	2
France	32	8	20	4
Germany	60	39	13	8
Greece	6	4	2	0
Ireland	11	3	1	7
Italy	24	15	4	5
Luxembourg	10	3	0	7
Malta	4	3	0	1
Netherlands	10	7	0	3
Portugal	6	4	0	2
Slovakia	3	0	0	3
Slovenia	4	2	0	2
Spain	23	14	6	3
Total	226	119	48	59

Table 2: Sample Representativeness

For each country, the table shows the aggregate values of main assets, loans to non-financial corporations (NFCs) and holdings of government debt in our dataset in January 2015 as percentages of the same variables in the aggregate data reported in the BSI statistics of the ECB.

Ratio of IBSI Aggregates to BSI Totals (%)

	Main Assets	Loans to Non-Financial Corporations	Bank Holdings of Sovereign Debt
Austria	40	38	50
Belgium	72	81	84
Cyprus	73	87	86
Estonia	87	90	74
Finland	85	82	86
France	74	68	87
Germany	64	48	74
Greece	92	91	85
Ireland	38	74	66
Italy	63	59	48
Luxembourg	34	69	36
Malta	30	81	77
Netherlands	87	89	91
Portugal	69	70	66
Slovakia	55	57	63
Slovenia	54	50	69
Spain	84	86	86
Average	64	72	71
Weighted Average	69	64	73

Table 3: Descriptive Statistics

The table presents the mean, median and standard deviation of banks' monthly sovereign exposures, loans to firms, CDS premia and interest rates (Panel A), and characteristics (Panel B). The stressed countries are Cyprus, Greece, Ireland, Italy, Portugal, Slovenia and Spain; the non-stressed countries are Austria, Belgium, Estonia, Finland, France, Germany, Luxembourg, Malta, the Netherlands, and Slovakia. Domestic Sovereign Exposures are domestic sovereign debt as a fraction of the corresponding bank's main assets. Bank Lending is the bank loans to non-financial corporations as a fraction of the corresponding banks' main assets. Bank Lending Growth and Sovereign Holdings Growth are the quarterly growth rates (in percent) of bank loans to non-financial companies and of their sovereign holdings. Interest Rate is the interest rate charged on loans to non-financial corporations. Leverage Ratio is the ratio of banks' total assets to their equity capital. T1/RWA is the ratio of Tier-1 common equity to risk-weighted assets. Public is the fraction of banks' shares owned by local or national government or publicly controlled institutions (*Fondazioni* in Italy, *Fundaciones* and *Cajas* in Spain, and *Sparkasse* and *Landesbank* in Germany). Bailout equals 1 starting in the quarter in which a bank was bailed out (unless acquired in the two subsequent quarters), and 0 before that date.

Panel A. Domestic Exposures, Bank Lending and Interest Rates (%)

	Stressed Countries			Non-Stressed Countries		
	Mean	Median	St. Dev.	Mean	Median	St. Dev.
Dom. Sov. Exposures (%)	4.9	4.0	4.9	3.8	1.7	6.6
Non-Dom. Sov. Exposures (%)	1.0	0.0	3.5	2.2	0.6	3.8
Bank Lending to Firms (%)	25.3	25.3	14.0	15.7	13.1	12.6
Bank CDS (%)	3.7	2.1	4.3	1.4	1.2	1.0
Interest Rate (%)	4.3	4.1	1.6	3.2	2.8	1.4
Bank Lending Growth (%)	-0.4	-0.3	12.5	0.2	0.3	10.8
Sov. Holdings Growth (%)	1.9	0.0	23.1	1.0	0.0	20.1

Panel B. Bank Characteristics

	Stressed Countries			Non-Stressed Countries		
	Mean	Median	St. Dev.	Mean	Median	St. Dev.
Assets (billion euro)	72.1	41.0	93.2	89.0	35.5	137.5
Leverage Ratio	22.1	10.3	116.0	29.0	17.4	172.8
T1/RWA (%)	9.4	9.3	2.7	10.1	9.9	3.4
Deposit/Liabilities (%)	66.7	68.9	16.9	64.3	67.7	24.8
Public	24.3	0.0	38.4	22.9	0.0	40.7
Bailout	0.1	0.0	0.3	0.1	0.0	0.2

Table 4: Determinants of Sovereign Holdings: Moral Suasion

The dependent variable is the growth rate of banks' domestic sovereign holdings in quarter t (defined as the percentage difference between the end-of-period values in quarter t and quarter $t-1$). The stressed countries are Greece, Ireland, Italy, Portugal, Slovenia and Spain. The non-stressed countries are Austria, Belgium, Finland, France, Germany, Malta and the Netherlands. $\Delta P_{jt}/P_{jt-1}$ is sovereign debt repricing, defined as the percentage change of debt prices in country j and quarter t, based on 10-year benchmark yields. $Public_{ijt}$ Public is the fraction of banks' shares owned by local or national government or publicly controlled institutions (*Fondazioni* in Italy, *Fundaciones* and *Cajas* in Spain, and *Sparkasse* and *Landesbank* in Germany). $VLTRO$ equals 1 in December 2011 and March 2012, and 0 otherwise. $Bailout_{ijt}$ equals 1 starting in the quarter t in which bank i in country j was bailed out (unless acquired in the two subsequent quarters), and 0 before quarter t. F_{ij} equals 1 if bank i in country j is a foreign subsidiary and 0 otherwise. All the regressions include the bank-level (lagged) deposit-liability ratio as a further control. The sample ranges from 2008:Q1 to 2014:Q4. Standard errors are clustered at the bank level and shown in parentheses: $^{***}p < 0.01,^{**}p < 0.05,^{*}p < 0.01$.

	Stressed Countries			Non-Stressed Countries		
	(1)	(2)	(3)	(4)	(5)	(6)
$Public_{it} \times \frac{\Delta P_{jt}}{P_{jt-1}}$	-0.37**	-0.29**	-0.35**	-0.04	-0.05	-0.05
	(0.14)	(0.14)	(0.15)	(0.04)	(0.05)	(0.05)
$Public_{it} \times VLTRO$	21.03***	16.52***	17.54***	4.10	2.27	1.61
	(6.04)	(5.92)	(5.72)	(3.68)	(3.95)	(4.18)
$Public_{it}$	4.41	3.99	4.12	5.77	5.93	10.84
	(5.25)	(5.13)	(6.37)	(4.21)	(4.14)	(6.86)
$Bailout_{it} \times VLTRO$			-5.41			-10.75
			(5.11)			(8.30)
$Bailout_{it}$			6.44**			-8.02
			(2.65)			(6.03)
$F_{ij} \times \frac{\Delta P_{jt}}{P_{jt-1}}$		0.19*			-0.06	
		(0.11)			(0.05)	
$F_{ij} \times VLTRO$		-11.98***			-6.83*	
		(4.29)			(3.83)	

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Table 4 (continued): Determinants of Sovereign Holdings: Moral Suasion

	Stressed Countries			Non-Stressed Countries		
	(1)	(2)	(3)	(4)	(5)	(6)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time × Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Only Domestic	No	No	Yes	No	No	Yes
Adjusted R^2	0.11	0.11	0.14	0.05	0.06	0.07
Banks	74	74	55	143	143	104
Observations	1892	1892	1401	3706	3706	2719

Table 5: Determinants of Sovereign Holdings in Stressed Countries: Moral Suasion and Carry Trade

The dependent variable is the growth rate of banks' domestic sovereign holdings in quarter t (defined as the percentage difference between the end-of-period values in quarter t and quarter $t-1$). The stressed countries are Cyprus, Greece, Ireland, Italy, Portugal, Slovenia and Spain. $\Delta P_{jt}/P_{jt-1}$ is sovereign debt repricing, defined as the percentage change of government bond prices in country j and quarter t, based on 10-year benchmark yields. $T1/RWA_{ijt-1}$ is the ratio of Tier-1 common equity to risk-weighted assets of bank i in country j and quarter $t-1$. $Public_{ijt}$ is the fraction of banks' shares owned by local or national government or publicly controlled institutions (*Fondazioni* in Italy, *Fundaciones* and *Cajas* in Spain, and *Sparkasse* and *Landesbank* in Germany). $VLTRO$ equals 1 in December 2011 and March 2012, and 0 otherwise. $Bailout_{ijt}$ equals 1 starting in the quarter t in which bank i in country j was bailed out (unless acquired in the two subsequent quarters), and 0 before quarter t. F_{ij} equals 1 if bank i in country j is a foreign subsidiary and 0 otherwise. All the regressions include the bank-level (lagged) deposit-liability ratio as a further control. The sample ranges from 2008:Q1 to 2014:Q4. Standard errors are clustered at the bank level and are shown in parentheses: $^{***}p < 0.01$,$^{**}p < 0.05$,$^{*}p < 0.01$.

	Stressed Countries		
	(1)	(2)	(3)
$T1/RWA_{ijt-1} \times \frac{\Delta P_{jt}}{P_{jt-1}}$	7.60***	10.22***	11.36***
	(2.57)	(2.70)	(3.24)
$T1/RWA_{ijt-1} \times VLTRO$	-104.86	-65.37	-153.74
	(176.82)	(174.85)	(142.24)
$T1/RWA_{ijt-1}$	-94.67	-175.02*	-190.03*
	(94.00)	(100.64)	(100.28)
$Public_{it} \times \frac{\Delta P_{jt}}{P_{jt-1}}$			0.11
			(0.24)
$Public_{it} \times VLTRO$			28.24**
			(11.80)
$Public_{it}$			3.88
			(5.71)

Continued on next page

Table 5 (continued): Determinants of Sovereign Holdings in Stressed Countries: Moral Suasion and Carry Trade

	(1)	(2)	(3)
$Bailout_{it} \times VLTRO$			4.66
			(5.74)
$Bailout_{it}$			4.76**
			(2.31)
Bank FE	Yes	Yes	Yes
Time × Country FE	Yes	Yes	Yes
Only Domestic	No	Yes	Yes
Adjusted R^2	0.14	0.16	0.16
Banks	41	31	31
Observations	686	523	523

Table 6: Lending and Sovereign Exposures in Stressed Countries

The dependent variable is the growth rate of loans by bank i to non-financial companies in quarter t in stressed country j (Greece, Ireland, Italy, Portugal and Spain). $\Delta P_{jt-1}/P_{jt-2}$ is sovereign debt repricing, defined as the percentage change of government bond prices in country j and quarter $t-1$, based on 10-year yields in columns 1-3 of Panel A and columns 1-2 of Panel B, and on 5-year yields in columns 4-6 of Panel A and columns 3-4 of Panel B. Exp_{ijt-1} is the domestic sovereign exposure of bank i in country j and quarter $t-1$. $Exp.Head_{iht-1}$ is the indirect exposure of the head bank of subsidiary i operating in country j to the sovereign risk of its home country $h \neq j$, and is set to zero if bank i is a domestic bank of country j, i.e. if $h = j$. D_{ij} equals 1 if bank i in country j is domestic and 0 otherwise, and $F_{ij} = 1 - D_{ij}$. The controls are the bank-level (lagged) capital-asset ratio and the lagged deposit-liability ratio, and their interactions with sovereign debt repricing. The sample ranges from 2008:Q1 to 2014:Q4. Standard errors are clustered at the bank level and are shown in parentheses: $^{***}p < 0.01$,$^{**}p < 0.05$,$^{*}p < 0.01$.

Panel A: Domestic and foreign banks

	10-Year Debt Repricing			5-Year Debt Repricing		
	(1)	(2)	(3)	(4)	(5)	(6)
$\frac{\Delta P_{jt-1}}{P_{jt-2}} \times Exp_{ijt-1}$	1.38***	1.39***		0.97**	0.97**	
	(0.52)	(0.52)		(0.43)	(0.44)	
$D_{ij} \times \frac{\Delta P_{jt}}{P_{jt-1}} \times Exp_{ijt-1}$			1.45***			1.03**
			(0.52)			(0.46)
$F_{ij} \times \frac{\Delta P_{jt}}{P_{jt-1}} \times Exp_{ijt-1}$			−0.50			−0.20
			(0.80)			(0.54)
Exp_{ijt-1}	10.49	12.08		4.28	6.11	
	(13.68)	(13.87)		(14.64)	(14.49)	
$D_{ij} \times Exp_{ijt-1}$			19.36			12.61
			(14.96)			(17.14)
$F_{ij} \times Exp_{ijt-1}$			−41.52			−41.39
			(28.09)			(26.58)
Controls	No	Yes	Yes	No	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time × Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.08	0.08	0.08	0.08	0.09	0.09
Banks	74	74	74	68	68	68
Observations	1921	1897	1897	1756	1732	1732

Table 6 (continued): Lending and Sovereign Exposures in Stressed Countries

Panel B: Domestic banks, using only head banks or imputing their exposures to subsidiaries

	10-Year Debt Repricing		5-Year Debt Repricing	
	(1)	(2)	(3)	(4)
$\frac{\Delta P_{jt-1}}{P_{jt-2}} \times Exp_{ijt-1}$	2.45**		1.96**	
	(0.98)		(0.91)	
Exp_{ijt-1}	16.35		5.07	
	(16.84)		(16.99)	
$\frac{\Delta P_{jt}}{P_{jt-1}} \times Exp.Head_{ijt-1}$		2.05**		1.96**
		(0.79)		(0.78)
$Exp.Head_{ijt-1}$		25.12		12.81
		(17.51)		(16.91)
Controls	Yes	Yes	Yes	Yes
Subsidiary	No	Yes	No	Yes
Bank FE	Yes	Yes	Yes	Yes
Time × Country FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.09	0.11	0.10	0.13
Banks	42	53	38	47
Observations	1115	1345	1004	1187

Table 7: Lending and Sovereign Exposures in Non-Stressed Countries
The dependent variable is the growth rate of loans by bank i to non-financial companies in quarter t in non-stressed country j (Austria, Belgium, Estonia, Finland, France, Germany, Luxembourg, Malta, the Netherlands and Slovakia). $\Delta P_{jt-1}/P_{jt-2}$ is sovereign debt repricing, defined as the percentage change of government bond prices in country j and quarter $t-1$, based on 10-year yields in columns 1-3 of Panel A and columns 1-2 of Panel B, and on 5-year yields in columns 4-6 of Panel A and columns 3-4 of Panel B. Exp_{ijt-1} is the domestic sovereign exposure of bank i in country j and quarter $t-1$. $Exp.Head_{iht-1}$ is the indirect exposure of the head bank of subsidiary i operating in country j to the sovereign risk of its home country $h \neq j$, and is set to zero if bank i is a domestic bank of country j, i.e. if $h = j$. D_{ij} equals 1 if bank i in country j is domestic and 0 otherwise, and $F_{ij} = 1 - D_{ij}$. The controls are the bank-level (lagged) capital-asset ratio and the lagged deposit-liability ratio, and their interactions with sovereign debt repricing. The sample ranges from 2008:Q1 to 2014:Q4. Standard errors are clustered at the bank level and are shown in parentheses: $^{***}p < 0.01$,$^{**}p < 0.05$,$^{*}p < 0.01$.

Panel A: Domestic and foreign banks

	10-Year Debt Repricing			5-Year Debt Repricing		
	(1)	(2)	(3)	(4)	(5)	(6)
$\frac{\Delta P_{jt-1}}{P_{jt-2}} \times Exp_{ijt-1}$	0.32	0.34		0.30^{*}	0.29^{*}	
	(0.37)	(0.34)		(0.18)	(0.17)	
$D_{ij} \times \frac{\Delta P_{jt}}{P_{jt-1}} \times Exp_{ijt-1}$			0.02			0.06
			(0.57)			(0.27)
$F_{ij} \times \frac{\Delta P_{jt}}{P_{jt-1}} \times Exp_{ijt-1}$			0.55^{**}			0.43^{***}
			(0.24)			(0.10)
Exp_{ijt-1}	-9.91	-13.49		-14.08	-17.48	
	(13.43)	(13.33)		(14.27)	(14.14)	
$D_{ij} \times Exp_{ijt-1}$			-10.50			-12.12
			(14.09)			(14.48)
$F_{ij} \times Exp_{ijt-1}$			-17.94			-24.27
			(29.07)			(29.33)
Controls	No	Yes	Yes	No	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time × Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.06	0.07	0.07	0.07	0.08	0.08
Banks	147	146	146	143	142	142
Observations	3923	3888	3888	3859	3826	3826

Table 7 (continued): Lending and Sovereign Exposures in Non-Stressed Countries

Panel B: Domestic banks, using only head banks or imputing their exposures to subsidiaries

	10-Year Debt Repricing		5-Year Debt Repricing	
	(1)	(2)	(3)	(4)
$\frac{\Delta P_{jt-1}}{P_{jt-2}} \times Exp_{ijt-1}$	0.96		0.46	
	(0.87)		(0.40)	
Exp_{ijt-1}	−23.81		−26.70	
	(16.52)		(17.84)	
$\frac{\Delta P_{jt}}{P_{jt-1}} \times Exp.Head_{ijt-1}$		0.75		0.38
		(0.80)		(0.38)
$Exp.Head_{ijt-1}$		−21.66		−24.23
		(14.98)		(16.27)
Controls	Yes	Yes	Yes	Yes
Subsidiary	Yes	No	Yes	No
Bank FE	Yes	Yes	Yes	Yes
Time × Country FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.14	0.10	0.15	0.10
Banks	73	104	72	103
Observations	1992	2771	1976	2755

Table 8: Lending by stressed-Country Subsidiaries Operating in Non-Stressed Countries

The dependent variable is the growth rate of loans to non-financial companies issued by bank i based in country h (the "home" country) operating in non-stressed country j. Bank i may be either a domestic country-j bank (in which case $j = h$) or the subsidiary of a bank based in stressed country h (in which case $j \neq h$). The stressed countries are Italy and Spain; the non-stressed countries are Austria, Belgium, Germany, Luxembourg, and Slovakia. $\Delta P_{ht-1}/P_{ht-1}$ measures the repricing of sovereign debt of the home country $h \neq j$ in quarter $t-1$, based on 10-year yields in columns 1-2, and on 5-year yields in columns 3-4. $Exp.Head_{iht}$ is the indirect exposure of the head bank of subsidiary i operating in country j to the sovereign risk of its home country $h \neq j$, and is set to zero if bank i is a domestic bank of country j, i.e. if $h = j$. The bank-level controls are Exp_{ijt-1} and $\Delta P_{jt-1}/P_{jt-2} \times Exp_{ijt-1}$ where Exp_{ijt-1} is the exposure of bank i (whether domestic or a subsidiary of a foreign bank) operating in country j to the sovereign debt of host country j in quarter $t-1$. The sample ranges from 2008:Q1 to 2014:Q4. Standard errors are clustered at the bank level and are shown in parentheses: $^{***}p < 0.01$,$^{**}p < 0.05$,$^{*}p < 0.01$.

	10-Year Debt Repricing		5-Year Debt Repricing	
	(1)	(2)	(3)	(4)
$\frac{\Delta P_{ht-1}}{P_{ht-2}} \times Exp.Head_{iht-1}$	3.26**	3.34**	1.71**	1.76**
	(1.32)	(1.36)	(0.70)	(0.72)
$Exp.Head_{iht-1}$	−72.28	−74.25	−70.84	−72.88
	(49.72)	(50.55)	(47.42)	(48.19)
Controls	No	Yes	No	Yes
Bank FE	Yes	Yes	Yes	Yes
Time × Country FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.07	0.07	0.07	0.07
Banks	82	82	82	82
Observations	2278	2278	2278	2278

Table 9: Lending and Sovereign Exposures of Domestic Banks in stressed Countries: IV Estimates

The dependent variable is the growth rate of loans by banks to non-financial companies in quarter t in stressed countries (Greece, Ireland, Italy, Portugal and Spain). $\Delta P^{10}_{jt-1}/P^{10}_{jt-2}$ and $\Delta P^{5}_{jt-1}/P^{5}_{jt-2}$ measure the percentage change of government bond prices in country j and quarter $t-1$, respectively for 10-year and 5-year debt. Exp_{ijt-1} is the domestic sovereign exposure of domestic bank i in country j and quarter $t-1$, defined as the ratio of sovereign debt holdings to main assets. The controls are the bank-level (lagged) capital-asset ratio and the lagged deposit-liability ratio, and their interactions with sovereign debt repricing. All regressions in this table are estimated by IV, using $Bailout_{ijt-1} \times \Delta P_{jt-1}/P_{jt-2}$ and $Public_{ijt} \times \Delta P_{jt-1}/P_{jt-2}$ as instruments for $Exp_{ijt-1} \times \Delta P_{jt-1}/P_{jt-2}$. $Bailout_{ijt}$ equals 1 starting in the quarter t in which bank i in country j was bailed out (unless acquired in the two subsequent quarters), and 0 before quarter t. $Public_{ijt}$ is the fraction of banks' shares owned by local or national government or publicly controlled institutions (*Fondazioni* in Italy, *Fundaciones* and *Cajas* in Spain, and *Sparkasse* and *Landesbank* in Germany). The sample ranges from 2008:Q1 to 2014:Q4. Standard errors are clustered at the bank level and are shown in parentheses: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.01$.

	Stressed Countries		Non-Stressed Countries	
	(1)	(2)	(3)	(4)
$Exp_{ijt-1} \times \frac{\Delta P^{10}_{jt-1}}{P^{10}_{jt-1}}$	3.65^{**}		-1.43	
	(1.42)		(2.95)	
$Exp_{ijt-1} \times \frac{\Delta P^{5}_{jt-1}}{P^{5}_{jt-1}}$		3.46^{*}		0.04
		(1.90)		(1.05)
Exp_{ijt-1}	4.25	-30.21	-0.90	-11.85
	(20.34)	(39.64)	(20.54)	(18.48)
Banks	54	48	104	104
First Stage F-Test	17	34	2	3
Observations	1396	1238	2822	2819

Table 10. Lending, Sovereign Exposures and Yield Surprises

The dependent variable is the growth rate of loans by bank i to non-financial companies in country j and quarter t. The stressed countries are Italy and Spain. The non-stressed countries are France, Germany and the Netherlands. $(Y_{jt} - Y^E_{jt})/Y_{jt-1}$ is the unexpected percentage change ("surprise") in the domestic 10-year benchmark sovereign yield in quarter t, computed as the average of the three monthly surprises in quarter t. Exp_{ijt} is the domestic sovereign exposure of bank i in country j and quarter t, defined as the ratio of sovereign debt holdings to main assets. D_{ij} equals 1 if bank i in country j is domestic and 0 otherwise, and $F_{ij} = 1 - D_{ij}$. The controls are the bank-level (lagged) capital-asset ratio and the lagged deposit-liability ratio, and their interactions with sovereign yield surprises. The sample ranges from 2008:Q1 to 2014:Q4. Standard errors are clustered at the bank level and are shown in parentheses: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.01$.

	Stressed Countries			Non-Stressed Countries		
	(1)	(2)	(3)	(4)	(5)	(6)
$\frac{Y_{jt-1} - Y^E_{jt-1}}{Y_{jt-2}} \times Exp_{ijt-1}$	-1.85^{**}	-1.83^{**}		-0.22	-0.11	
	(0.75)	(0.77)		(0.42)	(0.35)	
$D_{ij} \times \frac{Y_{jt-1} - Y^E_{jt-1}}{Y_{jt-2}} \times Exp_{ijt-1}$			-1.89^{**}			0.04
			(0.88)			(0.36)
$F_{ij} \times \frac{Y_{jt-1} - Y^E_{jt-1}}{Y_{jt-2}} \times Exp_{ijt-1}$			-1.07^{*}			-1.58
			(0.62)			(1.37)
Exp_{ijt-1}	-2.09	-0.51		-15.79	-19.99^{*}	
	(14.03)	(13.85)		(12.92)	(11.90)	
$D_{ij} \times Exp_{ijt-1}$			3.42			-21.37^{*}
			(17.60)			(12.38)
$F_{ij} \times Exp_{ijt-1}$			-28.62			17.00
			(26.09)			(29.35)
Controls	No	Yes	Yes	No	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time × Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.10	0.10	0.10	0.09	0.10	0.10
Banks	47	47	47	102	101	101
Observations	1195	1190	1190	2742	2709	2709

Table 11: Lending Rates and Sovereign Exposures in Stressed Countries

The dependent variable is the change in the average interest rate charged on new loans by bank i to non-financial corporations in country j and quarter t. The stressed countries are Ireland, Italy, Portugal, Spain and Slovenia. $\Delta P_{jt}/P_{jt-1}$ is sovereign debt repricing, defined as the percentage change of government bond prices in country j and quarter t, based on 10-year yields in columns 1-3 and on 5-year yields in columns 4-6. Exp_{ijt-1} is the domestic sovereign exposure of bank i in country j and quarter $t-1$, defined as the ratio of sovereign debt holdings to main assets. The controls are the bank-level (lagged) capital-asset ratio and the lagged deposit-liability ratio. The estimation method is OLS in columns 1, 2, 4 and 5 and IV in columns 3 and 6, using $Bailout_{it}\times\Delta P_{jt}/P_{jt-1}$ and $Public_{ijt}\times\Delta P_{jt-1}/P_{jt-2}$ as instruments for $Exp_{ijt-1}\times\Delta P_{jt}/P_{jt-1}$. $Bailout_{ijt}$ equals 1 starting in the quarter t in which bank i in country j was bailed out (unless acquired in the two subsequent quarters), and 0 before quarter t. $Bailout_{ijt}$ equals 1 starting in the quarter t in which bank i in country j was bailed out (unless acquired in the two subsequent quarters), and 0 before quarter t. $Public_{ijt}$ is the fraction of banks' shares owned by local or national government or publicly controlled institutions (*Fondazioni* in Italy, *Fundaciones* and *Cajas* in Spain, and *Sparkasse* and *Landesbank* in Germany). The sample ranges from 2008:Q1 to 2014:Q4. Standard errors are clustered at the bank level and are shown in parentheses: $^{***}p < 0.01$,$^{**}p < 0.05$,$^{*}p < 0.01$.

	10-Year Debt Repricing			5-Year Debt Repricing		
	(1)	(2)	(3)	(4)	(5)	(6)
$\frac{\Delta P_{jt}}{P_{jt-1}}\times Exp_{ijt-1}$	-0.06^{***}	-0.06^{***}	-0.01	-0.03^{***}	-0.03^{***}	-0.01
	(0.02)	(0.02)	(0.06)	(0.01)	(0.01)	(0.03)
Exp_{ijt-1}	0.80^{**}	0.79^{**}	0.24	0.67^{*}	0.66^{*}	0.36
	(0.35)	(0.35)	(0.76)	(0.36)	(0.35)	(0.64)
Controls	No	Yes	No	No	Yes	No
Bank FE	Yes	Yes	No	Yes	Yes	No
Time $\times$ Country FE	Yes	Yes	No	Yes	Yes	No
Adjusted R^2	0.47	0.46	-0.15	0.47	0.46	-0.15
Banks	55	55	55	55	55	55
First-stage F-Test			59			86
Observations	1482	1474	1482	1482	1474	1482

Table 12: Lending Rates and Sovereign Exposures in Non-Stressed Countries

The dependent variable is the change in the average interest rate charged on new loans by bank i to non-financial companies in country j and quarter t. The non-stressed countries are Austria, Belgium, Estonia, Finland, Germany, Luxembourg, Malta, the Netherlands and Slovakia. $\Delta P_{jt}/P_{jt-1}$ is sovereign debt repricing, defined as the percentage change of government bond prices in country j and quarter t, based on 10-year yields in columns 1-3 and on 5-year yields in columns 4-6. Exp_{ijt-1} is the domestic sovereign exposure of bank i in country j and quarter $t-1$, defined as the ratio of sovereign debt holdings to main assets. The controls are the bank-level (lagged) capital-asset ratio and the lagged deposit-liability ratio. The estimation method is OLS in columns 1, 2, 4 and 5 and IV in columns 3 and 6, using $Bailout_{it}\times\Delta P_{jt}/P_{jt-1}$ and $Public_{ijt}\times\Delta P_{jt-1}/P_{jt-2}$ as instruments for $Exp_{ijt-1}\times\Delta P_{jt}/P_{jt-1}$. $Bailout_{ijt}$ equals 1 starting in the quarter t in which bank i in country j was bailed out (unless acquired in the two subsequent quarters), and 0 before quarter t. $Public_{ijt}$ is the fraction of banks' shares owned by local or national government or publicly controlled institutions (*Fondazioni* in Italy, *Fundaciones* and *Cajas* in Spain, and *Sparkasse* and *Landesbank* in Germany). The sample ranges from 2008:Q1 to 2014:Q4. Standard errors are clustered at the bank level and are shown in parentheses: $^{***}p < 0.01$,$^{**}p < 0.05$,$^{*}p < 0.01$.

	10-Year Debt Repricing			5-Year Debt Repricing		
	(1)	(2)	(3)	(4)	(5)	(6)
$\frac{\Delta P_{jt}}{P_{jt-1}}\times Exp_{ijt-1}$	−0.01	−0.01	−0.08	−0.01	−0.01	−0.06
	(0.01)	(0.01)	(0.09)	(0.01)	(0.01)	(0.04)
Exp_{ijt-1}	−0.03	−0.12	0.78	0.08	−0.02	
	(0.38)	(0.38)	(1.08)	(0.36)	(0.36)	
Controls	No	Yes	No	No	Yes	No
Bank FE	Yes	Yes	No	Yes	Yes	No
Time × Country FE	Yes	Yes	No	Yes	Yes	No
Adjusted R^2	0.39	0.39	−0.15	0.39	0.39	−0.14
Banks	105	105	105	101	101	101
First stage F-Test			4			4
Observations	2672	2670	2672	2612	2612	2612

Table 13: Sovereign Risk Transmission to Banks: CDS Premia

The dependent variable is the change in banks' 5-year CDS premia in quarter t (defined as the difference between the end-of-period values in quarter t and quarter $t-1$). The stressed countries are Ireland, Italy, Portugal, Slovenia and Spain. The non-stressed countries are Austria, Belgium, Finland, France, Germany and the Netherlands. ΔCDS^S_{jt} is the change in the 5-year sovereign CDS premium in country j and quarter t. Exp_{ijt} is the average domestic sovereign exposure of bank i in country j and quarter t, defined as the ratio of sovereign debt holdings to main assets. D_{ij} equals 1 if bank i in country j is domestic and 0 otherwise, and $F_{ij}= 1 - D_{ij}$. The controls are the bank-level (lagged) capital-asset ratio and the lagged deposit-liability ratio. The sample ranges from 2008:Q1 to 2014:Q4. Standard errors are clustered at the bank level and are shown in parentheses: $^{***}p < 0.01$,$^{**}p < 0.05$,$^{*}p < 0.01$.

	Stressed Countries		Non-Stressed Countries	
	(1)	(2)	(3)	(4)
$D_{ij} \times \Delta CDS^S_{jt} \times Exp_{ijt}$	7.01***	6.98***	−3.02	−2.84
	(1.33)	(1.32)	(2.80)	(2.74)
$F_{ij} \times \Delta CDS^S_{jt} \times Exp_{ijt}$	−0.86	−0.91	−0.51	−0.51
	(0.82)	(0.83)	(0.63)	(0.63)
$D_{ij} \times Exp_{ijt}$	−67.86	−93.11	−3.08	−18.79
	(84.96)	(92.62)	(89.33)	(88.67)
$F_{ij} \times Exp_{ijt}$	15.21	16.80	−29.43	−49.46
	(110.18)	(94.72)	(28.77)	(33.99)
Controls	No	Yes	No	Yes
Bank FE	Yes	Yes	Yes	Yes
Time × Country FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.61	0.61	0.58	0.58
Banks	44	44	61	61
Observations	1142	1112	1601	1569

Table 14: Sovereign Risk Transmission to Banks: Yield Surprises

The dependent variable is the change of banks' 5-year CDS premia in quarter t (defined as the difference between the end-of-period values in quarter t and quarter $t-1$). The stressed countries are Italy and Spain. The non-stressed countries are France, Germany and the Netherlands. Y_{jt} is the 10-year government bond yield of country j in quarter t, and Y_{jt}^{E} is the consensus estimate of the same yield made at the end of quarter $t-1$, so that $(Y_{jt} - Y_{jt}^{E})/Y_{jt-1}$ is the unexpected percentage change ("surprise") in the domestic sovereign yield in quarter t. Exp_{ijt} is the average domestic sovereign exposure of bank i in country j and quarter t, defined as the ratio of sovereign debt holdings to main assets. The controls are the bank-level (lagged) capital-asset ratio and the lagged deposit-liability ratio. The sample ranges from from 2008:Q1 to 2014:Q4. Standard errors are clustered at the bank level and are shown in parentheses: $^{***}p < 0.01$,$^{**}p < 0.05$,$^{*}p < 0.01$.

	Stressed Countries		Non-stressed Countries	
	(1)	(2)	(3)	(4)
$\frac{Y_{jt}-Y_{jt}^{E}}{Y_{jt-1}} \times Exp_{ijt}$	9.68^{**}	9.62^{**}	-1.24	-1.42
	(4.37)	(4.36)	(3.36)	(3.37)
Exp_{ijt}	-113.83	-119.54	-13.09	-35.51
	(84.92)	(86.36)	(128.52)	(128.08)
Controls	No	Yes	No	Yes
Bank FE	Yes	Yes	Yes	Yes
Time × Country FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.61	0.61	0.53	0.52
Banks	26	26	46	46
Observations	680	672	1201	1169

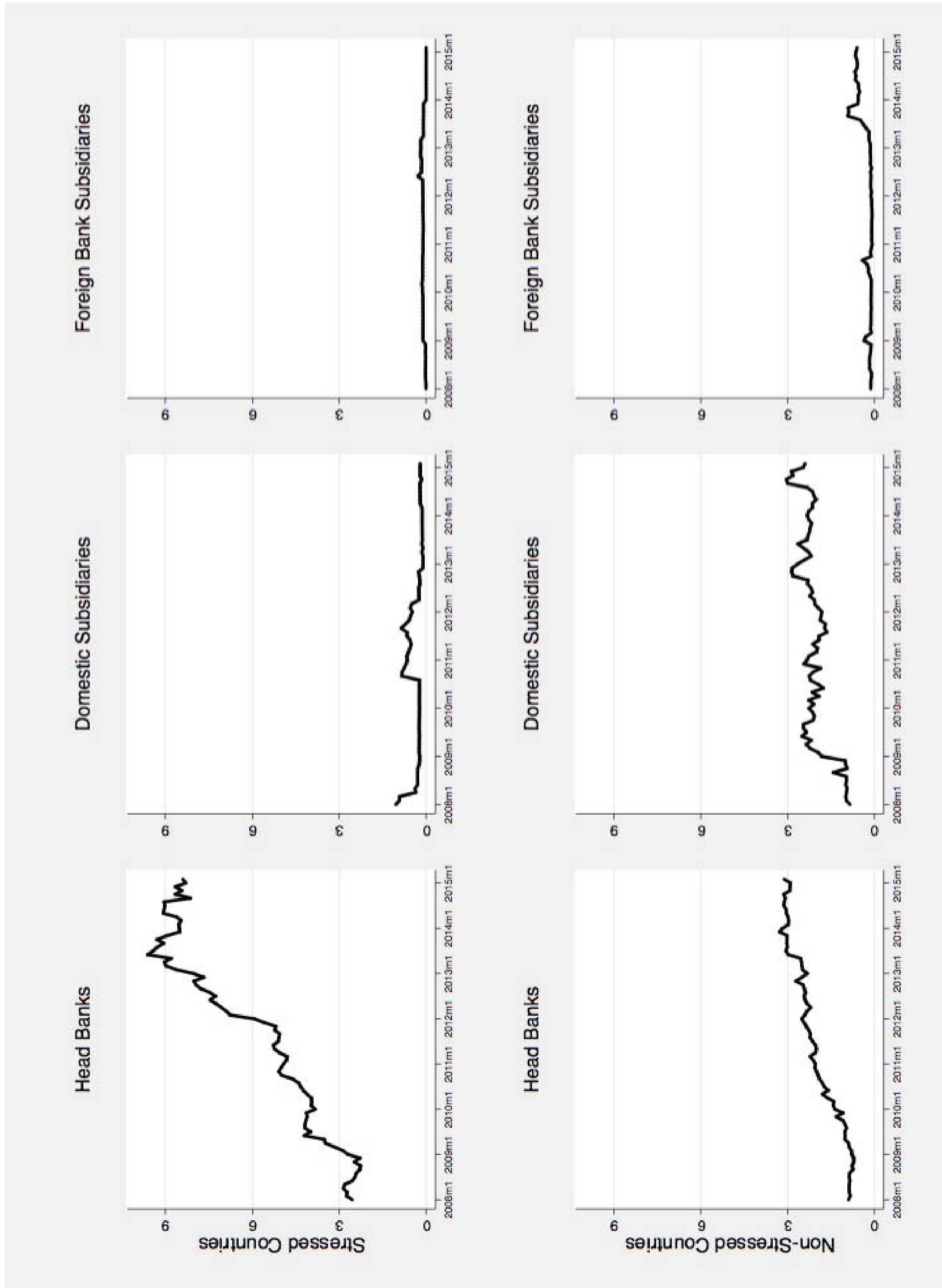

Figure 1: Median domestic sovereign exposure of head banks, domestic and foreign subsidiaries, monthly values. Domestic sovereign exposure is the ratio of domestic sovereign debt holdings to main assets (total assets less derivatives).

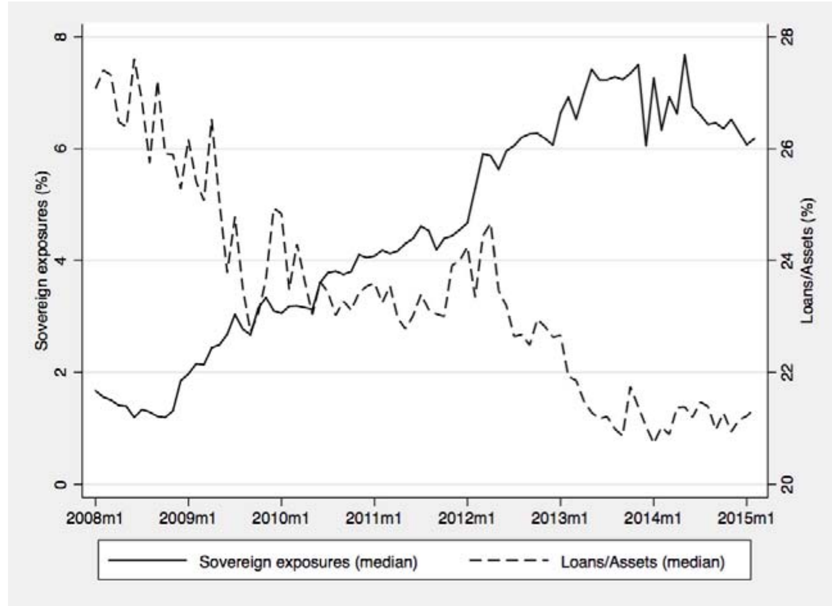

Figure 2: Domestic sovereign exposure and loan-asset ratio of the median bank in stressed countries, monthly values. Sovereign exposure is the ratio of domestic sovereign holdings to main assets; loan-asset ratio is lending to non-financial corporations divided by main assets.

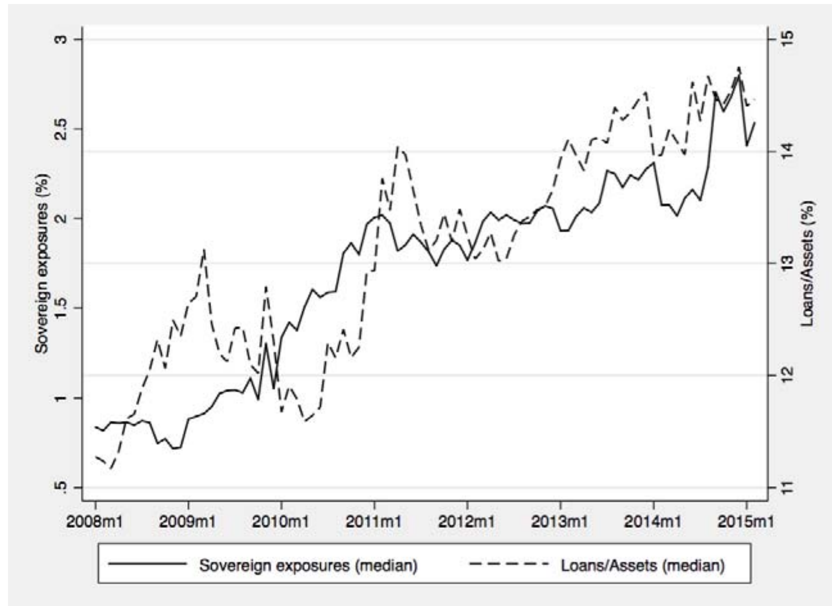

Figure 3: Domestic sovereign exposure and loan-asset ratio of the median bank in non-stressed countries, monthly values. Sovereign exposure is the ratio of domestic sovereign holdings to main assets; loan-asset ratio is lending to non-financial corporations divided by main assets.

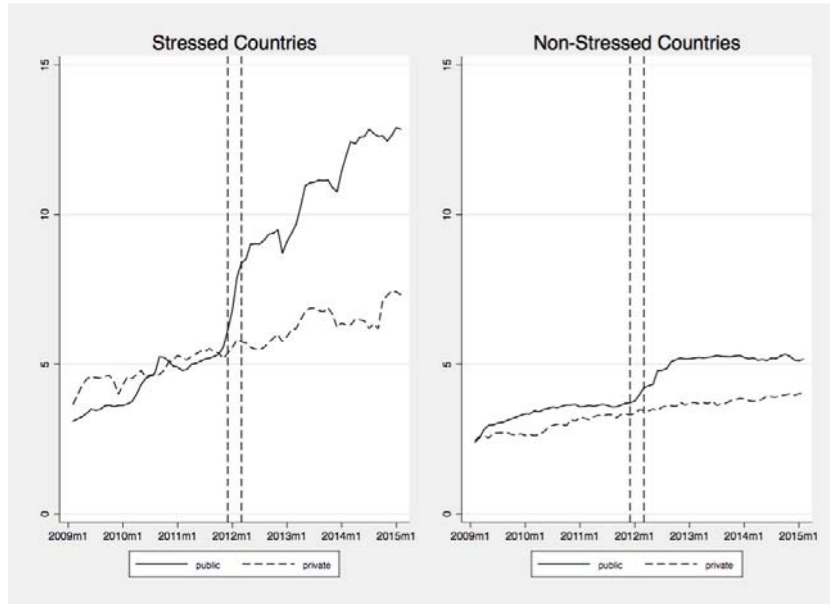

Figure 4: Domestic sovereign exposure and bank ownership, in stressed and non-stressed countries. The line labeled "public" ("private") plots the average monthly exposure of banks with a fraction of public ownership above (below) the relevant country average in 2008.

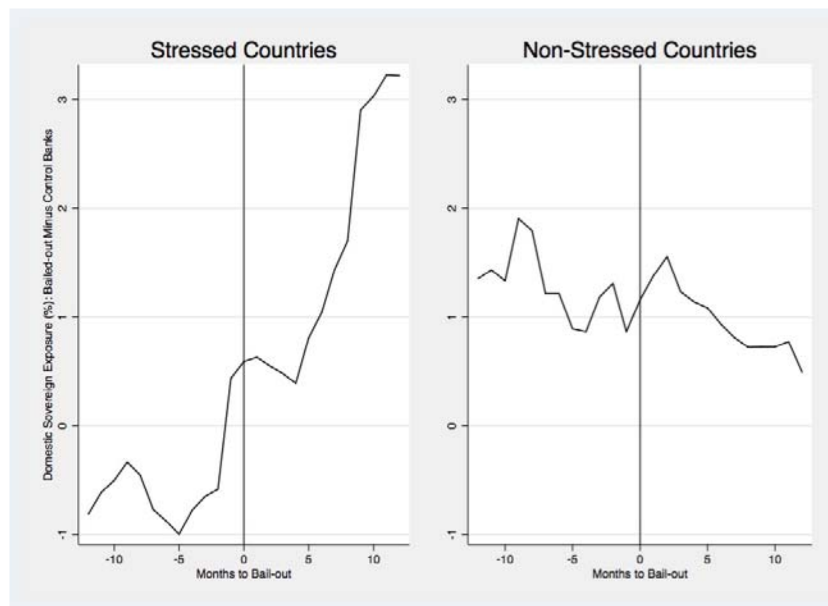

Figure 5: Difference between the average domestic sovereign exposure of bailed-out and control banks, in stressed and non-stressed countries. Control banks are not bailed-out ones. The difference refers to values observed in the same month and the same group of countries. Month 0 is the bailout date.

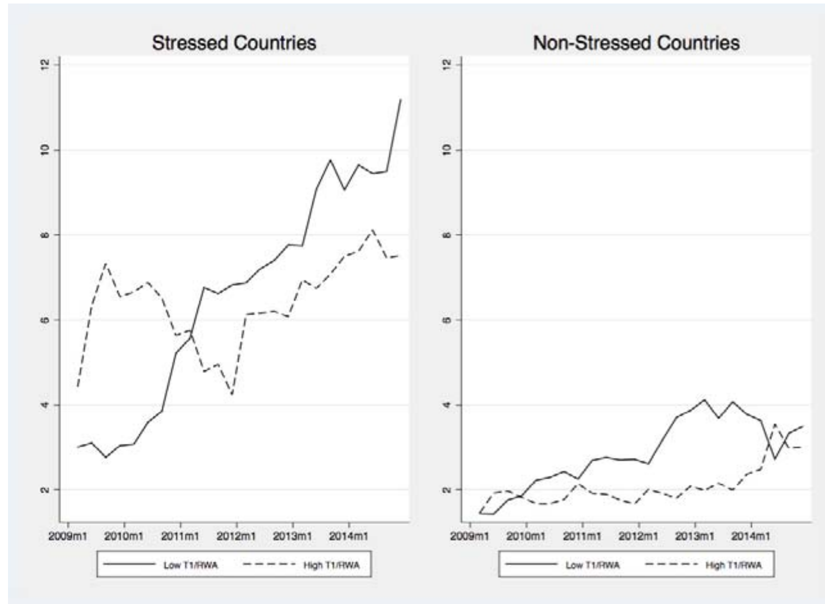

Figure 6: Domestic sovereign exposure and bank regulatory capital in stressed and non-stressed countries, monthly values. The line labeled "High (Low) T1/RWA" refers to the average exposure of banks with above-median (below-median) ratio of Tier 1 capital to risk-weighted assets.

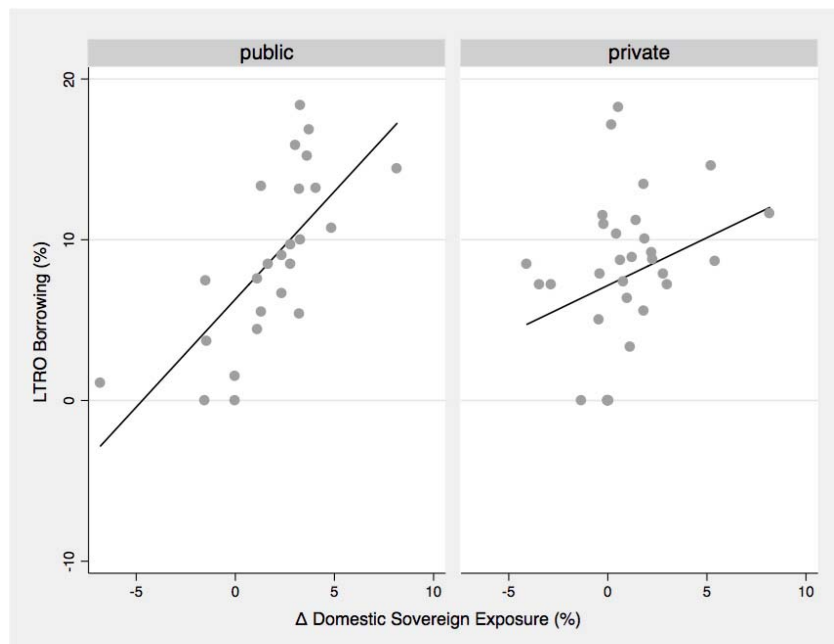

Figure 7: Change in domestic sovereign holdings and VLTRO borrowing, for public and private banks in stressed countries. The figure plots the change in a bank's domestic sovereign holdings from November 2011 to March 2012 against its total VLTRO take-up as of March 2012, scaled by total assets. Public (private) banks are those with public ownership fraction above (below) their country average.

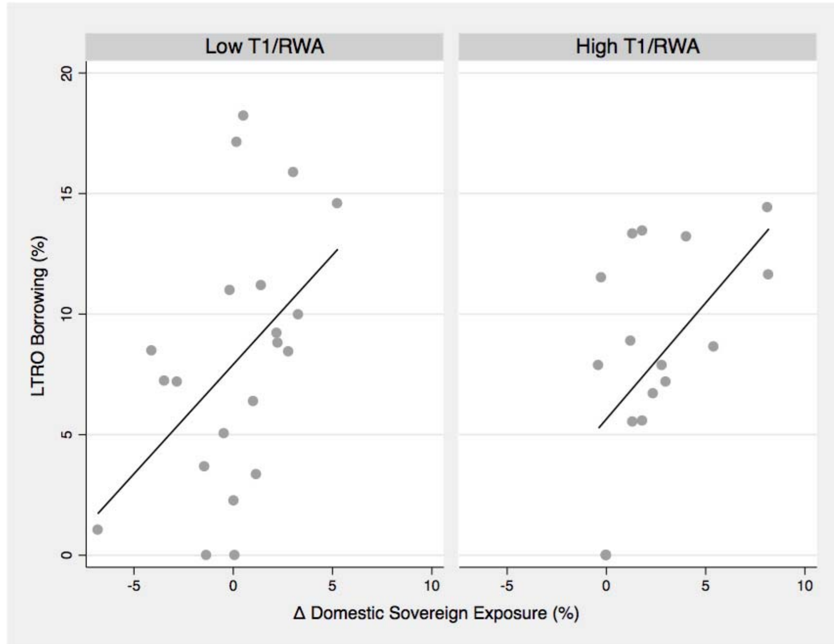

Figure 8: Change in domestic sovereign holdings and VLTRO borrowing, for banks with low and high regulatory capital in stressed countries. The figure plots the change in a bank's domestic sovereign holdings from November 2011 to March 2012 against its total VLTRO take-up as of March 2012. "Low $T1/RWA$" ("High $T1/RWA$") are banks with regulatory capital below (above) the median.

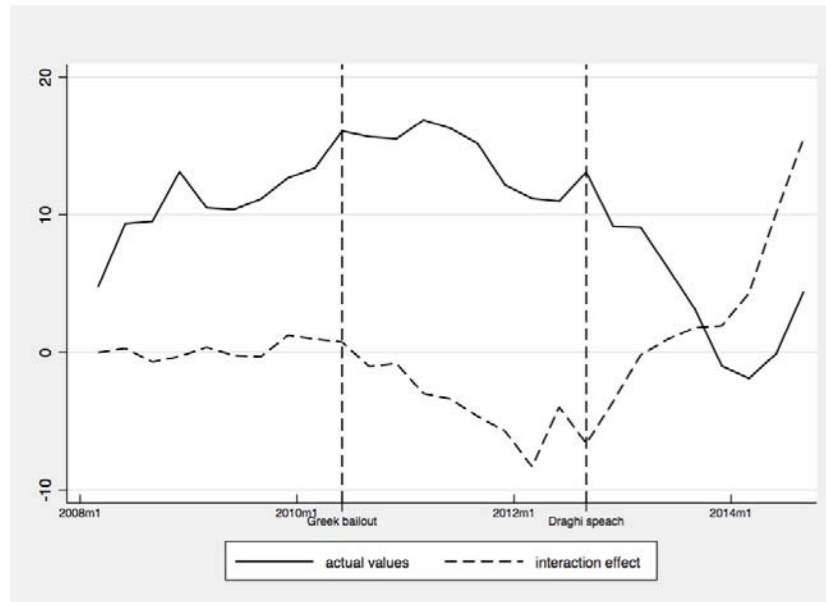

Figure 9: Actual bank lending and estimated amplification effect in stressed countries. The solid line plots actual average loans. The dashed line is the cumulated component of the loan growth rate predicted by the interaction term ($2.45 \times \Delta P_{jt-1}/P_{jt-2} \times Exp_{ijt-1}$), averaged across banks in stressed countries.

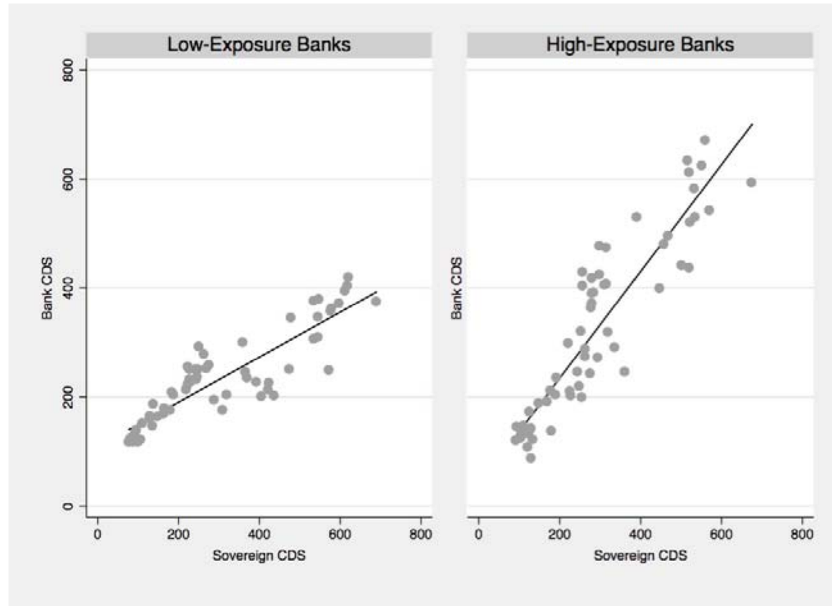

Figure 10: Sovereign CDS premia and average bank CDS premia, for low- and high-exposure banks in stressed countries. Each point is a monthly observation of the average bank and sovereign 5-year CDS premium. Banks with 2009 domestic sovereign exposure in the bottom quartile are low-exposure, those in the top quartile are high-exposure.

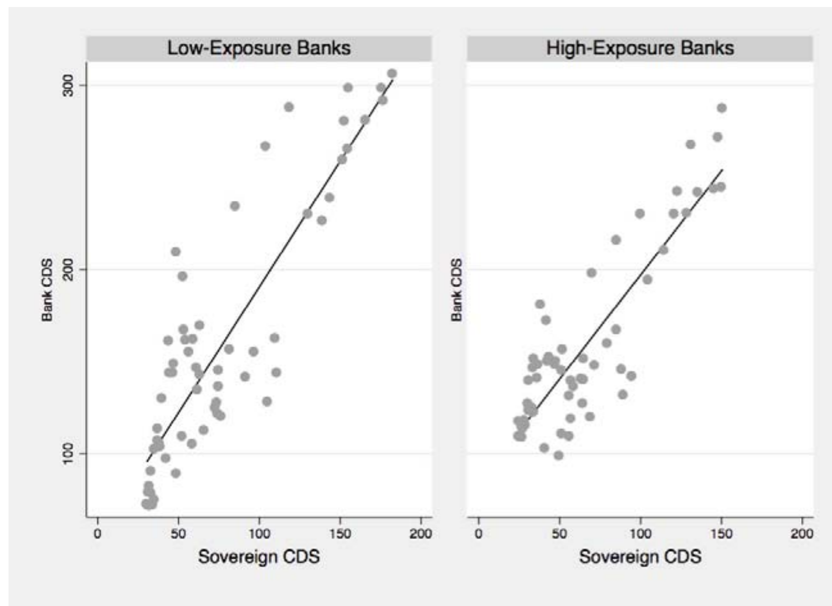

Figure 11: Sovereign CDS premia and average bank CDS premia, for low- and high-exposure banks in non-stressed countries. Each point is a monthly observation of the average bank and sovereign 5-year CDS premium. Banks with 2009 domestic sovereign exposure in the bottom quartile are low-exposure, those in the top quartile are high-exposure.

8 Internet Appendix

Table A1: List of Variables, Definitions and Sources

Variable	Symbol	Definition	Source	Units
Ownership	$Public_{ij}$	Fraction of bank equity held in country j and quarter t by local or national government or by publicly controlled institutions (Fondazioni in Italy, Fundaciones and Cajas in Spain, and Sparkasse and Landesbank in Germany).	Bankscope and authors' calculations	
Sovereign debt repricing	$\Delta P_{jt}/P_{jt-1}$	Percentage change of 10- or 5-year debt prices in country j and quarter t.	Datastream and authors' calculations	
Foreign subsidiary	F_{ij}	Dummy variable equal to 1 if bank i in country j is a foreign subsidiary and 0 otherwise.	ECB	
Bailout	$Bailout_{ijt}$	Dummy variable equal to 1 starting in the quarter t in which bank i in country j was bailed out (unless acquired in the two subsequent quarters), and 0 before t.	EU Commission - State Aid Database	
Sovereign holding growth rate	Sov. Holding Growth	Percentage growth rate of banks' sovereign holdings in quarter t.	IBSI-ECB and authors' calculations	
Tier-1 common equity over risk-weighted assets	$T1/RWA_{ijt-1}$	Ratio between Tier-1 common equity and risk-weighted assets of bank i in country j and quarter $t-1$.	SNL	
Sovereign CDS (first difference)	ΔCDS^S_{jt}	Change of the 5-year sovereign CDS premium in country j and quarter t.	Datastream	%
Bank CDS (first differences)	ΔCDS^B_{jt}	Change of banks' 5-year CDS premia, defined as the difference between the end-of-period value in quarter t and that in period $t-1$.	Datastream	%
Domestic sovereign exposures	Exp_{ijt}	Ratio between domestic sovereign debt holdings and main assets (total assets minus derivatives) of bank i in country j and quarter $t-1$.	IBSI-ECB	
Domestic	D_{ij}	Dummy variable equal to 1 if bank i in country j is domestic and 0 otherwise.	ECB	
10-year government yield	Y_{jt}	10-year benchmark government bond yield in country j and quarter t	Datastream	
10-year government yield forecast	Y^E_{jt}	Consensus estimate of the 10-year government yield of country j for quarter t made by professional forecasters at the end of quarter $t-1$.	Consensus Economics	
Surprise in sovereign yield	$(Y_{jt} - Y^E_{jt})/Y_{jt-1}$	Unexpected percentage change (with respect to consensus forecast) in the domestic sovereign yield of country j in quarter t.	Authors' calculations	%
Bank lending growth		Percentage growth rate of loans granted by bank i in country j to non-financial companies in quarter t.	IBSI-ECB and authors' calculations	%
Domestic sovereign exposure of head banks	$Exp.Head_{iht}$	Indirect exposure of subsidiary i operating in country j to the sovereign risk of its home country $h \neq j$, arising from the sovereign holdings of its head bank. Set to zero if bank i is a domestic bank of country j, i.e. if $h = j$.	IBSI-ECB and authors' calculations	
Bank-level loan interest rate (first differences)	ΔR_{ijt}	Change in the interest rate charged on new loans by bank i to non-financial coroporations in country j and quarter t.	IMIR-ECB and authors' calculations	%
Bank loan-asset ratio		Bank loans to non-financial corporations as a fraction of main assets.	IBSI - ECB	
Deposit-liabilities ratio		Ratio of bank's deposits to its total liabilities.	IBSI - ECB	

Table A2: Banks' Non-Performing Loans, Public Ownership and Bailouts

The dependent variable is the ratio of non-performing loans to total loans of bank i in country j and quarter t. The stressed countries are Ireland, Italy and Spain. The non-stressed countries are Austria, Belgium, Finland, France, Germany, and the Netherlands. $Public_{ijt}$ is the fraction of banks' shares owned by local or national government or publicly controlled institutions (*Fondazioni* in Italy, *Fundaciones* and *Cajas* in Spain, and *Sparkasse* and *Landesbank* in Germany). $VLTRO_t$ equals 1 in December 2011 and March 2012, and 0 otherwise. $Bailout_{ijt}$ equals 1 starting in the quarter t in which bank i in country j was bailed out (unless acquired in the two subsequent quarters), and 0 before quarter t. $\Delta P^{10}_{jt-1}/P^{10}_{jt-2}$ and $\Delta P^{5}_{jt-1}/P^{5}_{jt-2}$ measure the percentage change of government bond prices in country j and quarter $t-1$, respectively for 10-year and 5-year debt. The sample ranges from 2008:Q1 to 2014:Q4. Standard errors are clustered at the bank level and are shown in parentheses: $^{***}p < 0.01$,$^{**}p < 0.05$,$^{*}p < 0.01$.

	Stressed Countries		Non-Stressed Countries	
	(1)	(2)	(3)	(4)
$Bailout_{ijt-1}$	0.01	0.01	0.05	0.05
	(0.03)	(0.03)	(0.03)	(0.03)
$Public_{ijt-1}$	-0.00	-0.00	0.00*	0.00**
	(0.00)	(0.00)	(0.00)	(0.00)
$Bailout_{ijt-1} \times \frac{\Delta P^{10}_{jt-1}}{P^{10}_{jt-1}}$	0.00		0.00	
	(0.00)		(0.00)	
$Public_{ijt-1} \times \frac{\Delta P^{10}_{jt-1}}{P^{10}_{jt-1}}$	0.00		0.00	
	(0.00)		(0.00)	
$Bailout_{ijt-1} \times \frac{\Delta P^{5}_{jt-1}}{P^{5}_{jt-1}}$		-0.00		0.00
		(0.00)		(0.00)
$Public_{ijt-1} \times \frac{\Delta P^{5}_{jt-1}}{P^{5}_{jt-1}}$		0.00		0.00
		(0.00)		(0.00)
Banks	33	33	30	30
Observations	300	287	351	351

Table A3: Banks' Non-Performing Loans and Sovereign Exposures

The dependent variable is the ratio of non-performing loans to total loans of bank i in country j and quarter t. The stressed countries are Ireland, Italy and Spain. The non-stressed countries are Austria, Belgium, Finland, France, Germany, and the Netherlands. ΔCDS^S_{jt} is the change in the 5-year sovereign CDS in quarter t, Exp_{ijt} is the average domestic sovereign exposure of bank i in country j and quarter t, defined as the ratio of sovereign debt holdings to main assets, D_{ij} equals 1 if bank i in country j is domestic and 0 otherwise, and $F_{ij}= 1 - D_{ij}$. The controls are the bank-level (lagged) capital-asset ratio and the lagged deposit-liability ratio. The sample ranges from 2008:Q1 to 2014:Q4. Standard errors are clustered at the bank level and are shown in parentheses: $^{***}p < 0.01$,$^{**}p < 0.05$,$^{*}p < 0.01$.

	Stressed Countries		Non-Stressed Countries	
	(1)	(2)	(3)	(4)
$D_{ij} \times \Delta CDS^S_{jt} \times Exp_{ijt}$	−0.00	−0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
$F_{ij} \times \Delta CDS^S_{jt} \times Exp_{ijt}$	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
$D_{ij} \times Exp_{ijt}$	0.20**	0.19**	0.15	0.15
	(0.09)	(0.09)	(0.23)	(0.23)
$F_{ij} \times Exp_{ijt}$	−0.01	0.06	0.07	0.06
	(0.09)	(0.10)	(0.07)	(0.07)
Controls	No	Yes	No	Yes
Bank FE	Yes	Yes	Yes	Yes
Time × Country FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.84	0.85	0.86	0.86
Banks	35	35	43	43
Observations	378	374	519	498