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Bad Sovereign or Bad Balance Sheets? Euro Interbank Market Fragmentation and Monetary Policy, 2011-2015

Silvia Gabrieli[1] and Claire Labonne[2]

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ABSTRACT

We measure the relative role of sovereign-dependence risk and balance sheet (credit) risk in euro area interbank market fragmentation from 2011 to 2015. We combine bank-to-bank loan data with detailed supervisory information on banks' cross-border and cross-sector exposures. We study the impact of the credit risk on banks' balance sheets on their access to, and the price paid for, interbank liquidity, controlling for sovereign-dependence risk and lenders' liquidity shocks. We find that (i) high non-performing loan ratios on the GIIPS portfolio hinder banks' access to the interbank market throughout the sample period; (ii) large sovereign bond holdings are priced in interbank rates from mid-2011 until the announcement of the OMT; (iii) the OMT was successful in closing this channel of cross-border shock transmission; it reduced sovereign-dependence and balance sheet fragmentation alike.

Keywords: Interbank market, credit risk, fragmentation, sovereign risk, country risk, credit rationing, market discipline

JEL classification: G01, E43, E58, G15, G21

[1] Financial Stability Department, Banque de France. E-mail: silvia.gabrieli@banque-france.fr.

[2] Risk and Policy Analysis, Federal Reserve Bank of Boston. E-mail: claire.labonne@bos.frb.org (corresponding author).

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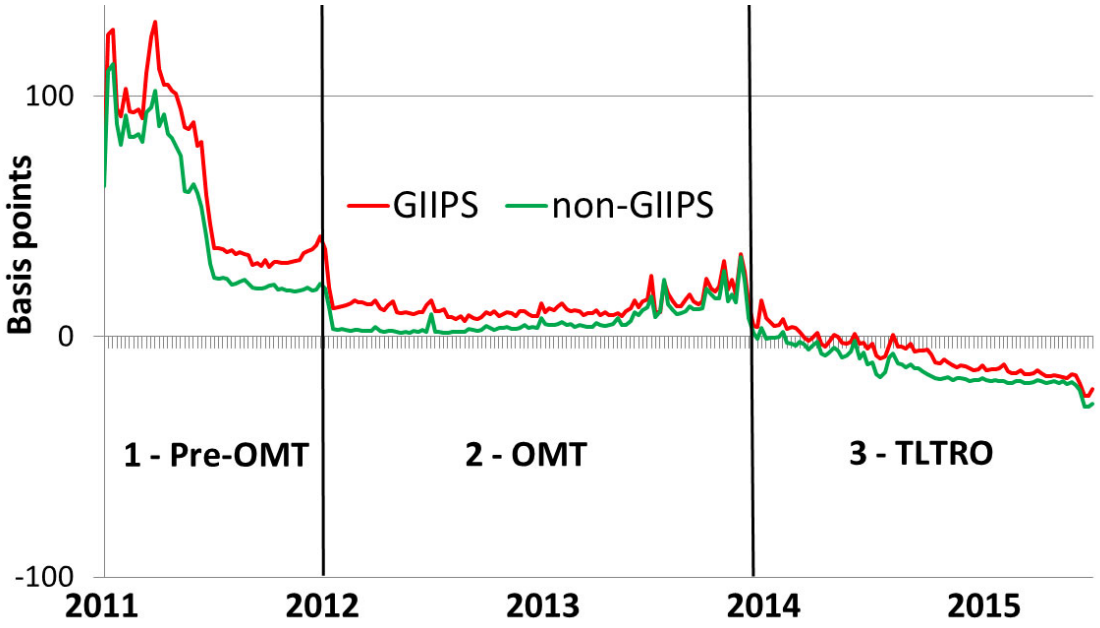
NON-TECHNICAL SUMMARY

Interbank market fragmentation can have significant welfare costs: by affecting the funding capacity of banks, it can hinder the smooth transmission of monetary policy and thus impair the provision of credit to the real economy. In the euro area, interbank fragmentation has been fuelled by the sovereign-bank nexus: in peripheral countries (Greece, Ireland, Italy, Portugal, Spain and Cyprus or *GIIPS*), banks have been affected by their own governments' debt problems and vice-versa.

We can distinguish two sources of fragmentation in the eurozone. First, while banks can freely provide financial services in all member countries, their domestic sovereigns are primarily responsible for bailing them out in case of failure. Bank funding could thus be negatively affected by pure home country sovereign risk. This is the sovereign-based source of fragmentation. Second, even if banks can serve the whole European market, they are overly exposed to their domestic economy, which makes balance sheet quality depend on local economic conditions. This is the balance sheet (credit risk) source of fragmentation. Indeed, when systemic risk is high and contagion very likely, as in 2011-2015, lenders could react to country risk rather than to idiosyncratic counterparty risk.

As shown in the figure, throughout 2011-2015, banks headquartered in peripheral countries paid on average higher rates (volume-weighted) than non-peripheral banks. The difference was especially large in December 2011, before the Eurosystem's first 3-years liquidity refinancing operation, and before the announcement of the Outright Monetary Transactions (OMT) programme in August 2012.

Weekly average interest rate in the euro area overnight interbank market for GIIPS and non-GIIPS banks



Source: TARGET2 data, authors' computations

Note: The vertical lines define three monetary policy periods: Period 1 (Pre-OMT): July 2011 - July 2012; Period 2 (OMT): August 2012 - June 2014; Period 3 (Targeted Long Term Refinancing Operations – TLTRO): July 2014 - December 2015. Averages of interest rates are volume-weighted.

This article tackles the following research questions. What determines the access and the interest rates served in the euro area interbank market in 2011-2015, what are lenders

pricing in? What is the relative role of the credit risk in bank balance sheets compared to the risk of sovereign dependence (because of the implicit guarantee of sovereign bailout)? How do lending conditions in the interbank market interact with monetary policy?

We provide a simple theoretical model to analyse the effects of balance sheet and sovereign risk on interbank market access and interest rates. The model takes into account the interaction between interbank lending conditions and central bank liquidity provision, including via non-conventional monetary policies. We then test the model predictions using granular interbank lending data and detailed information on banks' exposures, cross-border and cross-sector.

We highlight three findings. First, all other things equal, high non-performing loan (NPL) ratios on GIIPS assets hinder access of non-peripheral banks to the interbank market during all three monetary policy periods: higher NPL ratios on GIIPS assets decrease the probability to find a lender in the market. Second, from mid-2011 and until the OMT, a non-peripheral bank pays more for interbank loans the larger its exposures to GIIPS sovereigns. But the OMT closes this channel of shock transmission. In fact, after the OMT announcement, also the selection effect due to high NPL on GIIPS assets, while still significant, becomes much weaker. Third, the OMT announcement reduced sovereign-based and balance sheet fragmentation alike: it reduced country-premia paid by GIIPS borrowers, but it also affected lenders' pricing of counterparty credit risk.

Mauvais souverain ou mauvais bilans ? Fragmentation du marché interbancaire de la zone euro et politique monétaire, 2011-2015

RÉSUMÉ

Dans cette étude, nous analysons l'importance relative du risque souverain et du risque de crédit dans la fragmentation du marché interbancaire de la zone euro de 2011 à 2015. Nous combinons des données granulaires de prêts interbancaires avec les expositions transfrontalières et intersectorielles des banques emprenteuses. Cela nous permet d'étudier l'impact du risque de crédit au bilan des banques sur leur accès au marché interbancaire et sur le prix de la liquidité, tout en contrôlant le risque souverain et les chocs de liquidité des prêteurs. Nous constatons que : (i) des ratios élevés de créances douteuses dans le portefeuille d'actifs GIIPS entravent l'accès des banques au marché interbancaire tout au long de la période d'analyse ; (ii) à partir de mi-2011 jusqu'à l'annonce de l'OMT, plus l'exposition des banques aux souverains GIIPS est grosse, plus les taux d'intérêt de leurs prêts interbancaires sont élevés ; (iii) l'OMT a réussi à fermer ce canal de transmission transfrontalière des chocs ; il a réduit autant la fragmentation liée au risque souverain que celle due au risque de crédit.

Mots-clés : Marché interbancaire, risque de crédit, fragmentation, risque souverain, risque pays, rationnement du crédit, discipline de marché

Global banks are international in life but national in death.

– Sir Mervyn King, former Governor of the Bank of England

1 Introduction

Interbank market fragmentation can have significant welfare costs: by affecting the funding capacity of banks, it can hinder the smooth transmission of monetary policy and thus impair the provision of credit to the real economy. Without financial fragmentation and sovereign debt crises, the Eurozone would have experienced a boom-and-bust cycle similar to the one in the US (Martin and Philippon, 2017). Eurozone fragmentation has been fuelled by the sovereign-bank nexus (Farhi and Tirole, 2018)[1]: in the peripheral countries of the euro area (Greece, Ireland, Italy, Portugal, Spain and Cyprus or *GIIPS* countries), banks have been affected by their own governments' debt problems and vice-versa. GIIPS banks' lending terms have differed from those of non-GIIPS banks because of this two-way mechanism (Altavilla et al., 2016).

The recent fragmentation of the European (EU) interbank market has two distinct sources. First, while EU banks can freely provide financial services in all member countries, their domestic sovereigns were primarily responsible for bailing them out in case of failure. Bank funding could thus be negatively affected by pure home country sovereign risk. This is the *sovereign-based* source of financial fragmentation. Second, even if EU banks can serve the whole EU market, they are overly exposed to their domestic economy, which makes balance sheet quality depend on local economic conditions. This is the *balance sheet* -credit risk- source of financial fragmentation. Indeed, when systemic risk is high and contagion very likely, lenders could react to country risk rather than to idiosyncratic counterparty risk.

What determines the access to and the interest rates served in the euro area interbank market? What is the relative role of credit risk, as measured by the size and quality of bank exposures, cross-border and cross-sector, compared to the risk of sovereign dependence? How do lending conditions in this market interact with monetary policy? In this paper, we disentangle the sovereign-dependence and balance sheet sources of interbank fragmentation in 2011-2015. We analyse to what extent be-

[1] Crosignani et al. (2015) illustrate the link between bank behavior and the sovereign yield curve in an empirical exercise analyzing the ECB LTRO policy. Acharya et al. (2014) model the loop between sovereign and bank credit risk. They document that public bailouts triggered the rise of sovereign credit risk in 2008 and that post-bailout changes in sovereign CDS explain changes in bank CDS even after controlling for aggregate and bank-level determinants of credit spreads. Acharya and Steffen (2015) show that the banks-sovereign feedback-loop was the main determinant of euro zone bank risks between 2007 and 2013, with banks generating carry gains thanks to their peripheral (sovereign) bond exposures until the deteriorating returns on peripheral bonds adversely affected their balance sheets.

ing exposed to GIIPS assets determines banks' access to, and the price paid for, interbank liquidity. The use of granular *bank-to-bank* data allows to test for the existence of peer monitoring in interbank lending decisions based on observable measures of counterparty risk, while controlling for sovereign-dependence risk and lenders' liquidity shocks. Furthermore, we study how interbank lending conditions were affected by the Eurosystem's unconventional monetary policies.

We first provide a simple theoretical model to analyse the effects of balance sheet and sovereign risk on interbank market access and prices. We consider a lender pricing the borrower's default risk; the borrower has also access to central bank liquidity. The model shows that interbank interest rates should increase in the borrower's stand-alone and its sovereign's probability of default. That is, both balance sheet and sovereign dependence risk should be priced in interbank rates. Moreover, because of the central bank liquidity outside option, riskier borrowers (riskier balance sheet or riskier sovereign) could be left out of the interbank market. Besides 'traditional' monetary policy tools (such as the setting of the deposit facility or main refinancing rate), the model considers the introduction of unconventional monetary policies, such as outright asset purchases in secondary markets or making central bank liquidity provision conditional on banks' balance sheet size (as with the European TLTROs[2]). In such case, the model shows that reservation rates for low risk borrowers may be too low for transactions to occur on the interbank market.

We test the model predictions using detailed data disclosed since 2011 by the European Banking Authority (EBA) on capital positions and exposures of EU banks. Exposures data are broken down by sectors (sovereign, retail, corporate) and counterparties' geographic location. We combine them, at a consolidated level, with granular *lender-borrower* (bank-to-bank) information on unsecured interbank loans estimated from TARGET2 payments (Arciero et al., 2016). Our sample spans the period from 2011 to 2015. For each loan, we observe its originator and final beneficiary, its date, amount and annualized interest rate. We keep in the sample all European lenders active on the euro interbank market in 2011-2015. On the borrowing side, we restrict the sample to the 115 groups taking part to the EBA EU-wide stress tests or transparency exercises.

To identify how GIIPS risk is accounted for on the interbank market we focus on the sub-sample of non-peripheral (non-GIIPS) borrowers. We compare the loan conditions of non-peripheral banks with GIIPS exposures with those of non-peripheral banks without GIIPS exposures. Non-peripheral

[2]Targeted Long Term Refinancing Operations (TLTROs) were launched by the Eurosystem in June 2014. The amount of long term liquidity supplied through TLTROs is an increasing function of the borrower's supply of credit to the real economy.

banks exposed to GIIPS assets are key for disentangling the sovereign-dependence from the balance sheet sources of financial fragmentation. We cannot consider directly the conditions for banks located in a GIIPS country and exposed to GIIPS assets because they are simultaneously explained by the location in a GIIPS country, hence the dependence to a risky sovereign, and the large exposures to GIIPS assets. Instead, by using non-GIIPS banks' exposures to GIIPS we can compare interbank market access and rates across borrowers accounting for both the identity of their sovereign and the riskiness of their exposures. Furthermore, we also rely on the full sample variation and compare loan terms obtained by peripheral banks with those of non-peripheral banks when both types are exposed to GIIPS.

On the left-hand side of estimations, we consider both the extensive and the intensive margin of interbank intermediation - i.e. the probability to find a lender in the market and the rate of a loan. When analysing the extensive margin, we define a time-varying borrower-specific set of relevant lenders. That is, for each borrower, at each date, we assume she can trade with her set of this week plus last week actual lenders and we compare this set of relevant counterparties with actual lender-borrower loans observed in TARGET2.[3] On the right-hand side, we measure credit risk on banks' balance sheet by looking at the size of GIIPS sovereign, retail and corporate exposures (as a share of total assets) and at their quality (measured by the ratio of non-performing out of total GIIPS exposures). In addition, for each borrowing bank we compute the weighted average CDS spread on the GIIPS sovereigns it is exposed to, where each sovereign CDS spread is weighted by the volume of the corresponding bank's exposure. Finally, to apprehend pure sovereign-dependence risk, we take the borrower country fixed effects interacted with time from the interest rate estimations and use them to compute country trends in interbank spreads. We control for borrowers' characteristics (borrower fixed effects and time-varying size, capital ratio and rating) and for lender x time fixed effects, to absorb supply-side shocks.

The impact of GIIPS exposures on interbank loan terms is discussed against the backdrop of the Eurosystem's non-standard monetary interventions over 2011-2015. In this period, monetary policy has been greatly loosened through various instruments that might influence, directly or indirectly, the functioning of the interbank market. First, the ECB has decreased refinancing rates and offered long-term refinancing solutions to make up for receding interbank lending. Afterwards, it has intervened in asset markets to try and turn financial fragmentation around. The ECB's asset purchase programmes have affected price dynamics, both in non-GIIPS and GIIPS countries (ECB, 2015). This is likely

[3] If we considered that each borrower could trade with all possible lenders at a given date, we would end up with a very sparse matrix of bank-to-bank links, i.e. we would have almost all lender-borrower links set to zero. This would overestimate a selection effect, while a large number of lender-borrower couples are structurally unlikely. See section 5.3.

to influence the counterparty risk assessment of the banks holding assets eligible to the purchases. In our estimation we consider three monetary policy periods. The first one, from July 2011 to July 2012, is characterised by decreasing interest rates and the first 3-year Long Term Refinancing Operation (LTRO). The second period starts in August 2012 with the announcement of Outright Monetary Transactions (OMT) of sovereign debt securities and ends in June 2014 with the launch of Targeted Long Term Refinancing Operations (TLTROs). The third period goes from July 2014 to December 2015.

We highlight three findings, which are consistent with the predictions of our stylised theoretical model. First, all other things equal, high non-performing loan (NPL) ratios on GIIPS assets hinder access of non-peripheral banks to the interbank market during all three monetary policy periods: higher NPL ratios on GIIPS assets decrease the probability to find a lender.

Second, from mid-2011 and until the OMT, a non-peripheral bank pays more for interbank loans the larger its exposures to GIIPS sovereigns. Sovereign exposures, rather than retail or corporate ones, drive financial fragmentation. Specifically, an increase in the share of GIIPS sovereign exposures by 1 percentage point raises interest rate spreads by 1.3 basis points. This represents 13 percent of the average spread paid by non-GIIPS borrowers in this period. The OMT was successful in closing this channel of shock transmission. Moreover, after the OMT announcement in August 2012, the selection effect due to high NPL on GIIPS assets, while still significant, becomes much weaker in economic terms.

Third, while before the OMT we measure positive home country risk premia in interbank spreads (e.g. for Spanish, Italian and French banks), these premia vanish (for Italian and Spanish banks) or even turn to discounts (for French banks) afterwards. That is, after the OMT, when we observe fragmentation, it is mainly driven by idiosyncratic balance sheet risk. The OMT affected both sources of fragmentation: it reduced country-premia paid by GIIPS borrowers, but it also affected lenders'pricing of counterparty credit risk.

The rest of the paper is organized as follows. Section 2 discusses related literature and our contribution. Section 3 presents our simple model and its testable predictions. Section 4 describes the data. Section 5 details the identification strategy, estimation specification and construction of the set of relevant lenders. Section 6 presents the results and robustness tests. The last section concludes.

2 Literature Review and Contribution

Our paper relates to three strands of the literature: the measurement of fragmentation in Europe's single financial market; the (mal)functioning of the interbank market in times of crisis; the analysis of cross-border financial links as shock transmission channels.

In the first strand of literature, Gilchrist and Mojon (2016) compute credit risk indicators for euro area banks and non-financial corporations based on bond yields spreads. They show that the 2008 financial crisis led to a systematic divergence in credit spreads for financial firms across national boundaries. This divergence increased since the outbreak of the European debt crisis. Horny et al. (2016) measure the part of euro area corporates spreads vis-à-vis the German bund due to financial fragmentation, i.e. the differences in spreads between two securities with otherwise similar credit and maturity risk. They find fragmentation reached very high levels in 2011 and 2012 and receded since the announcement of the OMT programme by the Eurosystem. More directly related to ours, Garcia-de Andoain et al. (2014) document significant financial fragmentation in the unsecured overnight euro area interbank market from May 2010 until December 2011. The authors consider a simple model for a bank's average overnight borrowing rate and identify fragmentation through the estimation of a 'country (or group of countries) premium' significantly different from zero. Frutos et al. (2016) provide evidence that stress in the unsecured euro money market led to less cross-border transactions, particularly in the second half of 2011, which they consider as a measure of financial fragmentation. Rainone (2017) proposes a dyadic econometric model to analyze pairwise trading on the European interbank market during the sovereign debt crisis. He finds significant dispersion in rates and quantities driven by bank nationality and balance sheet items, especially during the peak of the crisis. We complement these papers by adding more granular borrower characteristics, and specifically cross-border and cross-sector exposures, to the TARGET2 interbank dataset. This allows shedding light on the exact channels through which risk adjustment was taking place and documenting if and when we observe peer monitoring in banks' lending decisions based on the country-mix and riskiness of banks' exposures.

An extensive theoretical and empirical literature has studied the functioning of the interbank market in crisis times. Among theories explaining interbank market failures, several models focus on the role of asymmetric information, counterparty credit risk and adverse selection (Flannery (1996), Freixas and Jorge (2008), Heider et al. (2015)). In Flannery (1996), higher uncertainty about the creditworthiness of counterparties induces banks to abstain from interbank lending. In a similar vein, Heider et al. (2015) (HHH) predict that lenders may be unwilling to lend and some borrowers will be rationed when the level and dispersion of counterparty risk is high. Freixas and Holthausen (2004)

(FH) study the scope for international integration of an interbank market with unsecured lending when cross-country information is noisy. The authors find that a segmented interbank market is always an equilibrium; on the contrary, an equilibrium with integrated interbank markets is only possible when the quality of cross-border information is sufficiently good. In this paper we provide evidence that the market adjusts to higher counterparty risk at the extensive margin and by interest rate increases. But we use *observable* measures of counterparty risk; we do not analyse crediworthiness uncertainty.

On the empirical side, Abbassi et al. (2014) analyze the impact of Lehman Brothers default and of the 2010 sovereign debt crisis on the European interbank market. They show that the price dispersion of overnight uncollateralized loans in the same morning for the same borrower increased massively during both crisis episodes and especially so for riskier borrowers. During the sovereign debt crisis effects were stronger for peripheral banks. Price dispersion receded following the Eurosystem's promise of unlimited liquidity access in October 2008 and the 3-year LTRO in December 2011. Afonso et al. (2011) examine the unsecured overnight market in the United States and show market activity shrinked considerably after the bankruptcy of Lehman, with the shrinkage being caused mostly by a withdrawal of supply. Angelini et al. (2011), studying the European interbank market (e-MID), find spreads became more reactive to creditworthiness measures after August 2007. Focusing on access to interbank market liquidity and borrowing rates, Cocco et al. (2009) shed light on the importance of lending relationships: relationships allow banks to insure liquidity risk in the presence of transaction and information costs.[4] Gabrieli and Georg (2014) show the existence of a *centrality premium* when banks act as intermediaries of liquidity: banks with a higher centrality in the network of interbank flows capture a significantly larger intermediation spread, in line with predictions from models of intermediation and bargaining in networks. Consistently with this literature, we take into account the formation of lending relationships between banks by identifying the effects at a lender-borrower level and controlling for any time-varying shock impacting the lending bank (i.e. supply shocks). We complement evidence on the impact of sovereign risk for fragmentation during the Eurozone sovereign debt crisis by showing that a 'balance sheet' (i.e. exposures driven) effect was at play besides a pure sovereign-dependence effect.

Finally, our paper relates to the empirical literature analyzing cross-border financial links as shock transmission channels. Understanding the compositional supply effects through cross-border lending is a crucial question for the euro area, where the fragmentation of the market for interbank liquidity,

[4]Similarly, Afonso et al. (2014) show that stable concentrated borrowing relationships are a useful way to hedge liquidity needs in the US interbank market. Affinito (2012) shows that, in Italy, domestic banks also establish stable and strong relationships. Bräuning and Fecht (2017) find that German banks also rely on repeated interactions with counterparties.

notably around the sovereign debt crisis, has been a main reason for non-standard monetary policy actions. Work by Cetorelli and Goldberg (2011), Cetorelli and Goldberg (2012b) and Cetorelli and Goldberg (2012a) on cross-border capital flows identifies three transmission channels of lending shocks: direct cross-border lending by foreign banks, local lending by foreign banks' affiliates and interbank lending. Our paper focuses on this third transmission channel. In particular, we contribute to the literature that analyzes the effects of sovereign bonds exposures. Popov and van Horen (2013) identify the transmission of tensions in European sovereign debt markets to the real economy through the bank lending channel. They find evidence that syndicated lending by non-GIIPS banks with sizeable exposures to GIIPS sovereigns decreased after the 2010 crisis. Altavilla et al. (2016) also find evidence of sovereign stress transmission to euro area banks' lending from 2007 to 2015 due to the banks' sovereign exposures. Their sample accounts for about 70% of total euro area lending. Finally, Bocola (2016) presents a theoretical framework to understand the macroeconomic impact of sovereign risk. He focuses on two channels: the liquidity channel, whereby the risk of a sovereign default tightens banks' funding thus reducing their resources to finance firms; and the risk channel, whereby sovereign risk generates precautionary deleveraging. We document the existence of the liquidity channel before the launch of the OMT, which also explains Popov and van Horen (2013) results. However, our results suggest that this channel is not independent from shocks to the quality of balance sheet items - Bocola (2016) risk channel - as low-quality / risky exposures are priced in interbank rates.

3 Model

This section presents a simple model of the participation constraints for a lending bank and a borrowing bank on the interbank market. We also discuss the conditions of central bank liquidity provision. As we are interested in the effects of *observable* GIIPS exposures, we abstract from asymmetric information considerations.

We consider a borrowing bank with stand-alone probability of default b, headquartered in a country whose sovereign default probability is g. A bank with excess liquidity can either use the deposit facility and get return r^{df} or lend on the interbank market, where its expected return is:

$$(1-b)r + b(1-g)\delta r$$

If the borrower does not default, with probability $1-b$, the lender gets return r. If the bank defaults but the sovereign does not, the bank will be bailed out and the lender will recover a fraction

$\delta \in [0,1]$ of its claim. We assume that in case of joint bank and sovereign defaults, the lender does not recover anything, consistently with this junior claim being unsecured. The lender's participation constraint is

$$r > \frac{1}{1-b(1-\delta(1-g))} r^{df} \tag{1}$$

The lender does not require a rate only higher than the deposit facility rate. Interbank rates also have to compensate for the borrower's probability of default: the lender's reservation rate is thus higher than the deposit facility rate and increasing in the sovereign's and bank's default probabilities. Moreover, the lender is not only worried about the borrower's stand alone probability of default. The latter is adjusted by the correction term $\delta(1-g)$. The correction is all the more important as the sovereign probability of default g is low and the expected recovery in case of bail-out δ is high.

The borrower can either go to the interbank market or get central bank liquidity.[5] On the interbank market, the borrower's expected payment is $(1-b)r$. As for central bank liquidity, the expected payment is $(1-b)r^{cb}$.[6] Hence, the borrower's participation constraint is:

$$r < r^{cb} \tag{2}$$

We observe an interbank market transaction only if the lender prefers the interbank market to the deposit facility ((1) is satisfied) and the borrower prefers the interbank market to central bank liquidity ((2) is satisfied). The borrower uses central bank liquidity instead if $r > r^{cb}$. There is no room for interbank market transactions if the lender's reservation rate is higher than the central bank rate, that is if the probability of default b is high enough:

$$b(1-\delta(1-g)) > \frac{r^{df} - r^{cb}}{r^{cb}} \tag{3}$$

This shows that interbank market access will also be a function of borrower's probability of default and its sovereign's. As the central bank offers an outside option for liquidity whose price is risk insensitive, riskier banks will be left out of the interbank market.

The lender can proxy b, the bank stand-alone probability of default, using publicly available data.

[5] The central bank lends under a collateral constraint. We do not model this constraint which anyway is not binding for a sizeable share of the borrowers distribution in the sample period of our analysis. Barthelemy et al. (2017) report the ratio of reserves borrowed to the value of the collateral pool after haircuts in June 2012 for the 177 largest euro area banks. They find only 11% of banks had a utilization rate of the pool greater than 90% (20% had a utilization rate greater than 80%.)

[6] r^{cb} is fixed under the fixed-rate full-allotment regime that the ECB has started in October 2008.

b is the probability that the capital ratio K falls below a regulatory threshold $\underline{\mathrm{K}}$:

$$\begin{aligned} b &= P(K < \underline{\mathrm{K}}), \\ &= P(\frac{\sum_i \mu_i A_i}{k} < \underline{\mathrm{K}}) \end{aligned}$$

with k the bank equity, $(A_i)_{i=1,...}$ the collection of the banks' assets and $(\mu_i)_{i=1,...}$ their respective riskiness. EBA data provide variables to proxy for b as they disclose equity positions, assets composition by sector and location and risk measures (non-performing exposures).

The central bank monetary policy affects interbank market functioning in a variety of ways. First and foremost, by setting r^{df} and r^{cb}, the central bank affects the reservation rates for the borrowing and lending banks.[7] Second, by purchasing assets or committing to do so, the central bank affects their prices. This can spur risk assessment revisions of various assets holdings. Lenders can become less sensitive to the quality of borrowers' holdings of assets they know the central bank will buy anyway.

Last, introducing liquidity operations that are conditional on the expansion of the bank's balance sheet is also likely to change interbank market pricing and access.[8] TLTROs make part of central bank liquidity access conditional on future lending to the real economy. For each bank, the central bank computes a future lending threshold $\underline{\mathrm{l}}$. The borrower's probability of default b is a function of future lending to the real economy. Because capital requirements are an increasing function of banks' assets and risk, we assume b is decreasing in future lending to the real economy. Supervision ensures that new lending does not increase the bank's probability of default. We denote by $\underline{\mathrm{b}}$ the borrower's probability of default consistent with $\underline{\mathrm{l}}$. When central bank liquidity access is conditional on future lending, r_{cb} in the borrowers' participation constraint becomes:

$$r^{cb} = \begin{cases} r^{tltro} \text{ if } b < \underline{\mathrm{b}} \\ r^{mro} \text{ if } b \geq \underline{\mathrm{b}} \end{cases}$$

r^{tltro} is a synthetic interest rate summarizing all costs of borrowing at the central bank's TLTRO: the interest rate per se ($r^{mro} + 10$ bps)[9] and the maturity premium subsidy as the central bank lends for a longer period of time (*de facto* eliminating roll-over risk). r^{mro} is the main refinancing operations

[7] By providing ample liquidity, the central bank alleviates liquidity risk. This could in itself affect interbank transactions as borrowers may prefer central bank refinancing to interbank liquidity. In our framework we rather focus on solvency issues.

[8] See section 4 for details on the ECB monetary policy during the period under study.

[9] See ECB (2014b).

rate. As main refinancing operations have a much shorter maturity than TLTROs, accounting for the maturity premium we have $r^{tltro} < r^{mro}$. The new liquidity providing operations are thus likely to affect interbank market participants. Before their introduction, the central bank rate r^{cb} was uniform across borrowers. Afterwards, the cost remains the same (r^{mro}) for banks with $b \geq \underline{b}$. For banks with $b < \underline{b}$, on the contrary, central bank liquidity is now cheaper which should make borrowers less willing to trade on the interbank market (equation (2)). Banks with $b < \underline{b}$ are also less likely to trade on the interbank market because their participation constraint (equation (3)) becomes more binding.

This simple framework predicts that (i) interbank rates (market access) increase (decrease) in the borrower's and its sovereign's probability of default; (ii) interbank rates (market access) can react differently depending on the size and riskiness of different asset holdings; (iii) conditional pricing of central bank liquidity may be channeled onto the interbank market.

4 Data and euro area monetary policy from 2011 to 2015

We combine data on unsecured euro-denominated interbank loans identified from TARGET2, the European large value payment system, with balance sheet composition data disclosed by the EBA for 115 banks, at a consolidated level. We work with weekly lender-borrower (bank-to-bank) information on amounts traded and interest rates paid (gained) on interbank loans.

4.1 Unsecured interbank loans retrieved from TARGET2 data

A Euro-denominated loan between two euro area banks, say bank A and bank B, consists of a 'send' transaction whereby A provides the agreed loan amount to B and a 'refund' transaction whereby B reimburses A of the loan, paying a certain interest rate on the notional amount received. These 'send' and 'refund' transactions between euro area banks are mainly settled via TARGET2, the large-value payment system owned and managed by the Eurosystem.[10]

We use interbank payments settled through TARGET2 to identify unsecured money market transactions (i.e. interbank loans) with overnight maturity. We rely on a methodology recently developed

[10] In 2015, TARGET2 processed 91% of the total value settled by large-value payment systems in euro (figures for the previous years of our sample are very close). This confirms the leading position of TARGET2 in the EU and world payment landscape (with a daily average of 343,729 transactions and EUR 1,835 billion settled in 2015, TARGET2 is one of the largest payment systems in the world, alongside Fedwire in the United States and the CLS multi-currency cash settlement system). See ECB (2016).

by the Eurosystem (Arciero et al., 2016) - a refined version of the Furfine (1999) algorithm - to find loan-refund combinations from payments data. In its simplest form the algorithm assumes a round value transferred from bank A to bank B at time t and the same value plus a plausible interest rate amount from bank B to bank A at time t+1. Among other enhancements, Arciero et al. (2016) investigate several areas of plausibility for implied interest rates (i.e. several interest rate corridors) and develop a method to choose the most plausible duration in case of multiple loan-refund matches. The implementation has been comprehensively validated against actual interbank loans data. Importantly, our dataset contains not only the settlement banks, but also the originator and final beneficiary of each transaction. The typical identification problem of numerous false positives pointed out by Armantier and Copeland (2012) for the Fedwire payment system is thus less prevalent in our data. [11] [12]

Fig. 1 provides an overview of weekly average market turnover and weekly weighted average interest rate on the interbank market from January 2011 to end-August 2016. We also report the marginal lending facility (ML) and deposit facility (DF) rates. At the beginning of our sample, the daily turnover on the unsecured interbank market was about 40 billion euros.[13] This turnover decreased sharply until reaching less than 10 billion euros between July 2012 and March 2013. Activity increased then until mid-2014, when the turnover exceeded 25 billion euros. Since then, activity has receded again and the average daily turnover in 2016 was about 10 billion euros. As regards the average interbank rate, it tracks the movements of the DF rate. It was quite volatile from January 2011 to January 2012. Volatility has receded since then. The interbank rate gets closer to the DF rate, except for the period of stronger activity from early 2014 to mid-2015. The rate has reached negative territory since mid-2014.

In this paper, we analyze the dispersion of interbank rates around this average behavior. Indeed, GIIPS risk has been a key concern for policymakers over the sample period of our analysis. Figure 2 plots weekly market turnover and interest rates prevailing in the market from 2011 to 2015 for borrowing banks headquartered in a GIIPS country and for non-GIIPS banks. We observe that GIIPS banks pay on average higher interest rates throughout the sample period compared to non-GIIPS, with the

[11] Validation of the implementation through actual interbank loan data reveals that the 'refined' Furfine algorithm used for our dataset correctly identifies about 99% of all e-MID trades, and over 90% of all trades reported in MID. This corresponds to a very low Type 2 error of 0.92% for the best algorithm set up, of which only 0.26% represent wrong matches (see Arciero et al. (2016) for more details). Such a good performance stands in contrast with the validation exercise of Armantier and Copeland for the US, performed on a plain-vanilla implementation of the Furfine algorithm.

[12] Rainone and Vacirca (2016) warn against over-estimating the number of zero rate loans when implementing Arciero et al. (2016) in the negative deposit facility rates environment (from June 2014). Zero-rate loans are negligible in our estimation sample over this period and we provide results excluding. Distributions of rates in each monetary policy period are reported in Appendix (Figure A.3). Results excluding zero-rates loans are reported in Appendix A.3. They are similar to results including them.

[13] The daily turnover was about 130 bn Euros in July 2008.

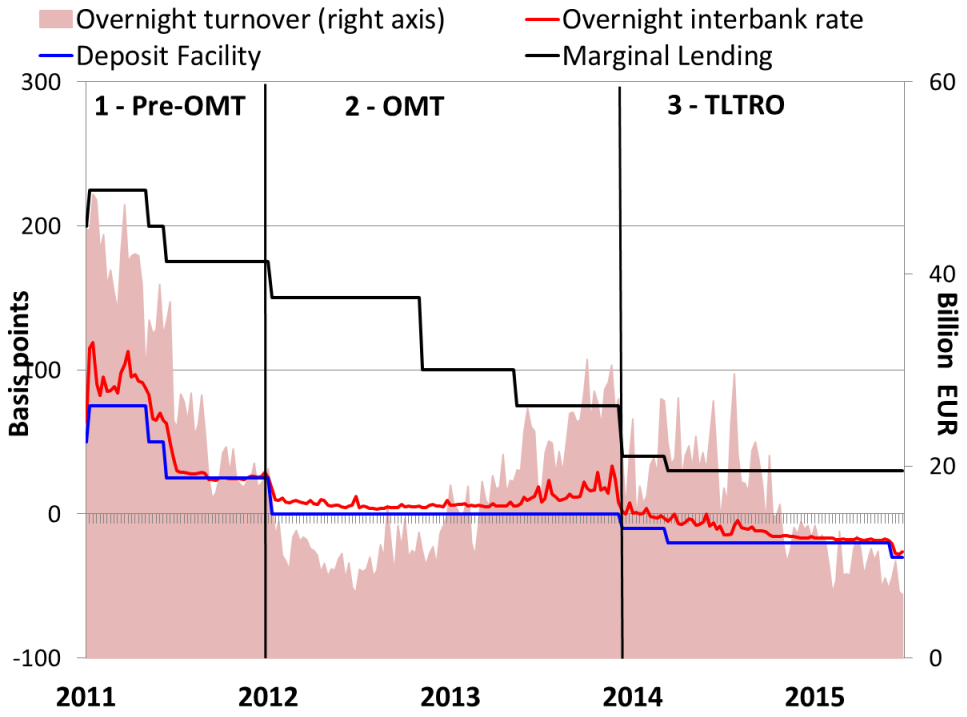


Figure 1: Weekly average market turnover and weekly average interest rate in the euro area overnight interbank market.
Source: TARGET2 data, ECB, authors' computations.
Note: The vertical lines delimit three monetary policy periods: Period 1 (pre-OMT): July 2011 - July 2012; Period 2 (OMT programme): August 2012 - June 2014; Period 3 (TLTRO): July 2014 - December 2015. Market turnover is computed on a daily basis, then averaged over a week. Averages of interest rates are volume-weighted

difference being particularly large before the first 3-year LTRO (December 2011) and in 2012 until the announcement of the OMT programme (August 2012). Borrowed volumes decreased both for GIIPS and non-GIIPS banks until August 2012, although the reduction was significantly larger for non-GIIPS borrowers. Borrowed volumes recovered for non-GIIPS after the announcement of the OMT, while they continued to decrease and then stabilized for GIIPS.

Figures 1 and 2 illustrate the strong interactions between central bank operations (the primary market for liquidity) and the interbank market (the secondary market for liquidity). As described in the stylised model of section 3, the ECB monetary policy can influence interbank market conditions through two main channels: its role as liquidity provider and its interventions on assets markets.

The first channel corresponds to conventional monetary policy and has been deepened by uncon-

ventional measures. The goods provided on the primary and secondary markets for liquidity are close substitutes. Since October 2008, the Eurosystem operates under 'fixed-rate full allotment'.[14] The ECB pre-announces its main interest rate and banks ask for the quantity of liquidity they want at this price. The central bank supplies all the liquidity required, provided banks have sufficient collateral available. The ECB main refinancing rate thus acts as an upper threshold on interbank rates. The DF rate acts as a lower threshold - lending on the interbank market cannot be less profitable than holding central bank reserves.

Providing liquidity at longer maturities may also affect interbank market access. Very Long Term Refinancing Operations (VLTROs, with a 3-year maturity) compress the term premium and eliminate roll-over risk for borrowing banks. The amount of long-term liquidity supplied through Targeted Long Term Refinancing Operations (TLTROs) is an increasing function of the borrower's supply of credit to the real economy. This makes borrowers' reservation rates a function of their future lending. This condition is likely to affect in turn interbank market participation (see section 3).

Interbank market functioning can also be hampered or improved by ECB interventions on asset markets. Holdings of risky assets can be priced in interbank lending rates. But ECB asset purchases could spur revisions of assets riskiness. In August 2012, the Governing Council announced its readiness to undertake Outright Monetary Transactions (OMTs) in secondary markets with regard to euro area sovereign bonds. These aimed at supporting the transmission mechanism and singleness of euro area monetary policy. OMTs replaced the previous Securities Markets Programme (SMP). ECB (2012) states OMTs contributed to an overall improvement in financing conditions as stressed countries' government bond yields declined. Lenders may thus have stopped pricing sovereign exposures, or reduced the extent to which they had done so. In 2014, the ECB launched two purchases programmes for selected private sector assets (ECB, 2014a): the asset-backed securities purchases programme announced in June for September and December 2014, and the covered bond purchases programme announced in September for October 2014. Again, this could have spurred a risk assessment revision and alter who was accepted on the interbank market and the rates served.

To account for the interdependency between the interbank market and monetary policy, we slice our sample into three periods (see Table 1). The first period spans July 2011 to July 2012.[15] During this period, the ECB first increased its policy rates by a total of 50 basis points because of inflationary

[14] See Vari (2016) for the impact of the fixed-rate full allotment mechanism on liquidity prices in the Euro Area. Drechsler et al. (2016) find weakly capitalized banks took out more LOLR loans.

[15] We take July 2011 as starting date of our sample because EBA data were disclosed for the first time in July 2011. No such detailed disclosure on asset holdings was available before.

Period 1	Pre-OMT	July 2011 - July 2012
Period 2	OMT programme and deposit facility rate at 0	August 2012 - June 2014
Period 3	Targeted LTRO (TLTRO) and negative deposit facility rate	July 2014 - December 2015

Table 1: Three Monetary Policy Periods

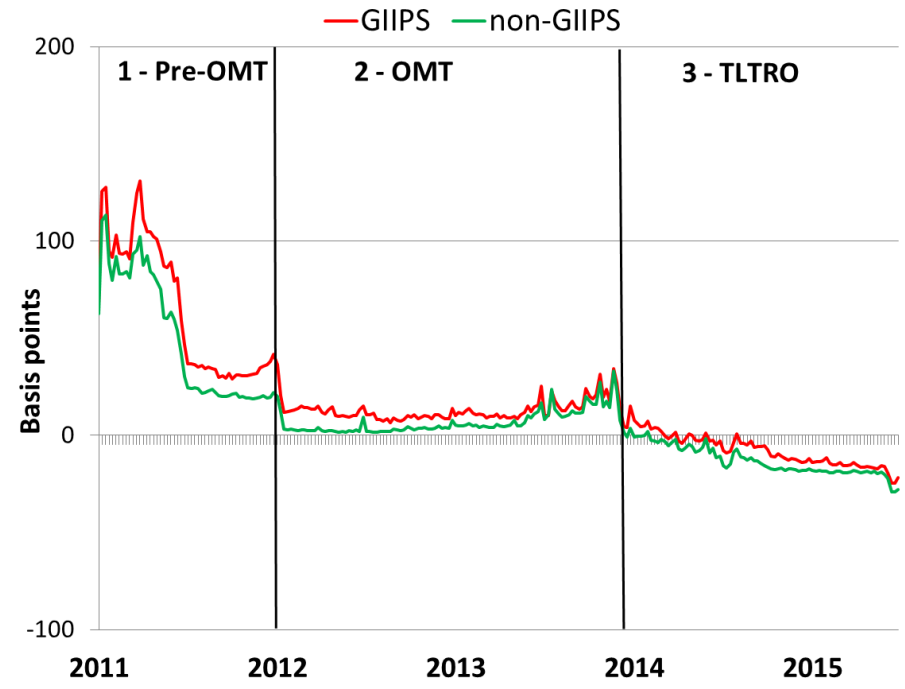
pressures linked to commodity prices. Rates were then cut by the same amount in two steps (November and December 2011). In August 2011, the Governing Council announced it would continue to provide liquidity through fixed-rate full allotment procedures and the SMP, initially focusing on Greek, Irish and Portuguese debt securities, was extended to include Italian and Spanish bonds. [16] Two longer-term refinancing operations (one-year maturity) were announced in October, to support bank funding and encourage banks to lend to households and non-financial corporations (ECB, 2011).[17] Two large three-year liquidity injections (VLTROs) followed in December 2011 and March 2012. In July 2012, the ECB cut its policy rates by 25 basis points.

The second period starts in August 2012 with the OMT announcement and ends in June 2014. This period witnessed two interest rate cuts due to diminished inflationary pressures. The ECB has also started using 'forward guidance' (July 2013) by announcing it expected the rates to remain at present or lower levels for an extended period of time (ECB, 2013).

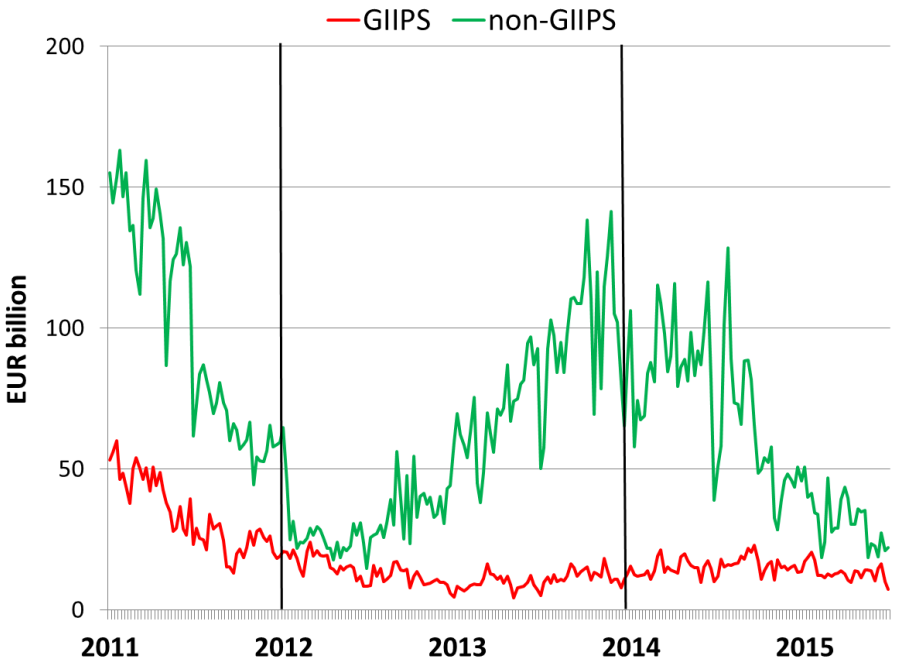
The third period covers July 2014 to December 2015. It is characterized by a switch from a policy focus on malfunctioning debt securities markets to a focus on incentivizing lending to the private non-financial sector. Between June and October 2014, the ECB cut its rates to the effective lower bound and introduced a series of Targeted LTROs with maturity up to 4 years to stimulate lending to the real economy. The ECB private sector asset purchase programmes allowed intervention in markets where the pass-through to the borrowing conditions of the euro area non-financial private sector is high.

[16] The SMP was announced in May 2010 'to safeguard an appropriate monetary policy transmission and the singleness of the monetary policy'. The programme aimed to address the malfunctioning of certain government bond markets. It worked via the purchase of sovereign debt securities on secondary markets (liquidity-providing effects were sterilized).

[17] In addition, in September, in coordination with other central banks, the Governing Council announced three three-month U.S. dollar liquidity-providing operations.



(a) Rates.



(b) Volumes.

Figure 2: Weekly market turnover and weighted average interest rate in the euro area overnight interbank market for GIIPS and non-GIIPS banks.

Source: TARGET2 data, ECB, authors' computations.

Note: The vertical lines delimit three monetary policy periods: Period 1 (pre-OMT): July 2011 - July 2012; Period 2 (OMT programme): August 2012 - June 2014; Period 3 (TLTRO): July 2014 - December 2015.

4.2 EBA Exposures Data

To understand rates dispersion in each of the three monetary policy periods defined above, we augment TARGET2 interbank loans data with data disclosed by the EBA since 2011 through transparency and stress tests exercises. The EBA data provide detailed information on the composition of bank balance sheet once or twice per year. In particular, banks' exposures are broken down by sectors (sovereign, retail, corporate) and counterparties' geographic location.

We compile data from the 2011, 2014 and 2016 Stress Test exercises, the 2012 Capital Exercise and 2013 and 2015 Transparency Exercises. We observe balance sheets, profit and loss accounts and exposures data for December 2010, December 2011, June and December 2012, June and December 2013, December 2014 and June and December 2015. For each borrowing bank identified in the interbank market in a given week of year t, we add information on its exposures as of end-December of year t-1. We replace these data by data as of end-June of year t for the second semester of year t when available.[18]

We work at the consolidation level defined by the EBA data. Consistently, we consolidate interbank trading data at this same observation level, i.e. we eliminate all intra-group transactions.

The sample of banks included in the various EBA exercises varies. From 2011 to 2015, the sample satisfied a criterion of minimum representativeness of the EU-wide as well as national banking sectors. The 2016 exercise sample rather focused on the biggest institutions.[19] The set of borrowers considered in our analysis is the intersection of the set of banks in EBA exercises and the set of banks active on the unsecured interbank market. There are 115 such borrowers, 51 of which are headquartered in a GIIPS country.[20] On the lender side, we restrict the sample to banks whose home country participated

[18] We present results for the database assuming lenders never observe or access information on cross-border exposures before EBA publication and consider only the last value published in Appendix A.4.

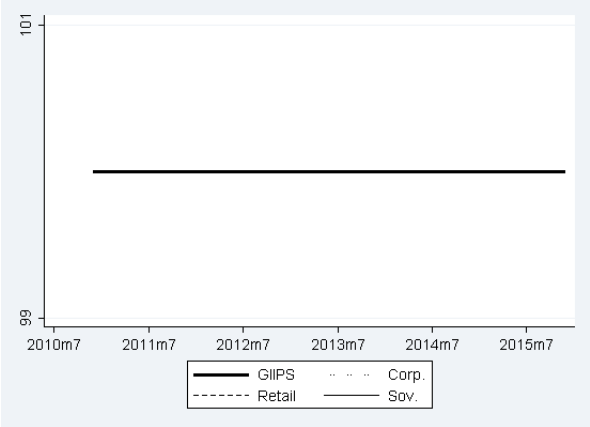
[19] The 2011 EU-wide stress test exercise was carried out on a group of banks covering over 65% of the EU banking system total assets, and at least 50% of the national banking sectors in each EU Member State, as expressed in terms of total consolidated assets as of end of 2010. The 2012 Capital Exercise sample consists of the same banks that participated in the 2011 stress test exercise, although a subset of small non cross-border banks was exempted. The 2013 EU-wide Transparency exercise provides updated information on the European banks that were part of the recapitalization exercise in 2012. The 2014 stress test exercise was carried out on a group of banks covering at least 50% of the national banking sector in each EU Member state, as expressed in terms of total consolidated assets as of end 2013. The 2016 exercise was carried out on a sample of banks covering broadly 70% of the banking sector in the Eurozone, each EU Member State and Norway (as expressed in terms of total consolidated assets as of end 2014). To be included in the sample, banks have to have a minimum of EUR 30 billion in assets (consistently with the definition of SSM significant institutions).

[20] Such a restriction reduces our sample from 526,096 to 363,233 daily observations. The restriction is however much less important in terms of overnight market turnover: our sample covers about 90% of the overall estimated daily turnover for 2011 and 82% on average for the following years. The sample of banks taking part to the EBA stress test or transparency exercises is not the same across years; thus our panel is unbalanced.

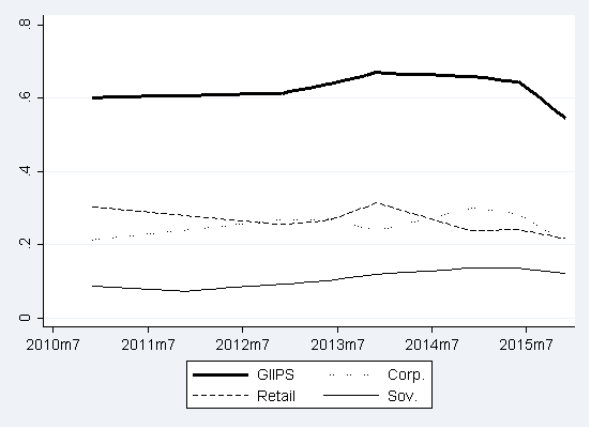
in the EBA exercise.

We extract from EBA data banks exposures broken down by type (sovereign, retail, corporate) and counterparties' geographical location as well as banks capital ratios.[21] Figures 3a to 3e present how exposures to GIIPS assets have evolved between 2011 and 2015. Throughout the period, all the GIIPS banks in our estimation sample have been exposed to GIIPS assets of every type (Figure 3a). GIIPS assets represent on average 60% of banks' balance sheets (Figure 3b): GIIPS sovereign exposures account for about 10% of the balance sheet, and retail and corporate assets for about 25% each. Figure 3c shows that, depending on the period considered, between 80% and 90% of non-GIIPS banks are exposed to GIIPS countries. Most of them are exposed through sovereign assets. The size of GIIPS assets is however much smaller in terms of balance sheet share than for GIIPS banks, consistently with the expected home bias (Figure 3d). This is confirmed by the distribution of GIIPS exposures over total assets for both GIIPS and non-GIIPS banks (Figure 3e).

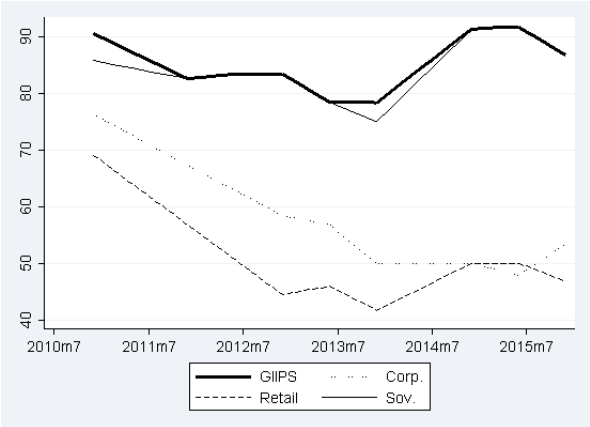
[21] As retail and corporate exposures are not available for the 2012 capital exercise, we use the value from the 2011 disclosure.



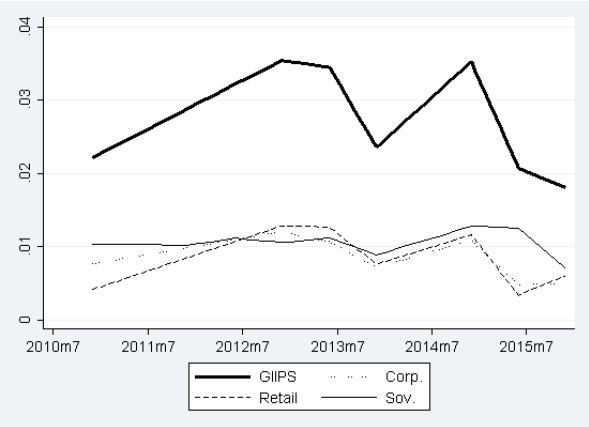
(a) Share of GIIPS borrowers exposed to GIIPS assets.



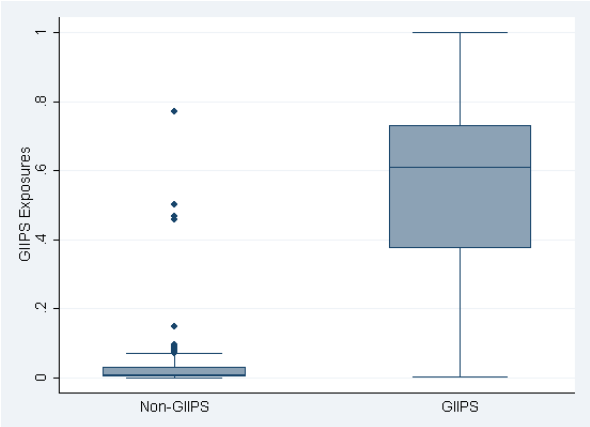
(b) Share of GIIPS assets in GIIPS borrowers balance sheet (% total assets).



(c) Share of non-GIIPS borrowers exposed to GIIPS assets.



(d) Share of GIIPS assets in non-GIIPS borrowers balance sheet (% total assets).



(e) Distribution of GIIPS Exposures: GIIPS and non-GIIPS Banks.

Figure 3: GIIPS exposures across GIIPS and non-GIIPS banks

Source: EBA data, authors' computations.

5 Estimation

5.1 Identification strategy

We want to identify how GIIPS risk is accounted for on the interbank market, through both market access and interest rates. We thus test whether interbank market conditions differ for borrowers more heavily exposed to GIIPS assets. Non-GIIPS exposures to GIIPS assets help us disentangling the sovereign-dependence from the balance sheet (credit risk) sources of fragmentation.

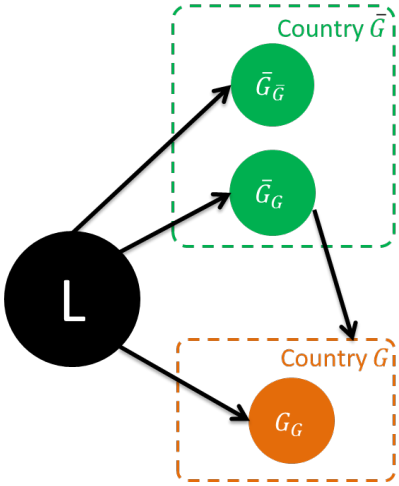


Figure 4: Interbank and cross-border exposures.
Note: Arrows denote exposures of either (i) a lender L to a borrower B located in country $\bar{G}$ (non-GIIPS) or G (GIIPS), or (ii) a borrower B to country G. Banks in a given country are exposed to assets located in this country.

The mechanism is illustrated in Figure 4. Let us consider a lending bank L. Bank L lends to different banks. Borrowing banks are situated in two different countries, G (GIIPS) and $\bar{G}$ (non-GIIPS). Some banks situated in country $\bar{G}$ are exposed to assets located in country G. We consider three types of banks: (i) G_G are peripheral banks with GIIPS exposures; (ii) $\bar{G}_G$ are non-peripheral banks with GIIPS exposures; (iii) $\bar{G}_{\bar{G}}$ are non-peripheral banks without GIIPS exposures.

For identification, we cannot consider directly the conditions for bank G_G, located in a GIIPS country and exposed to GIIPS assets because they are both explained by its location in a GIIPS country and its large exposures to GIIPS assets. In equation 1, the reservation rate depends on both b the banks' probability of default and g the sovereign's probability of default and their effects cannot be separately identified. This issue becomes all the more stringent when systemic risk increases, as banks

turn back home and increase their domestic sovereign holdings (Battistini et al., 2014). Identification therefore relies on $\bar{G}_G$ banks: they are also exposed to GIIPS assets, but are located in a non-GIIPS country. For them, the sovereign default risk g is zero, which allows identifying the effect of b in equation 1.

The variance in GIIPS assets holdings amongst non-GIIPS borrowers ($\bar{G}_G$ and $\bar{G}_{\bar{G}}$) helps us identifying the effects of GIIPS exposures, separately from the influence of the domestic sovereign. For the set of non-GIIPS banks, the sovereign's probability of default is very low ($g \to 0$) so the lender's participation constraint (equation 1) boils down to

$$r > \frac{1}{1 - b(1-\delta)} r^{df} \tag{4}$$

and the condition for interbank market transactions to be feasible (equation 3) becomes

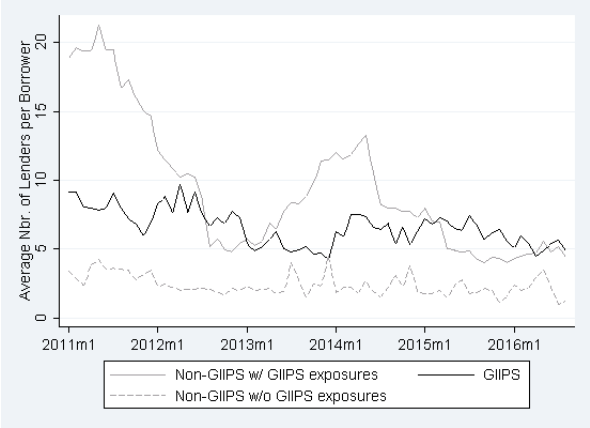
$$b(1-\delta) > \frac{r^{df} - r^{cb}}{r^{cb}} \tag{5}$$

In both cases, conditions are independent of g. This allows us to clearly identify the role of the borrower's default probability (b), focusing on the contribution of GIIPS exposures to it.

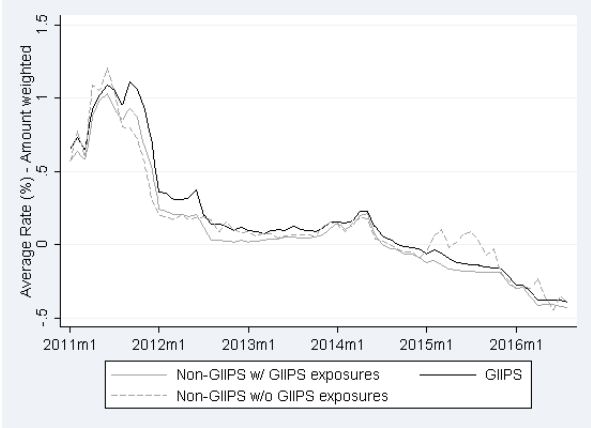
For the sake of completeness, we also provide comparisons of interbank market conditions across GIIPS and non-GIIPS borrowers. We thus compare interbank market conditions obtained by peripheral banks (G_G) with those of non-peripheral banks ($\bar{G}_G$) when both types are exposed to GIIPS. Indeed, when we work with the full distribution of GIIPS exposures (Figure 3e) estimation is complicated by the concentration of GIIPS exposures amongst GIIPS borrowers.

Figures 5a and 5b compare the average number of lenders and average borrowing rate across the three types of banks mentioned above. Non-GIIPS banks with GIIPS exposures are more dynamic on the interbank market than other bank types: on average over the period, they have a significantly higher number of active links (counterparties with which they have traded at least once over a two-weeks period) than the two other types. This may be due to the fact that these banks are big internationally active players, something we will control for in the estimation. The number of lenders decreases over the period for GIIPS banks, from about 10 in early 2011 to about 5 at the end of 2015; it also decreases for non-GIIPS banks without GIIPS exposures, from 3 in early 2011 to 2 at end-2015. Regarding loan rates (Figure 5b) we note that, if the average rates do differ by bank type, they follow similar patterns over time. In early 2011, GIIPS banks pay higher rates than non-GIIPS banks with GIIPS exposures.

But non-GIIPS banks without GIIPS exposures pay an even higher rate. From mid-2011 to mid-2013, GIIPS banks pay higher rates than respectively non-GIIPS banks with GIIPS exposures and without GIIPS exposures. This suggests that part of the price difference between GIIPS and non-GIIPS banks corresponds in fact to GIIPS exposures risk pricing. Since mid-2013, GIIPS banks pay higher rates but the smaller average rates are for the sample of non-GIIPS banks with GIIPS exposures.



(a) Average number of lenders by bank type.



(b) Average interest rates by bank type.

Figure 5: Average number of lenders and average loan rate across GIIPS and non-GIIPS banks

Source: TARGET2 data, EBA data, authors' computations.
Note: We present the average number of counterparties for borrowers, at monthly frequency. Rates are average interest rates on our estimation sample, weighted by the total amount traded between two banks, at monthly frequency.

5.2 Specification

To pin down the relative effect of having a 'bad' balance sheet (large and/or bad exposures to GIIPS assets) and having a 'bad' sovereign, we estimate:

$$y_{i,j,t} = \mathbb{1}_{Period}[GIIPSExposures'_{j,t}\beta + X'_{j,t}\gamma + Z'_{i,j,t}\theta] + \lambda_{i,t} + \mu_{c,t} + \nu_j + \epsilon_{i,j,t}$$

$y_{i,j,t}$ is either $Link_{i,j,t}$ or $Spread_{i,j,t}$. $Link_{i,j,t}$ is a dummy for the link between bank j (borrower) and bank i (lender) being active in week t (at least one loan is traded during week t). It is equal to 1 at date t if we can observe a transaction between bank j and bank i in week t, it is set to 0 otherwise (see subsection 5.3 for the construction of the matrix of relevant lenders). $Spread_{i,j,t}$ is the difference between the annualized (amount-weighted) average interest rate paid by bank j to bank i for overnight

liquidity in week t and the deposit facility rate.[22]

$\mathbb{1}_{Period}$ is a time period indicator, where each entry takes value 1 in the corresponding monetary policy period (periods as defined in Table 1). We thus interact this period indicator with the set of interest and control variables (excluding fixed effects). This allows to assess the marginal effect of the regressors in each of the three periods of our sample (for period 2 and period 3 the estimated coefficients provide the marginal effect compared to period 1).

β is the vector of coefficients of interest. $GIIPSExposures_{j,t}$ is a set of measures of the size and riskiness of bank j GIIPS-related assets. These include: the size of sovereign, corporate and retail exposures to GIIPS countries (computed by summing exposures in all the six GIIPS countries considered) normalised by bank j total assets; the share of non-performing out of total GIIPS exposures; the average CDS on GIIPS sovereigns (average of GIIPS sovereigns' CDSs weighted by the corresponding borrower's sovereign exposures). We use end of the previous year or mid-year data from EBA datasets to build these variables. They capture the balance sheet -credit risk- source of financial fragmentation.

$X_{j,t}$ is a set of time varying controls for bank j characteristics: its rating[23], size (log of total assets)[24] and capital ratio (at the end of the previous year or mid-year as available in EBA datasets). The rating and the capital ratio control for the distance to default of borrower j. The size variable accounts for the specific role of the biggest banks on the interbank market as well as the fact that some institutions are perceived as 'too-big-to-fail'. We control for all time invariant bank characteristics thanks to the borrowing bank fixed effects ν_j.

$Z_{i,j,t}$ is a set of transaction-level controls: a cross-border transaction dummy and the amount traded when the outcome variable is $Spread_{i,j,t}$. The cost of being exposed to GIIPS countries can be higher for cross-border relative to domestic interbank transactions. For example, information can be easier to gather on banks headquartered in the same country. Furthermore, a lending bank can expect domestic debtors to be preferred to foreign ones in liquidation hence request a premium for cross-border transactions.

[22] The dependent variables are constructed at a weekly frequency while the independent variables $GIIPSExposures_{j,t}$ and $X_{j,t}$ are available at semi-annual or annual frequency.

[23] Ratings are extracted from Bloomberg or SNL. We use data from any rating agency, depending on availability and convert them into a general scale. Because of data availability issue, we often work with a constant rating through the sample period.

[24] Assets data come from SNL or banks' annual reports.

$\lambda_{i,t}$ is a set of lending bank x time (week) fixed effects, allowing to control for supply-side dynamics on the credit market. [25] For example, a lending bank in a non-GIIPS country might also suffer from a negative liquidity shock and decide to charge a higher rate to two banks from a peripheral country. However, as soon as the two borrowing banks have different shares of exposure on GIIPS, the impact of these shares on the borrowing rate is identified cleaned from the liquidity shock impacting the lending bank. The lending bank x week fixed effect also allows controlling for the lender being a sound trading partner for the borrower, which can affect trading conditions (as in Afonso et al. (2014) or Bräuning and Fecht (2017)).

Finally, we include a set of borrower country x time (week) fixed effects $\mu_{c,t}$. They capture the sovereign-based source of financial fragmentation. Including these, we rely on within borrowers' countries variation as source of identification, leaving aside all cross-country dispersion. That is, we control for any time-varying development at the level of borrowers' countries, especially sovereign risk. This also controls for data patterns in foreign assets holdings. If non-GIIPS exposures to GIIPS assets are concentrated in a handful of countries, we risk capturing macroeconomic developments in these countries instead of the effects of GIIPS exposures per se.

All errors are clustered at the borrower level. We provide results for the set of non-GIIPS borrowers only (yielding the cleanest estimates of the effect of GIIPS exposures on interbank access and loan rates) and for the whole set of borrowers.

5.3 Relevant Interbank Market Networks

In the extensive margin estimation, we study how the probability for a given borrower to find a lender on the interbank market is affected by the riskiness of its assets. This estimation, performed at lender-borrower level, requires us to define, for each borrower, at each week t, the set of relevant lenders it could trade with. Is it, for each and every borrower, the set of all possible lenders in the market? Or is it more appropriate to disregard occasional (rare) lender-borrower links?

Figure 6a graphs the number of lenders active on the unsecured interbank market between 2011 and 2016. At the beginning of the period, we observe almost 500 lenders on the market in a month. The number decreases sharply until mid-2012, when we observe a little more than 200 lenders. Activity increases then until mid-2014 (about 300 lenders), but recedes again afterwards (about 100 lenders at

[25] Including lender x time fixed effects notably controls for lenders' liquidity hoarding behaviour. Afonso et al. (2011) show that counterparty risk plays a larger role than liquidity hoarding on the U.S. interbank market in the two days after Lehman Brothers' bankruptcy.

end-2015). We observe a similar pattern for the number of borrowers (Figure 6b) - which goes down from about 100 at the start of the sample period to about 65 at the end of 2015 - and for the number of lender-borrower couples (Figure 6c), which decreases from 2300 active bank-to-bank links at the start of 2011 to less than 500 at the end of our sample.

The general pattern of these time series is consistent with the developments of interbank market turnover (Figure 1). Changes in turnover amounts are thus not only changes in the average size of loans traded, keeping constant the network of participants. The interbank market also adjusts through the number of banks active on it.

Comparing the number of lenders and borrowers, on the one hand, with the number of (lender, borrower) couples, on the other, underlines the need to precisely delineate the set of relevant counterparties on the interbank market. If we consider that any lender can trade with any borrower, we may end up defining too big a set of relevant (lender, borrower) couples. For example, at the beginning of our sample, considering the full set of 500 lenders who can trade with the full set of 100 borrowers would make us work with a set of 50,000 (lender, borrower) couples. The corresponding network of links would be very sparse (i.e. filled with many zeros). In terms of the outcome variable $Link_{i,j,t}$, used on the left-hand side of the estimation, we could overestimate a selection effect in the market while in fact most of the possible links are structurally very unlikely.

As shown by Figure 6c, the set of observed (lender, borrower) couples has only 2,300 elements (corresponding to only 4.6% of the number of all possible links). This network sparsity is consistent with results on other interbank networks, for which it has been documented that few banks have many counterparties while most banks trade with a only a few others. The network density (ratio of the number of observed to the number of possible links) is about 1% in Germany (Craig and von Peter, 2014), 3% in the UK (Langfield et al., 2014), 8% in the Netherlands (in't Veld and van Lelyveld, 2014) and varies between 10% and 20% in Italy (Fricke and Lux, 2015).

We include a given lender in the relevant set of counterparties for a given borrower only if we do observe at least one transaction between them during our sample period. We therefore choose a conservative approach and define, for each borrower, at each week t, a set of relevant lenders. This set is borrower specific and time-varying. In the extensove margin extimations we compare this set to the set of transactions observed in TARGET2 data.

To start with, this choice prevents including in the sample links that are unlikely considering the network structure. We want to compare used and unused, not used and unlikely interbank transactions.

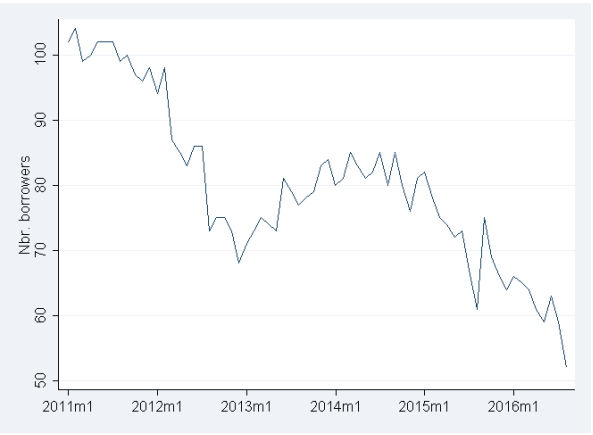
Secondly, we also want to account for the scarce persistency of interbank links. Figure 6d displays the distribution of the number of consecutive weeks in which we observe a given (lender, borrower) couple. The median of this distribution is 1, meaning that the interbank links we observe are very rarely persistent. Constant interbank links are an exception: 95% of the links we observe last for at most 7 weeks.[26] This underlines the importance to have a time-varying set of relevant lenders, to avoid mistaking spot transactions for relationship lending. This latter form of interbank links are especially important on the over-the-counter interbank market, as shown by Cocco et al. (2009) for Portugal, Afonso et al. (2014) for the U.S., Affinito (2012) for Italy and Bräuning and Fecht (2017) for Germany.

Therefore, we include a lender in the set of relevant potential counterparties for a given borrower if they have traded in week t and in week $t-1$. By construction, the set of lenders is borrower and time-specific. Spot transactions are also included but they do not add noise to our sample by being overly represented. The density of the so defined network (ratio of the number of observed to the number of possible links) is 59.8%.

To sum-up, for each borrower, in a given week, the set of relevant lenders is the set of lenders observed this week and the set of last week lenders. This matrix is filled with 1 when the (lender, borrower) couple is observed in TARGET2 data, with 0 otherwise.

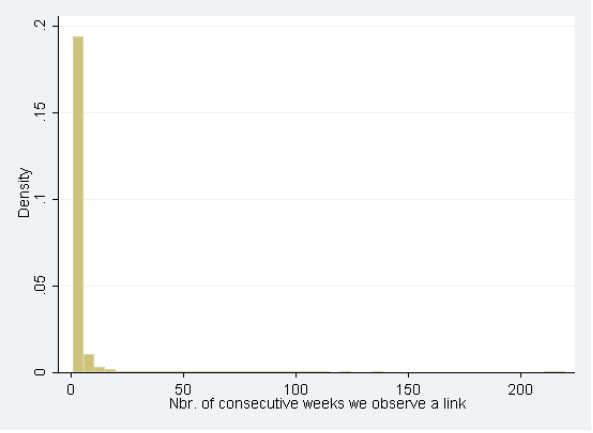
[26] By construction, we do not observe rollover in TARGET2 data as there is no exchange of principal. This certainly reduces the persistence of interbank relationships.

(a) Number of Lenders on the Unsecured Interbank Market.



(b) Number of Borrowers on the Unsecured Interbank Market.

(c) Number of Couples (Lender, Borrower) on the Unsecured Interbank Market.



(d) Interbank Links Persistence.

Figure 6: GIIPS exposures across GIIPS and non-GIIPS banks

Source: TARGET2 data, authors' computations.

Note: Descriptive statistics for the whole interbank market estimated from TARGET2 for the first three figures. In the last figure, sample is the intersection of the interbank market estimated from TARGET2 and borrowers to be found in EBA data.

6 Results

6.1 Balance sheet credit risk

Results are discussed against the following predictions: before the OMT, we expect GIIPS (sovereign but also retail and corporate) exposures to be priced in interbank rates and lenders to be sensitive to the underlying risk when choosing their counterparties. After the OMT, lenders might revaluate the riskiness of GIIPS exposures: following the ECB commitment to sovereign asset purchases, banks could be less sensitive to sovereign risk. The OMT announcement could thus lead to a reduction in balance sheet-based and sovereign-based fragmentations alike.

Main results are reported in Table 2. In column 1, we estimate the effect of GIIPS exposures on interbank market access focusing on the sample of non-GIIPS borrowers. For the first monetary policy period, from mid-2011 until July 2012, we find a significant and large negative effect of the ratio of GIIPS non-performing out of total GIIPS exposures on the probability to observe an interbank link. That is, controlling for supply-side shocks and for other characteristics affecting the demand for liquidity, we find that the higher is the NPL ratio, the lower is the probability to find a lender on the interbank market. Note that the effect of GIIPS NPL on the probability to find a lender is still significant and negative after the OMT and after the launch of TLTROs, but its magnitude is much weaker than in the first monetary policy period.[27]

Access seems instead insensitive to the relative size of GIIPS sovereign debt or its riskiness ('Exposures CDS'). It does not react to the level of GIIPS retail and corporate holdings either. Focusing on the sample of all borrowers in column 2, we cannot detect a similar effect of GIIPS NPL on market access.

In column 3, we estimate the effect of GIIPS exposures on interest rate spreads in the sample of non-GIIPS borrowers. We find evidence that GIIPS sovereign debt holdings and their risk are priced in interbank rates and sizeably so during the first monetary policy period: an increase in the share of GIIPS sovereign exposures ('GIIPS Sov') by 1 percentage point raises interest rates spreads by 1.3 basis points. This represents 13% of the average spread paid by non-GIIPS borrowers in this period. An increase in GIIPS sovereigns average CDS ('Exposures CDS') by 1 unit also raises interbank spreads by 1.3 basis points.

[27] The effect in Period 2 can be computed by summing the coefficients estimated for the first and the second monetary policy periods. This provides an effect of -0.125 for the period from August 2012 until June 2014 (OMT programme) and of -0.210 for the third period (TLTRO).

However, the marginal impact of sovereign exposures on the price of interbank liquidity becomes negative in period 2 and 3. Thus, a one percentage point increase in the share of GIIPS sovereign asset holdings decreases spreads by respectively 0.08 and 2.5 basis points, or about 1% and 27% of the average spread paid by non-GIIPS borrowers in the two periods. This effect is thus especially strong after June 2014. As for sovereign exposures risk (as measured by the 'Exposures CDS' variable), while it increases spreads before the OMT, it decreases them afterwards. In particular, a 1 unit increase in this weighted average of GIIPS sovereign CDSs reduces spreads by a small 0.1% of the average interest rate spread during this period. The period 3 effect is not significantly different from the average effect in period 1. All in all, as expected, the OMT reduced the GIIPS sovereign risk pricing channel.

We do not find any evidence of GIIPS NPL ratios or exposures to retail and corporate assets impacting spreads. We repeat the same exercise on the whole sample (GIIPS and non-GIIPS borrowers) in column 4. We find a very similar effect of sovereign exposures CDS on spreads before the OMT announcement. However, for this larger sample we observe a negative effect of this variable on the spreads in period 3. But there is no similar effect of GIIPS Sovereign exposures per se.

6.2 Sovereign dependence risk

To better distinguish the balance sheet impact - driven by idiosyncratic counterparty risk - from the sovereign country risk impact, we use the (borrower country x week) fixed effects from the model in column 4 and compute country trends in interbank spreads. Indeed, when systemic risk is high and contagion very likely, lenders could react to country risk rather than to the idiosyncratic counterparty risk measured by the coefficients of our estimations (as we control for borrower's country fixed effects). The country trends, plotted in Figures 7a to 7e[28], represent a measure of interbank fragmentation that controls for individual risk characteristics, à la Horny et al. (2016).

We observe that German banks enjoyed a negative country risk premium during the first monetary policy period (on average the premium stood at -0.1 basis points; see Figure 7a). On the contrary, Spanish banks paid a 4.4 basis points country risk premium on average (Figure 7b), representing about 40% of the average spread paid by all borrowers in this period or about one fifth of the average spread

[28] Our GIIPS banks sample mostly consists of banks from Spain, Italy and Portugal. We do not observe enough banks from Greece, Ireland and Cyprus to properly estimate country trends. Our conclusion cannot be extrapolated to these countries. We can capture more banks when relaxing the construction of the set of relevant lenders for each borrower. When working under the assumption that anybody can lend to anybody at any date, we find that cross-border links are less likely than domestic transactions.

paid by GIIPS borrowers (which stood at 25 basis points). French banks paid a comparable 3.6 basis points premium on interbank rates during this period (Figure 7c). Italian banks paid the biggest country risk premium (Figure 7d). It stood at 5.6 basis points or more than half (55%) of the average spread during this period or 22% of the GIIPS borrowers average interest rate spread. As for Portuguese banks, they paid a risk premium on average but we cannot distinguish it from zero (Figure 7e).

Turning to the second monetary policy period, the country premium remains statistically insignificant for Portugal. It turns insignificant for both Spain and Italy, except for the very end of the period, when it becomes slighly negative for both countries. The French premium becomes a discount at the very beginning and the very end of the second period and insignificant in between. This evidence suggests that the OMT announcement did not only affect balance sheet fragmentation but it also reduced pure (home) country risk.

The German premium remains negative at the beginning of the second period but spikes in its second half. While this result might appear counterintuitive, it is consistent with an increase in the number of German banks active in the market during this period. As more German banks are served in the market, the average German risk observed is higher.

As for the third monetary policy period, the German premium becomes insignificant. The Spanish, French and Italian premia are in negative territory. We do not observe enough Portuguese banks to estimate the Portuguese premium during this period. Sovereign dependence risk looks thus irrelevant at the end of the sample.

6.3 Robustness

In our analysis, we compare the pricing of interbank liquidity in different monetary policy periods and document that different banks are active on the market in different periods. Thus a first robustness check consists in testing if the results are consistent when focusing on banks that we can observe across all three periods.

We present the results in Table 3. Effects of the size and riskiness of sovereign exposures and of NPL ratios are consistent with previous results. But on this sample, we find a role for retail and corporate exposures. They increase the probability to find a lender in the second monetary period for both the sample of non-GIIPS borrowers and the whole sample (columns 1 and 2). They also reduce spreads during the first monetary period (column 3): increasing the share of retail and corporate exposures

by 1 percentage point decreases spreads by 0.5 basis points or 5% of the average spread. However, during the second period, an increase in retail and corporate exposures rather increases spreads by 0.6 basis points (or 6% of the average spread paid during these period). During the third period, retail and corporate exposures went back to decreasing spreads, but the magnitude of the effect is very small.

When analysing changes in a borrower's market access, we want to consider the lenders the borrower typically goes to and whether they say yes or no. We do not want to consider lenders borrowers would never have considered in the first place. We try and get as close to this as possible defining our time-varying borrower-specific set of relevant lenders. By construction, the minimum ratio of active to relevant links is 50% in our network. In the first period, this ratio is 69% (on average across borrowers). The ratio decreases in the second and third period to respectively 66% and 63%. Average densities are not significantly different for non-GIIPS and GIIPS borrowers. These high densities suggest borrowers present on the market are in demand for liquidity and idle links would rather correspond to lenders' behaviors.

As a second robustness test, we are even stricter and compute results on the set of borrowers with a least two active links in a given week. Doing so, we avoid working with two small amounts. This helps ruling out idle links because of low demand. Results are reported in Appendix Table A.5.

Results are left unchanged for the set of non-GIIPS borrowers (columns 1 and 3). On the sample of all borrowers, however, we find evidence of GIIPS Sovereign exposures as well as NPL ratios reducing the probability to find a lender (column 2). As in the results of our main specification, the effect of NPLs is especially strong in the first monetary period. While the average effect remains negative and significant in the two subsequent periods, it is orders of magnitude smaller than in period 1. GIIPS NPLs also impact spreads on the sample of all borrowers (column 4). They decrease spreads in the first period, which is certainly a result of the strong selection on this variable documented in column 2. Larger GIIPS NPLs, however, slightly increase spreads in period 2 and 3.

In our baseline specification we include lender x time fixed effects, thus reducing the sample to lenders lending to at least two borrowers in a given week. Focusing on this set of lenders may affect results because we may end up considering only the biggest interbank market participants, whose behaviour can differ from that of the whole set of lenders. For example, because they can have easier access to information about borrowers. Therefore, as an additional test, we replace the set of lender x time fixed effects with a set of lender fixed effects and a set of time fixed effects (not interacted). Results are presented in Appendix Table A.4.

Working on this other sample significantly increases the number of observations. The number of possible links considered for non-GIIPS borrowers (all borrowers) goes from 35,383 (59,592) to 50,323 (78,423). On such big networks, we fail to find any significant determinant of the probability to find a lender. We only find some evidence that higher CDS on sovereign bonds decrease this probability in the second period. Results are more consistent when working with spreads. On the sample of non-GIIPS borrowers (column 3), we find that larger sovereign exposures decrease interbank spreads in the third period, while higher (weighted) average sovereign CDS increase spreads before the OMT. We also find an effect of NPLs on spreads on this bigger sample: a higher ratio of NPL exposures explains lower spreads in the first period but higher spreads in periods 2 and 3.

Finally, the results discussed in previous subsections have documented the existence of a selection effect on the interbank market. This may affect our results on the interest rate spreads. We account for selection bias when modelling interest rates following the Heckman two-steps procedure (Heckman, 1979). We start by estimating a probit model of selection on the interbank market. We use results to compute the inverse Mills ratio of each observation and include this variable in the interest rate equation. Identification stems from the non-linearity separating the selection and the interest rate equations. We include traded loan volumes only in the interest rate equation, creating an exclusion restriction. We work with the same specification as in the previous section, including a set of borrower fixed effects, lender fixed effects, time fixed effects and borrower's country fixed effects. We do not use interacted fixed effects. Results are presented in Appendix Table A.6. Results are qualitatively left unchanged when controlling for selection bias.

VARIABLES	(1) Link	(2) Link	(3) Spread	(4) Spread
GIIPS Sov.	-1.181	0.012	1.323**	-0.085
	(1.286)	(0.755)	(0.529)	(0.532)
x Period 2	0.400	-1.162*	-1.407**	0.256
	(1.852)	(0.662)	(0.584)	(0.586)
x Period 3	-2.360	-0.594	-3.803***	0.234
	(3.099)	(0.716)	(1.251)	(0.593)
Exposures CDS	0.009	0.011	0.013**	0.012**
	(0.008)	(0.007)	(0.005)	(0.005)
x Period 2	-0.039*	-0.030	-0.023***	-0.011
	(0.021)	(0.018)	(0.005)	(0.008)
x Period 3	-0.523	-1.538	-0.641	-2.174***
	(1.458)	(1.060)	(0.415)	(0.758)
GIIPS NPL	-61.919**	-3.899	-17.621*	-14.489*
	(26.235)	(21.163)	(9.575)	(8.486)
x Period 2	61.794**	3.821	17.757*	14.694*
	(26.156)	(21.109)	(9.564)	(8.494)
x Period 3	61.709**	3.644	17.635*	14.576*
	(26.211)	(21.118)	(9.582)	(8.480)
GIIPS Retail and Corporate	-0.898	-0.265	0.271	0.091
	(0.689)	(0.180)	(0.241)	(0.080)
x Period 2	0.892	0.120	-0.070	-0.092
	(0.665)	(0.163)	(0.213)	(0.078)
x Period 3	1.143	0.269	0.012	-0.068
	(0.772)	(0.164)	(0.301)	(0.077)
Observations	35,383	59,592	23,384	39,327
R-squared	0.442	0.431	0.792	0.816
Borrower FE	Yes	Yes	Yes	Yes
Lender x Week FE	Yes	Yes	Yes	Yes
Borrower Country x Week FE	Yes	Yes	Yes	Yes
Borrowers	non-GIIPS	All	non-GIIPS	All

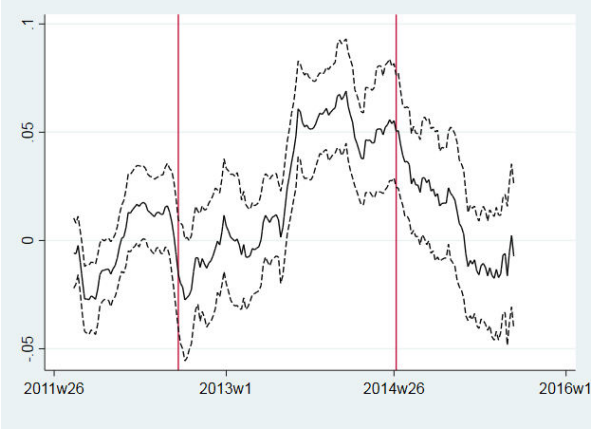
Table 2: Probability to find a lender and spreads paid, main specifications

*Note: The sample includes all borrowers identifiable in the TARGET2 database, for which cross-border exposures are available from the EBA databases. The sample is alternatively reduced to non-GIIPS borrowers only. Link is a dummy variable for the transaction between two banks being active at date t. For each borrower, each week t, its relevant set of potential counterparties include its set of week $t-1$ lenders plus its set of week t lenders. Spread is the difference between the annualized (amount-weighted) average interest rate paid by bank j to bank i for overnight liquidity in week t and the deposit facility rate. GIIPS Sovereign are borrowers' exposures to GIIPS sovereign assets over their total assets. Exposures CDS is the average of GIIPS sovereign CDSs, weighted by the borrower's exposures to each GIIPS sovereign. GIIPS Retail and Corporate are borrowers' exposures to retail (household and SMEs) and corporate assets located in GIIPS countries over their total assets. GIIPS NPL is borrowers' shares of defaulted assets amongst assets located in GIIPS countries. Period 2 and Period 3 are dummy variables taking value 1, respectively, from July 2011 to July 2012 (pre-OMT) and from August 2012 to June 2014(OMT programme); they equal zero otherwise. Controls included but not reported: a dummy for the transaction to be cross-border, amount borrowed (when dependent variable is spread), borrowing bank rating, its size, capital ratio. Regressions include a set of borrower, lender*week and borrower's country*week fixed effects. Standard errors are clustered at the borrower bank level.*

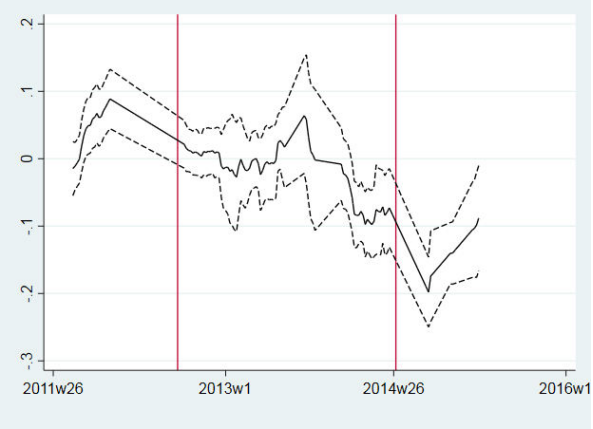
VARIABLES	(1) Link	(2) Link	(3) Spread	(4) Spread
GIIPS Sov.	-0.679	0.268	3.511***	-0.058
	(1.612)	(0.997)	(0.324)	(0.791)
x Period 2	0.586	-0.819	-2.988***	0.417
	(2.983)	(0.953)	(0.760)	(0.789)
x Period 3	-1.941	-0.193	-3.390***	0.109
	(2.295)	(0.954)	(0.736)	(0.806)
Exposures CDS	0.002	0.011	0.006	0.012**
	(0.008)	(0.008)	(0.004)	(0.005)
x Period 2	-0.027	-0.048**	-0.010**	-0.019**
	(0.020)	(0.020)	(0.005)	(0.008)
x Period 3	-2.253	-2.171	0.237	-2.517***
	(1.843)	(1.479)	(0.288)	(0.921)
GIIPS NPL	-64.480**	-9.649	-2.914	-19.169**
	(28.608)	(21.365)	(8.305)	(9.170)
x Period 2	63.854**	9.380	2.878	19.387**
	(28.586)	(21.321)	(8.311)	(9.175)
x Period 3	64.405**	9.399	2.902	19.251**
	(28.596)	(21.346)	(8.306)	(9.163)
GIIPS Retail and Corporate	1.291*	-0.336	-0.535***	0.082
	(0.743)	(0.208)	(0.188)	(0.083)
x Period 2	2.726**	0.327**	1.100***	-0.093
	(1.008)	(0.147)	(0.302)	(0.088)
x Period 3	-1.290	0.213	0.492***	-0.070
	(0.873)	(0.155)	(0.169)	(0.082)
Observations	33,144	48,966	21,839	31,885
R-squared	0.451	0.441	0.789	0.810
Borrower FE	Yes	Yes	Yes	Yes
Lender x Week FE	Yes	Yes	Yes	Yes
Borrower Country x Week FE	Yes	Yes	Yes	Yes
Borrowers	non-GIIPS	All	non-GIIPS	All

Table 3: Probability to find a lender and spreads paid, balanced panel

*Note: The sample includes all borrowers identifiable in the TARGET2 database, for which cross-border exposures are available from the EBA databases. We keep only borrowers that we observe in each of the three monetary policy periods considered. The sample is alternatively reduced to non-GIIPS borrowers only. Link is a dummy variable for the transaction between two banks being active at date t. For each borrower, each week t, its relevant set of potential counterparties include its set of week $t-1$ lenders plus its set of week t lenders. Spread is the difference between the annualized (amount-weighted) average interest rate paid by bank j to bank i for overnight liquidity in week t and the deposit facility rate. GIIPS Sovereign are borrowers' exposures to GIIPS sovereign assets over their total assets. Exposures CDS is the average of GIIPS sovereign CDSs, weighted by the borrower's exposures to each GIIPS sovereign. GIIPS Retail and Corporate are borrowers' exposures to retail (household and SMEs) and corporate assets located in GIIPS countries over their total assets. GIIPS NPL is borrowers' shares of defaulted assets amongst assets located in GIIPS countries. Period 2 and Period 3 are dummy variables taking value 1, respectively, from July 2011 to July 2012 (pre-OMT) and from August 2012 to June 2014(OMT programme); they equal zero otherwise. Controls included but not reported: a dummy for the transaction to be cross-border, amount borrowed (when dependent variable is spread), borrowing bank rating, its size, capital ratio. Regressions include a set of borrower, lender*week and borrower's country*week fixed effects. Standard errors are clustered at the borrower bank level.*

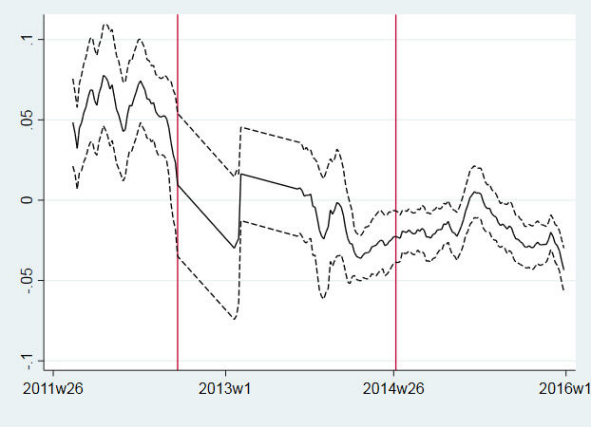


(a) Germany.

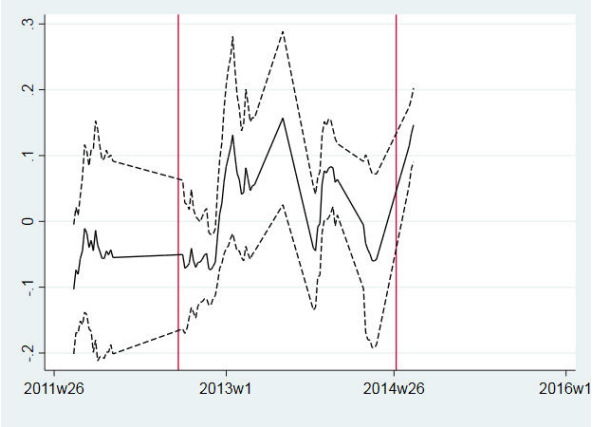


(b) Spain.

(c) France.



(d) Italy.



(e) Portugal.

Figure 7: Borrower's Country Trends: Example Countries.

Note: Solid lines are the country trend. Dotted lines delimit confidence intervals. Standard errors are estimated using a bootstrap procedure. Red vertical lines delimit the three monteary policy periods. The three monetary policy periods are defined as follows: Period 1 (pre-OMT): July 2011 - July 2012; Period 2 (OMT programme): August 2012 - June 2014; Period 3 (TLTRO): July 2014 - December 2015. We estimate country trends in three separate models by period. We provide one graph per country for the sake of clarity.

Source: Authors' computations.

7 Conclusion

In this paper we provide a simple theoretical model to analyse the effects of balance sheet and sovereign risk on interbank market access and interest rates. The model takes into account the interaction between interbank lending conditions and central bank liquidity provision, including via non-conventional monetary policies.

We test the model predictions using granular interbank lending data and detailed information on banks' exposures, cross-border and cross-sector. We focus on disentangling the sovereign-dependence and balance sheet -credit risk- sources of interbank fragmentation. We do this by studying the impact of the size and quality of banks' GIIPS exposures on their access to, and on the price paid for, interbank liquidity, while controlling for sovereign-dependence risk and lenders' liquidity shocks. Non-GIIPS banks' exposures to GIIPS assets are key to disentangle the two potential channels of fragmentation.

Our findings are consistent with the model predictions. First, high non-performing loan (NPL) ratios on GIIPS exposures hinder access of non-peripheral banks to the interbank market during the entire sample period: higher NPL ratios on GIIPS exposures decrease the probability to find a lender on the interbank market, contributing to the fragmentation of this segment of banks' short-term funding. Second, from mid-2011 and until the OMT, a non-peripheral bank pays more for interbank loans the larger her exposures to GIIPS sovereigns. But the OMT closes this channel of shock transmission. In fact, after the OMT announcement, also the selection effect due to high NPL on GIIPS assets, while still significant, becomes much weaker. Third, the OMT announcement reduced sovereign-based and balance sheet fragmentation alike: it reduced country-premia paid by GIIPS borrowers, but it also affected lenders'pricing of counterparty credit risk.

Our analysis contributes to a finer understanding of the frictions at work in cross-border wholesale funding markets during the recent financial crises. Liquidity tensions have indeed proved to be a powerful channel of shock transmission across borders, particularly in the euro area because of the importance of cross-border financial flows. While we look at one specific segment of banks' short-term funding, this is a crucial one in the euro area, both for the implementation of monetary policy and for financial stability. Such finer understanding is thus relevant to prevent this powerful channel of shock transmission across borders in the future.

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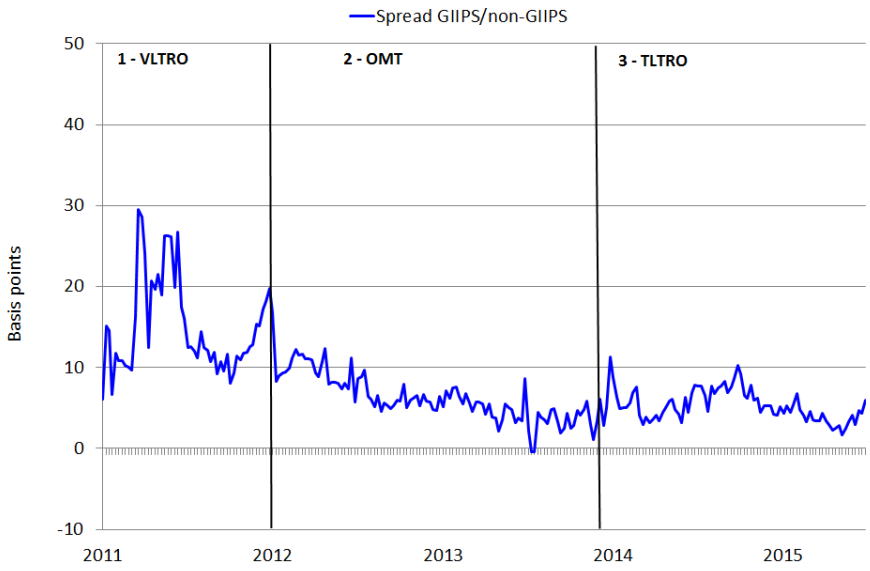
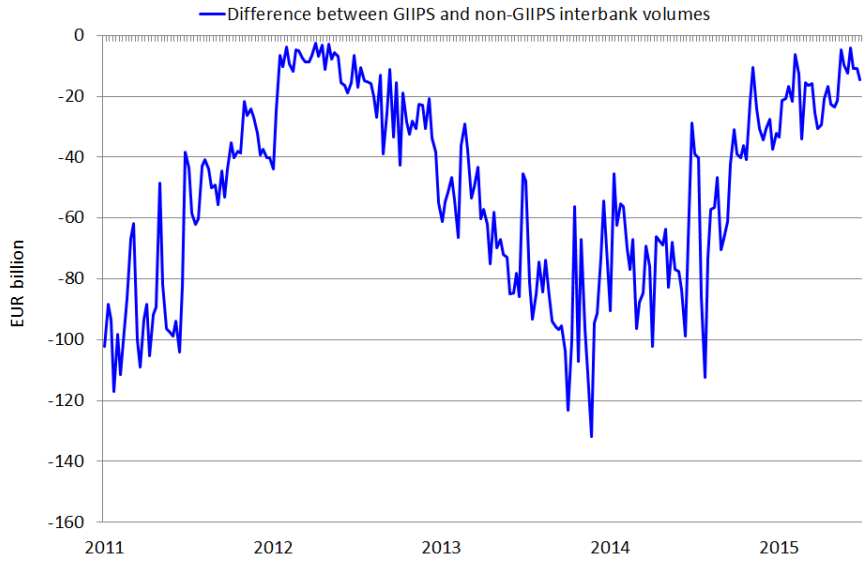
A Appendix



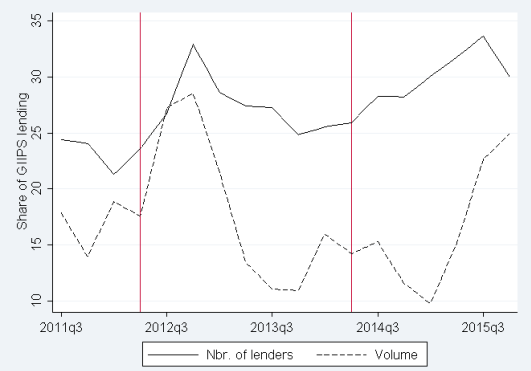
(a) Rates.



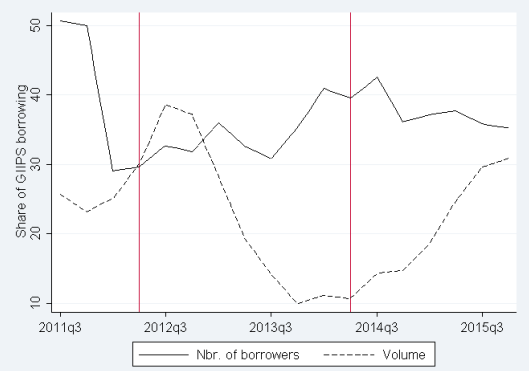
(b) Volumes.

Figure A.1: GIIPS - non-GIIPS rates and volumes spreads.

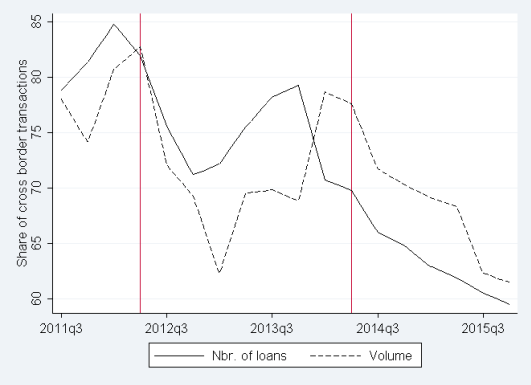
Source: TARGET2 data, ECB, authors' computations.
Note: The three monetary policy periods are defined as follows: Period 1 (pre-OMT): July 2011 - July 2012; Period 2 (OMT programme): August 2012 - June 2014; Period 3 (TLTRO): July 2014 - December 2015.



(a) Share of GIIPS Lending on the Unsecured Interbank Market.

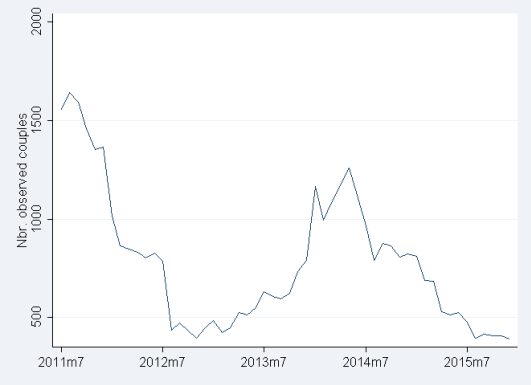


(b) Share of GIIPS Borrowing on the Unsecured Interbank Market.

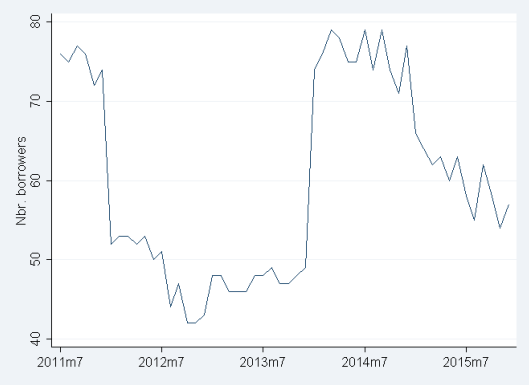


(c) Share of Cross-border Transactions on the Unsecured Interbank Market.

(d) Number of Lenders on the Unsecured Interbank Market - intersection with EBA data.



(e) Number of Couples (Lender, Borrower) on the Unsecured Interbank Market - intersection with EBA data.



(f) Number of Borrowers on the Unsecured Interbank Market - intersection with EBA data.

Figure A.2: GIIPS exposures across GIIPS and non-GIIPS banks

Source: TARGET2 data, authors' computations.
Note: Figures A.2d to A.2f provide statistics for the intersection between the unsecured interbank market estimated from TARGET2 and borrowers to be found in EBA data. Fig. A.2f displays the number of beneficiaries on the unsecured interbank market we consider in our estimation sample, between 2011 and 2016. This indicator is driven by both interbank market activity and EBA data availability issues. The latter explain the structural breaks at the beginning of 2014 and 2016.

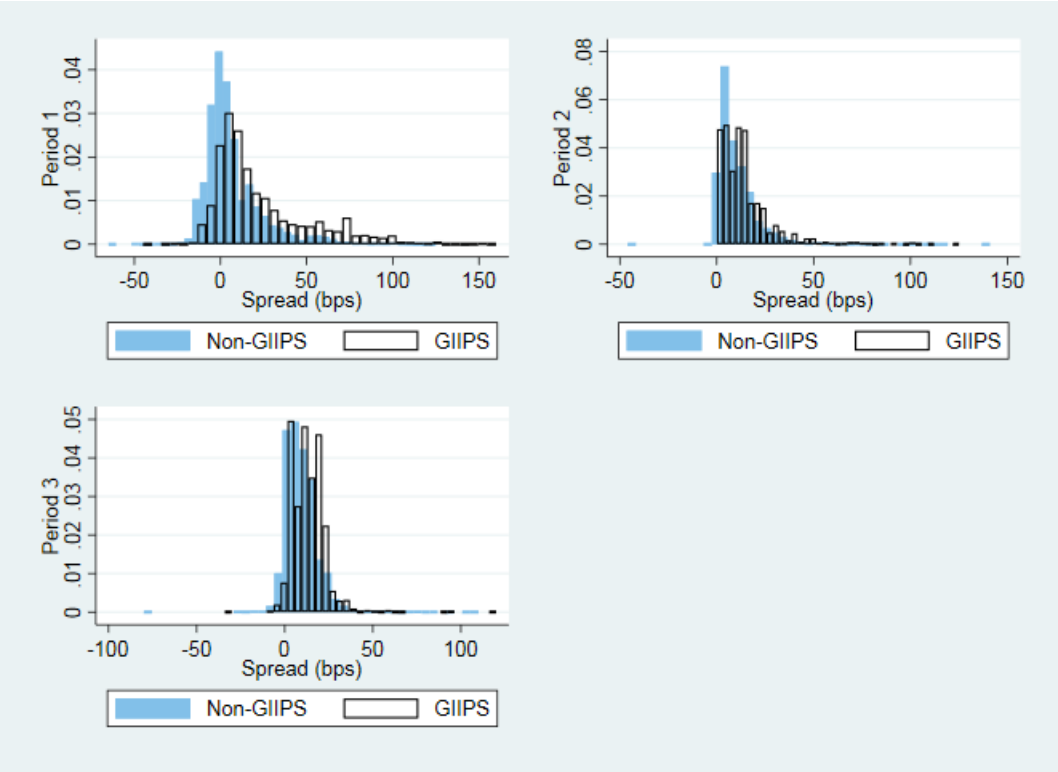


Figure A.3: Distribution of overnight interbank spreads.

Source: TARGET2 data, ECB, authors' computations.

Note: We display the distribution of spreads between overnight interbank spreads and the deposit facility rate over three monetary policy periods. The three monetary policy periods are defined as follows: Period 1 (pre-OMT): July 2011 - July 2012; Period 2 (OMT programme): August 2012 - June 2014; Period 3 (TLTRO): July 2014 - December 2015.

Period	1	2	3
Exposures CDS	1.076	.315	.111
	(.934)	(.547)	(.026)
GIIPS NPL	.001	.111	.07
	(.001)	(.118)	(.102)
Active Link	.725	.73	.71
	(.446)	(.444)	(.454)
GIIPS Retail and Corporate	.121	.217	.198
	(.191)	(.275)	(.28)
GIIPS Sov.	.031	.055	.096
	(.034)	(.071)	(.088)
Spread	.14	.116	.117
	(.217)	(.111)	(.079)

Table A.1: Descriptive Statistics: Whole sample

Period	1	2	3
Exposures CDS	1.234	.375	.108
	(.947)	(.645)	(.017)
GIIPS NPL	.001	.113	.078
	(.001)	(.14)	(.136)
Active Link	.727	.738	.717
	(.446)	(.44)	(.45)
GIIPS Retail and Corporate	.02	.046	.057
	(.02)	(.097)	(.131)
GIIPS Sov.	.016	.013	.013
	(.016)	(.019)	(.017)
Spread	.1	.091	.09
	(.174)	(.092)	(.071)

Table A.2: Descriptive Statistics: Non-GIIPS sample

VARIABLES	(1) Spread	(2) Spread
GIIPS Sov.	1.323**	-0.083
	(0.529)	(0.532)
x Period 2	-1.407**	0.255
	(0.584)	(0.586)
x Period 3	-3.803***	0.234
	(1.251)	(0.593)
Exposures CDS	0.013**	0.012**
	(0.005)	(0.005)
x Period 2	-0.023***	-0.011
	(0.005)	(0.008)
x Period 3	-0.642	-2.176***
	(0.416)	(0.759)
GIIPS NPL	-17.618*	-14.480*
	(9.575)	(8.482)
x Period 2	17.754*	14.686*
	(9.564)	(8.490)
x Period 3	17.632*	14.568*
	(9.582)	(8.476)
GIIPS Retail and Corporate	0.271	0.091
	(0.241)	(0.080)
x Period 2	-0.070	-0.092
	(0.213)	(0.078)
x Period 3	0.012	-0.068
	(0.301)	(0.077)
Observations	23,380	39,308
R-squared	0.792	0.816
Borrower FE	Yes	Yes
Lender x Week FE	Yes	Yes
Borrower Country x Week FE	Yes	Yes
Borrowers	non-GIIPS	All

Table A.3: Without zero rate loans in Period 3

*Note: The sample includes all borrowers identifiable in the TARGET2 database, for which cross-border exposures are available from the EBA databases. We exclude loans for which we estimate a zero rate. The sample is alternatively reduced to non-GIIPS borrowers only. Spread is the difference between the annualized (amount-weighted) average interest rate paid by bank j to bank i for overnight liquidity in week t and the deposit facility rate. GIIPS Sovereign are borrowers' exposures to GIIPS sovereign assets over their total assets. Exposures CDS is the average of GIIPS sovereign CDSs, weighted by the borrower's exposures to each GIIPS sovereign. GIIPS Retail and Corporate are borrowers' exposures to retail (household and SMEs) and corporate assets located in GIIPS countries over their total assets. GIIPS NPL is borrowers' shares of defaulted assets amongst assets located in GIIPS countries. Period 2 and Period 3 are dummy variables taking value 1, respectively, from July 2011 to July 2012 (pre-OMT) and from August 2012 to June 2014(OMT programme); they equal zero otherwise. Controls included but not reported: a dummy for the transaction to be cross-border, amount borrowed (when dependent variable is spread), borrowing bank rating, its size, capital ratio. Regressions include a set of lender*week and borrower's country*week fixed effects. Standard errors are clustered at the borrower bank level.*

VARIABLES	(1) Link	(2) Link	(3) Spread	(4) Spread
GIIPS Sov.	-0.757	-0.398	0.861	-0.135
	(0.749)	(0.452)	(0.519)	(0.676)
x Period 2	-0.450	-0.639	-0.679	0.090
	(0.733)	(0.396)	(0.582)	(0.735)
x Period 3	-4.091*	-0.163	-3.185***	0.138
	(2.142)	(0.420)	(1.113)	(0.756)
Exposures CDS	0.002	0.002	0.012***	0.014***
	(0.005)	(0.004)	(0.003)	(0.005)
x Period 2	-0.038**	-0.029***	-0.016***	-0.006
	(0.014)	(0.011)	(0.004)	(0.008)
x Period 3	-0.304	-1.418	-0.106	-1.907**
	(1.640)	(1.008)	(0.348)	(0.807)
GIIPS NPL	-14.075	3.324	-19.232**	-7.653
	(11.402)	(12.003)	(8.260)	(8.333)
x Period 2	14.102	-3.354	19.385**	7.859
	(11.358)	(11.974)	(8.263)	(8.361)
x Period 3	13.840	-3.534	19.320**	7.798
	(11.398)	(11.985)	(8.266)	(8.334)
GIIPS Retail and Corporate	-0.360	-0.161	-0.124	0.069
	(0.419)	(0.123)	(0.219)	(0.085)
x Period 2	0.331	0.028	0.322*	-0.099
	(0.422)	(0.122)	(0.186)	(0.087)
x Period 3	0.748	0.175	0.341	-0.066
	(0.487)	(0.115)	(0.222)	(0.082)
Observations	50,323	78,423	36,166	55,999
R-squared	0.115	0.112	0.692	0.707
Borrower FE	Yes	Yes	Yes	Yes
Lender x Week FE	Yes	Yes	Yes	Yes
Borrower Country x Week FE	Yes	Yes	Yes	Yes
Borrowers	non-GIIPS	All	non-GIIPS	All

Table A.4: Lender + Week Fixed Effects

*Note: The sample includes all borrowers identifiable in the TARGET2 database, for which cross-border exposures are available from the EBA databases. The sample is alternatively reduced to non-GIIPS borrowers only. Link is a dummy variable for the transaction between two banks being active at date t. For each borrower, each week t, its relevant set of potential counterparties include its set of week $t-1$ lenders plus its set of week t lenders. Spread is the difference between the annualized (amount-weighted) average interest rate paid by bank j to bank i for overnight liquidity in week t and the deposit facility rate. GIIPS Sovereign are borrowers' exposures to GIIPS sovereign assets over their total assets. Exposures CDS is the average of GIIPS sovereign CDSs, weighted by the borrower's exposures to each GIIPS sovereign. GIIPS Retail and Corporate are borrowers' exposures to retail (household and SMEs) and corporate assets located in GIIPS countries over their total assets. GIIPS NPL is borrowers' shares of defaulted assets amongst assets located in GIIPS countries. Period 2 and Period 3 are dummy variables taking value 1, respectively, from July 2011 to July 2012 (pre-OMT) and from August 2012 to June 2014(OMT programme); they equal zero otherwise. Controls included but not reported: a dummy for the transaction to be cross-border, amount borrowed (when dependent variable is spread), borrowing bank rating, its size, capital ratio. Regressions include a set of borrower, lender, week and borrower's country*week fixed effects. Standard errors are clustered at the borrower bank level.*

VARIABLES	(1) Link	(2) Link	(3) Spread	(4) Spread
GIIPS Sov.	-0.118	-1.309**	1.283**	0.018
	(0.966)	(0.609)	(0.535)	(0.485)
x Period 2	-0.754	0.140	-1.444**	0.428
	(1.710)	(0.740)	(0.625)	(0.589)
x Period 3	-1.015	0.854	-4.047***	0.407
	(3.736)	(0.823)	(1.375)	(0.593)
Exposures CDS	0.010	0.006	0.013**	0.012**
	(0.008)	(0.007)	(0.005)	(0.005)
x Period 2	-0.043**	-0.016	-0.022***	-0.007
	(0.018)	(0.020)	(0.006)	(0.009)
x Period 3	0.341	-0.103	-0.661	-2.397***
	(1.287)	(0.884)	(0.471)	(0.727)
GIIPS NPL	-78.894***	-46.729**	-15.840	-17.952**
	(26.463)	(20.572)	(10.263)	(8.791)
x Period 2	78.659***	46.561**	15.982	18.164**
	(26.393)	(20.516)	(10.254)	(8.801)
x Period 3	78.719***	46.490**	15.848	18.035**
	(26.438)	(20.514)	(10.274)	(8.787)
GIIPS Retail and Corporate	-0.013	-0.208	0.261	0.138*
	(0.579)	(0.157)	(0.240)	(0.081)
x Period 2	0.009	0.029	-0.076	-0.139*
	(0.549)	(0.159)	(0.215)	(0.079)
x Period 3	0.054	0.266*	0.055	-0.119
	(0.588)	(0.147)	(0.306)	(0.079)
Observations	34,395	57,155	23,118	38,667
R-squared	0.438	0.429	0.792	0.817
Borrower FE	Yes	Yes	Yes	Yes
Lender x Week FE	Yes	Yes	Yes	Yes
Borrower Country x Week FE	Yes	Yes	Yes	Yes
Borrowers	non-GIIPS	All	non-GIIPS	All

Table A.5: Sample reduced to borrowers with at least two active links during a given week.

*Note: The sample includes all borrowers identifiable in the TARGET2 database, for which cross-border exposures are available from the EBA databases. We sample only borrowers with at least two active links during a given week. The sample is alternatively reduced to non-GIIPS borrowers only. Link is a dummy variable for the transaction between two banks being active at date t. For each borrower, each week t, its relevant set of potential counterparties include its set of week $t-1$ lenders plus its set of week t lenders. Spread is the difference between the annualized (amount-weighted) average interest rate paid by bank j to bank i for overnight liquidity in week t and the deposit facility rate. GIIPS Sovereign are borrowers' exposures to GIIPS sovereign assets over their total assets. Exposures CDS is the average of GIIPS sovereign CDSs, weighted by the borrower's exposures to each GIIPS sovereign. GIIPS Retail and Corporate are borrowers' exposures to retail (household and SMEs) and corporate assets located in GIIPS countries over their total assets. GIIPS NPL is borrowers' shares of defaulted assets amongst assets located in GIIPS countries. Period 2 and Period 3 are dummy variables taking value 1, respectively, from July 2011 to July 2012 (pre-OMT) and from August 2012 to June 2014(OMT programme); they equal zero otherwise. Controls included but not reported: a dummy for the transaction to be cross-border, amount borrowed (when dependent variable is spread), borrowing bank rating, its size, capital ratio. Regressions include a set of borrower, lender*week and borrower's country*week fixed effects. Standard errors are clustered at the borrower bank level.*

	Spread	Spread
GIIPS Sov	1.366	.668
	(.134)	(.075)
x Period 2	-1.548	-.253
	(.136)	(.077)
x Period 3	-3.925	-.188
	(.238)	(.079)
Exposures CDS	.011	.003
	(.001)	(.001)
x Period 2	-.021	-.007
	(.002)	(.002)
x Period 3	.363	-.269
	(.121)	(.039)
GIIPS NPL	-17.484	-16.624
	(2.475)	(1.659)
x Period 2	17.531	16.667
	(2.474)	(1.658)
x Period 3	17.441	16.644
	(2.473)	(1.657)
GIIPS Retail and Corporate	.191	.145
	(.083)	(.017)
x Period 2	-.144	-.147
	(.08)	(.018)
x Period 3	.072	-.139
	(.076)	(.016)
Inverse Mills Ratio	.073	.035
	(.029)	(.034)
Borrower FE	Yes	Yes
Lender FE	Yes	Yes
Week FE	Yes	Yes
Country FE	Yes	Yes
Borrowers	Non-GIIPS	All
Replications	100	100

Table A.6: Selection Models.

Note: Spreads models accounting for selection bias on the interbank market. The sample includes all borrowers identifiable in the TARGET2 database, for which cross-border exposures are available from the EBA databases. The sample is alternatively reduced to non-GIIPS borrowers only. Spread is the difference between the annualized (amount-weighted) average interest rate paid by bank j to bank i for overnight liquidity in week t and the deposit facility rate. Inv. Mills is the inverse Mills ratio, measuring selection bias. GIIPS Sovereign are borrowers' exposures to GIIPS sovereign assets over their total assets. Exposures CDS is the average of GIIPS sovereign CDSs, weighted by the borrower's exposures to each GIIPS sovereign. GIIPS Retail and Corporate are borrowers' exposures to retail (household and SMEs) and corporate assets located in GIIPS countries over their total assets. GIIPS NPL is borrowers' shares of defaulted assets amongst assets located in GIIPS countries. Controls included but not reported: a dummy for the transaction to be cross-border, amount borrowed (when dependent variable is spread), borrowing bank rating, its size, capital ratio. Regressions include a set of borrower, lender, week and borrower's country, fixed effects. Standard errors are estimated with a bootstrap procedure.