Long-term Central Bank Repos and Bank Rollover Risk

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December 12, 2017

[1] Special thanks go to my PhD supervisor, Kjell Nyborg, for many great discussions throughout my PhD and many insightful comments on this paper. I gratefully acknowledge financial support from the Swiss National Science Foundation (project #100018_172679 "Trading and Financing during Market Stress"). Furthermore, I would like to thank Urs Birchler, Mike Burkart, Darrell Duffie, Thierry Foucault, Michel Habib, David Lando, Semyon Malamud, Alberto Manconi, Gregor Matvos, Per Östberg, Mitchell Petersen, Angelo Ranaldo, Eric Swanson, Yuri Tserlukevich, Christian Wagner, Lucas Fuhrer, René Hegglin, Philipp Lentner, Magnus Nyboe, Cornelia Rösler, the participants in Kjell Nyborg's Doctoral Colloquium (April 24, 2015), and the participants at the Zurich Workshop in Economics (September 2-4, 2015) for valuable comments and helpful suggestions. The responsibility for any errors is mine. Author: Jiri Woschitz, Department of Banking and Finance, Plattenstrasse 14, 8032 Zurich, Switzerland. Tel.: +41 44 634 29 49, email: jiri.woschitz@bf.uzh.ch.

Abstract

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Over a period of more than four years the ECB has repeatedly and in addition to its standard monetary refinancing operations offered repos with extraordinarily long durations. This paper argues that such operations serve the function of reducing rollover risks for Eurozone banks. The data shows that high rollover (and borrowing) costs of banks in struggling countries correlate with the ECB's offering periods of these additional longer-dated repos. Banks with high rollover costs take disproportionately more Eurosystem liquidity and profit, ex-post, exceptionally from market borrowing cost reductions. As discussed, sheltering banks from rollover risks prevents some banks' equity holders (possibly erroneously) from deciding to let the bank default on its obligations. Moreover, such measures neither solve bank debt overhang (Myers, 1977) nor do they bail out banks efficiently (Bhattacharya and Nyborg, 2013). The inefficiency feature may have implications for the observed increase in fragmentation in the Euro area, the bank-sovereign nexus, and the risk composition of the ECB's balance sheet.

JEL classification: G12, G21, E42, E51, E52, E58

Keywords: European Central Bank, Longer-term refinancing operations (LTROs), rollover costs, borrowing costs, yield curves, bank bailout, fragmentation, segmentation

1 Introduction

As of October 2008 the European Central Bank (ECB) uses different unconventional monetary policy tools with the aim to stabilize and stimulate the Euro area.[1] This paper focuses on one particular tool that the ECB has repeatedly applied from 2008 to 2012: Longer-Term Refinancing Operations (LTROs) with extraordinarily long-dated maturities of 6, 12, and 36 months (throughout this paper denoted as extraordinary LTROs, or "exLTROs").

Existing literature focuses on the impact of the three-year LTROs (and other unconventional measures) on sovereign yield spreads, bank lending, and the real activity by non-financial firms.[2] It provides evidence that the ECB's unconventional policy measures (inlcuding the three-year LTROs) have reduced sovereign bond yields, especially for financially weaker countries[3], that bank lending to the private sector has only increased modestly upon the three-year LTROs[4], and that the three-year LTROs potentially have had distorting effects on real activity.[5]

In contrast to this literature, this paper tries to better understand the mechanism behind extraordinary LTROs. Arguably, the first step is to understand why the ECB does, in the first place, *offer* extraordinary LTROs. The European Central Bank (2012a) states that "[t]he aim of the [three-year LTROs] ... [is] to ... ensure that monetary policy continues to be effectively transmitted to the real economy, thereby supporting the ability of banks to maintain and expand lending to euro area households and non-financial corporations." This statement suggests that the ECB – by offering exLTROs – steps in as the lender of last resort because of adverse developments in the markets in which banks raise liquidity. Bindseil and Laeven (2017) explain that "[c]entral bank lender of last resort ... measures respond to moments when solvent individual banks, or entire banking systems, are unable to maintain

[1]See, e.g., Cour-Thimann and Winkler (2013) or Nyborg (2017b, Table 3.1).

[2]One large literature discussed in more detail below addresses the question why banks have used the three-year uptake to buy sovereign debt.

[3]See, e.g., Eser and Schwaab (2016), Krishnamurthy, Nagel, and Vissing-Jorgensen (2015), Szczerbowicz (2015), and Falagiarda and Reitz (2015); De Pooter, Martin, and Pruitt (2016)

[4]See Carpinelli and Crosignani (2016), García-Posada and Marchetti (2016), and Andrade, Cahn, Fraisse, and Mésonnier (2015) for direct evidence. See also Bofondi, Carpinelli, and Sette (2013), Darracq-Paries and De Santis (2015), Ferrando, Popov, and Udell (2015), Popov and Van Horen (2015), and De Marco (2016).

[5]See, e.g., Daetz, Subrahmanyam, Tang, and Wang (2016) and Acharya, Eisert, Eufinger, and Hirsch (2017a). For bank lending after the failure of Lehman Brothers see Ivashina and Scharfstein (2010), in the context of the savings and loans crisis in the U.S. see Kane (1989), and in Japan's banking crisis in the early 1990s see Peek and Rosengren (2005), Caballero, Hoshi, and Kashyap (2008), and Giannetti and Simonov (2013).

depositor confidence ... . They allow the banking system to continue to provide transaction services through the payment system, and to provide credit to bank-dependent borrowers." Under such circumstances, during a credit crunch, Bagehot (1873) advises the lender of last resort to lend freely, at a high rate, and against good collateral (see also Goodhart, 1999; Thornton, 1802). Under full allotment (in place since October 2008), however, the ECB does already lend freely, at a fixed rate, and against collateral in its standard one-week and three-month operations. Hence, both the ECB's statement and the quote of Bindseil and Laeven (2017) above defy explanation as to why the ECB – even as lender of last resort – offers, for instance, three-year Eurosystem liquidity on top of standard one-week and three-month liquidity, especially given that rolling over one-week liquidity 156 times bears virtually the same costs.[6] This suggests that the duration – the only feature that distinguishes exLTROs from rolling over standard three-month or one-week liquidity – plays a decisive role in the ECB's decision making process.

Nyborg (2017b) argues that the three-year LTROs have reduced "uncertainty with respect to how long the full allotment policy would be in place." This paper suggests that extraordinary LTROs serve the function of reducing bank borrowing costs by reducing bank rollover risks on maturing bank debt. Put differently, extraordinary LTROs reduce the credit risk premium that the market requires on these banks by revoking the disciplinary effect that short-term debt has – through the frequently accruing rollover costs – on bank equity holders. This explanation is very similar to Nyborg (2017b)'s policy uncertainty argument but reveals in more detail who exactly profits from reduced policy uncertainty, namely banks (and possibly countries) faced with high rollover costs due to high credit risks as perceived by the market.

He and Xiong (2012) demonstrate this mechanism in a model. Liquidity deterioration in debt markets causes – through aggravated rollover risk on short-term debt – rollover losses. These losses are borne by the firm's equity holders who will have to issue new debt to replace maturing debt. Equity holders are willing to repay the maturing debt if the option of keeping the firm alive (from holding the equity) is higher than these rollover losses. If not, they will decide to default on the maturing debt. Consequently, deteriorating bond market liquidity does not only increase the liquidity premium but also the bonds' default probability and,

[6] The interest rate for the three-year liquidity was defined in terms of the average one-week rate. See ECB press release, December 8, 2011: "ECB announces measures to support bank lending and money market activity", https://www.ecb.europa.eu/press/pr/date/2011/html/pr111208_1.en.html.

thus, the credit risk premium.[7] Given this logic, extraordinary LTROs reduce the additional credit risk that tight short-term debt (or interbank) markets create for banks through rollover losses. Hence, if the ECB offers exLTROs because of increased bank rollover risks, equity holders of some banks, who would otherwise decide to default on the bank's obligations, might decide not to do so. One can think of extraordinary LTROs as an option value that the ECB offers banks faced with high rollover costs due to their credit riskiness as perceived by the market.[8]

The study provides evidence for this mechanism in two steps. Step one tests empirically whether high bank rollover risk correlates with the ECB's offering periods of exLTROs and whether banks faced with relatively higher rollover risks take more Eurosystem liquidity. I collect data for different Eurozone countries from Bruegel (see Pisani-Ferry and Wolff, 2012), the webpages of the Eurosystem's national central banks, the ECB's Statistical Data Warehouse, and Bloomberg to measure country-level Eurosystem liquidity uptake and create an estimate of bank rollover costs. I map out the exact timing of all exLTROs (not only the three-year LTROs) to relate them to the estimate of bank rollover costs from 2008 to 2013. First, I run simple time-series regressions of logarithmized LTRO duration on bank rollover cost measures using different subsets of countries. The results provide evidence that the ECB offers exLTROs when bank rollover costs are high, i.e., the empirical model predicts the ECB to increase LTRO duration by 257.21 days if bank rollover costs increase by EUR 1 bn in the subset of struggling Eurozone countries. Taking the subset of non-struggling countries projects an increase in LTRO duration of only 18.12 days.

Second, on a country-level, banks faced with high rollover costs take disproportionately more Eurosystem liquidity during months with exLTRO cash settlements. I run a country-level specification which regresses normalized Eurosystem liquidity uptake on the logarithm of LTRO duration, normalized bank rollover costs, sovereign yield spreads (above the policy rate), and normalized deposit flows. The specification predicts an increase in liquidity uptake by 163.68 (210.78) ppt if the ECB doubles LTRO duration at its mean (if normalized bank rollover costs increase by 1 ppt). Replacing bank rollover costs by an interaction term between logarithmized LTRO duration and bank rollover costs shows that the marginal

[7] In this context, see also Leland and Toft (1996), Acharya, Gale, and Yorulmazer (2011), Diamond and Rajan (2012), and Brancati and Macchiavelli (2016).

[8] Importantly, this argument does not claim that every bank which makes use of exLTROs automatically is one where equity holders are hanging in the balance between defaulting or not. This will be discussed in more detail in Section 6.

effect of LTRO duration on Eurosystem liquidity uptake is increasing in bank rollover costs, i.e., the model predicts that normalized liquidity uptake increases by 90.39 (638.24) ppt if the ECB doubles LTRO duration at its mean and if normalized rollover costs are fixed at 0% (15%).[9]

Step two studies the conjecture that extraordinary LTROs keep especially financially weaker banks – with ex-ante high rollover costs – alive. I trace bank borrowing costs over the three-year LTRO period to analyze their yield curves. This allows me to look at the market reaction in the cross-section of banks to better understand who exactly profits from the measure. I collect daily bank bond-level data from Thomson Reuter's Datastream and match bank equity ratios from SNL to it.

The results show that the three-year LTROs reduce yields for Italian banks, with ex-ante high yield curve levels, dramatically, and especially on bonds that mature before the three-year ECB loans mature. For German banks, with ex-ante low yield curve levels, no such effect is observed. Italian (German) banks have ex-ante (the day before the announcement of the three-year LTROs, December 7, 2011), on average, yields of 5.25% and 7.49% (2.21% and 4.72%) at the one and ten year maturity, respectively. Over the time until the allotment of the second three-year LTRO (February 29, 2012), yields in Italy (Germany) decrease, on average, by 1.74 (0.50) ppt at the one year and by 0.65 (0.42) ppt at the six year horizon. The cross-section of banks within a country reveals that these decreases are particularly driven by weakly capitalized banks within Italy. They exhibit, ex-ante, the highest yield curve levels and have profited ex-post the most from yield reductions, especially at the short end of the yield curve covered by the three-year loans. Weakly (strongly) capitalized Italian banks exhibit ex-ante, on average, yields of 5.73% (4.61%) at the one year and 8.97% (6.82%) at the ten year horizon. Until February 29, 2012, yields of weakly (strongly) capitalized banks decrease, on average, by 2.46 (0.68) ppt at the one year and by 1.86 (0.25) ppt at the five year horizon. This provides evidence that the three-year LTROs help, in particular, struggling banks in struggling countries.

For struggling banks in struggling countries the three-year LTROs steepen the yield

[9] In this specification the sovereign yield spread is likewise included in an interaction term with LTRO duration. These marginal effects are calculated under the assumption that the sovereign yield spread above the policy rate is 0%.

curve.[10] This is exactly the opposite effect of the Fed's intention with Operation Twist.[11] The aim of Operation Twist is to lower long-term sovereign yields which, in turn, should stimulate the real economy because the economy's long-term risk-free rate is lower and non-financial firms can borrow more cheaply from the banks. In Operation Twist the Fed sells U.S. short-term government bonds and buys, with the proceeds, bonds with longer-dated maturities to explicitly flatten the yield curve. In contrast, the three-year LTROs steepen the yield curves of banks and are therefore, arguably, an insufficient tool to stimulate the economy. This feature could explain why banks enhance private lending only modestly (Carpinelli and Crosignani, 2016; García-Posada and Marchetti, 2016; Andrade, Cahn, Fraisse, and Mésonnier, 2015).

More importantly though, this form of help for banks is inefficient. The conflict of interest between equity and debt holders in He and Xiong (2012) is similar in nature to Myers (1977)' debt overhang problem. The required investment in Myers (1977) reflects the rollover loss in He and Xiong (2012). The equity holders' decision not to issue equity in Myers (1977) reflects the decision not to bear the rollover loss (to default) in He and Xiong (2012). However, banks' equity holders choosing not to default because of exLTROs (reduced rollover risk) does, importantly, not solve these banks' debt overhang problem. This is in line with Nyborg (2017b) who argues that the three-year LTROs, by providing full-allotment liquidity and financing at the fixed policy rate, serve as indirect bailout for weaker banks and sovereigns. Full-allotment LTROs are – due to collateralization – always senior and, therefore, do not reduce the banks' debt overhang problem. Acharya, Pierret, and Steffen (2017b) provide evidence that the three-year LTROs have temporarily helped to reduce funding pressure for banks but that they have neither addressed bank nor sovereign solvency.

Both Bhattacharya and Nyborg (2013) as well as Philippon and Schnabl (2013) point out that a necessary condition for bank bailout to be efficient is to reduce debt overhang. Bhattacharya and Nyborg (2013) show theoretically that bank bailout is only efficient if tailored to each individual bank's balance sheet and if the cost of bailout funding increases in the bailout amount required by the bank. In similar context, Diamond and Rajan (2011)

[10] Crosignani, Faria-e Castro, and Fonseca (2017) and Pisani-Ferry and Wolff (2012) provide evidence that the three-year LTROs steepen yield curves of struggling sovereigns.

[11] The Fed used Operation Twist in its spurt into QE2 in 2010/2011 (Swanson, 2011). Very similar programs have, however, already been conducted in 1961 (see, e.g., Ross, 1966).

suggest that the authority's target must be to reallocate illiquid assets from distressed highly-levered banks to the less-levered ones, or to recapitalize banks. Extraordinary LTROs, however, do neither restructure banks' asset side of the balance sheet nor do they inject equity on the liability side (Nyborg, 2017b).[12]

A large literature tries to understand why banks may want to purchase risky sovereign debt. This is important in the context of extraordinary LTROs because Nyborg (2017b) argues that the three-year LTROs constitute indirect bailout for weaker banks *and* sovereigns. Hence if there is some underlying mechanism making the banks willing to use the exLTRO liquidity to purchase risky sovereign debt then this form of inefficient help spills over from banks to sovereigns.

One literature strand examines the idea that banks (and sovereigns) can shift risks to other parties and that especially financially weak banks have incentives to purchase risky domestic sovereign debt. For instance, Uhlig (2013) examines a monetary union with a common central bank. Banks can use sovereign bonds in central bank repos. Weak governments shift risks onto the common central bank by not regulating the domestic banking sector. In Livshits and Schoors (2009) banks shift potential losses to domestic depositors. The supervisor turns a blind eye on this because it allows the government to borrow more cheaply (as in Uhlig, 2013). In Acharya and Plantin (2017) the central bank (managing public debt for simplicity) can reduce the cost of capital for firms in response to a shock to restore efficient output levels. This comes at the cost of providing banks with carry-trade opportunities, which are socially costly because they lead to financial instability and crowd out real sector lending.[13] Crosignani, Faria-e Castro, and Fonseca (2017) show that Portuguese banks switch from short to long-term financing in the first three-year LTRO, buy high-yielding Portuguese short-term government bonds between to the three-year LTROs, and pledge them as collateral with the ECB to take even more Eurosytem liquidity in the second three-year LTRO. The idea is that when the sovereign bonds mature banks use the principal to pay back the ECB loans and, thus, profit from the high yielding bonds whose default risk they meanwhile shift – as in Uhlig (2013) – onto the Eurosystem. Sovereign

[12] Both Flannery (2005) and Duffie (2009) emphasize debt overhang as a decisive obstacle to bank recapitalization in and after crises. Homar (2016) analyzes recapitalizations from 2000 to 2013 for publicly traded banks in Europe and finds that well recapitalized banks increase lending. Banks that receive a too small recapitalization relative to their capital shortfall, however, reduce lending (see also Giannetti and Simonov, 2013, for Japanese banks from 1998 to 2005).

[13] Acharya and Steffen (2015) provide evidence that Eurozone banks, in particular banks with low capital ratios, have run such sovereign bond carry-trades over the period 2007 to 2013.

bonds are particularly vested because they represent the cheapest form of Eurosystem collateral (with the lowest haircuts, see Nyborg, 2017a,b) and have a risk weight of zero in the Basel II/III framework (Kirschenmann, Korte, and Steffen, 2016).[14]

A second strand of this literature examines the idea of "moral suasion" or "financial repression", whereby a government coaxes the banks to buy the risky sovereign debt.[15] Chari, Dovis, and Kehoe (2016) present a closed-economy model in this vein. A government obtains credibility to repay its debt by forcing domestic banks to purchase more government debt than optimal. A default were to reduce banks' net worth and, hence, future capital accumulation enabling the government to issue more debt credibly. A number of empirical papers find evidence for moral suasion (e.g. Battistini, Pagano, and Simonelli, 2014; Acharya and Steffen, 2015; Becker and Ivashina, 2016; De Marco and Macchiavelli, 2016).[16] Regarding my findings these two literature strands provide arguments why exLTROs not only offer inefficient help to banks but also – through the banks – to sovereigns (in line with Nyborg, 2017b). Notably the majority of these papers show that bank (and sovereign) actions reduce bank lending, which is likewise in line with my results.

To sum up, this paper provides evidence that extraordinary LTROs serve the function of reducing rollover risks for Eurozone banks. The findings provide evidence that high rollover (and borrowing) costs of banks in struggling countries correlate with the timing of the ECB to offer extraordinary LTROs. Banks with high rollover costs take disproportionately more Eurosystem liquidity. Ex-post, these banks profit exceptionally from market borrowing cost reductions and, among them, especially the weakly capitalized banks. This is important because this type of help is inefficient. It neither solves Myers (1977)' debt overhang nor fulfills Bhattacharya and Nyborg (2013)'s requirements for efficiency of bank bailout.

The paper proceeds as follows. Section 2 gives an overview of the institutional setting and the data. Sections 3 and 4 provide regression results of the ECB's decision to offer exLTROs and banks to take Eurosystem liquidity, respectively, as a function of bank rollover costs. Section 5 presents results of yield curve estimations for banks over the three-year LTRO period. Section 6 discusses the inefficiency feature and implications. Section 7 concludes.

[14]For further theoretical arguments or empirical evidence see Diamond and Rajan (2012), Farhi and Tirole (2012), Hildebrand, Rocholl, and Schulz (2012), Acharya and Rajan (2013), Broner, Erce, Martin, and Ventura (2014), Gennaioli, Martin, and Rossi (2014a,b), Buch, Koetter, and Ohls (2016), Crosignani (2015).

[15]See Reinhart and Sbrancia (2015) for a detailed definition of "financial repression."

[16]However, Ongena, Popov, and Van Horen (2016) do not find moral suasion to be fueled by the three-year LTROs.

2 Overview and data

This section provides an overview of exLTROs within the ECB's institutional framework, shows aggregate patterns over time, and describes the data as well as the variables.

2.1 Institutional setting and extraordinary LTROs

Prior to quantitative easing starting in 2014, the Eurosystem offered two main facilities to provide liquidity to banks: open market operations and the marginal lending facility.[17] Main refinancing operations (MROs) and longer-term refinancing operations (LTROs) represent the majority of outstanding liquidity over time in open market operations. In MROs and LTROs banks borrow liquidity on pre-specified terms against the provision of collateral. Currently, the ECB conducts MROs on a weekly basis with one-week maturities and LTROs on a monthly basis with three-month maturities. Indicative calendars for regular tender operations are announced well in advance and cover MROs and standard three-month LTROs but not exLTROs.[18] Both MROs and LTROs are implemented by means of reverse repurchase agreement (repo) transactions. The ECB sets the rules and auctions off the liquidity but actual liquidity provisioning is by the national central banks. The majority of national central banks uses a collateral pooling system, whereby the ECB sets criteria according to which banks can pledge collateral with the respective national central bank.[19] Both MRO and LTRO credit are then separately consolidated across national central banks on the Eurosystem's balance sheet.

Until October 7, 2008, the ECB applies a liquidity neutral policy that aims at injecting – through the operations – what banks need in the aggregate to satisfy reserve requirements.[20] The banks bid in variable rate tenders in terms of loan size and interest rate for the restricted allotment size.[21] Since October 8, 2008, the ECB conducts MROs and LTROs under the

[17]The marginal lending facility allows banks to borrow funds overnight from the ECB against the provision of collateral and is not further discussed in this paper.

[18]For instance, on September 14, 2016, the ECB publishes the indicative calendar for regular tender operations for the years 2017 and 2018.

[19]See, e.g., European Central Bank (2015). Nyborg (2017b) provides a comprehensive study of the ECB's collateral framework and its development over the financial crisis. The only national central using an earmarking system to some extent is the Banco d'Espana (Bank for International Settlements, 2013).

[20]See, e.g., Nyborg, Bindseil, and Strebulaev (2002) or Fecht, Nyborg, and Rocholl (2011). Other autonomous factors can also have an influence on the ECB's offered allotment size (see, e.g., European Central Bank, 2002).

[21]The term "liquidity neutral" has first been used by Nyborg, Bindseil, and Strebulaev (2002). Fecht, Nyborg, and Rocholl (2011) show that, under the liquidity neutral policy with variable rate tenders, banks

fixed rate full allotment policy. Banks receive as much liquidity as they need at the given policy rate (fixed by the ECB) against the provision of collateral. Thus, roughly 7,500 eligible banks pay, independent of their credit worthiness, the same price for liquidity (without an auction mechanism).

As of March 2008 the ECB starts to implement in addition to MROs and standard LTROs also extraordinary LTROs which are announced ad-hoc and not included in the indicative calendar for regular tender operations. Table 1 provides an overview of all operations since January 1999. Panel A shows that the ECB holds, additionally to the standard LTROs, 20 six-month, four one-year, and two three-year LTROs (denoted as exLTROs in this paper) over the years 2008 to 2012.[22] Panels B and C show that across exLTROs both the average number of bidders and average alloted amount are increasing in LTRO maturity within each year.

Insert Table 1 here.

Table 2 lists characteristics of the 26 exLTROs. Beginning of 2008 the ECB announces, still under the liquidity neutral system, three six-month LTROs. Banks bid for between 2.3 and 4.1 times more than what the ECB alloted. End of 2008, under the full allotment system, the ECB announces five and beginning of 2009 nine six-month LTROs. In total, banks reduce standard LTRO borrowing by more than what they take in exLTROs. This could point towards heterogenous needs among Eurozone banks if, overall, banks reduce central bank borrowing but some banks switch into longer-dated financing. This trend changes with the one-year LTROs announced on May 7, 2009. Banks still switch from standard into exLTROs but the overall uptake is now positive. In the first one-year LTRO 1,121 banks ask for EUR 442.2 bn, representing the heretofore largest Eurosystem liquidity uptake. Overall, banks reduce standard LTRO credit by EUR 22.3 bn. Two more six-month LTROs are held in 2009 and 2010 but then, from June 2010 to July 2011, the ECB stops to announce additional exLTROs.

Insert Table 2 here.

pay more for liquidity when the dispersion of liquidity across banks is high, which is consistent with the existence of short squeezing (Nyborg and Strebulaev, 2004). For evidence on banks' bidding behavior in standard three-month LTROs (under the liquidity neutral policy), see Linzert, Nautz, and Bindseil (2007).

[22] The two ">36m" LTROs held in 2014 represent "targeted LTROs" (four-year durations) where banks are forced to channel the liquidity to the private sector. They are not further considered in this paper.

On August 4, 2011, the ECB announces another six-month LTRO and, shortly thereafter, on October 6, two further one-year LTROs. Only the first of these two is held (on October 27). The second is replaced by the three-year LTROs announced on December 8, 2011 (hold on December 22, 2011 and March 1, 2012). In these two exLTROs 523 and 800 banks take EUR 489.2 and 529.5 bn, respectively, which exceeds anything seen so far. Compared to the previous day, banks reduce standard LTRO financing by EUR 156.6 and 81.9 bn in these two operations.[23]

2.2 Country-level data

The first data set, used in Sections 3 and 4, combines data from four sources. The combined data set is on a country level. First, I use monthly country-level data on outstanding liquidity from the national central bank webpages as collected by Bruegel.[24] The data covers the period January 2003 to July 2015. Unfortunately, the national central banks provide outstanding liquidity in different formats. Greece, Italy, Portugal, Belgium, Finland, Slovenia, and Luxembourg provide end-of-month figures separated into MRO and LTRO outstanding liquidity. Austria and Ireland provide "roughly" end-of-month outstanding liquidity separated into MRO and LTRO.[25] Germany and France provide at the end of each month an average of daily outstanding liquidity for the maintenance period that ended that month, with figures likewise separated in MRO and LTRO.[26] Spain provides end of each month an average of daily outstanding liquidity (separated into MRO and LTRO) for that month. The Netherlands, Cyprus, and Malta provide only *total* outstanding liquidity, with the figures not separated into MROs and LTROs. As I am only interested in LTRO liquidity uptake I drop these countries from the sample.[27] Notice that the position "LTRO liquidity" includes both standard three-month and extraordinary LTRO outstanding liquidity. Aggregate patterns

[23]In the three-year LTROs the ECB fixes the rate at the MROs' retrospective average rate over the respective time period (at 1% at that time). Interest will be paid at maturity. After one year counterparties are allowed to repay any parts on any day coinciding with a MRO allotment day if they inform the respective national central bank one week ahead. Counterparties who received liquidity in the one-year LTRO alloted on October 27, 2011 were allowed to shift this liquidity uptake into the first three-year LTRO.

[24]`http://bruegel.org/publications/datasets/eurosystem-liquidity/` (Bruegel webpage, September 17, 2015). See also Pisani-Ferry and Wolff (2012).

[25]For instance, in 2014, the Austrian national central bank provides outstanding liquidity on January 3, January 31, February 28, April 4, May 2, May 30, etc.

[26]If no maintenance period ends in a particular month, Bruegel replaces the missing value by an equally-weighted average of the values in the preceding and the subsequent month.

[27]Data for the Netherlands are not part of the Bruegel data. In an email with De Netherlandsche Bank I was told that the Dutch central bank only provides *total* outstanding liquidity in the monthly balance sheet.

in the next subsection will be shown for both positions, MRO and LTRO liquidity. In the regression analysis in Sections 3 and 4 I will only use LTRO liquidity.

Spain (monthly averages of outstanding liquidity) is taken as the benchmark to make the different formats comparable. For Greece, Italy, Portugal, Belgium, Finland, Slovenia, and Luxembourg I calculate equally-weighted averages of end-of-month outstanding liquidity. For Austria and Ireland I calculate, first, number-of-day-weighted averages of the "roughly" end-of-month outstanding amounts and, second, equally-weighted averages of those. For Germany and France I calculate number-of-day-weighted averages for each month. All calculations are done separately for MROs and LTROs.

Second, I download the history of all ECB open market operations from January 1999 to July 2015.[28] The data includes allotment (auction), cash settlement, and maturity dates as well as interest rate, alloted amount, number of bidders, and auction type (fixed versus variable rate tenders) for each MRO and LTRO (LTRO data includes exLTROs). In each month I calculate the average MRO rate and take the maximum duration of held LTROs. This is merged with the Bruegel data.

Third, I make use of data from the ECB's Statistical Data Warehouse. I download weekly Eurozone-level outstanding liquidity in MROs and LTROs. To show aggregate patterns over time this weekly data is used. Furthermore, for each Eurozone country, I download (1) aggregate monthly debt redemptions of Monetary Financial Institutions (MFIs), excluding the central bank itself, from the securities issues database, which covers debt securities that may be traded on secondary markets (including money market paper) but do not grant the holder any ownership rights in the issuing firm, (2) aggregate end-of-month outstanding deposits from the MFI balance sheets database comprising deposits of non-financial corporations, households, insurance companies, pension funds, and financial corporations (excluding deposits of other MFIs), and (3) the monthly Harmonized Index of Consumer Prices (HICP). This data is merged with the first two data sets.[29]

Fourth, I download daily generic sovereign bond yields (two, five, and ten years) for all Eurozone countries, the "Euribor" rate, and the "EoniaSwap" rate from January 2004 to July 2015 from Bloomberg. The yield history represents an aggregation of market yields (a

[28] `https://www.ecb.europa.eu/mopo/implement/omo/html/top_history.en.html` (the ECB's webpage, September 17, 2015).

[29] `http://sdw.ecb.europa.eu/reports.do?node=1000005314` (The ECB's Statistical Data Warehouse, February 10 and March 3, 2017).

Bloomberg composite that uses prices contributed to Bloomberg) for the past on-the-run bonds of each tenor. Euribor is the benchmark rate of the Euro money market, at which prime banks offer each other, quoted on a daily basis, Euro interbank three-month term deposits within the Economic and Monetary Union.[30] The EoniaSwap rate is the mid rate on three-month interest rate swaps (average of daily quotes by panel of prime banks), where parties agree to exchange a fixed rate against the (floating) Eonia rate. The latter is the effective overnight reference rate for the euro computed as a weighted average of all overnight unsecured lending transactions in the interbank market. EMMI discontinued the EoniaSwap rate as of July 1, 2014.[31] Bloomberg still provides an estimate (a Bloomberg composite), contributed by a number of providers. To show patterns over time in this section I use daily yields and monthly averages of the Euribor–EoniaSwap spread. Later I use monthly yield averages for each country merged with the first three data sets.

The next section shows aggregate patterns for this sample of eleven Eurozone countries (Germany, France, Spain, Italy, Portugal, Greece, Ireland, Belgium, Finland, Slovenia, and Austria) from January 2004 to July 2015 (139 months).

2.3 Aggregate patterns over time

Figure 1 plots outstanding liquidity, maturing bank debt, and several Euro area rates from January 2004 to July 2015. The vertical lines in each subfigure indicate exLTRO cash settlements (light dotted: six-month LTROs, short-dashed: one-year LTROs, dark long-dashed: three-year LTROs). Panel A shows, first, that exLTRO cash settlements move together with maturing bank debt (negative region of plot) and the Euribor–EoniaSwap spread (solid, yellow line on the second y-axis). The latter is often used to measure tightness in the interbank market (see Nyborg and Östberg, 2014). Second, banks make use of exLTROs when more of their debt matures and when short-term debt (or interbank) markets are tight. Over the four-year exLTRO period from 2008 to 2012 banks do not only replace standard three-month LTROs by exLTROs (Table 2) but also MRO financing (light red area) by LTRO financing (dark blue area). This suggests that the ECB offers and the banks make use of exLTROs when banks have large amounts of maturing debt and when short-term debt (and interbank) borrowing is expensive.

[30] See `https://www.emmi-benchmarks.eu/euribor-org/about-euribor.html`.

[31] See `https://www.emmi-benchmarks.eu/eoniaswap-org/about-eoniaswap.html`.

Insert Figure 1 here.

Panel B shows outstanding liquidity in MROs and LTROs per country as a fraction of the total. Until July 2007, the majority of outstanding liquidity is allocated through MROs and more than 50% to German banks. After the cash settlement of the second three-year LTRO in March 2012, LTRO liquidity makes up for the majority with more than 50% of the total being allocated to Spanish and Italian banks. The switch from MRO into LTRO financing and from German to Spanish and Italian banks takes place in exLTRO months.

Table 3 reports on quarterly liquidity uptake by country from January 2008 to July 2015. "Non-CGIIPS" includes Austria, Belgium, Finland, Luxembourg, and Slovenia and "CGIIPS" Greece, Ireland, and Portugal. The quarter marked with [1] ([2]) includes the cash settlement (maturity) of the first one-year LTRO. [3] and [4] ([5] and [6]) mark the cash settlements (start of repayments) of the two three-year LTROs. With the first one-year LTRO, banks substitute MRO by LTRO liquidity in all countries. A year later German banks pay back EUR 86.8 bn LTRO liquidity, which is more than they take in the first place (EUR 63.9 bn). This means that German banks reduce LTRO outstanding when the first one-year LTRO matures. Similarly, smaller Non-CGIIPS banks take EUR 27.4 bn and pay back, one year later, EUR 31.3 bn. Spanish, Italian, and smaller CGIIPS banks, however, switch back into standard LTROs and even increase LTRO liquidity.[32] In the two three-year LTROs German banks take EUR 54.5 bn. One year later they pay back EUR 55.5 bn, which is in total more than what they take in the first place. Again, German banks reduce LTRO outstanding. French banks take EUR 105.2 bn and pay back, one year later, EUR 69.2 bn. In the period thereafter they pay back the rest. Spanish and Italian banks, however, take in total EUR 272.2 and 206.8 bn and pay back, one year later, only EUR 81.2 and 12.0 bn, respectively.

Insert Table 3 here.

The Eurosystem represents an attractive alternative for funding if rolling over maturing debt in the short-term debt or interbank market is expensive (or not even possible). I

[32] Drechsler, Drechsel, Marques-Ibanez, and Schnabl (2016) use May/June 2010 as the cut-off for pre and post in a difference-in-difference analysis. They interpret May 2010 as the start of the sovereign debt crisis because of the first Greek bailout programme. Table 3 shows that their results may partly be driven by Non-CGIIPS paying back the one-year LTRO funding whereas CGIIPS countries roll it over into standard LTRO funding. In the authors' Figure 4, Panel B, one can clearly see start and end of the first one-year LTRO.

create a simple measure for bank rollover costs in month m by multiplying the amount of maturing debt in month m with the annualized three-month Euribor–EoniaSwap spread in the preceding month, $m-1$. Maturing debt in month m is exogenous in the sense that banks cannot adapt their behavior towards it if the cash settlement of an exLTRO takes place in the same month. For instance, maturing debt is not affected if banks in general issue more (or less) debt during months with exLTRO cash settlements. Nevertheless, a LTRO cash settlement in month m needs lead time for the ECB to decide upon and announce the measure. The advantage of bank debt maturing in month m is that the ECB knows it already in month $m-1$ (remember, this data is even collected from the ECB's data warehouse). However, the Euribor-EoniaSwap spread in month m is not known by the ECB in month $m-1$ as it is set by market forces only in month m. Therefore I use the Euribor–EoniaSwap spread in month $m-1$ as best estimate of interbank funding costs for the subsequent month, m.

As pointed out by Nyborg and Östberg (2014), the Libor-OIS spread can be viewed as the price of getting a quantity of liquidity for a certain period for sure instead of rolling over overnight liquidity, hedging interest risk, and bearing the risk not to receive the quantity at some point. The Libor-OIS spread is the U.S.' equivalent to the Euribor–EoniaSwap spread for the Euro area. Thus, bank rollover cost measure the extra cost that a bank bears to enter an interbank market transaction that for sure replaces its maturing debt by new zero-coupon debt (or funding) with the same face value and a maturity of one year (remember, I use the annualized three-month Euribor-EoniaSwap spread).

Table 4 provides maturing bank debt per quarter [in bn EUR] and the estimate of banks' rollover costs [in mn EUR] per country from January 2008 to July 2015. Amounts at the end of the quarter are the sum of amounts in the current and the previous two months. The first column provides the average Euribor–EoniaSwap spread ($EuEo$) in the month prior to the start of the quarter [in %]. Maturing debt is particularly high in all countries from after the collapse of Lehman Brothers in September 2008 to the announcement of the one-year LTROs in 2009. For instance, in the quarter November 2008 to January 2009, maturing bank debt ranges from EUR 34.4 (Italy) to 2,222.2 (France) bn. High amounts paired with the high average Euribor–EoniaSwap spread in October 2008 (1.35%) leads to high rollover costs ranging from EUR 534.6 to 35,114.0 mn in this quarter.

Insert Table 4 here.

Figure 2 plots monthly average outstanding LTRO liquidity (blue-shaded area), rollover costs, (solid-red line), as well as the rolling two-year (long-dashed, blue), five-year (dashed, green), and ten-year (short-dashed, black) yields on sovereign debt for the period January 2008 to December 2013 by country. Within countries bank rollover costs, sovereign yields, and positive net uptake in LTROs co-move with exLTRO cash settlements. Panel A covers the large economies Germany, France, Spain, and Italy. All of them, with the exception of Italy, see the highest rollover costs in 2008, shortly after the collapse of Lehman brothers. In Italy rollover costs peak in March, 2012, coinciding with the second three-year LTRO. In all four economies rollover costs are relatively larger in 2008 and beginning of 2009 as well as from mid-2011 to mid-2012 (exLTRO periods) compared to before the crisis, the intermediate period (second half of 2009 and 2010), and after the second three-year LTRO (non-exLTRO periods).

Insert Figure 2 here.

In later sections, the sovereign yield spread above the ECB's policy rate is an important control variable because this spread determines the "carry" on sovereign debt if a bank uses Eurosystem liquidity to finance carry-trades.[33] Whereas sovereign yields decrease in Germany over time they increase in Italy and Spain and are particularly high around the three-year LTROs. In Spain and Italy the sovereign yield curve prior to the three-year LTROs is flat at roughly 6%. After the second three-year LTRO the Spanish and Italian yield curves have an upward-sloping shape (two-year yield: 2%, ten-year yield: 5% and 4.5%, respectively) suggesting that banks have run sovereign bond carry-trades over the three-year LTRO period. Meanwhile the German sovereign yield curve has throughout an upward-sloping shape with a two-year (ten-year) yield of roughly 1% (2%).[34] In Panel B, smaller Non-CGIIPS countries show a picture similar to Germany and smaller CGIIPS countries one similar to Spain and Italy.[35]

Overall, the aggregate patterns provide evidence that the ECB announces exLTROs and

[33]For the notion of "carry trades" see , e.g., Acharya and Steffen (2015). For the notion of ECB-financed "collateral trades" see Crosignani, Faria-e Castro, and Fonseca (2017). For a discussion on the ECB's policy rate see Nyborg (2016).

[34]Di Cesare, Grande, Manna, and Taboga (2012) justify the three-year LTROs because they find that sovereign bond yields of the peripheral Eurozone countries are beyond of what can be fundamentally explained by fiscal and macroeconomic factors.

[35]Slovenia and Greece are shown separately because these two countries, together with France, are not taken into account in the regression analysis as will be explained below.

that banks make use of them when bank rollover costs are high, i.e. when the price of liquidity in the interbank market and the amount of maturing bank debt are high. Banks select themselves into long-term Eurosystem financing if rolling over in the market is expensive or difficult.

2.4 Variables

For the regressions the sample is pruned further. I lose France and Slovenia due to variable normalizations and lack of data (described below). Greece was under serious bailout programmes as of May 2010 and is, therefore, dropped from the sample. The regression sample covers eight Eurozone countries (Germany, Spain, Italy, Portugal, Ireland, Belgium, Finland, and Austria) and the period January 2008 to December 2013 (72 months).[36] I construct five sets of variables. Table 5 provides descriptive statistics for the pooled sample (Panel A) and by country (Panel B).

INSERT TABLE 5 HERE.

First, for each country I calculate liquidity uptake, *LiquUpt*, as the difference in average monthly outstanding LTRO liquidity from one month to the next [in bn EUR]. Panel A shows that the variable is highly skewed (6.14). Panel B reveals German (Italian) banks to have, with EUR -1.70 (2.96) bn, the lowest (highest) average *LiquUpt*. *NormLiquUpt* [in %] is *LiquUpt* normalized by average amount outstanding in LTROs from January to August 2007 (before the start of the crisis). Panel A shows that *NormLiquUpt* is less skewed (4.99) than the non-normalized measure. The mean of 134.29% reveals that banks take from January 2008 to December 2013, on average, more than the amount outstanding in LTROs before the start of the crisis. *NormLiquUpt* varies less between countries (standard deviation is 245.03%) than within countries (921.97%). In Panel B, comparing means of *NormLiquUpt* across countries disposes again German banks with a mean of -1.67% at the low end but Portuguese (mean of 683.10%) instead of Italian banks at the high end. Portugal, Italy (303.69%), and Spain (74.87%) exhibit the highest means.

Second, LTRO duration, *Dur*, is the maximum duration of all LTROs held in a month [in number of calendar days]. ln(*Dur*) takes the natural logarithm of *Dur*. *Dur* has a

[36] For Luxembourg there is no yield data and for Slovakia, Latvia, and Lithuania no outstanding liquidity. The Netherlands, Cyprus, and Malta provide only total outstanding liquidity.

pooled mean of 152.07 and a median of 91 days. The variable is highly skewed due to several months with standard LTROs only. The variable ranges from one-month LTROs (28 days) to three-year LTROs (1,134 days). Taking the logarithm removes the skewness (0.85). Both variables are Eurozone-wide the same and, therefore, only vary within countries.

Third, bank rollover costs, Roc [in bn EUR], are estimated by multiplying debt redemptions, $DebtRed$ [in bn EUR], in month m with the Euribor–EoniaSwap spread, $EuEo$, in the previous month, $m-1$ [in %]. The Euribor–EoniaSwap spread is the Euro area's equivalent to the U.S.' Libor-OIS spread. The latter is often used as measure to capture tensions in the interbank market. Nyborg and Östberg (2014) explain that the Libor-OIS spread can be viewed as the price of liquidity. As explained in the previous subsection, bank rollover cost measure the extra cost that a bank bears to enter an interbank market transaction that for sure replaces its maturing debt by new zero-coupon debt (or funding) with the same face value and a maturity of one year. Rollover costs are skewed (5.12) and range from EUR 0.46 to 1,538.77 mn. Comparing means across countries in Panel B, Portugal has the minimum mean (EUR 7.64 mn) and Germany the maximum mean (EUR 244.91 mn). $NormRoc$ represents Roc in month m normalized by the average amount of maturing debt from January to August 2007. $NormRoc$ ranges from 0.00% to 15.89%. Both Roc and $NormRoc$ vary considerably within countries (with standard deviations of EUR 118.34 mn and 1.07%) but less between countries (EUR 78.23 mn and 0.67%). Panel B shows that, in normalized terms, Ireland has the minimum mean (0.19%) and Portugal, with the minimum in non-normalized terms, exhibits the maximum mean (2.34%). Italy has the second-highest mean (0.92%).

Sovereign yield spreads, $2ySovSpr$ [in %], represent the two-year sovereign yield, $2ySovYield$ [in %], above the monthly average MRO rate, $avgMROrate$ [in %], which is the ECB's policy rate.[37] The minimum of -1.01% shows that the MRO rate can exceed the two-year yields (in 2008 and 2009 before the start of the sovereign debt crisis). $2ySovSpr$ varies both across and within countries (driven by the sovereign yields; the MRO rate only varies within country). Panel B shows that Germany has the minimum mean (-0.28%) and Portugal the maximum mean (3.76%). Spain, with 1.29%, has the second and Italy, with 1.17%, the third highest mean.

[37] See Nyborg (2016) for a discussion on the ECB's policy rate. Notice that I have also ran the regression specifications in later sections with one-year and three-year sovereign yields. The main results are not influenced by this choice. However, two-year sovereign yield series have proven to be the most complete ones in terms of data availability.

Finally, $DepFlow$ [in bn EUR] is calculated as change in deposits from one month to the next. Deposit flows vary considerably within countries (standard deviation is EUR 13.40 bn) but less between countries (EUR 3.04 bn). $NormDepFlow$ [in %] normalizes deposit flows by average outstanding deposits from January to August 2007. $Inflation$ [in %] is average inflation measured as the change in the HICP in each country from month m previous year to month m contemporaneous year with a mean of 1.98% and varying across both dimensions (country and months).

Section 3 makes use of the non-normalized variables. In Section 4 it will be crucial to use normalized terms if a variable is dependent on the size of the country.

3 OLS regressions: The decision to conduct exLTROs

This section provides evidence that the ECB holds exLTROs during months in which bank rollover costs and, to a lesser extent, sovereign yields are high using the sample described in the previous section (January 2008 to December 2013). As the maximum LTRO duration observed within a month is the same for all banks I build subsamples of countries and focus on one time-series at the time. The basic regression setup is as follows.

$$\ln(Dur)_m = \alpha_0 + \alpha_1 \; Roc_m + \alpha_2 \; 2ySovSpr_{m-1} + \alpha_3 \; Controls_{m-1} + \epsilon_m \quad (1)$$

The dependent variable is the natural logarithm of LTRO duration, $\ln(Dur)$. The independent variables of main interest are Roc_m [in bn EUR], measuring total bank rollover costs in month m for the respective subsample of countries, and the two-year sovereign yield spread in the previous month, $2ySovSpr_{m-1}$ [in %] (for each subsample and month an equally-weighted average across countries). The latter measures the carry that banks can earn on sovereign debt if they refinance such an investment at the Eurosystem. Crosignani, Faria-e Castro, and Fonseca (2017) provide evidence for this behavior by Portuguese banks over the three-year LTRO implementation period. If this carry is positive banks might be willing to use the Eurosystem liquidity uptake to buy risky domestic sovereign debt which would be in line with Nyborg (2017b) who argues that the ECB provides funding – through the struggling banks – also to struggling sovereigns. Therefore, this variable measures this potential channel as incentive for the ECB to offer exLTROs. Controls are $DepFlow_{m-1}$ [in bn EUR] and $Inflation_{m-1}$ [in %] as sum and average across countries, respectively. I run two further specifications with the two components of Roc_m instead of Roc_m on the RHS of Eq. 1. $DebtRed_m$ is total contemporaneous debt redemptions for the respective subsample [in bn EUR]. $EuEo_{m-1}$ is the Euribor–EoniaSwap spread taken at the end of the previous month, $m-1$ [in %]. Fourth, I run Eq. 1 by replacing Roc_m with one principal component from Roc_m, $DebtRed_m$, and $EuEo_{m-1}$. Finally, I include the residual from an OLS regression of Roc_m on $DebtRed_m$ and $EuEo_{m-1}$ into Eq. 1 to see its explanatory power beyond rollover costs.

Table 6 presents the results. I run OLS regressions with Newey-West corrected standard errors using three lags.[38] Underneath the coefficients the table reports, in parentheses, p-values. a, b, and c denote significance (two-tailed) at the 1%, 5%, and 10% level, respectively. Panel A covers, on the left, all Eurozone countries and, on the right, countries whose national central banks provide outstanding liquidity separately for MROs and LTROs. Panels B and C split these two samples into CGIIPS and Non-CGIIPS countries as indicated in the table.

Insert Table 6 here.

The adjusted R^2 across the three panels range from 0.070 to 0.214 showing that these predictors have explanatory power. The coefficient on bank rollover costs in Specification [1] is positive and highly statistically significant, independent of subsamples, providing evidence that the ECB increases the duration on LTROs during months in which banks face difficulties to roll over maturing debt. Both the coefficients on the components of rollover costs, debt redemptions in Specification [2] and the Euribor–EoniaSwap spread in Specification [3], are positive likewise and in most cases highly statistically significant. The principal component in Specification [4] confirms these results. The residual from regressing rollover costs on its components in Specification [5] has a negative coefficient always but is statistically significant only in half of the cases and maximally at the 10% significance level.

In terms of economic significance the coeffícents vary widely across subsamples. Considering the coefficient of 0.095 on rollover costs in Specification [5], Panel A for all Eurozone countries, an additional EUR 1 bn in bank rollover costs would lead the ECB to increase LTRO duration by only 15.13 days.[39] In December 2012, when the ECB holds the first three-

[38]One time-series includes 72 months and, thus, $T^{1/4} = 2.91 \approx 3$ (see, e.g., Greene, 2008).

[39]Remember, the dependent variable is the logarithm of LTRO duration, $\ln(Dur)_m$. Marginal effects are calculated by multiplying the mean of Dur_m, 152.07 (see Table 5, Panel A), with $e^{\hat{\alpha}_1}$ and subtracting the mean from this number. Thus, for instance, $e^{0.095} = 1.10$ and $152.07(1.10-1) = 15.13$. Marginal effects for given values of Roc_m are calculated similarly by using $e^{Roc_m \cdot \hat{\alpha}_1}$.

year LTRO, the specification predicts, given rollover costs of EUR 12.31 bn, an increase in LTRO duration by 336.81 days ($\approx$ 1 year). For the subsample of countries that provide outstanding liquidity separately by MROs and LTROs, the coefficient is 0.520 (instead of 0.095), meaning that a EUR 1 bn increase in rollover costs would lead the ECB to increase LTRO duration by 103.75 days (as compared to only 15.13). Notice that this subsample is biased towards large Eurozone economies and CGIIPS countries, which might have been the countries that have received more attention by the ECB over the term of the financial crisis. Across all Specifications [5] the coefficient of the Euribor–EoniaSwap spread ranges from 0.706 to 0.889, meaning that a 1 ppt increase in the spread leads to an increase of LTRO duration between 156.03 and 217.95 days, respectively.

Splitting all Eurozone countries into CGIIPS and Non-CGIIPS countries (Panel B) shows that the magnitude of the coefficient on bank rollover costs is roughly ten times larger for CGIIPS than for Non-CGIIPS countries. In Specification [5] the coefficient of 0.990 (0.113) for CGIIPS (Non-CGIIPS) countries translates into a marginal effect of a EUR 1 bn increase in rollover costs to increase LTRO duration by 257.21 (only 18.12) days. Splitting the subsample of countries that provide MRO and LTRO outstanding liquidity separately into CGIIPS and Non-CGIIPS countries (Panel C) shows a similar picture but with even larger coefficients. In Specification [5] the coefficient of 1.245 (0.759) for CGIIPS (Non-CGIIPS) countries translates into a marginal effect of a EUR 1 bn increase in rollover costs to increase LTRO duration by 376.28 (172.73) days. Again, the larger marginal effects in Panel C as compared to Panel B provides evidence that larger Eurozone economies and CGIIPS countries have received more attention in the ECB's decision to implement exLTROs.

The two-year sovereign yield spread is important in the subsample biased towards large Eurozone economies and CGIIPS countries. All five coefficients are positive and in four out of five cases statistically significant at least at the level of 10%. Positive coefficients suggest that the ECB holds exLTROs particularly when sovereign yield spreads are high. The coefficient of 0.099 in Specification [5] translates into a marginal effect of a 1 ppt increase in the spread to increase the duration on LTROs by 15.77 days. The yield spread of roughly 6% in Italy in the month prior to the announcement of the three-year LTROs would translate into an increase in LTRO duration by 97.00 days, while controlling for the effect of bank rollover costs.

Deposit flows are across subsamples of countries negative (but statistically significant only in two specifications and only at the significance level of 10%) except for Non-CGIIPS countries in Panel C where coefficients are positive (but not statistically significant). Marginal effects are small. A negative effect means that the ECB provides longer-dated funding when banks are exposed to deposit outflows. The positive effect in Non-CGIIPS countries provides evidence that the ECB has been offering the longer-dated LTROs especially to CGIIPS countries. Furthermore, this points towards a segmentation in terms of deposit flows along the CGIIPS versus Non-CGIIPS dimension.[40]

Inflation is across all panels and specifications negative and significant at least at the level of 10% in Panel A. The same holds for CGIIPS countries in Panels B and C. Coefficients for Non-CGIIPS countries in Panels B and C are less significant. Across all M5-specifications the coefficient lies between -0.162 and -0.077 meaning that a 1 ppt decrease in inflation leads to an increase in LTRO duration between 22.77 and 11.23 days, respectively. The negative coefficient on inflation is in line with the ECB's mandate of targeting inflation.[41]

These results provide evidence that the ECB offers exLTROs when banks face high rollover costs in the market. Sovereign borrowing costs seem to play a second-order role but are important as well as they determine the carry that banks can earn on sovereign bonds.

4 Panel regressions: Liquidity uptake and rollover costs

In this section I explore the panel structure of the data described in Section 2.4 to empirically test whether bank rollover costs and sovereign yield spreads have an influence on Eurosystem liquidity uptake. To examine the role of LTRO duration I create interaction terms between LTRO duration and these variables expecting that uptake is particularly high during LTRO months in countries with high bank rollover and sovereign refinancing costs. I run pooled as well as fixed effects regressions using normalized terms if a variable is dependent on country size (liquidity uptake, rollover costs, and deposit flows).

Specification [1] measures the impact of normalized bank rollover costs in month m ($NormRoc_{m,c}$ in %) and the sovereign yield spread in the previous month, $m-1$ ($2ySovSpr_{m-1,c}$ in %), on normalized liquidity uptake from month m to month $m+1$ ($NormLiquUpt_{m+1,c}$

[40]This is in line with what Fecht, Nyborg, Rocholl, and Woschitz (2016) find in an analysis of German banks' collateral pools and Eurosystem liquidity uptake from 2006 to 2010.

[41]The Taylor-rule (Taylor, 1993) suggest that a central bank decreases the short rate if inflation is too low. Thus, one would expect the ECB to provide more liquidity (exLTROs) if inflation is low (negative effect).

in %). The subscript c denotes "country" and indicates the panel structure of the data. Normalized deposit flows are embodied to control for outflows on other dimensions and are measured as the change in deposits from month $m-2$ to $m-1$ ($NormDepFlow_{m-1}$ in %). Specification [2] adds the logarithm of LTRO duration in month m, $\ln(Dur)_m$, to this set of variables and is used as the basis for all further specifications:

$$\begin{aligned} NormLiquUpt_{m+1,c} &= \beta_0 + \beta_1\ NormRoc_{m,c} + \beta_2\ 2ySovSpr_{m-1,c} \\ &\quad + \beta_3\ \ln(Dur)_m + \beta_4\ NormDepFlow_{m-1,c} + v_{m,c} \end{aligned} \tag{2}$$

Specification [3] ([4]) replaces bank rollover costs (sovereign yield spreads) by an interaction term of the variable with LTRO duration. These two specifications show whether banks take, during exLTRO months, relatively more Eurosystem liquidity if bank rollover costs or sovereign yield spreads are high. Specification [5] instead adds an interaction term of bank rollover costs with sovereign yield spreads to see whether these two variables combined have an additional effect on uptake. Finally, Specification [6] replaces both bank rollover costs and sovereign yield spreads by interaction terms of LTRO duration with them at the same time. This last specification shows which interaction dominates, bank rollover costs with LTRO duration or sovereign yield spreads with LTRO duration.

Table 7 provides the results. Panel A (B) shows pooled panel (fixed effects) regressions with standard errors clustered on the country level. Underneath the coefficients the table reports, in parentheses, p-values. a, b, and c denote significance (two-tailed) at the levels of 1%, 5%, and 10%, respectively. In both panels a, b, and c are also provided, in square brackets, for double clustering on country and months (p-values are not reported).

Insert Table 7 here.

I discuss the results from the pooled panel regressions and refer to the fixed effects regressions only if there are noteworthy differences. The adjusted R^2 in Panel A range from 0.168 to 0.223, showing that these three variables (and interactions of them) exhibit considerable explanatory power.

Specification [1] shows that both the coefficents on normalized bank rollover costs and on sovereign yield spreads have positive signs and are statistically significant at least at the level of 5%. This indicates that banks take more Eurosystem liquidity if they pay high rollover costs and if the potential for running carry-trades on domestic sovereign debt is high. An increase in normalized bank rollover costs (sovereign yield spread) of 1 ppt leads to an increase in normalized liquidity uptake of 241.54 (69.15) ppt. The sign of the coefficient of normalized deposit flows is negative (but not statistically significant) across all specifications, showing that banks tend to fill the gap of deposit outflows by Eurosystem liquidity.

Specification [2] adds the logarithm of LTRO duration to the set of variables. The coefficients on the variables from Specification [1] remain unchanged. $\ln (Dur)_m$ has a positive sign but is not statistically significantly different from zero (notice that the p-value is 12.9%). A 100% increase in LTRO duration (doubling the duration) leads to an increase in normalized liquidity uptake of 163.68 ppt.[42] Clustering on both dimensions or including fixed effects for countries renders the impact statistically insignificant.

Specifications [3] and [4] replace bank rollover costs and sovereign yield spreads separately by interaction terms of LTRO duration with the variables.[43] The coefficients of the interaction terms of LTRO duration with both bank rollover costs in Specification [3] and the yield spread in Specification [4] are positive and statistically significant at the level of at least 5%, independent of clustering type and whether fixed effects are included or not. This provides evidence that banks take relatively more Eurosystem liquidity during exLTRO months when, at the same time, bank rollover risks and sovereign yield spreads are high. The interaction term of bank rollover costs and sovereign yield spreads in Specification [5] shows that the combined additional effect of these variables is negligibly small and not statistically significant.

Specification [6] replaces both variables by interaction terms with LTRO duration at the same time. The results reveal that the interaction term of LTRO duration with bank rollover costs has both in terms of economic magnitude and statistical significance a stronger impact on uptake. The interaction term of LTRO duration and bank rollover costs is statistically significant at the level of a least 10%, independent of clustering type and whether fixed effects are included or not. The interaction term of sovereign yield spreads with LTRO duration is statistically significantly different from zero in the pooled panel regressions at the level of at

[42] The marginal effect is calculated as $\hat{\beta}_3 \cdot \ln(200/100)$ with $\hat{\beta}_3 = 236.14$.

[43] Specifications that include the interaction terms together with both interacted variables suffer from multicollinearity issues as assessed with variance inflation tests. Multicollinearity stems from the high correlations of 97.7% and 97.5% between bank rollover costs or yield spreads, respectively, with the interaction term of LTRO duration and these variables. I thank my supervisor for having drawn my attention to this issue.

least 10%. Notice, however, that the p-value in the fixed effects regressions is 12.1%.

Table 8 illustrates the marginal effects of LTRO duration on normalized liquidity uptake using Specification [6] from Table 5, Panel A, which has the highest adjusted R^2 among the specifications in Table 5. In Table 8 I fix normalized rollover costs and sovereign yield spreads at values of 0% to 5% (in steps of 1 ppt), 10%, and 15%. This range reflects the observed ranges of the variables in Table 5, Panel A. Normalized bank rollover costs lie between 0.00% and 15.89%. Sovereign yield spreads range from -1.01% to 15.55%. Underneath the coefficients the table reports p-values. Standard errors are calculated with the Delta method and clustered on the country level. a, b, and c denote significance (two-tailed) at the level of 1%, 5%, and 10%, respectively.

Insert Table 8 here.

Table 8 shows that the marginal effect of LTRO duration on normalized liquidity uptake increases in normalized rollover costs, independent of the sovereign spread level. For instance, if normalized rollover costs are 0% (15%) and the yield spread is 0%, a one unit change in logarithmized LTRO duration leads to an increase in Eurosystem liquidity uptake of 130.41 (920.79) ppt. The marginal effect of 130.41 (920.79) ppt translates into an increase in normalized liquidity uptake of 90.39 (638.24) ppt if the ECB doubles LTRO duration at its mean. If normalized rollover costs are 0% (15%) and the yield spread is, instead, 15%, Specification [6] predicts normalized liquidity uptake to increase by 280.09 (827.94) ppt if the ECB doubles LTRO duration at its mean. The effect of LTRO duration on liquidity uptake also increase if one fixes bank rollover costs and increases sovereign yield spreads. The effect, however, is stronger along the bank rollover cost dimension with fixed yield spreads than along the yield spread dimension with fixed bank rollover costs. This suggests that the uptake in exLTRO months is particularly driven by the non-linearity captured with the interaction of LTRO duration and bank rollover costs. Bank rollover costs play both statistically and economically a more important role for the effect of LTRO duration on liquidity uptake than sovereign yield spreads.

These findings provide evidence that banks take more Eurosystem liquidity during exLTRO months when they are, at the same time, faced with high rollover costs in the market and opportunities to run sovereign bond carry-trades. Statistically and economically the former factor proves to be more relevant. These findings suggest that particularly banks with difficulties to refinance maturing debt in the market make use of exLTROs.

5 The three-year LTROs and bank bond yields

To better understand the impact of exLTROs on the market's perception of banks' credit risks I trace market yields in a separate bond-level data set (described below). I estimate yield curves (using the Svensson, 1994, procedure) for banks not only across but also separately for weakly and strongly capitalized banks within countries. Several studies (see, e.g., Crosignani, Faria-e Castro, and Fonseca, 2017; Krishnamurthy, Nagel, and Vissing-Jorgensen, 2015) have done similar investigations for sovereign debt. Using bank debt instead allows to examine the cross-section of banks within a country to understand who exactly profits from extraordinary LTROs.

As shown in detail below this analysis will essentially be based on bank bonds issued by German and Italian banks. Germany and Italy are the largest economies within the Eurozone for which at least quotes on bank bonds are available. Focusing on the three-year LTROs allows to abstract from nuances that an analysis of at or below one-year durations would entail.

5.1 Bond-level data

In Thomson Reuters Eikon I create a list of straight bank bonds issued (maturing) before (after) the announcement of the three-year LTROs (December 8, 2011) issued by Eurozone banks. This list of 22,471 bonds is fed into Thomson Reuters Datastream to get bond characteristics. I lose 5,244 bonds that are not in Datastream. I drop 4 bonds without coupon information, 184 bonds with principal currency other than EUR, 65 bonds for which domicile and country of issue are not the same, 64 bonds issued in countries with a total of less than 100 bonds, 1 bond with seniority "Senior Subordinated Unsecured", 2,639 mortgage-backed or covered bonds, 44 called bonds, 88 index-linked bonds, and 197 bonds that reopened. This sample consists of 13,941 bonds issued in six countries (Germany 8,589; Italy 4,140; Austria 739; France 174; Spain 153; and Portugal 146).

For this sample I download time-series information from January 3, 2011 to December 31, 2012 from Datastream. I compute for each bond the fraction of days on which the bond has at least one quote, either over its lifetime or over the sample period. I drop the 76.65% (10,684) bonds that have quotes on less than 50% of the days, 102 bonds with missing face value or exact coupon dates, 49 bonds for which maturity and last coupon date differ, 33 bonds with inconsistencies in terms of coupon dates and accrued interest[44], 34 bonds with missing data on bid prices, 42 bonds with amortizing coupons, 1 bond which has a different coupon in Eikon compared to the value in Datastream, and the remaining 147,169 bond-day observations (out of 1,372,854) with theoretical prices only. This reduces the sample to 2,984 bonds. I merge in bank equity ratios at the end of 2010 and 2011 from SNL Financial. 233 bank bonds are not in SNL and for 85 bonds the issuer's equity ratio is missing. I drop issuers with less than 4 bonds in this sample (70 bonds). The final sample consists of 2,596 bank bonds (Germany 1,914; Italy 405; Austria 125; France 119; Spain 7; and Portugal 26).

Table 9 provides an overview of the number of bonds by country, issuer, bank capitalization (within country), and maturity year. Weakly capitalized refers to banks with equity ratios below and including the median within each country calculated on the sample of bonds (not banks), ensuring an equal distribution of bonds across the two capitalization buckets. Each panel covers a country (Spain and Portugal are taken together).

Insert Table 9 here.

Panel A shows that the sample contains 1,914 bank bonds issued by 28 German banks. 11 banks (with 811 bonds) have an equity ratio (2010) below the median of 2.80% and 17 banks (with 1,103 bonds) have it above the median. Panel B shows the 13 Italian banks (with 405 bonds) in the sample. Three banks (with 204 bonds) have equity ratios above and including the median of 9.32% and 10 banks (with 201 bonds) have it below the median. The bonds have maturities of no more than 10 years but are relatively similarly distributed across maturity and capitalization buckets. Panel C shows the 6 French banks (with 119 bonds) in the sample. Two strongly capitalized banks (with 28 bonds) have equity ratios of 4.50% and 4.29% (above the median of 4.19%). Four banks (with 91 bonds) have equity ratios below and including the median. The bonds are neither equally distributed across capitalization nor across maturity buckets. Panel D shows a similar picture for the 6 Austrian banks (with 125 bonds). Only one bank is allocated to the bucket of strongly capitalized banks because 77 out of the 125 bonds are issued by the median bank. Panel E shows that the sample includes only one Spanish (7 bonds) and one Portuguese bank (26 bonds).

[44]Information on coupon dates are sometimes not consistent with accrued interest. In 27 obvious cases, which applies to 51 quarterly paying bonds, I have corrected these mistakes. For example: coupon dates are March-10, June-10, Sept-10, and Oct-10. However, according to accrued interest the last coupon date is on Dec-10, consistent with the four regular payments that the bond pays per year.

5.2 Bank yield curves: Results

Figure 3 presents estimated yield curves for banks in Italy, Germany, France, and Austria in Panels A to D, respectively. I abstain from estimating yield curves for Spanish and Portuguese banks as the sample only contains one bank per country. Yield curves are provided on four days. The solid (blue) line represents the Svensson zero-coupon curve on the day before the announcement of the three-year LTROs (December 7, 2011) with actual yields as (blue) circles, the short-dashed (green) line the first three-year allotment (December 21, 2011), the dotted (magenta) line January 31, 2012, and the long-dashed (red) line the second three-year allotment (February 29, 2012) with actual yields as (black) dots. Panel A shows that Italian banks profit at all maturities in terms of yield reductions but particularly at the within three-year horizon. Relatively speaking, the yield curve for Italian banks steepens over the three-year LTRO period. Panel B shows a slight level downward shift of the German yield curve. Compared to Italian banks the yield reductions are tiny and the curve does not steepen. Borrowing costs of Italian banks are ex-ante much higher compared to those of German banks. The results for French banks (Panel C) are a mixture of those in Italy and Germany; those for Austrian banks (Panel D) are very similar to Germany. For French as well as Austrian banks, however, the data basis is thin.

Insert Figure 3 here.

Figure 4 shows yield curves for weakly and strongly capitalized banks in Italy and Germany as indicated in Panels A to D for the same four dates as above. Weakly (strongly) capitalized refers to banks with equity ratios below and including (above) the median within each country calculated on the bond sample. Comparing weakly (Panel A) and strongly (Panel B) capitalized Italian banks reveals that particularly weakly capitalized banks within Italy profit from borrowing cost reductions over the three-year LTRO period. Weakly capitalized banks exhibit, ex-ante, higher borrowing costs. A less dramatic picture unfolds by comparing weakly and strongly capitalized German banks in Panels C and D. Weakly capitalized German banks exhibit ex-ante slightly higher borrowing costs and profit slightly more in terms of yield reductions especially at the within three-year horizon.

Insert Figure 4 here.

Table 10 provides the numbers. In each panel the first column represents the estimated yield [in %] by maturity on the day before the announcement of the three-year LTROs

(December 7, 2011). Columns two to four in each panel are the differences [in ppt] compared to the yield on December 7, 2011, on the latter three dates in Figures 3 and 4. Panels A and B show results for Italy and Germany and Panels C and D (E and F) for weakly and strongly capitalized Italian (German) banks, respectively. The darker a cell is (in orange), the more yields have decreased.

INSERT TABLE 10 HERE.

Italian banks in Panel A (German banks in Panel B) have ex-ante, the day before the announcement of the three-year LTROs, on average, yields of 5.25% and 7.49% (2.21% and 4.72%) at the one and ten year maturity, respectively. Hence, Italian banks pay on average 2.37 and 1.59 times as much as German banks at the respective horizons. Until the second three-year allotment, yields in Italy (Germany) decrease, on average, by 1.74 (0.50) ppt at the one year and by 0.65 (0.42) ppt at the six year horizon. This shows that especially Italian banks profit in terms of yield reductions over the three-year LTRO period and in particular at the shorter end covered by the three-year loans.

Weakly (strongly) capitalized Italian banks in Panel C (D) exhibit ex-ante yields of 5.73% (4.61%) at the one year and 8.97% (6.82%) at the ten year horizon. Until February 29, 2012, yields for weakly (strongly) capitalized banks decrease on average by 2.46 (0.68) ppt at the one year and by 1.86 (0.25) ppt at the five year horizon.[45] Hence, especially weakly capitalized Italian banks profit from yield reductions over the three-year LTRO period. The yield curve steepens for both weakly and strongly capitalized Italian banks but the magnitudes are smaller for the strongly capitalized banks. Weakly (strongly) capitalized German banks in Panel E (F) exhibit ex-ante yields of 2.39% (2.10%) at the one year and 5.14% (4.52%) at the ten year horizon. Until February 29, 2012, yields for weakly (strongly) capitalized banks decrease, on average, by 0.73 (0.45) ppt at the one and by 1.13 (0.29) ppt at the ten year horizon. Yield reductions are, thus, smaller than in Italy for both weakly and strongly capitalized banks.

Finally, to put this in a broader context, Figure 5 provides estimated spot yields over the sample period January 3, 2011 to December 31, 2012 (521 business days around the three-year LTROs) for the same samples as discussed in the previous table and different

[45] The yield curve estimations for weakly capitalized banks are based on a relatively few number of observations for longer horizons.

maturities as indicated in Panels A to F and the figure's caption. The vertical lines in each subfigure represent certain dates as explained in the discussion below.

Insert Figure 5 here.

On August 4, 2011, the ECB announces a six-month (203 days) LTRO that is held on August 11, which is represented by the dotted and dash-dotted (light-grey) lines. Panel A shows that already this 203-days LTRO is an ECB reaction to increasing borrowing costs on Italian bank debt, particularly driven by weakly capitalized Italian banks (see Panels C and D). But the 203-days LTRO does not help to reduce borrowing costs. In fact borrowing costs increase further. Hence, on October 6, 2011, the ECB announces two one-year LTROs. Only the first of these two is held (on October 27). These dates are represented by the long-dashed and dash-dotted (medium-grey) lines. The second is not held but – as yields of (in particular weakly capitalized) Italian banks increase further – the ECB announces on December 8, 2011, the two three-year LTROs, represented by the short-dashed (black) line. The first (second) is held on December 22, 2011 (March 1, 2012) which is represented by the first (second) solid (black) line. From this announcement onwards borrowing costs of (especially weakly capitalized) Italian banks start to decrease. Panel A for all Italian banks and Panels C and D for weakly and strongly capitalized banks, respectively, show that especially the short end of the yield curves decreases. A comparison to German banks (Panel B), weakly as well as strongly capitalized (Panels E and F, respectively), shows that German banks have only slightly higher borrowing costs prior to the announcement of the three-year LTROs and that yield reductions are tiny compared to Italian banks.

In March 2012 yields of Italian banks reach their lowest level before they start to increase continuously especially for weakly capitalized banks. The ECB responds on July 26, 2012, with President Draghi's famous speech where he says that "the ECB is ready to do whatever it takes to preserve the euro" (European Central Bank, 2012b), represented by the first short-dashed (light-grey) line. A couple of days later, on August 2, the ECB announces the outright monetary transactions (OMT), which is represented by the second short-dashed (light-grey) line. After these two announcements yields of – especially weakly capitalized – Italian banks drop to levels below those in March 2012. The announcement of the technical OMT details on September 6, 2012, which is represented by the third short-dashed (light-grey) line, helps to further lower Italian bank yields and, again, especially those of weakly capitalized banks. Neither Draghi's "whatever it takes" speech nor the announcement of OMT have an effect on German bank bond yields.

The findings suggest that the ECB offers exLTROs when some banks suffer from high market borrowing costs. Rolling over maturing debt in the market is expensive and entails uncertainty for these banks. For banks exposed to high rollover losses exLTROs represent a cheap alternative to market financing. Hence, these banks take relatively more Eurosystem liquidity. The lower probability that equity holders of struggling banks default and the ability of these banks to pay back short-term liabilities (using the Eurosystem liquidity) calms down the market and disproportionately reduces these banks' borrowing costs for the period covered by the ECB loans.[46]

6 Discussion: The inefficiency feature and implications

The way extraordinary LTROs work does not rule out that the ECB may also have provided long-term funding to a (possibly small) subset of banks with solvency rather than liquidity issues. Uptake in exLTROs is only conditional on sufficient collateral and does not reveal a bank's inducement – whether it is a liquidity or solvency troubled bank – to take Eurosystem liquidity. Obviously, for a solvency troubled bank society prefers an efficient form of bailout that solves Myers (1977)' debt overhang and puts costly obligations on the bank to restructure the balance sheet as required by Bhattacharya and Nyborg (2013). However, before August 2014, no single European Union-wide bank resolution mechanism is in place and, hence, dealing with banks, which face more severe problems (not only liquidity issues), uniformly across the Union is a difficult undertaking. On August 19, 2014, the European Parliament and Council (2014) put the "Single Resolution Mechanism" as part of the European Banking Union in place (European Parliament and Council, 2010).[47]

In 2014 the European Banking Authority (2014) conducts Union-wide stress tests for 123 banks of which 24 (19.5%) fail. Out of the 15 covered Italian banks 9 (60%) fail, among them Veneto Banca and Banca Popolare di Vicenza (Caon, 2014). On Friday, July 29, 2016,

[46] These results are reminiscent of Piazzesi (2005) who models the interaction between the U.S. sovereign yield curve and decisions that the Federal Open Market Commitee takes in its meetings. In her model the yield curve before each meeting impacts on the Commitee's decisions taken in the meeting, which then feed back into the yield curve. Chun (2011) provides evidence that central banks take yield curve information into account when they set the short-rate.

[47] Farhi and Tirole (2016) emphasize in their Introduction the creation of the European Banking Union as a major outcome of the debate on the doom-loop (discussed below).

the European Banking Authority (2016) publishes results of another stress test round for 51 (5) large European Union (Italian) banks. The board of Monte dei Paschi di Siena, the Italian bank with the worst stress test results in 2014, approves late on that same Friday a rescue plan to fend a government bailout (Sjolin, 2016). The stock prices of the other four Italian banks drop on Monday by 9.4% (UniCredit), 3.5% (Intesa Sanpaolo), 6.2% (Unione di Banche Italiane), and 5% (Banco Popolare) because the Italian banking sector stands out as one of the weakest (Sjolin, 2016).[48] In April 2016, Banca Popolare di Vicenza finds in an attempt to raise capital – the underwriter being UniCredit – no buyers and analysts are concerned that also other Italian banks, for instance UniCredit and Veneto Banca, are not able to raise capital in the market (Sanderson, Barker, and Jones, 2016). In December 2016, Italy's government seeks bailout funding for eight of Italy's largest banks due to a total of EUR 360 bn bad loans on their balance sheets (McAuley, 2016). In this same month UniCredit announces to cut 11% of its workforce (Reuters, 2016).[49]

Notice that the three-year LTROs help to reduce high yields in 2011 and beginning of 2012 for the exactly same banks – they have not defaulted since 2011 – that struggle with weak balance sheets in 2016 and 2017. These developments – five to six years later – provide anecdotal evidence that extraordinary LTROs have helped banks to survive but have not solved their issues. In He and Xiong (2012)'s logic, some of these banks are still alive because exLTROs have prevented equity holders from defaulting. As exLTROs do neither solve Myers (1977)' debt overhang nor impose costly obligations on the banks as required for efficiency by Bhattacharya and Nyborg (2013) these banks still have the same weak balance sheets in 2016 and 2017. These developments suggest, retrospectively, that extraordinary LTROs represent a tool that enables the ECB to buy time for other authorities to come up with a framework to uniformly deal with struggling banks but that the measure itself does not help to solve the issues.

The findings in this paper have important implications. First, extraordinary LTROs may have contributed to the observed increase in fragmentation in the Euro area because they have provided inefficient help over a long period. For instance, Corradin and Rodriguez-Moreno (2016) show that Eurozone sovereign bonds denominated in USD have traded at

[48] Bank stocks to slump after the publication of stress test results is in line Faria-e- Castro, Martinez, and Philippon (2016) who theoretically model these issues.

[49] See also Merler and Minenna (2016), Merler (2016), Goodman (2016), Merler (2017), Alden and Bray (2014), and Gandrud and Hallerberg (2017).

substantially higher yields than bonds denominated in EUR from 2008 to 2013. The authors attribute the mispricing to different ECB collateral eligibility requirements for assets denominated in Euro versus USD and show that both the Securities Markets Programme (SMP) and the three-year LTROs widen this spread. Trebesch and Zettelmeyer (2014) find that the ECB buys high-yielding Greek sovereign bonds in the SMP and that yields of those bonds decrease thereafter while yields of non-purchased Greek bonds increase. Van Rixtel and Gasperini (2013) show that Spanish and Italian banks increase their interbank borrowing from 2009 to 2011, while German banks become net lenders in 2011 (money market segmentation). Bijsterbosch and Falagiarda (2015) provide evidence for a strong rise in heterogeneity in terms of output growth across Eurozone countries as of 2010. Pisani-Ferry and Wolff (2012) point towards heterogeneity in the Euro area in terms of interest rates for households and firms and find that the three-year LTROs have not reduced this heterogeneity. Furthermore, Fecht, Nyborg, Rocholl, and Woschitz (2016) discuss how systemic arbitrage may have contributed to the observed increase in financial fragmentation in the Euro area. This paper suggests that extraordinary LTROs may have widened the scope for systemic arbitrage and, hence, its contribution to financial fragmentation.

Second, extraordinary LTROs may have fueled the "doom-loop" or "deadly embrace," the two-way link between sovereign and bank balance sheets because banks have incentives to invest the Eurosystem liquidity uptake into domestic sovereign bonds. For instance, Farhi and Tirole (2016) detail the sovereign-bank doom-loop by allowing for both domestic bank bailouts and international creditors' forgiveness on domestic sovereign debt. Renationalization occurs, first, because banks have incentives to buy the unpriced put option to protect themselves against the sovereign downside. Second, the sovereign may relax domestic bank monitoring because the cost of excessive risk taking by domestic banks are shared with foreign creditors. A weakening of the sovereign balance sheet directly reduces banks' net worth and, hence, banks reduce investments. Too excessive investment reduction leads the government to bail out banks by issuing more debt which, in turn, decreases the sovereign's debt price and, thus, weakens the banks further (the doom-loop).[50] Cooper and Nikolov (2015) emphasize that if banks were to have adequate capital buffers ex-ante they

[50] For further literature see Broner, Martin, and Ventura (2010), Bolton and Jeanne (2011), Brunnermeier et al. (2011), Merler and Pisani-Ferry (2012), Acharya, Drechsler, and Schnabl (2014), Broner, Erce, Martin, and Ventura (2014), Gennaioli, Martin, and Rossi (2014b), König, Anand, and Heinemann (2014), Brunnermeier et al. (2016), and Leonello (2016).

were not to overinvest in their domestic sovereigns because their equity would absorb the losses and they cannot expect to be bailed out. In line, Acharya and Tuckman (2014) argue that lender of last resort facilities can lead struggling banks to reduce the extent to which they delever, i.e., without these facilities banks would sell their illiquid assets at prices below the fundamental value. Other papers study the bank-sovereign nexus without the doom-loop feature (see, e.g., Sosa Padilla, 2013; Gennaioli, Martin, and Rossi, 2014b; Perez, 2015). In Bocola (2016) banks, merely anticipating a sovereign default, reduce lending and, as there is not risk shifting, delever.[51] Hence, with and without the doom-loop feature, exLTROs entail the risk to aggravate the correlation between bank and sovereign financial health.

Third, extraordinary LTROs also have, through the Eurosystem's collateral framework, implications for the ECB itself. What matters for the ECB in terms of credit risk are counterparties, the collateral that these counterparties pledge, and the correlation between the two. Nyborg (2017b) argues that the ECB's collateral framework suffers from the "correlated default loophole" because it does not control for this correlation, which enables banks to use collateral with the Eurosystem that is more likely to default when the bank itself is more likely to default. In Uhlig (2013)'s logic governments might turn a blind eye on this because potential losses are shifted onto the ECB. Furthermore, Fecht, Nyborg, Rocholl, and Woschitz (2016) show that, within Germany, weaker capitalized banks ask, with lower quality collateral (measured by collateral haircuts), for more Eurosystem credit, a phenomenon that has already been present before the crisis.[52] Extraordinary LTROs expose the Eurosystem not only to financially weaker banks but, if these banks run carry-trades on the domestic sovereign bonds and use these securities in consecutive repos as shown by Crosignani, Faria-e Castro, and Fonseca (2017), then not only the credit risks stemming from counterparty and collateral increase but also the correlation between the two (doom-loop amplifies this correlation). This highlights the importance of extraordinary LTROs in the context of financial stability (see, for instance, Nyborg, 2016).

To sum up, extraordinary LTROs may have contributed to the increased fragmentation in the Euro area in the first place. They may have fueled the bank-sovereign nexus within countries and, hence, the potentially harmful doom-loop consequences. Likely exLTROs have

[51] Bocola (2016) also finds that the three-year LTROs have only a small effect on bank lending and output.

[52] Bindseil, Nyborg, and Strebulaev (2009) study ECB repo auction bidder level data and show that this market for liquidity is not allocationally efficient. The authors provide evidence that the ECB's haircuts on collateral do not equilibrate opportunity cost of capital (see also Nyborg, Bindseil, and Strebulaev, 2002).

also increased the ECB's credit risk composition on all three dimensions: counterparties, collateral, and the correlation between the two.

7 Conclusion

This paper tries to understand the mechanim behind an unconventional monetary policy measure that the ECB used over a period of more than four years: LTROs with extraordinarily long-dated maturities of six months, one year, and three years.[53] Arguing that the ECB acts as the lender of last resort defies justification for extraordinary LTROs because under fixed rate full allotment the ECB lends freely, at a fixed rate, and against collateral ("Bagehot's advice", see Thornton, 1802; Bagehot, 1873; Goodhart, 1999) in its standard operations already. Extraordinary LTROs are offered on top of these standard operations and bear essentially the same costs as rolling over, for instance, one-week Eurosystem liquidity.

This paper examines the only feature that distinguishes extraordinary LTROs from standard operations, which is their duration. The data shows, first, that the ECB offers exLTROs when banks are faced with high rollover (and borrowing) costs in the market. Second, banks take relatively more Eurosystem liquidity during exLTRO months if they are faced with high rollover costs.

He and Xiong (2012) show theoretically that deteriorating bond market liquidity, which leads to higher rollover losses on banks' short-term debt, increases the credit risk premium on the debt. Using extraordinary LTROs to reduce banks' rollover risks and, therefore, removing the disciplinary role of short-term debt, may prevent equity holders of some banks from defaulting. Extraordinary LTROs represent, however, an inefficient form of help because they neither solve a debt overhang problem (Myers, 1977), nor inject equity, nor put costly obligations on banks to restructure the balance sheet (see Nyborg, 2017b, for a detailed discussion).

To better understand the impact of exLTROs on banks' credit risks this paper uses bank bond data on Italian and German banks and traces their yield curves over the three-year LTRO period. The analysis shows that, in particular, Italian banks and, within Italy, especially weakly capitalized banks profit in terms of yield reductions. Furthermore, yield

[53]Notice that the ECB has also implemented "Targeted LTROs" (TLTROs) with durations of even four years. TLTROs are special because the banks that receive the liquidity in such a repo are obliged to lend it to the private sector with the ECB monitoring this process. They are not studied in this paper.

curves of these banks steepen with the three-year LTROs. The same banks exhibit ex-ante, prior to the announcement of the three-year LTROs, the highest yield curve levels. In Germany yield reductions are tiny compared to Italy. These developments show, first, that extraordinary LTROs help, in particular, financially weak banks in financially weak countries. Second, extraordinary LTROs steepen the yield curve of banks and are therefore an insufficient tool to stimulate the economy.

In short, this paper provides evidence that the ECB offers extraordinary LTROs when banks are faced with high rollover costs. Banks faced with high rollover costs take disproportionately more Eurosystem liquidity during exLTRO months. Ex-post these banks profit exceptionally from market borrowing cost reductions.

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Table 1: MRO and LTRO duration by year.

This table provides an overview on MRO and LTRO duration from 1999 to 2014. Duration (in calendar days) is categorized as follows: MROs are split into "7d" (5 to 9 days, inclusive) and "14d" (11 to 21 days). LTROs are split into standard and extraordinary LTROs. Standard LTROs have durations of "1m" (21 to 43 days) and "3m" (70 to 105 days). Extraordinary LTROs are split into "6m" (182 to 203 days), "12m" (364 or 371 days), and ">36m" (more than 1,092 days). Ranges not covered do not exist. Panel A reports on number of operations, Panel B on average number of bidders, and Panel C on average alloted amounts (in bn EUR). Source: ECB Statistical Data Warehouse.

Panel A: Number of transactions per year

	MROs		Stand. LTROs		Extr. LTROs		
	7d	**14d**	**1m**	**3m**	**6m**	**12m**	**36m**
1999		52	1	13			
2000		51		12			
2001	2	52		12			
2002		53		12			
2003	3	52		12			
2004	43	9		12			
2005	52			13			
2006	52			12			
2007	51	1		16			
2008	53		3	20	5		
2009	52		12	24	12	3	
2010	52		12	12	2		
2011	52		12	12	1	1	1
2012	52		12	12			1
2013	53		12	12			
2014	52		6	12			2

Panel B: Average number of bidders

	MROs		Stand. LTROs		Extr. LTROs		
	7d	**14d**	**1m**	**3m**	**6m**	**12m**	**36m**
1999		776.8	466.0	302.0			
2000		721.4		270.0			
2001	247.5	410.4		225.2			
2002		306.9		185.6			
2003	132.3	274.5		132.5			
2004	351.3	282.7		158.6			
2005	351.0			150.7			
2006	377.4			162.3			
2007	336.9	390.0		145.4			
2008	442.9		134.7	160.0	144.4		
2009	401.2		80.7	46.2	51.3	644.7	
2010	114.8		26.3	98.2	59.0		
2011	191.8		46.7	170.8	114.0	181.0	523.0
2012	94.7		25.5	43.3			800.0
2013	75.6		20.8	46.0			
2014	149.6		36.8	87.6			280.5

Panel C: Average alloted amount [bn EUR]

	7d	**14d**	**1m**	**3m**	**6m**	**12m**	**36m**
1999		69.4	15.0	17.3			
2000		80.0		17.5			
2001	63.0	79.1		20.0			
2002		66.5		17.5			
2003	53.7	98.3		15.0			
2004	244.1	107.2		25.0			
2005	290.1			29.0			
2006	307.1			40.0			
2007	255.2	348.6		52.1			
2008	201.1		91.8	54.4	35.9		
2009	149.8		61.3	14.2	11.1	204.8	
2010	133.8		33.0	45.1	26.8		
2011	159.0		66.8	72.7	49.8	56.9	489.2
2012	97.8		17.8	14.4			529.5
2013	108.0		5.3	7.2			
2014	110.8		15.2	11.1			106.2

Table 2: Overview on extraordinary LTROs.

This table reports on the various features of extraordinary LTROs. In total there are ten announcements for a total of 27 exLTROs. Only 26 actually take place (see table footnote, *). Simultaneously announced exLTROs are listed underneath the announcement date. For each exLTRO the table provides allotment date (liquidity is book-like alloted), cash settlement date, maturity date, auction type (variable or fixed rate tender), duration in calendar days, and number of bidders. Amounts per transaction are as follows. Amt. bid is what banks bid for in the auction (only provided for variable rate tenders because under full allotment amount bid and asked for is the same). Liquidity uptake is split into uptake in the extraordinary LTRO itself, net uptake in all LTROs as compared to the previous day, and – calculated from those two – uptake in standard LTROs as compared to the previous day. Source: ECB Statistical Data Warehouse.

Allotment date	Settlement date	Maturity date	Auction type	Dur.	# of bidders	Amt. bid	LiquUptake in LTROs Extr.	All	Stand.
Announced on 28-March-2008									
2-Apr-2008	3-Apr-2008	9-Oct-2008	variable	189	177	103.11	25.00	25.00	0.00
9-Jul-2008	10-Jul-2008	8-Jan-2009	variable	182	141	74.58	25.00	25.00	0.00
Announced on 4-Sept-2008									
8-Oct-2008	9-Oct-2008	9-Apr-2009	variable	182	181	113.79	50.00	25.00	-25.00
Announced on 15-Oct-2008									
12-Nov-2008	13-Nov-2008	14-May-2009	fixed	182	127	-	41.56	58.36	16.81
10-Dec-2008	11-Dec-2008	11-Jun-2009	fixed	182	96	-	38.08	44.00	5.92
7-Jan-2009	8-Jan-2009	9-Jul-2009	fixed	182	39	-	7.56	-7.99	-15.55
11-Feb-2009	12-Feb-2009	13-Aug-2009	fixed	182	39	-	10.72	-37.61	-48.33
11-Mar-2009	12-Mar-2009	10-Sep-2009	fixed	182	60	-	10.81	-14.88	-25.69
Announced on 5-Mar-2009									
8-Apr-2009	9-Apr-2009	8-Oct-2009	fixed	182	75	-	36.09	-13.91	-50.00
13-May-2009	14-May-2009	12-Nov-2009	fixed	182	97	-	20.69	-5.68	-26.37
10-Jun-2009	11-Jun-2009	10-Dec-2009	fixed	182	110	-	18.20	-35.57	-53.77
8-Jul-2009	9-Jul-2009	14-Jan-2010	fixed	189	56	-	9.07	-8.65	-17.71
12-Aug-2009	13-Aug-2009	11-Feb-2010	fixed	182	53	-	11.87	-19.49	-31.36
9-Sep-2009	10-Sep-2009	11-Mar-2010	fixed	182	23	-	3.69	-18.50	-22.19
7-Oct-2009	8-Oct-2009	8-Apr-2010	fixed	182	22	-	2.37	-35.59	-37.96
11-Nov-2009	12-Nov-2009	13-May-2010	fixed	182	21	-	0.78	-22.14	-22.92
9-Dec-2009	10-Dec-2009	10-Jun-2010	fixed	182	21	-	1.73	-16.70	-18.43
Announced on 7-May-2009									
24-Jun-2009	25-Jun-2009	1-Jul-2010	fixed	371	1,121	-	442.24	419.90	-22.34
30-Sep-2009	1-Oct-2009	30-Sep-2010	fixed	364	589	-	75.24	71.58	-3.66
16-Dec-2009	17-Dec-2009	23-Dec-2010	fixed	371	224	-	96.94	96.73	-0.21
Announced on 3-Dec-2009									
31-Mar-2010	1-Apr-2010	30-Sep-2010	fixed	182	62	-	17.88	17.33	-0.54
Announced on 10-May-2010									
12-May-2010	13-May-2010	11-Nov-2010	fixed	182	56	-	35.67	34.89	-0.78
Announced on 4-Aug-2011									
10-Aug-2011	11-Aug-2011	1-Mar-2012	fixed	203	114	-	49.75	49.75	0.00
Announced on 6-Oct-2011									
26-Oct-2011	27-Oct-2011	1-Nov-2012	fixed	371	181	-	56.93	16.52	-40.41
21-Dec-2011	22-Dec-2011	31-Jan-2013	fixed	406	*	*	*	*	*
Announced on 8-Dec-2011									
21-Dec-2011	22-Dec-2011	29-Jan-2015	fixed	1,134	523	-	489.19	332.58	-156.61
29-Feb-2012	1-Mar-2012	26-Feb-2015	fixed	1,092	800	-	529.53	447.65	-81.88

* Second one-year LTRO in 2011 has been replaced by the first three-year LTRO.

Table 3: Quarterly liquidity uptake by country from January 2008 to July 2015.

The table provides a quarterly estimate of liquidity uptake by country calculated as the change in average outstanding liquidity end of the quarter compared to end of the previous quarter. For instance, uptake from January to April represents average outstanding liquidity in April minus average outstanding liquidity in January. "Smaller Non-CGIIPS" includes Austria, Belgium, Finland, Luxembourg, and Slovenia and "Smaller CGIIPS" Greece, Ireland, and Portugal. The quarter marked with [1] ([2]) includes the cash settlement (maturity) of the first one-year LTRO. [3] and [4] ([5] and [6]) include the cash settlements (start of repayments) of the two three-year LTROs. For France this data is only available since January 2011 as collected by Bruegel. Source: Bruegel webpage (see also Pisani-Ferry and Wolff, 2012), webpages of the respective national central banks, and ECB Statistical Data Warehouse.

		Germany		France		Spain		Italy		Non-CGIIPS		CGIIPS	
End-of-quarter		**MRO**	**LTRO**	**MRO**	**LTRO**	**MRO**	**LTRO**	**MRO**	**LTRO**	**MRO**	**LTRO**	**MRO**	**LTRO**
Jan-2008		-1.84	-7.65	-	-	9.95	-3.46	1.74	3.89	16.06	-14.37	6.93	4.94
Apr-2008		-4.61	-21.20	-	-	-9.51	14.88	-6.06	-0.30	-11.18	15.28	-1.97	4.92
Jul-2008		-3.17	-0.66	-	-	-3.00	4.49	-1.92	1.47	-4.00	3.43	6.94	3.86
Oct-2008		24.06	42.48	-	-	5.78	23.00	13.22	1.20	4.19	29.58	23.33	13.98
Jan-2009		-22.20	38.00	-	-	0.82	6.59	-9.09	24.50	-21.69	10.31	24.35	17.42
Apr-2009		9.66	-76.69	-	-	-1.86	-14.79	-3.13	-9.52	-7.96	-18.97	16.04	21.95
Jul-2009	[1]	-29.40	63.90	-	-	-5.72	30.28	-2.71	3.93	-5.30	27.40	-60.95	67.64
Oct-2009		-19.43	-0.74	-	-	-8.83	3.22	-2.23	-5.06	-14.70	-9.49	-8.46	-32.10
Jan-2010		6.85	-8.82	-	-	-5.35	6.62	-2.18	3.95	1.34	-3.04	3.16	16.04
Apr-2010		-1.88	-3.95	-	-	0.76	0.79	-0.12	-2.15	-3.91	-0.94	14.78	-0.97
Jul-2010	[2]	18.30	-86.82	-	-	29.71	19.52	9.60	3.00	5.83	-31.32	34.66	24.18
Oct-2010		1.12	-44.59	-	-	-17.55	-51.19	-4.45	-2.13	-5.00	-28.48	24.70	-0.92
Jan-2011		-9.34	4.83	-	-	4.37	-18.54	10.46	6.01	4.64	-1.29	5.20	-2.52
Apr-2011		-30.38	8.62	1.51	-10.28	-7.05	-6.25	-8.13	-0.96	-2.74	-3.09	-35.04	16.64
Jul-2011		-3.25	-10.66	3.11	10.47	10.86	2.69	14.68	7.82	9.09	2.49	13.16	-8.82
Oct-2011		-10.73	-17.17	26.00	39.43	21.50	7.32	23.58	23.50	2.46	2.22	-27.50	4.99
Jan-2012	[3]	-3.19	24.19	-31.40	68.56	-36.74	111.98	4.08	94.19	-0.90	19.94	5.12	-7.06
Apr-2012	[4]	-1.91	30.34	-0.16	36.65	-4.66	160.18	-48.40	112.64	-14.47	35.84	-3.42	-3.87
Jul-2012		1.41	2.84	1.12	2.92	67.56	17.69	10.24	1.62	-0.13	-0.08	16.09	-38.64
Oct-2012		-0.85	-2.99	0.68	2.35	-21.91	-13.34	-8.81	3.05	-0.09	0.09	-27.84	-9.06
Jan-2013	[5]	-0.48	-9.32	2.20	-14.48	-12.59	-8.30	1.54	-5.32	0.47	-7.26	23.95	-7.87
Apr-2013	[6]	-1.09	-46.20	1.35	-54.68	-8.09	-72.88	0.70	-6.63	-0.43	-29.07	18.58	-20.14
Jul-2013		0.31	-6.47	-5.17	-13.08	-4.00	-9.19	2.43	-17.72	0.54	-2.49	-3.61	-7.49
Oct-2013		-0.43	-2.31	-1.34	-15.21	-7.13	-7.36	-7.28	-11.49	0.34	-1.33	1.44	-1.67
Jan-2014		15.51	2.75	2.52	-14.29	-0.20	-43.77	14.33	-17.40	4.02	-1.62	-5.85	-3.75
Apr-2014		-0.07	1.38	-2.52	-6.05	7.89	-16.98	1.77	-20.77	-0.76	-3.10	0.65	-11.97
Jul-2014		-8.47	-0.69	7.83	-18.47	3.22	-26.85	-9.91	-28.57	-2.44	-0.88	-14.99	-14.54
Oct-2014		0.31	1.78	-6.05	-5.25	0.82	-6.72	4.12	-0.74	-0.19	-1.64	-8.11	-0.87
Jan-2015		5.05	16.41	0.92	26.51	-0.35	-12.51	8.97	-5.78	3.06	1.51	21.50	-4.83
Apr-2015		-7.52	-1.47	-0.90	2.93	3.92	-9.97	-2.93	-13.48	-0.90	-2.99	-22.64	-4.64
Jul-2015		-2.84	7.10	0.23	8.20	-13.91	17.79	-7.32	9.14	0.80	1.09	-3.62	-2.02

Table 4: Quarterly debt redemptions and rollover costs by country from January 2008 to July 2015.

The table provides total maturing bank debt (redemptions, "Red." below) per quarter [in bn EUR] and rollover costs [in mn EUR] per country over time. Rollover costs (Roc) is estimated as follows: in each month m the amount of debt redemptions is multiplied with the average Euribor–EoniaSwap spread in the previous month $m-1$. Rollover costs at the end of the quarter is the sum of rollover costs in this and the previous two months. First column: average Euribor–EoniaSwap spread in the month prior to start of the quarter [in %]. "Smaller Non-CGIIPS" includes Austria, Belgium, Finland, Luxembourg, and Slovenia and "Smaller CGIIPS" Greece, Ireland, and Portugal. The quarter marked with [1] ([2]) includes the cash settlement (maturity) of the first one-year LTRO. [3] and [4] ([5] and [6]) include the cash settlements (start of repayments) of the two three-year LTROs. Source: ECB Statistical Data Warehouse and Bloomberg.

		Germany		France		Spain		Italy		Non-CGIIPS		CGIIPS	
End-of-quarter	**EuEo**	**Red.**	**Roc**	**Red.**	**Roc**	**Red.**	**Roc**	**Red.**	**Roc**	**Red.**	**Roc**	**Red.**	**Roc**
Jan-2008	0.821	145.7	989.7	1,833.6	12,430.2	105.5	727.9	23.4	157.0	42.4	282.9	162.5	1,084.2
Apr-2008	0.610	152.5	754.7	1,560.3	7,635.7	90.4	442.6	23.4	113.7	54.3	261.9	138.7	676.5
Jul-2008	0.726	158.1	1,213.6	1,585.1	12,112.5	89.5	682.3	28.1	213.8	49.8	381.6	118.4	905.6
Oct-2008	0.754	139.6	943.8	1,638.6	11,358.3	92.7	634.5	24.2	166.8	48.0	321.4	118.1	797.0
Jan-2009	1.351	249.6	3,882.6	2,222.2	35,114.0	87.6	1,398.1	34.4	534.6	45.6	716.8	110.9	1,747.4
Apr-2009	0.900	203.5	1,929.0	1,795.5	17,240.3	75.5	727.5	36.3	348.0	52.2	497.5	99.1	957.9
Jul-2009 [1]	0.483	206.2	1,159.8	1,491.8	8,418.1	70.3	397.4	38.4	213.6	42.1	237.7	62.4	352.5
Oct-2009	0.378	194.1	866.4	1,262.6	5,558.5	52.0	224.8	37.2	156.0	45.6	197.6	73.3	323.0
Jan-2010	0.314	244.6	709.0	1,303.1	3,839.6	63.0	183.5	44.5	130.5	53.7	159.4	50.4	148.4
Apr-2010	0.284	111.1	333.1	1,278.2	3,810.0	50.4	151.4	58.7	176.3	41.8	124.8	40.1	120.2
Jul-2010 [2]	0.300	205.8	586.1	1,362.4	3,792.2	61.2	168.6	42.6	118.3	44.8	124.0	55.8	154.1
Oct-2010	0.351	117.0	400.8	1,232.1	4,192.6	38.5	135.0	52.2	179.9	49.6	170.6	61.6	216.4
Jan-2011	0.378	109.8	336.0	1,214.0	3,679.4	43.3	130.4	55.3	166.1	50.8	152.5	33.5	96.8
Apr-2011	0.234	101.0	268.8	1,087.3	2,927.7	49.8	134.6	61.6	170.3	39.6	106.6	43.7	113.7
Jul-2011	0.220	118.5	273.4	1,175.7	2,701.6	45.7	105.7	57.2	133.3	42.1	97.4	23.2	53.6
Oct-2011	0.795	99.5	557.1	1,320.4	7,616.4	32.2	203.3	39.2	233.6	42.4	241.6	20.5	108.7
Jan-2012 [3]	0.971	132.6	1,186.8	1,624.8	14,275.8	47.9	430.9	42.9	382.3	49.2	436.7	22.5	202.3
Apr-2012 [4]	0.505	96.5	682.8	1,393.4	9,739.1	77.9	539.3	105.5	717.5	55.1	381.8	44.4	329.7
Jul-2012	0.408	106.4	422.7	1,263.5	5,017.2	58.6	231.3	36.7	145.7	43.2	171.3	36.1	144.0
Oct-2012	0.164	87.8	220.1	1,123.7	3,009.8	44.4	112.8	50.2	135.4	45.6	124.6	18.0	53.8
Jan-2013 [5]	0.124	90.1	109.9	955.5	1,163.0	71.0	86.3	49.8	60.5	42.5	51.6	22.2	26.7
Apr-2013 [6]	0.128	82.8	99.3	825.0	990.7	54.1	64.8	77.7	93.3	38.6	46.2	48.7	58.8
Jul-2013	0.118	97.9	123.4	677.0	854.3	76.5	96.0	46.6	58.4	29.2	36.9	45.9	58.6
Oct-2013	0.126	82.1	100.3	601.9	736.1	36.9	45.7	54.2	67.2	31.2	38.3	16.1	19.7
Jan-2014	0.115	80.3	91.6	653.8	744.5	44.1	50.3	69.9	79.8	29.0	32.9	36.0	40.2
Apr-2014	0.139	98.4	132.7	544.0	734.1	51.8	69.2	91.0	125.8	32.6	43.3	26.4	35.9
Jul-2014	0.181	84.1	145.8	471.7	789.5	47.4	78.0	88.3	145.8	33.4	55.1	39.4	67.9
Oct-2014	0.141	65.3	94.8	257.8	375.1	50.6	72.9	64.9	93.4	28.8	41.8	25.8	37.2
Jan-2015	0.092	62.6	59.5	236.4	225.2	35.8	33.6	51.4	48.7	24.2	22.9	32.6	31.0
Apr-2015	0.109	72.2	76.5	190.3	201.1	36.9	39.0	67.0	70.6	23.7	24.9	50.7	53.0
Jul-2015	0.111	88.2	96.2	217.9	237.7	28.5	30.7	60.9	66.1	23.3	22.3	34.6	37.5

Table 5: Descriptive statistics for the pooled sample.

This table provides descriptive statistics on the sample of eight Eurozone countries whose national central banks provide outstanding liquidity separated by MROs and LTROs (Germany, Spain, Italy, Austria, Belgium, Finland, Portugal, and Ireland) for the period January 2008 to December 2013 (72 months). Greece is dropped because it was under serious bailout programmes as of May 2010. France and Slovenia are lost because of variable normalizations and lack of data. Panel A: pooled sample for all variables, Panel B: by country for those variables that vary across countries.

The variables are categorized into liquidity uptake, LTRO duration, bank rollover costs, sovereign refinancing costs, and deposit flow and inflation. *LiquUpt* represents LTRO liquidity uptake and is calculated from average monthly outstanding LTRO liquidity at the end of each month [in bn EUR]. $NormLiquUpt$ [in %] is *LiquUpt* normalized by average LTRO outstanding from January to August 2007 [in bn EUR]. *Dur* is the maximum duration of all LTROs held within a month [in # of calendar days]. ln(*Dur*) is logarithmized LTRO duration [in ln(# of calendar days)]. *Roc* measures bank rollover costs [in bn EUR]. $NormRoc$ normalizes rollover costs by average debt redemptions from January to August 2007 [in bn EUR]. Bank rollover costs are estimated by multiplying debt redemptions, *DebtRed* [in bn EUR], in month m with the Euribor–EoniaSwap spread, *EuEo*, in the previous month, $m-1$ [in %]. Sovereign refinancing costs are measured by $2ySovSpr$ [in %], which is the difference between the two-year sovereign yield, $2ySovYield$ [in %], and the average monthly MRO rate, $avgMROrate$ [in %]. $DepFlow$ measures deposit flows [in bn EUR] and is calculated as the change in deposits from one month to the next. $NormDepFlow$ [in %] normalizes deposit flows by average outstanding deposits from January to August 2007 [in bn EUR]. $Inflation$ [in %] is measured as the change in the HICP from month m previous year to month m contemporaneous year.

Source: Bruegel webpage (see also Pisani-Ferry and Wolff, 2012), webpages of the respective national central banks, ECB Statistical Data Warehouse, and Bloomberg.

Panel A: Pooled sample (countries, months)		Mean	SE	SD	Skew	Med	Min	Max	N
Liquidity uptake									
LiquUpt	overall	0.55	0.47	11.19	6.14	-0.01	-61.64	163.01	576
[bn EUR]	between			1.47			-1.70	2.96	8
	within			11.10			-59.39	161.22	72
$NormLiquUpt$	overall	134.29	39.59	950.08	4.99	-0.47	-2,467.81	9,237.18	576
[%]	between			245.03			-1.67	683.10	8
	within			921.97			-3,016.62	8,688.36	72
LTRO duration									
Dur	overall	152.07	7.45	178.91	4.37	91.00	28.00	1,134.00	576
[# of cal. days]	between			0.00			152.07	152.07	8
	within			178.91			28.00	1,134.00	72
ln(*Dur*)	overall	4.74	0.03	0.67	0.85	4.51	3.33	7.03	576
[ln(# of cal. days)]	between			0.00			4.74	4.74	8
	within			0.67			3.33	7.03	72
Bank rollover costs									
Roc	overall	74.61	5.80	139.17	5.12	29.70	0.46	1,538.77	576
[mn EUR]	between			78.23			7.64	244.91	8
	within			118.34			-148.17	1,368.47	72
$NormRoc$	overall	0.80	0.05	1.24	5.72	0.47	0.00	15.89	576
[%]	between			0.67			0.19	2.34	8
	within			1.07			-1.40	14.35	72
DebtRed	overall	14.32	0.69	16.55	2.39	6.86	0.06	111.45	576
[bn EUR]	between			14.35			1.90	45.59	8
	within			9.67			-12.70	80.17	72
EuEo	overall	0.46	0.01	0.35	1.54	0.36	0.11	1.70	576
[%]	between			0.00			0.46	0.46	8
	within			0.35			0.11	1.70	72

Table to be continued

Table 5, Panel A – *continued*

		Mean	SE	SD	Skew	Med	Min	Max	N
Sovereign refinancing costs									
$2ySovSpr$	overall	1.05	0.10	2.39	3.36	0.37	-1.01	15.55	576
[%]	between			1.46			-0.28	3.76	8
	within			1.96			-3.31	13.49	72
$2ySovYield$	overall	2.55	0.10	2.47	2.72	1.88	-0.04	16.79	576
[%]	between			1.46			1.22	5.26	8
	within			2.06			-1.39	14.99	72
$avgMROrate$	overall	1.56	0.05	1.23	1.51	1.00	0.35	4.50	576
[%]	between			0.00			1.56	1.56	8
	within			1.23			0.35	4.50	72
Deposit flow and inflation									
$DepFlow$	overall	2.28	0.57	13.70	2.97	0.68	-76.46	164.34	576
[bn EUR]	between			3.04			-0.15	7.73	8
	within			13.40			-80.72	158.89	72
$NormDepFlow$	overall	0.37	0.07	1.71	2.94	0.24	-5.59	19.99	576
[%]	between			0.34			-0.07	0.94	8
	within			1.68			-5.32	19.41	72
$Inflation$	overall	1.98	0.06	1.53	-0.66	2.11	-2.90	5.89	576
[%]	between			0.64			0.62	2.66	8
	within			1.41			-2.12	5.50	72

Panel B: By country

		Mean	SE	SD	Skew	Med	Min	Max	N
					Germany				
Liquidity uptake									
$LiquUpt$	[bn EUR]	-1.70	1.69	14.34	-0.32	-1.22	-61.64	48.28	72
$NormLiquUpt$	[%]	-1.67	1.66	14.06	-0.32	-1.19	-60.43	47.33	72
Bank rollover costs									
Roc	[mn EUR]	244.91	32.78	278.16	2.67	146.86	22.14	1,538.77	72
$NormRoc$	[%]	0.63	0.08	0.71	2.67	0.37	0.06	3.93	72
$DebtRed$	[bn EUR]	45.59	2.50	21.19	1.40	39.03	18.58	111.45	72
Sovereign refinancing costs									
$2ySovSpr$	[%]	-0.28	0.05	0.43	0.26	-0.32	-1.01	0.56	72
$2ySovYield$	[%]	1.22	0.15	1.25	1.23	0.97	-0.04	4.56	72
Deposit flow and inflation									
$DepFlow$	[bn EUR]	6.55	2.18	18.48	-0.55	8.20	-76.46	71.22	72
$NormDepFlow$	[%]	0.28	0.09	0.78	-0.55	0.35	-3.23	3.01	72
$Infl$	[%]	1.75	0.11	0.97	-0.44	1.87	-0.75	3.45	72

Table to be continued

Table 5, Panel B – *continued*

		Mean	SE	SD	Skew	Med	Min	Max	N
		Spain							
Liquidity uptake									
LiquUpt	[bn EUR]	2.34	2.81	23.88	4.43	-0.94	-46.65	163.01	72
NormLiquUpt	[%]	74.87	90.22	765.58	4.43	-30.20	-1,495.49	5,225.76	72
Bank rollover costs									
Roc	[mn EUR]	107.03	13.13	111.42	2.13	58.31	7.71	617.60	72
NormRoc	[%]	0.31	0.04	0.32	2.13	0.17	0.02	1.76	72
DebtRed	[bn EUR]	20.59	0.91	7.69	0.57	19.21	5.91	41.92	72
Sovereign refinancing costs									
2ySovSpr	[%]	1.29	0.13	1.08	0.39	1.20	-0.70	4.22	72
2ySovYield	[%]	2.79	0.12	1.00	0.37	2.85	1.39	4.98	72
Deposit flow and inflation									
DepFlow	[bn EUR]	1.16	2.35	19.92	-0.46	2.80	-70.61	45.24	72
NormDepFlow	[%]	0.09	0.19	1.58	-0.46	0.22	-5.59	3.58	72
Infl	[%]	2.22	0.19	1.58	-0.31	2.39	-1.32	5.33	72
		Italy							
Liquidity uptake									
LiquUpt	[bn EUR]	2.96	1.55	13.14	3.40	0.05	-10.27	64.16	72
NormLiquUpt	[%]	303.69	158.85	1,347.89	3.40	5.56	-1,053.70	6,581.70	72
Bank rollover costs									
Roc	[mn EUR]	67.07	7.12	60.42	3.57	48.36	11.88	435.35	72
NormRoc	[%]	0.92	0.10	0.83	3.57	0.67	0.16	6.00	72
DebtRed	[bn EUR]	15.98	0.91	7.72	3.02	15.52	5.85	62.06	72
Sovereign refinancing costs									
2ySovSpr	[%]	1.17	0.12	1.05	1.40	0.87	-0.68	5.22	72
2ySovYield	[%]	2.67	0.14	1.16	0.85	2.24	1.24	6.33	72
Deposit flow and inflation									
DepFlow	[bn EUR]	7.73	3.04	25.84	3.20	3.48	-39.00	164.34	72
NormDepFlow	[%]	0.94	0.37	3.14	3.20	0.42	-4.74	19.99	72
Infl	[%]	2.26	0.14	1.17	-0.07	2.14	-0.11	4.25	72
		Austria							
Liquidity uptake									
LiquUpt	[bn EUR]	0.01	0.22	1.90	-0.10	0.00	-6.88	6.65	72
NormLiquUpt	[%]	0.57	9.20	78.08	-0.10	-0.13	-282.62	272.89	72
Bank rollover costs									
Roc	[mn EUR]	21.46	2.33	19.77	1.84	14.80	2.29	93.40	72
NormRoc	[%]	0.74	0.08	0.68	1.84	0.51	0.08	3.21	72
DebtRed	[bn EUR]	4.54	0.22	1.87	1.37	4.15	1.92	11.88	72
Sovereign refinancing costs									
2ySovSpr	[%]	-0.06	0.05	0.44	0.34	-0.10	-0.81	0.91	72
2ySovYield	[%]	1.44	0.15	1.26	1.07	1.05	0.03	4.66	72
Deposit flow and inflation									
DepFlow	[bn EUR]	0.72	0.28	2.35	0.00	0.64	-4.93	5.65	72
NormDepFlow	[%]	0.29	0.11	0.94	0.00	0.25	-1.98	2.27	72
Infl	[%]	2.28	0.14	1.15	-0.47	2.27	-0.43	4.04	72

Table to be continued

Table 5, Panel B – *continued*

		Mean	SE	SD	Skew	Med	Min	Max	N
		Belgium							
Liquidity uptake									
$LiquUpt$	[bn EUR]	0.09	0.49	4.20	-0.41	0.00	-12.98	11.32	72
$NormLiquUpt$	[%]	5.59	30.82	261.48	-0.41	-0.16	-809.01	705.23	72
Bank rollover costs									
Roc	[mn EUR]	25.66	2.43	20.61	1.35	20.33	2.65	105.19	72
$NormRoc$	[%]	0.66	0.06	0.53	1.35	0.52	0.07	2.71	72
$DebtRed$	[bn EUR]	5.43	0.26	2.20	1.51	5.10	2.26	13.96	72
Sovereign refinancing costs									
$2ySovSpr$	[%]	0.23	0.07	0.63	0.99	0.09	-0.78	2.45	72
$2ySovYield$	[%]	1.73	0.15	1.28	0.64	1.32	0.09	4.71	72
Deposit flow and inflation									
$DepFlow$	[bn EUR]	1.07	0.59	4.97	-0.17	0.50	-15.60	13.69	72
$NormDepFlow$	[%]	0.27	0.15	1.23	-0.17	0.12	-3.87	3.39	72
$Infl$	[%]	2.37	0.19	1.63	-0.26	2.62	-1.73	5.89	72
		Finland							
Liquidity uptake									
$LiquUpt$	[bn EUR]	0.03	0.05	0.42	1.14	0.00	-1.00	1.54	72
$NormLiquUpt$	[%]	7.49	11.81	100.24	1.14	0.00	-241.53	371.63	72
Bank rollover costs									
Roc	[mn EUR]	24.90	2.67	22.65	1.58	16.06	2.06	101.72	72
$NormRoc$	[%]	0.58	0.06	0.53	1.58	0.38	0.05	2.38	72
$DebtRed$	[bn EUR]	4.82	0.18	1.51	0.91	4.79	1.75	10.73	72
Sovereign refinancing costs									
$2ySovSpr$	[%]	-0.24	0.04	0.37	0.11	-0.21	-0.87	0.41	72
$2ySovYield$	[%]	1.26	0.15	1.28	1.28	0.98	0.00	4.64	72
Deposit flow and inflation									
$DepFlow$	[bn EUR]	0.64	0.15	1.31	0.82	0.56	-1.82	4.92	72
$NormDepFlow$	[%]	0.79	0.19	1.62	0.82	0.69	-2.24	6.06	72
$Infl$	[%]	2.66	0.11	0.97	-0.02	2.73	0.60	4.72	72
		Portugal							
Liquidity uptake									
$LiquUpt$	[bn EUR]	0.57	0.21	1.76	1.77	0.11	-2.07	7.77	72
$NormLiquUpt$	[%]	683.10	247.08	2,096.50	1.77	131.15	-2,467.81	9,237.18	72
Bank rollover costs									
Roc	[mn EUR]	7.64	1.01	8.58	2.75	4.99	0.46	51.95	72
$NormRoc$	[%]	2.34	0.31	2.62	2.75	1.53	0.14	15.89	72
$DebtRed$	[bn EUR]	1.90	0.18	1.51	1.43	1.43	0.06	7.41	72
Sovereign refinancing costs									
$2ySovSpr$	[%]	3.76	0.51	4.37	1.35	2.32	-0.60	15.55	72
$2ySovYield$	[%]	5.26	0.49	4.13	1.51	3.86	1.32	16.79	72
Deposit flow and inflation									
$DepFlow$	[bn EUR]	0.55	0.31	2.63	0.28	0.44	-7.33	7.62	72
$NormDepFlow$	[%]	0.35	0.20	1.66	0.28	0.28	-4.62	4.81	72
$Infl$	[%]	1.69	0.19	1.64	-0.47	2.11	-1.79	4.05	72

Table to be continued

Table 5, Panel B – *continued*

		Mean	SE	SD	Skew	Med	Min	Max	N
		Ireland							
Liquidity uptake									
LiquUpt	[bn EUR]	0.10	0.59	5.02	0.58	-0.39	-12.56	19.03	72
NormLiquUpt	[%]	0.65	3.95	33.51	0.58	-2.57	-83.84	127.00	72
Bank rollover costs									
Roc	[mn EUR]	98.19	16.06	136.26	1.88	34.80	2.35	573.29	72
NormRoc	[%]	0.19	0.03	0.26	1.88	0.07	0.00	1.11	72
DebtRed	[bn EUR]	15.68	1.56	13.28	0.92	10.92	1.64	46.50	72
Sovereign refinancing costs									
2ySovSpr	[%]	2.54	0.35	2.98	1.86	1.30	-0.36	14.98	72
2ySovYield	[%]	4.04	0.34	2.92	1.80	3.88	0.73	16.48	72
Deposit flow and inflation									
DepFlow	[bn EUR]	-0.15	0.35	2.98	0.97	-0.14	-6.77	12.70	72
NormDepFlow	[%]	-0.07	0.17	1.44	0.97	-0.07	-3.28	6.15	72
Infl	[%]	0.62	0.23	1.94	-0.30	1.09	-2.90	3.93	72

Table 6: OLS regressions of logarithmized LTRO duration on rollover costs and its components.

This table shows OLS regressions of logarithmized LTRO duration on rollover costs and its components for different samples of countries for the period January 2008 to December 2013. Each regression is based on 72 monthly observations and the variables represent either a sum or an average across each subsample of countries. Panel A covers, on the left, all Eurozone countries (changing composition) and, on the right, the eight countries whose national central banks provide outstanding liquidity separated by MROs and LTROs. Panel B (C) splits all Eurozone countries in Panel A on the left (on the right) into CGIIPS and Non-CGIIPS countries. CGIIPS, in this table, is an acronym for Cyprus, Greece, Italy, Ireland, Portugal, and Spain.

The dependent variable is logarithmized LTRO duration, ln(Dur) [in ln(# of calendar days)]. Roc_m measures total rollover costs in month m for the respective subsample [in bn EUR]. It is estimated by multiplying debt redemptions in month m with the Euribor–EoniaSwap spread in the previous month, $m-1$. Regressions are shown for these two rollover cost components separately. $DebtRed_m$ is total debt redemptions for the respective subsample taken contemporaneously [in bn EUR]. $EuEo_{m-1}$ is the Euribor–EoniaSwap spread taken end of the previous month, $m-1$ [in %]. PC is the first principal component from Roc_m, $DebtRed_m$, and $EuEo_{m-1}$. $Resid$ is the residual from an OLS regression of Roc_m on $DebtRed_m$ and $EuEo_{m-1}$. $2ySovSpr_{m-1}$ is the difference between the average two-year sovereign yield across countries in the respective subsample and the average monthly MRO rate [in %]. $DepFlow_{m-1}$ measures deposit flows as the change in total deposits across the subsample from month $m-2$ to $m-1$ [in bn EUR]. $Inflation_{m-1}$ measures inflation as the change in average HICP across the subsample from month $m-1$ previous year to $m-1$ contemporaneous year [in %].

Underneath the coefficients the table reports, in parentheses, p-values with standard errors corrected by the Newey-West procedure with three lags. a, b, and c denote significance (two-tailed) at the level of 1%, 5%, and 10%, respectively. Source: ECB Statistical Data Warehouse and Bloomberg.

Panel A: All Eurozone countries (changing composition) and sample countries

	Eurozone					**Sample countries**				
	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]
Roc_m [bn EUR]	0.083^a				0.095^a	0.491^a				0.520^a
	(0.002)				(0.000)	(0.000)				(0.000)
$DebtRed_m$ [bn EUR]		0.002^a					0.010^a			
		(0.000)					(0.005)			
$EuEo_{m-1}$ [%]			0.805^a					0.806^a		
			(0.000)					(0.000)		
PC				0.189^a					0.199^a	
				(0.000)					(0.000)	
$Resid$					-0.160					-0.801
					(0.151)					(0.174)
$2ySovSpr_{m-1}$ [%]	-0.011	0.002	-0.010	-0.006	-0.008	0.121^b	0.189^b	0.081	0.132^b	0.099^c
	(0.166)	(0.842)	(0.194)	(0.418)	(0.318)	(0.045)	(0.014)	(0.117)	(0.021)	(0.058)
$DepFlow_{m-1}$ [bn EUR]	-0.002	-0.002^c	-0.002	-0.002^c	-0.001	-0.000	-0.001	-0.000	-0.001	-0.000
	(0.109)	(0.056)	(0.136)	(0.083)	(0.168)	(0.656)	(0.493)	(0.966)	(0.416)	(0.635)
$Inflation_{m-1}$ [%]	-0.083^c	-0.096^b	-0.092^b	-0.096^b	-0.099^b	-0.138^b	-0.089^c	-0.148^b	-0.133^b	-0.141^a
	(0.057)	(0.032)	(0.028)	(0.024)	(0.019)	(0.027)	(0.058)	(0.015)	(0.014)	(0.007)
$Constant$	4.833^a	3.687^a	4.723^a	5.084^a	4.803^a	4.596^a	3.603^a	4.572^a	4.873^a	4.610^a
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Adj. R^2	0.123	0.166	0.133	0.150	0.130	0.151	0.158	0.142	0.177	0.159

Table to be continued

Table 6 – *continued*

Panel B: All Eurozone countries by CGIIPS and Non-CGIIPS

	CGIIPS					Non-CGIIPS				
	[1]	[2]	[3]	[4]	[5]	[1]	[2]	[3]	[4]	[5]
Roc_m [bn EUR]	0.891^a				0.990^a	0.099^a				0.113^a
	(0.002)				(0.000)	(0.001)				(0.000)
$DebtRed_m$ [bn EUR]		0.010^c					0.002^a			
		(0.079)					(0.000)			
$EuEo_{m-1}$ [%]			0.731^a					0.889^a		
			(0.000)					(0.000)		
PC				0.172^a					0.195^a	
				(0.001)					(0.000)	
$Resid$					-1.967^c					-0.207^c
					(0.095)					(0.098)
$2ySovSpr_{m-1}$ [%]	-0.004	-0.006^c	-0.004	-0.004	-0.003	0.193	0.267	0.172	0.212	0.164
	(0.187)	(0.089)	(0.189)	(0.227)	(0.314)	(0.323)	(0.195)	(0.366)	(0.273)	(0.388)
$DepFlow_{m-1}$ [bn EUR]	-0.002	-0.002	-0.001	-0.002	-0.002	-0.001	-0.002	-0.001	-0.002	-0.001
	(0.135)	(0.166)	(0.219)	(0.136)	(0.152)	(0.653)	(0.486)	(0.579)	(0.523)	(0.509)
$Inflation_{m-1}$ [%]	-0.124^a	-0.101^c	-0.122^a	-0.128^a	-0.131^a	-0.058	-0.053	-0.070	-0.068	-0.077
	(0.006)	(0.059)	(0.003)	(0.004)	(0.001)	(0.237)	(0.264)	(0.145)	(0.150)	(0.113)
$Constant$	4.820^a	4.532^a	4.723^a	5.076^a	4.778^a	4.632^a	3.777^a	4.533^a	4.941^a	4.656^a
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Adj. R^2	0.145	0.085	0.147	0.154	0.155	0.096	0.142	0.112	0.133	0.113

Panel C: Sample Countries by CGIIPS and Non-CGIIPS

	Italy, Spain, Portugal, Ireland					Germany, Austria, Finland, Belgium				
Roc_m [bn EUR]	1.219^a				1.245^a	0.626^a				0.759^a
	(0.000)				(0.000)	(0.001)				(0.000)
$DebtRed_m$ [bn EUR]		0.024^a					0.007			
		(0.000)					(0.196)			
$EuEo_{m-1}$ [%]			0.818^a					0.706^a		
			(0.000)					(0.000)		
PC				0.235^a					0.141^a	
				(0.000)					(0.001)	
$Resid$					-1.302					-1.565^c
					(0.307)					(0.079)
$2ySovSpr_{m-1}$ [%]	0.074^b	0.151^a	0.035	0.087^b	0.068^b	0.272^c	0.273	0.256^c	0.250^c	0.222
	(0.031)	(0.002)	(0.213)	(0.011)	(0.034)	(0.071)	(0.171)	(0.051)	(0.093)	(0.111)
$DepFlow_{m-1}$ [bn EUR]	-0.001	-0.000	-0.001	-0.001	-0.001	0.002	0.003	0.001	0.002	0.001
	(0.323)	(0.692)	(0.506)	(0.343)	(0.390)	(0.440)	(0.324)	(0.580)	(0.537)	(0.683)
$Inflation_{m-1}$ [%]	-0.164^a	-0.193^a	-0.135^a	-0.175^a	-0.162^a	-0.080	-0.029	-0.121^c	-0.073	-0.102^c
	(0.004)	(0.001)	(0.010)	(0.001)	(0.001)	(0.248)	(0.659)	(0.064)	(0.253)	(0.086)
$Constant$	4.520^a	3.421^a	4.517^a	4.851^a	4.522^a	4.726^a	4.380^a	4.693^a	4.909^a	4.737^a
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Adj. R^2	0.188	0.198	0.145	0.214	0.186	0.113	0.070	0.141	0.123	0.135

Table 7: Regressions of normalized LTRO liquidity uptake on LTRO duration, bank rollover costs, and sovereign refinancing costs.

This table shows regressions of normalized average LTRO liquidity uptake on LTRO duration, bank rollover costs, and sovereign refinancing costs for the period January 2008 to December 2013 (72 months). The sample covers eight Eurozone countries whose national central banks provide separate figures for MRO and LTRO liquidity outstanding (Germany, Spain, Italy, Austria, Belgium, Finland, Portugal, and Ireland). Greece is dropped because it was under serious bailout programmes as of May 2010. France and Slovenia are lost because of variable normalizations and lack of data. Panel A (Panel B) provides pooled panel (fixed effects) regressions with standard errors clustered on the country level. Underneath the coefficients the table reports, in parentheses, p-values. a, b, and c denote significance (two-tailed) at the level of 1%, 5%, and 10%, respectively (a, b, and c are also reported, in square brackets, for double clustering on country and time, p-values not reported).

The dependent variable is normalized LTRO liquidity uptake from month m to $m+1$ [in %]. LTRO liquidity uptake is calculated from average monthly outstanding LTRO liquidity at the end of each month [in bn EUR]. Normalization is by average LTRO outstanding from January to August 2007 [in bn EUR]. LTRO duration is logarithmized, $\ln(Dur)$, and measured as the logarithm of the maximum duration (in number of calender days) of all LTROs in month m. $NormRoc_m$ is normalized rollover costs in month m [in %]. Rollover costs are estimated by multiplying debt redemptions in month m with the Euribor–EoniaSwap spread in the previous month, $m-1$ [in bn EUR]. Normalization is by average debt redemptions from January to August 2007 [in bn EUR]. $2ySovSpr_{m-1}$ is the difference between the two-year sovereign yield and the average monthly MRO rate in month $m-1$ [in %]. $NormDepFlow_{m-1}$ measures normalized deposit flows [in %] as the change in deposits from month $m-2$ to $m-1$ [in bn EUR] and normalized by average deposits from January to August 2007 [in bn EUR]. Source: Bruegel webpage (see also Pisani-Ferry and Wolff, 2012), webpages of the respective national central banks, ECB Statistical Data Warehouse, and Bloomberg.

Panel A: Pooled panel regressions with clustering on countries [double clustering]						
	[1]	[2]	[3]	[4]	[5]	[6]
$NormRoc_m$ [%]	$241.54^{a,[a]}$	$210.78^{b,[a]}$		$197.46^{b,[a]}$	$201.28^{c,[b]}$	
	(0.007)	(0.012)		(0.025)	(0.064)	
$2ySovSpr_{m-1}$ [%]	$69.15^{b,[a]}$	$73.26^{b,[a]}$	$66.11^{b,[a]}$		$70.61^{c,[c]}$	
	(0.022)	(0.038)	(0.030)		(0.098)	
$\ln(Dur)_m$ [ln(#days)]		236.14	171.63	208.60	$237.51^{\cdot,[c]}$	130.41
		(0.129)	(0.201)	(0.128)	(0.114)	(0.199)
$\ln(Dur)_m \times NormRoc_m$			$46.65^{a,[a]}$			$52.69^{b,[b]}$
			(0.006)			(0.026)
$\ln(Dur)_m \times 2ySovSpr_{m-1}$				$17.50^{b,[a]}$		$18.24^{c,[b]}$
				(0.040)		(0.085)
$NormRoc_m \times 2ySovSpr_{m-1}$					1.41	-7.04
					(0.859)	(0.459)
$NormDepFlow_{m-1}$ [%]	-22.52	-19.01	-21.36	-16.20	-18.63	-20.71
	(0.234)	(0.325)	(0.282)	(0.370)	(0.317)	(0.292)
Constant	$-122.39^{a,[a]}$	$-1222.20^{c,[c]}$	-924.67	$-1093.17^{c,[c]}$	$-1221.21^{c,[c]}$	-762.23
	(0.009)	(0.096)	(0.142)	(0.091)	(0.096)	(0.130)
# of observations	576	576	576	576	576	576
# of months	72	72	72	72	72	72
# of countries	8	8	8	8	8	8
Adj. R^2	0.168	0.192	0.214	0.204	0.191	0.223
R^2	0.172	0.198	0.220	0.210	0.198	0.230

Table to be continued

Table 7 – *continued*

Panel B: Country fixed effects regressions with clustering on countries [double clustering]	[1]	[2]	[3]	[4]	[5]	[6]
$NormRoc_m$ [%]	$234.64^{b,[b]}$	$194.79^{b,[b]}$		$179.08^{b,[c]}$	177.99	
	(0.018)	(0.025)		(0.048)	(0.169)	
$2ySovSpr_{m-1}$ [%]	$72.82^{b,[a]}$	$76.30^{b,[b]}$	$67.66^{b,[b]}$		70.90	
	(0.030)	(0.045)	(0.041)		(0.157)	
$\ln(Dur)_m$ [ln(#days)]		241.94	177.35	212.67	244.80	133.71
		(0.120)	(0.187)	(0.117)	(0.101)	(0.171)
$\ln(Dur)_m \times NormRoc_m$			$44.73^{b,[b]}$			$50.60^{c,[c]}$
			(0.012)			(0.053)
$\ln(Dur)_m \times 2ySovSpr_{m-1}$				$18.78^{b,[b]}$		19.62
				(0.039)		(0.121)
$NormRoc_m \times 2ySovSpr_{m-1}$					2.31	-7.07
					(0.804)	(0.508)
$NormDepFlow_{m-1}$ [%]	-27.86	-24.79	-26.83	-22.03	-24.32	-25.87
	(0.160)	(0.226)	(0.200)	(0.253)	(0.216)	(0.211)
Constant	-118.80	-1238.03	-943.86	-1102.16^{c}	-1237.15	-774.56
	(0.109)	(0.101)	(0.146)	(0.095)	(0.100)	(0.119)
# of observations	576	576	576	576	576	576
# of months	72	72	72	72	72	72
# of countries	8	8	8	8	8	8
Adj. R^2	0.122	0.149	0.171	0.162	0.148	0.181
R^2	0.126	0.155	0.177	0.168	0.155	0.188

Table 8: Marginal effects of logarithmized LTRO duration on normalized LTRO liquidity uptake for certain values of bank rollover and sovereign refinancing costs.

This table shows marginal effects for regression specification M6 in Table 7 (Panel A, pooled panel regressions with clustering on the country level). The sample includes eight Eurozone countries whose national central banks provide figures separately for MRO and LTRO liquidity outstanding (Germany, Spain, Italy, Austria, Belgium, Finland, Portugal, and Ireland) and covers the period January 2008 to December 2013 (72 months).

The table shows marginal effects of logarithmized LTRO duration, $\ln(Dur)$ [in ln(# of calendar days)], on normalized liquidity uptake from month m to $m+1$ [in %] while fixing normalized rollover costs in month m, $NormRoc_m$ [in %], and the sovereign yield spread in the previous month $m-1$, $2ySovSpr_{m-1}$ [in %], at certain values. Value fixes for both $NormRoc_m$ and $2ySovSpr_{m-1}$ cover the range 0% to 5% (in steps of 1 ppt), 10%, and 15%. The variables themselves range from 0.00% to 15.89% ($NormRoc_m$) and -1.01% to 15.55% ($2ySovSpr_{m-1}$), see Table 5. Underneath the coefficients the table reports, in parentheses, p-values, with standard errors calculated using the Delta method and clustering on the country level. a, b, and c denote significance (two-tailed) at the level of 1%, 5%, and 10%, respectively.

Source: Bruegel webpage (see also Pisani-Ferry and Wolff, 2012), webpages of the respective national central banks, ECB Statistical Data Warehouse, and Bloomberg.

Marginal effects of $\ln(Dur)_m$ *on* $NormLiquUpt_{m\rightarrow m+1,c}$ *for fixed values of* $NormRoc_m$ *and* $2ySovSpr_{m-1}$

$NormRoc_m$	$2ySovSpr_{m-1}$ [in %]							
[in %]	0	1	2	3	4	5	10	15
0	130.41	148.65	166.90	185.14[c]	203.39[c]	221.63[c]	312.86[c]	404.08[b]
	(0.156)	(0.128)	(0.108)	(0.093)	(0.083)	(0.075)	(0.055)	(0.049)
1	183.10[c]	201.35[b]	219.59[b]	237.84[b]	256.08[b]	274.33[b]	365.55[b]	456.77[b]
	(0.051)	(0.043)	(0.038)	(0.034)	(0.032)	(0.030)	(0.027)	(0.028)
2	235.79[b]	254.04[b]	272.28[b]	290.53[b]	308.77[b]	327.02[b]	418.24[b]	509.47[b]
	(0.017)	(0.015)	(0.014)	(0.013)	(0.013)	(0.013)	(0.014)	(0.016)
3	288.49[a]	306.73[a]	324.98[a]	343.22[a]	361.47[a]	379.71[a]	470.94[a]	562.16[a]
	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)	(0.008)	(0.010)
4	341.18[a]	359.42[a]	377.67[a]	395.91[a]	414.16[a]	432.40[a]	523.63[a]	614.85[a]
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.006)
5	393.87[a]	412.12[a]	430.36[a]	448.61[a]	466.85[a]	485.10[a]	576.32[a]	667.54[a]
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)
10	657.33[a]	675.58[a]	693.82[a]	712.07[a]	730.31[a]	748.56[a]	839.78[a]	931.01[a]
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
15	920.79[a]	939.04[a]	957.28[a]	975.53[a]	993.77[a]	1,012.02[a]	1,103.24[a]	1,194.47[a]
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)

Table 9: Number of bank bonds by country, issuer, capitalization, and maturity.

This table provides number of bank bonds by country, issuer, bank capitalization, and maturity year for the pruned sample (the pruning is as described in Section 5.1). Weakly capitalized (strongly capitalized) refers to banks with equity ratios below and including (above) the median within each country with the median calculated on the sample of bonds (not banks). This ensures that the number of bonds are as equally distributed across the two capitalization buckets as possible. Notice that the number of bank bonds in the two capitalization per country is not exactly the same because bonds are nested within banks. Panel A covers Germany, Panel B Italy, Panel C France, Panel D Austria, and Panel E Spain and Portugal. Source: Thomson Reuters Eikon, Thomson Reuters Datastream, and SNL Financial.

	Equity		Number of bank bonds								
	ratio								2017-	2022-	
Bank name	**2010**	**Cutoff**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2021**	**2033**	**Total**
Panel A: Germany											
Mittelbrandenburgische Sparkasse in Potsdam	7.89	-	-	1	2	3	1	2	2	-	11
Berliner Volksbank eG	6.40	-	-	2	3	2	1	1	-	-	9
UniCredit Bank AG	6.36	-	-	10	4	3	3	1	6	-	27
Kreissparkasse Köln	5.48	-	-	-	-	1	2	1	1	-	5
Aareal Bank AG	4.82	-	-	2	2	3	1	-	-	-	8
Deutsche Apotheker- und Äerztebank eG	4.75	-	-	9	9	-	-	-	-	-	18
Bayerische Landesbank	4.40	-	2	26	23	13	11	8	26	-	109
Hamburger Sparkasse AG	4.18	-	-	19	18	14	10	6	1	1	69
Commerzbank AG	3.80	-	-	7	7	4	10	1	6	-	35
Landeskreditbank Baden-Württemberg-Förderbank	3.54	-	-	5	3	1	2	1	-	-	12
HSH Nordbank AG	3.37	-	6	61	55	41	29	19	43	2	256
Sparkasse KölnBonn	3.32	-	-	5	6	3	2	-	9	-	25
Westdeutsche ImmobilienBank AG	3.30	-	-	1	3	2	2	-	2	3	13
Westdeutsche Genossenschafts-Zentralbank AG	3.25	-	1	24	18	6	6	6	10	1	72
Landesbank Hessen-Thüringen Girozentrale	3.13	-	1	30	33	30	15	11	12	-	132
Bremer Landesbank Kreditanstalt Oldenburg-Girozentrale	2.84	-	-	10	25	15	14	4	17	-	85
DZ BANK AG Deutsche Zentral-Genossenschaftsbank	2.80	2.80	5	66	67	31	25	9	14	-	217
Total strongly-capitalized banks			15	278	278	172	134	70	149	7	1,103
Landesbank Baden-Württemberg	2.67	-	7	69	55	48	36	24	39	-	278
Deutsche Bank AG	2.64	-	1	3	7	6	9	4	6	1	37
Deutsche Postbank AG	2.62	-	1	2	1	-	3	1	-	-	8
NORD/LB Norddeutsche Landesbank Girozentrale	2.54	-	3	29	30	29	16	15	48	1	171
Landesbank Saar	2.36	-	-	1	-	1	-	1	2	-	5
Münchener Hypothekenbank eG	2.24	-	2	11	13	10	6	2	2	-	46
Portigon AG	2.14	-	-	23	28	28	29	12	30	-	150
Landesbank Berlin Holding AG	2.07	-	1	18	24	7	3	6	5	-	64
Berlin Hyp AG	2.04	-	-	1	1	2	2	1	3	-	10
Deutsche Pfandbriefbank AG	1.80	-	2	10	3	2	1	2	3	2	25
Hypothekenbank Frankfurt AG	1.53	-	-	7	3	5	1	1	-	-	17
Total weakly-capitalized banks			17	174	165	138	106	69	138	4	811

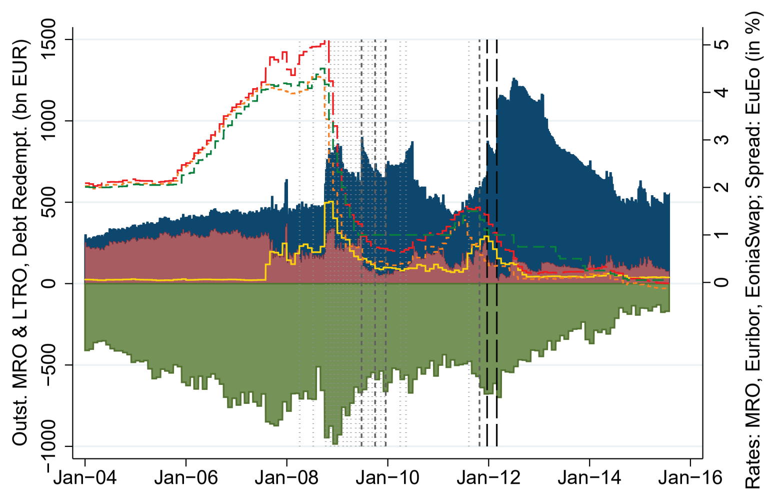
Table to be continued

Table 9 – *continued*

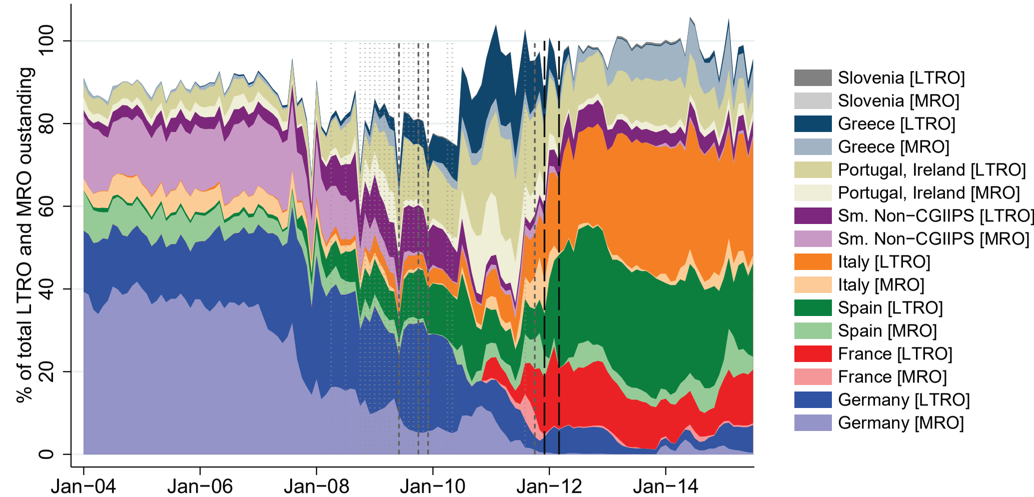
Bank name	Equity ratio 2010	Cutoff	Number of bank bonds 2011	2012	2013	2014	2015	2016	2017-2021	2022-2033	Total
Panel B: Italy											
Veneto Banca SpA	10.48	-	1	13	17	14	16	2	-	-	63
Banco di Desio e della Brianza SpA	9.65	-	-	9	22	8	4	6	2	-	51
Banca Popolare di Vicenza SpA	9.32	9.32	1	33	16	17	10	9	4	-	90
Total strongly-capitalized banks			2	55	55	39	30	17	6	0	204
Unione di Banche Italiane SpA	9.15	-	-	1	-	2	-	1	-	-	4
Mediobanca - Banca di Credito Finanziario SpA	8.95	-	-	-	1	3	-	-	1	-	5
Intesa Sanpaolo SpA	8.29	-	1	24	52	2	2	-	2	-	83
UniCredit SpA	7.28	-	1	4	3	1	-	-	-	-	9
Banca Apulia SpA	7.01	-	1	5	4	-	-	-	-	-	10
Banco Desio Lazio SpA	6.53	-	-	1	5	-	-	-	-	-	6
Cassa di Risparmio di Firenze SpA	5.95	-	-	4	1	-	-	-	-	-	5
Banca Nazionale del Lavoro SpA	5.22	-	-	14	20	16	10	3	1	-	64
Dexia Crediop SpA	2.67	-	-	-	1	-	-	2	1	-	4
Banca IMI SpA	2.40	-	-	1	6	1	2	-	1	-	11
Total weakly-capitalized banks			3	54	93	25	14	6	6	0	201
Panel C: France											
Société Générale SA	4.50	-	-	3	3	2	2	3	7	-	20
BNP Paribas SA	4.29	-	-	2	2	1	2	-	1	-	8
Total strongly-capitalized banks			0	5	5	3	4	3	8	0	28
BPCE SA	4.19	4.19	-	6	3	3	6	8	29	-	55
Banque Fédérative du Crédit Mutuel SA	3.62	-	-	-	1	1	1	4	1	-	8
Crédit Agricole SA	3.27	-	1	5	7	2	-	1	6	2	24
Crédit Agricole Corp. and Inv. Bank SA	2.14	-	-	-	1	2	-	1	-	-	4
Total weakly-capitalized banks			1	11	12	8	7	14	36	2	91
Panel D: Austria											
BKS Bank AG	10.06	-	-	-	-	2	2	-	4	-	8
Total strongly-capitalized banks			0	0	0	2	2	0	4	0	8
Erste Group Bank AG	8.05	8.05	2	11	22	14	12	7	9	-	77
Oberbank AG	6.92	-	-	-	1	1	-	3	1	-	6
Bank für A/W und Österr. Postsparkasse AG	6.19	-	-	5	1	1	2	1	1	1	12
Allgemeine Sparkasse Oberösterreich Bank-AG	4.68	-	-	-	-	-	1	3	1	1	6
Österreichische Volksbanken-AG	4.24	-	-	2	3	3	4	2	1	1	16
Total weakly-capitalized banks			2	18	27	19	19	16	13	3	117
Panel E: Spain and Portugal											
BFA, Tenedora de Acciones, SAU (ES)	2.08	-	-	2	2	1	2	-	-	-	7
Santander Totta, SGPS SA (PT)	5.85	-	-	4	7	4	6	5	-	-	26

Table 10: Estimated zero-coupon yields and yield differences over three-year LTRO period.
This table provides predicted zero-coupon yields (using the Svensson, 1994, procedure) over the three-year LTRO period. In each panel the first column represents the estimated yield [in %] by maturity on the day before the annoucement of the three-year LTROs (December 7, 2011). Columns two to four are the differences [in ppt] compared to the level on December 7, 2011 on the following three days: December 21, 2011 (first three-year allotment), January 31, 2012, and February 29, 2012 (second three-year allotment). A negative number shows a yield decrease as compared to December 7, 2011. Panels A and B show results for all sample bank bonds in Italy and Germany, Panels C and D for weakly and strongly capitalized Italian banks, and Panels E and F for weakly and strongly capitalized German banks, respectively. The darker a cell is (in orange) the more yields have decreased. Source: Datastream, SNL Financial, the ECB Statistical Data Warehouse, and the ECB webpage.

	Dec-07, 2011	Dec-21, 2011	Jan-31, 2012	Feb-29, 2012	Dec-07, 2011	Dec-21, 2011	Jan-31, 2012	Feb-29, 2012
	level [in %]	difference [in ppt]	difference [in ppt]	difference [in ppt]	level [in %]	difference [in ppt]	difference [in ppt]	difference [in ppt]
Mat	*Panel A: Italy – all banks*				*Panel B: Germany – all banks*			
1	5.25	-0.10	-1.20	-1.74	2.21	-0.06	-0.40	-0.50
2	5.39	0.00	-0.89	-1.41	2.26	-0.11	-0.33	-0.46
3	5.46	0.12	-0.59	-1.05	2.45	-0.14	-0.30	-0.43
4	5.64	0.20	-0.42	-0.80	2.73	-0.16	-0.31	-0.42
5	5.91	0.22	-0.36	-0.68	3.06	-0.17	-0.33	-0.42
6	6.23	0.18	-0.35	-0.65	3.42	-0.18	-0.36	-0.42
7	6.57	0.09	-0.38	-0.70	3.77	-0.18	-0.38	-0.44
8	6.89	-0.03	-0.42	-0.80	4.11	-0.18	-0.39	-0.45
9	7.20	-0.17	-0.47	-0.93	4.43	-0.17	-0.40	-0.47
10	7.49	-0.34	-0.51	-1.08	4.72	-0.16	-0.39	-0.48
	Panel C: Italy – weakly capitalized				*Panel D: Italy – strongly capitalized*			
1	5.73	-0.58	-2.07	-2.46	4.61	0.43	-0.07	-0.68
2	5.66	-0.18	-1.69	-2.18	4.97	0.33	0.09	-0.55
3	5.70	0.10	-1.41	-1.98	5.23	0.27	0.11	-0.38
4	5.95	0.15	-1.33	-1.88	5.52	0.22	0.04	-0.29
5	6.34	0.03	-1.39	-1.86	5.81	0.18	-0.05	-0.25
6	6.82	-0.21	-1.53	-1.92	6.09	0.15	-0.10	-0.24
7	7.34	-0.54	-1.72	-2.03	6.33	0.14	-0.09	-0.23
8	7.88	-0.93	-1.92	-2.17	6.54	0.15	-0.02	-0.22
9	8.43	-1.36	-2.13	-2.35	6.70	0.17	0.11	-0.20
10	8.97	-1.82	-2.33	-2.54	6.82	0.21	0.29	-0.17
	Panel E: Germany – weakly capitalized				*Panel F: Germany – strongly capitalized*			
1	2.39	-0.17	-0.52	-0.73	2.10	-0.03	-0.32	-0.45
2	2.39	-0.31	-0.42	-0.62	2.19	-0.04	-0.27	-0.39
3	2.50	-0.24	-0.35	-0.46	2.44	-0.07	-0.27	-0.37
4	2.69	-0.14	-0.33	-0.36	2.76	-0.12	-0.29	-0.37
5	2.97	-0.08	-0.34	-0.33	3.12	-0.15	-0.31	-0.38
6	3.31	-0.06	-0.37	-0.38	3.47	-0.18	-0.33	-0.38
7	3.70	-0.10	-0.43	-0.49	3.79	-0.19	-0.32	-0.37
8	4.14	-0.19	-0.49	-0.65	4.08	-0.19	-0.30	-0.36
9	4.63	-0.33	-0.57	-0.87	4.32	-0.17	-0.27	-0.33
10	5.14	-0.52	-0.66	-1.13	4.52	-0.14	-0.22	-0.29



Panel A: Aggregate MRO and LTRO outstanding, debt redemptions, and Euro area rates



Panel B: Outstanding liquidity in MROs and LTROs by country

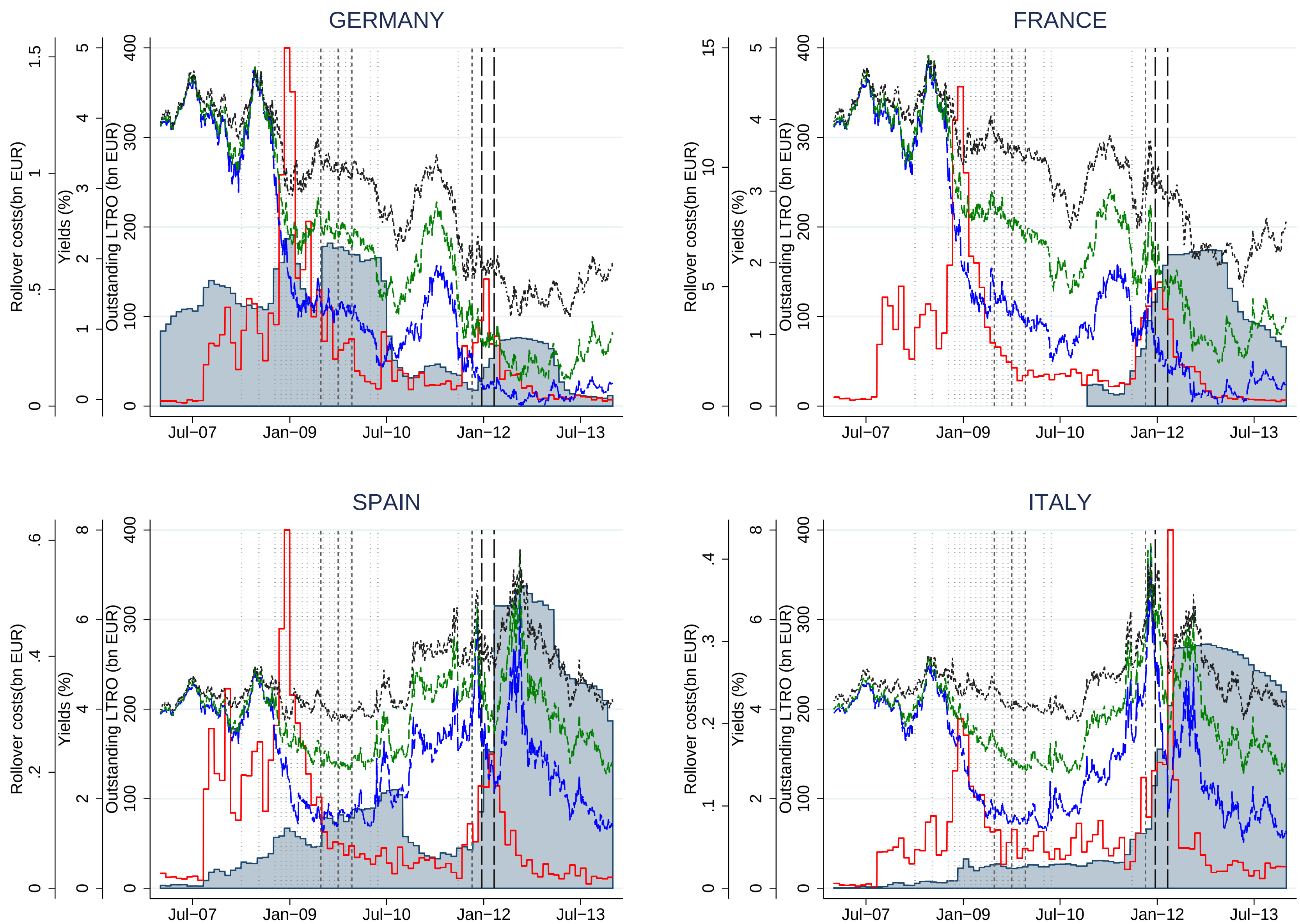
Figure 1: MRO and LTRO liquidity outstanding, debt redemptions, and Euro area rates.

This figure provides aggregate patterns over time for outstanding liquidity in MROs and LTROs, bank debt redemptions, and several Euro area rates from January 2004 to July 2015. The vertical lines in each subfigure indicate extraordinary LTRO cash settlements. Light dotted vertical lines represent six-month LTROs, medium-intense short-dashed lines one-year LTROs, and dark long-dashed lines three-year LTROs.

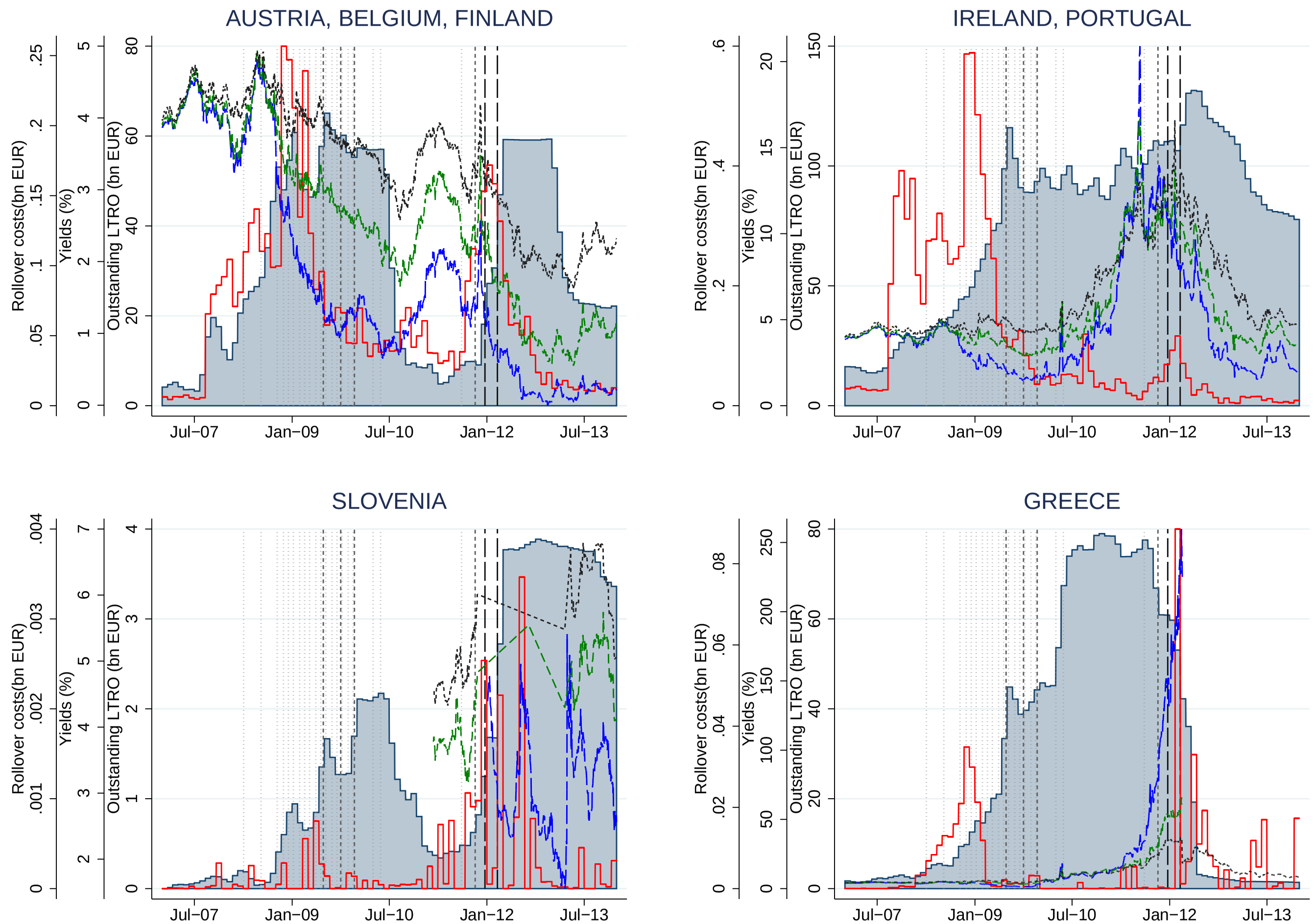
In Panel A the light (red) shaded area in the positive region represents aggregate outstanding liquidity in MROs [weekly, in bn EUR]; the dark (blue) shaded area is outstanding LTRO liquidity [weekly, in bn EUR]. The (green) shaded area in the negative region represents aggregate debt redemptions [monthly, in bn EUR]. Rates represent monthly averages and are plotted on the second y-axis [in %]. The long-dashed (red) line is the Euribor rate. The short-dashed (orange) line is the EoniaSwap rate. The solid (yellow) line is the Euribor–EoniaSwap spread (*EuEo*). The dashed (green) line is the MRO rate.

Panel B provides monthly average outstanding liquidity by country over time covering countries whose national central banks provide statistics on outstanding liquidity separated by MROs and LTROs. Each color represents one country with intense (light) colors for LTROs (MROs). "Smaller Non-CGIIPS" includes Austria, Belgium, Finland, and Luxembourg. For France this data is only available since January 2011 as collected by Bruegel.

Source: Bruegel webpage (see also Pisani-Ferry and Wolff, 2012), webpages of the respective national central banks, ECB Statistical Data Warehouse, and Bloomberg.



Panel A: Largest Eurozone economies



Panel B: Non-CGIIPS (left) and CGIIPS (right) countries.

Figure 2: Outstanding LTRO liquidity, rollover costs, and sovereign bond yields by country from January 2007 to December 2013.
The blue-shaded area represents monthly average outstanding LTRO liquidity [bn EUR]. The solid (red) line is rollover costs [bn EUR]. Rollover costs are estimated by multiplying debt redemptions in month m with the Euribor–EoniaSwap spread in month $m-1$. The long-dashed (blue) line represents the rolling two-year yield on the country's sovereign debt, the dashed (green) line the five-year yield, and the short-dashed (black) line the ten-year yield. The vertical lines indicate extraordinary LTRO cash settlements. Light dotted vertical lines represent six-month LTROs, medium-intense short-dashed lines one-year LTROs, and dark long-dashed lines three-year LTROs. The figure covers countries whose national central banks provide statistics on outstanding liquidity separated by MROs and LTROs. For France this data is only available since January 2011 as collected by Bruegel. Source: Bruegel webpage (see also Pisani-Ferry and Wolff, 2012), webpages of the respective national central banks, ECB Statistical Data Warehouse, and Bloomberg.

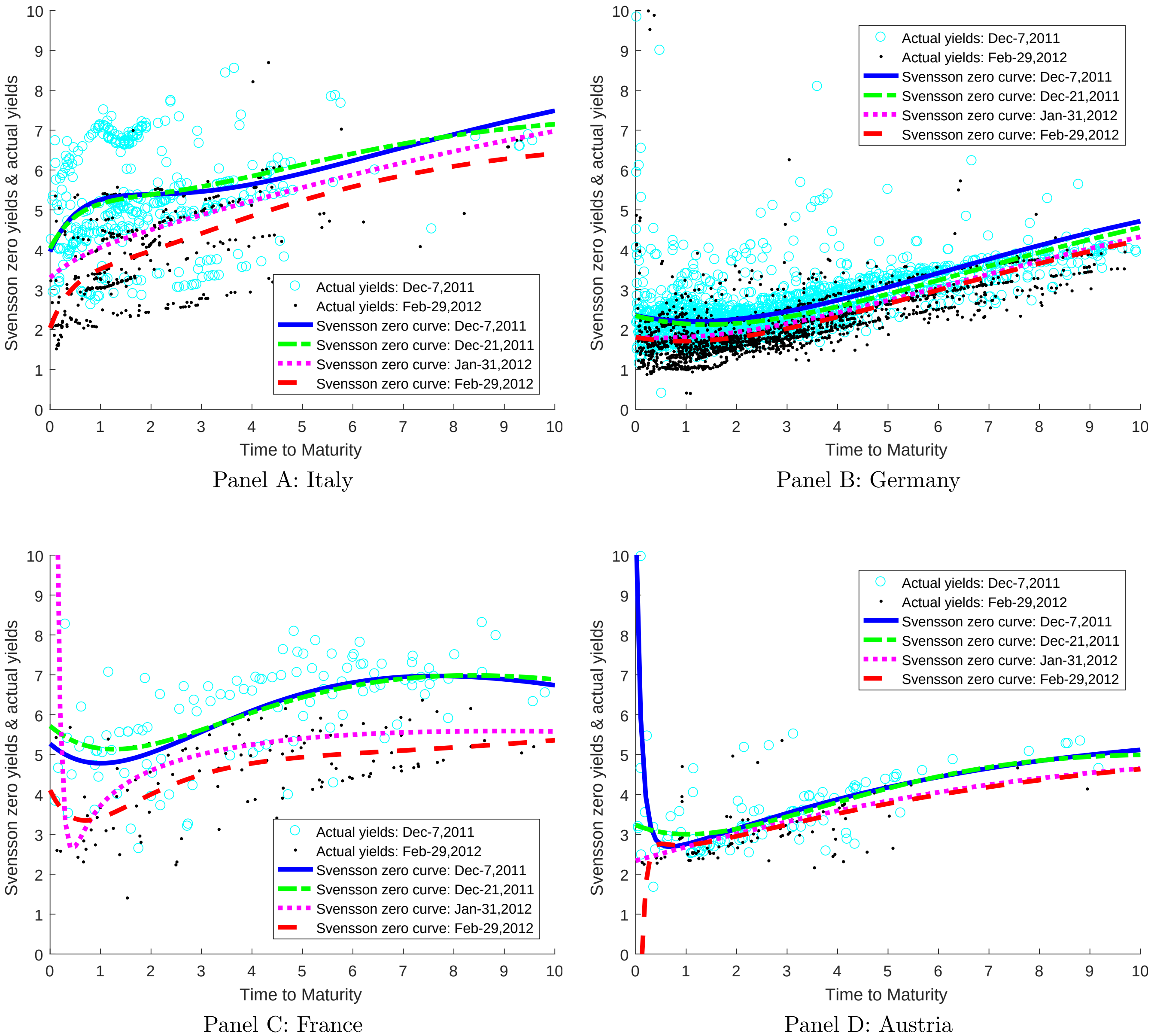
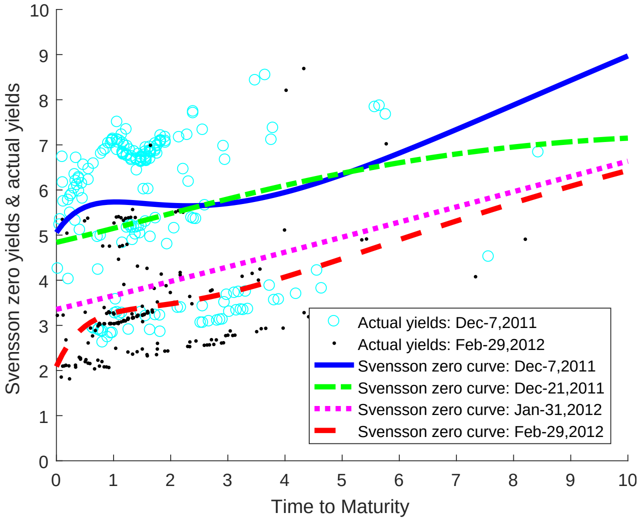
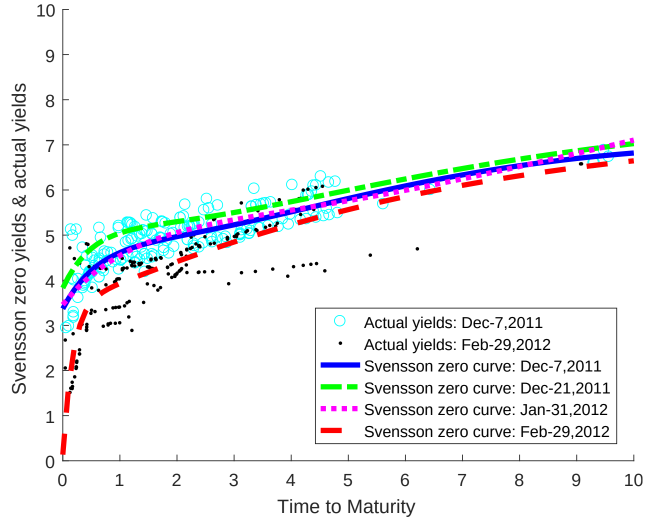


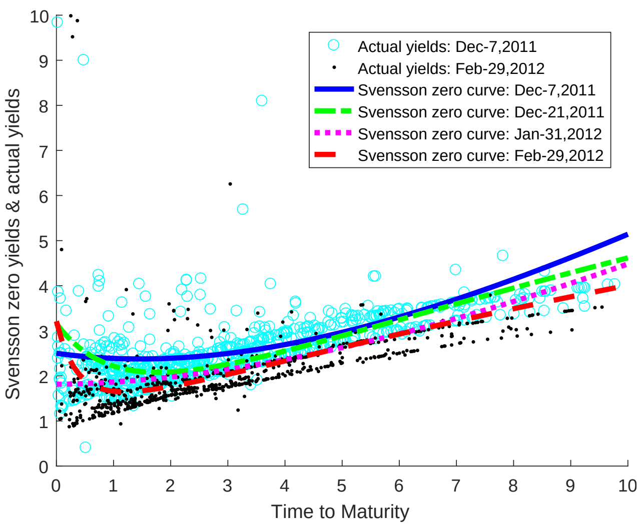
Figure 3: Yield curves for bank bonds in Italy, Germany, France, and Austria.
This figure shows estimated yield curves (using the Svensson, 1994, procedure) for Italian (Panel A), German (Panel B), French (Panel C), and Austrian (Panel D) bank bonds as indicated underneath each subfigure. Yield curves are provided on four dates: the solid (blue) line represents the Svensson zero coupon curve on the day before the announcement of the three-year LTROs (December 7, 2011) with actual yields as (light-blue) circles; the short-dashed (green) line represents the first three-year allotment (December 21, 2011); the dotted (magenta) line represents January 31, 2012; and, the long-dashed (red) line represents the second three-year allotment (February 29, 2012) with actual yields as (black) dots. Source: Datastream, SNL Financial, and ECB Statistical Data Warehouse.



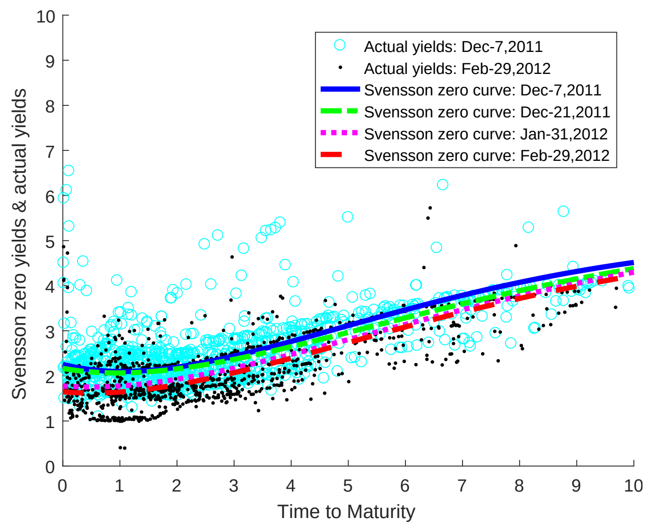
Panel A: Italy – weakly capitalized



Panel B: Italy – strongly capitalized

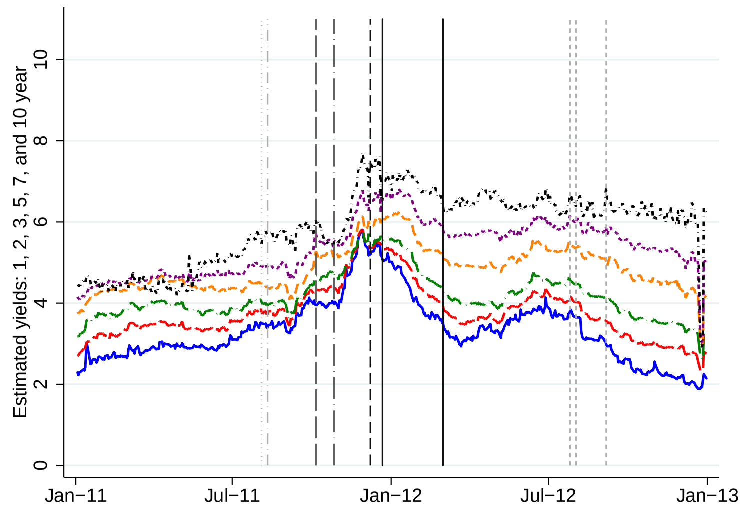


Panel C: Germany – weakly capitalized

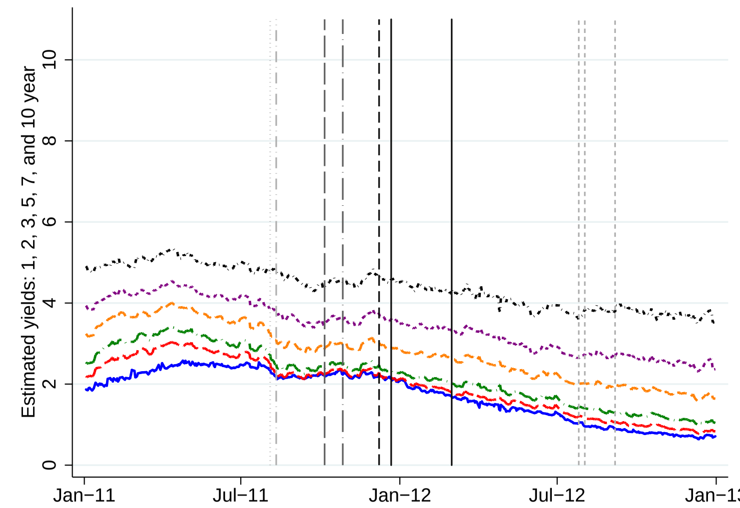


Panel D: Germany – strongly capitalized

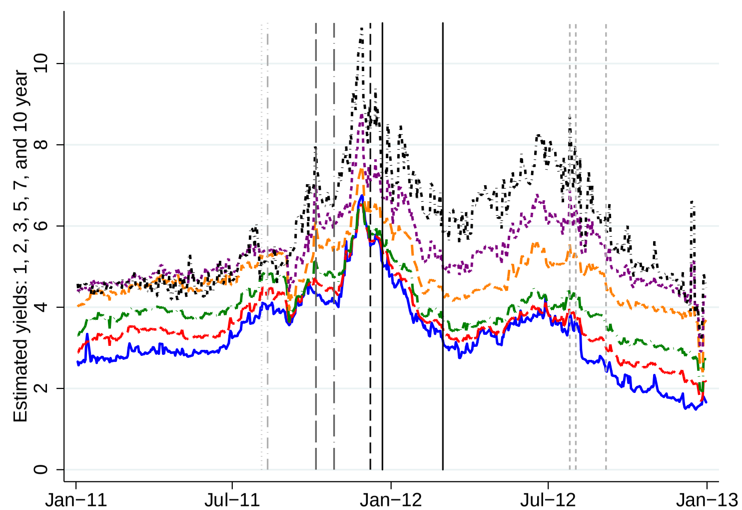
Figure 4: Yield curves for weakly and strongly capitalized banks in Italy and Germany.
This figure shows estimated yield curves (using the Svensson, 1994, procedure) for weakly (left panels) and strongly (right panels) capitalized banks in Italy (first row) and Germany (second row) as indicated underneath each subfigure (Panels A to D). Weakly (strongly) capitalized refers to banks with equity ratios below and including (above) the median within each country with the median calculated on the sample of bonds (not banks, see Table 9). Yield curves are provided on four dates: the solid (blue) line represents the Svensson zero coupon curve on the day before the announcement of the three-year LTROs (December 7, 2011) with actual yields as (light-blue) circles; the short-dashed (green) line represents the first three-year allotment (December 21, 2011); the dotted (magenta) line represents January 31, 2012; and, the long-dashed (red) line represents the second three-year allotment (February 29, 2012) with actual yields as (black) dots. Source: Datastream, SNL Financial, and ECB Statistical Data Warehouse.



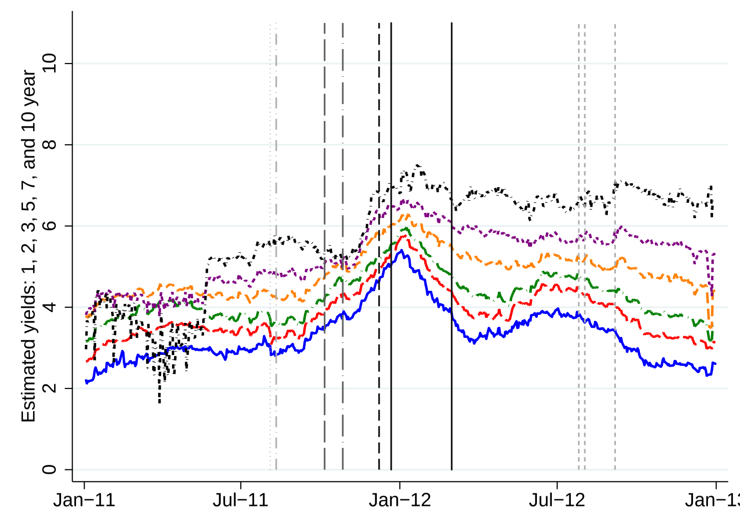
Panel A: Italy – all banks



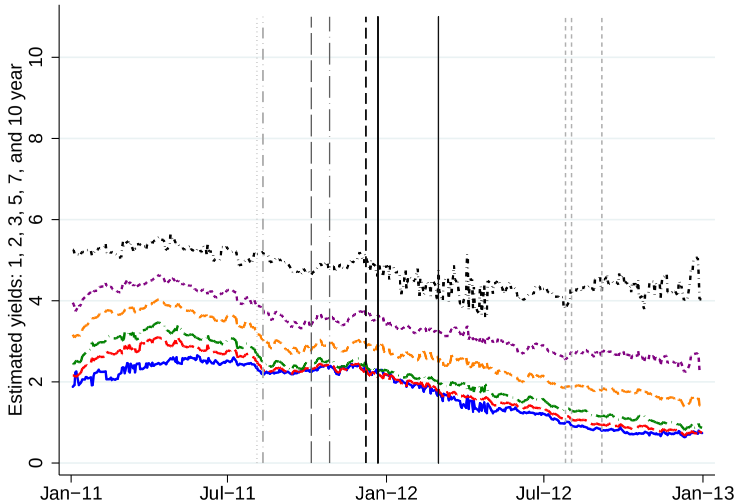
Panel B: Germany – all banks



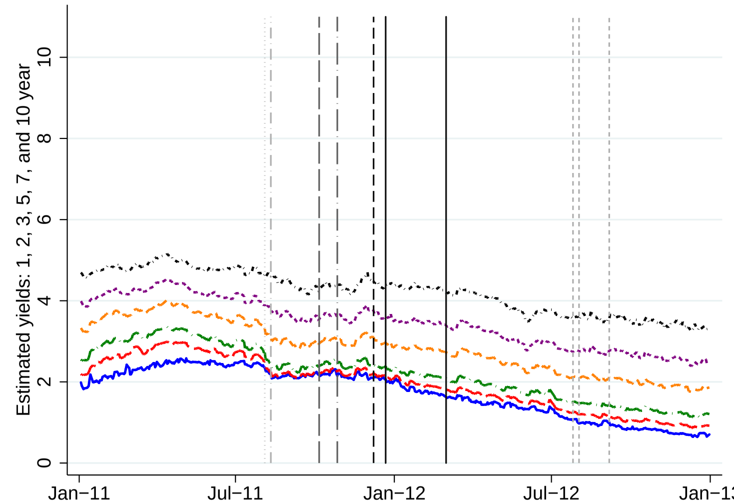
Panel C: Italy – weakly capitalized banks



Panel D: Italy – strongly capitalized banks



Panel E: Germany – weakly capitalized banks



Panel F: Germany – strongly capitalized banks

Figure 5: Yield curves for bank bonds in Italy and Germany from January 3, 2011 to December 31, 2012.

This figure shows the results of yield curve estimations for all sample bank bonds in Italy and Germany (Panels A and B, respectively) as well as for weakly and strongly capitalized Italian banks (Panels C and D) and German banks (Panels E and F). The sample period covers 521 business days from January 3, 2011 to December 31, 2012, which is roughly plus/minus one year around the three-year LTRO announcement (December 8, 2011). Each line represents predicted zero-coupon yields (using the Svensson, 1994, procedure) with different maturities: one-year maturity is the solid (blue) line, two-year maturity the long-dashed (red) line, three-year maturity the longdash-dotted (green) line, five-year maturity the dashed (orange) line, seven-year maturity the short-dashed (purple) line, and ten-year maturity the shortdash-dotted (black) line.

The vertical lines in each subfigure over time are as follows. August 4, 2011: announcement of the six-month (203 days) LTRO (dotted, light-grey); August 11, 2011: cash settlement of the six-month LTRO (dash-dotted, light-grey); October 6, 2011: announcement of the one-year LTRO (long-dashed, medium-grey); October 27, 2011: cash settlement of the one-year LTRO (dash-dotted, medium-grey); December 8, 2011: announcement of the three-year LTROs (short-dashed, black); December 22, 2011: cash settlement of the first three-year LTRO (first solid black line); March 1, 2012: cash settlement of the second three-year LTRO (second solid black line); July 26, 2012: ECB President Draghi's famous "whatever it takes" speech (first short-dashed light-grey line); August 2, 2012: announcement of the outright transactions in secondary sovereign bond markets (known as outright monetary transactions, OMT, second short-dashed light-grey line); and September 6, 2012: the announcement of the technical details of OMTs (third short-dashed light-grey line).

Source: Datastream, SNL Financial, the ECB Statistical Data Warehouse, and the ECB webpage.