# Can Central Banks Boost Corporate Investment? Evidence from the ECB Liquidity Injections[*]

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### Abstract

While it is well documented that corporate investment decreases during a liquidity crunch, the effect of a liquidity injection is much less studied. In this paper, we analyze firm-bank level data to examine the largest liquidity intervention in history: the Longer-Term Refinancing Operations (LTROs) by the European Central Bank (ECB). We show that, contrary to the intended result of improving real economy, more LTRO funds to banks are associated with lower corporate investments. Riskier banks took more funds from ECB through the LTRO and subsequently increased their holdings of risky sovereign debt. Our findings reveal the difficulty of boosting corporate investment through central bank injection of liquidity into the banking system when bank balance sheets are impaired.

# 1. Introduction

Since the 2008 global financial crisis, many central banks around the world have undertaken the unconventional monetary policy of directly injecting liquidity into the banking system. Some of these liquidity injections were of significant size and scope, and have attracted massive press coverage and academic attention. However, whether these liquidity injections indeed helped the real economy, as intended, remains unanswered. While one may conjecture that monetary policies are likely to affect the real sector through the transmission channel of credit, this transmission may be impaired in reality. In this paper, we fill this gap in the literature by empirically examining the impact of unconventional liquidity interventions on corporate policies, particularly those relating to investment. Our findings have important policy implications for both ongoing interventions and future monetary tools.

The Eurozone provides an ideal laboratory to study the impact of unconventional monetary policies due to its unique structure of a monetary union catering to diverse economies from the member states of the Eurosystem. Since 2010, several Eurozone countries experienced severe fiscal difficulties and financial problems. As a reaction to heightened sovereign credit risk, the ECB engineered a series of interventions to improve market liquidity and real output. The largest of these interventions were the Longer-Term Renancing Operations (LTROs) with a three-year maturity, implemented in December 2011 and February 2012, respectively.[1] ECB used LTROs to inject more than one trillion euros into the commercial banks of Eurozone countries. However, the efficacy of LTRO as a prominent tool of unconventional monetary intervention remains hotly debated.

Prior studies have shown that *negative* credit supply shocks result in a reduction in corporate investment (e.g., Chava and Purnanandam (2011)). However, whether a *positive* credit supply shock can boost investment is an under-studied open question. Corporations do not base their investment decisions exclusively on their current cost of funding; new

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[1]Figure 1 provides a detailed time-line of the ECBs recent unconventional monetary policies, while the details of related ECB interventions are discussed in Appendix Note 1.

investments tend to be driven by long-term plans. In general, under stochastic financing conditions, corporate policies are affected by their anticipation of a future financial crisis: Firms may cut back investment in good states, in preparation for a future downturn (Bolton, Chen, and Wang (2013)). Hence, even theoretically, liquidity injections by central banks do not necessarily translate into more *corporate* investment (see, e.g., Christiano (1994)).

Bank lending to corporations may respond weakly to the unconventional liquidity interventions, due to the banks' precautionary motive to deleverage, especially when banks hold large amounts of risky sovereign debt (Bocola (2016)). Corporations' own liquidity, financing, and investment policies may not fully align with those of the banks. On the one hand, unconventional monetary policies that aim at boosting bank liquidity may make corporations less concerned about their own future financing. On the other hand, corporations may interpret the high LTRO uptake of their banks as a sign of bank risk such as unobservable risk shifting incentives. Indeed, banks can borrow from the lender of last resort and subsequently increase their investment in distressed sovereign debt (Crosignani, Faria-e-Castro, and Fonseca (2019); Drechsler, Drechsel, Marques-Ibanez, and Schnabl (2016)). Out of concerns about future financing, corporations may reduce their investments. Thus, the extent to which macro-liquidity injections are converted into investment and economic output also depends on corporate expectations of future financing conditions, which can be affected by bank risk. Ultimately, the tradeoff between these complex effects can only be investigated in an empirical context.

It is, therefore, important and necessary to empirically examine the effect of liquidity injections on the real economy. We do so by investigating investment and employment policies in a larger sample of Eurozone corporations around the LTRO implementation. We build a comprehensive dataset that combines monetary policy data from the ECB Statistical Data Warehouse, loan information on Eurozone lenders from the Thomson Reuters Loan Pricing Corporation (LPC) DealScan database, corporate fundamental data from Compustat Global and S&P Capital IQ, credit ratings on non-financial corporations from CreditPro®

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by S&P Capital IQ, credit default swaps (CDS) data from Markit, and relevant data from other sources. A unique feature of our research is that we capture the LTRO impact on corporate-specific policies, using both country- and bank-level LTRO uptake information.

Based on our comprehensive data set, we find that, surprisingly, corporations connected with banks that had a higher LTRO uptake reduced their investment more than those associated with banks that had a lower or no LTRO uptake. However, this negative association between the LTRO uptake of banks and corporate investment does not necessarily imply a *causal* relationship. When we directly address causality by analyzing the determinants of a bank's LTRO uptake, we find evidence that LTRO uptake positively relates to bank risk, which is consistent with Drechsler, Drechsel, Marques-Ibanez, and Schnabl (2016). In counter-factual analyses, we also find that the two three-year LTROs halted the deterioration in corporate investment, as evidenced by the fact that non-Eurozone corporations in Europe experienced even larger investment cuts, post-LTRO.

To better understand the counter-intuitive result of lower investment associated with greater liquidity injection, we further explore the role of bank risk in explaining the decrease in corporate investments following ECB's LTRO. We expect that the corporations with risky bank lenders are more concerned about future financing conditions. We find those corporations indeed experienced greater decreases in investment following their bank lenders LTRO uptakes. In addition, we find that banks with LTRO funds increased their risky sovereign debt holdings during the post-LTRO period, while their borrowers decreased investment proportional to their LTRO uptake amount. These findings are consistent with the LTRO's role in the "revelation of unobservable bank risks" and underscore corporations' uncertainty about their own future financing conditions. Furthermore, we find that the banks' holding period of the LTRO funds played a significant role in the transmission of unconventional monetary policies: When banks repaid their ECB funds early, their own corporate borrowers did not decrease investments. Thus, the investment reduction comes mainly from corporations connected to banks that retained the LTRO funds for a longer period. These findings reveal

the distributional effects of unconventional monetary policies, and cast doubt on the real benefits of the liquidity injection, as the countries that were most affected by the Eurozone crisis did not experience an improvement in their respective real economic performance.

Recent discussions of the impact of central bank interventions in the face of anemic economic growth, even after many years of monetary easing, have shifted the debate to the role of fiscal policies. Hence, we also investigate the role of fiscal policies for the effectiveness of the LTROs. This analysis is interesting because LTROs are Eurozone-wide monetary policies but corporations are also subject to disparate national fiscal policies. In a monetary union such as the Eurozone, individual governments can (and often do) undertake different fiscal actions, which are sometimes unrelated to ECB policies. Analyzing the country-level fiscal policies in Europe concurrent with the liquidity injection, we show that when individual national governments cut their corporate taxes or increase their public investments, the LTRO uptake of banks domiciled in those countries is associated with an increase in corporate investment therein. These findings demonstrate the importance of coordinated monetary and fiscal policies for corporate investment, as there are limits to the efficacy of monetary policies implemented in isolation.

Our findings help us to understand the real effects of unconventional monetary policies, along the lines of Berger and Roman (2017), Luck and Zimmermann (2018), Chakraborty, Goldstein, and MacKinlay (2019), Cong, Gao, Ponticelli, and Yang (2019), Carpinelli and Crosignani (2018) etc. One closely related paper in the European setting is Acharya, Eisert, Eufinger, and Hirsch (2019). They find evidence of zombie lending by banks, following the announcement of Outright Monetary Transactions (OMT) in the summer of 2012. We distinguish our study from theirs by focusing on *corporate* policies, following the largest real liquidity injection, i.e., three-year LTROs. We also explore the role of banks' early repayment decisions of their LTRO borrowing on the corporations' decisions, as well as the interaction between these monetary policies and fiscal policies. Although we do not find any positive effect of LTRO in boosting corporate investment, we argue that LTRO had not harmed

the economy either. Furthermore, we suggest that it is important to consider monetary policies in tandem with banks' weak balance sheets, as well as the impact of potentially contractionary fiscal policies.

The rest of the paper proceeds as follows. We discuss the related literature in Section 2. Section 3 provides a description and specification of our data, and the setting for our empirical analysis. In Section 4, we investigate the impact of macro-liquidity injections on corporate investment, and explore the role of bank risk in explaining the effect. Section 5 examines the real economic implications of the overall policy design of unconventional monetary policies. Section 6 concludes.

## 2.  Institutional Background and Relevant Literature

During the recent European sovereign debt crisis, the two three-year LTROs were among the major efforts by the ECB to provide liquidity to the financial sector and ease credit conditions. The LTROs were allotted on December 21, 2011 ("LTRO I") and February 29, 2012 ("LTRO II") respectively, with a total amount of 1,018.7 billion Euros. The three-year LTROs were attractive for Eurozone commercial banks due to the long maturity, low interest rates, and the option to repay the loans without any penalty (after one year, either in part or in full). Subject to the provision of eligible collateral, banks were able to borrow unlimited funds for three years, with no restrictions on the use of the money.[2]

ECB's LTROs are part of the unconventional monetary policies by central banks all over the world in recent years. Other related policies include asset purchases (e.g., Quantitative Easing (QE) in the US, the Eurozone-wide Asset Purchase Programme (APP)), indirect bank balance sheet recapitalizations (e.g., the announcement effects of the ECB's bailout funding program (OMT)), and the yield curve flattening (e.g., the maturity extension pro-

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[2]See ECB Monthly Bulletin, March 2012. To further ease the credit conditions for the real economy, the ECB announced the targeted LTROs (TLTROs) in 2014 that provided financing to credit institutions with a maturity of up to four years, with the bank borrowing amount linked to their corporate lending.

gram (MEP) in the US).[3] However, those other policies are different from *direct* central bank liquidity injections into commercial banks, and may affect different banks and bank dependent borrowers heterogenously.[4] For instance, the announcement of the OMT in summer 2012 lead to an indirect recapitalization of banks' balance sheets, especially for those with high sovereign debt as noted by Acharya, Eisert, Eufinger, and Hirsch (2019). Structurally, and different from this bailout funding program that has not actually been implemented so far, the size and popularity of the three-year LTROs make them an interesting policy intervention to understand banks' voluntary access to central bank liquidity injections, and corporations' policy response, when their bank lenders tapped liquidity through these liquidity injections. Understanding and comparing different policies to stimulate the real economy can, therefore, deliver valuable policy implications.[5]

The evidence of the impact of unconventional monetary policies on corporate investment and employment is mixed, and depends on the characteristics of the intervention. Kasahara, Sawada, and Suzuki (2016) find that bank capital injections made by the Japanese government in March 1998/1999 had a negligible impact on the average investment rate of their borrowers. Bergman, Iyer, and Thakor (2017) find a positive effect of cash injection during the Farm Debt Crisis of the 1980s. Berger and Roman (2017) find a positive impact on "Main Street" after the Troubled Asset Relief Program (TARP) in the US. Foley-Fisher, Ramcharan, and Yu (2016) find that non-financial corporations with a high reliance on longer-term debt increased their investments during the MEP. While Luck and Zimmermann (2018) find

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[3] Prior papers have studied the impact of such policies on sovereign bond markets (Eser and Schwaab (2016), De Pooter, Martin, and Pruitt (2018), De Pooter, DeSimone, Martin, and Pruitt (2015), Trebesch and Zettelmeyer (2018), Pelizzon, Subrahmanyam, Tomio, and Uno (2016), Krishnamurthy, Nagel, and Vissing-Jorgensen (2018)), interbank markets (Garcia-de Andoain, Heider, Hoerova, and Manganelli (2016)), banks' risk taking (Duchin and Sosyura (2015), Acharya, Pierret, and Steffen (2017), Acharya and Steffen (2015), Rodnyansky and Darmouni (2017)), and households (Agarwal, Chomsisengphet, Mahoney, and Stroebel (2015), Di Maggio, Kermani, and Palmer (2016), Di Maggio, Kermani, Keys, Piskorski, Ramcharan, Seru, and Yao (2017), Beraja, Fuster, Hurst, and Vavra (2018), Luck and Zimmermann (2018)).

[4] For example, banks with greater MBS holdings may have had greater exposure to the US QE1 and QE3, which had further real effects on household and corporate borrowers that relied on these banks for financing (Luck and Zimmermann (2018)), while the yield curve flattening effort through the US MEP affected more non-financial corporations with a high reliance on long-term debt (Foley-Fisher, Ramcharan, and Yu (2016)).

[5] See Appendix Note 1 for more background on ECB's open market operations.

a positive impact of the US QEs on employment, Chakraborty, Goldstein, and MacKinlay (2019) find that the Federal Reserve Bank's mortgage-backed security (but not Treasury bond) purchases crowded out banks' commercial lending, and decreased corporate investment. Focusing on China's economic stimulus plan of 2009-2010, Cong, Gao, Ponticelli, and Yang (2019) find an increase in credit expansion, investment and employment following the stimulus. However, the effect is concentrated in state-owned corporations, suggesting the crucial role of implicit government guarantees.

Acharya, Imbierowicz, Steffen, and Teichmann (2017) focus on the fixed-rate full allotment policy announced in October 2008 that aimed to reduce the short-term funding risk in the banking system. They find that the transmission of monetary policy is not effective for bad banks and long-term loans, as evidenced by the resulting loan spreads and weak results for investment. In contrast to their work, we investigate firm investment following the three-year LTROs with full allotment. Investment is a long-term decision for corporations and is expected to be more positively affected by the availability of longer-term funding associated with the three-year LTROs, if the transmission was indeed effective.

A few recent country-specific papers have shown that the three-year LTROs by the ECB indeed had a positive, moderately sized effect on the supply of bank credit to corporations (see, Carpinelli and Crosignani (2018) for Italy, Garcia-Posada and Marchetti (2016) for Spain, and Andrade, Cahn, Fraisse, and Mésonnier (2018) and Cahn, Duquerroy, and Mullins (2018) for France). For example, Carpinelli and Crosignani (2018) find a positive impact for LTROs on long term credit supply in Italy, although banks used most of the additional money to increase their holdings of sovereign bonds. However, government guarantees improved the Italian banks' access to the LTRO injections and promoted the transmission of monetary policy. Cahn, Duquerroy, and Mullins (2018) utilize the unexpected extension of eligible collateral, i.e., Additional Credit Claims (ACC) in LTRO II, to identify the causal effect of LTRO on bank lending in France. They find positive lending effects for the LTRO-ACC program on both target corporations (whose loans were eligible for ECB collateral) and

ineligible multi-bank corporations. Different from these country-specific studies, we focus on *all* Eurozone corporations and emphasize the role of bank risk, early repayment options, and government fiscal policies in affecting corporate investment and employment.

Our paper also relates to research on the impact of financial conditions on bank lending and real economic outcomes. A substantial body of this literature has shown that negative credit supply shocks reduce various source of lending and negatively affect the real economy such as corporate investment (Ivashina and Scharfstein (2010), Bord, Ivashina, and Taliaferro (2018), Benmelech, Meisenzahl, and Ramcharan (2017), Greenstone, Mas, and Nguyen (2018), Chava and Purnanandam (2011), Amiti and Weinstein (2018), Chodorow-Reich (2014), Cingano, Manaresi, and Sette (2016), Bottero, Lenzu, and Mezzanotti (2019), De Marco (2019), Buca and Vermeulen (2017), Acharya, Eisert, Eufinger, and Hirsch (2018)). In contrast to these papers, we contribute to the literature by investigating the impact of a major liquidity injection on corporate investment and employment, in conjunction with fiscal policies by individual governments in a monetary union.

## 3. Data and Methodology

### 3.1 Data

We collect data from several databases that contain European data ranging from 2009 to 2014, thereby allowing us to look at differences in corporate policies during the European Sovereign Debt Crisis period and the subsequent periods characterized by ECB interventions. We use data on corporate fundamentals from the Compustat Global database.[6] From this source, we identify a sample of European corporations with quarterly corporate financial and stock price data. Since financial and utility corporations often have capital structures that are quite different from the average corporation, we exclude financial corporations (SIC codes 6000 to 6999), utility corporations (SIC codes 4900 to 4999) and corporations for which no

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[6]The advantage of using data from Compustat rather than, for instance, Amadeus, is that we have quarterly rather than only annual data, which allows for greater granularity in our analysis.

SIC code is available. Furthermore, because we are interested in only active corporations, we follow Bates, Kahle, and Stulz (2009) and require corporations to have *both* a non-negative asset value and non-negative sales to be included in a given year (quarter). We supplement the data from Compustat with corporate data from the Capital IQ database which compiles, inter alia, detailed information on corporate debt structure using financial footnotes contained in corporations' financial reports. Finally, we use CreditPro® (S&P Capital IQ) rating data as a proxy for corporate credit risk.[7] In addition to the corporate data, we also collect country- and industry-specific data from several other sources, including five-year sovereign CDS spreads from Markit, and measures of a country's overall exposure to other countries' economic conditions from the World Bank.

We restrict our main sample to corporations located in countries that belong to the Eurozone, i.e., the Eurosystem, and which thereby were directly affected by the liquidity interventions.[8] However, we also collect similar data for EU corporations outside the Eurozone, i.e., for non-Eurozone corporations, and use these as a control group in some of our subsequent analyses. To assess the impact of liquidity interventions on corporate policies, we use the ECB's provision of unconventional three-year LTROs. As presented in Appendix Figure A1, the interventions turned out to be of significant size. Since we are interested in whether and how much of the ECB's liquidity injections flowed to individual banks, we specifically make use of hand-collected bank-level information on the Eurozone banks' uptake of LTRO I and LTRO II.[9]

Table 1 outlines the LTRO uptakes in the Eurozone by country. Appendix Figure A2 shows the graphical distribution. We find that banks from the periphery countries were highly active in the program because of their actual capital needs, as the LTRO was their only option for accessing medium-term funding. However, participation in the unconventional

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[7]To mitigate the effect of outliers, we winsorize the observations for our variables at the $1^{st}$ and $99^{th}$ percentiles. Furthermore, we follow the approach in related empirical research and assume that a corporation has no R&D expenditure (or M&A activities), if it is reported as "missing" by Compustat.

[8]To exclude any potential biases, we include only corporations from countries that adopted the Euro as a common currency in 1999, and joined the European Monetary System at the time of its inception in 2001.

[9]We thank Matteo Crosignani for kindly sharing the bank-level LTRO data from Bloomberg.

LTROs also provided banks with an opportunity to replace their shorter-term borrowing with low-cost three-year borrowing (Fitch-Ratings (2012)). Therefore, banks in even highly rated and safe Eurozone countries such as Germany and France participated in the three-year LTROs. In addition, the participation in, and the uptake from, the two LTROs were quite similar (both at the aggregate and country levels). The two LTROs together amounted to approximately 918 billion Euro, with Italian and Spanish banks being the most active in their participation in terms of both the number of participating banks and the amounts borrowed.[10] GIIPS countries had the highest total LTRO borrowings relative to the central government debt. The individual banks in GIIPS countries also borrowed relatively more from the LTROs. Thus, the liquidity injection, as such, was greatest for the Eurozone periphery, i.e., those countries affected the most by the European Sovereign Debt Crisis. We supplement these intervention-specific data with other Eurozone-wide data that are obtained from National Central Bank (NCB) and the EBA stress testing reports, as well as the ECB Statistical Data Warehouse.[11]

## 3.2 Empirical Design

To investigate the impact of the three-year LTROs on corporate investment, we conduct the main analyses in a bank-firm linked sample in Eurozone during 2009 to 2014. Specifically, we create a sample of corporations with bank lender information based on the LPC Dealscan and our baseline Eurozone corporations in Compustat Global as described in the previous subsection.[12] Then, we use our bank-level LTRO uptake information to identify bank lenders with access to LTRO funds in the Dealscan-Compustat linked sample.[13] We end up with a

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[10]The slight difference in the total LTRO amount in our sample and the public number of 1,018.7 billion Euro is due to the lack of data on the actual LTRO uptake by Greek and non-Eurozone banks. Non-Eurozone banks participated through their Eurozone subsidiaries and accounted for about 5% of the total uptake.

[11]Source: https://sdw.ecb.europa.eu/home.do, https://eba.europa.eu/risk-analysis-and-data and http://www.ecb.europa.eu/stats/monetary/res/html/index.en.html. Note that the ECB does not provide detailed data on its intervention programs.

[12]We match Dealscan borrowers with Compustat corporations by using the link provided by Chava and Roberts (2008), and by hand-matching corporations by name and country of origin.

[13]Based on our sample of LTRO-banks, we identify 89 out of 109 banks as bank lenders in LPC Dealscan.

sample of 816 corporations in the linked sample, 416 of which have at least one borrowing relationship with a LTRO bank up to five years of the LTRO injections. Then, we estimate the following specification:

$$\text{Investment}_{i,t} = \alpha + \beta \text{Bank LTRO Uptake}_{i,t} + \gamma \text{Y}_{i,t} + \delta \text{Z}_{c,t} + \theta \text{Firm}_i + \eta \text{Year}_t + \epsilon_{i,t} \quad (1)$$

where $i$ refers to the corporation, $t$ indicates the year-quarter, $c$ refers to the country. Our main measure of *Investment* is the ratio of capital expenditure to total assets. We also examine corporate investment in human capital as measured by the logarithm of corporations' total salaries and wages (*Wages*). To capture the liquidity injection impact of the three-year LTROs, we mainly use the corporate specific measure of *Bank LTRO Uptake*$_{i,t}$. The variable equals zero, until the first round of the unconventional LTROs, Q4-2011, and thereafter equals the average LTRO borrowing amount of related banks (LTRO I and LTRO II), scaled by total assets of each related bank as of 2011:

$$\text{Bank LTRO Uptake}_{i,t} = \sum_{j=1}^{N_i} \left( \frac{\text{Bank LTRO Borrowing}_{j,t}}{\text{Bank Size}_{j,2011}} \right) / N_i \quad (2)$$

where $j$ refers to a related bank and $N_i$ refers to the total number of LTRO-bank relationships the corporation has. A high value of *Bank LTRO Uptake* implies that the LTRO borrowing of banks with which the corporation has an existing lending relationship (compared to the size of the related banks), on average, was significant which, all else being equal, makes it more likely that the corporation had access to additional funds stemming from the LTRO liquidity injections.[14] $Y_{i,t-1}$ are a set of explanatory variables including *Cash Flow*, *Market to Book*, *Firm Size*, *Leverage* and *Rated*.[15] To control for sovereign credit risk and the diversification of the economy across markets, we also incorporate country specific controls

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[14] For the average corporation with a LTRO-bank relationship, the median (mean) value of *Bank LTRO Uptake* is 4.1% (15.9%), with a large degree of cross-corporation and cross-country variation. To measure the country-specific significance of the LTRO impact, we also use the *Country LTRO Uptake* that equals the amount of each country banks' total uptake through LTRO I and II, scaled by the country's central government debt for period after Q4-2011, and zero otherwise.

[15] Descriptions of all variables presented in this section can be found in Appendix Table A1.

($Z_{c,t}$), including the natural logarithm of sovereign CDS spreads (*Sovereign Risk*) and the countries' export to GDP ratios (*Sovereign Export*). We have also included the firm ($Firm_i$) and time fixed effects ($Year_t$). Table 2 shows the summary statistics for all key measures in our Dealscan-Compustat linked corporate sample.[16] There is a large degree of cross-country and time-series variation in *Sovereign Risk*. The average corporation in our main sample uses 2.98% of its total assets on investment in each quarter, with mean bank debt to total asset ratio of 61.8%.

Our main results (i.e., those reported in Section 4) are based on *Bank LTRO Uptake* measure, as the LTRO provided liquidity to the banking sector, and banks' incentives for participating in the LTROs are important to understand its transmission efficiency to the real economy. We also analyze the determinants of banks' LTRO borrowings using bank-level data from Bankscope and Markit. For our country-level analysis in section 5, we investigate policy interactions and policy design implications by using the *Country LTRO Uptake* measure.

## 4. Central Bank Liquidity Injections and Corporate Investment

In this section, we investigate the impact of the unconventional liquidity intervention on the real economy. We focus on the effect of the three-year LTROs implemented by the ECB on corporate investment in the Eurozone. Within this, we will particularly focus on the role of bank risk in determining banks' LTRO uptakes and affecting the LTRO effects.

### 4.1 Bank LTRO Uptake and Corporate Investment: Baseline Results

Corporate access to debt markets has an impact on corporations' investments (Harford and Uysal (2014)), and financing frictions do affect investment decisions (Almeida and Campello (2007)). During the recent financial crisis, banks were undercapitalized and faced funding

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[16]Appendix Table A2, Panel A, shows the summary statistics for the baseline Compustat corporate sample, i.e., where we do not require information on corporations' lending relationships, and confirms that there is no major sample bias induced by our procedure for identifying loan relationships.

risk which not only implied an inadequately credit tightening, but also negatively affected corporate credit conditions more generally. In order to support bank financing and lending in the Euro area and to prevent the consequent downturn in the real economy, the ECB designed the three-year LTROs. The resulting positive credit supply shock to the banking sector created by ECB can be extended to the corporate level through bank lending and may, thus, positively affect corporations' investment policies. However, as there were no restrictions on banks' use of the LTRO funding in the design of the program, banks could use the LTRO funding for other purposes, rather than pass on the liquidity to the firm level. Accordingly, corporations may also have had concerns about future access to financing because of the bank lenders' impaired balance sheets or their risk taking. If the LTRO uptake was viewed as a signal of bank risk and future financing constraints, corporations may have even decreased their investments.

To investigate whether the LTRO intervention had an impact on corporate investment and employment decisions, we utilize detailed bank-firm relationship data (from LPC Dealscan) and bank-level LTRO uptake data (from the ECB) to measure the liquidity injection effects at the corporate level. *Bank LTRO Uptake* provides a corporate-specific measure of the total LTRO Uptake of a corporations' bank lenders. If the LTROs were sufficiently effective, we expect that corporations that had an existing borrowing relationship with banks that obtained a significant amount of the LTRO funds were more likely, in general, to be positively affected by the LTRO credit supply shock. We conduct our analyses in the sample of all corporations in the Eurozone with the sample period of 2009 to 2014.

The results are presented in Table 3. In Model (1), we use the ratio of capital expenditure to total assets as our proxy for corporate investment, and add controls that may also affect the corporate capital expenditure decision. In Model (2), we provide the same analysis for corporate employment compensation which is the natural logarithm of total wage expenses. As shown in Table 3, rather than a positive impact, we find a *negative* and statistically significant coefficient of *Bank LTRO Uptake* for investment, whereas the coefficient is statistically

insignificant for wages.[17] Since investments and employment may also be determined by the lagged ratios of alternative investment measures, e.g., R&D and acquisitions, along with profitability and the degree of competition in the considered industry (see, e.g., Almeida and Campello (2007) and Duchin, Ozbas, and Sensoy (2010)), we use these controls for robustness checks. Appendix Table A3 shows that our results are robust to these additional controls. Overall, the analyses in this section suggest that the average corporation did not increase its investment or employment following the ECB's LTRO liquidity injections.

## 4.2 Endogeneity of Bank LTRO Uptake

As banks' incentives for participating in the LTROs are important to understand the transmission efficiency from the ECB to the real economy, we next analyze the determinants of banks' LTRO uptake to understand the role of bank risk in explaining both the LTRO uptake and the decrease in investment. To this end, we focus on all banks with loan information in LPC Dealscan and a lending relationships to the Eurozone corporations in our main sample, and then investigate each bank's borrowing from the ECB's three-year LTROs based on the hand-collected information on banks' participation in the LTRO interventions. Specifically, we define two measures: (1) an indicator variable that is equal to one if the bank participated in one of the LTROs, and (2) the natural logarithm of one plus the bank's total borrowing in billion Euro from LTRO I (Dec-2011) and II (Feb-2012).

Drechsler, Drechsel, Marques-Ibanez, and Schnabl (2016) find that weakly capitalized banks took out more lender-of-last-resort loans. Thus, for the analysis on banks' LTRO borrowings, we use measures for bank risk as determinants of the LTRO uptake. The variable *High Risk Bank* is equal to one, if one year before the first three-year LTRO intervention (i.e., Q4-2010) a bank had a five-year CDS spread above the median five-year CDS spread of the banks in our sample, and zero otherwise. As larger banks may have had sufficient collateral to access the LTRO funds and may have had better access to liquidity injections

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[17]Given the insignificant results for employment, we focus on corporate investment in the rest of the paper.

because they were "too big to fail" we also add *Bank Size* to capture a potential size effect. We measure *Bank Size* as the natural logarithm of bank's total assets at the end of 2010. Besides bank characteristics, we further add proxies for borrower and country risk, which may affect banks' access to, and the usage of, LTRO funds. *Borrower Size* refers to the average size (measured as the natural logarithm of total assets) of the banks' borrowers at the end of 2010. Likewise, *Borrower Leverage*, *Borrower Short-term Debt*, and *Borrower Cash Flow* are the average leverage, short-term debt and cash flow of the banks' borrowers at the end of 2010. Finally, we include *Sovereign Risk*, which is the countries' CDS spread at the end of 2010, expressed as a natural logarithm.[18]

We implement our test of the determinants of banks' LTRO uptakes in a regression framework and present the results in Table 4. Panel A focuses on the probability of a bank participating in LTRO liquidity interventions, while Panel B reports the determinants of the amounts of the LTRO uptakes. The results indicate that risky banks (as proxied by *High Risk Bank*) are more likely to borrow, and borrow a greater amount from the LTRO liquidity injections, relative to low risk banks. We also find that large banks accessed the LTRO injections much more than small banks, which is consistent with our prediction. In addition, banks from riskier countries borrowed more from the LTROs. Compared to bank and country risk measures, the characteristics of the borrowing corporations are less significant in determining the banks' LTRO borrowing probability and the uptake amount. In Models (4) and (5) of Table 4, we separate banks into GIIPS and non-GIIPS banks, and show that the previous conclusions are robust. Interestingly, we find that for non-GIIPS banks, bank risk significantly increases the probability of participating in LTRO liquidity injections, as well as the uptake amount. Overall, we find evidence that banks' participation in the LTROs and their LTRO uptake amounts positively relate to bank and country risks. This is consistent with the explanation for our results outlining a decrease in investment

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[18]We collect the bank-level measures from Bankscope as well as Markit, while the borrower-related data are based upon information in our main sample. After combining all the bank-specific data, we end up with a sample of 185 banks with available information. Summary statistics for all the bank-related measures can be found in Appendix Table A4.

following the LTRO, i.e., that corporations read the LTRO uptake as a signal of risk and, consequently, decreased their investments.

## 4.3 Bank Risk and the LTRO Effect

In this section, we explore the role of bank risk in explaining the decrease in corporate investment following the LTROs. If corporations interpret banks' LTRO uptakes as signals of bank risk and future financing constraints, we expect a more pronounced decrease in investment for corporations with risky bank lenders. In addition, we examine the changes in bank risk following the LTRO liquidity injections in terms of banks' risky sovereign debt holdings, and the role of banks' early repayments of LTRO funds as a sign of normalisation.

### 4.3.1 The Role of Bank Risk

The previous analysis of the determinants of banks' LTRO uptakes suggests that risky banks tend to take more LTRO funds. To further understand the role of bank risk in explaining the decrease in investment following LTROs, we first separate our sample firms into subsamples of *Risky Bank Lender* and *Safe Bank Lender*, based upon the average five-year CDS spread of their respective bank lenders, one year before the first three-year LTRO intervention, i.e., Q4-2010. Then, we compare the changes in corporate investment following LTRO uptakes by banks in both subsamples. The results are presented in Models (1) and (2) of Table 5. We find a significant decrease in investment after the LTRO uptakes by banks for corporations in the *Risky Bank Lender* subsample, whereas the coefficient of *Bank LTRO Uptake* for corporations with safe bank lenders is positive, but statistically insignificant.

As countries that were affected the most by the Sovereign Debt Crisis also would be the ones that have a higher country risk, ex ante, we also explore the interaction of bank and country risk, and the LTRO impact. Specifically, we conduct an investigation of corporate investment in subsamples where we separate corporations based on both corporations' bank lender risk and country risk, i.e., GIIPS and non-GIIPS. As evidenced by Models (3) to (6)

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of Table 5, we find that the decrease in investment following the banks LTRO uptakes is concentrated in corporations that are located in GIIPS countries and have risky lenders, i.e., corporations with lending relationships to banks that used the LTRO liquidity the most. The decrease in investment is not significant for corporations with risky bank lenders in non-GIIPS countries. However, for corporations with relatively safe bank lenders in both GIIPS and non-GIIPS countires, we find a positive sign for *Bank LTRO Uptake*, although the changes are not statistically significant.

Therefore, the above findings suggest that bank risk helps us to explain the decrease in investment following the LTRO intervention. The decrease in investment following LTROs is concentrated in the subsample of corporations with risky bank lenders. While the past bank risk positively relates to banks participation in the three year LTROs, LTRO uptake itself can signal future bank risk shifting incentives, which cannot be easily observed. In the next subsection, we explore further the signalling role of banks' LTRO uptakes by examining bank risky sovereign debt holdings following LTROs.

### 4.3.2   Bank Holdings of Sovereign Debt

During the European sovereign debt crisis, banks tended to increase their domestic sovereign debt holdings because of moral suasion (Becker and Ivashina (2018), Ongena, Popov, and van Horen (2019), Altavilla, Pagano, and Simonelli (2017)), banks risk-shifting (Crosignani (2017)) and collateral trade incentives (Crosignani, Faria-e-Castro, and Fonseca (2019)). Crosignani, Faria-e-Castro, and Fonseca (2019) specifically find that LTROs induced banks to purchase shorter-term peripheral sovereign debt which can be used as collateral for LTRO borrowings. The increased sovereign debt holdings by banks can generate crowding out of both corporate (Becker and Ivashina (2018), Gennaioli, Martin, and Rossi (2018)) and household lending (Ongena, Popov, and van Horen (2019)). To understand banks' holding of risky sovereign debts and its role in explaining the decrease in corporate investment following LTROs, we next conduct additional tests based on banks' sovereign debt holdings around

the LTRO. If banks used the LTRO funds to finance sovereign debt, we expect that LTRO banks would have increased their sovereign debt holdings following LTROs. Considering the significant LTRO participation of banks from GIIPS, we expect that LTRO banks exhibit a greater increase in risky GIIPS sovereign debt holdings. Furthermore, we expect a greater decrease in investment for corporations with banks that increased their GIIPS sovereign holdings following the LTRO intervention.

We test this prediction using data on banks' sovereign debt holdings from the European Banking Authority (EBA) Stress Test in 2011 and 2014.[19] According to the EBA, the 90 (123) banks that are covered in the 2011 (2014) stress test represent about 65% (70%) of the bank assets in the EU banking sector. After linking the stress test data with our sample banks, we obtain, for 33 of our sample banks, end-of-year information on their sovereign debt holdings in 2010 and 2013.[20] In Table 6, Panel A, we first investigate the mean change in banks' sovereign debt holdings and specifically compare the changes between LTRO and non-LTRO banks. In line with the literature, we find that banks in general increased their *total* sovereign debt holdings. However, the magnitude of the increase is much higher for LTRO banks (18.8%) than for non-LTRO banks (1.5%). We also compare the banks' holdings in risky and safe sovereign debt, where we define risky sovereign debt as banks' holdings in GIIPS sovereigns. As expected, we find that LTRO banks significantly increased (decreased) their holdings of risky, GIIPS (safe, non-GIIPS) sovereign debt. In contrast, non-LTRO banks reduced (increased) their holdings of GIIPS (non-GIIPS) sovereign debt.

In Panel B, Table 6, we investigate the impact of banks' LTRO uptakes, conditional on their holding of sovereign debt. Specifically, starting from the 33 banks for which we have the sovereign debt holding information, we identify a sample of 576 corporations with lending relationship with at least one of those 33 banks in the five years before the LTROs. Then, we classify each corporation into subsamples based on whether we observe that the

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[19]Source: https://eba.europa.eu/risk-analysis-and-data/eu-wide-stress-testing

[20]We have data for only 33 of the banks covered in the EBA Stress Test samples as we only focus on Eurozone banks and further require that the bank is covered in both the 2011 and 2014 Stress Test and is in our Dealscan linked sample.

corporation has a lending relationship to a bank that increased its holdings of risky sovereign debt from Dec-2010 to Dec-2013 (*Increase in Bank Lenders' Risky Sovereign Debt Holdings*), or not (*Decrease in Bank Lenders' Risky Sovereign Debt Holdings*).In Model (1) of Panel B, we confirm the negative impact of banks' LTRO uptakes on corporate investment in this restricted sample. In Models (2) and (3) of Panel B, we conduct our baseline analyses in the two subsamples. The results suggest that the negative impact of banks' LTRO uptake is concentrated in corporations whose bank lenders increased their risky sovereign debt holdings following the LTROs. Hence, we not only observe that LTRO banks increased their holdings of risky assets following LTRO in terms of GIIPS sovereign debt, but also find that these banks' borrowers decreased investment accordingly. The results are consistent with the signalling role of banks' LTRO uptake related to bank risk, which induced the decrease in corporate investment.

### 4.3.3   Early Repayment of LTRO Funds

While the uptake of central bank liquidity injections may signal bank risk, "a falling demand for liquidity can be seen as a sign of normalisation."[21] The LTROs provided a three-year funding opportunity for Eurozone banks. However, in order to increase the attractiveness of the unconventional LTROs, participating banks were given the option to repay, either in part or in full, the amount of their borrowings already after one year, and without any penalty. Since banks are closely monitored by financial market participants, it is likely that LTRO-participating banks would have chosen to repay the three-year LTRO funds at the earliest opportunity, either to signal improvements in their individual funding conditions or because of their decreased funding needs following the process of balance sheet adjustment.[22]

To investigate the role of early repayment, we use end-of-year country-level LTRO data reported by the NCBs to proxy for country-specific LTRO early repayments by banks. Specifically, we measure early repayments of the three-year LTROs across banks as the percent-

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[21]See $https://www.ecb.europa.eu/press/key/date/2011/html/sp111021_1.en.html$
[22]See ECB Monthly Bulletin, February 2013.

age changes in the country-level LTRO holdings between 2012 and 2013 (for details, see Appendix Table A5).[23] One interesting observation from this measure is that the bank repayments differ for non-GIIPS (core) and GIIPS (periphery) countries. In general, the non-GIIPS countries in our sample had high LTRO repayment rates. At one extreme, German banks exhibited a 80% decrease in their reliance on LTRO funds from 2012 to 2013. Other non-GIIPS countries (i.e., Austria, the Netherlands, Belgium, and France) showed a sharp decrease of approximately 64% in their balances of LTRO funding during this period. In contrast, there are mixed patterns in the LTRO early repayment for GIIPS countries, with only modest amounts for banks in Portugal (13%), Italy (20%), and larger repayments of approximately 45% in Spain and Ireland. Based on our proxy for banks' early LTRO repayments, we separate our sample of corporations into three groups: *Low Early LTRO Repayment* (Portugal and Italy), *Medium Early LTRO Repayment* (Spain, Ireland, Austria, the Netherlands, Belgium, and France), and *High Early LTRO Repayment* (Germany).

In Table 7 we examine the impact of the LTRO intervention on corporate investment, conditional on banks' LTRO-repayments, by conducting our baseline analyses in the three subsamples. As seen from the table, the impact of the LTRO intervention on corporate policies differs significantly across the early LTRO-repayment groups. The decrease in investment is concentrated in corporations in countries in the low early repayment group, i.e., Portugal and Italy (Model (1)). For those in the medium early repayment group (Model (2)), the change in investment is not significant. However, the German corporations in the high early repayment group (Model (3)) *increased* their investments after their banks' LTRO uptake, although the coefficient is not statistically significant.

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[23]Although most of the LTROs were of three-year maturity, the NCBs' country-level LTRO data may contain LTROs with other maturities, i.e., three-month and one-year. As discussed in the 2013 annual report of the Bank of Spain, "Most of the decrease in this balance took place in January when institutions availed themselves of the early redemption option offered by three-year refinancing operations."

## 4.4 Bank Dependence and Financial Constraints

Since the LTRO liquidity injections were conducted through the banking sector, the expected transmission channel to the real economy is through bank lending. Corporations with greater dependence on bank debt financing were exposed more to, and may have benefited more from, the liquidity injections. Accordingly, the LTROs may also have stimulated corporate investment for these corporations. However, corporations with greater dependence on bank debt financing may also have had greater concerns about future bank debt financing, especially when the LTRO uptake was viewed as a signal of bank risk.

To test this prediction, we construct a proxy for bank debt dependence based on Capital IQ data. Specifically, we separate corporations into two subsamples, *High Bank Debt* and *Low Bank Debt*, based upon their bank debt obligations one year before the first three-year LTRO intervention, i.e., Q4-2010. Then, we rerun the baseline analysis for corporate investment in both subsamples. The results are presented in Table 8, Models (1) and (2). Since we only find a negative and statistically significant coefficient of *Bank LTRO Uptake* for corporations with *High Bank Debt*, we find evidence that corporations with a relatively high reliance on bank debt invested less following their bank lenders' LTRO uptake.

As a robustness test, we further investigate whether the impact of the bank-level LTRO uptake depends on corporations' financial constraints more generally. Financially constrained corporations rely more on bank debt financing, and have fewer capital market alternatives, when their bank lenders face a drying up of funding and decrease their credit supply. Therefore, financially constrained corporations may have greater concerns about, and respond more to, signals of current or future liquidity risk. Following the literature, we use both size and credit rating as proxies for corporate financial constraints and expect small and non-rated corporations to be more financially constrained. As evidenced in Table 8, Models (3) to (6), respectively, we find that the decrease in investment following the LTRO uptake is concentrated in the subsamples of small and non-rated corporations. For rated and large corporations, there is even some evidence of an increase in investment after their banks'

LTRO uptake.[24] Overall, the results confirm the role of corporations concerns about future bank debt financing related to their banks' LTRO uptakes.

## 5. Policy Interactions and Counterfactual Analysis

Our previous evidence suggests that corporations decrease their investment following their bank lenders' LTRO uptake. However, the effects vary with bank risk and corporate bank debt dependency. In this section, we further explore policy interactions, and investigate what would have happened in the absence of LTRO liquidity injections. We also discuss the potential implications of these findings for policy design.

### 5.1 The Role of Fiscal Policy

Fiscal and monetary policies interact closely in reality, and these interactions can lead to very different outcomes than those predicted by the analysis of each policy in isolation (Dixit and Lambertini (2003)). Whereas the ECB has launched a plethora of expansionary monetary interventions since the onset of the European Sovereign Debt Crisis, many Eurozone member states implemented austerity plans to cut government spending, intending to reduce their fiscal deficits and sovereign debt at the same time. One feature of the Eurozone economies is that although the ECB determines the common monetary policy for all member countries, each member state's government decides its own fiscal policy. This feature limits the flexibility of economic policymaking and introduces greater complexity to overall economic policies, with attendant spillover effects on product supply and consumer demand in the Eurozone. In particular, fiscal policies that do not support the Eurosystem-wide monetary policy may offset the positive liquidity shock created by the ECB, because they may weaken the signaling effect by the banks, and potentially hurt corporations even more.

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[24]In addition, corporations with lower cash holdings, i.e., liquidity buffers, will be more sensitive to changes in credit conditions (Bolton, Chen, and Wang (2013)) and, hence, likewise have greater concerns about, and respond more to, signals of current or future liquidity risk. We test this prediction in unreported robustness tests and find that the decrease in investment is concentrated in the subsample of less liquid corporations.

Therefore, we expect the decrease in investment to be more pronounced when there is a lack of coordination between monetary and fiscal policies, i.e., an expansionary monetary policy through the LTROs, accompanied by a contractionary fiscal policy in a particular country. In the contrary, when there is closer coordination between monetary and fiscal policies, we expect to observe increased corporate investment following the implementation of the ECB's unconventional monetary policy.

To investigate the role of fiscal policy, we analyze the impact of the country-level changes in corporate tax rates and government investment expenditures, as proxies for the country-specific fiscal policies. We define, contractionary fiscal policies to involve increasing corporate taxation, decreasing government spending (investment expenditures), or both. Specifically, we measure the changes in tax policy as the country-specific change in the corporate tax rate from one year before, to one year after, the first LTRO intervention, i.e., the change from Q4-2010 to Q4-2012. Next, we classify corporations into subsamples based on whether their local national government increased, maintained or decreased its corporate tax rate, and conduct our investment analysis within the subsamples of corporations located in *Increased Corporate Tax*, *Unchanged Corporate Tax* and *Decreased Corporate Tax* countries, respectively.[25] To account for governments' spending policies, we again use the country-specific change in the government investment expenditures from one year before to one year after the first LTRO intervention, i.e., the change from Q4-2010 to Q4-2012. Then, we conduct our investment analysis within the subsamples of corporations located in *Increased Government Investment*, and *Decreased Government Investment* countries, respectively.

The results of our analysis of fiscal policies are presented in Table 9. Given that fiscal policy is conducted at country level in the Eurozone, we employed the country-level measure of monetary policy (*Country LTRO Uptake*) when investigating the interactions between monetary and fiscal policy. In column (1), the analysis is conducted in the baseline Euro-

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[25]During the period Q4-2010 to Q4-2012, France and Portugal increased, and Finland, the Netherlands and Greece decreased their nominal corporate tax rates. The remaining countries did not change their corporate tax rates.

zone sample, with *Country LTRO Uptake* as a proxy for monetary policy. Similar to our baseline results, we find that corporations decrease investment following LTRO liquidity injections. Furthermore, we find significant negative coefficients for *Country LTRO Uptake* for corporations in countries that increased/unchanged their corporate taxes or decreased government investments, as we can see from Models (2), (3) and (6). These results indicate that in countries with relatively contractionary fiscal policies, corporations decreased their investments following the LTRO liquidity injection. However, when governments adopted accommodative fiscal policies in the face of substantial monetary stimulus, corporations actually *increased* their investment along with their local banks' uptake of the LTRO liquidity injections (Models (4) and (5)). Overall, the results in this section provide additional evidence about the potential for increased corporate investment in countries with coordinated monetary and fiscal policies.

## 5.2  The Efficiency of LTRO in Decelerating the Economic Decline

How effective were the LTROs in boosting the real economy compared to a situation where the ECB did not provide unconventional liquidity? In order to compare corporate investment with and without the influence of the LTRO liquidity injections, we use investment information for non-Eurozone corporations. Whereas banks in Eurozone countries had access to LTRO liquidity injections during the two rounds of unconventional LTROs, banks (and hence, indirectly corporations) in non-Eurozone countries did not have such access.[26] Although using non-Eurozone corporations as the benchmark may be challenged based on other fundamental differences between Eurozone and non-Eurozone economies in Europe, the comparison can be considered as a rough "counterfactual analysis" investigating the impact of the ECB's three-year LTROs.

In Figure 2, we first plot the change in corporate investment around the LTRO inter-

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[26]This is valid with the exception of non-Eurozone banks with bank subsidiaries located in the Eurozone. Additionally, we do not account for other stimulus measures that may have been implemented in the non-Eurozone countries during the same period, which would be biased against our finding a positive impact of the LTROs in the Eurozone countries relative to the non-Eurozone countries.

ventions for Eurozone and non-Eurozone corporations. Before the LTRO implementation, Eurozone and non-Eurozone corporations generally showed similar trends in their investments, with a slightly greater decrease in investment for Eurozone corporations. However, after the LTRO implementation, Eurozone corporations sustained their investments better than non-Eurozone corporations, particularly during the first year after the LTRO liquidity injections. This finding provides some preliminary evidence that the three-year LTROs may have halted the deterioration in Eurozone corporations' investments.

We then investigate corporate investment policies after the LTRO intervention occurred in a sample of corporations located in the EU, with non-Eurozone corporations used as the control group for the LTRO effects. To account for major differences in economic conditions across countries and the corresponding deferred impact, we also match the EU sample countries based upon their sovereign risk when investigating the impact of the LTROs. In particular, we measure country risk using the countries' CDS spreads two years before the LTRO intervention. *Risky (Safe) Sovereign* is defined as a CDS spread above (below) the median in the pre-intervention and crisis periods, i.e., 2009 and 2010.

The results are presented in Table 10. In Model (1), we use the full sample of corporations. The variable *Post-LTRO* is a time dummy variable equal to one, for year-quarter observations occurring after the ECB had implemented the first three-year LTRO intervention (Q4-2011). The *Eurozone* is a dummy variable equal to one, for corporations located in countries that belong to the Eurozone. The variable of interest is *Post-LTRO × Eurozone*, which captures the effect of the liquidity intervention on corporate policies in LTRO countries (the "treatment" effect). We find a positive and significant coefficient for the term *Post-LTRO × Eurozone* for both the investment analyses. The coefficient for *Post-LTRO* is significantly negative. In Models (2) and (3) of Table 10, when we separate our sample of corporations in the EU into high and low sovereign-risk subsamples, we find that Eurozone corporations in both the high- and low-risk subsamples experienced a smaller decrease in their investments following the unconventional LTROs than did non-Eurozone corporations.

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These findings suggest that although all EU corporations decreased investments during the post LTRO period, Eurozone corporations exhibited less decrease than non-Eurozone corporations. If one takes non-Eurozone corporations (or sovereign risk-matched non-Eurozone corporations) as the "counterfactual" of Eurozone corporations exposed to LTRO liquidity injections, the results in this section suggest that the LTROs helped Eurozone corporations sustain their investments better than corporations elsewhere in Europe at the onset of the European Sovereign Debt Crisis.

## 5.3 Implications for Policy Design

In general, the transmission of monetary policy to corporate liquidity and investment is not an easy task. The transfer mechanism is complex, and depends on the longer-term funding risk, bank risk, and corporate financial risk managements etc. However, as our previous evidence suggests the efficiency of the transmission can be facilitated by the *design* of the monetary policy (e.g., liquidity maturity, eligible collateral requirements, early repayment option, restrictions on banks' use of the liquidity) and *coordinated policies* from individual governments and NCBs (e.g., coordinated fiscal policies, government guarantee program to support banks access to the ECB liquidity).

Specifically, short-term and long-term central bank liquidities may have different effects on corporate liquidities and investments. Acharya, Imbierowicz, Steffen, and Teichmann (2017) find impaired transmission of the fixed-rate full allotment policy in October 2008, which targets to reduce banks' short-term funding risk. Compared with short-term liquidity injection, the longer maturity of central bank liquidity as in the LTROs may help banks to restore their lending to corporations, especially when there is rollover risk of short-term liquidity (Carpinelli and Crosignani (2018)).

However, the maturity extension cannot itself solve the problem. Banks may have impaired balance sheet and risk taking incentives which impede the transmission of monetary policies. In particular, banks' impaired balance sheet may prohibit their access to liquidity

injections. In this regard, programs such as the Additional Credit Claim (ACC) program that was designed by the ECB and implemented by individual NCBs may help to support banks access to the ECB liquidity injections. Further, the ACC program can affect which group of corporations benefit from the liquidity injections, i.e., corporations whose loans are newly eligible as collateral under ACC. Since the cost of lending to eligible corporations is decreased, banks will increase lending to these newly eligible corporations (Cahn, Duquerroy, and Mullins (2018)). In addition, banks' risk taking behavior may impede the transmission in terms of banks usage of additional liquidity. Carpinelli and Crosignani (2018) find Italian banks use most of the LTRO uptake to buy domestic government bonds.

Individual governments can do more to facilitate the transmission of monetary policy and stimulate corporate investment. For example, as discussed in Carpinelli and Crosignani (2018), banks with high exposure to a drying up of liquidity before the liquidity injections may have had limited access to the three-year LTROs because of the lack of collateral. Whereas the government guarantee program in Italy supported these high-exposure banks' access to the ECB liquidity, it was the same banks that drove the increase in credit supply, particularly for low profitability and high-risk corporations. However, the involvement of governments in the guarantee may intensify the contagion loop between sovereigns and banks.

Finally, corporations' own risk management may impede the stimulating effects of policies on investments. For example, corporations may have concerns about future financing risk (because of banks' impaired bank balance sheet and risk taking) or market demand risk. As a result, they may decrease investment even when their current liquidity condition is good. The coordinated expansionary fiscal policy can help build up corporate confidence and stimulate investments. In this regard, the Targeted LTROs (TLTROs) implemented in 2014 may be a more effective way to restrict banks' risk taking and stimulate corporate investment, a question that can be explored further.[27]

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[27]Focusing on Spanish corporations, Arce, Gimeno, and Mayordomo (2017) find that TLTROs amplify the credit reallocation to smaller corporations following the ECB's Corporate Sector Purchase Programme.

# 6.  Summary and Conclusion

In this paper, we investigate whether, and how, corporate investment is affected by unconventional monetary interventions by analyzing the largest central bank liquidity injections in history. Focusing on the ECB's Longer-Term Refinancing Operations (LTROs) which provided over one trillion euros to commercial banks at very low rates for relatively long maturity of up to three years, we find that non-financial corporations in the Eurozone did not increase their investments even after these massive liquidity injections. Specifically, our analysis shows that investments of these corporations are negatively associated with the amount of funds that their banks obtained from the ECB. Such a negative liquidity injection effect on corporate investment is concentrated in corporations whose lenders are risky and have weak balance sheets.

We further demonstrate the role of bank risk in explaining the decrease in corporate investment following the LTROs. Our analysis shows that riskier banks took more funds from the ECB and subsequently increased their risky sovereign debt holdings. Their borrowers exhibit greater decrease in investment during the post-LTRO period. Accordingly, we argue that the decrease in investment is related to borrowers' concern on lender risk as signaled by banks' uptakes from the ECB unconventional liquidity injection. Furthermore, we find that the negative investment effect varies across banks' repayment choices, which can signal the normalization of bank balance sheets. Our findings suggest that corporations whose lenders held the ECB funds for a longer period did decrease their investment following their lenders' LTRO uptake. Overall, these results suggest that bank risk and the signalling role of the banks' LTRO uptake can impede the transformation of liquidity injection into real economic output.

While we find some evidence that liquidity injections can decelerate economic decline, our study reveals that unhealthy banks can impede the effectiveness of unconventional monetary policies in improving real economic output. When bank balance sheets are stressed, it would be difficult to stimulate corporate investment by just injecting liquidity into poorly

capitalized banks. Accommodative fiscal policies and other unconventional monetary policies, including the more aggressive Targeted LTRO, may have resulted in different outcomes, but they too should be carefully discussed and analyzed. We leave these issues for future study once additional data become available.

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LTRO I and II:
3y maturity

Initial round
T-LTROs

LTROs:
1y maturity

Additional
T-LTROs

LTROs:
6m maturity

OMT
Announced

OMT
Approved

Draghi:
*"Whatever-it-takes"*

APP
Implemented

Weekly MROs
+ 3m LTROs

SMP I

SMP II

MRO: Fixed rate
full allotment

LTRO: Fixed rate
full allotment -

'00-'07  2008  2009  2010  2011  2012  2013  2014  2015  2016
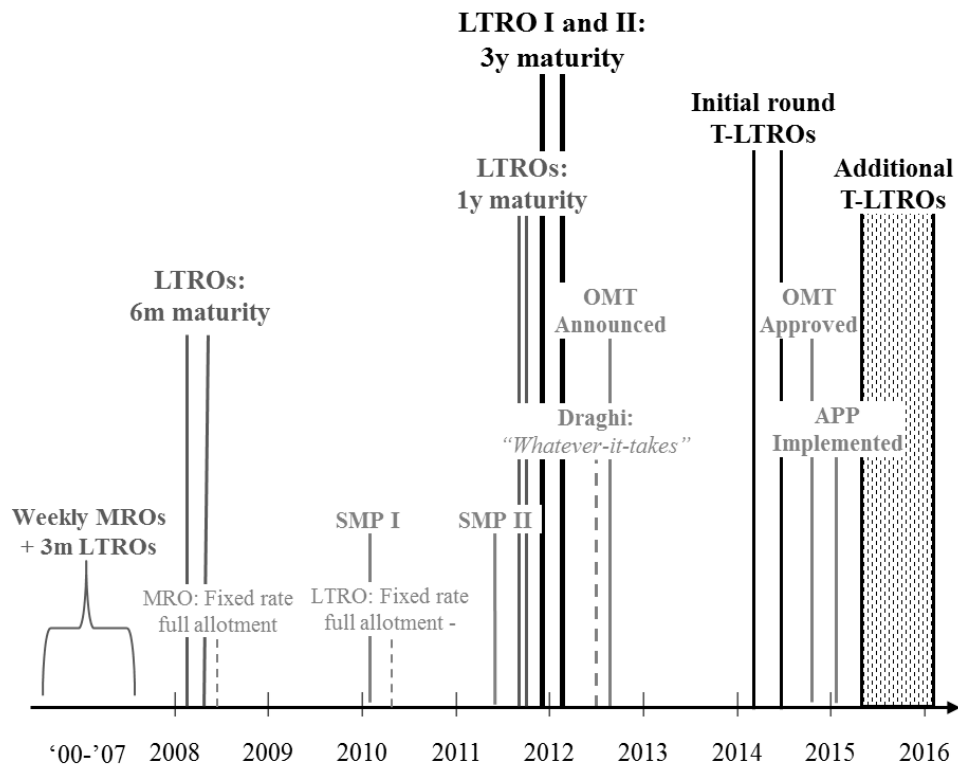
**Figure 1. ECB's unconventional monetary policies**

This figure outlines the timeline of recent unconventional monetary policies implemented by the European Central Bank (ECB). *MRO* labels the standard Marginal Refinancing Operations that are conducted on a weekly basis. *LTROs* refers to Longer-Term Refinancing Operations, while *TLTROs* refers to the recently introduced Targeted Longer-Term Refinancing Operations. *SMP*, the Securities Markets Program, was more recently replaced by the Outright Monetary Transactions (*OMT*) program. *APP* represents the most recently introduced Asset Purchase Program, that is still under way. The "*whatever-it-takes*" event refers to a speech made by Mario Draghi, the President of the ECB, at the Global Investment Conference, London, 26 July 2012.
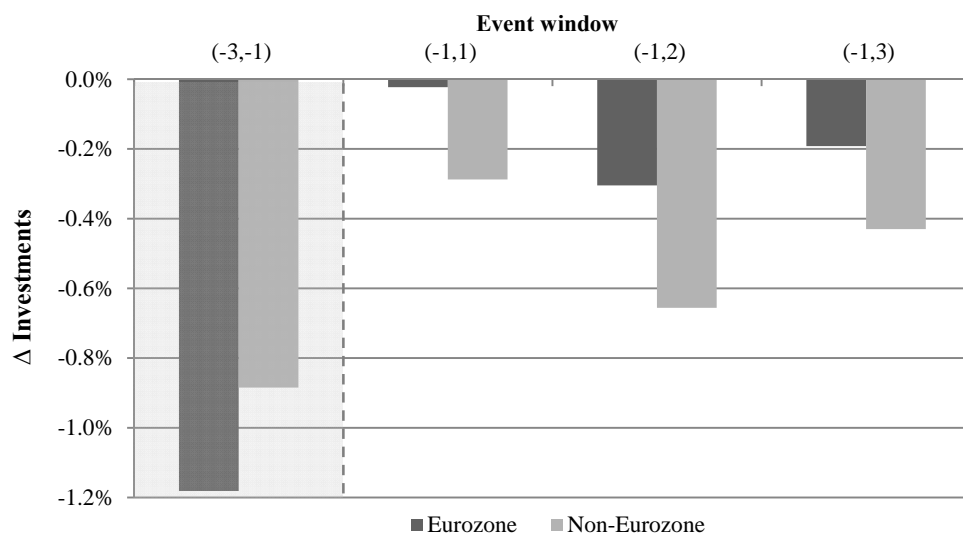
**Figure 2. The change in corporate investment before and after the LTRO intervention**

This figure outlines the changes in the investment ratios for Eurozone and non-Eurozone corporations. The changes outline the the average of corporations' investment ratios and reflect the change from before the financial crisis (Q2-2008) to before the three-year LTRO interventions (Q2-2011), as well as from before the three-year LTRO interventions (Q2-2011) to respectively one (Q4-2012), two (Q4-2013) and three (Q4-2014) years after the three-year LTRO interventions. Our measure for corporate investment is *Investments*, which is the corporate capital expenditure, scaled by total assets. The overall sample of corporations is taken from Compustat Global and is restricted to EU countries.

**Table 1. Liquidity injection from the ECB's three-year Longer-Term Refinancing Operations**

| Country | LTRO I: Dec-2011 EUR bn (1) | LTRO II: Feb-2012 EUR bn (2) | Total Country LTRO Borrowing EUR bn (3) | Country LTRO Uptake percentage (4) | Average Bank LTRO Uptake percentage (5) |
|---|---|---|---|---|---|
| Austria | 3.66 | 7.83 | 11.49 | 4.82 | 7.10 |
| Belgium | 45.28 | 43.71 | 88.99 | 25.02 | 12.30 |
| France | 5.59 | 6.52 | 12.12 | 0.61 | 3.40 |
| Germany | 12.25 | 13.13 | 25.38 | 1.67 | 6.70 |
| Greece | 60.94 [§] | n.a. | 60.94 | 25.54 | n.a. |
| Ireland | 21.91 | 17.62 | 39.52 | 22.33 | 11.50 |
| Italy | 172.08 | 128.11 | 300.20 | 15.92 | 13.40 |
| Netherlands | 8.86 | 1.96 | 10.81 | 2.58 | 9.80 |
| Portugal | 24.54 | 24.76 | 49.30 | 29.37 | 11.80 |
| Spain | 153.21 | 165.53 | 318.74 | 51.44 | 15.70 |
| Total | 508.32 | 409.17 | 917.49 | | |

This table presents data on the liquidity injections that Eurozone countries obtained from the three-year Longer-Term Refinancing Operations (LTROs) initiated by the European Central Bank (ECB) on December 21, 2011 (LTRO I) and February 29, 2012 (LTRO II), respectively. *Total Country LTRO Borrowing* refers to the total amount that banks in the respective country obtained through LTRO I and II, with the numbers given in billion EUR. In Column 4, we scale the *Total Country LTRO Borrowing* for each country by the country's central government debt obligations, as of December 2011. In Column 5, we report for each country the average bank-level LTRO borrowing, scaled by the respective banks' total assets in 2010. The information about the bank and country-specific LTRO uptake is based upon hand-collected data from Bloomberg, as well as central bank announcements and public commentaries. The data on banks' total assets are obtained from Bankscope and available public financial reports, while the information for government debt by country is obtained from the World Bank Database. [§]In the case of Greece, we only have information about the total LTRO amount which, besides the three-year LTROs, also includes the standard one-month and three-month LTROs. As we cannot separate the latter, the number is not directly comparable to the uptake numbers for the other countries.

**Table 2. Summary statistics for Eurozone sample with existing loan information from LPC Dealscan**

*Panel A: Corporate-specific measures*

| Country | AUT | BEL | DEU | ESP | FIN | FRA | GRC | IRL | ITA | NLD | PRT | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Investments | 5.51 | 3.28 | 3.45 | 2.36 | 2.96 | 2.95 | 2.34 | 2.41 | 2.70 | 2.65 | 5.14 | 2.98 |
| Wages | 3.91 | 3.12 | 3.31 | 3.78 | 3.99 | 3.90 | 2.54 | 2.07 | 3.39 | 4.03 | 4.26 | 3.55 |
| Cash | 8.49 | 7.21 | 9.65 | 7.39 | 6.38 | 9.05 | 4.93 | 10.0 | 7.55 | 6.69 | 5.79 | 8.19 |
| Leverage | 27.1 | 25.5 | 22.5 | 35.5 | 27.8 | 23.9 | 45.2 | 28.2 | 30.8 | 24.9 | 38.0 | 26.8 |
| Net Debt | 54.6 | 60.3 | 60.7 | 67.4 | 60.3 | 61.4 | 70.2 | 62.2 | 69.7 | 60.9 | 72.1 | 62.6 |
| Firm Size | 6.75 | 6.77 | 6.60 | 7.45 | 7.03 | 7.24 | 6.13 | 7.40 | 6.70 | 7.51 | 8.28 | 6.98 |
| Market to Book | 111. | 108. | 117. | 104. | 116. | 110. | 89.4 | 135. | 107. | 126. | 106. | 112. |
| Cash Flow | 3.61 | 3.58 | 4.05 | 4.66 | 3.89 | 2.81 | 1.19 | 2.44 | 2.68 | 3.84 | 2.74 | 3.32 |
| Industry Sigma | 3.44 | 4.69 | 7.61 | 3.57 | 4.16 | 5.65 | 3.58 | 3.26 | 3.57 | 4.57 | 2.67 | 4.73 |
| Net Working Capital | 9.02 | -3.3 | 4.51 | -3.6 | 2.67 | -3.6 | -2.4 | -0.4 | -1.7 | -0.6 | -10. | -0.2 |
| R&D/ Sales | 0.96 | 0.10 | 0.35 | 0.00 | 0.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Acquisition Activity | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.10 | 0.00 | 0.05 | 0.00 | 0.00 |
| Bank Debt | 65.7 | 57.6 | 61.6 | 85.1 | 49.2 | 56.8 | 47.3 | 51.7 | 80.6 | 64.4 | 21.6 | 61.8 |
| Short-term Debt | 0.08 | 0.04 | 0.04 | 0.08 | 0.08 | 0.05 | 0.17 | 0.02 | 0.10 | 0.04 | 0.09 | 0.06 |
| # N | 491 | 949 | 4979 | 1324 | 1181 | 4424 | 950 | 574 | 1668 | 1617 | 189 | 18346 |
| # Firms | 23 | 41 | 222 | 61 | 50 | 193 | 40 | 25 | 77 | 76 | 8 | 816 |
| # LTRO-Bank Rel. | 10 | 24 | 113 | 41 | 18 | 92 | 9 | 13 | 48 | 41 | 7 | 416 |

*Panel B: Country-specific measures*

| Country | AUT | BEL | DEU | ESP | FIN | FRA | GRC | IRL | ITA | NLD | PRT | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sovereign Risk | 50.2 | 58.6 | 31.5 | 135. | 30.3 | 59.3 | 492. | 216. | 149. | 46.5 | 368. | 73.0 |
| Sovereign Export | 0.53 | 0.81 | 0.44 | 0.28 | 0.38 | 0.27 | 0.25 | 1.03 | 0.26 | 0.77 | 0.34 | 0.38 |
| Government Debt | 81.5 | 105. | 75.5 | 64.8 | 48.2 | 83.9 | 155. | 93.7 | 115. | 59.9 | 103. | 82.2 |

This table provides sample averages (medians) of corporate characteristics for each country in our samples of Eurozone corporations. Panel A outlines the summary statistics for the corporate-specific measures. In Panel B, we show summary statistics for country-specific measures used in our main analysis. The sample period for each country is 2009-2014, and the variables are based on quarterly observations. For the specific definition of each variable we refer to Appendix Table A1. The corporate fundamental data are obtained from Compustat Global, LPC Dealscan and Capital IQ, while country-specific data are obtained from Markit, the World Bank, as well as the ECB Statistical Data Warehouse. For any data unavailable for a specific quarter, we replace the missing values with yearly observations. Ratios are given in percentages.

**Table 3. LTRO effect on investment and employment**

|  | Investments | Wages |
|---|---|---|
|  | (1) | (2) |
| Bank LTRO Uptake | -0.158** | -0.034 |
|  | (0.08) | (0.05) |
| Cash Flow | 0.006** | 0.004 |
|  | (0.00) | (0.00) |
| Market to Book | 0.005*** | 0.001 |
|  | (0.00) | (0.00) |
| Firm Size | 0.160** | 0.695*** |
|  | (0.07) | (0.05) |
| Leverage | -0.015*** | -0.001 |
|  | (0.00) | (0.00) |
| Rated | 0.016 | -0.044 |
|  | (0.15) | (0.12) |
| Sovereign Risk | -0.650*** | -0.036 |
|  | (0.05) | (0.04) |
| Sovereign Export | -0.057*** | 0.004 |
|  | (0.00) | (0.00) |
| Time FE | Y | Y |
| Firm FE | Y | Y |
| $R$-square | 0.721 | 0.744 |
| $N$ | 16320 | 12458 |

This table presents estimates of the effect of the liquidity uptake from the ECB's three-year Longer-Term Refinancing Operations (LTROs) on corporate investment and employment compensation in a sample of Eurozone corporations with existing loan information in LPC Dealscan. Our measure for investment is *Investments*, which is the corporations' capital expenditure, scaled by total assets. Our measure for employment compensation is *Wages*, which is the corporations' total salaries and wages, given in logarithms. The variable *Bank LTRO Uptake* is equal to zero until Q4-2011, and equal to the LTRO uptake amount of the corporate-related banks, scaled by the size of each bank, thereafter. We classify Eurozone banks as related if the corporation in the five years prior to the first LTRO intervention had a loan relation to the bank. The information about the bank-specific LTRO uptake is based upon hand-collected data from Bloomberg, as well as central bank announcements and public commentaries. The loan information data is obtained from LPC Dealscan. In all models, we include base corporate-level financial variables in addition to macro-economic variables. The sample period is 2009-2014, based on quarterly observations. (*** denotes significance at the 1% level, ** significance at the 5% level, and * significance at the 10% level. The numbers in parentheses are standard errors.)

**Table 4. Determinants of banks' LTRO borrowing**

*Panel A: Bank-level LTRO borrowing indicator*

| | LTRO Indicator$_{j,11/12}$ | | | LTRO Indicator$_{j,11/12}$ | |
|---|---|---|---|---|---|
| | All Banks (1) | All Banks (2) | All Banks (3) | GIIPS Banks (4) | Non-GIIPS Banks (5) |
| High Risk Bank$_{j,10}$ | 1.237*** | 1.584*** | 1.414*** | 1.053 | 3.032*** |
| | (0.358) | (0.424) | (0.446) | (0.833) | (1.076) |
| Bank Size$_{j,10}$ | 0.174** | 0.388*** | 0.538*** | 1.266*** | 0.551** |
| | (0.080) | (0.111) | (0.134) | (0.345) | (0.264) |
| Borrower Size$_{j,10}$ | | -0.11 | -0.18 | -0.62 | -0.21 |
| | | (0.264) | (0.281) | (0.511) | (0.704) |
| Borrower Leverage$_{j,10}$ | | 0.034 | 0.016 | 0.038 | -0.01 |
| | | (0.023) | (0.026) | (0.050) | (0.066) |
| Borrower Short-term Debt$_{j,10}$ | | -7.66 | -9.08* | -15.3* | -49.3* |
| | | (4.689) | (5.284) | (9.235) | (26.50) |
| Borrower Cash Flow$_{j,10}$ | | -0.26** | -0.21* | -0.52** | 0.060 |
| | | (0.117) | (0.114) | (0.231) | (0.200) |
| Sovereign Risk$_{10}$ | | | 1.269*** | 1.986 | 0.174 |
| | | | (0.405) | (2.787) | (0.898) |
| Pseudo $R$-square | 0.085 | 0.222 | 0.280 | 0.501 | 0.417 |
| N | 185 | 155 | 155 | 80 | 75 |

*Panel B: Bank-level LTRO borrowing amount*

| | Log(1 + LTRO Borrowing) | | | Log(1 + LTRO Borrowing) | |
|---|---|---|---|---|---|
| | All Banks (1) | All Banks (2) | All Banks (3) | GIIPS Banks (4) | Non-GIIPS Banks (5) |
| High Risk Bank$_{j,10}$ | 0.782*** | 0.789*** | 0.621*** | 0.450* | 0.502** |
| | (0.18) | (0.19) | (0.19) | (0.26) | (0.21) |
| Bank Size$_{j,10}$ | 0.061*** | 0.174*** | 0.248*** | 0.484*** | 0.099** |
| | (0.00) | (0.03) | (0.04) | (0.06) | (0.03) |
| Borrower Size$_{j,10}$ | | -0.138** | 0.033 | -0.028 | -0.107 |
| | | (0.05) | (0.06) | (0.13) | (0.07) |
| Borrower Leverage$_{j,10}$ | | 0.012 | 0.005 | 0.002 | 0.006 |
| | | (0.00) | (0.00) | (0.01) | (0.00) |
| Borrower Short-term Debt$_{j,10}$ | | -2.969** | -1.818 | -2.797 | -3.485* |
| | | (1.42) | (1.38) | (1.98) | (1.99) |
| Borrower Cash Flow$_{j,10}$ | | -0.045 | -0.028 | -0.067** | 0.005 |
| | | (0.03) | (0.02) | (0.03) | (0.04) |
| Sovereign Risk$_{10}$ | | | 0.486*** | 0.728** | -0.023 |
| | | | (0.12) | (0.28) | (0.11) |
| $R$-square | 0.418 | 0.447 | 0.500 | 0.750 | 0.293 |
| N | 185 | 155 | 155 | 80 | 75 |

This table presents estimates of the effect of bank, country and borrower measures on banks' borrowings from the ECB's three-year Longer-Term Refinancing Operations (LTROs) in a sample of banks with borrowers located in the Eurozone. In Panel A, our measure for banks' LTRO borrowings is *LTRO Indicator*, which is an indicator that is equal to one, if the bank participated in one of the LTROs. In Panel B, our measure for banks' LTRO borrowings is *Log(1 + LTRO Borrowing)*, which is the natural logarithm of 1 plus the banks' total borrowing from LTRO I (Dec-2011) and II (Feb-2012). We regress the bank LTRO borrowing measures on a set of control variables. *High Risk Bank* is a dummy variable equal to one, if the bank at the end of 2010 had a CDS spread above the median CDS spread, and zero otherwise. *Bank Size* is the banks' total assets at the end of 2010, given in natural logarithm. *Borrower Size* refers to the average size (measured by total assets given in natural logarithm) of the banks' borrowers at the end of 2010. Likewise, *Borrower Leverage*, *Borrower Short-term Debt* and *Borrower Cash Flow* is the average leverage, short-term debt and cash flow of the banks' borrowers at the end of 2010. *Sovereign Risk* is the countries' CDS spread at the end of 2010, given in natural logarithm. (*** denotes significance at the 1% level, ** significance at the 5% level, and * significance at the 10% level. The numbers in parentheses are standard errors.)

**Table 5. LTRO effect on investment: The role of bank risk**

| | Investments | | Investments | | | |
| --- | --- | --- | --- | --- | --- | --- |
| | | | GIIPS | | Non-GIIPS | |
| | Risky Bank Lender (1) | Safe Bank Lender (2) | Risky Bank Lender (3) | Safe Bank Lender (4) | Risky Bank Lender (5) | Safe Bank Lender (6) |
| Bank LTRO Uptake | -0.337*** | 0.047 | -0.513*** | 2.114 | -0.213 | 0.038 |
| | (0.10) | (0.08) | (0.14) | (2.06) | (0.14) | (0.08) |
| Cash Flow | 0.010* | 0.007 | 0.010 | 0.059*** | 0.015** | 0.004 |
| | (0.00) | (0.00) | (0.00) | (0.01) | (0.00) | (0.00) |
| Market to Book | 0.006*** | 0.009*** | 0.016*** | 0.013*** | 0.001 | 0.009*** |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| Firm Size | 0.139 | 0.097 | -0.079 | -1.039*** | 0.559*** | 0.218* |
| | (0.12) | (0.11) | (0.20) | (0.33) | (0.14) | (0.11) |
| Leverage | -0.016*** | -0.021*** | -0.011** | 0.015* | -0.032*** | -0.025*** |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| Rated | 0.008 | 0.352 | -1.131*** | 1.401** | 0.524** | 0.295 |
| | (0.18) | (0.22) | (0.30) | (0.61) | (0.21) | (0.23) |
| Sovereign Risk | -0.830*** | -0.247*** | -0.300*** | -0.087 | -0.928*** | -0.104 |
| | (0.08) | (0.08) | (0.11) | (0.12) | (0.17) | (0.13) |
| Sovereign Export | -0.089*** | -0.068*** | -0.205*** | 0.063 | -0.060*** | -0.067*** |
| | (0.01) | (0.01) | (0.03) | (0.04) | (0.01) | (0.01) |
| Time FE | Y | Y | Y | Y | Y | Y |
| Firm FE | Y | Y | Y | Y | Y | Y |
| R-square | 0.774 | 0.794 | 0.777 | 0.826 | 0.796 | 0.793 |
| N | 4869 | 5168 | 1906 | 475 | 2963 | 4693 |

This table presents estimates of the effect of bank characteristics and the liquidity uptake from the ECB's three-year Longer-Term Refinancing Operations (LTROs), on corporate investment, in a sample of Eurozone corporations with existing loan information in LPC Dealscan. Our measure for investment is *Investments*, which is the corporations' capital expenditure, scaled by total assets. In Models (1) and (2) we separate corporations into *Risky* and *Safe Lender*. *Risky (Safe) Lender* is a dummy variable equal to one if the corporations' lenders one year before the first three-year LTRO intervention, i.e., Q4-2010, on average had a CDS spread above (below) the median, and zero otherwise. In Models (3) to (6) we further separate corporations into *GIIPS* and *Non-GIIPS*, where *GIIPS* (*Non-GIIPS*) is a dummy variable equal to one for corporations that are (not are) located in either Greece, Ireland, Italy, Portugal or Spain. The variable *Bank LTRO Uptake* is equal to zero until Q4-2011, and equal to the LTRO uptake amount of the corporate-related banks, scaled by the size of each bank, thereafter. The sample period is 2009-2014, based on quarterly observations. (*** denotes significance at the 1% level, ** significance at the 5% level, and * significance at the 10% level. The numbers in parentheses are standard errors.)

**Table 6. LTRO effect on investment: the role of banks' post-LTRO sovereign debt holdings**

*Panel A: Changes in bank-level sovereign debt holdings from 2010 to 2013*

|  | Δ Total Sovereign Debt | Δ Risky Sovereign Debt | Δ Safe Sovereign Debt |
|---|---|---|---|
|  | (1) | (2) | (3) |
| LTRO Banks (n=19) | 18.81% | 11.29% | -27.26% |
| Non-LTRO Banks (n=14) | 1.51% | -36.79% | 30.26% |

*Panel B: LTRO uptake effect on investment and bank lenders' risky sovereign debt holdings*

|  | | Investments | |
|---|---|---|---|
|  | Investments | Increase in Bank Lenders' Risky Sovereign Debt Holdings | Decrease in Bank Lenders' Risky Sovereign Debt Holdings |
|  | (1) | (2) | (3) |
| Bank LTRO Uptake | -0.147** | -1.949*** | 0.036 |
|  | (0.06) | (0.20) | (0.07) |
| Cash Flow | 0.009** | 0.007 | 0.012** |
|  | (0.00) | (0.00) | (0.00) |
| Market to Book | 0.007*** | 0.009*** | 0.007*** |
|  | (0.00) | (0.00) | (0.00) |
| Firm Size | 0.150* | 0.116 | 0.230* |
|  | (0.08) | (0.10) | (0.13) |
| Leverage | -0.019*** | -0.026*** | -0.011*** |
|  | (0.00) | (0.00) | (0.00) |
| Rated | 0.079 | 0.298** | -0.755* |
|  | (0.13) | (0.14) | (0.39) |
| Sovereign Risk | -0.592*** | -0.782*** | -0.429*** |
|  | (0.06) | (0.08) | (0.08) |
| Sovereign Export | -0.085*** | -0.025** | -0.145*** |
|  | (0.00) | (0.01) | (0.01) |
| Time FE | Y | Y | Y |
| Firm FE | Y | Y | Y |
| R-square | 0.782 | 0.783 | 0.789 |
| N | 10052 | 5785 | 4267 |

This table presents the changes in bank lenders' sovereign debt holdings from 2010 to 2013 and the estimates of the effect of the liquidity uptake from the ECB's three-year Longer-Term Refinancing Operations (LTROs), on corporate investment. The sample of banks consists of all banks which are covered in the EBA Stress test and which in the five years before the LTRO intervention had a lending relationship to at least one corporation in our sample of Eurozone corporations with existing loan information in LPC Dealscan. Panel A provides sample averages of the change in banks' sovereign debt holdings from Dec-2010 to Dec-2013, i.e., around the LTRO intervention. *Risky Sovereign Debt* refers to banks' sovereign debt holdings in Greece, Ireland, Italy, Portugal and Spain, while *Safe Sovereign Debt* refers to banks' sovereign debt holdings in Germany, Austria, France, Netherlands, Belgium and Finland. Panel B shows the estimates of the effect of the liquidity uptake from the ECB's three-year Longer-Term Refinancing Operations (LTROs), on corporate investment in the sample of Eurozone corporations. Our measure for investment is *Investments*, which is the corporation's capital expenditure, scaled by total assets. The variable *Bank LTRO Uptake* is equal to zero until Q4-2011, and equal to the LTRO uptake amount of the corporation's related banks, scaled by the size of each bank, thereafter. We classify Eurozone banks as related if the corporation in the three years prior to the first LTRO intervention had a loan relation to the bank. In Models 2 and 3 we separate corporations into the subsamples *Increase in Bank Lenders' Risky Sovereign Debt Holdings* and *Decrease in Bank Lenders' Risky Sovereign Debt Holdings* based on whether the corporations have a lending relationship to a bank that increased its holdings of risky sovereign debt from Dec-2010 to Dec-2013, or not. The sample period is 2009-2014, based on quarterly observations. (*** denotes significance at the 1% level, ** significance at the 5% level, and * significance at the 10% level. The numbers in parentheses are standard errors.)

**Table 7. LTRO effect on investment: Banks' early repayment of LTRO**

| | Investments | | |
|---|---|---|---|
| | Low Early LTRO-Repayment (1) | Medium Early LTRO-Repayment (2) | High Early LTRO-Repayment (3) |
| Bank LTRO Uptake | -4.219*** | -0.132 | 1.055 |
| | (0.73) | (0.08) | (2.96) |
| Cash Flow | 0.016 | 0.005 | 0.008 |
| | (0.01) | (0.00) | (0.00) |
| Market to Book | 0.009*** | 0.003*** | 0.007*** |
| | (0.00) | (0.00) | (0.00) |
| Firm Size | 0.006 | 0.121 | 0.681*** |
| | (0.23) | (0.10) | (0.14) |
| Leverage | -0.006 | -0.015*** | -0.027*** |
| | (0.00) | (0.00) | (0.00) |
| Rated | -0.554 | 0.002 | 1.064*** |
| | (0.36) | (0.18) | (0.40) |
| Sovereign Risk | 0.075 | -1.244*** | 0.992 |
| | (0.10) | (0.10) | (2.26) |
| Sovereign Export | -0.245*** | -0.073*** | 2.688 |
| | (0.03) | (0.01) | (4.02) |
| Time FE | Y | Y | Y |
| Firm FE | Y | Y | Y |
| $R$-square | 0.693 | 0.747 | 0.722 |
| $N$ | 2407 | 8406 | 4396 |

This table presents estimates of the effect of LTRO repayment policies and the liquidity uptake from the ECB's three-year Longer-Term Refinancing Operations (LTROs) on corporate investment, in a sample of Eurozone corporations with existing loan information in LPC Dealscan. Our measure for corporate investment is *Investments*, which is the corporation's capital expenditure, scaled by total assets. In Models (1) through (3) corporations are separated based on their location and the respective country's LTRO repayment policy, compared to the initial *Country LTRO Uptake*. *Low* (*Medium*, *High*) *Early LTRO Repayment* is defined as a LTRO repayment ratio from 2012 to 2013, i.e., at the first possible LTRO repayment date, that is below 30% (between 30% and 70%, above 70%). The variable *Bank LTRO Uptake* is equal to zero until Q4-2011, and equal to the LTRO uptake amount of the corporate-related banks, scaled by the size of each bank, thereafter. We classify Eurozone banks as related if the corporation in the three years prior to the first LTRO intervention had a loan relation to the bank. The sample period is 2009-2014, and based on quarterly observations. In all models, we include base corporate-level financial variables in addition to macro-economic variables. (*** denotes significance at the 1% level, ** significance at the 5% level, and * significance at the 10% level. The numbers in parentheses are standard errors.)

**Table 8. LTRO effect on Investment: Corporate financial constraints**

| | Investments | | | Investments | | | Investments | |
|---|---|---|---|---|---|---|---|---|
| | High Bank Debt (1) | Low Bank Debt (2) | | Large Firm (3) | Small Firm (4) | | Rated Firm (5) | Non-Rated Firm (6) |
| Bank LTRO Uptake | -0.255** | -0.025 | | 0.063 | -0.544*** | | 0.581*** | -0.245*** |
| | (0.10) | (0.12) | | (0.08) | (0.17) | | (0.14) | (0.08) |
| Cash Flow | 0.000 | 0.008** | | 0.003 | 0.006 | | 0.008 | 0.006* |
| | (0.00) | (0.00) | | (0.00) | (0.00) | | (0.00) | (0.00) |
| Market to Book | 0.008*** | 0.004*** | | 0.008*** | 0.004*** | | -0.002 | 0.006*** |
| | (0.00) | (0.00) | | (0.00) | (0.00) | | (0.00) | (0.00) |
| Firm Size | -0.241** | 0.561*** | | -0.021 | 0.361*** | | 0.229 | 0.085 |
| | (0.11) | (0.10) | | (0.10) | (0.11) | | (0.14) | (0.08) |
| Leverage | -0.021*** | -0.010*** | | -0.024*** | -0.011*** | | -0.010** | -0.016*** |
| | (0.00) | (0.00) | | (0.00) | (0.00) | | (0.00) | (0.00) |
| Rated | 0.012 | 0.023 | | 0.233 | 0.727 | | | |
| | (0.30) | (0.17) | | (0.14) | (0.56) | | | |
| Sovereign Risk | -0.739*** | -0.497*** | | -0.727*** | -0.608*** | | -0.799*** | -0.632*** |
| | (0.07) | (0.07) | | (0.07) | (0.07) | | (0.10) | (0.05) |
| Sovereign Export | -0.044*** | -0.061*** | | -0.057*** | -0.048*** | | -0.017 | -0.064*** |
| | (0.01) | (0.01) | | (0.01) | (0.01) | | (0.01) | (0.01) |
| Time FE | Y | Y | | Y | Y | | Y | Y |
| Firm FE | Y | Y | | Y | Y | | Y | Y |
| R-square | 0.718 | 0.716 | | 0.759 | 0.683 | | 0.829 | 0.715 |
| N | 6977 | 9235 | | 8302 | 7910 | | 2452 | 13868 |

This table presents estimates of the effect of corporate financial constraints and the liquidity uptake from the ECB's three-year Longer-Term Refinancing Operations (LTROs) on corporate investment, in a sample of Eurozone corporations with existing loan information in LPC Dealscan. Our measure for investment is *Investments*, which is the corporation's capital expenditure, scaled by total assets. *Bank Debt* is the debt from bank loans, divided by total assets. In Models (1) and (2), corporations are separated into *High* and *Low Bank Debt*. *Bank Debt* is the debt from bank loans, divided by total assets. *High (Low) Bank Debt* is a dummy variable equal to one if the corporations' bank debt ratio one year before the first three-year LTRO intervention (Q4-2010) had a bank debt ratio above (below) the median, and zero otherwise. In Models (3) and (4), corporations are separated into *Large Firm* and *Small Firm*. *Large (Small) Firm* is a dummy variable equal to one if the corporation's total assets, given in logarithms, one year before the first three-year LTRO intervention (Q4-2010) is above (below) the median, and zero otherwise. In Models (5) and (6), corporations are separated into *Rated Firm* and *Non-rated Firm*, based upon whether there is a credit rating available for the respective corporations one year before the first three-year LTRO intervention (Q4-2010). The variable *Bank LTRO Uptake* is equal to zero until Q4-2011, and equal to the LTRO uptake amount of the corporate's related banks, scaled by the size of each bank, thereafter. We classify Eurozone banks as related if the corporation in the three years prior to the first LTRO intervention had a loan relation to the bank. The sample period is 2009-2014, based on quarterly observations. (*** denotes significance at the 1% level, ** significance at the 5% level, and * significance at the 10% level. The numbers in parentheses are standard errors.)

**Table 9. Country LTRO effect on investment: the role of fiscal policy**

| | Investments | Investments | | | Investments | |
|---|---|---|---|---|---|---|
| | Sample: All Eurozone Firms (1) | Increased Corp. Tax (2) | Unchanged Corp. Tax (3) | Decreased Corp. Tax (4) | Increased Gov. Inv. (5) | Decreased Gov. Inv. (6) |
| Country LTRO Uptake | -0.791*** | -4.222** | -1.259*** | 16.314** | 3.241*** | -1.212*** |
| | (0.19) | (1.89) | (0.26) | (6.74) | (0.55) | (0.23) |
| Cash Flow | 0.000 | -0.010** | 0.000 | 0.018*** | -0.001 | 0.001 |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| Market to Book | 0.005*** | 0.004*** | 0.005*** | 0.005*** | 0.003*** | 0.006*** |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| Firm Size | 0.619*** | -0.029 | 0.755*** | 0.811*** | 0.086 | 0.898*** |
| | (0.05) | (0.10) | (0.08) | (0.12) | (0.09) | (0.07) |
| Leverage | -0.007*** | -0.001 | -0.011*** | -0.001 | 0.003 | -0.014*** |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| Rated | 0.198 | -0.135 | 0.174 | 0.635 | -0.264 | 0.457* |
| | (0.17) | (0.26) | (0.25) | (0.56) | (0.27) | (0.23) |
| Sovereign Risk | -0.504*** | -1.268*** | -0.242*** | -0.613*** | -0.461*** | -0.475*** |
| | (0.03) | (0.27) | (0.08) | (0.05) | (0.05) | (0.07) |
| Sovereign Export | -0.047*** | 0.022 | 0.058*** | -0.097*** | -0.121*** | -0.008 |
| | (0.00) | (0.10) | (0.02) | (0.01) | (0.01) | (0.01) |
| Time FE | Y | Y | Y | Y | Y | Y |
| Firm FE | Y | Y | Y | Y | Y | Y |
| $R$-square | 0.665 | 0.743 | 0.649 | 0.598 | 0.677 | 0.657 |
| $N$ | 42029 | 12243 | 21525 | 8261 | 19297 | 22732 |

This table presents estimates of the effect of fiscal policy and the liquidity uptake from the ECB's three-year Longer-Term Refinancing Operations (LTROs) on corporate investment in a sample of Eurozone corporations. Our measure for corporate investment is *Investments*, which is the corporate capital expenditure, scaled by total assets. Model (1) shows the baseline result when using the variable *Country LTRO Uptake* which is equal to zero until Q4-2011, and equal to the country-specific total LTRO uptake amount, scaled by the central government debt of the country, thereafter. In Models (2) to (4), corporations are separated into those with increased, unchanged and decreased corporate tax rates (*Increased (Unchanged, Decreased) Corporate Tax*), based on the home countries' (absolute) change of the corporate tax rate between Q4-2010 and Q4-2012, i.e., around the first LTRO. The corporate tax rate data are given on a quarterly basis. In Models (5) and (6), corporations are separated into those with increased and decreased government investments (*Increased (Decreased) Government Investment*), based on the home countries' (relative) change in the government investment expenditures to GDP ratio between Q4-2010 and Q4-2012, i.e., around the first LTRO. In all models, we use the broader sample of corporations located in the Eurozone, i.e., the sample for which we do not require loan information from LPC Dealscan. The sample period is 2009-2014, based on quarterly observations. (*** denotes significance at the 1% level, ** significance at the 5% level, and * significance at the 10% level. The numbers in parentheses are standard errors.)

**Table 10. Counterfactual analysis: Eurozone versus Non-Eurozone**

| | Investments (1) | | Investments | |
| --- | --- | --- | --- | --- |
| | | | Risky Sovereign (2) | Safe Sovereign (3) |
| Post-LTRO | -1.534*** | | -1.580*** | -1.206*** |
| | (0.10) | | (0.21) | (0.13) |
| Post-LTRO × Eurozone | 0.541*** | | 0.373*** | 0.379*** |
| | (0.04) | | (0.10) | (0.06) |
| Cash Flow | -0.005*** | | 0.009** | -0.011*** |
| | (0.00) | | (0.00) | (0.00) |
| Market to Book | 0.003*** | | 0.009*** | 0.002*** |
| | (0.00) | | (0.00) | (0.00) |
| Firm Size | 0.423*** | | 0.896*** | 0.299*** |
| | (0.04) | | (0.09) | (0.04) |
| Leverage | -0.007*** | | -0.007** | -0.006*** |
| | (0.00) | | (0.00) | (0.00) |
| Rated | -0.218 | | -0.452 | -0.050 |
| | (0.17) | | (0.36) | (0.19) |
| Sovereign Risk | -0.403*** | | -0.180*** | -0.230*** |
| | (0.03) | | (0.05) | (0.04) |
| Sovereign Export | -0.001 | | 0.116*** | 0.014 |
| | (0.00) | | (0.01) | (0.00) |
| Eurozone FE | Y | | Y | Y |
| Time FE | Y | | Y | Y |
| Firm FE | Y | | Y | Y |
| R-square | 0.668 | | 0.602 | 0.702 |
| N | 78606 | | 20477 | 55819 |

This table presents estimates of the "counterfactual" effect of the liquidity uptake from the ECB's three-year Longer-Term Refinancing Operations (LTROs) on corporate investment, in a sample of corporations located in the European Union (EU), i.e., both inside or outside the Eurozone. Our measure for investment is *Investments*, which is the corporation's capital expenditure, scaled by total assets. The variable *Post-LTRO* is a dummy variable equal to one, for year-quarter observations after the ECB had implemented the first three-year LTRO intervention (Q4-2011). The variable *Post-LTRO × Eurozone* is the interaction variable between the Eurozone dummies and LTRO intervention and captures the effect of the liquidity intervention on corporate policies in non-LTRO countries ("counterfactual" effect) accordingly, which equals one for non-Eurozone corporations after the first LTRO intervention (for details see Appendix A1). In Model (1), we use the full sample of Eurozone corporations, i.e., where we do not require loan information from CDS Dealscan. In Models (2) and (3), corporations are separated into high and low-risk sovereigns, based on their location and the respective country's CDS spreads. *Risky (Safe) Sovereign* is defined as a CDS spread above (below) the median in the pre-intervention and crisis period (2009 and 2010). The sample period is 2009-2014, based on quarterly observations. (*** denotes significance at the 1% level, ** significance at the 5% level, and * significance at the 10% level. The numbers in parentheses are standard errors.)

# Appendices

**Note 1.   Background on ECB's open market operations**

The ECB open market operations are aimed "to steer short-term interest rates, to manage the liquidity situation and to signal the monetary policy stance in the euro area" and can be classified into regular open market operations and non-standard monetary policies.[28] Regular open market operations consist of main refinancing operations (MROs) and three-month longer-term refinancing operations (three-month LTROs). MROs are the ECB's primary, regular open market operations and refer to regular one-week liquidity-providing reverse transactions. In October 2008, the ECB switched to a fixed-rate full allotment mode such that Eurozone banks were then able to obtain unlimited short-term liquidity at a fixed rate, provided they pledged sufficient eligible collateral. To provide additional, longer-term refinancing, the ECB also offers three-month LTROs which in 2003 amounted to 45 billion EUR (about 20% of the overall liquidity provided by the ECB). In recent years, the regular open market operations have been complemented by a set of non-standard monetary policies. On 28 March 2008, the ECB announced two six-month LTROs (allotted on 2 April and 9 July 2008), which were both present for the amount of 25 billion EUR. The three- and six-month LTROs were carried out through a variable-rate standard tender procedure. On 8 October 2008, ECB introduced full allotment in MROs to increase liquidity in the banking system. In June 2010, the ECB Governing Council decided to adopt a fixed-rate tender procedure with full allotment in the regular three-month LTROs (allotted on 28 July, 25 August, and 29 September 2010). On 6 October 2011, the ECB further announced two twelve-month LTROs as fixed-rate tender procedures with full allotment. These were conducted in addition to the regular and special term refinancing operations in October and December 2011, respectively.

On 8 December 2011, to increase the ECB's support for the Eurozone banking sector and to improve the real economy, two three-year LTROs were announced. The LTROs were allotted on 21 December 2011 (LTRO I) and 29 February 2012 (LTRO II) and settled with maturities on 29 January 2015 and 26 February 2015, respectively. The interest rate on the two long-term loans was the average MRO rate over the life of the operation and approximately 1%. The three-year LTROs eased credit conditions, not only by allowing banks to borrow unlimited funds for three years (given the provision of eligible collateral) but also by assisting banks with the management of their "gap risk", i.e., increasing banks' ability to match the tenor of their assets and liabilities. Prior to the LTROs, many banks were only able to secure overnight funding. To increase the attractiveness of the unconventional LTROs, participating banks were given the option to repay part or the full amount of their borrowings after one year without any penalty, i.e., as of 25 January (LTRO I) and 22 February (LTRO II) 2013, respectively. While banks used the LTROs loans to rollover previous and to obtain new central bank borrowing, it was stated, that "there is no limit on what the banks can do with the money".[29]

In total, 523 credit institutions participated in LTRO I and were provided with 489.2 billion EUR amounting to a net injection of 210 billion EUR. As outlined by Fitch-Ratings (2012), the participants in LTRO I can roughly be divided into two groups. On the one hand, banks from the periphery countries were highly active due to their actual capital needs, as the LTROs provided them with their only option for accessing medium-term funding. On the other hand, the unconventional LTROs simply provided an opportunity to replace shorter-term funds with 1% three-year borrowing for the banks. Following the ECB, 45.72 billion EUR of the total uptake was used to replace the twelve-month allotment that had taken place in October 2011, and many of the 123 counter-parties

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[28]For details about the financial instruments that are used to achieve open market transactions, see https://www.ecb.europa.eu/mopo/implement/html/index.en.html.

[29]Source: http://www.nytimes.com/2011/12/22/business/a-central-bank-doing-what-central-banks-do.html?_r=0.

were located in highly rated, safe countries such as France and Germany.[30] In particular, the banks that placed the highest bids were those that had 1) the highest upcoming rollover needs and 2) the lowest maturity structures. However, it was also claimed that certain banks avoided the LTROs due to concerns that participating banks would be stigmatized as troubled institutions.[31] Since a considerable portion of the banks' collateral was already pledged at the ECB at the time of the first allotment, the central banks relaxed the collateral requirements to encourage uptake in LTRO II.[32] In the end, LTRO II provided a liquidity injection of 529.5 billion EUR (310 billion EUR in net terms) to 800 credit institutions. Table 1 provides the LTRO amounts by country.

In June 2014, to "further ease private sector credit conditions and stimulate bank lending to the real economy", the ECB announced targeted LTROs (TLTROs) that provide financing to credit institutions with maturity of up to four years. Under the TLTRO, counter-parties are only allowed to borrow an amount that is capped in accordance with their corporate lending. In September and December 2014, the ECB initially introduced two successive TLTROs, in which counterparties were able to borrow in accordance with their initial allowance, at a rate equal to a 10 basis point spread over the MRO rate. In the series of four rounds of TLTRO conducted between March 2015 and June 2016, the ECB eliminated this excess MRO spread. The TLTROs will all mature on 26 September 2018, while the voluntary early repayment depend on the actual settlement dates.

In addition to the refinancing operations, the ECB implemented several outright asset purchase programs (APP) since 2009. Under the expanded APP, the ECB purchases marketable debt instruments from both the public and private sectors to inject liquidity into the banking system, with a monthly purchase target of initially 60, and currently, 80 billion EUR. The active APP consists of the third covered bond (CBPP3), asset-backed securities (ABSPP), and public sector (PSPP) purchase programs that where initiated on 20 October 2014, 21 November 2014, and 9 March 2015, respectively. These programs were intended to be carried out "until the end of March 2017 and in any case until the Governing Council sees a sustained adjustment in the path of inflation that is consistent with its aim of achieving inflation rates below, but close to, 2% over the medium term." Besides the still-active APPs, there have been several terminated APP programs in the past years. CBPP was active from July 2009 to June 2010 and reached a nominal amount of 60 billion Euro. CBPP2 followed from November 2011 to October 2012 with a nominal amount of 16.4 billion Euro. The Securities Market Program (SMP) was started in May 2010 with the aim of "addressing the severe tensions in certain market segments which had been hampering the monetary policy transmission mechanism" and provided liquidity in selected secondary sovereign bond markets. In September 2012, SMP was replaced by outright monetary transactions (OMT), a bailout funding program of the European Stability Mechanism (ESM).[33]

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[30]Source: ECB Monthly Bulletin, January 2012.

[31]See, for instance, `http://www.zerohedge.com/contributed/ltro-users-manual`.

[32]For instance, the rating threshold was reduced for certain asset-backed securities (ABS), and rated corporate loans were allowed to be used as collateral under given circumstances.

[33]Previous the European Financial Stability Facility and European Financial Stabilization Mechanism.
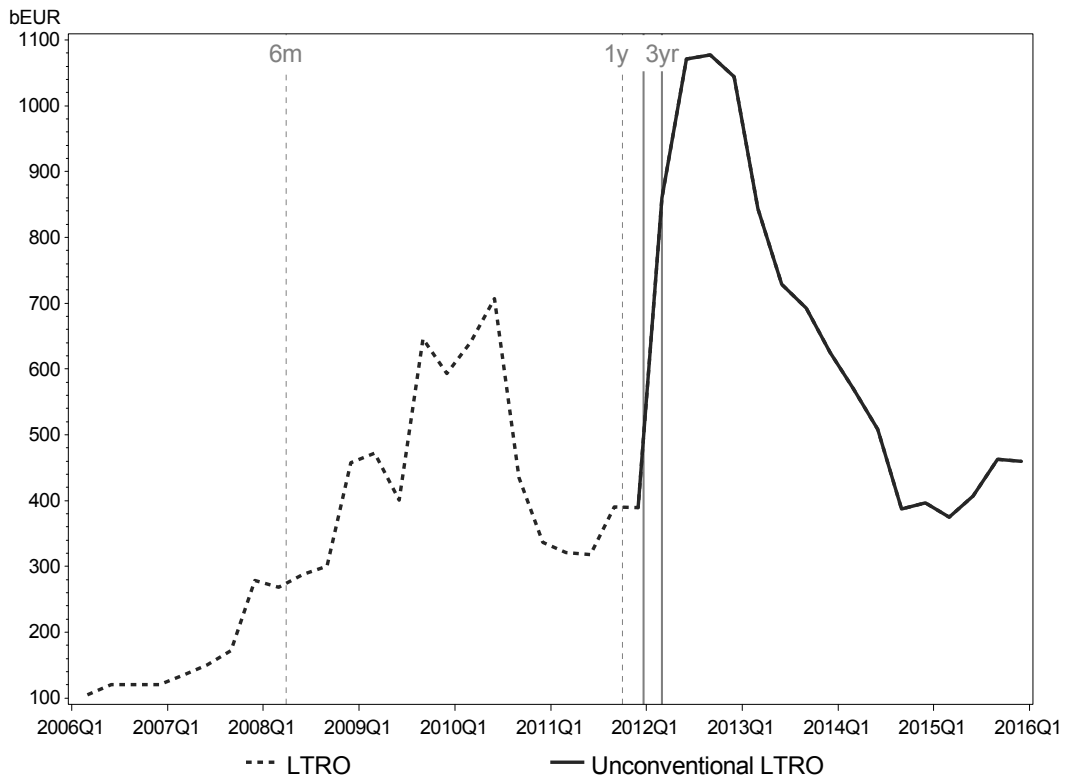
**Figure A1. Time series of the ECB's Longer-Term Refinancing Operations**

This figure plots the amounts of the ECB's Longer-Term Refinancing Operations (LTROs) for the period 2006 to 2016. The numbers are given in billion EUR. Unconventional LTROs refers to the two three-year LTROs. The data source is the ECB Statistical Data Warehouse, which publishes monthly numbers for the outstanding amounts.
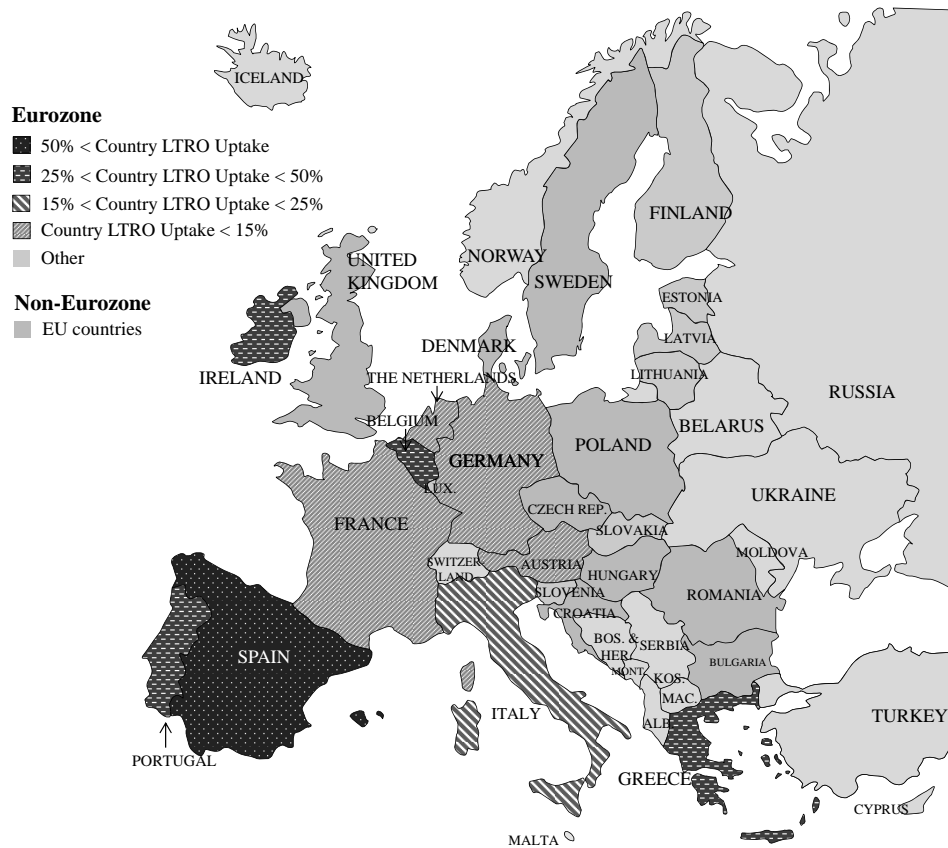
**Figure A2. LTRO uptake in the Eurozone**

This figure presents the total liquidity injection that countries within the Eurozone obtained from the three-year Longer-Term Refinancing Operations (LTROs), which were initiated by the European Central Bank (ECB) on December 21, 2011 (LTRO I) and February 29, 2012 (LTRO II), respectively. The color shading refers to the respective countries' total LTRO uptake, scaled by the central government debt. The information about the country-specific LTRO uptake is based upon hand-collected data from Bloomberg as well as central bank announcements and public commentaries. The information on central government debt by country is obtained from the World Bank Database. In the case of Greece, we only have information about the total LTRO amount that, besides the three-year LTROs, also includes the standard one-month and three-month LTROs. As we cannot separate the latter, the number is not directly comparable to the uptake numbers for other countries.

**Table A1. Description of main variables**

| Main Explanatory Variables | | Description |
|---|---|---|
| Bank LTRO Uptake | Average (Bank LTRO Borrowing/ Bank Size $_{2011}$) of related bank lenders | The firm-level average of a related bank lenders' borrowings through the two three-year LTROs (LTRO I and II), scaled by the size of the respective bank. Accordingly, the variable is equal to zero until time Q4-2011 (first round of three-year LTRO) and afterwards equal to the average of related banks' LTRO uptake. Quarterly corporate measure. Source: Bloomberg and annual reports. |
| LTRO-Bank Relation | Dummy | Dummy variable equal to one for corporations that in the three years prior to Q4-2011 (first round of three-year LTRO) had a loan relation to a Eurozone bank that participated in the three-year LTROs as of December 2011 and February 2012. Corporate measure. Source: LPC Dealscan. |
| Country LTRO Uptake | Total Country LTRO Borrowing/ Central Government Debt$_{2011}$ | Total Country LTRO Uptake is the sum of the euro amounts of the two three-year LTROs (LTRO I and II) for each country. Accordingly, the variable is equal to zero until time Q4-2011 (first round of three-year LTRO) and afterwards equal to each country's total uptake, scaled by the central government debt holdings in the year 2011. Quarterly country measure. Source: Bloomberg and the World Bank. |
| Post-LTRO | Dummy | Dummy variable equal to one for the post-intervention period, i.e., Q1-2012 to Q4-2014 (zero otherwise). Quarterly measure. Source: ECB Statistical Data Warehouse. |
| Non-Eurozone | Dummy | Dummy variable equal to one for corporations located in a EU-country outside the Eurozone, as of 2014 (zero otherwise). Country measure. Details of included countries are provided in Appendix Table A2. |

| Main Corporate Variables | | Description |
|---|---|---|
| Investments | Capital Expenditures/ Total Assets | Corporate capital spending. Quarterly corporate measure. Source: Compustat. |
| Wages | Log(Total Wage Payments) | The natural logarithm of total expenses related to salaries and wages. Quarterly corporate measure. Source: Compustat. |
| Cash | Cash/ Total Assets | Corporate cash holdings including marketable securities. Quarterly corporate measure. Source: Compustat. |
| Leverage | Debt/ Total Assets | The book value of the sum of current and long-term debt, scaled by total assets. Quarterly corporate measure. Source: Compustat. |
| Net Debt | (Total Liabilities - Cash)/ Total Assets | The sum of current and non-current liabilities minus cash holdings, scaled by total assets. Quarterly corporate measure. Source: Compustat. |
| Short-term Debt | (Debt Due in 1 Year)/ Total Assets | Fraction of long-term debt that is due in one year, scaled by total assets. Quarterly corporate measure. Source: Compustat. |
| Bank Debt | Bank Debt/ Total Assets | Bank debt is the amount of debt from bank loans. Quarterly corporate measure. Source: Capital IQ. |
| Firm Size | Log(Total Assets) | Book value of assets, given in logarithms. Quarterly corporate measure. Source: Compustat. |
| Rated | Dummy | Dummy variable equal to one for corporations with available rating information (zero otherwise). Corporate measure. Source: S&P Capital IQ. |

**Description of main variables (cont.)**

| Other Corporate Variables | | Description |
|---|---|---|
| Market to Book | (Total Liabilities + Market Equity) / Total Assets | Market value of total assets, scaled by book value of total assets. Market equity is the amount of shares outstanding times the share price as of the end of the fiscal quarter/year. Quarterly corporate measure. Source: Compustat. |
| Cash Flow | EBIT/ Total Assets | Operating income before interest and taxes (after depreciation), scaled by total assets. Quarterly corporate measure. Source: Compustat. |
| Industry Sigma | Cash-flow Risk | Average standard deviation of corporate cash flows within the same two-digit SIC code (minimum 3 observations). Quarterly industry measure. Source: Compustat. |
| Net Working Capital | (Net Working Capital - Cash)/ Total Assets | Corporate working capital net of cash holdings, scaled by total assets. Quarterly industry measure. Source: Compustat. |
| R&D/Sales | R&D/ Total Sales | Costs related to research and development, scaled by corporate sales. Quarterly corporate measure. Source: Compustat. |
| Sales | Log(EBIT) | Operating income before interest and taxes (after depreciation), given in logarithms. Quarterly industry measure. Source: Compustat. |
| Acquisition Activity | Acquisitions/ Total Assets | The amount used for M&A activities, scaled by total assets. Quarterly corporate measure. Source: Compustat. |
| Dividends | Dummy | Dummy variable equal to one for corporations with positive dividends in a given quarter/year (zero otherwise). Quarterly corporate measure. Source: Compustat. |

| Other Bank and Country Variables | | Description |
|---|---|---|
| LTRO Bank | Dummy | Dummy variable equal to one for banks that used funds from the three-year LTROs. Bank-level measure. Source: Bloomberg. |
| Bank Risk | Log(5-year CDS Spread) | End-of-quarter observation of five-year CDS spreads of banks. Quarterly bank measure. Source: Markit. |
| $\Delta$ Total Sovereign Debt | $\Delta$ Sovereign Debt Holdings$_{2010-2013}$ | The percentage change in banks' total holdings of sovereign debt from Dec-2010 to Dec-2013. The sovereign debt holdings are given in gross terms. Bank-level measure. Similar, '$\Delta$ Risky (Safe) Sovereign Debt' refers to the change in banks' holdings of sovereign debt in GIIPS (other Eurozone countries) from Dec-2010 to Dec-2013. Source: EBA Stress Test (2011 and 2014 reports). |
| Early LTRO Repayment | $(\Delta$ NCB LTRO Holdings$_{2012-2013})$/ Country LTRO Uptake$_{2011/2012}$ | The change in National Central Banks' LTRO Holdings from 2012 to 2013, scaled by the total intital LTRO uptake in the respective country. Country measure. Source: National Central Bank Reports and Bloomberg. |
| Sovereign Risk | Log(5-year Sovereign CDS spread) | End-of-quarter observation of five-year sovereign CDS spreads. Quarterly country measure. Source: Markit. |
| Sovereign Export | Total Exports/GDP | Exports of goods and services, scaled by GDP. Yearly country measure. Source: The World Bank. |
| GIIPS | Dummy | Dummy variable equal to one for corporations located in either Greece, Ireland, Italy, Portugal or Spain. Country measure. Source: Compustat. |
| Corporate Tax | Corporate Tax Rate | National corporate tax rates. Quarterly country measure. Source: ECB Statistical Data Warehouse. |
| Government Investments | Government Investments/ GDP | Local government investment expenditures, scaled by GDP. Quarterly country measure. Source: ECB Statistical Data Warehouse and The World Bank. |
| Government Debt | Government Debt Holdings | The total debt amount held by the local government. Quarterly country measure. Source: ECB Statistical Data Warehouse. |

This table provides descriptions of all the variables used in the analyses. All financial variables are winsorized at the $1^{st}$ and $99^{th}$ percentiles, and in our empirical specifications we use ratios given in percentages.

**Table A2. Summary statistics for sample based on Compustat data**

*Panel A: Eurozone corporations*

| Country | AUT | BEL | DEU | ESP | FIN | FRA | GRC | IRL | ITA | NLD | PRT | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Investments | 4.63 | 3.15 | 3.02 | 2.35 | 2.80 | 2.67 | 1.41 | 2.19 | 2.06 | 2.65 | 2.03 | 2.61 |
| Wages | 3.26 | 2.09 | 1.86 | 3.17 | 2.37 | 1.94 | 1.15 | 1.41 | 2.25 | 2.99 | 2.69 | 2.11 |
| Cash | 9.02 | 8.23 | 11.0 | 7.82 | 8.19 | 10.6 | 3.93 | 11.7 | 6.64 | 6.89 | 4.92 | 8.71 |
| Leverage | 22.5 | 21.9 | 16.8 | 31.9 | 25.2 | 18.7 | 38.1 | 21.3 | 29.1 | 22.9 | 44.1 | 22.8 |
| Net Debt | 55.0 | 56.0 | 54.9 | 64.7 | 58.2 | 57.6 | 64.4 | 52.3 | 65.3 | 58.1 | 75.5 | 58.7 |
| Firm Size | 5.76 | 5.48 | 4.73 | 6.51 | 5.20 | 4.80 | 4.74 | 6.09 | 5.67 | 6.74 | 6.18 | 5.15 |
| Market to Book | 107. | 107. | 119. | 112. | 122. | 114. | 85.8 | 122. | 107. | 121. | 101. | 111. |
| Cash Flow | 3.96 | 3.34 | 4.27 | 4.51 | 5.43 | 2.52 | 0.83 | 2.23 | 2.10 | 3.96 | 1.90 | 2.95 |
| Industry Sigma | 3.45 | 4.32 | 8.49 | 3.95 | 5.18 | 7.25 | 4.07 | 4.52 | 4.14 | 5.30 | 3.02 | 5.34 |
| Net Working Capita | 3.49 | -0.8 | 5.67 | -4.1 | 1.31 | 0.76 | 1.28 | 0.15 | -2.1 | 0.20 | -9.6 | 1.20 |
| R&D/Sales | 0.16 | 0.00 | 0.00 | 0.00 | 0.41 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Acquisition Activity | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Bank Debt | 71.5 | 72.8 | 85.7 | 90.8 | 71.7 | 78.5 | 67.2 | 77.6 | 89.8 | 70.9 | 53.0 | 79.7 |
| Short-term Debt | 0.07 | 0.05 | 0.04 | 0.08 | 0.07 | 0.05 | 0.17 | 0.02 | 0.11 | 0.05 | 0.15 | 0.06 |
| Gov. Debt | 81.5 | 105. | 75.5 | 64.8 | 48.2 | 83.9 | 155. | 93.7 | 115. | 59.9 | 103. | 82.2 |
| Corporate Tax | 25.0 | 33.9 | 30.1 | 30.0 | 25.2 | 36.1 | 26.0 | 12.5 | 31.4 | 25.0 | 31.5 | 30.1 |
| Gov. Investment | 2.95 | 2.35 | 2.27 | 3.88 | 3.97 | 4.00 | 3.75 | 2.80 | 2.80 | 4.01 | 3.09 | 3.06 |
| Sovereign Risk | 50.2 | 58.6 | 31.5 | 135. | 30.3 | 59.3 | 492. | 216. | 149. | 46.5 | 368. | 73.0 |
| Sovereign Export | 0.53 | 0.81 | 0.44 | 0.28 | 0.38 | 0.27 | 0.25 | 1.03 | 0.26 | 0.77 | 0.34 | 0.38 |
| Credit Rating | AAA | AA | AAA | BB | AAA | A | CCC | BB | BB | AAA | B | |
| # N | 1408 | 2092 | 13205 | 2432 | 2685 | 13111 | 4525 | 1046 | 4843 | 2587 | 1044 | 48978 |
| # Firms | 69 | 101 | 660 | 115 | 123 | 644 | 210 | 54 | 235 | 132 | 48 | 2391 |

*Panel B: Non-Eurozone corporations*

| Country | BGR | CZE | DNK | GBR | HUN | LTU | POL | ROU | SWE | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Investments | 3.60 | 3.99 | 2.37 | 2.10 | 5.99 | 2.69 | 3.07 | 3.19 | 1.48 | | 2.21 |
| Wages | 1.44 | 4.79 | 3.59 | 0.40 | 7.77 | 1.89 | 2.01 | 1.63 | 2.56 | | 1.37 |
| Cash | 3.72 | 3.33 | 5.54 | 9.34 | 6.84 | 2.06 | 5.13 | 3.11 | 8.04 | | 7.60 |
| Leverage | 31.5 | 11.5 | 19.4 | 14.0 | 18.1 | 27.3 | 16.7 | 7.02 | 15.3 | | 15.3 |
| Net Debt | 47.8 | 40.2 | 53.3 | 48.7 | 43.2 | 50.6 | 46.3 | 33.9 | 52.6 | | 48.8 |
| Firm Size | 5.34 | 8.77 | 6.51 | 4.19 | 10.4 | 5.36 | 4.83 | 5.17 | 5.59 | | 4.79 |
| Market to Book | 93.2 | 126. | 119. | 124. | 103. | 75.0 | 110. | 76.7 | 143. | | 120. |
| Cash Flow | 4.39 | 3.59 | 2.66 | 2.62 | 3.74 | 3.62 | 2.03 | 4.88 | 2.26 | | 2.48 |
| Industry Sigma | 3.48 | 4.22 | 6.55 | 13.2 | 3.25 | 6.92 | 7.42 | 4.86 | 14.8 | | 9.93 |
| Net Working Capita | 3.35 | 1.22 | 0.55 | -1.7 | 6.53 | -0.0 | 6.15 | 4.86 | 1.41 | | 0.67 |
| R&D/Sales | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 |
| Acquisition Activity | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.00 |
| Bank Debt | 95.9 | 98.3 | 94.1 | 89.8 | 99.9 | 96.7 | 87.8 | 99.2 | 91.9 | | 90.6 |
| Short-term Debt | 0.11 | 0.03 | 0.05 | 0.03 | 0.06 | 0.12 | 0.08 | 0.10 | 0.06 | | 0.05 |
| Sovereign Risk | 200. | 83.4 | 34.2 | 58.4 | 338. | 225. | 127. | 290. | 32.0 | | 101. |
| Sovereign Export | 0.62 | 0.74 | 0.53 | 0.29 | 0.87 | 0.78 | 0.43 | 0.37 | 0.45 | | 0.46 |
| Credit Rating | A | AA | AAA | AAA | B | A | AA | BB | AAA | | |
| # N | 588 | 160 | 2689 | 26517 | 306 | 616 | 9693 | 1418 | 9602 | | 51589 |
| # Firms | 29 | 8 | 127 | 1474 | 16 | 29 | 451 | 77 | 500 | | 2711 |

This table provides sample averages (medians) of corporate characteristics for each country in our sample of corporations in the European Union. The broader sample consists of corporations with available information in Compustat, for which we do not require loan information from LPC Dealscan. Panel A outlines the summary statistics for corporations located in the Eurozone, while Panel B shows the summary statistics for corporations located outside the Eurozone, but inside the European Union. The sample period for each country is 2009-2014, and the variables are based on quarterly observations. For the specific definition of each variable we refer to Appendix Table A2. The corporate fundamental data are obtained from Compustat Global, while country-specific data are obtained from Markit, the World Bank, as well as the ECB Statistical Data Warehouse. For any data unavailable for a specific quarter, we replace the missing values with yearly observations. Ratios are given in percentages.

**Table A3. LTRO effect on investment and employment: Controlling for lagged corporate measures**

| | Investments | Wages |
|---|---|---|
| | (1) | (2) |
| Bank LTRO Uptake | -0.222** | 0.019 |
| | (0.08) | (0.06) |
| Cash Flow | 0.001 | -0.001 |
| | (0.00) | (0.00) |
| Market to Book | 0.006*** | 0.001* |
| | (0.00) | (0.00) |
| Firm Size | -0.160 | 0.365*** |
| | (0.10) | (0.07) |
| Leverage | -0.015*** | 0.000 |
| | (0.00) | (0.00) |
| Rated | 0.232 | -0.016 |
| | (0.18) | (0.13) |
| Lagged Div. Dummy | 0.085 | 0.008 |
| | (0.05) | (0.03) |
| Lagged R&D/Sales | 0.236 | -0.228 |
| | (0.22) | (0.15) |
| Lagged Acquisition Activity | -2.794*** | -0.317 |
| | (0.57) | (0.41) |
| Industry Sigma | -0.041*** | 0.004 |
| | (0.01) | (0.00) |
| Net Working Capital | 0.001 | 0.001 |
| | (0.00) | (0.00) |
| Log Sales | 0.383*** | 0.307*** |
| | (0.06) | (0.04) |
| Competition | -0.001 | 0.004 |
| | (0.00) | (0.00) |
| Sovereign Risk | -0.625*** | -0.011 |
| | (0.05) | (0.04) |
| Sovereign Export | -0.057*** | -0.001 |
| | (0.01) | (0.00) |
| Time FE | Y | Y |
| Firm FE | Y | Y |
| $R$-square | 0.740 | 0.752 |
| $N$ | 13635 | 10944 |

This table presents estimates of the effect of the liquidity uptake from the ECB's three-year Longer-Term Refinancing Operations (LTROs) on corporate investment and employment compensation in a sample of Eurozone corporations with existing loan information in LPC Dealscan. Our measure for corporate investment is *Investments*, which is the corporations' capital expenditure, scaled by total assets. Our measure for employment compensation is *Wages*, which is the corporations' total salaries and wages, given in logarithms. The Models include in addition to basic investment and employment compensation determinants, lagged values of alternative investment measures and other corporate and industry controls. The variable *Bank LTRO Uptake* is equal to zero until Q4-2011, and equal to the LTRO uptake amount of the corporate-related banks, scaled by the size of each bank, thereafter. We classify Eurozone banks as related if the corporation in the three years prior to the first LTRO intervention had a loan relation to the bank. The sample period is 2009-2014, based on quarterly observations. (*** denotes significance at the 1% level, ** significance at the 5% level, and * significance at the 10% level. The numbers in parentheses are standard errors.)

**Table A4. Summary statistics for sample bank lenders**

| | Bank Risk (1) | Bank Size (2) | Borrower Size (3) | Borrower Leverage (4) | Borrower Short-term Debt (5) | Borrower Cash-flow (6) |
|---|---|---|---|---|---|---|
| **Pre-LTRO (2010):** | | | | | | |
| LTRO banks (n=54) | 191.13 | 11.21 | 8.42 | 34.89 | 8.26 | 3.76 |
| Non-LTRO banks (n=101) | 127.52 | 9.37 | 8.40 | 31.28 | 7.61 | 3.89 |
| **Post-LTRO (2013):** | | | | | | |
| LTRO banks (n=41) | 302.41 | 11.31 | 8.49 | 35.56 | 8.65 | 3.80 |
| Non-LTRO banks (n=77) | 150.45 | 9.52 | 8.63 | 31.56 | 8.63 | 3.78 |

This table present summary statistics for banks before and after the LTRO intervention. Specifically, the table provides sample averages (medians) of bank characteristics for banks that in the five years before the LTRO intervention had a lending relation with at least one corporation in our Dealscan-Compustat linked corporate sample. *Bank Risk* is the five-year CDS spread of the bank, given in natural logarithm. *Bank Size* is the banks' total assets, given in natural logarithm. *Borrower Size* refers to the average size (measured by total assets given in natural logarithm) of the banks' borrowers. Likewise, *Borrower Leverage*, *Borrower Short-term Debt* and *Borrower Cash Flow* is the average leverage, short-term debt and cash flow of the banks' borrowers. All numbers are based on end-of-year observations. The bank-level information is based upon data from Markit, Bankscope and Compustat.

**Table A5. Total LTRO holdings by National Central Banks**

| | Total LTRO Holdings | | | | Repayment Ratio |
|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | 2013 | 2012 to 2013 |
| Country | EUR billion (1) | EUR billion (2) | EUR billion (3) | EUR billion (4) | percentage (5) |
| Austria | 3.49 | 7.18 | 15.71 | 5.87 | -62.62 |
| Belgium | 4.12 | 17.97 | 39.92 | 14.29 | -64.22 |
| France | 20.22 | 123.14 | 172.88 | 61.53 | -64.41 |
| Germany | 33.46 | 47.11 | 69.65 | 13.77 | -80.23 |
| Greece | 78.38 | 60.94 | 1.95 | 1.39 | -28.79 |
| Ireland | 56.03 | 76.29 | 63.09 | 34.50 | -45.31 |
| Italy | 31.01 | 160.61 | 268.30 | 213.71 | -20.35 |
| Netherlands | 0.92 | 3.19 | 24.48 | 8.81 | -63.99 |
| Portugal | 22.97 | 39.03 | 49.26 | 42.69 | -13.33 |
| Spain | 39.66 | 156.68 | 315.35 | 178.06 | -43.53 |
| Total | 290.26 | 692.13 | 1020.58 | 574.62 | -43.70 |

This table presents the holdings and repayment of Longer-Term Refinancing Operations (LTROs) by National Central Banks (NCB) in the Eurozone. *Total LTRO Holdings* include all Longer-Term Refinancing Operations, i.e., the three-month to the three-year Longer-Term Refinancing Operations initiated by the European Central Bank (ECB) on December 21, 2011 (LTRO I) and February 29, 2012 (LTRO II), respectively, and are end-of year values. In Column 5, the table outlines the percentage change in the total LTRO holdings by NBCs from 2012 to 2013. The information about the NCB LTRO holdings is based upon hand-collected data from the NCBs' websites.