

Can Central Banks Boost Corporate Investment: Evidence from the ECB Liquidity Injections*

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November 3, 2018

*For helpful comments and discussions, we thank Viral Acharya, Michele Boldrin, Murillo Campello, David Cook, Xiaodan Gao, Gary Gorton, Regina Hammerschmid, Balint Horvath, Nigel Jones Barradale, Raj Iyer, Andrew Karolyi, Mico Loretan, Andrew MacKinlay, Simone Manganelli, Martin Oehmke, Antonio Paradiso, Davide Tomio, Neeltje Van Horen, Yan Xu, and seminar and conference participants at the Reserve Bank of Australia, Shanghai Advanced Institute of Finance at Shanghai Jiao Tong University, the Chinese University of Hong Kong, the Chinese University of Hong Kong (SZ), University of Macau, the Hong Kong Polytechnic University, Cass Business School, Copenhagen Business School, NYU Stern, Bocconi University, University of Warwick, University of Surrey, Goethe University of Frankfurt, FMA 2018, the 2017 HKMA/FRB/Atlanta Fed Joint Research Conference on Unconventional Monetary Policy, 16th International Conference CREDIT, the CICF 2017, FMA Asia 2017, The 4th International Conference on Sovereign Bond Markets, the conference on “Asymmetries in Europe: Causes, Consequences, and Remedies” in Pescara, Swiss Society for Financial Market Research 2017, Bank of Canada Annual Conference 2016, European Banking Center Network Conference 2016, 15th International Conference Credit, 6th IWH/INFER Workshop on (Ending) Unconventional Monetary Policy, EFA 2016, Indian School of Business (ISB) Summer Research Conference, IF2016 Annual Conference in International Finance at City University of Hong Kong, and the 2016 FEBS Conference. We also acknowledge the support of Research Center SAFE at Goethe University, Marcel Heinrichs from S&P Capital IQ, and Matteo Crosignani for helping us with data. Daetz gratefully acknowledges support from the Center for Financial Frictions (FRIC), grant no. DNRF102. Subrahmanyam thanks the Volkswagen Foundation, the Anneliese Maier Research Award of the Alexander von Humboldt Foundation, and the Center for Global Economy and Business at NYU Stern for their generous support. Disclaimer: The views expressed in this paper are those of the authors and do not necessarily reflect the position of Danmarks Nationalbank.

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Abstract

Can monetary stimulus by central banks boost corporate investment? We answer this question by studying ECB's Longer-Term Refinancing Operations (LTROs), which provided cheap funding to Eurozone commercial banks to support the real sector. We find that, against the intended result, firms reduced investment after their banks took LTRO funds from the ECB. Investment reduction is concentrated in firms with risky lenders, suggesting that borrowers' concern on lender risk encourages them to curb investment. LTRO uptakes are endogenously chosen: riskier banks took more funds from the LTROs. LTRO funds are mostly used to rollover existing loans. However, for firms that obtained new loans from LTRO banks, they increased investment. Overall, our results highlight the difficulty of boosting corporate investment by central bank injection of liquidity into the banking system, especially when bank balance sheets are impaired.

1. Introduction

After the 2008 credit crisis, many central banks around the world have undertaken a series of unconventional monetary policy actions, such as injecting liquidity into the banking system. These liquidity injections were of significant size and scope and have attracted massive press coverage. The nascent literature on this topic has primarily focused on the impact of central banks' unconventional monetary policy on the banking sector and its related financial ramifications. However, the important question of whether these liquidity injections have indeed helped the real economy, as intended, remains unanswered. In this paper, we fill this gap in the literature by examining the impact of unconventional liquidity interventions on corporate policies, particularly those relating to investment. Our findings will have important policy implications as many central banks around the world are actively intervening in markets in order to stimulate economic growth.

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 default risk, the EU, the IMF, and the ECB engineered a series of interventions to improve market liquidity and real output. The largest of these interventions was the liquidity injected by the ECB into the commercial banks of Eurozone countries through two unconventional Longer-Term Refinancing Operations (LTROs) with a three-year maturity, implemented in December 2011 and February 2012, respectively.¹ However, the efficacy of such prominent examples of unconventional monetary interventions 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 a under-studied open question. Corporations do

¹Figure 1 provides a detailed timeline of the ECB's recent unconventional monetary policies, while the details of related ECB interventions are discussed in Appendix Note 1.

not base their investment decisions exclusively on their cost of funding; new investments tend to be driven by long-term plans. Theoretically, liquidity injections by central banks do not always translate into *corporate* investment (see, e.g., Christiano (1994)). First, bank lending to corporations may respond weakly to the unconventional liquidity interventions due to banks' precautionary motive to deleverage. This concern is especially acute when banks hold large amounts of risky sovereign debt (Bocola (2016)). Moreover, how long this cheap funding will be available is another important factor for both the banks and the borrowers. The liquidity transmission mechanism clearly depends upon bank risk characteristics. Second, corporations' own liquidity, financing, and investment policies may not fully correlate with those of the banks. On one hand, unconventional monetary policies that aim at boosting bank liquidity may make corporations less concerned about future financing. On the other hand, corporations may also interpret the high LTRO uptake of their banks as a signal of poor bank quality. They may then borrow as much as possible and at the same time reduce their investments due to their concern about their respective banks. Thus, the extent to which macro-liquidity injections are converted into economic output also depends on corporate characteristics, such as reliance on debt financing from the banking sector, as well as economic conditions and fiscal policies, more generally.

It is necessary to empirically examine the effect of liquidity injections on the real economy.² We investigate 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[®] by S&P Capital IQ, credit default swaps (CDS) data from Markit, and relevant data from other sources. A unique feature of

²There is a substantial degree of disagreement among business economists about the real effects of such liquidity injections. For example, the Spanish bank BBVA expresses a more optimistic view and argues that ECB liquidity injections could have boosted Eurozone GDP by between 0.3% and 0.5%.

our research is that we capture the LTRO impact on corporate-specific policies, using both country- and bank-level LTRO uptake information.

Making use of these comprehensive data, we find that, surprisingly, corporations connected to banks that had a higher LTRO uptake reduced their investment more than those associated with banks that had a lower LTRO uptake. However, a negative association between the LTRO uptake of banks and corporate investment does not necessarily imply a *causal* relationship. In order to directly address causality, we analyze the determinants of a bank's LTRO uptake and find evidence that LTRO uptake positively relates to bank risk, which is consistent with Drechsler, Drechsel, Marques-Ibanez, and Schnabl (2016). Consequently, we do find that the causal relationship between the LTRO uptake and corporate investment is weak when we account for relevant country, bank, and corporate characteristics, suggesting no causal relationship between the LTRO uptake and the decrease in corporate investment. In fact, we find in counterfactual analyses that the two three-year LTROs halted the deterioration in corporate investment; moreover, as evidenced by the fact that non-Eurozone corporations in Europe experienced even larger investment cuts, post-LTRO.

To better understand the counterintuitive result of lower investment associated with greater liquidity injection, we further explore whether the decrease in corporations' investments following LTRO liquidity injections relates to corporate, bank and/or country characteristics. First, we find that corporations with a greater dependence on bank debt, and those with risky bank lenders, experienced greater decreases in their investment when their bank lenders had greater LTRO uptakes. These findings are consistent with the LTRO's role in the "revelation of bank quality" and underscore corporations' uncertainty about the real impact of these monetary policy measures. Second, we find that the banks' holding period for the LTRO funds played a significant role in terms of the transmission of the liquidity to the corporate sector: When banks repaid ECB funds early, their borrowers actually increased investments; while investment reduction mainly comes from firms connected to banks that kept the LTRO funds for a longer period. These findings reveal the interesting distributional

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

Not all firms are affected by LTROs equally, some can obtain new loans while other cannot. We find that, if firms can get new funding (instead of rollovering existing loans), then their investment reduction is less severe. Therefore, for LTRO to have a positive effect on corporate investment, banks need to take a more proactive role in new lending.

Recent discussions of the impact of macroeconomic 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 to investigate the effect of Eurozone-wide monetary policies, conditional on national 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. Related to this discussion, we show that when individual national governments cut their corporate taxes or increased 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 taken in isolation.

Although we do not find any positive effect of LTRO in boosting corporate investment, we do not argue that LTRO had harmed the economy. In fact, we find that non-Eurozone firms, which are not directly affected by LTRO, cut investments even more than Eurozone firms. Such counterfactual analysis sheds light on the bright side of the central bank liquidity injection in terms of decelerating the economic decline.

Existing studies of unconventional monetary policies are mostly in the U.S. setting (e.g., Berger and Roman (2016)). One related contemporaneous work examining the European setting is Acharya, Eisert, Eufinger, and Hirsch (2017). They find evidence of zombie lending by banks, following the announcement of Outright Monetary Transactions (OMT) in the

summer of 2012. Our study is distinguished from theirs in that we focus on corporate policies, following the largest real liquidity injection, i.e., three-year LTRO liquidity injections. We also explore the role of banks' early repayment decisions of their LTRO borrowing on the corporations' decisions. While we find that ECB liquidity injections have been largely ineffective in boosting corporate investment, we do *not* argue for a causal relationship between the LTRO uptake of banks and the corporate investment of their clients. Instead, we find that the LTRO uptake amount significantly proxies for bank risk, particularly for non-GIIPS banks. We show in addition, based on a counterfactual analysis, that these liquidity injections may have halted economic deterioration in the Eurozone. Furthermore, we suggest that it is important to consider monetary policies in tandem with fiscal policies. Our results also imply that unless a bank's balance sheet becomes healthy, the monetary policy transmission mechanism can be ineffective.

The rest of the paper proceeds as follows. We discuss the related literature in Section 2. Section 3 provides descriptive statistics for our data and specifies the empirical setting for our analysis. In section 4, we investigate the impact of macro-liquidity injections on corporate investment. In section 5, we examine the policy interactions and discuss implications for policy design. Section 6 concludes.

2. Institutional Background and Relevant Literature

During the recent European sovereign debt crisis, the two three-year LTROs (LTRO I, II) were one of the major efforts by the ECB to provide liquidity to the financial sector and ease credit conditions. The LTROs were allotted on 21 December 2011 (LTRO I) and 29 February 2012 (LTRO II) respectively, with total amount of 1018.7 billion Euros. The three-year LTROs were attractive because of the long three-year maturity, low interest rates, and the option to repay part or the full amount after one year without any penalty. Given the provision of eligible collateral, banks can borrow unlimited funds for three years with no

restrictions on the use of the money.³

In addition to LTRO, there are a number of alternative types of unconventional monetary policies, such as asset purchases (e.g. QEs in the US, APP in Eurozone etc.), indirect banks balance sheet recapitalizations (e.g. the announcement effects of the bailout funding program OMT in Euro zone), yield curve flattening (e.g. the maturity extension program (MEP) in the US) etc. These policies are different from the direct central bank liquidity injections, and may affect different group of banks and bank dependent borrowers. For example, banks with greater MBS holdings may have greater exposure to QE1 and QE3 in the US, which further have real effects on household and corporate borrowers that rely on these banks for financing (Luck and Zimmermann (2018)). However, the yield curve flattening effort through MEP in the US affects more non-financial corporations with a high reliance on longer-term debt (Foley-Fisher, Ramcharan, and Yu (2016)). In Europe, while there are OMT announced in the summer of 2012, this bailout funding program has not been exercised so far. However, the announcement effects can indirectly recapitalize banks balance sheet especially for those with high sovereign debt (Acharya, Eisert, Eufinger, and Hirsch (2017)). Different from OMT, the size and popularity of the three-year LTROs make it an interesting setting to understand banks' voluntary access to central bank liquidity injections, and firms' policy response when their bank lenders tapped liquidity through these liquidity injections.

Furthermore, the fixed-rate full allotment policy announced in October 2008 is another significant non-standard measure the ECB is implementing. While the original fixed-rate full allotment is operated through its main refinancing operations (MROs) to provide short-term liquidity to the banking system, the three-year LTROs with full allotment can further reduce the funding risk faced by the banking system over a longer time horizon. Understanding and comparing among different policies can deliver valuable policy implications.⁴

Our paper relates to works on the impact of unconventional monetary policies. Previ-

³See ECB Monthly Bulletin, March 2012. To further ease the credit condition for the real economy, the ECB announced the targeted LTROs (TLTROs) in 2014 that provide financing to credit institutions with maturity of up to four years with the bank borrowing amount linked to their corporate lending.

⁴See Appendix Note 1 for more background on ECB's open market operations.

ous papers have investigated the impact of interventions on sovereign bond market (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)), the interbank market (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)).

The evidence of the impact of unconventional monetary policies on corporate investment and employment are mixed and depends on the characteristics of the intervention. Kasahara, Sawada, and Suzuki (2016) find 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 (2016) 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 positive impacts of QEs in the US on employment, Chakraborty, Goldstein, and MacKinlay (2017) find that the mortgage-backed security purchases (but not Treasury bond purchases) made by the Federal Reserve may crowd out banks' commercial lending and decrease corporate investment.

Acharya, Imbierowicz, Steffen, and Teichmann (2017) focus on the fixed-rate full allotment policy announced in October 2008 that targets to reduce the short-term funding risk in the banking system. They find the transmission of monetary policy is not effective for bad banks and long-term loans, as evidenced by the loan spreads and weak results for investment.

Different from their work, we investigate firm investment following the three-year LTROs with full allotment. Investment are long-term decisions and is expected to be more positively affected by the availability of the longer term funding associated with 3-year LTRO if the transmission is effective.

A few recent country-specific papers have shown that the three-year LTROs by the ECB can indeed have 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, Fraise, and Mésonnier (2018) and Cahn, Duquerroy, and Mullins (2018) for France). For example, Carpinelli and Crosignani (2018) find positive impact of LTROs on long term credit supply in Italy, although banks use most of the additional money to hold more sovereign bond. However, government guarantee improve Italian banks' access to the LTRO injections and promotes 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 of LTRO-ACC program on both target firms (whos loans are eligible for ECB collateral) and ineligible multi-bank firms. Different from these country specific study, we focus on all Eurozone firms and emphasize the role of bank risk, early repayment options, and government fiscal policy in affecting corporate investment and employment policies.

Our paper also relates to works on the impact of financial conditions on bank lending and real economic outcomes. A substantial body of 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 (2017), Benmelech, Meisenzahl, and Ramcharan (2017), Greenstone, Mas, and Nguyen (2017), Chava and Purnanandam (2011), Amiti and Weinstein (2017), Chodorow-Reich (2014), Cingano, Manaresi, and Sette (2016), Bottero, Lenzu, and Mezzanotti (2015), De Marco (2017), Buca and Vermeulen (2017), Acharya, Eisert, Eufinger, and Hirsch (2018)).

Different from these works, we contribute to investigate the impact of a major liquidity injection on corporate investment and employment.

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 along periods characterized by ECB interventions. We use data on corporate fundamentals from the Compustat Global database.⁵ From this source, we identify a sample of European corporations and collect all yearly and quarterly corporate financial and stock price data for the period from 2009 to 2014. Since financial and utility corporations often have capital structures that are quite different from the average corporation, we follow the literature and exclude financial corporations (SIC codes 6000 to 6999), utility corporations (SIC codes 4900 to 4999) and corporations for which no 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. Capital IQ 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 so that we can estimate the impact of the ECB's extraordinary liquidity injection, after controlling for such risk.⁶ In addition to the corporate data, we also collect country- and industry-specific data from several other sources,

⁵The 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.

⁶To mitigate the effect of outliers, we winsorize the observations for our variables at the 1st and 99th 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.

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.

To analyse the impact of the liquidity interventions made by the ECB, we restrict our main sample to corporations located in the Eurozone. This sample includes all corporations located in countries that belong to the Eurosystem (i.e., the Eurozone), and which thereby were directly affected by the ECB’s liquidity interventions. However, we collect similar data for both Eurozone and EU corporations outside the Eurozone, i.e. non-Eurozone, and use the latter as a control group for some of our subsequent analyses.⁷

To address the impact of liquidity intervention on corporate policies, we use the ECB’s implementation of its unconventional three-year LTROs. These operations were announced in early December 2011, and were implemented on December 21, 2011 (LTRO I) and February 29, 2012 (LTRO II).⁸ In general, as indicated by the steep increase in the amount of outstanding LTRO as presented in Appendix Figure A1, the interventions overall turned out to be of significant size. Since we are particularly interested in whether and how much of the ECB’s liquidity injections flowed to individual banks, we make use of both country-specific aggregate information on the Eurozone banks’ uptake of LTRO I and LTRO II, and bank-level uptake information that is hand-collected from Bloomberg.⁹

Table 1 outlines these LTRO uptake numbers within the Eurozone, sorted by country.¹⁰ As shown in the table, banks from the periphery countries were highly active because of their actual capital needs, as the LTRO was their only option for accessing medium-term funding. However, for many banks, participation in the unconventional LTROs also provided them with an opportunity to replace their shorter-term borrowing with low-cost three-year

⁷To exclude any potential biases or country-specific reasons for the later adoption of the euro by some countries, we include only corporations from those countries that adopted the euro as a common currency in 1999, and joined the European Monetary System at the time of its inception in January 2001. For details, please see Appendix Table A1.

⁸For details of various unconventional programs of ECB, please see Appendix Note 1.

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

¹⁰Appendix Figure A2 provides a graphical presentation of these numbers. It should be noted that although the ECB liquidity injection was available only to Eurozone banks, approximately 5% of the total uptake involved non-Eurozone banks that participated through their subsidiaries situated in the Eurozone.

borrowing (FitchRatings (2012)). Therefore, banks in even highly rated and safe Eurozone countries such as Germany and France participated in the three-year LTRO. In addition, as Table 1 indicates, the participation in, and the uptake from, the two LTROs were quite similar (both at the aggregate and country levels). The aggregate uptake was approximately 918 billion Euro, with Italian and Spanish banks being, by far, the most active in their participation in terms of both the number of participating banks and the amounts borrowed. Together, banks in these two countries had an uptake of approximately 68% of the aggregate uptake. In terms of the significance of the ECB liquidity intervention, we can see from the ratio of the total LTRO uptake to central government debt in the country that the liquidity injection was greatest for countries in the Eurozone periphery, i.e., GIIPS countries. Furthermore, we also see that banks in the GIIPS countries had the highest LTRO borrowings (scaled by the banks' total assets), and that the bank-level uptake was very similar across the periphery countries. We supplement these intervention-specific data with other Eurozone-wide data that are obtained from National Central Bank (NCB) reports from members of the Eurosystem and the ECB Statistical Data Warehouse, where all published reports and historical data are stored on a monthly or weekly basis, depending on the source.¹¹

3.2 Empirical Design

To provide an in depth investigation of the corporate-level impact of the LTRO uptake by Eurozone banks, we specifically investigate the lending relationships to banks that participated in the LTROs, *LTRO-bank*, of the corporations in the baseline data sample. To obtain information on each corporation's bank relations, we first collect syndicated loan information from the LPC Dealscan database and create a subsample of corporations from the baseline sample with lender and loan information.¹² Then, we match the information on LTRO-banks

¹¹Source: <https://sdw.ecb.europa.eu/home.do> and <http://www.ecb.europa.eu/stats/monetary/res/html/index.en.html>. Note that the ECB does not provide data regarding its intervention programs.

¹²Specifically, 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.

with the lender-share and loan-facility data in LPC DealScan.¹³ By using the loan-facility data, we specifically match the LTRO-banks (as lenders) with a sub-sample of the Eurozone corporations (as borrowers) and, thus, identify whether the corporations in the Dealscan-Compustat linked sample have a relationship with a LTRO-bank. Using this procedure, we match 816 corporations, 416 of which have an LTRO-bank relationship. In the following, we use this sample of matched corporations as our main data sample.

With regard to our investigation of the impact of unconventional LTROs on the real economy, we focus on corporate investment and wage policies. As a proxy for corporations' investments, *Investments*, we follow the literature and use the ratio of capital expenditure to total assets. As shown in Table 2, Panel A, the average corporation in our main sample uses 2.98% of its total assets on investment in each quarter. As a proxy for employment compensation, we use *Wages*, which represents the corporations' total salaries and wages, expressed in logarithms. We relate corporate investment and wages to a set of explanatory variables and other controls, including both firm- and time-fixed effects. Our main controls in the investment and employment compensation model specifications are *Cash Flow*, *Market to Book*, *Firm Size*, *Leverage* and *Rated*. *Cash Flow* is the ratio of cash flow to total assets, where cash flow is defined as the earnings after interest and related expenses, income taxes, and dividends. *Market to Book* is the book value of assets minus the book value of equity plus the market value of equity, divided by the book value of assets. *Firm Size* is the logarithm of total assets. *Leverage* is measured as the book value of the long-term debt plus debt in current liabilities, divided by total assets. Finally, *Rated* is a dummy variable that is equal to one if the corporation is rated, and zero otherwise. Since investment 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 respective industry, we also use these controls in extended specifications. Table 2, Panel B, shows the summary statistics for the baseline corporate sample, i.e., where we do not require information on

¹³Based upon our sample of LTRO-banks, we identify 89 banks as lenders with syndicated loans covered in LPC Dealscan.

corporations' lending relationships, and confirms that there is no major sample bias induced by our procedure for identifying loan relationships.¹⁴

To capture the liquidity injection impact of the three-year LTROs, we use the measures *Lender LTRO Uptake* and *Country LTRO Uptake*. *Lender LTRO Uptake* measures the differences between corporations in terms of their access to the three-year LTROs by reflecting the corporate-specific uptake of liquidity by related banks. In particular, we define *Lender LTRO Uptake* as a corporate-specific LTRO exposure measure which is equal to 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 the size of each related bank, i.e., total assets, as of 2011. The measure is based upon the hand-collected bank-level uptake from Bloomberg and specifically determined as

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

where t indicates the year-quarter, i refers to the corporation, 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 *Lender 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 (and obtained) additional funds stemming from the LTRO liquidity injections.¹⁵

While the advantage of *Lender LTRO Uptake* is that it proxies for the corporate-level access to the unconventional LTRO funds, the disadvantage is that it is only available for the sub-sample of corporations for which we also have loan-level information. In order to provide a broader investigation of the impact of the LTRO uptake by Eurozone banks we also use *Country LTRO Uptake* which measures the differences between countries in terms of

¹⁴There is a minor sample bias in terms of corporate size because LPC Dealscan provides loan pricing information on syndicated loans, which are typically made to larger corporations.

¹⁵For the average corporation with a LTRO-bank relationship the median (mean) Lender LTRO Uptake measure is 4.1% (15.9%) with a large degree of cross-corporation and cross-country variation.

participation in the three-year LTROs by reflecting the country-specific uptake of liquidity. Similar to *Lender LTRO Uptake*, *Country LTRO Uptake* is equal to zero until the first unconventional LTRO, Q4-2011. However, thereafter it equals the amount of each country's total uptake through LTRO I and II, i.e., the sum of banks' LTRO uptake in the respective country, scaled by each country's central government debt holdings in the year 2011. Thus,

$$\text{Country LTRO Uptake}_{t,c} = \frac{\text{Total Country LTRO Uptake}_{t,c}}{\text{Central Government Debt}_{2011,c}} \quad (2)$$

where t indicates the year-quarter and c refers to the country. Hence, this variable measures the country-specific significance of how the unconventional monetary policy implemented by the ECB differentiates between countries that had a high or low uptake. Accordingly, we expect corporations located in countries that received relatively high liquidity injections to have been more heavily affected and to show a stronger reaction in their investment policies.¹⁶

Since this paper is based upon Eurozone corporations and provides a cross-country study, we also include the natural logarithm of sovereign CDS spreads, *Sovereign Risk*, and the countries' ratios of exports to GDP, *Sovereign Export*, in our model specifications, to control for sovereign credit risk and the diversification of the economy across markets. As outlined in Table 2, Panel C, the median CDS spread over the sample period within the Eurozone is approximately 73.0 bps. The sovereign CDS spread variable shows a large degree of cross-country and time-series variation, which implies that this is a suitable proxy for our study of unconventional monetary policies within the Eurozone. Likewise, we find a large variation in the countries' dependence on exports.¹⁷

In section 4, we focus on the impact of the *Lender LTRO Uptake* measure on corporate investment and employment compensation. As the transmission of the LTRO liquidity injection by the ECB occurred through the banking sector, and banks' incentives for partic-

¹⁶In robustness tests, we use the ratio of the country-specific LTRO uptake to the country's GDP as a proxy for the size of each country's economy. Our main results are robust to this alternative specification.

¹⁷Appendix Table A6 provides summary statistics for the non-Eurozone sample, and shows no general differences between Eurozone and non-Eurozone corporations.

icipating in the LTRO programs are important to understand the transmission efficiency, we also analyze the determinants of banks' usage of LTRO funds. To this end, we also collect bank-level data from Bankscope and Markit and investigate the role of bank, country and borrower characteristics *prior* to the LTRO implementation for banks' borrowings through LTRO I and LTRO II. In section 5, we further investigate the impact of the granularity of the LTROs on corporations' investments, including the impact of *Country LTRO Uptake*. We start from the corporations' reliance on bank debt, and investigate the role of this reliance in determining the impact of the country, as well as lender-specific LTRO uptake measures. Next, we investigate the effect of lender and country characteristics, such as the average risk and size of the corporations' lenders, as well as the role of the banks' overall policies on the repayments of the LTRO and (local) fiscal policies.¹⁸

4. Central Bank Liquidity Injections and Corporate Policies

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 Eurozone. We further investigate the role of bank and borrowing firm characteristics in affecting the LTRO effects and determining banks' LTRO uptakes. We further compare investments among firms in countries with different LTRO repayment speeds, and those with/without new loans from LTRO banks.

4.1 Lender LTRO Uptake and Corporate Investment

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 financial crisis, banks face funding risk which negatively affects corporate credit conditions. The three-year LTROs are designed to support bank financing and lending in Euro area, although there is no restrictions on banks' use of the LTRO funding. The

¹⁸Descriptions of all variables presented in this section can be found in Appendix Table A2.

resulting positive credit supply shock created by ECB may have been extended to corporate level through bank lending and positively affected firms' investment policies. However, banks may use the LTRO funding for other purpose rather than pass the macro liquidity to firm level. Corporations may also have concern about future access to financing because of bank lenders' impaired balance sheet or risk taking. If LTRO uptakes were viewed as a signal of bank risk/future liquidity risk, corporations may have even decreased their investments, even when their current access to financing was good.

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. *Lender LTRO Uptake* provides a corporate-specific measure of their bank lenders' LTRO uptake. If LTROs are sufficiently effective, we expect that corporations that had an existing borrowing relationship with banks that obtained a significant amount of the LTRO funds are, in general, more likely to be positively affected by the LTRO credit supply shock. We conduct 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 affect the corporate capital expenditure decision. In Model (2), we provide the same analysis for corporate employment compensation which is the logarithmic of total wages expenses. However, as shown in Table 3, rather than a positive impact, we find a *negative* and statistically significant coefficient of *Lender LTRO Uptake* for investment, whereas the coefficient is statistically insignificant for wages.¹⁹ 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

¹⁹Given the insignificant results for wage payments, we focus on corporate capital expenditure in the following analyses.

for robustness checks and present the results in Appendix Table A3. The results are robust to the additional controls. Overall, the analyses in this section suggest that the average corporation did not increase its investment and wage payment following the ECB liquidity injections through 3-year LTROs.

4.2 Bank Risk and LTRO Impact

We further investigate the role of bank risk in explaining the decrease in corporate investment following lenders' LTRO uptake. As discussed above, corporations may take the LTRO uptakes as signals of lenders' risks and future financing constraints and may, accordingly, respond by decreasing investment. These concerns tend to be more significant for those with risky lenders. Therefore, we may expect the decrease in investment to be more significant for corporations with risky lenders.

To investigate the roles of bank risk, we separate corporations into subsamples of *Risky Lender* and *Safe Lender*, based upon the average CDS Spread of their lenders, *Bank Risk*, one year before the first three-year LTRO intervention, i.e., Q4-2010. Then we conduct analyses of corporate investment in both subsamples. These results are presented in Models (1) and (2) of Table 4. As outlined in the table, we find significant decreases in investment after the LTRO uptakes for the *Risky Lender* subsample in Model (1). In Model (2), the coefficient of *Lender LTRO Uptake* for firms with safe lender is positive but not statistically significant. The results outline the potential role of bank risk in explaining the decrease in corporate investment after the LTRO uptake.

To further explore the interaction of bank risk, country risk, and the LTRO impact, we first separate corporations into subsamples based on country risk, i.e., GIIPS and non-GIIPS. GIIPS countries are most affected by the Sovereign Debt Crisis and have a higher country risk, ex ante. The corporations in each subsample are further separated into groups based on their bank lenders' risk. The results are presented in Models (3) to (6) of Table 4. For corporations in GIIPS countries, we find evidence that corporations with risky lenders experienced

a greater decrease in investment after the LTRO uptakes, while the change in investment is not significant for those with safe lenders. However, for corporations in non-GIIPS countries, we find an insignificant decrease in investment after LTRO for both the *Risky Lender* and *Safe Lender* subsamples. Overall, the findings in this section suggest the role of bank risk in explaining the decrease in investment following the LTRO uptake, especially given corporations' access to the LTRO funding through their lending relationships.

4.3 Corporate Bank Debt Reliance and Financial Constraints

The LTRO liquidity injections are conducted through the banking sector, since the expected transmission channel to the real economy is through bank lending. Corporations with greater dependence on bank debt financing are exposed more to, and may benefit more from, these liquidity injections, which may further stimulate corporate investment. However, these firms may also have greater concern on future bank debt financing, especially when the LTRO uptake has been viewed as 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 the subsamples *High Bank Debt* and *Low Bank Debt*, based upon their bank debt obligations (*Bank Debt*), one year before the first three-year LTRO intervention, i.e., Q4-2010. Next, we run the same subsample analysis for corporate investment. The results are presented in Table 5. We use the corporate-specific LTRO uptake measure, *Lender LTRO Uptake*, to capture the LTRO impact. We find a negative coefficient of *Lender LTRO Uptake* for the subsample of corporations with *High Bank Debt*, whereas the coefficient for corporations in the *Low Bank Debt* sample is insignificant. Thus, we find evidence that corporations with a relatively high reliance on bank debt invest less if their lenders had a high LTRO uptake.

We further investigate whether the impact of the bank-level LTRO uptake differs for firms that are relatively less versus more financially constrained. Financially constraint firms rely more on bank debt financing. They generally have fewer capital market alternatives

when their bank lenders face funding dry-ups and decrease credit supply. Thus, financially constrained firms may have greater concern of bank lenders' risk when LTRO uptake signals current or future liquidity risk. Following previous literature, we use both credit rating and size as proxies for corporate financial constraints. Non-rated firms and small firms are expected to be more constrained. The results are presented in Table 6. As seen from the table, we find that the decrease in investment following the LTRO uptake is concentrated in the subsamples of non-rated firms and small firms. For rated and big firms, there is even some evidence of increase in investment after their banks' LTRO uptake.

4.4 Endogeneity of LTRO Uptake

The previous results suggest that firms decrease investment following their bank lenders' uptake of LTRO funds. The decrease is concentrated in firms with risky lenders and financially constrained firms who are more sensitive to bank lenders' risk. In this section, we 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.

The analysis is conducted on a sample of banks with borrowers located in the Eurozone. Specifically, we make use of loan data from SDC Dealscan and investigate all banks with lending relationships to the Eurozone corporations in our sample. Then, based upon hand-collected information on banks' participation in the LTRO interventions, we capture bank borrowing from the ECB's three-year LTROs using 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 Euros from LTRO I (Dec-2011) and II (Feb-2012).

Drechsler et al. (2016) find that weakly capitalized banks took out more lender-of-last-resort loans. Thus, we add measures for bank risk as determinants of the LTRO uptake. The variable *High Risk Bank* is equal to one, if at the end of 2010, a bank had a CDS spread above the median CDS spread and zero otherwise. In addition, we add *Bank Size*, which is

the bank’s total assets at the end of 2010, to capture the potential difference in accessing the liquidity injection because of the size effect. Larger banks may have had sufficient collateral to access the LTRO funds. Also, they may have had better access to liquidity injections because they were “too big to fail.” Besides bank characteristics, we also add proxies for borrower risk and country risk, which may affect banks’ access to, and usage of, LTRO funds. *Borrower Size* refers to the average size (measured by total assets as a natural logarithm) 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. *Sovereign Risk* is the countries’ CDS spread at end-2010, expressed as a natural logarithm.²⁰

We implement our test in a regression framework and the results are presented in Table 7. Panel A focuses on the probability of a bank participating in LTRO liquidity interventions. Panel B reports the determinants of the amounts of the LTRO uptakes. The results indicate that risky banks (*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 access the LTRO injections that much more, which is consistent with our prediction. In addition, banks in 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 Table 7, when we further separate banks into GIIPS and non-GIIPS banks, the implications are generally similar. Interestingly, we find that for non-GIIPS banks, bank risk significantly increases the probability of participating in LTRO liquidity injections as well as the amount of LTRO uptake. Overall, we find evidence that banks’ participation in LTRO and their LTRO uptake amounts positively relate to bank risk and country risk. This is consistent with the explanation for the decrease in investment following an LTRO, i.e., that

²⁰We collect the bank-level measures from Bankscope as well as Markit, while the borrower-related data are based upon the information in our main sample (for details, see Section 3). After combining all the bank-specific data, we end up with 185 banks with all available information to provide us with a balanced dataset.

corporations took the LTRO uptake as a signal of risk and, consequently, decreased their investments.

4.5 The Effect of 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. Participating banks were given the option to repay, either in part or in full, the amount of their borrowings after one year, without any penalty in order to increase the attractiveness of the unconventional LTROs. 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 early opportunity, either to signal improvements in their individual funding conditions or because of their decreased funding needs during the process of balance sheet adjustment.²²

To investigate the role of early repayment, we rely on the end-of-year country-level LTRO data reported by the NCBs to proxy for country-specific LTRO early repayments by banks. Specifically, we use the percentage changes in the country-level LTRO holdings between 2012 and 2013 as a proxy for early repayments of the three-year LTROs across countries (for details, see Appendix Table ??).²³ One interesting observation from this measure is that the bank repayments differ for non-GIIPS (core) and GIIPS (periphery) countries. In general, non-GIIPS countries 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 in our sample (i.e., Austria, the Netherlands, Belgium, and France) also showed a sharp decrease of approximately 64% in their balances of LTRO funding during this period. Among GIIPS countries, there are mixed patterns in the LTRO early repayment,

²¹See <https://www.ecb.europa.eu/press/key/date/2011/html/sp1110211.en.html>

²²See ECB Monthly Bulletin, February 2013.

²³The NCBs’ country-level LTRO data may contain LTROs with other maturities, i.e., three-month and one-year. However, most of the LTROs were of three-year maturity. 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.”

with more modest amounts for banks in Portugal (13%), Italy (20%), and Greece (29%), and larger repayments of approximately 45% in Spain and Ireland. Based on our proxy for early LTRO repayments, we separate our sample of corporations into three groups: *Low Early LTRO Repayment* (Portugal and Italy)²⁴, *Medium Early LTRO Repayment* (Spain, Ireland, Austria, the Netherlands, Belgium, and France), and *High Early LTRO Repayment* (Germany). Next, we examine the impact of the LTRO intervention on corporate investment for the three different groups.

The results are presented in Table 8. 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 with low early repayment group (Portugal and Italy in Model (1)). For those in the medium early repayment group (Spain, Ireland, Austria, the Netherlands, Belgium, France in 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.

4.6 Firms with New Loans from LTRO Banks

We have further restricted our analyses in a sample of firms have lending relationship with LTRO banks during up to five years before the liquidity injections. Then we compare corporate investments between those with and without new loans from LTRO banks during the period after the LTRO liquidity injections (2012-2014). We expect that firms with new loans from LTRO banks increase their investment, particularly for those depend on bank debt financing.

Based on DealScan data, we identified 305 firms that borrowed from LTRO banks before LTRO liquidity injections, among which 168 firms obtained new loans from their LTRO lender after the first LTRO intervention.²⁵ *New Loan* is a dummy variable equal to one

²⁴Greece had low early repayment, but is not covered by the analysis due to missing bank LTRO data.

²⁵See Appendix Table A5 for sample summary statistics.

if the corporations obtained a new loan from a bank that participated in the three-year LTROs during post LTRO intervention, and zero otherwise. The coefficients of interest are on *Lender LTRO Uptake* and the interaction term of *Lender LTRO Uptake* \times *New Loan*.

The results are presented in Table 9. In column (1), we conduct the baseline analyses in the sample of firms with LTRO-bank relationship before the liquidity injections. We find a negative but insignificant coefficient for *Lender LTRO Uptake*. When we further add the interaction term of *Lender LTRO Uptake* \times *New Loan*, we find that firms with new loans from LTRO bank lenders after LTRO liquidity injections increase investment, although the coefficient is only marginally significant. Columns (3) and (4) in Table 9 further decompose our sample firms with LTRO relationship into subsamples of High Bank Debt and Low Bank Debt. The results suggest that for those with high bank debt dependency, firms decrease investment with their lenders' LTRO uptake. However, firms increase investment following lenders' LTRO uptake when they obtained new loans from their LTRO lenders, as evidenced by the positive and significant coefficient of *Lender LTRO Uptake* \times *New Loan* in column (3). For firms with low bank debt dependency, they increase investment following lenders' LTRO uptake regardless of whether they have obtained additional loans from LTRO-banks. Therefore, from the above analyses we find evidence that when macro-liquidity is transmitted to firm level, firms that obtained new loans from LTRO banks increased their investment.²⁶

5. Policy Interactions and Implications for Policy Design

Our previous evidence suggests that firms decrease investment following their lenders' LTRO uptake. However, the effects vary with bank risk, corporate bank debt dependency and whether firms can receive additional funding from their loan lenders. In this section, we further explore the policy interactions and investigate what if there is no LTRO liquidity injections. We have also discussed the potential implications for policy design.

²⁶When investigating the characteristics of corporations that obtain new loans from LTRO banks we find similar to Carpinelli and Crosignani (2018) these firms are relatively good firms, i.e., with better investment opportunities.

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. 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 the corporations even more. 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., expansionary monetary policy through the LTROs, accompanied by a contractionary fiscal policy in a particular country. However, 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. Accordingly, contractionary fiscal policies 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.²⁷

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. Specifically, we use the median of the ratio of the quarterly government investment expenditures to GDP for each year to classify corporations into subsamples based on whether their national government increased or decreased the amount of investment expenditures between Q4-2010 to Q4-2012. Next, 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 10. Given the fiscal policy is conducted at country level, 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 Eurozone sample, with *Country LTRO Uptake* as a proxy for monetary policy. Similar to our baseline results, we find that firms 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 of the potential for increased

²⁷During 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.

corporate investment in countries with coordinated monetary and fiscal policies.

5.2 What if there were No LTRO?

We use non-Eurozone corporations as the benchmark to compare corporate investment with and without the influence of the LTRO liquidity injections. 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 interventions 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 sustain 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. Whereas banks in the Eurozone countries may have had access to LTRO liquidity injections during the two rounds of unconventional LTROs, non-Eurozone countries did not have such access.²⁸ 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

²⁸This 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.

above (below) the median in the pre-intervention and crisis periods (2009 and 2010).

The results are presented in Table 11. 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), and indicates the timing of the LTRO intervention. The variable *Eurozone* is a dummy equal to one, for corporations located in countries that belong to the Eurozone. The variable of interest in this counterfactual analysis is $Post-LTRO \times Eurozone$, which is the interaction term between the LTRO intervention and Eurozone dummies. The variable equals one, for Eurozone corporations in year-quarters following the first LTRO intervention, which captures the effect of the liquidity intervention on corporate policies in LTRO countries (the “treatment” effect). We find a positive and significant coefficient of the term $Post-LTRO \times Eurozone$ for both the investment analyses. The coefficient for *Post-LTRO* is significantly negative. This finding suggests that non-Eurozone corporations may not only have had less access to a substantial financing source, but may also have experienced an even greater decrease in investment than corporations in the Eurozone.

In Models (2) and (3) of Table 11, we further separate our sample of corporations in the EU into high and low sovereign-risk subsamples, based on the risk of the country in which a corporation is located. We then compare corporate policies during the post-LTRO intervention period for the high and low sovereign-risk groups. We find that Eurozone corporations in both the high- and low-risk groups experienced a less decrease in their investments following the unconventional LTROs than did 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

Our previous evidence suggests that the unconventional ECB liquidity injections were not sufficient to boost average corporate investment, but these injections may have halted the decline in investment. When the central bank liquidity is transmitted to corporate level and when there is coordinated fiscal policies, we observe increase in corporate investment following LTRO liquidity injections. In this section, we discuss potential implications for policy design based on our analyses and findings from previous literature.

The transmission of monetary policy to corporate liquidity and investment is not easy. The picture is more complex and depends on the longer-term funding risk, bank risk, and corporate financial risk managements etc. However, 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 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 may help banks to restore their lending to firms, especially when there is rollover risk of short-term liquidity (Carpinelli and Crosignani, 2018).

However, the maturity extension cannot solve all the problem. Banks may have impaired balance sheet and risk taking incentives which impede the transmission of monetary policies. Banks' impaired balance sheet may prohibit their access to liquidity injections. The Additional Credit Claim (ACC) program designed by the ECB and implemented by individual NCBs can help to support banks access to the ECB liquidity injections. The ACC program can further affect which group of firms benefit from the liquidity injections, i.e. firms

whose loans are newly eligible as collateral under ACC. Since the cost of lending to eligible firms is decreased, banks increase lending to these newly eligible firms. (Cahn, Duquerroy, and Mullins, 2018) In addition, banks' risk taking behavior may impede the transmission of monetary policy. 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 liquidity dry up before the liquidity injections may have limited access to the 3-year LTROs because of the lack of collateral. Government guarantee program in Italy supported those high exposure banks access to the ECB liquidity. Those high exposure banks further drove the increase in corporate credit supply particularly for low profitability and high-risk firms. However, the involvement of governments in the guarantee may intensify the contagion loop between sovereigns and banks.

Furthermore, firms are doing their own risk management which may impede the stimulating effects of policies on investments. For example, firms may have concerns on 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 to build up corporate confidence and stimulate investments. TLTRO implemented in 2014 may be an effective way to restrict banks' risk taking and stimulate corporate investment which can be explored further.

6. Conclusions

In this paper we investigate whether, and how, corporate investment is affected by unconventional monetary interventions by analyzing the largest liquidity injections in history. Focusing on the ECB's three-year LTROs, we find that non-financial corporations in the Eurozone did not increase their investments after these massive liquidity injections. Specifi-

cally, our analysis shows that investment of these corporations are negatively associated with the amount of funds their banks obtained from the ECB. The effect is concentrated in firms with risky lenders, a high reliance on bank debt and financially constraint firms.

We further investigate the role of bank risk in explaining the decrease in corporate investment following the LTROs. The analysis shows that LTRO uptakes are endogenously determined by bank risk with riskier banks took more funds from the LTROs. Accordingly, we argue that the decrease in investment following the LTRO intervention is related to borrowers' concern on lender risk. Furthermore, we find that the negative investment effect of the unconventional LTROs varies across LTRO repayment choices that relate to the persistence of the LTRO interventions. The findings suggest that corporations whose lenders' held the LTRO funds for a longer period did decrease investment following their lenders' LTRO uptake. Overall, these finding suggests that bank risk and the signalling role of the banks' LTRO uptake might have impeded the transformation of liquidity injection into real economic outputs. In order to investigate the LTRO transmission channel we also study the provision of additional lending to firms with a relationship to a bank that participated in LTRO. We find evidence that firms, that obtained new loans from LTRO banks following the liquidity injection, increased their investment.

While LTRO may not have boosted corporate invested, it is important for the discussion of the effectiveness of these liquidity injections to shed light on what if there were no LTRO? We find that non-Eurozone firms which are not directly affected by LTROs reduced investments more than Eurozone firms. Such a counterfactual analysis suggests that LTROs helped Eurozone corporations to decelerate their investment decline. Furthermore, we find that when governments adopted more accommodative fiscal policies at the same time, corporate investment increased in response to their lenders' LTRO uptakes.

While our results suggest that liquidity injections can decelerate economic decline, our study outlines the significance of bank and country characteristics that 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. 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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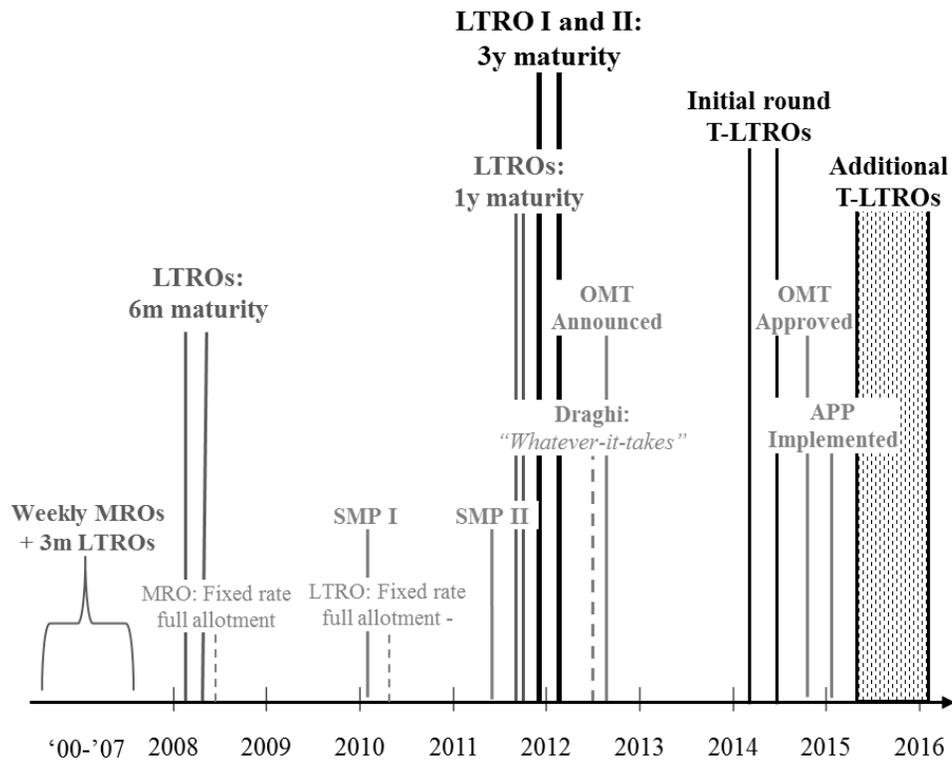


Figure 1
ECB's unconventional monetary policies

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.

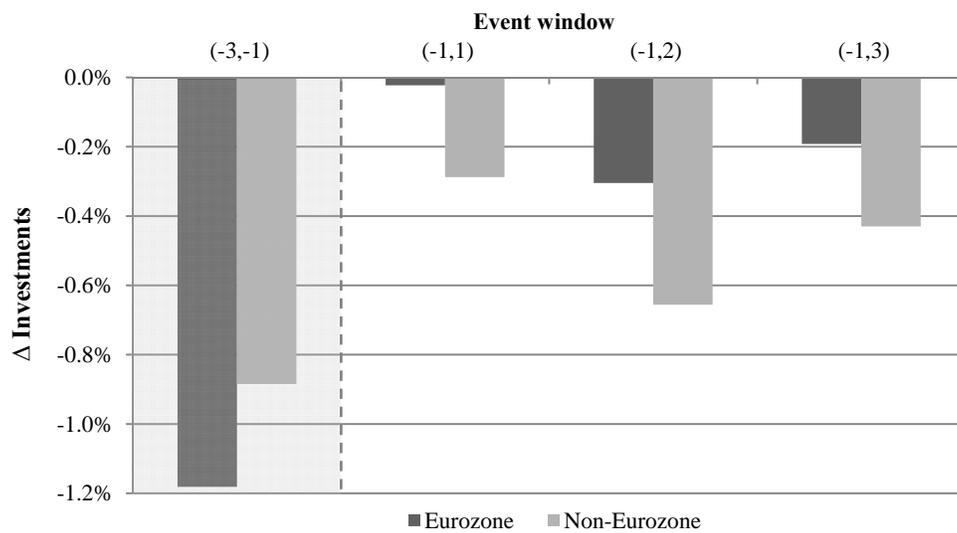


Figure 2
Time series of corporate investment before and after the LTRO intervention in Europe

This figure plots the changes in the investment ratios for Eurozone and non-Eurozone corporations, from before the financial crisis (Q2-2008) before the three-year LTRO interventions (Q2-2011), respectively from before (Q2-2011) to one (Q4-2012), two (Q4-2013) and three (Q4-2014) years after the three-year LTRO interventions. Specifically, the figure outlines the average of corporations' investment ratios. 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. For details, please see Appendix Table A1.

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

Country	LTRO I:	LTRO II:	Total LTRO	Country	Bank
	Dec-2011	Feb-2012	Borrowing	LTRO Uptake	LTRO Uptake
	EUR bn	EUR bn	EUR bn	% of Gov. Debt	% of Bank Size
	(1)	(2)	(3)	(4)	(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 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 LTRO Borrowing* for each country by the country's central government debt obligations, as of December 2011. In column 5, we report the average LTRO borrowing by banks, scaled by the banks' total assets in 2010, in the respective country. 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

<i>Panel A: Sample with existing loan information from LPC Dealscan</i>												
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 Capita	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
Sovereign Risk	62.2	101.	38.4	233.	30.5	78.8	872.	266.	189.	47.9	429.	68.8
Sovereign Export	0.53	0.81	0.44	0.28	0.38	0.27	0.25	1.03	0.26	0.77	0.34	0.37
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

<i>Panel B: Sample based on Compustat Data</i>												
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
Sovereign Risk	62.2	85.6	38.4	233.	30.5	78.8	784.	266.	189.	47.9	409.	74.5
Sovereign Export	0.53	0.81	0.44	0.28	0.38	0.27	0.25	1.03	0.26	0.77	0.34	0.32
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
# 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

<i>Panel C: Country-specific measures</i>												
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
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

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 main data sample, while Panel B shows the summary statistics for a broader sample of Eurozone corporations, for which we do not require loan information from LPC Dealscan. In Panel C, we show summary statistics for country-specific measures used in our 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 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 3
LTRO uptake effect on investment and employment

	Investments	Wages
	(1)	(2)
Lender LTRO Uptake	-0.158** (0.08)	-0.034 (0.05)
Cash Flow	0.006** (0.00)	0.004 (0.00)
Market to Book	0.005*** (0.00)	0.001 (0.00)
Firm Size	0.160** (0.07)	0.695*** (0.05)
Leverage	-0.015*** (0.00)	-0.001 (0.00)
Rated	0.016 (0.15)	-0.044 (0.12)
Sovereign Risk	-0.650*** (0.05)	-0.036 (0.04)
Sovereign Export	-0.057*** (0.00)	0.004 (0.00)
Time FE	Y	Y
Firm FE	Y	Y
<i>R</i> -square	0.721	0.744
<i>N</i>	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 corporations located in the Eurozone. 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 *Lender 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 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
LTRO effect on investment: The role of lender characteristics

	Investments		Investments			
	Risky Lender (1)	Safe Lender (2)	GIIPS		Non-GIIPS	
			Risky Lender (3)	Safe Lender (4)	Risky Lender (5)	Safe Lender (6)
Lender LTRO Uptake	-0.337*** (0.10)	0.047 (0.08)	-0.513*** (0.14)	2.114 (2.06)	-0.213 (0.14)	0.038 (0.08)
Cash Flow	0.010* (0.00)	0.007 (0.00)	0.010 (0.00)	0.059*** (0.01)	0.015** (0.00)	0.004 (0.00)
Market to Book	0.006*** (0.00)	0.009*** (0.00)	0.016*** (0.00)	0.013*** (0.00)	0.001 (0.00)	0.009*** (0.00)
Firm Size	0.139 (0.12)	0.097 (0.11)	-0.079 (0.20)	-1.039*** (0.33)	0.559*** (0.14)	0.218* (0.11)
Leverage	-0.016*** (0.00)	-0.021*** (0.00)	-0.011** (0.00)	0.015* (0.00)	-0.032*** (0.00)	-0.025*** (0.00)
Rated	0.008 (0.18)	0.352 (0.22)	-1.131*** (0.30)	1.401** (0.61)	0.524** (0.21)	0.295 (0.23)
Sovereign Risk	-0.830*** (0.08)	-0.247*** (0.08)	-0.300*** (0.11)	-0.087 (0.12)	-0.928*** (0.17)	-0.104 (0.13)
Sovereign Export	-0.089*** (0.01)	-0.068*** (0.01)	-0.205*** (0.03)	0.063 (0.04)	-0.060*** (0.01)	-0.067*** (0.01)
Time FE	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y
<i>R</i> -square	0.774	0.794	0.777	0.826	0.796	0.793
<i>N</i>	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 corporations located in the Eurozone. Our measure for investment is *Investments*, which is the corporations' capital expenditure, scaled by total assets. 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 *Lender 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 5
LTRO effect on Investment: The role of corporations' bank debt reliance

	Investments	
	High Bank Debt (1)	Low Bank Debt (2)
Lender LTRO Uptake	-0.255** (0.10)	-0.025 (0.12)
Cash Flow	0.000 (0.00)	0.008** (0.00)
Market to Book	0.008*** (0.00)	0.004*** (0.00)
Firm Size	-0.241** (0.11)	0.561*** (0.10)
Leverage	-0.021*** (0.00)	-0.010*** (0.00)
Rated	0.012 (0.30)	0.023 (0.17)
Sovereign Risk	-0.739*** (0.07)	-0.497*** (0.07)
Sovereign Export	-0.044*** (0.01)	-0.061*** (0.01)
Time FE	Y	Y
Firm FE	Y	Y
<i>R</i> -square	0.718	0.716
<i>N</i>	6977	9235

This table presents estimates of the effect of the corporate reliance on bank debt and 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 Eurozone. 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*. *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. The variable *Lender 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 6
LTRO effect on Investment: The role of corporations' access to financing

<i>Panel A: Firm Credit Rating</i>		
	Investments	
	Rated Firm (1)	Non-Rated Firm (2)
Lender LTRO Uptake	0.581*** (0.14)	-0.245*** (0.08)
Cash Flow	0.008 (0.00)	0.006* (0.00)
Market to Book	-0.002 (0.00)	0.006*** (0.00)
Firm Size	0.229 (0.14)	0.085 (0.08)
Leverage	-0.010** (0.00)	-0.016*** (0.00)
Sovereign Risk	-0.799*** (0.10)	-0.632*** (0.05)
Sovereign Export	-0.017 (0.01)	-0.064*** (0.01)
Time FE	Y	Y
Firm FE	Y	Y
<i>R</i> -square	0.829	0.715
<i>N</i>	2452	13868

<i>Panel B: Firm Size</i>		
	Investments	
	Large Firm (1)	Small Firm (2)
Lender LTRO Uptake	0.063 (0.08)	-0.544*** (0.17)
Cash Flow	0.003 (0.00)	0.006 (0.00)
Market to Book	0.008*** (0.00)	0.004*** (0.00)
Firm Size	-0.021 (0.10)	0.361*** (0.11)
Leverage	-0.024*** (0.00)	-0.011*** (0.00)
Rated	0.233 (0.14)	0.727 (0.56)
Sovereign Risk	-0.727*** (0.07)	-0.608*** (0.07)
Sovereign Export	-0.057*** (0.01)	-0.048*** (0.01)
Time FE	Y	Y
Firm FE	Y	Y
<i>R</i> -square	0.759	0.683
<i>N</i>	8302	7910

This table presents estimates of the effect of the corporate reliance on bank debt and 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 Eurozone. 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 Panel A, Models (1) and (2), 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). In Panel B, Models (1) and (2), 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. The variable *Lender 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 7
Determinants of banks' LTRO borrowing

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

<i>Panel B: Bank-specific LTRO borrowing amount</i>					
	Log(1 + Total Bank LTRO Borrowing)			Log(1 + Total Bank 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*** (0.18)	0.789*** (0.19)	0.621*** (0.19)	0.450* (0.26)	0.502** (0.21)
Bank Size $_{j,10}$	0.061*** (0.00)	0.174*** (0.03)	0.248*** (0.04)	0.484*** (0.06)	0.099** (0.03)
Borrower Size $_{j,10}$		-0.138** (0.05)	0.033 (0.06)	-0.028 (0.13)	-0.107 (0.07)
Borrower Leverage $_{j,10}$		0.012 (0.00)	0.005 (0.00)	0.002 (0.01)	0.006 (0.00)
Borrower Short-term Debt $_{j,10}$		-2.969** (1.42)	-1.818 (1.38)	-2.797 (1.98)	-3.485* (1.99)
Borrower Cash Flow $_{j,10}$		-0.045 (0.03)	-0.028 (0.02)	-0.067** (0.03)	0.005 (0.04)
Sovereign Risk $_{10}$			0.486*** (0.12)	0.728** (0.28)	-0.023 (0.11)
<i>R</i> -square	0.418	0.447	0.500	0.750	0.293
<i>N</i>	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 Borrowing 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 + Total Bank 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 Cash Flow* and *Borrower Short-term Debt* is the average leverage, cash flow and short-term debt 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 8
LTRO effect on investment: The role of banks' early repayment of LTRO

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

This table presents estimates of the effect of the liquidity uptake from the ECB's three-year Longer-Term Refinancing Operations (LTROs) by loan-related banks, and LTRO repayment policies on corporate polices, in a subsample 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 *Lender 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 9
LTRO effect on investment: The role of post-LTRO borrowings and bank debt reliance

	Investments			
	Investments	Investments	High Bank Debt	Low Bank Debt
	(1)	(2)	(3)	(4)
Lender LTRO Uptake	-0.010 (0.07)	-0.096 (0.08)	-0.418*** (0.14)	0.200** (0.09)
Lender LTRO Uptake × New Loan		0.269* (0.14)	0.676*** (0.20)	0.529 (0.97)
Cash Flow	0.005 (0.00)	0.005 (0.00)	0.004 (0.00)	0.006 (0.00)
Market to Book	0.007*** (0.00)	0.007*** (0.00)	0.007*** (0.00)	0.007*** (0.00)
Firm Size	0.028 (0.10)	0.028 (0.10)	-0.657*** (0.18)	0.545*** (0.13)
Leverage	-0.029*** (0.00)	-0.028*** (0.00)	-0.024*** (0.00)	-0.034*** (0.00)
Rated	-0.142 (0.17)	-0.145 (0.17)	-0.593 (0.40)	-0.093 (0.16)
Sovereign Risk	-0.641*** (0.08)	-0.641*** (0.08)	-0.885*** (0.15)	-0.146 (0.09)
Sovereign Export	-0.093*** (0.01)	-0.093*** (0.01)	-0.143*** (0.02)	-0.055*** (0.01)
LTRO-Bank Relation $P_{re-LTRO}$	Y	Y	Y	Y
Time FE	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y
<i>R</i> -square	0.774	0.774	0.755	0.807
<i>N</i>	6342	6342	2488	3820

This table presents estimates of the effect of the corporate reliance on bank debt and 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 Eurozone and with a LTRO-bank relation. Our measure for investment is *Investments*, which is the corporation's capital expenditure, scaled by total assets. *New Loan* is a dummy variable equal to one if the corporations after the LTRO intervention (2012-2014) obtained a new loan from a bank that participated in the three-year LTROs, and zero otherwise. The variable *Lender 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 10
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*** (0.19)	-4.222** (1.89)	-1.259*** (0.26)	16.314** (6.74)	3.241*** (0.55)	-1.212*** (0.23)
Cash Flow	0.000 (0.00)	-0.010** (0.00)	0.000 (0.00)	0.018*** (0.00)	-0.001 (0.00)	0.001 (0.00)
Market to Book	0.005*** (0.00)	0.004*** (0.00)	0.005*** (0.00)	0.005*** (0.00)	0.003*** (0.00)	0.006*** (0.00)
Firm Size	0.619*** (0.05)	-0.029 (0.10)	0.755*** (0.08)	0.811*** (0.12)	0.086 (0.09)	0.898*** (0.07)
Leverage	-0.007*** (0.00)	-0.001 (0.00)	-0.011*** (0.00)	-0.001 (0.00)	0.003 (0.00)	-0.014*** (0.00)
Rated	0.198 (0.17)	-0.135 (0.26)	0.174 (0.25)	0.635 (0.56)	-0.264 (0.27)	0.457* (0.23)
Sovereign Risk	-0.504*** (0.03)	-1.268*** (0.27)	-0.242*** (0.08)	-0.613*** (0.05)	-0.461*** (0.05)	-0.475*** (0.07)
Sovereign Export	-0.047*** (0.00)	0.022 (0.10)	0.058*** (0.02)	-0.097*** (0.01)	-0.121*** (0.01)	-0.008 (0.01)
Time FE	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y
<i>R</i> -square	0.665	0.743	0.649	0.598	0.677	0.657
<i>N</i>	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. 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 include base corporate-level financial variables in addition to macro-economic variables and 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 11
Counterfactual analysis: Eurozone versus Non-Eurozone

	Investments (1)	Investments	
		Risky Sovereign (2)	Safe Sovereign (3)
Post-LTRO	-1.534*** (0.10)	-1.580*** (0.21)	-1.206*** (0.13)
Post-LTRO × Eurozone	0.541*** (0.04)	0.373*** (0.10)	0.379*** (0.06)
Cash Flow	-0.005*** (0.00)	0.009** (0.00)	-0.011*** (0.00)
Market to Book	0.003*** (0.00)	0.009*** (0.00)	0.002*** (0.00)
Firm Size	0.423*** (0.04)	0.896*** (0.09)	0.299*** (0.04)
Leverage	-0.007*** (0.00)	-0.007** (0.00)	-0.006*** (0.00)
Rated	-0.218 (0.17)	-0.452 (0.36)	-0.050 (0.19)
Sovereign Risk	-0.403*** (0.03)	-0.180*** (0.05)	-0.230*** (0.04)
Sovereign Export	-0.001 (0.00)	0.116*** (0.01)	0.014 (0.00)
Eurozone FE	Y	Y	Y
Time FE	Y	Y	Y
Firm FE	Y	Y	Y
<i>R</i> -square	0.668	0.602	0.702
<i>N</i>	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 policies, in a sample of corporations located in the European Union (EU), both either 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.²⁹ 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”.³⁰

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 FitchRatings (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

²⁹For details about the financial instruments that are used to achieve open market transactions, see <https://www.ecb.europa.eu/mopo/implementation/html/index.en.html>.

³⁰Source: 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.³¹ 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.³² 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.³³ 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 were 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).³⁴

³¹Source: ECB Monthly Bulletin, January 2012.

³²See, for instance, <http://www.zerohedge.com/contributed/ltro-users-manual>.

³³For 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.

³⁴Previous the European Financial Stability Facility and European Financial Stabilization Mechanism.

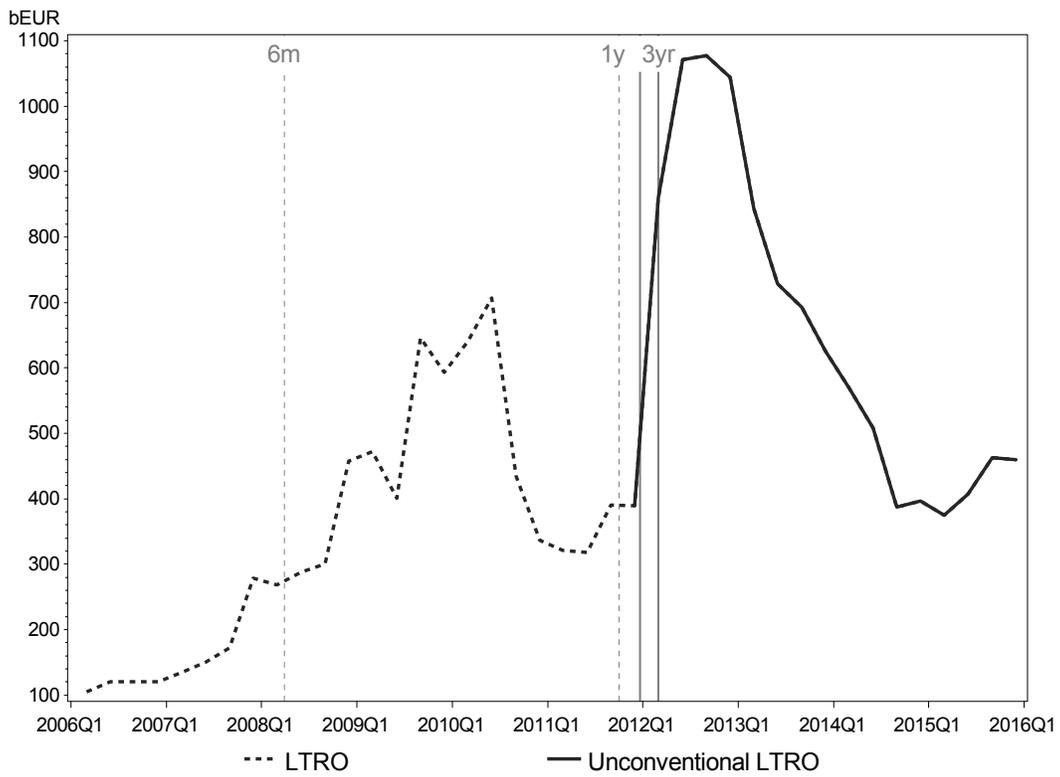


Figure A1
Time series of the ECB's Longer-Term Refinancing Operations

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.

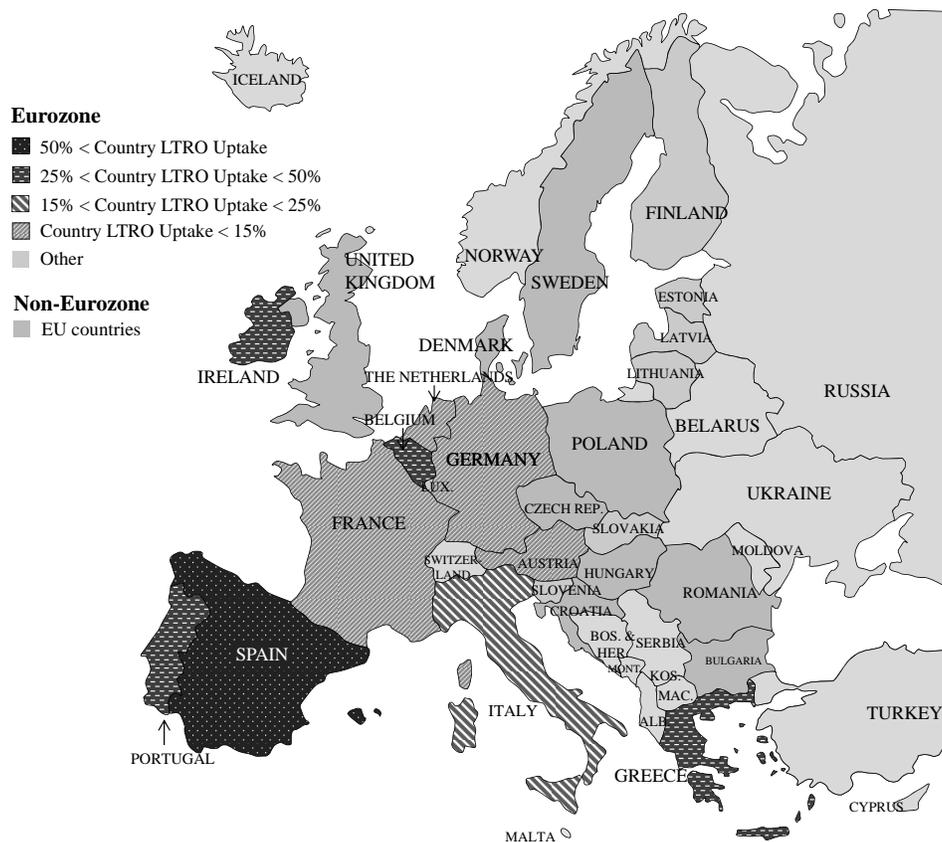


Figure A2
LTRO uptake in the Eurozone

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
Sample countries

<i>Panel A: Eurozone</i>					
Country	Country Code	EU Membership	Euro Adoption	Region	Credit Rating (2011)
Austria	AUT	1995	1999	Core	AAA
Belgium	BEL	1995	1999	Core	AA
Finland	FIN	1995	1999	Core	AAA
France	FRA	1995	1999	Core	A
Germany	DEU	1995	1999	Core	AAA
Greece	GRC	1995	2001	Periphery	CCC
Ireland	IRL	1995	1999	Periphery	BB
Italy	ITA	1995	1999	Periphery	BB
Netherlands	NLD	1995	1999	Core	AAA
Portugal	PRT	1995	1999	Periphery	B
Spain	ESP	1995	1999	Periphery	BB

<i>Panel B: Non-Eurozone</i>					
Country	Country Code	EU Membership	Euro Adoption	Region	Credit Rating (2011)
Bulgaria	BGR	2007		Periphery	A
Czech Republic	CZE	2004		Periphery	AA
Denmark	DNK	1995		Core	AAA
Hungary	HUN	2004		Periphery	B
Lithuania	LTU	2004	2015	Periphery	A
Latvia	LVA	2004	2014	Periphery	A
Poland	POL	2004		Periphery	AA
Romania	ROU	2007		Periphery	BB
Sweden	SWE	1995		Core	AAA
United Kingdom	GBR	1995		Core	AAA

This table presents details of the European countries included in our sample. Panel A covers the countries in our Eurozone sample, Panel B those in our non-Eurozone sample. The *Eurozone* sample only includes countries that agreed to use the euro as a common currency in 1999, and adopted the euro right from its introduction in January 2001, and for which data are available. Eurozone countries that are excluded from the analysis are Slovenia (joined in 2007), Cyprus and Malta (joined in 2008), Slovakia (joined in 2009), Estonia (joined in 2011), Latvia and Lithuania (joined in 2015), Poland and the Czech Republic (current applicants), and Luxembourg (missing data). The sample *Non-Eurozone* includes countries that are outside the Eurozone but are part of the European Union (EU). Accordingly, our sample of EU corporates is the combination of the Eurozone and non-Eurozone samples. *EU Membership* shows the year the country became a member of the EU. Likewise, *euro Adoption* shows the year in which a given country adopted the euro as its local currency. *Credit Rating* is based on information from Markit Data as of end-2011. The overall sample of corporations is taken from Compustat Global and is restricted to EU countries. For details, please see Section 3.

Table A2
Description of main variables

<i>Main Explanatory Variables</i>			<i>Description</i>
Lender Uptake	LTRO	Average (Bank LTRO Uptake/ Bank Size ₂₀₁₁) of related banks	The firm-level average of a related banks' uptake in 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' total 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.
LTRO Borrower	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 LTRO-Bank Relation and obtained a loan from an LTRO-bank after the LTRO intervention (2012 to 2014). Corporate measure. Source: LPC Dealscan.
Country LTRO Uptake	LTRO	Total Country LTRO Uptake/ 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 are provided in Appendix A1.
<i>Main Corporate Variables</i>			<i>Description</i>
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 one 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.

Description of main variables (cont.)

<i>Other Corporate Variables</i>		<i>Description</i>
Firm Size	Log(Total Assets)	Book value of assets, given in logarithms. Quarterly corporate measure. Source: Compustat.
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. 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. Corporate 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.
Rated	Dummy	Dummy variable equal to one for corporations with available rating information (zero otherwise). Corporate measure. Source: S&P Capital IQ.
<i>Other Bank and Country Variables</i>		<i>Description</i>
Bank Risk	log(5-year Bank CDS spread)	End-of-quarter observation of five-year bank CDS spreads. Quarterly country measure. Source: Markit.
Early LTRO Repayment	(Δ 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 initial LTRO uptake in the respective country. Country measure. Source: National Central Bank Reports and Bloomberg.
Government Debt	Government debt/ GDP	Total Government debt, scaled by GDP. Quarterly country measure. Source: ECB Statistical Data Warehouse.
Sovereign Risk	Log(5-year Sovereign CDS spread)	End-of-quarter observation of five-year sovereign CDS spreads. Quarterly country measure. Source: Markit.
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	Investment expenditures by governments/ GDP	Local government spending on investments, scaled by GDP. 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 1st and 99th percentiles, and in our empirical specifications we use ratios given in percentages.

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

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

Country	Total LTRO Holdings				Repayment Ratio
	2010	2011	2012	2013	2012 to 2013
	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.

Table A5
Summary statistics for Eurozone firms with LTRO-bank relation

Country	AUT	BEL	DEU	ESP	FIN	FRA	GRC	IRL	ITA	NLD	PRT	Total
Investments	5.51	2.91	3.55	2.59	3.65	3.44	9.80	2.00	2.99	2.58	5.40	3.21
Wages	3.93	3.72	4.47	4.47	4.18	5.19	3.79	2.94	4.07	4.65	4.44	4.39
Cash	8.49	7.56	9.70	7.93	6.36	8.66	6.51	7.98	7.71	6.83	8.06	8.39
Leverage	23.5	24.6	23.1	45.2	30.3	26.8	47.5	26.5	33.0	25.1	36.3	27.5
Net Debt	59.4	60.4	63.1	73.7	59.8	63.1	66.8	58.4	71.0	61.3	71.0	64.4
Firm Size	6.97	7.40	7.58	7.68	7.79	8.74	7.00	7.45	7.49	8.17	8.63	7.81
Market to Book	95.5	106.	113.	104.	118.	114.	103.	142.	108.	128.	104.	112.
Cash Flow	2.57	3.28	3.69	4.98	2.67	2.80	2.58	2.57	2.72	3.50	2.79	3.27
Industry Sigma	3.00	4.78	6.18	2.50	5.08	4.57	8.06	3.14	3.58	3.45	2.67	4.51
Net Working Capita	4.18	-3.0	2.43	-6.9	2.38	-7.3	0.05	-2.4	-4.1	1.45	-7.5	-2.4
R&D/Sales	0.59	0.28	0.58	0.00	0.50	0.00	0.00	0.00	0.01	0.03	0.00	0.03
Acquisition Activity	0.00	0.00	0.00	0.02	0.03	0.06	0.00	0.34	0.00	0.15	0.00	0.00
Sovereign Risk	70.2	85.6	38.4	233.	30.5	78.8	872.	266.	189.	47.9	429.	72.9
Sovereign Export	0.53	0.81	0.44	0.28	0.38	0.27	0.25	1.03	0.26	0.77	0.34	0.37
Bank Debt	74.5	32.6	41.6	75.8	33.5	30.8	40.4	45.4	79.1	47.6	42.2	47.2
Short-term Debt	0.06	0.04	0.04	0.08	0.06	0.05	0.08	0.02	0.09	0.04	0.08	0.05
# N	169	468	1939	648	296	1486	75	296	821	688	114	7000
# Firms	8	20	83	31	12	63	3	12	37	31	5	305
# Firms w. LTRO-Loan	3	10	60	17	5	39	-	6	11	15	2	168

This table provides sample averages (medians) of corporate characteristics for each country in our samples of Eurozone corporations with loan information from LPC Dealscan and with a relation to a LTRO-bank in the five years before the LTRO intervention. 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 A6
Summary statistics for 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
Sovereign Risk	202.	87.3	34.2	61.3	326.	228.	133.	296.	33.0	64.0
Sovereign Export	0.62	0.71	0.52	0.28	0.86	0.75	0.42	0.36	0.46	0.30
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
# 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 non-Eurozone corporations. *Cash* is the ratio of cash and short-term investments to total assets. *Investments* is the ratio of capital expenditure to total assets. *Wages* is the total salaries and wages, given in logarithms. *Leverage* is the book value of the long-term debt plus debt in current liabilities, divided by total assets. *Net Debt* is the ratio of current plus non-current liabilities minus cash holdings to total assets. *Short-term Debt* is the ratio of current liabilities to total assets. *Bank Debt* is the amount of debt from bank loans, divided by total assets. *Firm Size* is the total assets, given in logarithms. *Market to Book* is the book value of assets minus the book value of equity plus the market value of equity, all divided by the book value of assets. *Cash Flow* is the ratio of the cash flow to total assets, where cash flow is the earnings after interest and related expenses, income taxes, and dividends. *Industry Sigma* is industry cash flow risk, measured by the mean cash flow volatility across two-digit SIC codes. *Net Working Capital* (NWC) is the difference between current assets and current liabilities net of cash, divided by total assets. *R&D/Sales* is the ratio of R&D to sales. *Acquisition Activity* is the ratio of acquisitions to total assets. *Sovereign Risk* is the five-year sovereign CDS spread for the country. *Sovereign Export* is the country's export-to-GDP ratio. The sample period for each country is 2002-2014, and the variables are based on quarterly observations. For the specific definition of each variable we refer to Appendix Table A3. 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.