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Working Papers 2016

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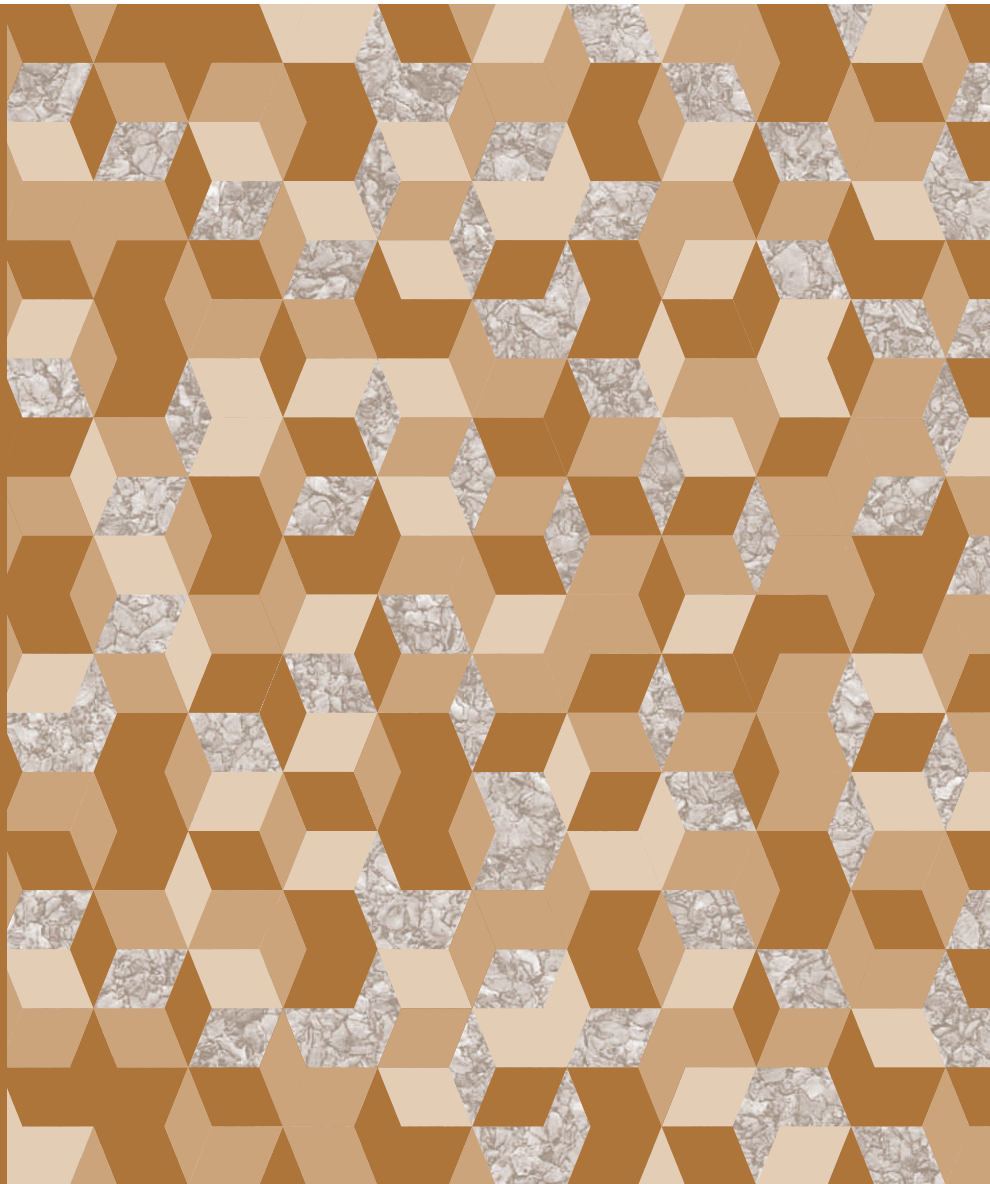

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The Effect of Quantitative Easing on Lending Conditions

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Abstract
We analyze the effect of the ECB's Quantitative Easing program (Expanded Asset Purchase Program - EAPP) on bank lending using security-level bank balance sheet data combined with a comprehensive dataset on new loans in Portugal. Our identification relies on the fact that only a subset of Portuguese banks was exposed to EAPP via prior holdings of EAPP-eligible securities and origination of eligible ABS and covered bonds. Using a difference-in-differences specification with borrower and bank fixed effects, we find that lending rates to the same borrower drop by 64 b.p. at banks exposed to QE relative to banks not exposed to QE. Loan volumes to existing corporate clients grow by one percentage point faster at exposed banks relative non-exposed banks. This result is robust to including both bank and borrower*time fixed effects, as well as a wide range of loan and borrower characteristics. At the extensive margin, the probability of credit approval to a new corporate client is about 1 percentage point higher at exposed banks post-QE announcement.

JEL: E43, E44, E52, G21, G28, E44

Keywords: quantitative easing, unconventional monetary policy.

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1. Introduction

A key goal of Quantitative Easing (QE) is to ease funding conditions for households and firms when policy rates are constrained by the zero lower bound. The ECB's Quantitative Easing program, the Expanded Asset Purchase Program (EAPP) was introduced with the explicit goal to improve lending conditions for firms and households. EAPP, which was announced on January 20, 2015, significantly increased the scope of the ECB's purchases of asset-backed securities (ABSPP) and covered bonds (CBPP3), and extended purchases to sovereign bonds (PSPP). While there is ample evidence on the effect of QE on bond yields (Gagnon *et al.* (2011) and Krishnamurthy and Vissing-Jorgensen (2011)), there is little evidence on the impact of QE on lending conditions to households and firms. This is mainly due to the lack of micro data on asset purchases and interest rates charged by financial institutions. We exploit a new comprehensive dataset on new loans issued in Portugal and combine this data with transaction-level data on EAPP purchases in Portugal. Security-level bank balance sheet data allows us to compute bank-level balance sheet exposure to EAPP. Portugal is a relevant case to study since the size of the EAPP purchases was large relative to the size of the market suggesting a potentially large impact of EAPP. Moreover, firms and households in Portugal are heavily dependent on bank credit, which provides a good setting to study the transmission of QE to the real economy via the bank lending channel. We employ a difference-in-differences design that compares the change in interest rates and lending quantities at banks highly exposed to QE to the change in lending conditions at banks not exposed to QE. Our empirical strategy addresses two key identification concerns: First, we employ borrower as well as borrower*time fixed effects in order to isolate movements in credit *supply* from movements in credit demand. Second, our exposure measure only uses information prior to the announcement of EAPP in order to avoid picking up banks' endogenous responses to EAPP. Detailed loan- and firm-level information from the Central Credit Register and the Portuguese Firm Register (*Informação Empresarial Simplificada*) allows us to control for other lending determinants such as borrower risk, collateral and maturity.

We define two main channels through which financial institutions are exposed to QE: the balance sheet channel and the origination channel.[1] The balance sheet channel is composed of two parts: First, the price increase of the securities that are purchased as part of EAPP leads to valuation gain for the banks that hold them as assets.[2] This in turn improves liquidity positions and capital

1. See also the discussion in Dunne *et al.* (2015).

2. We confirm that there is a positive price impact of EAPP in Portugal using an event-study regression based on the EAPP announcement dates. We find that the announcement of EAPP operations leads to drops in yields between 16 and 93 basis points for eligible Portuguese securities. See also Figure .1 and Appendix A.

ratios, which allows banks to pass on some of this valuation gain in the form of lower interest rates or larger loan quantities. Second, banks may choose to sell the eligible securities on their balance sheet to the central bank in return for cash. This asset sale is likely to lead to a profit for the bank since central bank asset purchases tend to push prices up. Moreover, the exchange of a risky security for riskless cash also improves both liquidity and capital ratios.

The origination channel refers to the increased incentives to originate ABS and covered bonds given improved issuance conditions due to higher market liquidity and increased prices. Covered bonds, which are bonds backed by a pool of mostly high-grade mortgages or loans to the public sector, are an important source of long-term funding for banks and decrease banks' reliance on short-term money market funds. This reduces the maturity mismatch between banks' assets and liabilities and hence improves banks' ability to take on more long-maturity assets (i.e. loans). The ability to securitize lending and issue an ABS also encourages banks to improve access to finance since it allows banks to shift some of the lending risk off their balance sheets. We consider a bank exposed if it is exposed via at least one of the two channels since this yields the most conservative control group and hence the cleanest identification.

Using a difference-in-differences specification with borrower and bank fixed effects, we find that lending rates to the same borrower drop by 64 b.p. in the post-QE period at banks exposed to QE relative to banks not exposed to QE. Turning to quantities, we distinguish between intensive and extensive margin effects: Loan volumes to existing corporate clients, the intensive margin, grow by 1 percentage point faster at exposed banks relative to non-exposed banks. This result is robust to including both bank and borrower*time fixed effects, as well as extensive controls on borrower and loan characteristics. The probability of credit approval to a new corporate client, the extensive margin, is about 1 percentage point higher at exposed banks post-QE announcement. We also provide preliminary evidence on changes in the composition of credit due to QE. The extensive margin results provide evidence that that higher-risk borrowers have a higher probability of being approved at exposed banks relative to high-risk borrowers at non-exposeed banks following QE. We also find evidence that loans eligible for a cover pool register a faster credit growth following the introduction of QE.

1.1. Related Literature

The existing literature focuses on estimating the effect of QE on bond yields using an event study design. Gagnon *et al.* (2011) and Krishnamurthy and Vissing-Jorgensen (2011) examine the announcement effects of long-term asset purchases by the US Federal Reserve. Similarly, Krishnamurthy *et al.* (2013) use an event study to evaluate the two ECB unconventional policies prior to

QE that involve government bond purchases.[3] Falagiarda and Reitz (2015) also look at the effects of ECB unconventional policy announcements on sovereign spreads. Beirne *et al.* (2011) estimate the effect of the ECB's first two covered bond purchase programs on covered bond spreads. There is also a nascent literature focusing on the transmission of unconventional monetary policy to the real sector. Stroebel and Taylor (2012) analyze the effect of the Federal Reserve's mortgage-backed securities purchase program on mortgage spreads. Similar to our research design, Acharya *et al.* (2015) exploit heterogeneous bank exposure to the ECB's Outright Monetary Transactions (OMT) program to study the effect of the announcement on lending conditions in the European syndicated loan market. However, they only study a particular segment of the loan market and focus on a different type of unconventional policy. Carpinelli and Crosignani (2015) also use Central Credit Register data but analyze the effects of long-term refinancing operations (LTRO) on bank lending. To the best of our knowledge, we are the first to evaluate the real effects of Quantitative Easing using comprehensive loan-level data.

2. Background and Data

2.1. Background on EAPP

The Expanded Asset Purchase Program (EAPP) is the first Quantitative Easing program undertaken by the European Central Bank and is the latest unconventional policy measure undertaken in response to the European financial crisis since 2009. EAPP, which was announced on January 20, 2015, significantly increased the scope of the ECB's purchases of asset-backed securities (ABSPP) and covered bonds (CBPP3), and extended purchases to sovereign bonds (PSPP).

The ECB began its first smaller-scale asset purchase program in 2009: The covered bond purchase program CBPP1 was in operation between July 2009 and June 2010. This program was succeeded by a second covered bond purchase program, CBPP2, in 2011. However, the purchase volumes with EUR 60 billion and EUR 16.4 billion respectively were small compared to the EUR 143 billion of covered bonds purchased under EAPP as of January 2016.[4] The first sovereign bond purchase program, the Securities Market Program (SMP), was announced in 2010 and targeted sovereign bonds of distressed Eurozone members. The SMP was superseded in 2012 by the Outright Monetary Transactions (OMT) program which allows the ECB to buy government debt

3. The Securities Purchase Program (SMP) and the Outright Monetary Transactions (OMT) program.

4. See `https://www.ecb.europa.eu/mopo/implement/omt/html/index.en.html` for updated numbers. Accessed 07.01.2016

of countries that are part of an official financial assistance program. To date, the OMT has not been used.

In September 2014, the ECB announced the third covered bond purchase program CBPP3 and added a purchase program for asset-backed securities (ABSPP). With the announcement of EAPP in January 2015, the ECB significantly extended the scope of CPPP3 and ABSPP and complemented the two programs with a public sector bond purchase program (PSPP). See table .1 for exact announcement and implementation dates. Figure .2 shows the total purchases under EAPP. The bulk of the EUR 60 bn monthly purchase volume is concentrated in sovereign bonds (PSPP). ABSPP is the smallest of the three purchase programs reflecting the lack of large, liquid ABS markets in Europe. ABS, covered bonds and sovereign bonds are eligible for EAPP as long as they are denominated in EUR, issued by a financial institution (or sovereign) that is resident in the Eurozone, and eligible for collateral at the ECB. In September 2015, the ECB clarified the conditions to extend ABSPP purchases from senior to mezzanine ABS tranches.

As in previous programs, the purchases, which are mostly conducted by national central banks, can take place both in primary and secondary markets with purchases being concentrated in secondary markets for all three programs.

Portugal provides an excellent laboratory to study the effect of EAPP on lending conditions since purchases were large relative to market size and low liquidity markets are likely to register a larger price impact than larger and more liquid markets. Figure .3 shows total purchases in Portugal and Figure **??** the fraction of EAPP transactions conducted in Portugal. On average, monthly purchases in Portugal present about 3%-8% of Eurozone-wide purchases. However in January 2015, the fraction of ABS purchased in Portugal peaked at close to 35% of Eurozone-wide purchase volumes of ABS.

2.2. Data

2.2.1. Credit register. Our main data set is the loan level Central Credit Register maintained by the Banco de Portugal. Our sample period throughout the analysis is January 2013 until June 2015. With a loan threshold of EUR 50, the Credit Register contains almost the universe of outstanding loans to firms and individuals. We impute interest rates on household loans by using information on monthly installments according to the following formula:

$$i_{it} = \frac{I_{it} - (L_{it-1} - L_{it})}{L_{it-1}}$$

where I_{it} is the value of the installment on loan i in month t and L_{it} is the outstanding balance of the loan. The Portuguese Credit Register does not contain a loan identifier that would allow us to track loans over time. We therefore reconstruct a loan identifier based on an individual's anonymized ID, the lender ID and loan characteristics (type of product, level of lender's

responsibility, original maturity and a variable which identifies if the loan is collateralized). Installments are reported for consumer credit, automobile loans, mortgages and other housing credits. We hence have interest rates for 53% of the Credit Register for individuals, which amounts to a monthly average of 3.3 million loans.[5] Our interest rate regressions only use information on new loans which we define as loans that appear in the data for the first time.

Our data on firm interest rates comes from a database on new lending operations that contains information on the amount, maturity and the interest rate of new loans as well as information on collateral. This new operations data was made a mandatory reporting requirement for the eight largest Portuguese commercial banks in June 2012. In January 2015, the reporting scope is extended to all banks. This reporting restriction is important since all eight largest commercial banks fall under our definition of exposure and hence we lack information on the corporate lending rates for the non-exposed group in the pre-treatment period. This restriction does not apply to individuals which allows us to run a difference-in-differences specification on the whole sample that combines firms and individuals. The banks that start reporting after January 2015 represent on average 13.9% of new lending operations.

In addition, we make use of special loan characteristics reported by banks. In particular, we use the codes that identify whether a loan is securitized, or whether the loan is part of the cover pool of a covered bond. This allows us to identify the loans that banks use to issue an ABS or a covered bond and to investigate if these loans were affected differently by QE.

For corporate lending, we also draw on the database on loan consultations.[6] Banks can request information on a potential borrower from the Central Credit Register. While the cost of this request is zero, consultations are usually conducted for a serious enquiry of a potential new corporate client.

An important feature of the data is that non-financial firms and individuals have multiple lending relationships. On average 54% of the firms in our sample have multiple banking relationship with the average number of lenders being 1.9 (median of 2). For households, the average number of lenders is 2.5 (median 2). 58% of households in our sample have more than 1 lender. This allows us to implement a borrower fixed effect strategy following Khwaja and Mian (2008).

Finally, we match each firm loan to information from the firm's financial statements from the Portuguese Firm Register (Informação Empresarial Simplificada) which allows us to calculate a time-varying credit risk measure (z-score).

5. In the next iteration of this paper, we will have access to a loan-level database that contains direct information on interest rates of individual household loans.

6. Privacy concerns currently restrict access to the loan consultations on individuals.

2.2.2. Bank data. We draw on several data sources to compute banks' exposure to QE. First, we use the Monthly Financial Statistics that contain balance sheet information for financial institutions operating in Portugal. We merge this data with ISIN-level security holdings from the SIET database (*Estatìsticas de Emissões de Títulos*). Our sample of financial institutions contains credit granting financial institutions that both report to the Central Credit Register and the Monthly Financial Statistics. This includes foreign bank subsidiaries operating in Portugal. We have a total of 80 institutions. Second, we use transaction-level data on all EAPP purchases conducted by the Bank of Portugal on behalf of the European Central Bank. This data includes the date, volume and counterparty of each EAPP transaction in Portugal. In order to compute exposure of a financial institution to EAPP, we need to determine which securities on the bank's balance sheet are eligible for purchase under EAPP. We apply the definition set out by the ECB in decicions 2014/45 (including annex 1 and annex 2) and 2015/774.[7] The main criteria is that the security be of the correct asset class and eligible for collateral at the ECB. We obtain the list of marketable securities that are eligible for collateral from the ECB website at the monthly frequency.[8] We then check that the securities listed at the ECB also fulfill the additional criteria for EAPP eligibility, namely that the security be denominated in Euro and is issued in the Eurozone.

3. Effect on Credit Supply

3.1. Exposure Channels

We define two main channels of bank exposure to QE: The balance sheet channel and the origination channel.

Balance sheet channel. The balance sheet channel is composed of two parts: First, the price increase of the securities that are purchased as part of EAPP leads to valuation gain for the banks that hold them as assets. This in turn improves banks' liquidity position and capital ratios, which allows banks to pass on some of this valuation gain in the form of lower interest rates, or larger lending quantities. We confirm that there is a positive price impact of EAPP in Portugal using an event-study regression based on the EAPP announcement dates (see Appendix A). We find that the announcement of EAPP leads to

7. The relevant documents can be found at: PSPP `https://www.ecb.europa.eu/ecb/legal/pdf/oj_jol_2015_121_r_0007_en_txt.pdf`. ABSPP `https://www.ecb.europa.eu/press/pr/date/2014/html/pr141002_1_Annex_1.pdf?c4144e9908c29df066a053246f81d1ff`. CBPP `https://www.ecb.europa.eu/press/pr/date/2014/html/pr141002_1_Annex_2.pdf?0ba2a520b8a2b7ad8ff6bfb99333ba2`

8. The list is available at `https://www.ecb.europa.eu/paym/coll/assets/html/index.en.html`

drops in yields between 16 and 93 basis points for eligible Portuguese securities. Figure .1 illustrates the evolution of yield spreads of Portuguese government bonds, covered bonds, and ABS during the announcement and implementation of QE.[9]

Second, banks may choose to sell securities on their balance sheet to the central bank in return for cash. This asset sale is likely to lead to a profit for the bank since central bank purchases tend to push prices up. Given the low profitability of Portuguese banks during the period we study, the profit gain is a particular important aspect. Moreover, the exchange of a risky security for riskless cash improves both liquidity and capital ratios. From August 2014 to June 2015, Portuguese banks reduced their holdings of eligible covered bonds and ABS by 34.5% (in nominal value). From December 2014 to June 2015 Portuguese banks also decreased their holdings of eligible government bonds by 8% (nominal value). This suggets that banks indeed engaged in a portfolio re-balancing away from EAPP-eligible securities.

Origination channel. The origination channel refers to the increased incentives to originate ABS and covered bonds given improved issuance conditions such as higher market liquidity and securities prices. Covered bonds, which are bonds backed by a pool of mostly high-grade mortgages or loans to the public sector, are an important source of long-term funding for financial institutions. They are considered as relatively safe by investors since investors have a preferential claim on the assets in the cover pool in the event of default. The issuance of covered bonds decreases banks' reliance on short-term money market funds. This reduces the maturity mismatch between banks' assets and liabilities and hence improves banks' ability to take on long-maturity assets (i.e. loans). On the asset side, the ability to securitize lending also encourages banks to improve access to finance since it allows banks to shift some of the lending risk off their balance sheets. As of June 2015, banks issued a total of 12.7 EUR billion in covered bonds and ABS following the announcement of CBPP3 and ABSPP on September 4, 2014. Of these, 4.4 EUR billion were eligible for EAPP (see table .4 for a list of issuances).

Exposure definition. In our ideal experiment, we would compare the responses to QE of banks that are randomly assigned holdings of QE-eligible securities and/or the ability to issue covered bonds and ABS. However, in reality the balance sheet composure and the decision to issue new covered bonds and ABS are endogenous choices. In order to address these potential endogeneity concerns, we use exposure measures that only use pre-announcement information. For the balance sheet exposure, we use bank holdings of EAPP-eligible assets in the month prior to the EAPP anouncement as a measure of exposure. For ABSPP and CBPP, we use holdings of eligible

9. Unfortunately, it is not possible to identify the yield impact over the course of the purchases which means it is not possible to calculate the total realized valuation gain for each financial institution.

ABS and covered bonds in August 2014, the month prior to the announcement of these two programs. Since EAPP was an extension of the existing ABS and covered bond programs, we consider the announcement of the original programs as the relevant cut-off date. For PSPP, we use eligible sovereign bond holdings in December 2014, the month before PSPP was announced. If the announcement is unexpected, the holdings of eligible assets prior to announcement are not affected by EAPP. We run a news search for articles related to the asset purchase programs and do not find evidence of coverage prior to August 2014.[10] Moreover, we find evidence of a significant announcement effect on yields both in September 2014 (for ABSPP and CBPP) and in January 2015 (for PSPP) which is further evidence that the purchase programs were not anticipated prior to announcement (see Appendix A). This definition thus ensures that our measure of exposure is not confounded by endogeneous changes in holdings in response to the announcement of QE. Figure .4 shows the average exposure to eligible government bonds and ABS/covered bonds as well as the dispersion of exposure across financial institutions. Pre-EAPP exposure to eligible securities is on average 12% of total assets with a large standard deviation of 6 p.p. Figure .5 shows a histogram which illustrates that there is considerable dispersion in the exposure to QE via the balance sheet channel.

For origination, our measure of exposure is whether a financial institution had a covered bond or ABS outstanding prior to the Lehman bankruptcy in 2008. The rationale for this measure is that only a subset of financial institutions operating in Portugal have the technology to issue covered bonds and/or ABS. For example, a credit institution that has issued a covered bond has the ongoing obligation to maintain sufficient assets in the cover pool, to monitor the assets' credit quality, to maintain the correct amount of over-collateralization and to keep up-to-date valuations of the loans' underlying collateral. Moreover, the credit institution needs access to the technology to structure and place the security. We choose the 2008 cut-off because the Lehman bankruptcy led to a widespread collapse of the securitized asset market in Europe and many banks stopped issuing ABS and covered bonds post-2008. Hence issuance post-2008 is not a good proxy of whether a credit institutions possesses the issuance technology. Only 13 (out of 80) institutions in our sample have outstanding ABS or covered bonds before 2008. Of these, 7 institutions issue eligible ABS and/or covered bonds following the announcement of CBPP3 and ABSPP in September 2014. One institution which did not have covered bonds outstanding prior to 2008 issues an eligible covered bond in September 2015.

We take the union of the two measures and define an institution as exposed to QE if it is either exposed via the balance sheet or origination channel. This yields a total of 26 exposed institutions and 54 non-exposed institutions. The

10. The first mention is in the FT on the 25th of August in a blog by Gavin Davies entitled "Draghi steals the show at Jackson Hole".

non-exposed banks hold roughly 9% of the total credit volume in Portugal prior to QE. Table .3 summarizes the number of institutions that are exposed under each measure. Exposed banks are on average larger, worse capitalized but less levered than their non-exposed counterparts (see table .2). Profitability is extremely low for both groups reflecting low profitability of Portuguese banks more generally. For both groups, credit to household and firms represents an important balance sheet item, while securities holdings are much larger for exposed banks. Exposed banks rely more on household deposits and less on debt financing. However, both have similar exposure to firm deposits.

3.2. Effect on Credit Supply

We employ a difference-in-differences strategy to identify the effect of EAPP on lending conditions. We look at the following three main outcomes: (1) The effect on interest rates of new loans to firms and households, (2) the effect on the lending supply to existing customers (intensive margin), (3) the effect on the lending supply to new customers (extensive margin). In the first specification, given in equation 1, the dependent variable is the interest rate on a new loan j to a non-financial firm or household i at bank b in month t. Exp_{bt} is 1 for banks exposed to quantitative easing and 0 otherwise, and Post is 1 after the announcement event and 0 otherwise. β is the coefficient of interest that captures the change in lending rates post-QE at banks exposed to QE relative to banks not exposed to QE. As long as lending trends at both groups of banks would have evolved in the same way absent QE, β identifies the causal effect of QE on lending rates.

$$r_{jibt} = \beta(\text{Exp}_{bt} \times \text{Post}) + \mathbf{X}_{jibt}\gamma + \theta_t + \varphi_i + \mu_b + \varepsilon_{ibt} \tag{1}$$

We include an exhaustive list of controls in our regression: Our baseline results include time, bank and borrower fixed effects following the design employed by Khwaja and Mian (2008) and Jiménez *et al.* (2014). The date fixed effects absorb any changes common to all banks in a given month. The bank fixed effects absorb any heterogeneity across banks that is not time-varying. The borrower fixed effects absorb any heterogeneity across borrowers. In the quantities regression (specification 2), we also include borrower*time bank fixed effects. The borrower*time fixed effects control for time-varying changes in credit demand at the borrower-level and hence address concerns that changes in lending conditions may be driven by the borrowers' credit demand rather than by credit supply.[11] We control for loan-level characteristics including the size of the loan, collateral, maturity and product. In addition, we control for

11. We cannot include borrower*time fixed effects in the interest rate specification since there are insufficient new lending operations by the same borrower with multiple lenders *in the same month.*

borrower-bank level variables such as the duration of the lending relationship and whether the borrower has any defaulted with that bank.[12] In addition to bank fixed effects that capture time-invariant unobserved differences among banks, we include measures of banks (time-varying) funding conditions. Since the ECB continued the LTRO and TLRO operations concurrently with the EAPP purchases, we include the amount of a bank's LTRO and TLTRO as a share of assets as a control variable. We cluster standard errors at the bank level. An important restriction imposed by our data is that the new operations database for firms until January 2015 is only mandatory reporting for the eight largest commercial banks. Since all eight largest commercial banks fall under the exposed definition, we lack observations for the control group in the pre-treatment period. However, when complementing the firm loan-level data with the data on inviduals, we can run the difference-in-differences specification in the full sample.

Equation 2 gives the difference-in-differences specification for quantities at the intensive margin, that is the evolution of credit to existing borrowers. The dependent variable is the log change in total credit volume at the borrower-bank level.[13] The reason that we move to the borrower-bank level is that the Portuguese Credit Register does not track individual loans over time.[14] However, the advantage of the quantity specification is that we can include borrower*time fixed effects that account for time-varying changes in credit demand.

$$\Delta Log(Credit_{ijt}) = \beta(\text{Exp}_{bt} \times \text{Post}) + \mathbf{X}_{jibt}\gamma + \theta_{it} + \mu_b + \varepsilon_{ibt} \qquad (2)$$

Our third specification, given in equation 3, considers the extensive margin of credit supply. Here we ask whether the change in the probability of a loan application being approved following QE increases at banks exposed to QE relative to banks not exposed to QE. In order to define the probability of a successful loan application, we draw on a database that records all consultations

12. We define a loan as being in default when the loan has been overdue for more than three consecutive months.

13. The loan volume includes regular, potential, overdue and renegotiated credit. We exclude written off credit since this is credit that the bank no longer expects to recover. The reason for combining the remaining categories is that classifications of regular credit into overdue or renegotiated credit can induce movements of regular credit that are unrelated to movements in the total credit volume of the firm. Similarly, the drawing down of credit lines leads to a reduction in potential credit and an increase of regular credit. Such movements do not reflect the granting of additional credit but merely the reallocation of existing resources. Abstracting from these movements and only focusing on regular credit could lead to misleading results. Any increase in the credit volume will be due to an increase in either in regular credit or in potential credit, which is the effect we want to capture.

14. It is difficult to construct a loan identifier based on loan characteristics since there were several breaks in the reporting format.

a bank makes about potential clients. The dependent variable equals 1 if the loan consultation made in month t by bank b about firm i is successful and we see a credit relationship between t and t+12 and equals 0 otherwise. Figure .6 shows that virtually all successful loan applications get approved within the first twelve months with the majority being approved within three months. We run a logit specification that includes the same controls as in the intensive margin regression. Given the nature of the consultations data, we can only include borrower, bank and time fixed effects. Borrower*time fixed effects would require a firm repeatedly making loan applications to different banks in the same month, which is a very strong requirement of the data.

$$Pr(\text{loan app granted})_{ibt} = \beta(\text{Exp}_{bt} \times \text{Post}) + \mathbf{X}_{ibt}\gamma + \theta_t + \mu_b + \varepsilon_{ibt} \qquad (3)$$

3.3. Results

Our baseline result in table .5, which includes separate bank and borrower fixed effects, suggests that lending rates to the same borrower drop by 64 b.p. at banks exposed to QE relative to banks not exposed to QE. The magnitude of the effect is very similar in the specification with and without a large set of control variables about borrower characteristics. When interacting the Exp × Post coefficient with the type of loan product, the most significant interest rate reductions occur for products usually associated with firms such as securities leasing, factoring, current accounts, general firm finance and discounts (in order of magnitude).

At the intensive margin (specification 2), loan volumes grow by 1 percentage point faster at banks exposed to QE following the first program announcement. This result is virtually unchanged across different specifications that include (a) bank, time and borrower fixed effects with and without controls (colums 1 and 2 of table .6), and (b) borrower*time fixed effects in the third column of table .6. The interaction of product reveals a heterogeneous picture with some types of credit, such as discounts and current accounts increasing more, while some types (overdrafts) growing less at exposed banks post-QE. Overall, the effect of QE seems relatively evenly spread across product types.

At the extensive margin, the probability of a loan approval is 1 p.p. higher at exposed banks following the first QE announcement (see first column of table .7). Due to few repeated observations for the same firm, we cannot include borrower fixed effects in the regression. We hence cannot control for shifts in the composition of loan applications at exposed relative to non-exposed banks that occur concurrently with the introduction of QE. When controlling for a measure of credit risk (z-score), we find that the effect is no longer statistically significant but a high z-score, that is a high risk measure, reduces the likelihood of credit approval as expected. In column (3) however, we interact the z-score with the Exp × Post coefficient and find evidence consistent with a risk-shifting effect: A p.p. increase in the z-score of the applicant leads to a 0.07 p.p. increase

in the likelihood of approval at an exposed bank post QE announcement relative to a non-exposed bank in the post-QE period. However, given an average loan approval rate of 2.5%, this magnitude is economically significant.

3.4. Robustness

The key assumption of our difference-in-differences design is that lending conditions at exposed and non-exposed banks follow parallel trends. In order to formally test this assumption, we run a dynamic difference-in-differences version of each specification in the preceding section that includes monthly lags and leads around the QE announcement dates for exposed banks (see equation 4). The set of lags and leads summarizes the difference of the set of exposed banks relative to the non-exposed banks. In this specification, we can test for the existence of pre-trends by testing for the equality of the lag dummies. If exposed banks exhibit no significant pre-trends, the F-test should fail to reject the equality of the lag dummies for exposed banks. In addition, if there is no significant difference in *levels* between exposed and non-exposed banks, then we should also fail to reject a F-test on the joint significance of the lags. Similarly, we can run F-tests on the equality of the leads as well as the joint significance of the leads. This tests whether there is a divergence in trend or level respectively for exposed banks *after* QE announcement. We include 6 lags before the announcement month.[15] The specifications we report in the preceding section effectively contain the same information but for ease of interpretation summarize the set of lead dummies with a single indicator (namely the Exp $\times$ Post interaction).

$$r_{jibt} = \sum_{k=-6,9} \beta_k^{\text{exp}} 1_{L_{jibt}^{\text{exp}}=k} + \mathbf{X}_{jibt}\gamma + \theta_t + \varphi_i + \mu_b + \varepsilon_{ibt} \tag{4}$$

$$\begin{aligned} H_0^{\text{Pre}} &: \beta_{-6}^{\text{exp}} = \beta_{-5}^{\text{exp}} = \cdots = \beta_{-1}^{\text{exp}} \\ H_0^{\text{Post}} &: \beta_0^{\text{exp}} = \beta_1^{\text{exp}} = \cdots = \beta_9^{\text{exp}} \end{aligned} \tag{5}$$

Table .8 reports the F-tests for each of the three specifications. In each case, we use our preferred specification. For the quantity intensive margin, we report results both for the specification with borrower, time, and bank fixed effects, as well as for the tighter specification with borrower*time and bank fixed effects.

15. We normalize the 5th lag to 1. This normalization is necessary since the full set of leads and lags always sum up to one for the exposed group and our specification includes individual fixed effects, therefore one of the leads and lags must be "normalized" to one.

4. Effect on Loans Eligible for Securitization and Cover Pools

Since one of the stated goals of EAPP is to revive the securitization and covered bond markets by spurring origination of these vehicles, we may expect loans eligible for securitization or inclusion in a covered bond pool to be affected differently from non-eligible loans. A credit institution looking to issue a new covered bond or ABS may offer better lending conditions to a borrower whose loan can be securitized or included in a cover pool. We identify loans eligible for inclusion in a cover bond pool and loans eligible for securitization from several special codes in the Credit Register. This definition implies that we have to use an event-study specification for the sample of banks exposed via the origination channel. The reason we cannot employ a difference-in-differences design is that our current definition of an eligible loan only identifies loans at banks that have the technology to issue covered bonds or ABS, that is, banks exposed via the origination channel.[16]

Equation 6 shows the specification for the eligiblity regressions. β_{ABS} tells us whether loans eligible for securitization at banks that have the technology to issue ABS (as measured by pre-Lehman issuance) see a larger reduction in interest rates compared to non-eligible loans at the same bankin the post-QE period. β_{CB} gives the corresponding quantity for covered bonds. We include the same controls as before and again cluster standard errors at the bank level.

$$\begin{aligned} r_{jibt} = \beta_{ABS}\left(\text{Post} \times \text{ABS eligible}_{jibt}\right) + \beta_{CB}\left(\text{Post} \times \text{CB eligible}_{jibt}\right) \\ +\gamma_1 \text{ABS eligible}_{jibt} + \gamma_2 \text{CB eligible}_{jibt} + \theta_t + \varphi_i + \mu_b + \varepsilon_{jibt} \end{aligned} \tag{6}$$

We also run the eligiblity specification for quantities at the intensive and extensive margins, where again we consider the loan volume at the borrower-bank level. For the extensive margin, we assume that a new relationship is eligible for securitization or a cover pool if at least part of the loan exposure of this relationship is included in an ABS or a cover pool three months after its inception.

4.1. Results

We find that there is a highly significant increase in loan quantities for eligible loans at banks with pre-exisiting technology to issue covered bonds following the announcement of CBPP3. We find that at those banks the lending volumes of cover pool eligible loans grow by 2.8 p.p. faster after QE relative to the pre-QE period (see column 1 of table .9). We find no corresponding effect for ABS. The effect is robust across specifications with and without borrower fixed

16. In future versions of this paper, we will use loan characteristics to identify loans that would be hypothetically eligible for securitization, or a covered bond pool at non-exposed banks.

effects. For rates, the results do not appear very conclusive. Due to limited observations of loans eligible for inclusion in covered bonds in the sample of loans for which we observe interest rates, the coefficients get dropped in the regression. For ABS, table .10 suggests that there is a positive effect on interest rates, which goes counter our prior that ABS should benefit proportionally more from the introduction of QE. Results for the extensive margin are similar (see table .9). Cover pool coefficients get dropped because there are not enough new cover pool eligible loans. Eligibility for ABS increases the likelihood of having successful consultations by about 4 p.p. However, the introduction of QE does not seem to have a significant impact.

5. Conclusion

We study the effect of Quantitative Easing on lending conditions to firms and households using comprehensive loan-level data from Portugal. We find evidence of a significant easing of lending conditions to firms and households at banks exposed to Quantitative Easing both via lower prices and larger quantities. We also provide a framework for studying bank exposure to Quantitative Easing. Banks can be exposed via two channels: The balance sheet channel includes both valuation gains from holding QE-eligible securities, whose prices get pushed up by QE, and profits from selling these QE-eligible securities. The origination channel refers the gain from improved conditions to issue ABS and covered bonds. These improved issuance conditions in turn improve the funding conditions of banks and offer an opportunity to move lending risk off their balance sheet. These findings are important for informing unconventional monetary policy, which has become an increasingly important tool in a zero-lower bound environment. Our results suggest that there is a transmission of QE to the real economy via the bank lending channel. We also provide preliminary evidence that there is also a shift in lending composition in response to QE. Our results suggest that there may be significant heterogenous effects according to borrower risk and type of loan. In particular, we find that riskier firms have a higher chance of loan approval at banks exposed to QE. These compositional shifts provide interesting avenues for further work.

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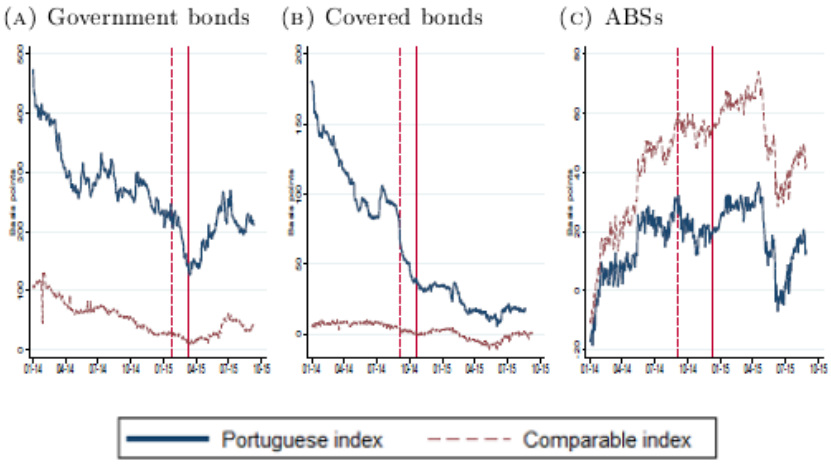

FIGURE .1: **Yield spread of Portuguese asset indices affected by QE.** The blue line represents the spread over the risk-free rate of the Portuguese index . The red dashed line represents the spread of a comparable index that is not affected by EAPP. We use the generic euro-denominated 10-year government bond yields of Portugal and Poland in the first graph. In the second graph we compare the Portuguese and the British euro-denominated covered bond indices from iBoxx. We create euro-denominated ABS indices for Portugal and the UK using EAPP-eligible securities. The vertical lines represent the announcement and implementation dates of EAPP for each asset class.

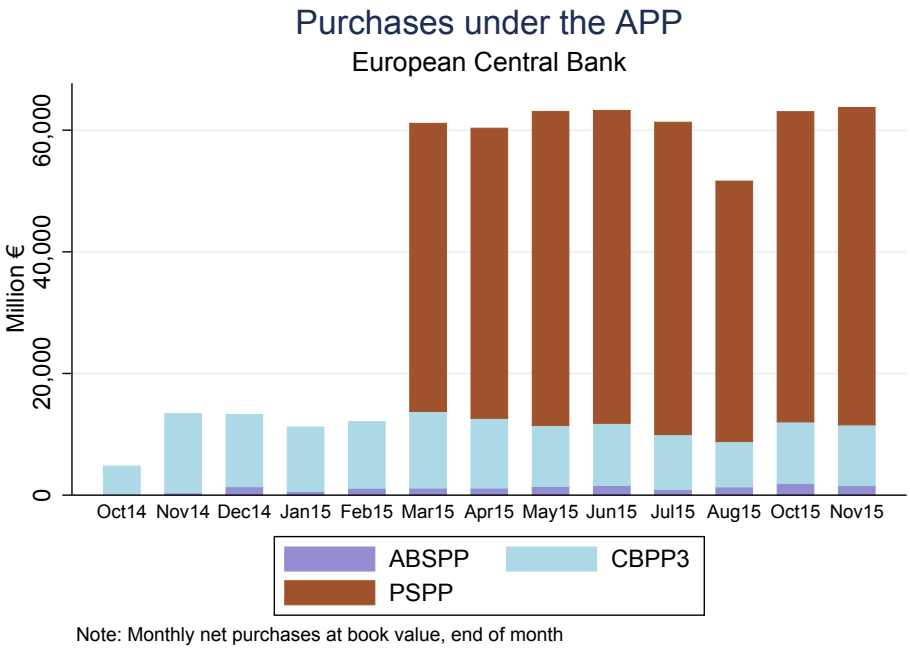

FIGURE .2: **Global volume of purchases under the EAPP.** The figure displays the volume of asset purchases under EAPP from October 2014 to November 2015 for all members of the Euro Area.

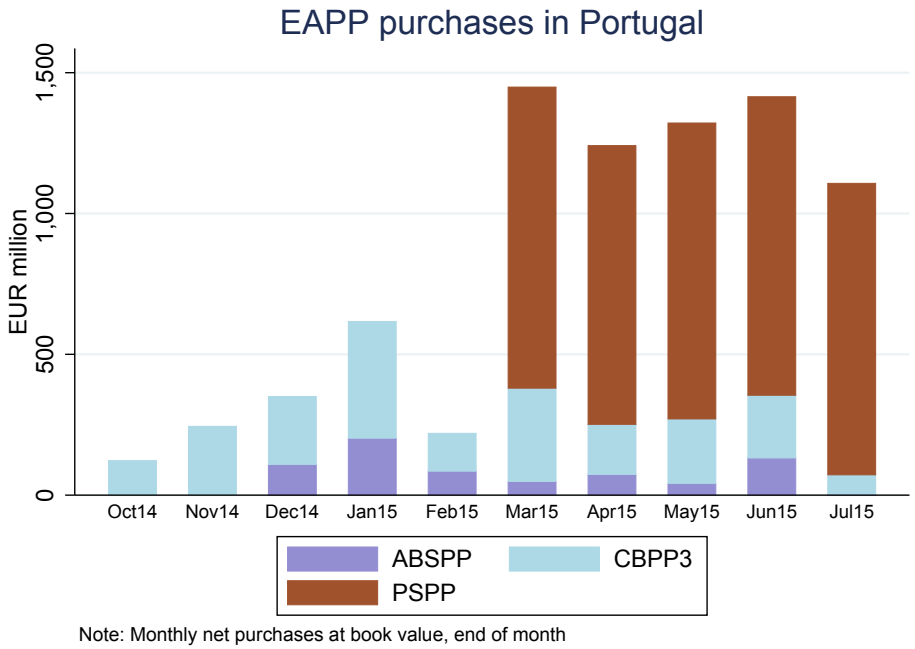

FIGURE .3: **EAPP purchase volume in Portugal.** The figure displays the volume of asset purchases in Portugal under EAPP from October 2014 to July 2015.

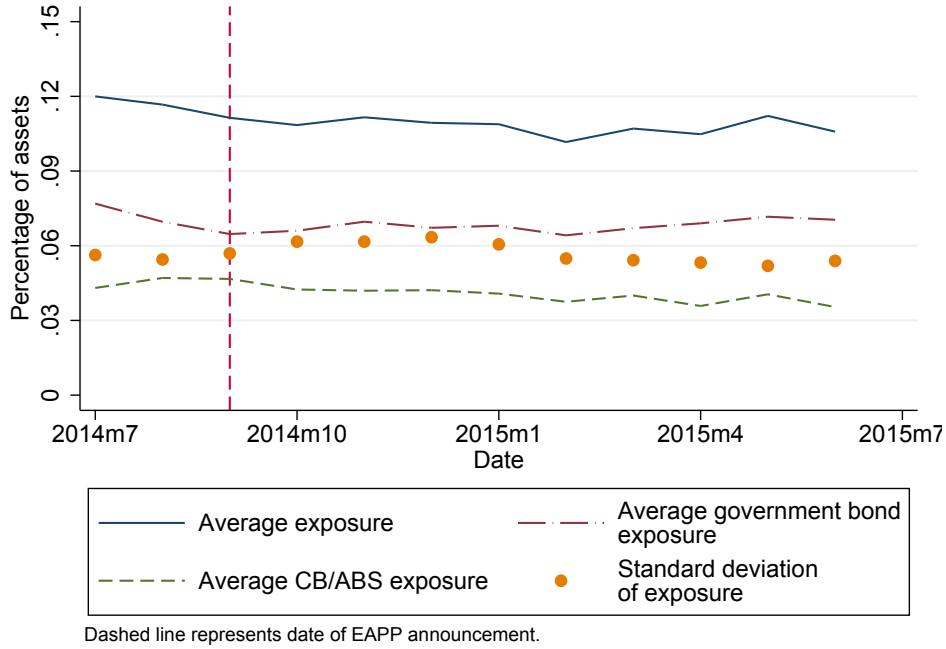

FIGURE .4: **Bank exposure to QE.** The figure displays the average exposure of Portuguese banks to Quantitative Easing.

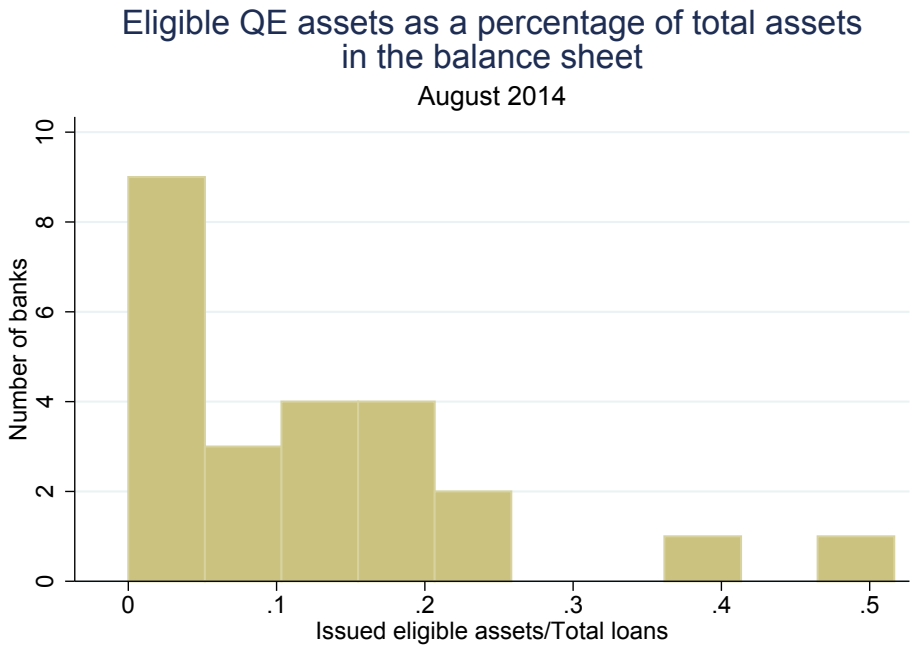

FIGURE .5: **Histogram of Balance Sheet Exposure**The figure displays the share of eligible EAPP securities as a fraction of total loans. Securities are measured in book values.

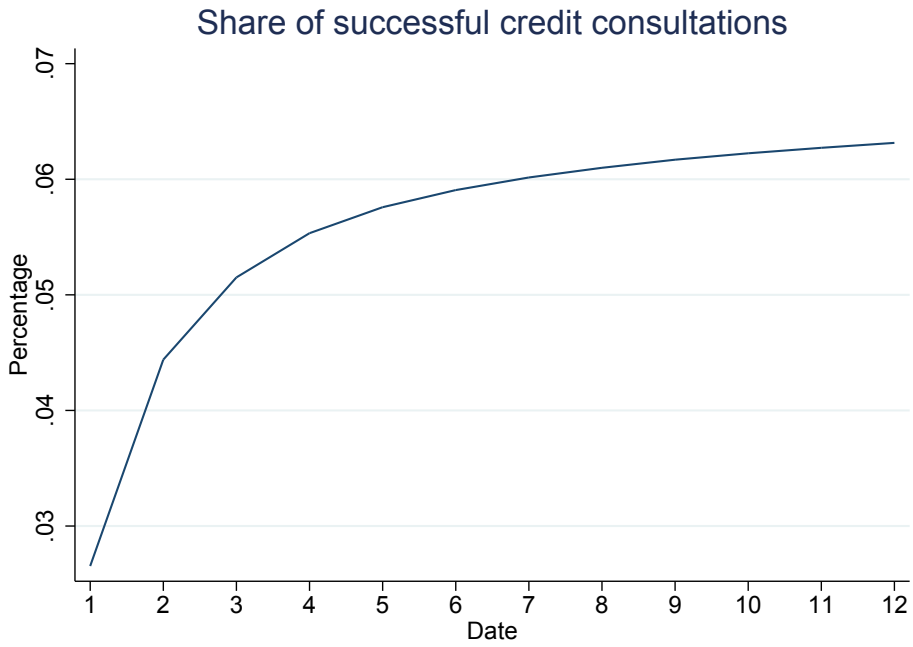

FIGURE .6: **Approved loan consultations.** The figure displays the percentage of loan consultations that get approved t months after the consultation is made.

Program	**Announcement**	**Implementation (Portugal)**
CBPP3	Sep. 4 2014	Oct. 20 2014
ABSPP	Sep. 4 2014	Nov. 21 2014
PSPP	Jan. 22 2015	Mar. 9 2015

TABLE .1. QE announcement and implementation dates

	Exposed	Non exposed	Normalized difference
Size (EUR bn)	61,516.99	7,246.11	2.40
Tier 1 Ratio (units)	0.25	0.44	-0.86
Leverage (units)	0.87	0.91	-0.53
Net Income (% of Assets)	-0.00	0.01	-1.57
Credit to Households (% of Assets)	0.27	0.34	-0.38
Credit to Firms (% of Assets)	0.20	0.24	-0.20
Securities (% of Assets)	0.25	0.06	2.38
LTRO/TRLTRO (% of Assets)	0.03	0.00	0.56
Households' Deposits (% of Assets)	0.24	0.04	2.19
Firms' Deposits (% of Assets)	0.20	0.24	-0.20
*Interest rate (%)	7.80	10.03	-0.67
*Loan volume (Euro)	284,020	142,460	0.01
*Acceptance rate (% of consultations)	0.01	0.00	0.62
N	26	54	.

The table shows means weighted by total assets for each exposure group in August 2014.
Variables marked with * are medians.
Exposed banks are either exposed via EAPP-eligible asset holdings, or the origination of ABS or covered bonds prior to 2008.
The normalized difference is $\frac{\bar{X}_{\text{exp}} - \bar{X}_{\text{non exp}}}{\sqrt{S^2_{\text{exp}} + S^2_{\text{non exp}}}}$

TABLE .2. Descriptive statistics for exposed and non-exposed banks

	No balance sheet exposure	Balance sheet exposure	Total
No origination exposure	54	14	68
Origination exposure	2	10	12
Total	56	24	80

Number of banks exposed in each channel.
A bank is exposed via the balance sheet channel if if holds EAPP eligible assets prior to the EAPP announcements.
A bank is exposed via the origination channel if it originated an ABS or covered bond prior to 2008.

TABLE .3. Exposure Channels

Issuer/originator	Type	Date of issuance	Amount issued	Eligible (8 Jan 2016)
Banif	ABS	30-09-2014	465	Yes
Banif	ABS	30-09-2014	186	No
Banif	ABS	30-09-2014	180	No
Banif	ABS	30-09-2014	55	No
Banif	ABS	30-09-2014	41	No
Banif	Covered bond	27-10-2014	50	Yes
Banco Popular	Covered bond	30-12-2014	290	Yes
CGD	Covered bond	27-01-2015	1,000	Yes
Santander Totta	Covered bond	04-03-2015	750	Yes
BPI	Covered bond	30-03-2015	1,250	Yes
Montepio	ABS	03-06-2015	546	Yes
Montepio	ABS	03-06-2015	399	No
Montepio	ABS	03-06-2015	87	No
Montepio	ABS	03-06-2015	76	No
Montepio	ABS	03-06-2015	16	No
Banif	ABS	07-06-2015	440	Yes
Banif	ABS	07-06-2015	173	No
Banif	ABS	07-06-2015	164	No
Banif	ABS	07-06-2015	36	No
Banif	ABS	07-06-2015	33	No
Banco Popular	Covered bond	30-06-2015	225	Yes
Credibom	ABS	21-07-2015	500	Yes
Credibom	ABS	21-07-2015	146	No
Banco Popular	Covered bond	28-09-2015	300	Yes
Novo Banco	Covered bond	07-10-2015	1,000	Yes
Novo Banco	Covered bond	07-10-2015	1,000	Yes
Novo Banco	Covered bond	07-10-2015	1,000	Yes
Novo Banco	Covered bond	07-10-2015	700	Yes
BPI	Covered bond	07-10-2015	200	Yes
BPI	Covered bond	07-10-2015	100	Yes
Santander Totta	Covered bond	27-10-2015	750	Yes
Montepio	Covered bond	09-12-2015	500	Yes

TABLE .4. Origination of ABS and Covered Bonds post-EAPP

	1	2	3
Exposed × Post	-0.534**	-0.641*	
	(0.023)	(0.081)	
Share LTRO		1.282*	0.934*
		(0.091)	(0.087)
Exposed × Post × Discounts			-1.201***
			(0.004)
Exposed × Post × Current accounts			-2.135***
			(0.002)
Exposed × Post × Overdrafts			-0.676
			(0.313)
Exposed × Post × Factoring			-2.473***
			(0.000)
Exposed × Post × Real estate leasing			-0.209
			(0.882)
Exposed × Post × Securities leasing			-3.450**
			(0.011)
Exposed × Post × Firm finance			-1.833***
			(0.007)
Exposed × Post × Mortgage			-1.947
			(0.523)
Exposed × Post × Consumer			2.869
			(0.214)
Exposed × Post × Automobile			-2.927
			(0.128)
Exposed × Post × Other			0.326
			(0.857)
Exposed × Post × Guarantees			-0.319
			(0.925)
Observations	2,363,595	1,776,558	1,776,558
Bank FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Borrower FE	Yes	Yes	Yes
Controls	No	Yes	Yes

p-values in parentheses
Monthly data. Sample: December 2013-June 2015
* p<0.1, ** p<0.05, *** p<0.01

TABLE .5. Regression results: Effect of QE on Lending Rates

	1	2	3	4
Exposed × Post	0.010***	0.010***	0.009**	0.002
	(0.007)	(0.002)	(0.012)	(0.733)
Share LTRO	-0.014		-0.014	-0.014
	(0.182)		(0.148)	(0.155)
Exposed × Post				0.014*
× Discounts				(0.080)
Exposed × Post				0.016**
× Current Account				(0.037)
Exposed × Post				-0.034***
× Overdrafts				(0.000)
Exposed × Post				-0.022
× Factoring with recourse				(0.604)
Exposed × Post				-0.069
× Factoring without recourse				(0.181)
Exposed × Post				0.002
× Real Estate Leasing				(0.776)
Exposed × Post				0.009
× Securities Leasing				(0.356)
Exposed × Post				0.008
× Firm Finance				(0.235)
Exposed × Post				0.014*
× Credit Card				(0.098)
Exposed × Post				-0.004
× Consumer Credit				(0.865)
Exposed × Post				-0.005
× Automobile Loans				(0.591)
Exposed × Post				-0.019**
× Other Credits				(0.022)
Exposed × Post				0.001
× Guarantees				(0.962)
Observations	11,112,933	11,116,434	11,112,933	11,112,933
Bank FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	No	No
Borrower FE	Yes	Yes	No	No
Borrower x time FE	No	No	Yes	Yes
Controls	No	Yes	Yes	Yes

p-values in parentheses
Monthly data. Sample: Jan 2013-June 2015
* p<0.1, ** p<0.05, *** p<0.01

TABLE .6. Regression Results: The Effect of QE on Credit Supply (intensive margin)

	1	2	3
Exposed × Post	0.006***	0.002	0.001
	(0.000)	(0.105)	(0.394)
zscore		-0.041***	-0.052***
		(0.000)	(0.000)
Exposed × Post			0.034***
× zscore			(0.001)
Share LTROs	-0.004***	-0.002**	-0.002*
	(0.003)	(0.037)	(0.051)
Observations	6,195,857	4,091,619	4,091,619
Bank FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Borrower FE	No	No	No

Marginal effects; p-values in parentheses
Monthly data. Sample: Jan 2013-June 2015
* p<0.1, ** p<0.05, *** p<0.01

TABLE .7. Regression Results: Extensive Margin

	Interest rates	Intensive margin Borrower FE	Intensive margin Borrower*time FE	Extensive margin
H^{pre} trends	.395	.161	.482	.186
H^{pre} levels	.414	.015	.208	.160
H^{post} trends	.000	.000	.000	.000
H^{post} levels	.000	.000	.000	.000

This panel reports the p-values of F-tests for equality and joint significance of the β^{exp} coefficients in specification (4) before and after QE. The equality of coefficients is Trends refers to the F-test on the equality of the leads and lags respectively given by given by equation 5 Levels refers to the F-test of the joint significance of leads and lags. P-values are adjusted for the clustering of standard errors around banks. * p<0.1, ** p<0.05, *** p<0.01

TABLE .8. Robustness

	1	2
Exposed × Post × ABS	-0.003	-0.009
	(0.621)	(0.109)
Exposed × Post × CB	0.028**	0.034***
	(0.025)	(0.000)
ABS	-0.000	0.006
	(0.958)	(0.320)
CB	-0.002	-0.072***
	(0.919)	(0.000)
Share LTRO	-0.025*	-0.022
	(0.090)	(0.153)
Observations	8,840,740	8,840,740
Bank FE	Yes	Yes
Time FE	Yes	No
Borrower FE	No	Yes
Controls	Yes	Yes

p-values in parentheses
Monthly data. Sample: Jan 2013-June 2015
* p<0.1, ** p<0.05, *** p<0.01

TABLE .9. Regression Results: Effect of Eligibility for ABS and Cover Pool on Loan Quantity

	1	2
Exposed × Post × ABS	0.533**	0.007
	(0.028)	(0.959)
Exposed × Post × CB	0.000	0.000
	(.)	(.)
ABS	-0.047	0.126
	(0.731)	(0.153)
CB	0.000	0.000
	(.)	(.)
Observations	926,720	926,720
Bank FE	Yes	Yes
Time FE	Yes	Yes
Borrower FE	No	Yes
Controls	Yes	Yes

p-values in parentheses
Monthly data. Sample: Jan 2013-June 2015
* p<0.1, ** p<0.05, *** p<0.01

TABLE .10. Regression Results: Effect of Eligibility for ABS and Cover Pool on Interest Rates

	1	2	3
Exposed × Post	-0.006***	-0.000	0.000
× ABS	(0.000)	(0.862)	(0.997)
Exposed × Post	0.000	0.000	0.000
× CB	(.)	(.)	(.)
ABS	0.044***	0.044***	0.044***
	(0.000)	(0.000)	(0.000)
CB	0.000	0.000	0.000
	(.)	(.)	(.)
zscore		-0.023***	-0.031***
		(0.009)	(0.000)
Exposed × Post			0.023***
× zscore			(0.001)
Share LTRO	-0.005***	-0.001	-0.001
	(0.001)	(0.200)	(0.235)
Observations	4,734,821	3,032,887	3,032,887
Bank FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Borrower FE	No	No	No

p-values in parentheses
Monthly data. Sample: Jan 2013-June 2015
* p<0.1, ** p<0.05, *** p<0.01

TABLE .11. Regression Results: Effect of Eligibility for ABS and Cover Pool on Extensive Margin Quantity

Appendix: A - Yield Impact

This appendix provides details on the event study regression that we run to estimate the yield impact of the QE announcements. We regress a panel of daily yields on announcement day dummies as well as a set of control variables. Equation A.1 shows the regression specification. Our dependent variables are the yields of government bonds that enter the Portuguese sovereign bond index GTPTE10Y Govt, the yields of covered bonds that enter the Portuguese covered bond index provided by iBoxx and all yields of outstanding ABS issued by Portuguese banks.[17] The controls include the risk free-rate, which we approximate by the 5-year Euro swap rate, the daily purchase amount of the security type under EAPP once implementation begins and spreads of comparable securities outside the Eurozone area. For the PSPP regression, we choose the Polish 10-year sovereign bond index denominated in Euro as a comparable index. We also include the yield of a Greek sovereign bond index which controls for Portuguese sovereign yield fluctuations driven by spillovers from the Greek crisis. For the covered bond regression we use the UK Euro-denominated covered bond index provided by iBoxx as a control for movements in covered bond markets unrelated to QE. For the ABS regression, we construct a comparable index from UK ABS denominated in Euro.

$$y_{it} = \alpha_0 + \alpha_1 \Delta q_{it} + \beta_1 D_{\text{announce}} + \beta_2 D_{\text{day post announce}} + \mathbf{x}_{it}\gamma + \varepsilon_{it} \quad \text{(A.1)}$$

The results in table A.1 show that there is a large and highly significant negative impact on all three yield types on the day of announcement. For sovereign bonds and covered bonds, the effect persists on the day after the announcement. These estimates identify the causal effect of the announcement on yields as long as (a) the announcement is not expected and (b) capital is sufficiently fast-moving to affect yields within a day. In all specifications, dummies for the one and two days ahead of the announcement are insignificant (results not reported) suggesting that announcement was not expected immediately prior to the announcement day.[18] The fact that we find a significant impact on the day after the announcement suggests some element of a slow-moving effect.

The actual purchase quantities have no measurable effect on yields. However, this could be due to a lack of daily variation in purchase amounts. Moreover, this specification does not identify the causal effect since we cannot

17. The sovereign bond and covered bond indexes are available on Bloomberg. There is no ABS index available and we hence consider all outstanding ABS.

18. Of course, this does not rule out that EAPP expectations were formed at some point prior to 1-2 days ahead of the announcement and the effect was already priced in at that time. This would lead us to underestimate the true announcement effect.

rule out reverse causality (central bank purchases respond to yield movements) or omitted variables driving both purchase amounts and yields.

	(1) PSPP	(2) PSPP	(3) CBPP3	(4) ABSPP
Announcement	-17.20***	-13.55***	-7.097***	-0.928**
	(1.988)	(2.054)	(0.522)	(0.186)
Day After	-13.47***	-8.543***	-9.045***	0.472
Announcement	(1.587)	(1.714)	(2.277)	(0.637)
Δ risk-free	0.356***	0.637***	0.452***	0.112**
	(0.0281)	(0.0471)	(0.137)	(0.0282)
Δ PSPP	0.00790**	-0.00116		
	(0.00273)	(0.00289)		
Δ spread	0.0803***	0.0582***		
comparable PSPP	(0.0176)	(0.0133)		
Δ Greek		0.0660***		
control		(0.00329)		
Δ CBPP3			0.00236	
			(0.00270)	
Δ spread			0.548***	
comparable CBPP3			(0.131)	
Δ ABSPP				-0.000241
				(0.000418)
Δ spread				0.130**
comparable ABSPP				(0.0375)
N	3,528	3,528	5,292	3,087
Nr of securities in index	8	8	12	4

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

TABLE A.1. Yield Regressions

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