The Asset Reallocation Channel of Quantitative Easing. The Case of the UK

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Abstract

We investigate the impact of the Bank of England's asset purchase program (APP) on the composition of assets of UK banks with unique data on the received reserves injections. Compared to the control group, receiving banks reallocated their assets towards lower risk-weighted investments, such as government securities, but did not supply more credit to the real economy. Overall, our findings suggest that risk-based capital constraints can limit the effectiveness of expansionary unconventional monetary policies and provide incentives for carry trade activities when banks are not adequately capitalised.

Key words: Finance, monetary policy, quantitative easing, bank lending.
***JEL* classification**: E51, G21.

1. Introduction

How do banks adjust their balance sheets in response to unconventional monetary policies, and what are the implications for the real economy? These questions have been raising a lot of interest since the recent financial crisis as a number of major central banks implemented these policies to boost economic recovery and continue to do so during the recent corona crisis. Banks receive cheap liquidity, in the form of central bank reserves injections, as a direct effect of the asset purchase programs. This should encourage banks to lend more to households and businesses, transmitting the impact to the real economy. However, if banks are not adequately capitalised, expansionary unconventional monetary policies might coincide with adverse investment incentives, in the presence of risk-weighted capital requirements. This might limit the aforementioned impact on bank lending. Motivated by the central role of the banking system in supplying credit to the real economy, this paper investigates the impact of the two main waves of the UK asset purchase program (APP), also referred to as quantitative easing (QE), on UK banks' balance sheets, and the role played by capital regulation in shaping this impact. We argue that banks who received liquidity via QE but don't have enough capital to support additional lending (or were unwilling to use capital buffers as capital requirements were increasing), invested in high-yielding sovereigns rather than keeping cash idle.

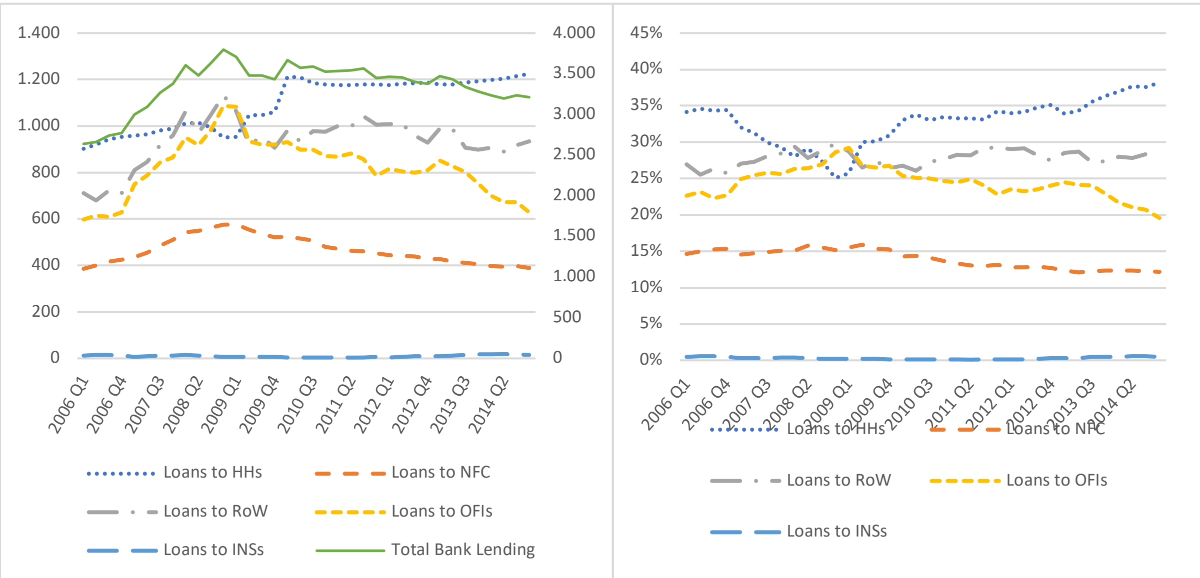
The Bank of England (BOE) Monetary Policy Committee (MPC) launched its program in March 2009, following the precedent first set by the Bank of Japan in 2001, and more recently by the US Federal Reserve (Fed), which introduced its Large Scale Asset Purchase (LSAPs) programs in November 2008. As it is designed to provide monetary easing, the UK APP targeted non-bank financial institutions by purchasing long-term government bonds (gilts) instead of short-term gilts, the latter being predominately held by banks (Joyce and Spaltro, 2014).[1] Additionally, while the BOE's APP concentrated mainly on gilts, the LSAP programs included purchasing large amounts of mortgage-backed securities (MBS) and other agency securities. An important feature of APP is that it targets the stock of asset holdings rather than the rate at which assets are purchased. The purchase is done relatively quickly when the BOE decides to expand, compared to US LSAPs where MBSs are purchased at a certain frequency, mainly weekly. The intrinsic design and operational differences between the UK QE and other QE programs make this empirical exercise unique and differentiate it from other studies discussed in the Literature section.

[1] Regarding the targeting of non-bank financial institutions, especially Insurance Companies and Pension Funds, see point 42 in the minutes of the MPC meeting for the 4 and 5 March 2009 available at: http://www.bankofengland.co.uk/publications/minutes/Documents/mpc/pdf/2009/mpc0903.pdf

In the UK, asset purchases are funded by creating electronic central bank reserves. These reserves are then deposited into the reserves account of the seller's bank (QE-banks) which, in turn, credit the same amount into the deposit account of the seller. APP has provided large amounts of cheap liquidity to banks, in the form of central bank reserves. Therefore, it is plausible to expect an increase in bank lending.

Over the 3 years from the start of the APP, however, total bank lending fell by 1% to 3% annually. Figure 1 shows a fall or little to no growth in every quarter except for 2013 Q1, probably because of funding for lending scheme (FLS) (Churm et al. 2015). Domestic lending fell by over £200 billion when including lending to rest of the world (ROW). Further, lending was skewed in the direction of mortgage lending to households with its share of total bank lending rising from 25.69% in 2009Q1 to 38.18% by the end of 2014. In contrast, the share of loans to non-financial businesses (non-financial corporations and SMEs) fell from 15.91% to 12.16% over the same period.

Figure 1: UK Bank Lending to Different Sectors 2006 to 2014



(a) Amounts Bank Lending (£Billion, RHS Total) *(b) Proportions of Total Lending*

Source: UK ONS Flow of Funds Project: Financial Accounts Excel Sheet 3.2

Notes: UK Bank lending refers to lending by Monetary and Financial Institution; RoW: Rest of World; HHs: Households; PNFCs: Private non-Financial Corporates; OFIs: other financial institutions; INSs: insurance companies and pension funds.

There is consequently a growing debate on whether QE impact can transmit into the real economy through the Bank Lending Channel (BLC). The fall in corporate debt yields and the rise in equity prices, as a result of the portfolio-rebalancing effects of QE,[2] would lower the cost of borrowing for big corporations in capital markets. This can result in corporates substituting bank loans with capital market financing (Nick Butt et al. 2014; Fatouh, Markose, and Giansante 2019). However, the fall in total lending does not necessarily rule the BLC hypothesis out as QE-banks might have increased (or limited the reduction of) lending to the real economy because of the APP cash injections. In this study, we add to the above cited literature by targeting differences in investment behaviour between banks that directly received liquidity through APP and banks that did not.

The paper thereby contributes to the current debate on quantitative easing and banks asset reallocation related to two main strands of literature within the bank lending channel field: the monetary policy literature (Kashyap and Stein 1994; 1995) on the one side, and the capital regulations literature (Peek and Rosengren, 1995) on the other. This paper is the first to empirically assess the impact of UK QE on bank lending by comparing UK banks that received reserve injections from APF, called QE-banks, with those that did not. This is made possible by using a confidential dataset on the UK APP that records both the magnitude of the injections and the identity of the QE-banks involved. This dataset provides the ideal research design for a difference-in-differences exercise that can help answer the empirical question of how banks adjust their balance sheets in response to QE reserve injections and if this adjustment had real economic consequences. Note that recent studies such as Rodnyansky and Darmouni (2015), Kandrac and Schlusche (2017) and Butt et al. (2014) did not have access to a perfect identification of QE banks like we do and had to employ statistical approximation techniques to control for any selection bias.

We construct a panel dataset of 18 years with semi-annual consolidated statements of UK headquartered banks from the second half of 2000 to the first half of 2018. This provides us with nine years before and nine years after the introduction of APP in March 2009. We assess the treatment effect on bank lending after the first and second round of quantitative easing (QE1 and QE2). Consistent with the macroeconomic evidence on total lending to the economy, QE-banks (the treated group) did not show any increase in bank lending compared to the non-QE-banks (the control group). We find that in QE2, customer/retail loans of the treated banks were about 50% lower than those of the control group. Changes to corporate/commercial lending and mortgages did not vary between the two groups. These findings are robust even

[2] This channel leads to the lower yields as the sellers try to buy higher-yielding assets. This is not relevant to banks in UK QE as they do not sell any assets to the BOE. Hence, this channel is not relevant to explain the behaviour of banks in our exercise.

when accounting for potential demand-side effects using loan-level data and controlling for borrower fixed effects.

We then direct our attention to other asset reallocation channels to which banks can reinvest the proceeds of QE. We observe substantially higher central bank reserves and government securities by treated banks in QE1, in the range of 50% and 40%, respectively. We also observe an even larger increase in government securities of around 50% in QE2. We argue that the combination of lower bond yields and higher capital requirements on banks, which, respectively, impact demand and supply of credit in the UK, played a role in the drop of bank loans to businesses. Under risk-weighted capital requirements, banks would prefer to reinvest QE cash in instruments with lower risk weights, like government securities, limiting the effectiveness of monetary policy expansion. Acharya and Steffen (2015) provide strong evidence of carry trade activity of European banks towards GIIPS sovereigns due to risk shifting and regulatory arbitrage. The latter describes the incentive of undercapitalized banks to increase short-term return on equity by investing in the highest-yielding assets with the lowest risk weights to meet their capital requirements. By employing a similar sensitivity analysis on daily market data controlling for the two groups of banks, we confirm that QE-banks were more exposed to peripheral EU sovereigns during both QE waves. This suggests that the cheap liquidity the banks received through APP operation promoted carry trade strategies among QE-banks. Additionally, we confirm our results by exploiting two confidential datasets that include UK banks exposures to the public sector and the sovereigns of different countries. The analysis of the two datasets indicates that the higher sensitivity of stock returns of QE banks is driven by their direct exposures to peripheral EU sovereigns (holdings of these sovereigns), rather than their indirect exposures (exposures to other banks with large exposures to these sovereigns).

There are several challenges to identify the effect of the APP on banks' lending behaviour. First, the selection of banks through which non-bank financial institutions received the value of the gilts sales from APF is most likely not random but reflects specific bank characteristics, like size and the specialisation of the banks business model towards securities. To alleviate the correlation between the QE treatment and banks characteristics, we employ a matching methodology based on a non-parametric probit model that eliminates these differences. We also control for those differences in the main difference-in-differences specifications. Second, the number of QE-banks is quite small and a 1:1 match with control group banks would make our sample size too small for meaningful statistics. We therefore opt for a 1:5 match for the main empirical exercises that provides us with a decent sample size, but still eliminates any differences across covariates.

The paper also includes a variety of robustness checks to validate our results. Following Rodnyansky and Darmouni (2015), we examine the timing of the QE effect between treated and the control group to test time-varying heterogeneity across the two groups. Second, we run a set of placebo tests by dropping all QE-banks. We test the same difference-in-differences specifications, by sampling placebo-treated banks among non-QE-banks and controlling for specific characteristics. We also re-estimate the bank equity return sensitivity model to returns on sovereigns using alternative treatment measures and time windows. Finally, we test our main model specifications under different matching strategies, time horizons and subgroups of treated banks based on their size to unpack the average effects observed in the baseline specification.

The remainder of the paper proceeds as follows. We review the related literature in Section 2, discuss the APP in Section 3, and outline our methodology in Section 4. We discuss the main results in Section 5 and include robustness tests in Section 6. We conclude in Section 7.

2. Related Literature

This paper is mainly related to the two main literature streams: the monetary policy and bank lending literature pioneered by Kashyap and Stein (1994, 1995, 2000) and the bank lending literature under capital constraints of Peek and Rosengren (1995). We investigate the impact of monetary policy on bank lending through the lens of capital regulation theory.

Kashyap and Stein (1994, 1995) present a framework that directly links monetary policy with bank deposits. Positive monetary shocks provide a cheaper source of bank financing that can lead to an increase in lending supply. Monetary policy contractions, on the other end, reduce bank lending, in particular for small banks. The empirical evidence of Kashyap and Stein (2000) shows that this effect is stronger for small banks with less liquid assets, or with high leverage ratios (Kishan and Opiela 2000; Gambacorta and Mistrulli 2004).

The issue of capital constraints is a key element in the bank lending framework of Peek and Rosengren (1995) that also closely relates with our setting. Capital constrained banks will be forced not to increase their lending, limiting the effectiveness of expansionary monetary policies. Jackson et al. (1999) points out that weakly capitalized banks tend to substitute away from assets with higher risk weights and to cut their total lending to enhance their capital ratios. These findings are supported by several studies (Gambacorta and Mistrulli 2004; Rime 2001; Furfine 2000) including Gambacorta and Marques-Ibanez (2011) who confirm that banks with weaker capital ratios and greater dependence on market funding and non-interest income sources strongly decreased their lending during the crisis.

The bank portfolio allocation studied by Celerier, Kick, and Ongena (2020) corroborates our claim on the asset reallocation mechanism by showing how banks allocates more to the category where the risk-weight is lower than the actual risk. This supports our claim on the asset reallocation mechanism towards sovereign securities that were actively kept at zero risk weight by the government themselves to increase demand for higher risk sovereign debt (Acharya and Steffen, 2015). Our study is also related to the study of EU carry trade of Acharya and Steffen (2015) and regulatory arbitrage. The latter assign a zero (or very low) risk weight for investments in sovereign debt, regardless of the riskiness of the exposure. They state that "undercapitalized banks (i.e., banks with low tier 1 capital ratios) have incentives to increase the short-term return on equity by shifting their portfolios into the highest-yielding assets with the lowest risk weights in an attempt to meet regulatory capital requirements without having to issue economic capital (regulatory capital arbitrage)". This mechanism is also linked to the 2011 EBA capital exercise run by the ECB that is studied by (Gropp et al. 2019). The combination of capital regulation theory and regulatory arbitrage provides supporting evidence of the risk that QE can pose to the economy by exacerbating adverse incentives of banks' investments (carry trades strategies) arising from misaligned risk weighting assets. The empirical strategy of the above two papers also includes controls for borrower firm fixed effects by employing the framework of Khwaja and Mian (2008) to identify credit demand effects at the loan level.

The growing empirical work on quantitative easing and the bank lending channel is also very much related to this study. Rodnyansky and Darmouni (2015) investigate the impact of the Fed LSAPs on the bank lending behaviour of commercial banks in the US. They are the first to find strong evidence of a positive impact of QE on lending during the first and third rounds of QE that was targeting mortgage-backed security holdings. The second wave of QE that targeted Treasuries held by banks did not show any impact on bank lending. Considering that the vast majority of assets purchased by the APP were gilts, this finding can shed a light on the implications of the type of asset purchased via QE and its repercussions to bank lending. With a specific focus on the mortgage market, Chakraborty, Goldstein, and MacKinlay (2020) investigates the effects of QE programs in the U.S. on bank lending and finds that banks benefiting more from QE increased mortgage originations but reduced commercial lending, consistent with a crowding out effects of other loans not related to MBS purchases in QE.[3] These insights are not directly applicable to UK QE due to the different implementation of the program and the instruments being purchased. While US banks likely increased origination (and then securitisation) as the Fed was buying MBSs from them, we observe crowding out of loans by UK banks in favour of profitable, yet low risk-weight, alternatives such us sovereign bonds.

Joyce et al. (2012) introduces both a theoretical model explaining and an assessment of the effectiveness of the first waves of QE after the 2007 financial crisis in the UK.[4] The main focus of this strand of literature is on the macroeconomic impact, such as the increase in asset prices and the decline of long-term yields (Joyce, Tong, and Woods 2011; Bridges et al. 2011; Kapetanios et al. 2012), spillover effects on global portfolio funds (Fratzscher, Lo Duca, and Straub 2018). As Rodnyansky and Darmouni (2015) noted in their study on the US LSAPs, monetary policy treatments are difficult to be assessed at the macro level due to the absence of a control group that is unaffected by the QE treatment.

Recent studies have specifically targeted the bank lending channel to analyse QE in the UK. They point to the 'flightiness' of deposits from other non-bank financial institutions, which are likely to be the main sellers of gilts to the Asset Purchase Facility (APF),[5] as the main cause of the weak bank lending in UK (Butt et al., 2014). They find that increased non-bank financial institutions deposits due to asset purchases (QE) tend to be short-lived in the bank balance sheet, therefore limiting the impact of QE via the bank lending channel. The flightiness of deposits suggests that not all reserves injections might stay with the beneficiary bank. Given the banks are aware of the extemporaneous flightiness of deposits, they would be likely reluctant to lend medium to long term, and rather invest in marketable securities. Although these are very good reasons not to expect an increase in lending at the QE-banks, the lack of proper identification of the treatment group by this study calls for further investigation into this hypothesis.

Looking at historical bank-level relationship between deposits and bank lending prior to the implementation of the UK APP, Joyce and Spaltro (2014) suggest that variation in deposits had a small but positive impact on bank lending in the past. This would imply a positive impact

[3] Other examples can be found in Maddaloni and Peydró (2011); Krishnamurthy and Vissing-Jorgensen (2011); Di Maggio et al. (2017); Morais et al. (2019).

[4] More contributions can be found in the special issue "Unconventional Monetary Policy after the Financial Crisis," The Economic Journal, Volume 122, Issue 564, November 2012.

[5] The Asset Purchase Facility Fund is a subsidiary of BOE. It was established in January 2009. Its main objective is to buy and manage assets acquired through monetary policy operations.

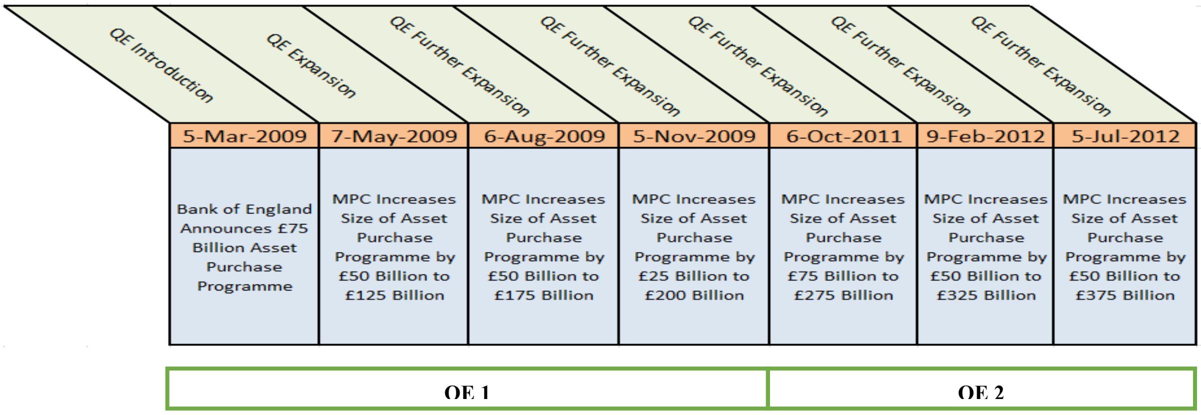
of the first wave of QE in UK on bank lending. However, they also find that the low level of bank capital might have limited the effectiveness of QE. The Basel post-crisis reforms increased the capital requirements for banks considerably. As such, the capital positions of many banks were deemed to be low relative to the new higher requirements. Recent work of Alper et al. (2020) looks at the spill-over effect of major QE programs through cross-border borrowing of Turkish banks using loan level data. They find a strong positive impact of Fed QE on cross-border lending to Turkish banks while ECB and UK QE show only moderate boost of credit to the same banks.

It is also worth noting that additional liquidity rules were also proposed from 2010, i.e., the net stable funding ratio (NSFR) and the liquidity coverage ratio (LCR), along with the leverage ratio framework and the output floor. However, the implementation of these requirements was far into the future at the time (deadline for implementation was 2019). The liquidity reforms went live in the UK in 2018, whereas the leverage ratio came in early in 2016. Recent work by Fatouh at al. (2021) shows that the presence of the newly implemented leverage ratio did stimulate the bank lending channel with positive real effects, as it reduced differentials in risk weights between different assets.

3. The Asset Purchase Program in UK

To fight the economic slowdown following the great financial crisis, the monetary authorities of the developed economies decreased their policy rates to unprecedented levels and started to use unconventional monetary policy measures, mainly QE. The UK MPC, for example, decreased the short-term policy rate many times down to 0.5% in March 2009. However, the monetary loosening was judged not sufficient to keep expected inflation level to its 2% target. After the collapse of Lehman Brothers in September 2008, the BOE initiated its APP in March 2009.

Figure 2 - Quantitative Easing Timeline in the UK



Source: Bank of England (http://www.bankofengland.co.uk)

The MPC regularly chooses the level of asset holdings, which started at £75 billion. The first wave of quantitative easing, QE1, that started in March 2009 expanded asset purchases to £200 billion by November 2009. Another £175 billion were purchased from October 2011 till July 2012 during the second wave of quantitative easing, QE2. In less than four years after the introduction of the program, the MPC increased the size of the program to £375 billion. The level of gilts purchases was expanded again in August 2016, following the Brexit vote, to £435 billion, and complemented by the purchase of £10 billions of corporate bonds. Figure 2 presents the key stages of Bank of England asset purchase program until late November 2012.

4. Methodology

We are interested in the changes of bank lending to businesses, i.e., large corporations and SMEs, and households. The mortgage lending channel is also investigated. It can be argued that this channel has been one of the reasons for the rapid and large increases in house prices in the UK in the past decade (Fatouh, Markose, and Giansante 2019). The exact identification of the QE-banks that received reserve injections from the sale of gilts as the result of the APP provides the ideal setup for a difference-in-differences exercise where QE-banks are compared with non-QE banks.

4.1. Data

We rely on three main data sources: (1) the BOE's confidential data on APP for the exact identification of banks that received liquidity via QE operations as well as the amounts of cash deposited,[6] (2) the consolidated financial reports of UK banks retrieved from FitchConnect (Table 1 for descriptive statistics), and (3) market data on banks equity returns, returns ON sovereigns and macroeconomic indicators collected from Datastream. Variable definitions are in the Appendix.

Compared with similar studies that required sophisticated model to identify banks who received QE cash injections, the confidential APP data employed here provides precise identification.

There are 24 banks that received reserves injections through APP, 8 of which are UK headquartered banks. Note that the non-UK banks (mostly large international banks) have been receiving (probably larger) liquidity injections through the larger QE and other unconventional monetary schemes in other regions. On the other hand, UK headquartered banks' main source of unconventional liquidity injections has been the UK QE programme. Hence, including non-UK banks would overstate the impact of UK QE. We follow Rodnyansky and Darmouni (2015)'s selection strategy and use the 8 UK headquartered banks as our treatment group. In the robustness Section 6.4, we extend the treated group by including all 24 treated banks, both domestic and foreign, for completeness. Consolidated financial reports of UK institutions, excluding their nonbank subsidiaries, are collected from June 2000 to December 2018. Descriptive statistics are provided in Table 1.

<Table 1>

There are 118 banks in our sample when excluding subsidiaries of non-bank divisions, 8 of which are treated banks and the other 110 are non-treated banks. We are not interested in assessing why these specific 8 banks were involved in QE operations (most likely they are the main banks of the sellers of the Gilts). However, next Section investigates if and how they differ from the rest of the sample in the pursuit of constructing a comparable control group for our empirical exercises.

4.2. Empirical Design

The first step is to assess the correlation of individual characteristics to the treatment, in order to isolate the impact of the QE program.

[6] The dataset includes information on the size of all purchases done by APF, and the banks which received proceedings of the sale on behalf of the seller. We use the values of the sales BOE paid directly to the sellers' banks. Therefore, securities are not held by banks, rather banks received the value of the sale.

<Table 2 here>

Table 2 shows the correlations of the treatment with the main bank characteristics at the end of 2008, just before the implementation of QE. The variable *Treated* equals one for QE-banks and 0 for the non-QE-Banks.[7] Following Rodnyansky and Darmouni (2015) and Gropp et al. (2019), bank characteristics are chosen to capture size, profitability and the business model, in line with the literature on bank lending (Kashyap and Stein 2000). The *p-values* indicate that we can reject the hypothesis that all coefficients are zero; in other words, correlations between the treatment status and the bank characteristics are statistically significant. On average, treated banks tend to be bigger and holding more securities than non-treated banks. These dimensions will be used as control variables in the main difference-in-differences exercise.

Our database includes few large banks that are not QE-banks, suggesting that a matching technique could further alleviate those differences. Therefore, we propose a propensity score matching using the covariates from the regressors of model (2) in Table 2 that shows the highest significance of securities. Due to the small size of the treated group, we match each treated bank with five non-treated banks with replacement, i.e., a matching ratio of 1:5.

<Table 3>

Table 3 shows the effect of matching in eliminating average differences between the two groups.[8] The χ^2 test also confirms that we cannot reject the hypothesis that all coefficients are equal to zero in the post-matching models as reported by the p value = 0.765. For robustness checks, we vary the matching ratio between 1:1 and 1:8 reporting same results. The χ^2 test reported in Table 9 of the Supplementary Materials confirms that we cannot reject the hypothesis that all coefficients are zero in the post-matching models, suggesting that the 1:5 ratio is the best compromise in terms of *p-values* and groups size.

[7] In the main difference-in-differences specifications, we will also use the log of the QE cash as continuous treatment variable for robustness. This continuous treatment variable shows identical correlations with the individual bank characteristics as our dummy *Treated* and we omit these results for conciseness.

[8] Note that some non-QE-banks have been matched with several treated banks more than once. We therefore retain the frequency weights from the matching for each non-discarded non-QE-bank as in Rodnyansky and Darmouni (2015).

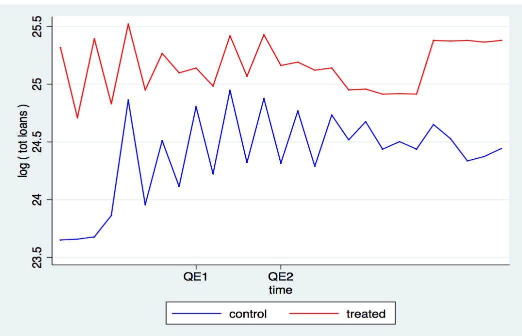
5. Results

This section presents the difference-in-differences specifications and discusses three main sets of findings. The first one investigates the impact of quantitative easing on the bank lending channel, specifically on total lending, commercial and corporate lending, customer/retail lending and mortgages. The second set of findings focuses on the asset allocation channel of QE-banks after the implementation of the APP, specifically on lending to banks, reserves and government securities. The latter represents a subset of total securities carrying a lower risk weight reported in our dataset. The third set of tests concentrates on the exposure of QE-banks to sovereign securities by employing a difference-in-differences sensitivity analysis of banks equity returns on returns on sovereigns. The last part of this section discusses a list of robustness tests.

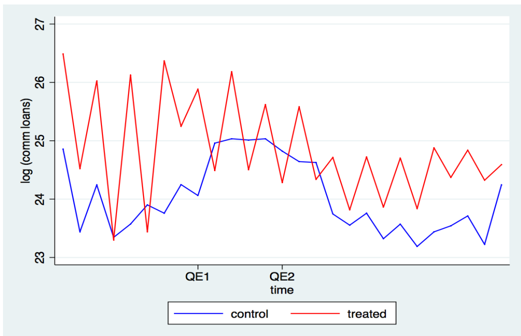
5.1. The Bank Lending Channel

We begin the analysis of the bank lending channel by showing the differences in lending behaviour between treated and control groups as constructed in Section 4.2. Figure 3 plots the average group trends reported in natural logs for total lending, corporate and commercial lending, customer/retail lending and mortgages. In the pursuit of spotting interesting trends between the two groups that can guide our empirical exercise, we can confirm that there is no clear evidence of variation in the lending behaviour between the two groups after the two QE waves, with the exception of customer/retail loans in the pre QE1 phase.

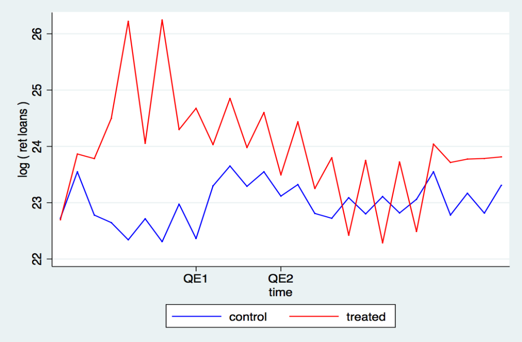
Figure 3 – Quantitative easing and the bank lending channel



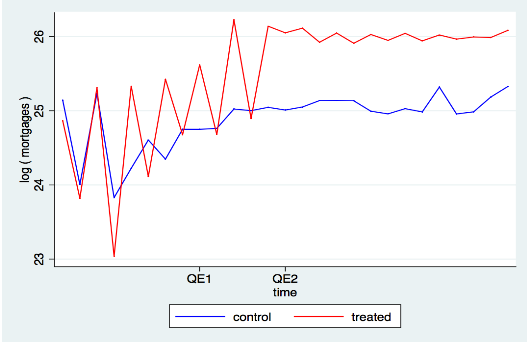
(a) log of total lending (averaged by group)



(b) log of commercial loans (averaged by group)



(c) log of retail loans (averaged by group)



(d) log of mortgages (averaged by group)

This figure plots the time series of the main bank lending channels as average values by the control and treated groups with semi-annual frequency. Note that QE1 started in 2009h1 and QE2 in 2011h2. Panel (a) refers to the total lending series, (b) to the corporate and commercial lending, (c) to the customer/retail lending and (4) to the mortgage lending. Absolute £ values are reported in logs.

As we can see in Figure 3(c), treated banks started reducing their retail lending after QE1, with the larger fall after QE2. According to Fatouh, Markose, and Giansante (2019), this fall can be driven by a combination of lower gilts yields (resulting from QE) and higher risk-based capital requirements, mainly affecting the relatively larger QE banks. Control group banks, on the contrary, appear to have picked up the slack by increasing their retail lending during the first wave of QE. In order to empirically validate the evidence above, we estimate the following panel model:

$$\log(Y_{i,t}) = \beta_i + \gamma \boldsymbol{QE}_t + \delta(Treated_i \boldsymbol{QE}_t) + \theta X_{i,t} + \varsigma(X_{i,t} \boldsymbol{QE}_t) + \upsilon_{i,t} \qquad (1)$$

where $Y_{i,t}$ is the log of total loans, corporate and commercial loans, customer/retail loans, or mortgages, β_i is a bank fixed effect, $Treated_i$ is an indicator variable that equals to 1 for the eight QE-banks and 0 for the control group banks, $\boldsymbol{QE}_t = [QE_{1,t}, QE_{2,t}]$ is a set of two indicator variables that becomes one after the introduction of each QE wave. Specifically, the first wave QE1 started in 2009h1 while the second one QE2 started in 2011h2. Butt et al. (2012) classify the QE expansion in July 2012 as a third wave. However, due to the short time gap with the last expansion of QE2 in February 2012, we did not differentiate between them. This is also confirmed by an inequality test between coefficients of this QE3 and the other two that cannot reject the hypothesis that these coefficients are equal. The $Treated_i * \boldsymbol{QE}_t$ is the interaction term of the treatment status and the QE episodes. The variable $X_{i,t}$ is a matrix of controls that includes size measured as the log of total assets, equity over total assets, return on assets (ROA) for profitability, securities over total assets and net interest income over total assets to control for the business models of the banks. As an alternative treatment status, we will also use a continuous treatment variable $log(QEcash_i)$ that equals to the log of the sum of cash injections received by QE-banks and zero for non-QE-banks. Following Rodnyansky and Darmouni (2015), we also include interaction terms $X_{i,t} * \boldsymbol{QE}_t$ as robustness check for possible heterogeneous responses to the intervention by banks of different nature. All standard errors are clustered at the bank level to allow for serial correlation across time.[9] We are interested in the element δ from equation (1) that represents the difference-in-differences coefficient.

Table 4 reports the regression results of the log of total loans (1-2) and its decomposition into corporate and commercial loans (3-4), customer/retail loans (5-6) and mortgages (7-8) using both dummy and continuous treatment status. Confirming our initial impression from the average trends of the two groups in Figure 3, we find no evidence that suggests a boost in bank lending. We note that after QE2, customer/retail loans of the treated banks were about 45% lower than the control group, and the differences between QE1 and QE2 coefficients are different as reported by the *p-value* at the bottom of Table 4. This suggests that QE2 cash injections did amplify some of the lending decline observed at the macro level. Similar conclusions can be drawn on the insignificant result for corporate and commercial loans suggesting that QE did not help limiting and/or slowing down their decline at the macro level shown in Figure 1. Results are robust under the continuous treatment variable and various adjustments in sample periods and treatments overlaps (see Section 6.5).

<Table 4 here>

Our findings are in line with the reduced level of credit to the real economy after the implementation of quantitative easing captured at the macroeconomic level (Joyce, Tong, and Woods 2011; Bridges et al., 2011). With a precise identification of the treated banks, we can confirm that the APP, which targeted gilts, did not have a positive impact on the bank lending channel of QE-banks. The latter is an important point to clarify. Although the lack of lending to the real economy at the macro level during the QE periods is well established, this is not enough to rule out any possible bank lending channel as QE cash injections might have slowed down this decline in lending for QE-banks compared to non-QE-banks. This result also finds

[9] We also test our main models using a wild cluster bootstrap approach (Cameron et al., 2008) to account for the few banks in the sample, with no change to the main results. Tables are available from the authors upon request.

supporting evidence in Rodnyansky and Darmouni (2015). They report the failure of the second wave of the US asset purchase program, that specifically targeted Treasuries, in boosting lending to the real economy, compared the other two that targeted instruments to which banks were heavily exposed to, i.e., Mortgage Backed Securities. This might raise the issue of the importance of the type of asset being purchased in supporting the bank lending channel. With respect to mortgages, we report that our findings differ from those in the prior literature on US discussed above, which find an increase in mortgage lending. Note that our mortgage variable includes only residential mortgages and not commercial real estate ones. The risk weights on these loans are relatively low risk-weights, and have been falling since the internal-rating based (IRB) to calculate risk weights was introduced. The fall in risk weights on mortgages appears for QE-banks and non-QE banks, explaining why mortgage lending of QE-banks does not differ from that of non-QE banks.

5.2. Demand-side Effect

The bank lending channel analysis above assumes that realized credit amounts reflect banks' willingness to lend. However, these patterns may also be explained by the demand side – borrower characteristics as a result of firms substituting bank loans with cheaper capital market borrowing due to the lower yields. This section looks deeper at corporate loans issuance by attempting a more direct separation of credit supply from credit demand. As treatment and control banks are fundamentally different, so are their borrowers. Therefore, we need to test the alternative explanation suggesting that borrowers of QE banks demanded less credit over the post QE period. We further investigate whether borrowing behaviour of corporates shifted from traditional banks to non-bank financials (shadow banking). Tests are performed by employing a quasi-Khwaja and Mian (2008) framework,[10] in order to identify credit demand effects at the loan level. Loan level data is retrieved from DealScan.[11] We collect the total dollar amount of each loan for the entire syndicate of lenders as well as the size of the loan of each separate lender using the loan shares allocation. We manually matched 10 of our UK banks that were involved in syndicate loans, 5 of which are QE banks. Khwaja and Mian

[10] The original framework also includes firm time fixed effect to control the banks that lent to the same borrower after the shock.

[11] In the absence of loan application data that can quantify the amount borrowed asked and their approval rate, the demand-side test proposed in our paper can help disentangling the demand from the supply of loans, as also implemented in similar settings (e.g., Rodnyansky and Darmouni, 2015). This analysis is also limited to corporate loans and does not account for other lending, i.e., mortgages and retail lending. In terms of mortgages, there is unfortunately no dataset available to us that includes information similar to what Deal Scan provides for corporates. Nevertheless, mortgages have much longer maturities, and hence the lender-borrower linkages can be expected to last much longer.

(2008)'s framework defines the change in loan issuance for each bank-firm pair before and after the treatment event as dependent variable. Following Rodnyansky and Darmouni (2015) and Gropp et al. (2019), we selected a comparable time window that span between two years before a QE event and two years after the event. The inclusion of firm fixed effects allows us to control for any borrower characteristics that could have influenced the loan issuance. The model estimated is the following:

$$\log\left(1 + L_{i,j}^{post}\right) - \log\left(L_{i,j}^{pre}\right) = \eta_j + \delta\, Treated_i + \upsilon_{i,j} \tag{2}$$

where $L_{i,j}^{post}$ ($L_{i,j}^{pre}$) is the total dollar value of the loan by lending bank i to borrowing firm j in the two years after (before) the QE event, η_j is the borrower firm fixed effect, $Treated_i$ is an indicator variable that equals to 1 for the five QE-banks in the sample and 0 for the remaining banks, and $\upsilon_{i,j}$ is the idiosyncratic error term. All standard errors are double clustered at the bank and firm level.

Table 5 presents the estimation outputs for each of the two QE waves across several sets of controls, including firm industry fixed effects in models (3-6) (using SIC1 digit as in Gropp et al., 2019), firm country fixed effect in models (5-6) and the interaction of the two in (7-8) to absorb any endogenous difference in borrower characteristics between the treatment and control group. In all specifications, we find no evidence that lower lending by QE banks after the two QE waves is caused by differences in the demand for loans between the treatment and control groups.

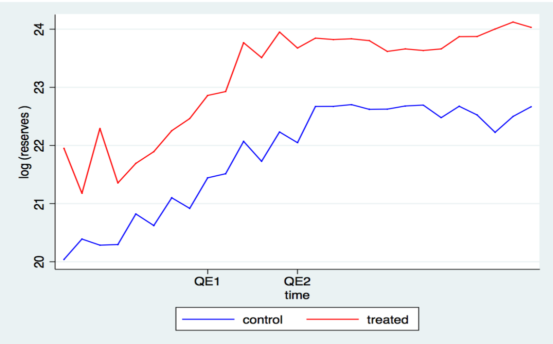
<Table 5 here>

The growing presence of shadow banking in providing credit to the real economy has been documented by several authors (e.g., Culp (2013), Hsu and Moroz (2010)) and could provide an alternative hypothesis for the lack of bank lending channel we documented. In a variant of our quasi-Khwaja and Mian (2008) estimates of the relative change in loan issuance between banks and non-bank financials, we document a positive and marginally significant coefficient of lending from non-bank financial in the two years after each the two QE waves. This result is however not robust when industry fixed effects are added. The discussion of this hypothesis is reported in the Robustness Check Section 6.8 and estimation Table 9.

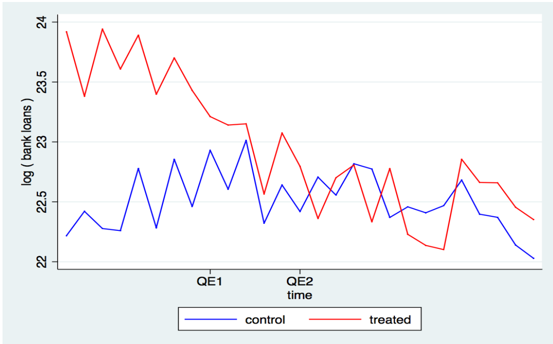
5.3. The Asset Reallocation Channel

The lack of evidence from the bank lending channel exercise after the deposit injection from QE opens questions regarding the use of this source of liquidity by the treated banks. Although pursuing higher returns, banks with inadequate capital levels might prefer investing in low risk weighted assets such as government securities and that could limit the effectiveness of non-traditional monetary policies (Kishan and Opiela 2000; Gambacorta and Mistrulli 2004).

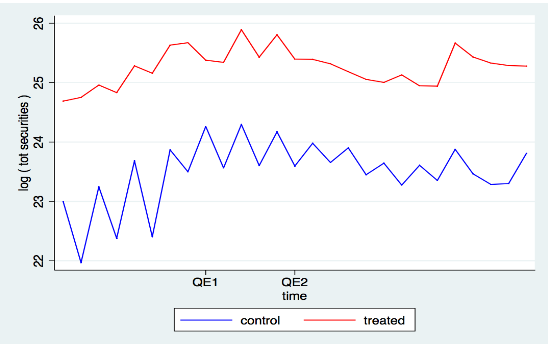
Figure 4 – Quantitative easing and the asset reallocation channel



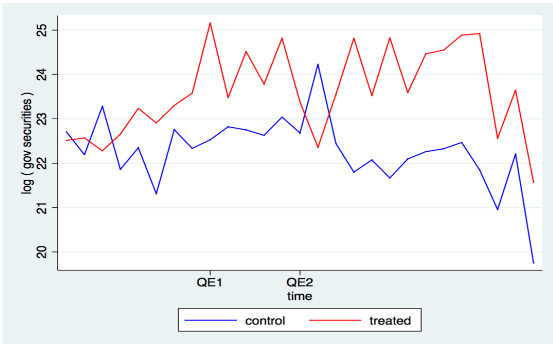
(a) log of reserves (averaged by group)



(b) log of bank loans (averaged by group)



(c) log of total securities (averaged by group)



(d) log of government securities (averaged by group)

This figure plots the time series of the main asset reallocation channels as average values by the control and treated groups with semi-annual frequency. Note that QE1 started in 2009h1 and QE2 in 2011h2. Panel (a) refers to the reserves series, (b) to the lending to banks, (c) to total securities and (4) to government securities. Absolute £ values are in logs.

To better understand balance sheet reactions to QE, we plot time series of banks' exposure to other financial instruments, such as loans to banks and securities. As a robustness test, we also investigate potential increase of off-balance sheet loans positions as an alternative of outright lending (see Section 6.9 for details).

In line with the bank lending channel section, we average them by groups (control and treated) and report in Figure 4, along with the total reserves of panel (a). We note that treated banks had a positive jump in reserves compared to the control group after QE1 depicted by the widening gap between the two lines[12]. Note that although all QE-banks have increased their reserves at the time of the QE cash injections, this does not necessarily mean that a positive gap should be expected, due to potential flight of deposit (Butt et al., 2014) or more generally of active management of liquidity (Adrian and Shin 2010).

<Table 6 here>

The positive gap in deposits might infer that treated banks took advantage of the QE cash to restore and/or increase their liquidity. However, when looking at the other assets we clearly observe a reduction of interbank lending by the treated banks as well as an increase of government securities as plotted on Figure 4(b) and (d) respectively. This could indicate that treated banks might have reallocated their assets from high risk-weighted instruments (like retail loans and bank loans) towards other assets with lower risk weights like government securities. This is also in line with the fact that this difference disappears when looking at the total securities trends of Figure 4(c). We also note that there is a big fall in 2012 of the treated banks' exposure to government securities right at the peak of the EU sovereign debt crisis, in line with what is reported by Acharya and Steffen (2015) on the unwinding of the carry trade strategy by European banks. This evidence motivated our next set of empirical tests aimed at assessing the impact of QE on the log of reserves, bank loans, total securities and government securities.

As expected, Table 6 confirms that treated banks reallocated their resources towards government securities that have low risk weights. This is observed marginally (at 10% significance) in QE1 (40% higher compared to the control group), but very significant in QE2 (more than 54%). We also find that QE banks hold almost 60% more reserves, which provide liquidity with no impact on risk weighted assets. Both bank loans in QE1 and customer/retail loans in QE2 (from Table 4) that require higher capital requirements observed a negative impact. The differentiation between the two waves of QE is also supported by the p-values at the bottom of Table 6 that confirm that coefficients of QE1 and QE2 are different for the models (3-8). Finally, we report that the results are robust under the continuous treatment status.

[12] The actual cash injections as a result of QE cannot be plotted due to Bank of England data confidentiality.

The huge carry trade activity by European banks towards zero-to-low risk-weighted sovereign debt provided high returns during this period at no (or little) extra cost of capital. Our results suggest that QE has facilitated this bank behavior. We confirm this in Section 5.5 by testing the sensitivity of UK treated banks equity returns on GIIPS and German bond returns in a similar vein as Acharya and Steffen (2015).

The sensitivity estimates of that sections have also been used as control for the main model of Table 4 (see Supplementary Table 19). Our main results are confirmed even although some effect is absorbed by the sensitivity control for QE2 period. This result is expected as sensitivity has sharply increased at the beginning of QE2 period for all banks as reported in section 5.5. However, QE banks still show higher investments in these securities that is in line with what found in Table 6 and support our main claims.

5.4. The Timing of Effects

Rodnyansky and Darmouni (2015) suggest a supplementary robustness test on the timing of effects to confirm that our asset reallocation effects actually happened after the QE waves. We follow their model specification by estimating a fixed-effect regression using the matched sample of banks as follows

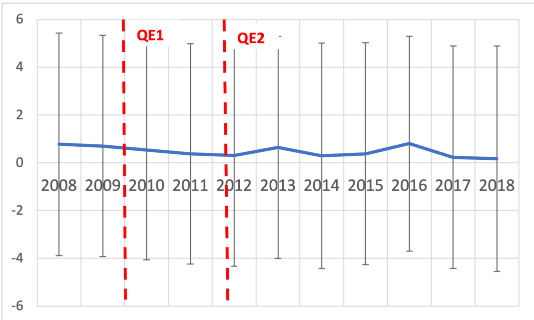
$$\log(Y_{i,t}) = \beta_i + \sum_t \gamma_t \boldsymbol{D}_t + \sum_t \delta_t (Treated_i \boldsymbol{D}_t) + \theta X_{i,t} + \sum_t \varsigma (X_{i,t} \boldsymbol{D}_t) + \upsilon_{i,t} \tag{3}$$

where $Y_{i,t}$ is the log of customer/retail lending, reserves, bank loans and government securities, β_i is a bank fixed effect, $Treated_i$ is an indicator variable that equals 1 for the eight QE-banks and 0 for the control group banks, D_t is an indicator function of the time period from end of 2007 to end of 2017 2018h1 with 2006 as the omitted category. $Treated_i \times D_t$ is the interaction term of the treatment status and the time dummies. $X_{i,t}$ is a matrix of controls that includes size measured as the log of total assets, equity over total assets, return on assets (ROA) for profitability, securities over total assets and net interest income over total assets. In line with equation (1), we also include interaction terms $X_{i,t} \times D_t$ as robustness check.

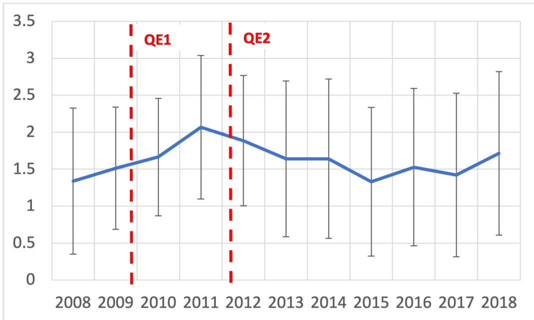
Figure 5 supports our findings by confirming the timing of the main effects. Starting from panel (a), a slow decline below zero in the second part of QE2 is observed for customer/retail loans, although of a marginal magnitude. The trend of reserves in panel (b) appears to start its climb in 2010 reaching a peak in 2011, after the start of QE1.

This trend looks more stable after QE2 and is in line with our findings. We find that same results but opposite sign for the loans to banks in panel (c) that shows a clear pronounced decline from 2009 till 2011. This trend then stabilises in the QE2 period. Finally, panel (c) reports the time coefficients for the government securities model. We finally observe the positive trend after each of the QE waves. Note that the variable ‘government securities’ might not fully capture the asset reallocation channel of banks towards sovereign securities (mainly from GIIPS countries) as this balance sheet variable does not distinguish between securities and their risk weighting. Section 5.5 provides additional empirical evidence of the exposure of QE banks to specific sovereigns to support this claim.

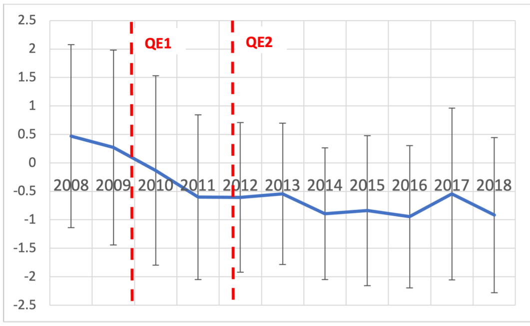
Figure 5 – Time coefficients



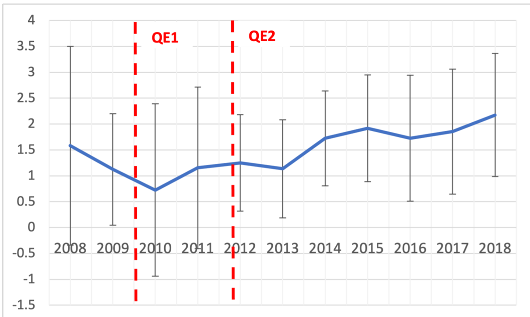
(a) log of retail loans



(b) log of reserves



(c) log of loans to banks



(d) log of government securities

This figure plots the coefficients δ_t of equation (2) with the 95% confidence intervals for each semi-annual time dummy from 2007h1 to 2018h1 with 2006h2 as the omitted category. Dashed lines mark the beginning of the two QE waves. Note that the y-axis of all panels are on a different scale.

5.5. Exposure to Sovereigns

This section investigates the exposure of treated banks to sovereigns during the two QE periods by using market data. Due to the lack of micro-level data on sovereign positions. we employ Acharya and Steffen (2015)’s sensitivity analysis of banks’ stock returns to returns on sovereigns within a difference-in-difference exercise, estimating the following model

$$R_{i,t} = \beta_i + \beta_{Country} R_{Country,t} + \beta_{FTSE} R_{FTSE,t} + \delta_{Country}\left(R_{Country,t} Treated_i\right) + \delta_{FTSE}\left(R_{FTSE,t} Treated_i\right) + \gamma X_t + \upsilon_{i,t} \quad (4)$$

where $R_{i,t}$ is the daily stock return of UK bank i, β_i is a bank fixed effect, $Treated_i$ is an indicator variable that equals to 1 for the QE-banks and 0 for the control group banks, $R_{Country,t}$ is the daily return of ten-year government bonds from Greece, Italy, Ireland, Portugal or Spain (GIIPS). We also include government bond returns of UK, Germany, US and Japan. $R_{FTSE,t}$ is the FTSE 350 daily return orthogonalized by both UK and German bond return series[13], and X_t is the vector of macroeconomic state controls variables.[14] According to the authors, a combination of positive loadings of the β coefficients for the GIIPS countries combined with a negative loading for that of Germany is consistent with carry trade behaviour by banks. By controlling for the treated banks, the estimation of our difference-in-differences coefficients δ can shed a light on the role of QE in promoting the carry trade in Europe and therefore confirming our asset reallocation channel hypothesis. More precisely, if QE banks reallocated APP cash injections towards peripheral EU countries sovereigns, we would expect positive loads on some of the GIIPS countries' δ coefficients as well as negative load for German bonds.

Equation (4) is estimated using pooled ordinary least squares regressions with standard error clustered at both bank and time level. The control group is reconstructed among listed non-QE banks following the same propensity score matching procedure and list of covariates reported in Section 4.2 for consistency. This is an important step as smaller non-QE banks could be less exposed to global developments, such as the euro area banking crisis, and would have a lower correlation with GIIPS stocks. However, we anticipate that compelling evidence discussed below and depicted in Figure 6 from Bank of England confidential data shows that QE banks

[13] Following Acharya and Steffen (2015), we use the residual from the regression of the FTSE daily log returns on daily UK Gilts and German bund returns. As robustness we also replaced FTSE 350 with the FTSE 100 index (not reported) with no changes in the results.

[14] We include all the control variables from Acharya and Steffen (2015) model: "VSTOXX, the change in the volatility index of the European stock market; TermStructure, measured as the difference between the yield on a 10-year euro area government bond and the one-month Euribor; BondDefSpread, the difference between the yield on 10-year German BBB bonds and yields on 10-year German government debt; 1mEuribor, the one-month Euribor; ΔESI, the monthly change in the economic sentiment indicator; ΔIntProd, the monthly change in the level of industrial production; ΔCPI, the change in the rate of inflation measured as the monthly change in the European consumer price index; and ΔFX-Rate, the change in the effective exchange rate of the euro" (pg. 221, footnote 20).

did not own more peripheral debt prior to the second wave of QE. The results of banks' sensitivity analysis to GIIPS sovereign exposures are reported in Table 7.

Panel A in Table 7 reports the estimates from the period of QE1 (5th of March 2009) onwards whereas Panel B considers the QE2 period only (6th of October 2011 onwards). Due to the high correlation of the GIIPS bond returns, we test the sensitivity of equity returns of UK banks with GIIPS bond returns individually. However, we also report models when controlling for all GIIPS returns in Supplementary Table 14 for robustness.

When controlling for the impact of QE via the asset reallocation channel, we find that this exposure was larger for QE banks. In QE1, positive factor loadings of all GIIPS diff-in-diff interaction terms δ except for Greek bonds, along with negative loading of $\delta_{Germany}$ (the interaction term of German bonds and treated status) in Table 7 confirm our previous findings that QE banks reinvested APP cash injections into low-to-zero risk weighted GIIPS sovereigns. Note that the insignificant coefficient of Greek bonds can be easily explained by the lack of confidence in the country which has been facing a sovereign debt crisis since 2009.

During QE2, this effect is mainly concentrated on Italian and Spanish bonds. Note that those were most popular sovereigns used by European banks as part of the carry trade activity (Acharya and Steffen, 2015). We also note the positive loadings of δ_{Japan} for treated banks. This can be puzzling, given the very low yields on Japanese government bonds. However, we believe QE banks might have channelled a part of APP cash into these bonds, anticipating a boost in their prices when the Bank of Japan (BOJ) relaunched its QE programme, following its announcement in October 2010 that it would examine the purchase of ¥5 trillion of assets. BOJ implemented this a year later in October 2011. Since this is very close to the start of UK QE2, we can validate our proposition about the stockpiling of Japanese government bonds by QE banks by comparing the coefficients of Japanese government bonds in QE1 and QE2. Indeed, Supplementary Table 18 shows the coefficient of Japanese government bonds is significant in QE1 and insignificant in QE2.

<Table 7 here>

We also test the baseline models of Acharya and Steffen (2015) for UK banks in Supplementary Table 14 (models 1 and 3) with the diff-in-diff models (2) and (4). Estimates of Model (1) are well matched with both signs and magnitudes of factor loadings of Acharya and Steffen (2015)'s findings. We report positive and significant β coefficients for the GIIPS countries, as well as negative for Germany. We also find UK banks showed the largest correlation with prices of Italian sovereigns in QE1, as also discovered by Acharya and Steffen (2015). This suggests that UK banks, along with other European banks, engaged in risk-shifting and regulatory arbitrage activity to meet capital requirements and enhance returns.

Results are robust under several variations of the model specification, including replacing treated status with the continuous treatment variable $log(QEcash_i)$ reported in Supplementary Table 15, and estimating the model over the whole period of 2000-2018 using a triple interaction of bond return, treated status and QE time dummies in Supplementary Table18. Details are reported in Section 6.8.

Nevertheless, the sensitivity of bank stock returns to returns on sovereigns could arise from indirect exposures of banks to these sovereigns rather than direct exposures. That is, banks may have direct or indirect exposures to other institutions that have direct exposures to sovereigns. In fact, BOE's Financial Stability Report of June 2011 states that UK banks had modest direct exposures to sovereigns of Greece, Ireland and Portugal,[15] but had stronger indirect exposures to these sovereigns through their exposures to French and German banks, which had large exposures to vulnerable European economies.

Hence, to verify our regulatory arbitrage argument, we need to show that the higher sensitivity of QE banks stock returns to returns on sovereigns is resulting from direct exposures to sovereigns. To do that we use two confidential datasets from Bank of England. The first dataset shows exposures of a number of UK banks to the public sector of different countries, including central banks, since 2004. The second includes direct exposures to sovereigns of different countries since 2014.[16] According to the first dataset, non-QE banks reduced their exposures to public sectors of GIIPS countries at a quarterly rate of 2.4% between 2009 Q2 and 2018 Q4, on average.[17] Meanwhile, QE banks increased their corresponding exposures by 4.3%, on average.[18] The patterns in the second datasets are in line with the ones we observed in the first

[15] Bank of England Financial Stability Report; Issue No. 29; June 2011; P19.

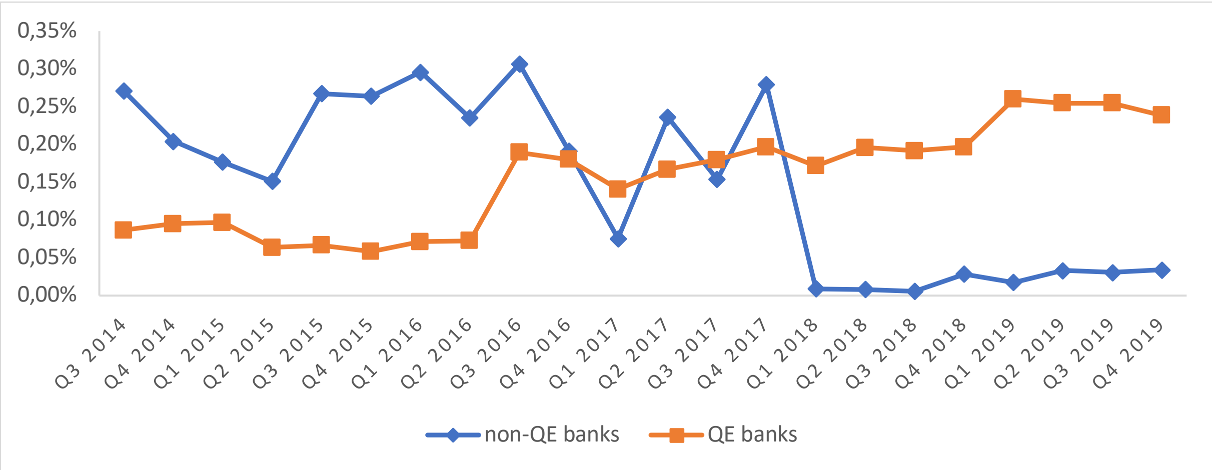
[16] Both datasets could not be used for a meaningful diff-in-diff exercise. The first dataset provides sufficiently granular data, but only covers a part of post-QE period. The second dataset covers both pre-QE and post-QE periods, but it doesn't provide sufficiently granular data. First, the dataset only covers a small number of banks, and not all QE banks are included. Second, the dataset shows that non-QE banks eliminated their exposures to two of GIIPS countries (Greece and Italy) briefly after APP was introduced. Third, the data shows exposure to public sector entities, including exposures to central banks and direct lending to public sector.

[17] Beyond average quarterly growth rates, we are unable to present further details on the two datasets, due to data confidentiality constraints.

[18] Country-level analysis demonstrates very similar trends, except for Ireland and Portugal. On average, QE banks increased exposures to public sector in Greece (1.4%), Ireland (3.2%), and Spain (5.3%), and reduced exposures to Italy (4.5%) and Portugal (0.1%). Non-QE banks wiped-out all exposure to Greece and Italy, increased exposures to Ireland (3.4%) and Portugal (3.0%), and reduced exposures to Spain (1.4%).

dataset. Between 2014 Q1 and 2018 Q4, QE banks increased their exposures to sovereigns of GIIPS by 2.2%, per quarter, on average. On the contrary, non-QE banks reduced their exposures to these sovereigns at an average quarterly rate of 5.3% during the same period.[19] The ratios of exposures of GIIPS sovereign of the two groups pictured in Figure 6 also confirm that treated banks did not own significantly more peripheral debt. On the contrary, the higher sensitivity of stock returns of QE banks appears to be driven by increasing holdings of sovereigns of GIIPS countries post-QE, at least partially. This is in line with our regulatory arbitrage argument.

Figure 6 - Ratios of Exposures of GIIPS Sovereign (% of total assets)



Source: Bank of England

6. Robustness Checks

6.1. Placebo Test

The matching strategy and the various controls in the model specifications have accounted for potential correlations between the QE treatment and individual bank characteristics as well as allowing for heterogeneous responses to APP. To provide further reassurance that our findings are indeed the result of the QE program, we run alternative exercises with non-QE-banks only,

[19] Country-level analysis shows that QE banks increased their exposures to sovereigns of all GIIPS countries, except Greece. The average quarterly growth rates of exposures to individual sovereigns are: -0.5% (Greece), 7.0% (Ireland), 3.0% (Italy), 2.3% (Portugal), and 5.8% (Spain). On average, non-QE banks increased their exposures to sovereigns of Ireland (5.4%) and Italy (2.6%), and reduced exposures to sovereigns of Greece (2.5%), Portugal (0.5%) and Spain (6.9%).

therefore excluding the real treated banks from the test[20]. We construct a placebo treated group among the non-QE-banks such that both placebo treated and control groups (i.e., the remaining non-QE) are comparable vis-à-vis characteristics that are correlated with the actual treatment, such as size and level of securities (see Section 4.2 for details). By ranking non-QE-banks by either size or securities and selecting banks in the odd ranking positions as placebo treated, we guarantee that the distributions of either size or securities between treated and control groups are comparable. The resulting $PlaceboTreated_i^{SIZE}$ and $PlaceboTreated_i^{SEC}$, where the superscripts indicate the ranking characteristic used for the selection of the groups, are used in the same model specifications as of Section 0 and results are reported in Table 8.

These placebo experiments show that the effects of QE on banks' balance sheet disappear as no differential effects on retail lending, reserves, loans to banks and government securities can be found. They also help us to rule out the presence of important omitted variables bias that could have driven our findings.

<Table 8 here>

Supplementary Table 19 provides further reassurance on the robustness of our results by showing results of another placebo. Specifically, we manually selected 8 banks from the control group that would be expected to be in the treatment group on the basis of their individual characteristics. They have been used as treated banks in this alternative placebo experiment.

6.2. Matching Ratios

To further isolate the potential impact of matching strategies on our findings, we perform the same difference-in-differences exercises of Sections 5.1 and 0 with alternative matching ratios, ranging from 1:1 to 1:8. We first show in Table 9 of the Supplementary Materials that the propensity score matching eliminates average differences between treated and control groups under all matching ratios.

[20] Rodnyansky and Darmouni (2015) recommend an alternative placebo test to rule out the hypothesis that changes in bank lending might have been facilitated by economic recovery phases right after an economic recession, testing their model right after the US depression of early 2000 caused by the NASDAQ crash and the collapse of the dot-com bubble. Note, however, that the UK avoided the recession, and no bank lending channel has been found in relation with QE, therefore negating this alternative hypothesis.

We find that our main results are robust against matching ratios and a subset of these results is presented in the Supplementary Materials. Table 10 and Table 11 report the outcomes from the bank lending channel exercise of Section 5.1 using 1:4 and 1:3 matching ratios respectively. The results confirm our main finding on the negative value of the difference-in-differences coefficient for customer/retail loans in QE2. Table 12 and Table 13 of the same Supplementary Materials report the outcomes of the asset reallocation exercise of Section 0 using 1:4 and 1:3 matching ratios respectively. These results also confirm our findings on a negative coefficient for bank loans in QE1 and positive coefficient for government securities in QE2. Due to the marginal positive significance of reserves and government securities in QE1, we observe a small loss of significance of the difference-in-differences coefficient in some specifications due to smaller sample size.

6.3. Unpacking Average Effects

One potential limitation of the small set of treated banks is that the results could be just affected by one of two main institutions. Are the results driven by all eight recipients or just a couple of banks? In order to unpack this average effect we have re-estimated our main models in a reduced form for 2 sets of the banks: the top three and the bottom six. Although the third largest treated bank is included in both sets, this is to ensure a good balance between the number of institutions and market share represented. The above tests can help understand whether different banks and/or group of banks show different patterns. Outcomes of these tests are reported in Supplementary Table 20. We find that the top largest banks were more involved with government securities in QE1, most likely due to their business model that was already more exposed to those securities, while the others banks mainly shifted their portfolio to sovereigns in QE2.

6.4. Including non-UK QE Banks

Another potential limitation of our proprietary dataset is the small number of UK banks who received cash injections via the APP. For the sake of completeness, we included an exercise that considers all QE banks. The only advantage of this test is related to the improved sample size, in particular for the treated banks group. Results for both bank lending and asset reallocation channels are reported in Supplementary Table 25. The test is in line with the lack of bank lending to the economy even when including foreign banks who benefitted from QE cash (negative but not significant coefficient for retail loans). Impact on reserves is positive (although not significant) QE1 and negative in QE2 as in the main model. We also find supporting evidence of the asset reallocation channel towards government securities in QE1, along with a negative impact on bank lending, supporting our findings. Note, however, that those non-UK treated banks have been probably exposed to larger liquidity injections through other unconventional monetary schemes in other regions, and for this reason omitted from the main analysis.

6.5. Sample Period and Treatment Overlaps

The choice of a long sample period of 18 years, although improving the sample size when dealing with a small number of institutions, might diminish the causal nature of the paper's diff-in-diff inferences. To address this issue, we have re-estimated our main model by restricting the sample period to 4 years prior to the QE event. Estimates for both the bank lending and the asset reallocation channel are consistent with our main results and reported in Supplementary Table 21. Results are also robust when excluding the last two years due to Brexit turmoil.[21]

Finally, we also address potential concerns related to overlapping treatment events by modifying our dummy variables QE1 to run from March 2009 to September 2011 (right before the second wave of QE2). Estimates are consistent with our main results and reported in Supplementary Table 22. However, we would like to stress the fact that this would undermine the assessment of QE1 since the actual impact could very easily be observed later than September 2011.

6.6. Capital Adequacy Ratio

Bank equity as a percentage of total assets might not fully capture the level of capital a bank has in relationship with the level of risk of their assets. This becomes quite important in our study as regulatory capital requirements play an important role in explaining the absence of the bank lending channel, as a consequence of QE, in favour of a reallocation of investments towards low risk weighted securities. The aim is to alleviate potential endogeneity caused by different level of risk exposure between the two groups. To account for more risk-weighted measures of banks performance, we re-estimate our main model by replacing equity to total assets with the Basel III Capital Adequacy Ratio (CAR) as covariates in our propensity score matching and as control in the difference-in-differences exercise. Note that the CAR is

[21] The table is not reported for conciseness but is available from the authors upon request.

calculated as equity over risk weighted assets. Estimates are consistent with our main results and reported in Supplementary Table 24.

6.7. Funding for Lending Scheme

In their paper, Churm et al. (2015) argue that the introduction of the Funding for Lending Scheme (FLS) by the Bank of England might have influenced the asset reallocation after QE2. In particular, how does our methodology distinguish the impact of QE from that of the FLS? FLS was initiated in July 2012, which is just after the start of QE2 in 2011h2. Given that much of our results are attributed to QE2, it is important that any effect of the FLS be accounted for. Therefore, we have addressed this issue by re-estimating our main models by controlling for the banks that benefitted from relatively cheap FLS funds. Specifically, we identified the two main waves of FLS, the first starting in July 2012 (FLS1) and the second in January 2014 (FLS2). 9 UK banks were involved in FLS1 while 28 banks in FLS2. Estimates from this exercise are still consistent with our main findings and reported in Supplementary Table 23.

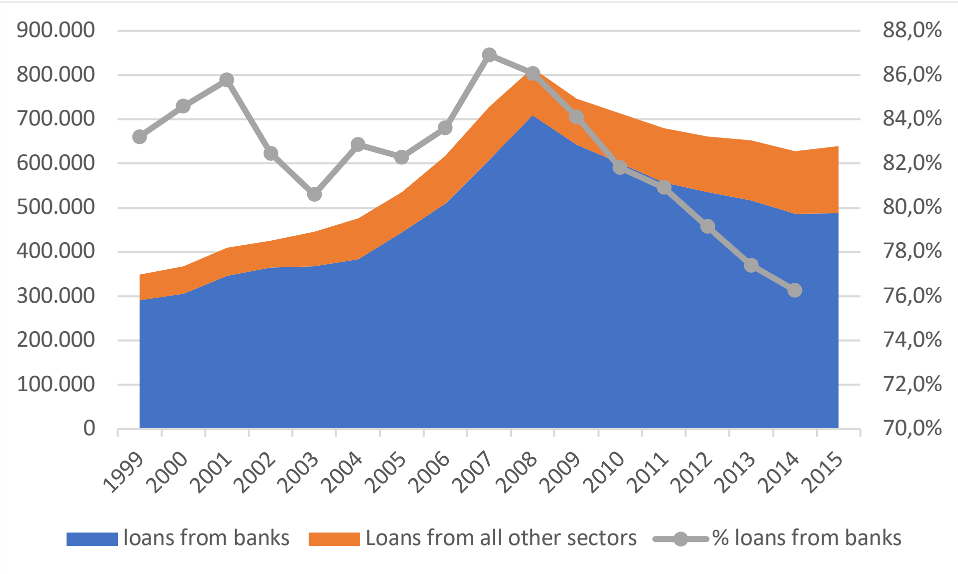
6.8. Variations of Sovereign Exposures Exercise

To further validate our findings on the estimation of model (3), we run several robustness tests. We begin by reporting the test results of the sensitivity of banks returns to all GIIPS bond returns in Supplementary Materials Table 14, noting however the high correlation of GIIPS bond returns as also reported in Acharya and Steffen (2015). Results still show evidence of carry trade activity of QE banks with Italian sovereign bonds, supporting our asset reallocation channel hypothesis. The latter were the most popular securities in those carry trade positions reported in Acharya and Steffen (2015). We also replace the treated status variable $Treated_i$ with the continuous treated variable $log(QEcash_i)$ that equals to the log of the sum of cash injections received by QE-banks and zero for non-QE-banks. The loading factors reported in the Supplementary Material Table 15 are consistent with the main estimates of Table 14 both in terms of sign and magnitude with even stronger statistical significance. The last set of robustness tests estimates the model over the whole period of 2000-2018 by controlling for both treated status and QE time dummies interacted with sovereigns. Results are reported in Table 18 of the Supplementary Materials.

6.9. Lending from Non-Bank Financials (Shadow banking)

The expansion in lending by shadow banks was a direct result of them having little to no regulations compared to mainstream banks. The stricter banking regulation post the financial crisis has likely magnified that effect, making lending to the real economy (which normally carries high risk weights for banks) more economical (less costly) for shadow banking institutions which are not exposed to any capital requirements. In order to test the role of non-bank financials in providing an alternative source of credit to corporations, we first looked at the flow of fund data as reported in Figure 7 below. These accounts, collected from the financial accounts within the UK ONS Flow of Funds Project, quantify the lending-borrowing linkages between the main sectors of economy across different asset categories (e.g., loans, debt securities, and equity shares). The chart is based on the indebtedness (liability) of the non-financial corporations sector to other sectors under the loans category.

Figure 7 – Lending from banks and non-bank financials



Source: UK ONS Flow of Funds Project: Financial Accounts.

Borrowing of non-financial corporates (NFCs) from all domestic sectors except banks (i.e., households, other financials, government) is less than 25% of their total loans (i.e., non-security borrowing). As the Chart shows, total loans of NFCs increased steadily before the financial crisis, and while the share on non-bank loans increased early in 2000s, it fell back again between 2004 and 2007. Meanwhile, in the years following the crisis, NFCs' total loans had a downward trajectory, whereas the share of loans from non-banks had increased.

This result is consistent with the idea that following the crisis, with new regulation and a loss of trust in the banking system, lending demand could likely have shifted from traditional banks to shadow institutions (e.g., finance companies, fintech lenders), as documented in Culp (2013) and Hsu and Moroz (2010).

To further investigate the role of non-bank financials to corporate lending, and therefore providing further testing of an alternative explanation of the results obtained in our demand-side effect section, we have collected additional data from syndicated loan of the corporates tested in our quasi-Khwaja and Mian (2008) estimates of Section 5.2. Specifically, we want to further exploit the lenders syndicate and differentiate lenders by type, specifically between banks and non-bank financials that are listed in the syndicate profile. Following the same methodology of Section 5.2, we create a dummy variable $NonBankFinancial_i$ that equals to 1 for non-banks financial lenders and 0 for lender banks. We expect a positive and significant load of the coefficient for this dummy in the event of a positive shifting from banks to shadow banking occurred.

<Table 9 here>

Table 9 presents our estimates for each QE event separately (and in line with our main Table 5 for easy better comparison). Although often positive, and although at times marginally significant, the estimates for this dummy in our baseline models (1) and (2), does not provide robust evidence supporting this alternative scenario when saturating the model with more controls, specifically industry fixed effects. Note that all relative changes in loan issuance from pre-QE to post-QE periods are negative, again in line with the macro trend plotted in Figure 7. However, no confounding evidence of this shifting behaviour was found in the loan level analysis.

In general, our analysis shows that the negative trend did not affect QE and non-QE banks disproportionally, and that the lack of lending support by banks was not strongly replaced by non-bank financials for companies previously borrowing from QE banks.

6.10. Off-Balance Sheet Positions

The potential increase of off-balance sheet positions, which include mainly credit facilities, guarantees and securitisation-related exposures (e.g., Special Purpose Vehicles), might be an alternative hypothesis of the asset reallocation channel we discuss in the paper. In order to address this point, we have collected additional off-balance sheet data of banks and tested this alternative hypothesis by using our asset reallocation difference-in-differences model using measures of off-balance sheet exposure as dependent variable. The Supplementary Table 18 below presents our estimates. No relative differences between QE banks and the control group can be found when both the log of total off-balance sheet exposure and the ratio between off-balance sheet exposure and total business volume is used. QE banks do not show and any significant asset reallocation channel towards off-balance sheet exposure compared to the control group that could support this alternative hypothesis.

7. Conclusions

We analysed the reaction of the balance sheets of UK banks to APP of BOE. The comparison of lending behaviour of treated or QE banks with a control group that is unaffected by the QE treatment helps to uncover the mechanisms by which monetary policy operates and its potential real economy implications.

We used a unique confidential dataset of APP that identifies QE treated banks, i.e., those which received reserves injections through APP. Our difference-in-differences exercises shows that treated banks appear to have reacted to QE cash injections by reallocating their assets towards those asset categories with low risk weights (government securities), promoting carry trade activity. These results are robust even when controlling for demand-side changes using loan level data and borrower firm fixed effects. No evidence of a positive impact of QE through the bank lending channel is confirmed.

The combination of lower gilts yields, resulting at least partly from QE and risk-based capital requirements might have given banks the incentives to shift their portfolios into high-yielding assets with the low risk weights in an attempt to optimise the use of regulatory capital. Thus, the presence of risk-weighted capital requirements could limit QE impact via the bank lending channel, as they may induce inadequately capitalised banks to substitute away from lending to businesses. These requirements may have reinforced the concentration of investment in sovereign debt instruments that contribute to the decline of market values as recorded on many EU banks involved in carry trade operations right before the EU sovereign debt crisis (Acharya and Steffen, 2015).

In light of our empirical evidence, if a central bank wants to provide an additional boost to the economy beyond what QE provides, it should consider using alternative credit easing tools, such as direct lending to small businesses, with no access to capital markets, or allow these businesses to have direct access to the central bank balance sheet, maybe via a central bank digital currency. In this regard it is interesting to observe how during the current corona crisis countries, like Switzerland, already follow this path by actually having commercial banks grant the loans directly to small businesses, interest-free and with full governmental guarantee of repayment. Our findings also encourage policy makers to pay attention to the type of assets purchased via the program in relation with banks' exposures (Rodnyansky and Darmouni, 2015). This is key to achieve an effective transmission of QE impact to the real economy via bank lending.

8. Appendix: Variable Definition

The treated status and the QE cash data are sourced by confidential APP data. The rest of the balance sheet variables are sourced by FitchConnect at the semi-annual frequency. All values are in GBP. Definitions of reported variables are:

- **Treated** – Dummy variable that equals to 1 for QE-banks and 0 for non-QE-banks.
- **QE1, QE2** – Dummy variables covering the first and second wave of QE. They equal 1 from 2009h1 onwards and 2011h2 onwards respectively.
- **QEcash** – Log of the sum of cash injections received by QE-banks and zero for non-QE-banks
- **Size** – Log of total assets
- **Reserves** - Cash including any balances disclosed under 'Cash and Due from Banks' in the financial report
- **Comm loans** – Corporate and commercial loans measured as loans and leases to corporate and commercial enterprises
- **Ret loans** – Consumer and retail loans defined as loans and leases to individuals, which are either unsecured or secured by assets other than residential property
- **Mortgages** – Loans secured by residential property + non-residential/commercial property mortgage loans, which are undefined with respect to the borrower type
- **Tot loans** – Net loans measured as Comm loans + Ret loans + Mortgages + other loans and leases that do not fall in any of the other category
- **Bank loans** – Interest bearing balances to central and commercial banking institutions
- **Securities** – Total securities measured as reverse repos and cash collateral + trading securities and at FV through income + derivatives + available for sale securities + held to maturity securities + at-equity investments in associates + other securities.
- **Gov securities** – Securities issued by central or local/municipal government
- **Liquid assets** – Cash and due from depository institutions + securities
- **Deposits** – Customer deposit current + customer deposit savings + customer deposits term
- **Bank deposits** – Deposits made by banking institutions
- **Net Income** – Net income before profit transfers – profit transfer to parent companies
- **Net int inc** – Net interest income measured as gross interest and dividend Income – total interest expense.

- **ROA** – Return on assets
- **ROE** – Return on equity

Marked data series are sourced by Datastream at the daily frequency. Definition of reported variables are:

- **R** – Daily equity returns of banks
- **GR** - Daily returns on ten-year Greek government bonds
- **IT** - Daily returns on ten-year Italian government bonds
- **IR** - Daily returns on ten-year Irish government bonds
- **PR** - Daily returns on ten-year Portuguese government bonds
- **SP** - Daily returns on ten-year Spanish government bonds
- **GE** - Daily returns on ten-year German government bonds
- **UK** - Daily returns on ten-year UK government bonds
- **US** - Daily returns on ten-year US government bonds
- **JP** - Daily returns on ten-year Japanese government bonds
- **FTSE** - Residual from the regression of the FTSE 350 daily log returns on daily UK Gilts and German bund returns
- **VSTOXX** - Daily return of the VSTOXX Index for the European stock market
- **TermStructure** - Term Structure is the slope of the term structure of interest rates measured as the difference between the yield on a ten-year euro area government bond and the one-month Euribor
- **BondDefSpread** - Bond default spread; difference between the yield on ten-year German BBB bonds and yields on ten-year German government debt
- **1mEURIBOR** - One-month Euribor, level of the short-term risk-free interest rate measured as the one-month Euribor
- **ΔFX-Rate** - Change of the nominal effective exchange rate of the euro
- **ΔESI** - Change in European economic sentiment; monthly change in the economic sentiment indicator obtained from opinion surveys conducted by the European Central Bank
- **ΔIndProd** - Change in level of industrial production; monthly change in the level of industrial production
- **ΔCPI** - European Consumer Price Index is the change in inflation measured as the monthly change in the European Consumer Price Index

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TABLES

Table 1 – Descriptive statistics of Financial Reports

VARIABLES	N obs	mean	sd	p25	p50	p75
log(tot assets)	1,758	22.72	2.926	20.49	22.49	24.49
Reserves/ tot assets	1,684	0.0944	0.148	0.00577	0.0539	0.111
Tot loans/ tot assets	1,561	0.568	0.254	0.393	0.643	0.774
Comm loans/ tot assets	674	0.135	0.113	0.0409	0.111	0.199
Retail loans/ tot assets	489	0.0867	0.139	0.0166	0.0335	0.0870
Mortgages/ tot assets	1,758	0.260	0.330	0.000	0.000	0.657
Bank loans/ tot assets	1,419	0.125	0.162	0.0249	0.0650	0.150
Securities/ tot assets	1,704	0.205	0.205	0.0567	0.144	0.280
Gov securities/ tot assets	737	0.0527	0.0949	0.0103	0.0366	0.0727
Liquid assets/ tot assets	1,746	0.249	0.214	0.0982	0.187	0.324
Liabilities/ tot assets	1,754	0.865	0.191	0.883	0.934	0.951
Customer deposits/ tot assets	1,437	0.627	0.248	0.461	0.704	0.834
Bank deposits/ tot assets	1,360	0.113	0.166	0.0218	0.0569	0.125
Net income/ tot assets	1,755	0.00297	0.0862	0.00103	0.00349	0.00826
Net int inc/ tot assets	1,721	0.0118	0.0133	0.00523	0.0103	0.0160
ROA	1,662	0.637	8.661	0.130	0.420	0.970
ROE	1,622	21.85	18.97	10.84	21.37	29.21

Source: FitchConnect. Descriptive statistics are based on consolidated financial reports of UK institutions, excluding their nonbank subsidiaries, from 2000h2 to 2018h1. All variables are semi-annual.

Table 2 – Multivariate regression between treatment and individual characteristics

$Treated_i$	(1)		(2)		(3)	
	coeff	SE	coeff	SE	coeff	SE
Size	**0.363*****	(0.104)	**0.281*****	(0.087)	**0.329*****	(0.108)
ROA	-0.005	(0.006)	-0.002	(0.006)	0.094	(0.242)
Liabilities/tot assets	-0.481	(0.709)	0.263	(0.701)	0.169	(4.885)
Net int inc/tot assets			13.249	(8.111)	12.685	(15.917)
Securities/tot assets			**2.430****	(1.214)	1.309	(1.840)
Total loans/tot assets					-1.388	(1.686)
Deposits/tot assets					-0.016	(1.641)
Constant	9.656***	(2.587)	-9.262***	(2.134)	-9.354**	(4.350)
$Adj\ R^2$	0.349		0.407		0.411	
p-value	0.005		0.000		0.000	
N	77		73		65	

Probit regressing the treatment on bank characteristics in 2008h2. The dependent variable is the bank treatment status. The independent variables are size as the natural log of total assets, return on assets (ROA), total liabilities over total assets, net interest income over total assets, total securities over total assets, total loans over total assets and customer deposits over total assets. Coefficients and standard errors are reported for each variables. Standard errors are clustered at the bank level and reported in brackets, * $p<0.10$ ** $p<0.05$ *** $p<0.01$.

Table 3 – Propensity Score Matching

$Treated_i$	(1)		(2)	
	coeff	SE	coeff	SE
Size	**0.281****	(0.128)	0.142	(0.188)
Equity	-0.263	(3.080)	14.957	(24.383)
ROA	-0.002	(0.037)	-0.148	(0.330)
Securities	**2.430***	(1.353)	1.142	(2.004)
Net int inc	13.249	(16.673)	-15.950	(78.355)
Constant	8.999***	(3.293)	-5.526	(4.947)
Matching	-pre		-post	
$Adj\ R^2$	0.407		0.076	
p-value	0.001		**0.765**	
N	73		48	

Probit regressing the treatment on bank characteristics in 2008h2. The dependent variable is the bank treatment status. The independent variables are size as the natural log of total assets, equity as total assets minus total liabilities, return on assets (ROA), total securities over total assets and net interest income over total assets. Model (1) reports the pre-matching results while model (2) reports the post matching results with matching ratio 1:5. Coefficients and standard errors are reported for each variable. Standard errors are clustered at the bank level and reported in brackets, * p<0.10 ** p<0.05 *** p<0.01.

Table 4 – The Bank Lending Channel

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(tot loans)		log(comm loans)		log(ret loans)		log(mortgages)	
$Treated_i * \boldsymbol{QE}_{1,t}$	0.00132		-0.162		0.0263		0.0454	
	(0.0642)		(0.702)		(0.331)		(0.102)	
$Treated_i * \boldsymbol{QE}_{2,t}$	0.0954		0.192		**-0.441****		-0.0560	
	(0.0959)		(0.185)		(0.160)		(0.115)	
$log(QEcash_i) * \boldsymbol{QE}_{1,t}$		-0.000165		-0.00714		8.51e-05		0.00199
		(0.00256)		(0.0276)		(0.0133)		(0.00407)
$log(QEcash_i) * \boldsymbol{QE}_{2,t}$		0.00424		0.00749		**-0.0173****		-0.00221
		(0.00379)		(0.00738)		(0.00638)		(0.00458)
Observations	1,079	1,079	593	593	579	579	583	583
R-squared	0.595	0.595	0.502	0.502	0.532	0.532	0.708	0.708
Number of Banks	26	26	21	21	19	19	19	19
QE	YES	YES	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Controls * **QE**	YES	YES	YES	YES	YES	YES	YES	YES
Bank FEs	YES	YES	YES	YES	YES	YES	YES	YES
p-value	0.1288	0.1304	0.6968	0.6871	0.3979	0.4024	0.0201	0.0213

Coefficient estimates from specification of semi-annual consolidated statements of UK banks from 2000h2 to 2018h1 using a 1:5 matching ratio. Treatment status $Treated_i$ equals to 1 for QE-banks and 0 for non-QE-banks. The continuous treatment status $log(QEcash_i)$ equals to the log of the sum of cash injections received by QE-banks and zero for non-QE-banks. Controls are size as log of total assets, equity over total assets, return on assets (ROA), securities over total assets and net interest income over total assets. The reported *p-values* test the coefficient inequality between QE1 and QE2. Standard errors are clustered at the bank level and reported in brackets, * p<0.10 ** p<0.05 *** p<0.01.

Table 5 - Loan Issuance Estimator

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	QE1	QE2	QE1	QE2	QE1	QE2	QE1	QE2
$Treated_i$	0.0286	-0.204	0.112	-0.201	0.194	-0.271	0.399	0.0378
	(0.194)	(0.183)	(0.202)	(0.181)	(0.202)	(0.211)	(0.285)	(0.173)
Constant	-0.0423	0.313	0.0915	0.381*	-0.933***	0.0688	-1.778***	0.0837
	(0.208)	(0.202)	(0.224)	(0.225)	(0.346)	(0.355)	(0.298)	(0.335)
Observations	103	185	103	184	103	184	103	184
R-squared	0.000	0.018	0.021	0.021	0.117	0.034	0.319	0.298
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Industry FE			YES	YES	YES	YES		
Country FE					YES	YES		
Industry ∗ Country FE							YES	YES

Coefficient of the quasi-Khwaja and Mian (2008)' estimates of the relative change in loan issuance by treated and control banks in the two years before and after each the two QE waves. Treatment status $Treated_i$ equals to 1 for QE-banks and 0 for non-QE-banks. The Industry fixed effect is evaluated using the SIC1 code. Standard errors are double clustered at the bank and firm level and reported in brackets, * p<0.10 ** p<0.05 *** p<0.01.

Table 6 – The Asset Reallocation Effect

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(deposits)		log(reserves)		log(bank loans)		log(gov securities)	
$Treated_i * \boldsymbol{QE}_{1,t}$	0.0700		**0.594***		**-0.877*****		**0.418***	
	(0.0743)		(0.306)		(0.272)		(0.209)	
$Treated_i * \boldsymbol{QE}_{2,t}$	0.0588		-0.371		-0.348		**0.541*****	
	(0.0993)		(0.233)		(0.272)		(0.174)	
$log(QEcash_i) * \boldsymbol{QE}_{1,t}$		0.00262		**0.0245***		**-0.0356*****		**0.0167***
		(0.00305)		(0.0126)		(0.0112)		(0.00817)
$log(QEcash_i) * \boldsymbol{QE}_{2,t}$		0.00292		-0.0142		-0.0135		**0.0215*****
		(0.00382)		(0.00946)		(0.0112)		(0.00680)
Observations	1,057	1,057	1,078	1,078	1,062	1,062	650	650
R-squared	0.364	0.364	0.643	0.643	0.180	0.179	0.415	0.415
Number of Banks	25	25	27	27	25	25	24	24
QE	YES	YES	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Controls * **QE**	YES	YES	YES	YES	YES	YES	YES	YES
Bank FEs	YES	YES	YES	YES	YES	YES	YES	YES
p-value	0.0055	0.0059	0.8199	0.7958	0.6066	0.5978	0.6046	0.6134

Coefficient estimates from specification of semi-annual consolidated statements of UK banks from 2000h2 to 2018h1 using a 1:5 matching ratio. Treatment status $Treated_i$ equals to 1 for QE-banks and 0 for non-QE-banks. The continuous treatment status $log(QEcash_i)$ equals to the log of the sum of cash injections received by QE-banks and zero for non-QE-banks. Controls are size as log of total assets, equity over total assets, return on assets (ROA), securities over total assets and net interest income over total assets. The reported *p-values* test the coefficient inequality between QE1 and QE2. Standard errors are clustered at the bank level and reported in brackets, * p<0.10 ** p<0.05 *** p<0.01.

Table 7 - Banks' sensitivity to Sovereign Exposures on Individual GIIPS

Panel A - DiD on QE1

VARIABLES	(1) GRE	(2) ITA	(3) IRI	(4) POR	(5) SPA
GR	0.0103				
	(0.00805)				
$GR * Treated_i$	0.00962				
	(0.0138)				
IT		0.0570**			
		(0.0272)			
$IT * Treated_i$		**0.170*** **			
		(0.0423)			
IR			0.0383		
			(0.0321)		
$IR * Treated_i$			**0.107** **		
			(0.0526)		
PR				0.0273	
				(0.0213)	
$PR * Treated_i$				**0.0733** **	
				(0.0328)	
SP					0.0552*
					(0.0319)
$SP * Treated_i$					**0.138*** **
					(0.0505)
UK	-0.547***	-0.547***	-0.546***	-0.546***	-0.549***
	(0.0619)	(0.0618)	(0.0618)	(0.0618)	(0.0619)
$UK * Treated_i$	-0.105	-0.101	-0.104	-0.102	-0.108
	(0.0942)	(0.0940)	(0.0941)	(0.0941)	(0.0941)
GE	-1.032***	-1.051***	-1.053***	-1.043***	-1.050***
	(0.0778)	(0.0772)	(0.0790)	(0.0775)	(0.0772)
$GE * Treated_i$	**-0.369*** **	**-0.396*** **	**-0.410*** **	**-0.380*** **	**-0.397*** **
	(0.114)	(0.114)	(0.117)	(0.114)	(0.114)
US	-0.0471	-0.0445	-0.0444	-0.0469	-0.0459
	(0.0491)	(0.0491)	(0.0492)	(0.0491)	(0.0491)
$US * Treated_i$	-0.0533	-0.0613	-0.0551	-0.0584	-0.0619
	(0.0785)	(0.0785)	(0.0786)	(0.0786)	(0.0785)
JP	-0.194**	-0.169*	-0.180*	-0.185**	-0.170*
	(0.0939)	(0.0950)	(0.0943)	(0.0943)	(0.0947)
$JP * Treated_i$	**0.515*** **	**0.387*** **	**0.460*** **	**0.465*** **	**0.427*** **
	(0.0853)	(0.0911)	(0.0882)	(0.0872)	(0.0923)
$FTSE$	1.065***	1.065***	1.067***	1.066***	1.065***
	(0.0288)	(0.0290)	(0.0288)	(0.0287)	(0.0290)
$FTSE * Treated_i$	**0.136*** **	**0.113*** **	**0.129*** **	**0.127*** **	**0.122*** **
	(0.0336)	(0.0342)	(0.0336)	(0.0336)	(0.0343)
Observations	49,604	49,604	49,604	49,604	49,604

R-squared	0.372	0.373	0.372	0.372	0.373
Macro Controls	YES	YES	YES	YES	YES
Bank FEs	YES	YES	YES	YES	YES

Panel B - DiD on QE2

VARIABLES	(1) GRE	(2) ITA	(3) IRI	(4) POR	(5) SPA
GR	0.00988				
	(0.00716)				
$GR * Treated_i$	0.00171				
	(0.0113)				
IT		0.0628**			
		(0.0290)			
$IT * Treated_i$		**0.169*****			
		(0.0432)			
IR			0.115**		
			(0.0564)		
$IR * Treated_i$			0.0201		
			(0.0884)		
PR				0.0512**	
				(0.0253)	
$PR * Treated_i$				0.0484	
				(0.0357)	
SP					0.0764**
					(0.0367)
$SP * Treated_i$					**0.129****
					(0.0561)
UK	-0.585***	-0.583***	-0.583***	-0.581***	-0.587***
	(0.0694)	(0.0692)	(0.0691)	(0.0689)	(0.0694)
$UK * Treated_i$	-0.0452	-0.0330	-0.0446	-0.0398	-0.0443
	(0.0998)	(0.0989)	(0.0992)	(0.0990)	(0.0993)
GE	-1.013***	-1.034***	-1.074***	-1.028***	-1.034***
	(0.0831)	(0.0819)	(0.0865)	(0.0824)	(0.0819)
$GE * Treated_i$	**-0.325*****	**-0.349*****	**-0.336*****	**-0.334*****	**-0.348*****
	(0.109)	(0.108)	(0.115)	(0.108)	(0.108)
US	-0.0824	-0.0776	-0.0799	-0.0834	-0.0803
	(0.0560)	(0.0559)	(0.0560)	(0.0560)	(0.0560)
$US * Treated_i$	-0.0881	-0.0892	-0.0883	-0.0909	-0.0938
	(0.0803)	(0.0803)	(0.0803)	(0.0804)	(0.0802)
JP	-0.211*	-0.184	-0.211*	-0.205*	-0.180
	(0.115)	(0.117)	(0.117)	(0.116)	(0.116)
$JP * Treated_i$	**0.453*****	**0.299*****	**0.446*****	**0.413*****	**0.354*****
	(0.0896)	(0.0937)	(0.0948)	(0.0902)	(0.0954)
$FTSE$	1.105***	1.101***	1.099***	1.099***	1.099***
	(0.0333)	(0.0335)	(0.0332)	(0.0330)	(0.0337)
$FTSE * Treated_i$	0.0104	-0.0240	0.00940	0.00145	-0.0107
	(0.0358)	(0.0361)	(0.0358)	(0.0357)	(0.0365)

Observations	49,604	49,604	49,604	49,604	49,604
R-squared	0.364	0.365	0.365	0.365	0.365
Macro Controls	YES	YES	YES	YES	YES
Bank FEs	YES	YES	YES	YES	YES

Coefficient estimates from specification of daily equity returns of UK banks using a 1:4 matching ratio. Treatment status $Treated_i$ equals to 1 for QE-banks and 0 for non-QE-banks. Panel A reports estimates from the period of QE1 (5th of March 2009) onwards whereas Panel B considers the QE2 period only (6th of October 2011 onwards). Variables GR, IT, IR, PR, SP, UK, GE and JP are daily returns of 10 years bond of Greece, Italy, Ireland, Portugal, Spain, UK, Germany and Japan respectively. Macro Controls are (i) *VSTOXX*, the change in the volatility index of the European stock market; (ii) *TermStructure*, measured as the difference between the yield on a 10-year euro area government bond and the one-month Euribor; (iii) *BondDefSpread*, the difference between the yield on 10-year German BBB bonds and yields on 10-year German government debt; (iv) *1mEuribor*, the one-month Euribor; (v) *ΔESI*, the monthly change in the economic sentiment indicator; (vi) *ΔIntProd*, the monthly change in the level of industrial production; (vii) *ΔCPI*, the change in the rate of inflation measured as the monthly change in the European consumer price index; and (viii) *ΔFX-Rate*, the change in the effective exchange rate of the euro. Standard errors are double clustered at the bank and time level and reported in brackets, * p<0.10 ** p<0.05 *** p<0.01.

Table 8 – Placebo exercise

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(ret loans)		log(reserves)		log(bank loans)		log(gov securities)	
$PlaceboTreated_i^{SIZE} * \boldsymbol{QE}_{1,t}$	-0.428		-0.183		-0.0687		0.0776	
	(0.351)		(0.322)		(0.174)		(0.278)	
$PlaceboTreated_i^{SIZE} * \boldsymbol{QE}_{2,t}$	-0.280		-0.0562		0.0245		-0.260	
	(0.272)		(0.289)		(0.141)		(0.340)	
$PlaceboTreated_i^{SEC} * \boldsymbol{QE}_{1,t}$		0.213		0.107		0.0275		0.430
		(0.349)		(0.330)		(0.203)		(0.305)
$PlaceboTreated_i^{SEC} * \boldsymbol{QE}_{2,t}$		0.0592		-0.438		0.220		0.488
		(0.238)		(0.280)		(0.147)		(0.316)
Observations	282	282	1,133	1,097	997	980	465	452
R-squared	0.349	0.338	0.589	0.589	0.203	0.205	0.349	0.367
Number of Banks	23	23	70	66	60	58	52	49
QE	YES	YES	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Controls $*$ **QE**	YES	YES	YES	YES	YES	YES	YES	YES
Bank FEs	YES	YES	YES	YES	YES	YES	YES	YES
p-value	0.0299	0.1454	0.2826	0.1645	0.7646	0.8400	0.1515	0.1865

Coefficient estimates from specification of semi-annual consolidated statements of UK banks from 2000h2 to 2018h1 using a 1:1 matching ratio. Treatment status $PlaceboTreated_i^{SIZE}$ equals to 1 for treated non-QE-banks and 0 for control non-QE-banks when controlling for size measured as log of total assets and security, whereas $PlaceboTreated_i^{SEC}$ when controlling for security holdings measured as log of total securities. Controls are size as log of total assets, equity over total assets, return on assets (ROA), securities over total assets and net interest income over total assets. The reported *p-values* test the coefficient inequality between QE1 and QE2. Standard errors are clustered at the bank level and reported in brackets, * p<0.10 ** p<0.05 *** p<0.01.

Table 9 - Loan Issuance Estimator from Non-Banks Financials

VARIABLES	(1) QE1	(2) QE2	(3) QE1	(4) QE2	(5) QE1	(6) QE2
$NonBankFinancial_i$	**0.185****	0.851*	0.0382	0.611	0.380	0.544
	(0.0895)	(0.448)	(0.217)	(0.801)	(0.250)	(0.674)
Constant	-3.888***	-4.166***	-3.983***	-5.307***	-2.846***	-3.688***
	(0.129)	(0.130)	(0.150)	(0.242)	(0.455)	(0.615)
Observations	103	185	103	184	103	184
R-squared	0.000	0.018	0.021	0.021	0.117	0.034
Firm FE	YES	YES	YES	YES	YES	YES
Industry FE	NO	NO	YES	YES	YES	YES
Country FE	NO	NO	NO	NO	YES	YES

Coefficient of the quasi-Khwaja and Mian (2008) estimates of the relative change in loan issuance by banks and non-banks financials in the two years before and after each the two QE waves. Dummy status $NonBankFinancial_i$ equals to 1 for non-banks financial lenders and 0 for lender banks. The Industry fixed effects are based on the SIC1 code. Standard errors are double clustered at the bank and firm level and reported in brackets, * p<0.10 ** p<0.05 *** p<0.01.