



BANK OF ENGLAND

Staff Working Paper No. 883

Does quantitative easing boost bank lending to the real economy or cause other bank asset reallocation? The case of the UK

Simone Giansante, Mahmoud Fatouh and Steven Ongena

August 2020

Staff Working Papers describe research in progress by the author(s) and are published to elicit comments and to further debate. Any views expressed are solely those of the author(s) and so cannot be taken to represent those of the Bank of England or to state Bank of England policy. This paper should therefore not be reported as representing the views of the Bank of England or members of the Monetary Policy Committee, Financial Policy Committee or Prudential Regulation Committee.



BANK OF ENGLAND

Staff Working Paper No. 883

Does quantitative easing boost bank lending to the real economy or cause other bank asset reallocation? The case of the UK

Simone Giansante,⁽¹⁾ Mahmoud Fatouh⁽²⁾ and Steven Ongena⁽³⁾

Abstract

We investigate the impact of the asset purchase program (APP) introduced by the Bank of England (BOE) in 2009 on the composition of assets of UK banks, and the implications for bank lending to the real economy, using a unique database on the program. Knowing the identity of the banks that receive reserves injections through the BOE's APP (QE banks) provides us with an ideal empirical design for a difference-in-differences exercise.

The Monetary Policy Committee (MPC) didn't expect there to be strong transmission of the APP's impact through the bank lending channel. In line with that, we find no evidence that suggests that QE directly boosted bank lending to the real economy, even when controlling fully for demand-side effects. The overall reduction of retail lending is more pronounced for treated (QE) banks than for the control group. QE banks reallocated their assets towards lower risk-weighted investments, such as government securities, as suggested by the increased sensitivity of their equity returns to peripheral EU bond returns. Overall, our findings suggest that, if banks are not adequately capitalised, risk-based capital constraints can limit the transmission of expansionary unconventional monetary policies via the bank lending channel, and provide incentives for carry trade activities.

Key words: Monetary policy, quantitative easing, bank lending.

JEL classification: E51, G21.

(1) School of Management, University of Bath. Email: s.giansante@bath.ac.uk

(2) Bank of England. Email: mahmoud.fatouh@bankofengland.co.uk

(3) University of Zurich, Swiss Finance Institute, KU Leuven, and CEPR. Email: steven.ongena@bf.uzh.ch

The views expressed in this paper are those of the authors, and not necessarily those of the Bank of England or its committees. We are grateful to Mike Joyce, Simon Hall, Bonnie Howard, Douglas Cumming and three anonymised reviewers for their input, which enhanced the quality of this work.

The Bank's working paper series can be found at www.bankofengland.co.uk/working-paper/staff-working-papers

Bank of England, Threadneedle Street, London, EC2R 8AH

Email enquiries@bankofengland.co.uk

© Bank of England 2020

ISSN 1749-9135 (on-line)

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 2007/08 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-weight capital requirements. This might limit the abovementioned 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 (March 2009 to November 2009 and October 2011 to October 2012) 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.

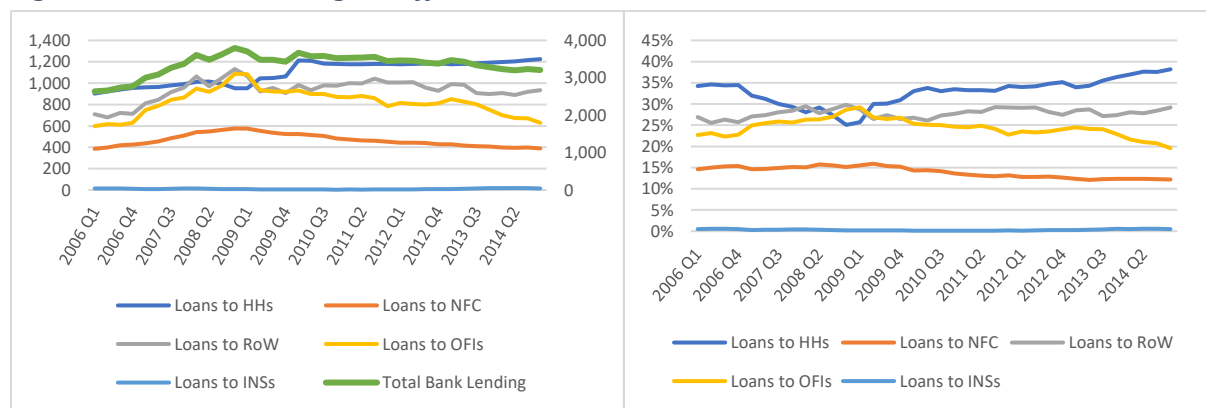
The Bank of England's (BOE) Monetary Policy Committee (MPC) launched its program in March 2009, following the precedent first set by the Bank of Japan in 2001, and more recently by the US Federal Reserve (Fed), which introduced its first Large Scale Asset Purchase (LSAP) program in November 2008. As 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 Fed's LSAP programs included purchasing large amounts of mortgage-backed securities (MBSs) and other agency securities. Asset purchases are funded by creating electronic central bank money. This money is then deposited into the reserves account of the

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>

seller’s bank which, in turn, credit the same amount into the deposit account of the seller. The MPC didn’t anticipate strong transmission of the APP through the bank lending channel². However, APP has provided large amounts of cheap liquidity to banks, in the form of central bank reserves. Therefore, it might be plausible to expect an increase in bank lending as one of the potential channels of transmission to the real economy. So, what does the bank lending data tell us?

Figure 1 shows a fall or little to no growth in every quarter except for 2013 Q1, perhaps because of The 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, as a consequence, a growing debate on whether QE impact can transmit into the real economy through the bank lending channel. The main focus of QE literature is on the broader macroeconomic impacts of QE, such as the increase in asset prices and the decline of long-term yields

² Para 34 of the MPC [Minutes on March 4-5 2009](#) states that: “The current strains in the financial system, and in particular the pressures on banks to reduce the size of their balance sheets, meant banks were less likely to increase their lending substantially following an increase in their reserves”.

(Joyce, Tong, and Woods 2011; Bridges et al., 2011). As Rodnyansky and Darmouni (2015) noted in their study on the US LSAPs, the effects of monetary policy treatments are difficult to be assessed due to the absence of a control group that is unaffected by the QE treatment. Recent studies have specifically targeted the bank lending channel of 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),³ as the main cause of the weak bank lending in UK (Butt et al., 2014). They also look at the low levels of bank capital that might have limited the positive relation between deposits and bank lending observed in the past (Joyce and Spaltro, 2014). More generally, the fall in corporate debt yields and the rise in equity prices, as a result of the portfolio-rebalancing effects of QE, would lower the cost of borrowing for big corporations in capital markets. This can result in corporates substituting banks loans with capital market financing (Butt et al. 2014; Fatouh et al., 2019). However, it is not clear whether QE reserve injections did amplify or marginally compensate for this fall in bank lending. In this study, we target differences in investment behaviour between banks that directly received liquidity through APP and banks that did not.

The paper contributes to the current debate on the effectiveness of quantitative easing to boost economic recovery by combining 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 direct 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. We do not assess the potential indirect QE effects on bank lending (impact of improved real economy on bank lending). This is made possible by the use of confidential dataset on 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.

³ The Asset Purchase Facility Fund is a subsidiary of BOE. It was established in January 2009. Its main rule is buy and manage assets acquired through monetary policy operations

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 actually 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 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 the real economy. Under risk-weighted capital requirements, banks, in a downturn, would prefer to reinvest reserves 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 GIIPS⁴ 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 in order to meet their capital requirements. By employing a similar sensitivity analysis on daily market data, 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

⁴ Greece, Italy, Ireland, Portugal and Spain.

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 are 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 asset reallocation mechanism we investigate in this study is motivated by the evidence 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 argue that

governments themselves could have had incentives to preserve the zero-risk weight to increase demand for higher risk sovereign debt. 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. (2018). 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.

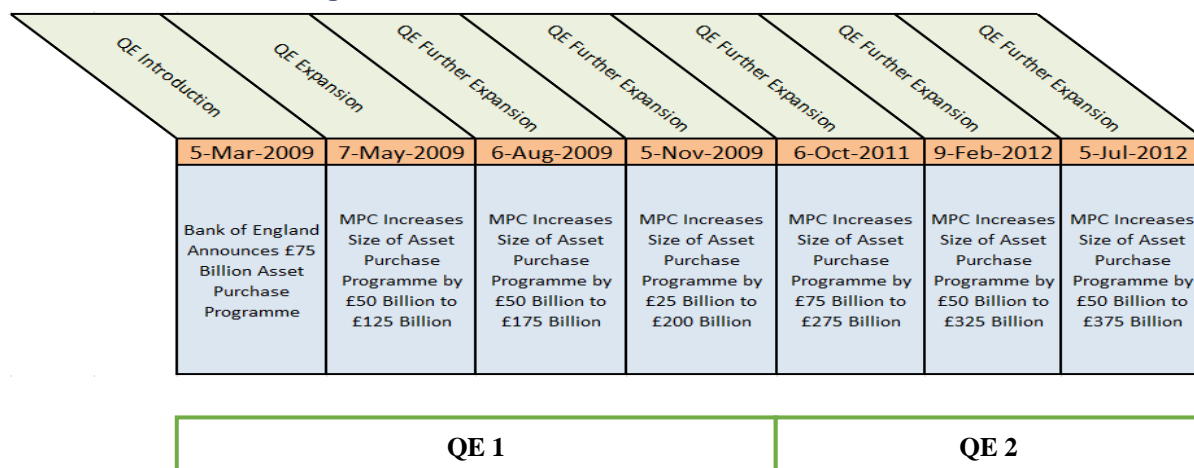
The growing empirical work on quantitative easing and the bank lending channel is also very much related to this study. Rodnyansky and Darmouni (2015) investigate the impact of the Fed LSAPs on the bank lending behaviour of commercial banks in the US. They are the first to find strong evidence of a positive 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. Butt et al. (2014) look at the stickiness of the deposits from other non-bank financial institutions during the UK APP. 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. 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 variations in deposits had a small but positive impact on bank lending in the past. This would imply a positive impact 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.

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. As a result, the BOE initiated its APP in March 2009.

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 October 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 billion of corporate bonds. Figure 2 presents the key stages of Bank of England asset purchase program until late November 2012.

Figure 2 - Quantitative Easing Timeline in the UK



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

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 et al., 2018). 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. The following empirical strategy follows the studies of Rodnyansky and Darmouni (2015) and Gropp et al. (2018).

4.1. Data

We rely on three main data sources: (1) the BOE's confidential data on the APP for the exact identification of banks that received liquidity via QE operations as well as the amounts of reserves deposited⁵, (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. Variables definitions are in the Appendix.

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 semiannual.

⁵ The dataset include information on the size of all purchases done by APF, and the banks which received proceedings of the sale on behalf of the seller.

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 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 program. 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. 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. 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.

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.

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)
<i>Adj R²</i>		0.349		0.407		0.411
<i>p-value</i>		0.005		0.000		0.000
<i>N</i>		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 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.⁶ Following Rodnyansky and Darmouni (2015) and Gropp et al. (2018), 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 and therefore 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.

Table 3 – Propensity Score Matching

<i>Treated_i</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
<i>Adj R²</i>		0.407		0.076
<i>p-value</i>		0.001		0.765
<i>N</i>		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 variables. Standard errors are clustered at the bank level and reported in brackets, * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$.

In order to further alleviate those differences, 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

⁶ 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.

with replacement, i.e., matching ratio 1:5. Table 3 shows the effect of matching in eliminating average differences between the two groups.⁷ 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.

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 third set of tests concentrates on the exposure of QE-banks to sovereign securities by employing a 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

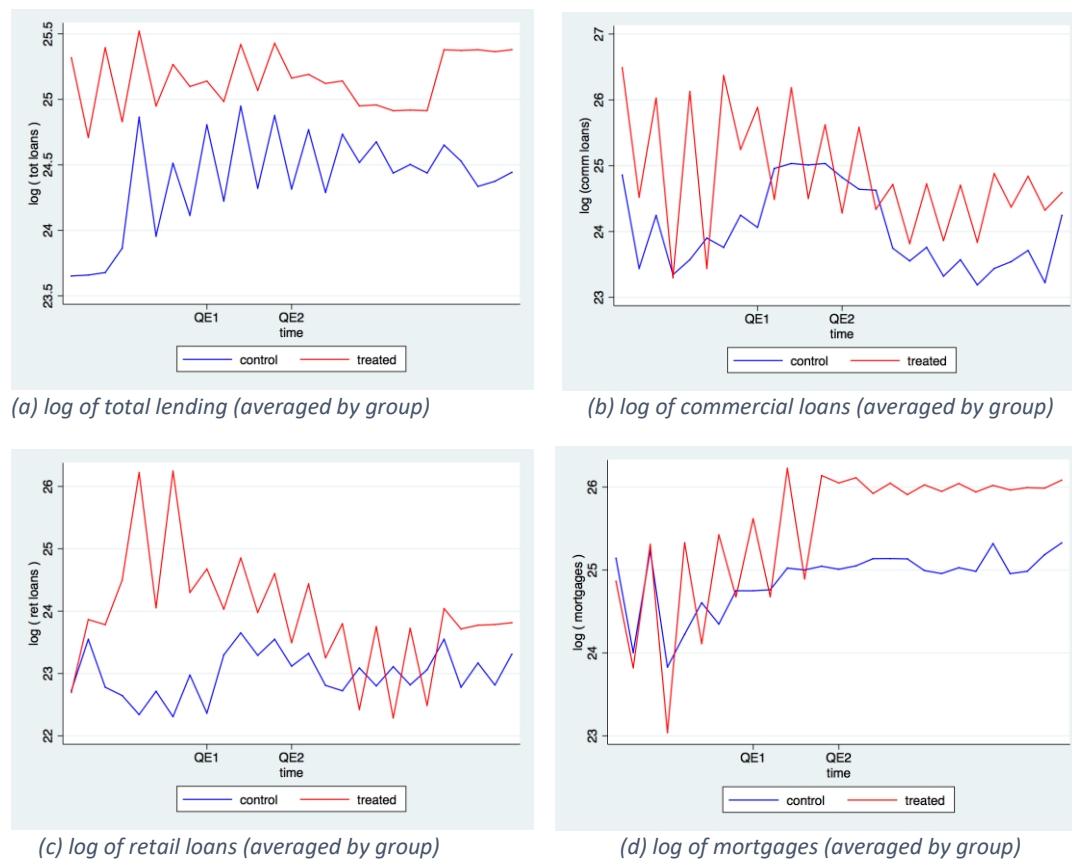
We begin the analysis of the bank lending channel by showing the differences in lending behaviour between treated and control groups as constructed in Section 4.2. Figure 3 plots the average group trends reported in natural logs for total lending, corporate and commercial lending, customer/retail lending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

⁷ 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).

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 et al (2019), this fall can be driven by 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 evidences above, we estimate the following panel model

$$\log(Y_{i,t}) = \beta_i + \gamma QE_t + \delta(Treated_i QE_t) + \theta X_{i,t} + \zeta(X_{i,t} QE_t) + v_{i,t} \quad (1)$$

Figure 3 – Quantitative easing and the bank lending channel



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.

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, $QE_t = [QE_{1,t}, QE_{2,t}]$ 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 2011h2⁸. The $Treated_i * QE_t$ 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 reserves received by QE-banks and zero for non-QE-banks. Following Rodnyansky and Darmouni (2015), we also include interaction terms $X_{i,t} * QE_t$ 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. 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 QE directly boosted 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 reserves injections were associated with a decline in lending at the macro level. Results are robust under the continuous treatment variable.

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

⁸ 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 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.

periods is well established, this is not enough to rule out any possible bank lending channel as QE reserves injections might have slowed down this decline in lending for QE-banks compared to non-QE-banks. This result also finds 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., MSBs. This might raise the issue of the importance of the type of asset being purchased in supporting the bank lending channel.

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)	
$Treated_i * QE_{1,t}$	0.00132		-0.162		0.0263		0.0454	
	(0.0642)		(0.702)		(0.331)		(0.102)	
$Treated_i * QE_{2,t}$	0.0954		0.192		-0.441**		-0.0560	
	(0.0959)		(0.185)		(0.160)		(0.115)	
$log(QEcash_i) * QE_{1,t}$		-0.000165		-0.00714		8.51e-05		0.00199
		(0.00256)		(0.0276)		(0.0133)		(0.00407)
$log(QEcash_i) * QE_{2,t}$		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
<i>p-value</i>	0.1288	0.1304	0.6968	0.6871	0.3979	0.4024	0.0201	0.0213

Coefficient estimates from specification of semiannual 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 reserves 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, * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$.

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. The test is performed by employing the widely applied framework of Khwaja and Mian (2008) to identify credit demand effects at the loan level.

Loan level data is retrieved from DealScan. 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 (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. (2018), 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:

$$\log(1 + L_{i,j}^{post}) - \log(L_{i,j}^{pre}) = \eta_j + \delta Treated_i + v_{i,j} \quad (2)$$

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 $v_{i,j}$ 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., 2018), 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 - Loan Issuance Estimator

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	QE1	QE2	QE1	QE2	QE1	QE2	QE1	QE2
<i>Treated_i</i>	0.0286 (0.194)	-0.204 (0.183)	0.112 (0.202)	-0.201 (0.181)	0.194 (0.202)	-0.271 (0.211)	0.399 (0.285)	0.0378 (0.173)
Constant	-0.0423 (0.208)	0.313 (0.202)	0.0915 (0.224)	0.381* (0.225)	-0.933*** (0.346)	0.0688 (0.355)	-1.778*** (0.298)	0.0837 (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

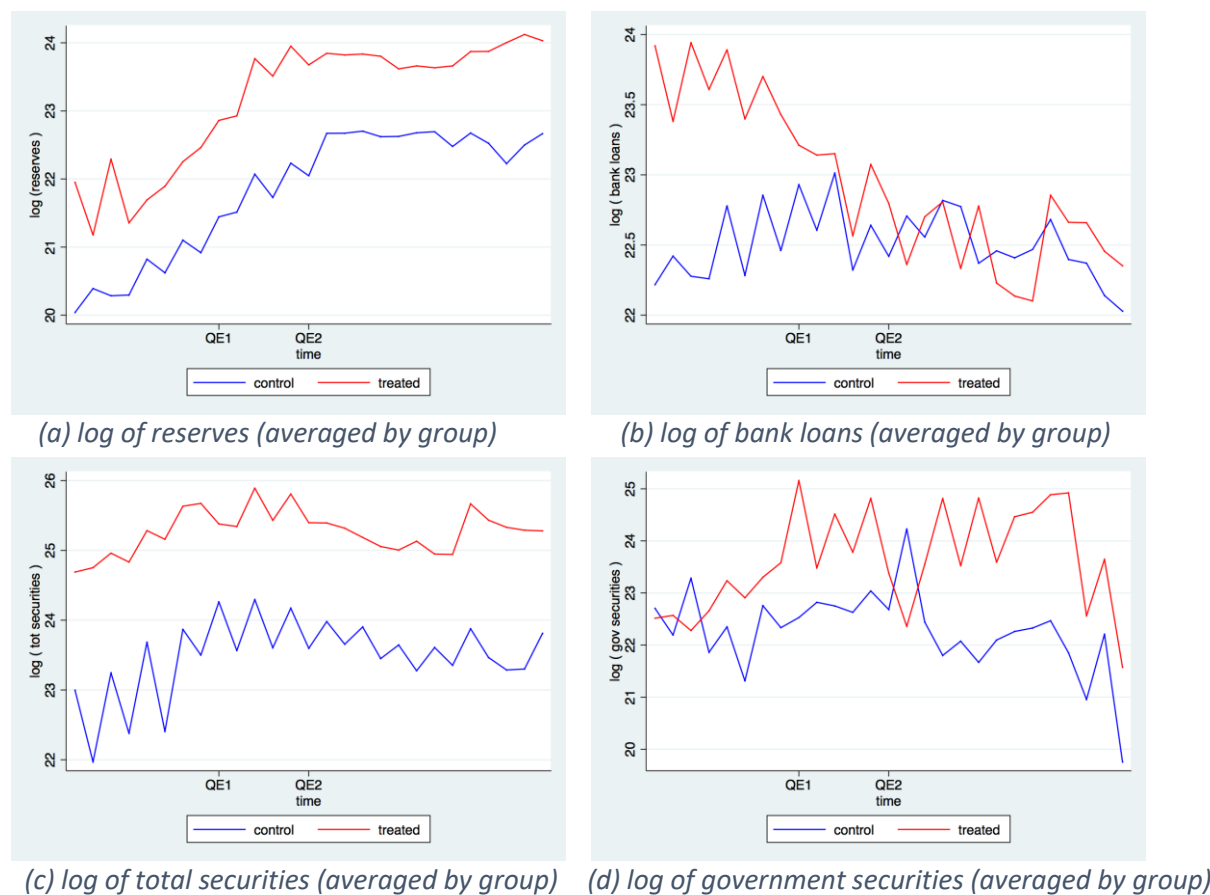
Coefficient of the Khwaja and Mian (2008)' estimates of the relative change in loan issuance by treated and control banks in the two years before and after each the two QE waves. Treatment status *Treated_i* equals to 1 for QE-banks and 0 for non-QE-banks. The Industry fixed effect is evaluated using 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.

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).

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. 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. Note that although all QE-banks have increased their reserves at the time of the QE injections, this does not necessarily mean that a positive gap should be expected, due to potential flight of deposits (Butt et al., 2014) or more generally of active management of liquidity (Adrian and Shin 2010).

Figure 4 – Quantitative easing and the asset reallocation channel



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.

The positive gap in reserves 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 (Panel b) 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.

Table 6 – The Asset Reallocation Effect

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(deposits)		log(reserves)		log(bank loans)		log(gov securities)	
$Treated_i * QE_{1,t}$	0.0700		0.594*		-0.877***		0.418*	
	(0.0743)		(0.306)		(0.272)		(0.209)	
$Treated_i * QE_{2,t}$	0.0588		-0.371		-0.348		0.541***	
	(0.0993)		(0.233)		(0.272)		(0.174)	
$log(QEcash_i) * QE_{1,t}$		0.00262		0.0245*		-0.0356***		0.0167*
		(0.00305)		(0.0126)		(0.0112)		(0.00817)
$log(QEcash_i) * QE_{2,t}$		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
<i>p-value</i>	0.0055	0.0059	0.8199	0.7958	0.6066	0.5978	0.6046	0.6134

Coefficient estimates from specification of semiannual 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 reserves 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, * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$.

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.

The carry trade activity by European banks towards zero-to-low risk-weighted sovereign debt provided higher 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 the same vein as Acharya and Steffen (2015).

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

$$\log(Y_{i,t}) = \beta_i + \sum_t \gamma_t \mathbf{D}_t + \sum_t \delta_t (\text{Treated}_i \mathbf{D}_t) + \theta X_{i,t} + \sum_t \zeta(X_{i,t} \mathbf{D}_t) + v_{i,t} \quad (3)$$

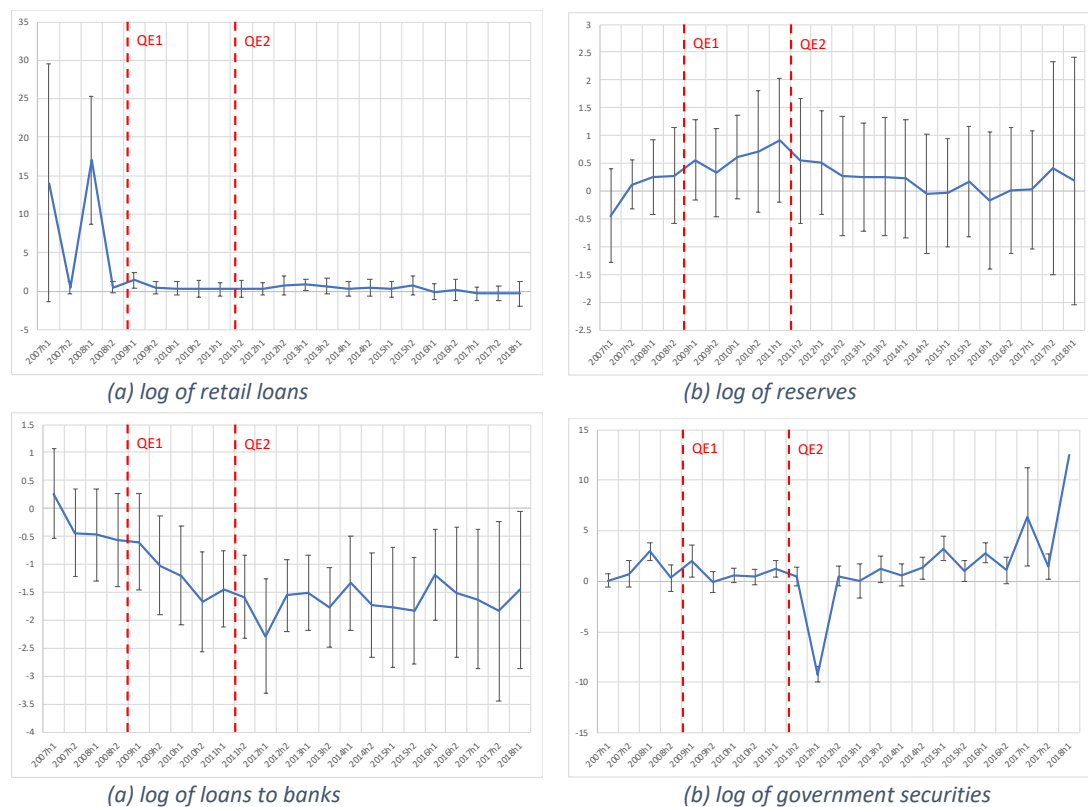
where $Y_{i,t}$ is the log of customer/retail lending, reserves, bank loans and government securities⁹, β_i is a bank fixed effect, Treated_i is an indicator variable that equals 1 for the eight QE-banks and 0 for the control group banks, \mathbf{D}_t is an indicator function of the time period (semi-annual) from 2007h1 to 2018h1 with 2006h2 as the omitted category. $\text{Treated}_i \times \mathbf{D}_t$ 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 $X_{i,t} \times \mathbf{D}_t$ as robustness check.

Figure 5 validates our findings by confirming the timing of the main effects. Starting from panel (a), a steady decline after QE2 is observed for customer/retail loans. The trend of reserves in panel (b) appears to start its climb in the first half of 2010 reaching a peak in 2011h1, 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 show a clear decline from 2009h2 till 2010h2.

⁹ We also tested the other dependent variables used in our exercises that show no significant impact. Figures are reported in the Supplementary Materials **Error! Reference source not found.**

This trend then stabilises in the QE2 period. Finally, panel (c) report the time coefficients for the government securities model. Although we notice some volatility, we observe the positive trend after each of the QE waves, noting that the big fall of 2012h2 is very likely to have been caused by the EU sovereign debt crisis that forced those banks involved in carry trade activity to unwind their positions (Acharya and Steffen, 2015).

Figure 5 – Time coefficients



This figure plots the coefficients δ_t of equation (2) with the 95% confidence intervals for each semiannual 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 variable ‘government securities’ might not fully capture the asset reallocation channel of banks towards sovereign securities (mainly from GIPS 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.

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 of sovereign positions, we employ Acharya and

Steffen (2015)'s sensitivity analysis of banks' stock returns to returns on sovereigns, estimating the following model

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

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 series¹⁰, and X_t is the vector of macroeconomic state controls variables.¹¹ 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 reserves injections towards peripheral EU countries sovereigns, we would expect positive loads on some of the GIIPS countries' δ coefficients as well as a 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. The results are reported in Table 7.

¹⁰ 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.

¹¹ 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; Δ ESI, the monthly change in the economic sentiment indicator; Δ IntProd, the monthly change in the level of industrial production; Δ CPI, the change in the rate of inflation measured as the monthly change in the European consumer price index; and Δ FX-Rate, the change in the effective exchange rate of the euro" (pg. 221, footnote 20).

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

Panel A - DiD on QE1

VARIABLES	(1) GRE	(2) ITA	(3) IRI	(4) POR	(5) SPA
<i>GR</i>	0.0103 (0.00805)				
<i>GR * Treated_i</i>	0.00962 (0.0138)				
<i>IT</i>		0.0570** (0.0272)			
<i>IT * Treated_i</i>		0.170*** (0.0423)			
<i>IR</i>			0.0383 (0.0321)		
<i>IR * Treated_i</i>			0.107** (0.0526)		
<i>PR</i>				0.0273 (0.0213)	
<i>PR * Treated_i</i>				0.0733** (0.0328)	
<i>SP</i>					0.0552* (0.0319)
<i>SP * Treated_i</i>					0.138*** (0.0505)
<i>UK</i>	-0.547*** (0.0619)	-0.547*** (0.0618)	-0.546*** (0.0618)	-0.546*** (0.0618)	-0.549*** (0.0619)
<i>UK * Treated_i</i>	-0.105 (0.0942)	-0.101 (0.0940)	-0.104 (0.0941)	-0.102 (0.0941)	-0.108 (0.0941)
<i>GE</i>	-1.032*** (0.0778)	-1.051*** (0.0772)	-1.053*** (0.0790)	-1.043*** (0.0775)	-1.050*** (0.0772)
<i>GE * Treated_i</i>	-0.369*** (0.114)	-0.396*** (0.114)	-0.410*** (0.117)	-0.380*** (0.114)	-0.397*** (0.114)
<i>US</i>	-0.0471 (0.0491)	-0.0445 (0.0491)	-0.0444 (0.0492)	-0.0469 (0.0491)	-0.0459 (0.0491)
<i>US * Treated_i</i>	-0.0533 (0.0785)	-0.0613 (0.0785)	-0.0551 (0.0786)	-0.0584 (0.0786)	-0.0619 (0.0785)
<i>JP</i>	-0.194** (0.0939)	-0.169* (0.0950)	-0.180* (0.0943)	-0.185** (0.0943)	-0.170* (0.0947)
<i>JP * Treated_i</i>	0.515*** (0.0853)	0.387*** (0.0911)	0.460*** (0.0882)	0.465*** (0.0872)	0.427*** (0.0923)
<i>FTSE</i>	1.065*** (0.0288)	1.065*** (0.0290)	1.067*** (0.0288)	1.066*** (0.0287)	1.065*** (0.0290)
<i>FTSE * Treated_i</i>	0.136*** (0.0336)	0.113*** (0.0342)	0.129*** (0.0336)	0.127*** (0.0336)	0.122*** (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
<i>GR</i>	0.00988 (0.00716)				
<i>GR * Treated_i</i>	0.00171 (0.0113)				
<i>IT</i>		0.0628** (0.0290)			
<i>IT * Treated_i</i>		0.169*** (0.0432)			
<i>IR</i>			0.115** (0.0564)		
<i>IR * Treated_i</i>			0.0201 (0.0884)		
<i>PR</i>				0.0512** (0.0253)	
<i>PR * Treated_i</i>				0.0484 (0.0357)	
<i>SP</i>					0.0764** (0.0367)
<i>SP * Treated_i</i>					0.129** (0.0561)
<i>UK</i>	-0.585*** (0.0694)	-0.583*** (0.0692)	-0.583*** (0.0691)	-0.581*** (0.0689)	-0.587*** (0.0694)
<i>UK * Treated_i</i>	-0.0452 (0.0998)	-0.0330 (0.0989)	-0.0446 (0.0992)	-0.0398 (0.0990)	-0.0443 (0.0993)
<i>GE</i>	-1.013*** (0.0831)	-1.034*** (0.0819)	-1.074*** (0.0865)	-1.028*** (0.0824)	-1.034*** (0.0819)
<i>GE * Treated_i</i>	-0.325*** (0.109)	-0.349*** (0.108)	-0.336*** (0.115)	-0.334*** (0.108)	-0.348*** (0.108)
<i>US</i>	-0.0824 (0.0560)	-0.0776 (0.0559)	-0.0799 (0.0560)	-0.0834 (0.0560)	-0.0803 (0.0560)
<i>US * Treated_i</i>	-0.0881 (0.0803)	-0.0892 (0.0803)	-0.0883 (0.0803)	-0.0909 (0.0804)	-0.0938 (0.0802)
<i>JP</i>	-0.211* (0.115)	-0.184 (0.117)	-0.211* (0.117)	-0.205* (0.116)	-0.180 (0.116)
<i>JP * Treated_i</i>	0.453*** (0.0896)	0.299*** (0.0937)	0.446*** (0.0948)	0.413*** (0.0902)	0.354*** (0.0954)
<i>FTSE</i>	1.105*** (0.0333)	1.101*** (0.0335)	1.099*** (0.0332)	1.099*** (0.0330)	1.099*** (0.0337)
<i>FTSE * Treated_i</i>	0.0104 (0.0358)	-0.0240 (0.0361)	0.00940 (0.0358)	0.00145 (0.0357)	-0.0107 (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.

Panel A in Table 7 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). 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 reserves 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 was facing sovereign debt crisis problems over the period in question.

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 reserves into these bonds, anticipating a boost in their prices when the Bank of Japan (BOJ) relaunch its QE program, 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.

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 Table 18. Details are reported in Section 6.6. 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 2011¹² states that UK banks had modest direct exposures to sovereigns of Greece, Ireland and Portugal, 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 2014¹³. 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 average¹⁴. Meanwhile, QE

¹² Bank of England Financial Stability Report; [Issue No. 29; June 2011](#); P19.

¹³ 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.

¹⁴ Beyond average quarterly growth rates, we are unable to present further details on the two dataset, due to data confidentiality constraints.

banks increased their corresponding exposures by 4.3%, on average¹⁵. The patterns in the second datasets are in line with the ones we observed in the first 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 period¹⁶. Thus, compared to the control group, the higher sensitivity of stock returns of QE banks appears to be driven by increasing holdings of sovereigns of GIIPS countries, at least partially. This is in line with our regulatory arbitrage argument.

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, therefore excluding the real treated banks from the test. 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 5 and results are reported in Table 8.

¹⁵ 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%).

¹⁶ 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%).

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.

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 threatened banks in this alternative placebo experiment.

Table 8 – Placebo exercise

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(ret loans)		log(reserves)		log(bank loans)		log(gov securities)	
$PlaceboTreated_i^{SIZE} * QE_{1,t}$	-0.428		-0.183		-0.0687		0.0776	
	(0.351)		(0.322)		(0.174)		(0.278)	
$PlaceboTreated_i^{SIZE} * QE_{2,t}$	-0.280		-0.0562		0.0245		-0.260	
	(0.272)		(0.289)		(0.141)		(0.340)	
$PlaceboTreated_i^{SEC} * QE_{1,t}$		0.213		0.107		0.0275		0.430
		(0.349)		(0.330)		(0.203)		(0.305)
$PlaceboTreated_i^{SEC} * QE_{2,t}$		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
<i>p-value</i>	0.0299	0.1454	0.2826	0.1645	0.7646	0.8400	0.1515	0.1865

Coefficient estimates from specification of semiannual 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, * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$.

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 5.3 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.

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 5.3 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-estimating 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. 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.

Finally, we also address potential concerns related to overlapping treatment events by modifying our dummy variables QE1 to be 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.

6.5. 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.

6.6. 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 sovereigns 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 reserves 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.

7. Conclusions

We analysed the reaction of the balance sheets of UK banks to the APP of the BOE. The comparison of lending behaviour of treated or QE banks with a control group that is unaffected by the QE treatment helps 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. The MPC didn't anticipate strong transmission of APP impact through the bank lending channel. In line with that, our difference-in-differences exercise finds no evidence of a positive impact of QE through the bank lending channel. Treated banks appear to have reacted to QE reserves 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.

The combination of lower gilts yields, resulting at least partly from QE and risk-based capital requirements might have given capital-constrained 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 the direct QE impact via the bank lending channel, as they may induce inadequately capitalised banks to substitute away from lending to the real economy. These requirements may have reinforced the concentration of investment in sovereign debt, contributing to the decline of market values of many EU banks involved in carry trade operations right before the EU sovereign debt crisis (Acharya and Steffen, 2015). As it treats symmetrically, the introduction of a regulatory leverage ratio is likely to reduce banks' incentives to invest in assets with low-risk weights, such as sovereign bonds.

If the policy objective is to provide an additional boost to the economy through supporting bank lending in a time of stress and uncertainty, it might be valuable consider using alternative credit easing tools. This may include programs such as Funding for Lending Scheme (FLS), Term Funding Scheme (TFS) and Term Funding Scheme with additional incentives for SMEs (TFSME). Other alternatives include guaranteed lending to small businesses, with no access to capital markets, or allow access to central bank balance sheet, maybe through a central bank digital currency. Our findings also encourage policy makers to pay attention to the type of asset purchased via the QE programs 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 Definitions

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 semiannual 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.
- **QEcash** – Log of the sum of reserves 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
- **Δ FX-Rate** - Change of the nominal effective exchange rate of the euro
- **Δ ESI** - Change in European economic sentiment; monthly change in the economic sentiment indicator obtained from opinion surveys conducted by the European Central Bank
- **Δ IndProd** - Change in level of industrial production; monthly change in the level of industrial production
- **Δ CPI** - European Consumer Price Index is the change in inflation measured as the monthly change in the European Consumer Price Index

References

- Acharya, Viral V., and Sascha Steffen. 2015. "The 'Greatest' Carry Trade Ever? Understanding Eurozone Bank Risks." *Journal of Financial Economics* 115 (2): 215–36.
<https://doi.org/10.1016/j.jfineco.2014.11.004>.
- Adrian, Tobias, and Hyun Song Shin. 2010. "Liquidity and Leverage." *Journal of Financial Intermediation* 19 (3): 418–37. <https://doi.org/10.1016/j.jfi.2008.12.002>.
- Bridges, By Jonathan, Neil Rossiter, Ryland Thomas, Monetary Assessment, and Strategy Division. 2011. "Understanding the Recent Weakness in Broad Money Growth." *Bank of England Quarterly Bulletin*, no. 1: 22–35.
- Butt, Nicholas, Sílvia Domit, Michael Mcleay, and Ryland Thomas. 2012. "What Can the Money Data Tell Us about the Impact of QE ?" *Bank of England*, no. 1: 321–31.
- Butt, Nick, Rohan Churm, Michael McMahon, Arpad Morotz, and Jochen Schanz. 2014. "QE and the Bank Lending Channel in the United Kingdom." *Bank of England Working Paper*, no. 511: 1–45.
<http://www.bankofengland.co.uk/research/Documents/workingpapers/2014/wp511.pdf>
<http://www.bankofengland.co.uk/publication/uuid/AE95C2A9-9674-4ECA-AC0C-24DF760BB1EC>.
- Churm, Rohan, Michael Joyce, George Kapetanios, Rohan Churm, Michael Joyce, and George Kapetanios. 2015. "Staff Working Paper No . 542 Unconventional Monetary Policies and the Macroeconomy : The Impact of the United Kingdom ' s QE2 and Funding for Lending Scheme Staff Working Paper No . 542 Unconventional Monetary Policies and the Macroeconomy : The Impact Of," no. 542.
- Fatouh, Mahmoud, Sheri M. Markose, and Simone Giansante. 2018. "The Impact of Quantitative Easing on UK Bank Lending: Why Banks Do Not Lend to Businesses?" *SSRN Electronic Journal*.
- Furfine, Craig. 2000. "Evidence on the Response of US Banks to Changes in Capital Requirements." *Bank For International Settlements*, no. 88: 1–32.
<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.395.8097&rep=rep1&type=pdf>.
- Gambacorta, Leonardo, and David Marques-Ibanez. 2011. "The Bank Lending Channel: Lessons from

- the Crisis." *Economic Policy* 26 (66): 135–82. <https://doi.org/10.1111/j.1468-0327.2011.00261.x>.
- Gambacorta, Leonardo, and Paolo Emilio Mistrulli. 2004. "Does Bank Capital Affect Lending Behavior?" *Journal of Financial Intermediation* 13 (4): 436–57. <https://doi.org/10.1016/j.jfi.2004.06.001>.
- Gropp, Reint, Thomas Mosk, Steven Ongena, and Carlo Wix. 2018. "Bank Response To Higher Capital Requirements: Evidence from A-Quasi-Natural Experiment." *Review of Financial Studies* in press. <https://doi.org/http://dx.doi.org/10.2139/>.
- Jackson, Patricia, Craig Furfine, Masao Yoneyama, and Diana Hancock. 1999. "Basle Committee on Banking Supervision Capital Requirements and Bank Behaviour ." *Basel Committee on Banking Supervision Working Papers*, no. 1.
- Joe Peek and Eric S. Rosengren. 1995. "Peek, Joe, and Eric S. Rosengren. "Bank Lending and the Transmission of Monetary Policy." *Conference Series-Federal Reserve Bank of Boston* 39.
- Joyce, Michael A S, and Marco Spalatro. 2014. "Quantitative Easing and Bank Lending: A Panel Data Approach." *Bank of England Working Paper* 504. <https://doi.org/10.2139/ssrn.2487793>.
- Joyce, Michael, Matthew Tong, and Robert Woods. 2011. "The United Kingdom's Quantitative Easing Policy: Design, Operation and Impact." *Bank of England Quarterly ...*, no. 3: 200–212. <http://www.bankofengland.co.uk/publications/Documents/quarterlybulletin/qb110301.pdf>.
- Kashyap, Anil K., and Jeremy C. Stein. 2000. "What Do a Million Observations on Banks Say about the Transmission of Monetary Policy?" *American Economic Review* 90 (3): 407–28. <https://doi.org/10.1257/aer.90.3.407>.
- Kashyap, Anil K, and Jeremy C Stein. 1994. "Monetary Policy and Bank Lending." *Monetary Policy*, no. January: 221–61. [https://doi.org/10.1016/S0378-4266\(02\)00200-5](https://doi.org/10.1016/S0378-4266(02)00200-5).
- . 1995. "The Impact of Monetary Policy on Bank Balance Sheets*." *Carnegie-Rochester Conference Series on Public Policy* 42: 151–95. [https://doi.org/10.1016/0167-2231\(95\)00032-U](https://doi.org/10.1016/0167-2231(95)00032-U).
- Khwaja, Asim Ijaz, and Atif Mian. 2008. "Tracing the Impact of Bank Liquidity Shocks: Evidence from

an Emerging Market.” *American Economic Review* 98 (4): 1413–42.

<https://doi.org/10.1257/aer.98.4.1413>.

Kishan, Ruby P ., and Timothy P . Opiela. 2000. “Bank Size , Bank Capital , and the Bank Lending Channel.” *Journal of Money , Credit and Banking* 32 (1): 121–41.

Rime, Bertrand. 2001. “Capital Requirements and Bank Behavior: Empirical Evidence for Switzerland.” *Journal of Banking & Finance* 25: 789–805. [https://doi.org/10.1016/S0378-4266\(00\)00105-9](https://doi.org/10.1016/S0378-4266(00)00105-9).

Rodnyansky, Alexander, and Olivier Darmouni. 2015. “The Effects of Quantitative Easing on Bank Lending Behavior.” *Review of Financial Studies*. Vol. 37.

<https://doi.org/10.1016/j.irfa.2014.11.004>.

SUPPLEMENTARY MATERIAL FOR ONLINE PUBLICATION

A. Robustness checks with different matching ratios

Table 9 – Propensity score matching under different matching ratios

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	treat	treat	treat	treat	treat	treat	treat	treat	treat
Size	0.281**	0.290	0.212	0.125	0.151	0.142	0.217	0.087	0.173
	(0.128)	(0.330)	(0.271)	(0.153)	(0.172)	(0.188)	(0.198)	(0.126)	(0.112)
Equity	-0.263	24.748	26.652	22.378	13.201	14.957	21.454	1.195	2.493
	(3.080)	(25.523)	(18.261)	(18.508)	(17.042)	(24.383)	(24.459)	(3.937)	(3.882)
ROA	-0.002	0.779	-0.035	-0.268	-0.089	-0.148	-0.144	0.093	0.145
	(0.037)	(0.642)	(0.453)	(0.401)	(0.350)	(0.330)	(0.331)	(0.243)	(0.243)
Securities	2.430*	-1.753	-0.075	0.926	0.893	1.142	0.968	1.751	1.500
	(1.353)	(2.775)	(2.423)	(1.791)	(1.568)	(2.004)	(2.094)	(1.405)	(1.443)
Net int inc	13.249	-80.288	-13.424	-10.929	-8.411	-15.950	-28.670	-4.859	-0.350
	(16.673)	(74.354)	(17.975)	(27.364)	(31.543)	(78.355)	(77.720)	(30.450)	(25.148)
Constant	-8.999***	-6.641	-6.765	-5.033	-5.579	-5.526	-7.568	-4.095	-6.430*
	(3.293)	(8.539)	(6.979)	(4.387)	(4.889)	(4.947)	(5.049)	(3.688)	(3.342)
Matching	-pre	-post	-post	-post	-post	-post	-post	-post	-post
ratio	-	1:1	1:2	1:3	1:4	1:5	1:6	1:7	1:8
r2_p	0.407	0.155	0.082	0.077	0.059	0.076	0.102	0.081	0.085
p	0.001	0.728	0.652	0.767	0.800	0.765	0.542	0.593	0.574
N	73	16	24	32	40	48	56	64	72

Probit regressing the treatment on bank characteristics in 2008h2. Model (1) reports the pre-matching results while models (2-9) reports the post matching results with ratios 1:1 to 1:8. 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 variables. Standard errors are clustered at the bank level and reported in brackets, * p<0.10 ** p<0.05 *** p<0.01.

Table 10 – The bank lending channel with 1:4 matching ratio

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(tot loans)		log(comm loans)		log(ret loans)		log(mortgages)	
$Treated_i * QE_{1,t}$	-0.00898		0.217		0.228		0.0688	
	(0.0706)		(0.573)		(0.298)		(0.105)	
$Treated_i * QE_{2,t}$	0.0769		0.112		-0.448**		-0.0383	
	(0.102)		(0.165)		(0.170)		(0.117)	
$log(QEcash_i) * QE_{1,t}$		-0.000580		0.00773		0.00819		0.00294
		(0.00282)		(0.0227)		(0.0122)		(0.00421)
$log(QEcash_i) * QE_{2,t}$		0.00349		0.00423		-0.0175**		-0.00152
		(0.00398)		(0.00656)		(0.00682)		(0.00468)
Observations	928	928	484	484	466	466	452	452
R-squared	0.571	0.572	0.476	0.475	0.544	0.544	0.686	0.686
Number of Banks	25	25	20	20	18	18	18	18
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

Coefficient estimates from specification of semiannual consolidated statements of UK banks from 2000h2 to 2018h1 using a 1:4 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 reserves 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. Standard errors are clustered at the bank level and reported in brackets, * p<0.10 ** p<0.05 *** p<0.01.

Table 11 - The bank lending channel with 1:3 matching ratio

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(tot loans)		log(comm loans)		log(ret loans)		log(mortgages)	
$Treated_i * QE_{1,t}$	-0.0296 (0.0702)		0.170 (0.551)		-0.0354 (0.235)		0.0500 (0.0965)	
$Treated_i * QE_{2,t}$	0.190* (0.105)		0.114 (0.160)		-0.444*** (0.137)		-0.0432 (0.112)	
$log(QE_{cash}_i) * QE_{1,t}$		-0.00144 (0.00283)		0.00610 (0.0217)		-0.00240 (0.00933)		0.00216 (0.00386)
$log(QE_{cash}_i) * QE_{2,t}$		0.00753* (0.00420)		0.00433 (0.00636)		-0.0176*** (0.00538)		-0.00169 (0.00447)
Observations	741	741	402	402	382	382	371	371
R-squared	0.578	0.577	0.435	0.434	0.437	0.438	0.707	0.707
Number of Banks	23	23	19	19	17	17	17	17
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

Coefficient estimates from specification of semiannual consolidated statements of UK banks from 2000h2 to 2018h1 using a 1:3 matching ratio. Treatment status $Treated_i$ equals to 1 for QE-banks and 0 for non-QE-banks. The continuous treatment status $log(QE_{cash}_i)$ equals to the log of the sum of reserves 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. Standard errors are clustered at the bank level and reported in brackets, * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$.

Table 12 - The Asset Reallocation Effect with 1:4 matching ratio

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(deposits)		log(reserves)		log(bank loans)		log(gov securities)	
$Treated_i * QE_{1,t}$	0.0700 (0.0743)		0.554 (0.327)		-0.919*** (0.238)		0.443* (0.215)	
$Treated_i * QE_{2,t}$	0.0588 (0.0993)		-0.423* (0.247)		-0.329 (0.286)		0.578*** (0.159)	
$log(QEcash_i) * QE_{1,t}$		0.00292 (0.00323)		0.0229 (0.0134)		-0.0368*** (0.00985)		0.0177** (0.00835)
$log(QEcash_i) * QE_{2,t}$		0.00187 (0.00426)		-0.0163 (0.0100)		-0.0126 (0.0117)		0.0229*** (0.00623)
Observations	906	906	927	927	911	911	551	551
R-squared	0.327	0.327	0.614	0.614	0.244	0.240	0.412	0.412
Number of Banks	24	24	26	26	24	24	23	23
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

Coefficient estimates from specification of semiannual consolidated statements of UK banks from 2000h2 to 2018h1 using a 1:4 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 reserves 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. Standard errors are clustered at the bank level and reported in brackets, * p<0.10 ** p<0.05 *** p<0.01.

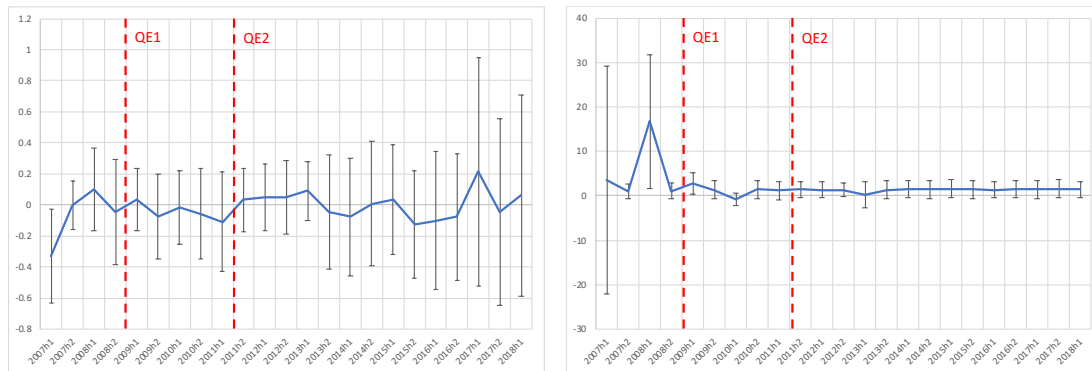
Table 13 - The Asset Reallocation Effect with 1:3 matching ratio

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(deposits)		log(reserves)		log(bank loans)		log(gov securities)	
$Treated_i * QE_{1,t}$	0.0847 (0.0984)		0.532* (0.307)		-0.708*** (0.211)		0.387 (0.239)	
$Treated_i * QE_{2,t}$	0.103 (0.103)		-0.336 (0.259)		-0.281 (0.291)		0.598*** (0.167)	
$log(QEcash_i) * QE_{1,t}$		0.00294 (0.00391)		0.0208 (0.0127)		-0.0282*** (0.00853)		0.0156 (0.00930)
$log(QEcash_i) * QE_{2,t}$		0.00444 (0.00411)		-0.0132 (0.0104)		-0.0105 (0.0118)		0.0237*** (0.00652)
Observations	719	719	729	729	724	724	468	468
R-squared	0.319	0.319	0.620	0.620	0.254	0.251	0.380	0.380
Number of Banks	22	22	23	23	22	22	21	21
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

Coefficient estimates from specification of semiannual consolidated statements of UK banks from 2000h2 to 2018h1 using a 1:3 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 reserves 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. Standard errors are clustered at the bank level and reported in brackets, * p<0.10 ** p<0.05 *** p<0.01.

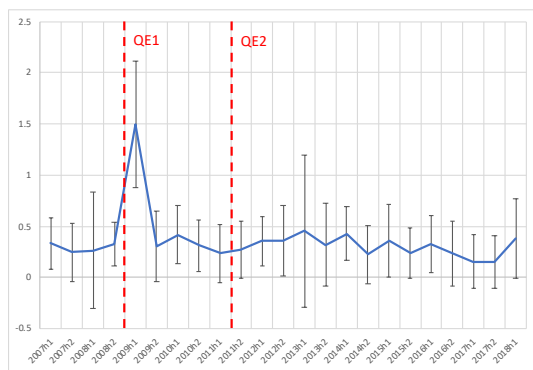
B. Timing of effect of bank lending channel

Figure 6 - Time coefficients for the bank lending channel



(a) log of total lending

(b) log of commercial lending



(c) log of mortgages

Figure 6 plots the coefficients δ_t of equation (2) with the 95% confidence intervals for each semiannual time dummy from 2007h1 to 2018h1 with 2006h2 as the omitted category. Dashed lines mark the beginning of the two QE waves.

C. Robustness Tests on Sovereign Exposures

Table 14 - Banks's sensitivity to Sovereign Exposures - Acharya and Steffen (2015)'s model of UK banks

VARIABLES	QE ₁		QE ₂	
	(1)	(2)	(3)	(4)
<i>GR</i>	0.0197*** (0.00694)	0.00634 (0.00764)	0.0207*** (0.00665)	0.00415 (0.00724)
<i>GR * Treated_i</i>		-0.00735 (0.0124)		-0.00741 (0.0112)
<i>IT</i>	0.131*** (0.0366)	0.0332 (0.0421)	0.0852** (0.0384)	0.00807 (0.0445)
<i>IT * Treated_i</i>		0.162** (0.0639)		0.199*** (0.0657)
<i>IR</i>	0.107*** (0.0304)	0.0109 (0.0348)	0.188*** (0.0571)	0.0681 (0.0632)
<i>IR * Treated_i</i>		0.0406 (0.0546)		-0.134 (0.0954)
<i>PR</i>	0.0265 (0.0202)	0.0111 (0.0232)	0.0603** (0.0241)	0.0324 (0.0279)
<i>PR * Treated_i</i>		0.0332 (0.0332)		0.0251 (0.0383)
<i>SP</i>	0.107** (0.0431)	0.0126 (0.0493)	0.137*** (0.0484)	0.0308 (0.0560)
<i>SP * Treated_i</i>		-0.0278 (0.0759)		0.00366 (0.0844)
<i>UK</i>	-0.565*** (0.0542)	-0.550*** (0.0619)	-0.568*** (0.0605)	-0.582*** (0.0690)
<i>UK * Treated_i</i>		-0.0991 (0.0941)		-0.0328 (0.0987)
<i>GE</i>	-0.885*** (0.0684)	-1.048*** (0.0792)	-0.954*** (0.0767)	-1.063*** (0.0883)
<i>GE * Treated_i</i>		-0.412*** (0.116)		-0.301** (0.118)
<i>US</i>	0.0980** (0.0424)	-0.0445 (0.0492)	0.0903* (0.0475)	-0.0779 (0.0560)
<i>US * Treated_i</i>		-0.0618 (0.0786)		-0.0892 (0.0802)
<i>JP</i>	1.960*** (0.0578)	-0.156 (0.0954)	1.941*** (0.0649)	-0.178 (0.118)
<i>JP * Treated_i</i>		0.370*** (0.0947)		0.334*** (0.0968)
<i>FTSE</i>	0.984*** (0.0259)	1.064*** (0.0290)	0.932*** (0.0294)	1.093*** (0.0336)
<i>FTSE * Treated_i</i>		0.112*** (0.0343)		-0.0201 (0.0363)
Observations	49,604	49,604	36,104	36,104
R-squared	0.369	0.373	0.364	0.366
Macro Controls	YES	YES	YES	YES
Bank FEs	YES	YES	YES	YES

Coefficient estimates from specification of daily equity returns of UK banks using a 1:4 matching ratio. Models (1-2) are tested over the QE1 period (from 5th of March 2009 to 31st of Dec 2018), whereas models (3-4) over the QE2 period (from 6th of October 2011 to 31st of Dec 2018). Treatment status $Treated_i$ equals to 1 for QE-banks and 0 for non-QE-banks. 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 15 - Banks's sensitivity to Sovereign Exposures using continuous treated status

VARIABLES	QE ₁		QE ₂	
	(1)	(2)	(3)	(4)
<i>GR</i>	0.0197*** (0.00694)	0.00655 (0.00763)	0.0207*** (0.00665)	0.00438 (0.00722)
<i>GR * log(QEcash_t)</i>		-0.000342 (0.000506)		-0.000347 (0.000462)
<i>IT</i>	0.131*** (0.0366)	0.0323 (0.0420)	0.0852** (0.0384)	0.00665 (0.0444)
<i>IT * log(QEcash_t)</i>		0.00672*** (0.00260)		0.00832*** (0.00268)
<i>IR</i>	0.107*** (0.0304)	0.0101 (0.0347)	0.188*** (0.0571)	0.0689 (0.0631)
<i>IR * log(QEcash_t)</i>		0.00182 (0.00222)		-0.00559 (0.00389)
<i>PR</i>	0.0265 (0.0202)	0.0106 (0.0232)	0.0603** (0.0241)	0.0314 (0.0278)
<i>PR * log(QEcash_t)</i>		0.00145 (0.00135)		0.00120 (0.00156)
<i>SP</i>	0.107** (0.0431)	0.0127 (0.0493)	0.137*** (0.0484)	0.0303 (0.0559)
<i>SP * log(QEcash_t)</i>		-0.00112 (0.00309)		0.000276 (0.00343)
<i>UK</i>	-0.565*** (0.0542)	-0.547*** (0.0619)	-0.568*** (0.0605)	-0.582*** (0.0689)
<i>UK * log(QEcash_t)</i>		-0.00459 (0.00385)		-0.00142 (0.00403)
<i>GE</i>	-0.885*** (0.0684)	-1.040*** (0.0790)	-0.954*** (0.0767)	-1.055*** (0.0881)
<i>GE * log(QEcash_t)</i>		-0.0183*** (0.00476)		-0.0138*** (0.00478)
<i>US</i>	0.0980** (0.0424)	-0.0441 (0.0491)	0.0903* (0.0475)	-0.0778 (0.0559)
<i>US * log(QEcash_t)</i>		-0.00261 (0.00323)		-0.00364 (0.00327)
<i>JP</i>	1.960*** (0.0578)	-0.165* (0.0953)	1.941*** (0.0649)	-0.184 (0.118)
<i>JP * log(QEcash_t)</i>		0.0169*** (0.00386)		0.0149*** (0.00392)
<i>FTSE</i>	0.984*** (0.0259)	1.059*** (0.0290)	0.932*** (0.0294)	1.090*** (0.0335)
<i>FTSE * log(QEcash_t)</i>		0.00557*** (0.00139)		-0.000221 (0.00146)
Observations	49,604	49,604	36,104	36,104
R-squared	0.339	0.343	0.374	0.366
Macro Controls	YES	YES	YES	YES
Bank FEs	YES	YES	YES	YES

Coefficient estimates from specification of daily equity returns of UK banks using a 1:4 matching ratio. Models (1-2) are tested over the QE1 period (from 5th of March 2009 to 31st of Dec 2018), whereas models (3-4) over the QE2 period (from 6th of October 2011 to 31st of Dec 2018). Continuous Treatment variable $\log(QEcash_t)$ equals to the log of the sum of reserves received by QE-banks and zero for non-QE-banks. 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 16 - Banks's sensitivity to Sovereign Exposures on Individual GIIPS – Baseline on QE1

VARIABLES	(1) GRE	(2) ITA	(3) IRI	(4) POR	(5) SPA
<i>GR</i>	0.0472*** (0.00762)				
<i>IT</i>		0.286*** (0.0256)			
<i>IR</i>			0.233*** (0.0285)		
<i>PR</i>				0.131*** (0.0192)	
<i>SP</i>					0.302*** (0.0293)
<i>UK</i>	-0.556*** (0.0546)	-0.554*** (0.0543)	-0.552*** (0.0545)	-0.549*** (0.0545)	-0.568*** (0.0544)
<i>GE</i>	-0.755*** (0.0673)	-0.861*** (0.0666)	-0.876*** (0.0687)	-0.809*** (0.0670)	-0.867*** (0.0667)
<i>US</i>	0.112*** (0.0422)	0.106** (0.0423)	0.114*** (0.0423)	0.108** (0.0423)	0.0994** (0.0423)
<i>JP</i>	2.152*** (0.0548)	2.023*** (0.0572)	2.080*** (0.0555)	2.117*** (0.0555)	2.032*** (0.0577)
<i>FTSE</i>	0.992*** (0.0260)	0.987*** (0.0259)	0.992*** (0.0259)	0.991*** (0.0260)	0.989*** (0.0260)
Observations	49,604	49,604	49,604	49,604	49,604
R-squared	0.368	0.369	0.368	0.368	0.369
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. 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 17 - Banks's sensitivity to Sovereign Exposures on Individual GIIPS – Baseline on QE2

VARIABLES	(1) GRE	(2) ITA	(3) IRI	(4) POR	(5) SPA
<i>GR</i>	0.0446*** (0.00724)				
<i>IT</i>		0.273*** (0.0267)			
<i>IR</i>			0.406*** (0.0546)		
<i>PR</i>				0.154*** (0.0230)	
<i>SP</i>					0.318*** (0.0328)
<i>UK</i>	-0.576*** (0.0620)	-0.563*** (0.0613)	-0.567*** (0.0611)	-0.562*** (0.0614)	-0.583*** (0.0614)
<i>GE</i>	-0.762*** (0.0730)	-0.863*** (0.0713)	-1.002*** (0.0756)	-0.823*** (0.0719)	-0.874*** (0.0711)
<i>US</i>	0.102** (0.0478)	0.102** (0.0479)	0.0992** (0.0477)	0.0924* (0.0478)	0.0888* (0.0477)
<i>JP</i>	2.191*** (0.0616)	2.050*** (0.0637)	2.064*** (0.0645)	2.138*** (0.0621)	2.050*** (0.0644)
<i>FTSE</i>	0.962*** (0.0296)	0.942*** (0.0294)	0.951*** (0.0294)	0.951*** (0.0296)	0.944*** (0.0297)
Observations	49,604	49,604	49,604	49,604	49,604
R-squared	0.363	0.364	0.363	0.363	0.364
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. 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 18 - Banks's sensitivity to Sovereign Exposures on the whole period

VARIABLES	(1) baseline	(2) DID	VARIABLES	(3) baseline	(4) DID
GR	0.0174** (0.00705)	0.0212** (0.00830)	GR	0.0174** (0.00705)	0.0214*** (0.00827)
GR * Treated _i * QE _{1,t}		-0.0181 (0.0419)	GR * log(QEcash _i) * QE _{1,t}		-0.000744 (0.00167)
GR * Treated _i * QE _{2,t}		0.0118 (0.0422)	GR * log(QEcash _i) * QE _{2,t}		0.000442 (0.00168)
IT	0.154*** (0.0404)	0.146*** (0.0488)	IT	0.154*** (0.0404)	0.145*** (0.0486)
IT * Treated _i * QE _{1,t}		0.503** (0.201)	IT * log(QEcash _i) * QE _{1,t}		0.0210** (0.00821)
IT * Treated _i * QE _{2,t}		-0.409** (0.201)	IT * log(QEcash _i) * QE _{2,t}		-0.0169** (0.00823)
IR	0.0979*** (0.0364)	0.0824* (0.0429)	IR	0.0979*** (0.0364)	0.0819* (0.0428)
IR * Treated _i * QE _{1,t}		0.108 (0.0709)	IR * log(QEcash _i) * QE _{1,t}		0.00460 (0.00289)
IR * Treated _i * QE _{2,t}		-0.108 (0.0990)	IR * log(QEcash _i) * QE _{2,t}		-0.00477 (0.00407)
PR	0.0376* (0.0209)	0.0379 (0.0252)	PR	0.0376* (0.0209)	0.0373 (0.0251)
PR * Treated _i * QE _{1,t}		-0.0389 (0.0581)	PR * log(QEcash _i) * QE _{1,t}		-0.00155 (0.00235)
PR * Treated _i * QE _{2,t}		0.0811 (0.0595)	PR * log(QEcash _i) * QE _{2,t}		0.00343 (0.00242)
SP	0.117*** (0.0450)	0.131** (0.0543)	SP	0.117*** (0.0450)	0.130** (0.0542)
SP * Treated _i * QE _{1,t}		-0.331* (0.179)	SP * log(QEcash _i) * QE _{1,t}		-0.0136* (0.00733)
SP * Treated _i * QE _{2,t}		0.341* (0.183)	SP * log(QEcash _i) * QE _{2,t}		0.0142* (0.00753)
UK	-0.408*** (0.0559)	-0.389*** (0.0648)	UK	-0.408*** (0.0559)	-0.387*** (0.0648)
UK * Treated _i * QE _{1,t}		-0.402** (0.180)	UK * log(QEcash _i) * QE _{1,t}		-0.0178** (0.00736)
UK * Treated _i * QE _{2,t}		0.198 (0.186)	UK * log(QEcash _i) * QE _{2,t}		0.00938 (0.00762)
GE	-0.918*** (0.0706)	-0.841*** (0.0815)	GE	-0.918*** (0.0706)	-0.837*** (0.0814)
GE * Treated _i * QE _{1,t}		-0.144 (0.240)	GE * log(QEcash _i) * QE _{1,t}		-0.00658 (0.00994)
GE * Treated _i * QE _{2,t}		-0.218 (0.247)	GE * log(QEcash _i) * QE _{2,t}		-0.00952 (0.0102)
US	0.104** (0.0492)	0.0971* (0.0550)	US	0.104** (0.0492)	0.0976* (0.0550)
US * Treated _i * QE _{1,t}		-0.0294 (0.122)	US * log(QEcash _i) * QE _{1,t}		-0.00137 (0.00503)
US * Treated _i * QE _{2,t}		-0.0523 (0.125)	US * log(QEcash _i) * QE _{2,t}		-0.00198 (0.00518)
JP	1.798***	1.703***	JP	1.798***	1.699***

	(0.0582)	(0.0641)		(0.0582)	(0.0641)
$JP * Treated_i * QE_{1,t}$		0.353*	$JP * \log(QEcash_i) * QE_{1,t}$		0.0161**
		(0.186)			(0.00764)
$JP * Treated_i * QE_{2,t}$		0.156	$JP * \log(QEcash_i) * QE_{2,t}$		0.00576
		(0.196)			(0.00803)
<i>FTSE</i>	1.029***	0.986***	<i>FTSE</i>	1.029***	0.984***
	(0.0330)	(0.0356)		(0.0330)	(0.0356)
$FTSE * Treated_i * QE_{1,t}$		0.340***	$FTSE * \log(QEcash_i) * QE_{1,t}$		0.0154***
		(0.0640)			(0.00259)
$FTSE * Treated_i * QE_{2,t}$		-0.404***	$FTSE * \log(QEcash_i) * QE_{2,t}$		-0.0174***
		(0.0668)			(0.00271)
Observations	73,064	73,064	Observations	73,064	73,064
R-squared	0.339	0.343	R-squared	0.339	0.343
QE	NO	YES	QE	NO	YES
Controls	YES	YES	Controls	YES	YES
Controls * QE	NO	YES	Controls * QE	NO	YES
Bank FEs	YES	YES	Bank FEs	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. Continuous Treatment variable $\log(QEcash_i)$ equals to the log of the sum of reserves received by QE-banks and zero for non-QE-banks. 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) $\Delta IntProd$, 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) $\Delta FX-Rate$, 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 19 - Alternative Placebo Test

	(1)	(2)	(3)	(4)
	log(ret loans)	log(reserves)	log(bank loans)	log(gov securities)
$PlaceboTreated_i * QE_{1,t}$	0.148 (0.147)	-0.999** (0.378)	0.489 (0.463)	-0.0109 (0.438)
$PlaceboTreated_i * QE_{2,t}$	0.162 (0.122)	0.363 (0.265)	0.334 (0.200)	-0.00933 (0.587)
Observations	697	724	668	440
R-squared	0.721	0.640	0.213	0.378
Number of Banks	20	21	19	18
QE	YES	YES	YES	YES
Controls	YES	YES	YES	YES
Controls * QE	YES	YES	YES	YES
Bank FEs	YES	YES	YES	YES

Coefficient estimates from specification of semiannual consolidated statements of UK banks from 2000h2 to 2018h1 using a 1:5 matching ratio. Treatment status $PlaceboTreated_i$ equals to 1 for treated non-QE-banks and 0 for control non-QE-banks. $PlaceboTreated_i$ are manually selected banks from the control group that would be expected to be in the treatment group on the basis of their individual characteristics. 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. Standard errors are clustered at the bank level and reported in brackets, * p<0.10 ** p<0.05 *** p<0.01.

Table 20 – Asset Reallocation Channel

Panel A - Top 3 QE banks

	(1)	(2)	(3)	(4)
VARIABLES	log(cust dep)	log(tot res)	log(bank loans)	log(gov securities)
$Treated_i * QE_{1,t}$	-0.0395 (0.175)	-0.0845 (0.286)	0.0667 (0.278)	0.578** (0.136)
$Treated_i * QE_{2,t}$	-0.316 (0.254)	0.499 (0.410)	-0.779 (0.412)	0.264 (0.157)
Observations	164	278	178	147
R-squared	0.815	0.485	0.804	0.587
Number of Banks	5	8	6	5
QE	YES	YES	YES	YES
Controls	YES	YES	YES	YES
Controls * QE	YES	YES	YES	YES
Bank FEs	YES	YES	YES	YES

Panel B - Bottom 6 QE banks

	(1)	(2)	(3)	(4)
VARIABLES	log(cust dep)	log(tot res)	log(bank loans)	log(gov securities)
$Treated_i * QE_{1,t}$	0.151* (0.0809)	0.421 (0.324)	-0.862** (0.322)	0.166 (0.255)
$Treated_i * QE_{2,t}$	0.0172 (0.0943)	-0.381 (0.256)	-0.320 (0.282)	0.466** (0.196)
Observations	766	787	772	444
R-squared	0.312	0.645	0.162	0.412
Number of Banks	23	25	23	22
QE	YES	YES	YES	YES
Controls	YES	YES	YES	YES
Controls * QE	YES	YES	YES	YES
Bank FEs	YES	YES	YES	YES

Coefficient estimates from specification of semiannual 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. Panel A uses only the top three largest treated banks while Panel B uses the bottom six. 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 21 - Sample period restricted to 4 years prior to QE

Panel A – The Bank Lending Channel

VARIABLES	(1)	(2)	(3)	(4)
	log(tot loans)	log(comm loans)	log(cust/ret loans)	log(mortgages)
$Treated_i * QE_{1,t}$	0.00693 (0.0621)	-0.0893 (0.701)	-0.109 (0.311)	0.0433 (0.102)
$Treated_i * QE_{2,t}$	0.120 (0.0862)	0.193 (0.183)	-0.374** (0.174)	-0.0635 (0.115)
Observations	1,036	565	547	560
R-squared	0.615	0.497	0.520	0.712
Number of Banks	26	21	19	19
QE	YES	YES	YES	YES
Controls	YES	YES	YES	YES
Controls * QE	YES	YES	YES	YES
Bank FEs	YES	YES	YES	YES

Panel B – The Asset Reallocation Channel

VARIABLES	(1)	(2)	(3)	(4)
	log(cust dep)	log(tot res)	log(bank loans)	log(gov securities)
$Treated_i * QE_{1,t}$	0.0756 (0.0747)	0.576* (0.299)	-0.870*** (0.276)	0.413* (0.238)
$Treated_i * QE_{2,t}$	0.0911 (0.0801)	-0.323 (0.205)	-0.327 (0.273)	0.524** (0.208)
Observations	1,015	1,035	1,020	638
R-squared	0.356	0.676	0.194	0.420
Number of Banks	25	27	25	24
QE	YES	YES	YES	YES
Controls	YES	YES	YES	YES
Controls * QE	YES	YES	YES	YES
Bank FEs	YES	YES	YES	YES

Coefficient estimates from specification of semiannual 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. 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 22 - QE periods overlap

Panel A – The Bank Lending Channel

VARIABLES	(1)	(2)	(3)	(4)
	log(tot loans)	log(comm loans)	log(cust/ret loans)	log(mortgages)
$Treated_i * QE_{1,t}$	0.00132 (0.0642)	-0.162 (0.702)	0.0263 (0.331)	0.0454 (0.102)
$Treated_i * QE_{2,t}$	0.0967 (0.100)	0.0304 (0.789)	-0.414 (0.369)	-0.0106 (0.158)
Observations	1,079	593	579	583
R-squared	0.595	0.502	0.532	0.708
Number of Banks	26	21	19	19
QE	YES	YES	YES	YES
Controls	YES	YES	YES	YES
Controls * QE	YES	YES	YES	YES
Bank FEs	YES	YES	YES	YES

Panel B – The Asset Reallocation Channel

VARIABLES	(1)	(2)	(3)	(4)
	log(cust dep)	log(tot res)	log(bank loans)	log(gov securities)
$Treated_i * QE_{1,t}$	0.0700 (0.0743)	0.594* (0.306)	-0.877*** (0.272)	0.418* (0.209)
$Treated_i * QE_{2,t}$	0.129 (0.0850)	-0.224 (0.496)	-1.225*** (0.331)	0.959** (0.221)
Observations	1,057	1,078	1,062	650
R-squared	0.346	0.643	0.180	0.415
Number of Banks	25	27	25	24
QE	YES	YES	YES	YES
Controls	YES	YES	YES	YES
Controls * QE	YES	YES	YES	YES
Bank FEs	YES	YES	YES	YES

Coefficient estimates from specification of semiannual 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. $QE_{1,t}$ equals 1 from 2009h1 to 2011 h1 while $QE_{2,t}$ equals 1 from 2011 h2 onwards. 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 23 - Funding for Lending Scheme

Panel A – The Bank Lending Channel

VARIABLES	(1) log(tot loans)	(2) log(comm loans)	(3) log(cust/ret loans)	(4) log(mortgages)
$Treated_i * QE_{1,t}$	0.000801 (0.0649)	-0.135 (0.719)	-0.00950 (0.333)	0.0351 (0.0966)
$Treated_i * QE_{2,t}$	0.0871 (0.0978)	0.152 (0.152)	-0.520*** (0.180)	-0.0216 (0.106)
Observations	1,079	593	579	583
R-squared	0.600	0.512	0.546	0.716
Number of Banks	26	21	19	19
QE	YES	YES	YES	YES
FLS	YES	YES	YES	YES
Controls	YES	YES	YES	YES
Controls * QE	YES	YES	YES	YES
Bank FEs	YES	YES	YES	YES

Panel B – The Asset Reallocation Channel

VARIABLES	(1) log(cust dep)	(2) log(tot res)	(3) log(bank loans)	(4) log(gov securities)
$Treated_i * QE_{1,t}$	0.0699 (0.0756)	0.598* (0.301)	-0.877*** (0.269)	0.382* (0.215)
$Treated_i * QE_{2,t}$	0.0570 (0.0850)	-0.535** (0.496)	-0.162*** (0.331)	0.331** (0.221)
Observations	1,057	1,078	1,062	650
R-squared	0.367	0.651	0.203	0.436
Number of Banks	25	27	25	24
QE	YES	YES	YES	YES
FLS	YES	YES	YES	YES
Controls	YES	YES	YES	YES
Controls * QE	YES	YES	YES	YES
Bank FEs	YES	YES	YES	YES

Coefficient estimates from specification of semiannual 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. $QE_{1,t}$ equals 1 from 2009h1 to 2011 h1 while $QE_{2,t}$ equals 1 from 2011 h2 onwards. **FLS** = [FLS1, FLS2] equals 1 for banks borrowing by the FLS during the FLS waves. 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, * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$.