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The impact of liquidity regulation on banks

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Ryan N Banerjee[1] and Hitoshi Mio[2]

Abstract

We present the first study to estimate the causal effect of liquidity regulation on bank balance sheets. It takes advantage of the heterogeneous implementation of tighter liquidity regulation by the UK Financial Services Authority in 2010. We find that banks adjusted the composition of both assets and liabilities, increasing the share of high-quality liquid assets and non-financial deposits while reducing intra-financial loans and short-term wholesale funding. We do not find evidence that the tightening of liquidity regulation caused banks to shrink their balance sheets, nor reduce the amount of lending to the non-financial sector.

JEL classification: E32, E51, F30, G21, G28.

(1) Bank for International Settlements. Email: ryan.banerjee@bis.org.
(2) Bank of Japan. Email: hitoshi.mio@boj.or.jp.

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Publications Team, Bank of England, Threadneedle Street, London, EC2R 8AH
Telephone +44 (0)20 7601 4030 Fax +44 (0)20 7601 3298 email publications@bankofengland.co.uk

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I. INTRODUCTION

During the international financial crisis which started in mid-2007, liquidity in short-term money markets dried up and banks suffered severe funding problems, including secured funding for highly-rated assets. By September 2007, Northern Rock experienced the first bank run by retail depositors in the UK since 1878. The significant reduction in market liquidity forced major central banks across the globe to provide huge amounts of liquidity assistance to their banking systems.

In 2010 the UK Financial Services Authority (FSA) introduced a new quantitative liquidity requirement called the Individual Liquidity Guidance (ILG). Internationally the Basel Committee on Banking Supervision agreed on the Liquidity Coverage Ratio (LCR) in 2013, which is similar in design to the ILG. In the UK, the ILG will be superseded by the LCR from 1st October 2015. This paper estimates the average treatment effect on banks from the introduction of the ILG in the UK. We estimate the impact on bank balance sheet size, composition and average interest rates on loans and deposits by exploiting the heterogeneous implementation of tighter liquidity regulation in the UK. In particular, when the FSA introduced the ILG in 2010 it exempted some banks from this new regulation. The granting of certain ILG modifications, which exempted some banks from quantitative liquidity requirements, provides a control group which enables identification of the average effect. To the best of our knowledge, this is the first empirical study to estimate the causal effect of liquidity regulation on bank balance sheets.

The ILG aims to make the banking system more resilient to liquidity shocks by requiring banks to hold a minimum quantity of high quality liquid assets (HQLA) consisting of cash, central bank reserves and government bonds to cover net outflows of liabilities under two specific stress scenarios lasting 2 weeks and 3 months respectively. In these scenarios, it is assumed that banks that are more heavily dependent on short-term wholesale funding, especially from foreign counterparts, would experience greater funding outflows and therefore need to hold higher ratios of HQLA to total assets to ensure immediate survival in stressed funding conditions.

Although more stringent liquidity regulation can reduce the risk of bank runs and freezing of the interbank market, there has been a vigorous debate about the potential negative impact of liquidity regulation due to its impact on bank lending to the real economy and bank profitability. The ILG is designed to encourage banks to increase the ratio of HQLA

relative to other assets and reduce the share of short-term wholesale funding relative to more stable deposit and equity funding. Beyond that, the design does not provide predictions about how banks will respond along other dimensions, including its impact on bank balance sheet size.

Banks can respond in a myriad of ways to meet the ILG requirement which are likely to have different welfare implications. For example shrinking the size of a bank's balance sheet by cutting lending to the non-financial sector would increase the ratio of HQLA to stressed liability outflows, as would increasing the size of balance sheets by issuing equity to acquire HQLA. Alternatively, a bank could also meet the regulation without changing balance sheet size but by changing the composition of assets or liabilities. In short, there are many possible ways for banks to meet tighter liquidity requirements.

The multiple potential adjustment dimensions and scarcity of historical episodes to evaluate the response of banks to a tightening of liquidity regulation has created a wide range of views about the impact of liquidity regulation. Financial industry groups have argued that liquidity regulation will substantially increase the cost of bank funding and damage the real economy as banks reduce credit supply and pass on higher costs to the real economy (IIF, 2010). Others have argued that liquidity regulation will have a more limited impact (MAG, 2010).

This paper empirically identifies the dimensions along which banks responded to the tightening of liquidity regulation in the UK. We find that banks adjusted both their asset and liability structures to meet tighter liquidity regulation. However, we do not find evidence that the tightening of liquidity regulation had an impact on the overall size of bank balance sheets.

On the asset side of bank balance sheets, banks subject to the ILG increased the share of HQLA to total assets by 12 percentage points on average relative to those with exemptions. Within the possible menu of HQLA, cash and central bank reserves constituted around 75% of the increase with 25% in UK T-bills and longer-maturity gilts. The increased share of HQLA was matched by an almost equal reduction in the share of short-term intra-financial loans. We do not find evidence that banks reduced the quantity of lending to the non-financial sector in response to tighter liquidity regulation.

On the liability side of bank balance sheets, banks increased funding from sources considered more stable under the ILG such as UK non-financial deposits and reduced their

dependence on less stable short-term wholesale funding and non-resident deposits by a similar magnitude.

Turning to the price impact of the ILG, for the limited balance sheet items for which data are available, we do not find evidence that banks significantly increased the average interest rate on loans to the non-financial sector. Although ILG banks increased the share of funding from more stable UK non-financial deposits, surprisingly we do not find significant evidence that ILG banks increased the interest rate paid to attract those deposits. Our finding that the ILG had a significant impact on balance sheet composition but only a limited interest rate impact suggests that tougher liquidity regulation affects bank profitability primarily through the substitution towards lower yielding HQLA and more expensive non-financial deposit funding.

Since the selection of banks into control and treatment groups was not purely random, we are aware that our results could be affected by sample selection bias. In our estimation method we make significant efforts to control for selection bias. Even though it is not possible to formally test whether we have completely purged bias from our results, when examining our results in their entirety, they are unlikely to be contaminated by serious treatment selection bias. In particular it is difficult to explain how sample selection bias could consistently explain our set of estimation results for different dependent variables, different end-points and for a subset of non-UK banks as we discuss in the later sections.

We are also aware that our results could be dependent on the specific macro-financial environment, especially the relative cost of holding HQLA when liquidity regulation was tightened. Because banks chose to meet their liquidity requirements in large part by increasing their holdings of central bank reserves, it is important to consider the influence of operational procedures related to the quantitative easing (QE) programme. Changes to Bank of England operational procedures allowed commercial banks to deposit an unlimited quantity of reserves at the Bank of England that were remunerated at Bank rate. This facility created a perfectly elastic HQLA supply curve. If this facility had not existed, the tightening of liquidity regulation could have been more costly as the higher demand for other forms of HQLA such as T-bills and gilts would have increased the prices of those assets.

There has only been limited empirical research which evaluates the impact of liquidity regulation on banks. The principal reason is the scarcity of recent instances of demanding prudential liquidity regulation. For example liquidity regulation was excluded from both

Basel I and Basel II regulations. A notable exception is the Dutch Liquidity Ratio introduced in 2003 (DNB, 2003). Although there are a number of recent studies which have analysed this regulation, unlike our paper, none have examined the impact of policy interventions which changed liquidity regulation.

Bonner (2012) and Bonner and Eijffinger (2012) test how the Dutch Liquidity Ratio affects interbank funding costs and corporate lending rates by exploiting the variation between banks that are just above or below their regulatory liquidity requirements. Consistent with our results they find that banks below their liquidity requirements do not charge higher interest rates on corporate loans. They also find that banks below their liquidity requirements pay higher interest rates on unsecured interbank funding, even though there is no public disclosure of this regulatory information.

Duijm and Wierts (2014) use a panel error correction framework to examine how banks adjust their balance sheets to meet the Dutch Liquidity Ratio following liquidity shocks. They find that when the gap between a bank's actual liquidity ratio and its required ratio is below its long-term average, banks adjust their balance sheets by increasing the share of stable forms of funding, while the response of liquid assets is insignificant. This result is broadly in line with our study although we find banks adjusted the composition of assets in addition to the composition of liabilities following a tightening of liquidity regulation.

De Haan and van den End (2013a) find that Dutch banks hold more liquid assets than required by liquidity regulation and that more solvent banks had smaller liquid asset buffers. However, they find that the relationship between solvency and liquidity buffers disappeared during the 2007-08 financial crisis.

Other microeconomic studies about bank liquidity management have also examined liquidity regulation and bank cash holdings, Bonner et. al. (2013); the liquidity transformation of banks, Berger and Bouwman (2009), regulatory intervention and liquidity transformation, Berger et. al. (2014) and the management of cash holdings and liquid securities, De Haan and van den End (2013b).

The remainder of the paper is organised as follows, Section II describes the institutional background and Section III the data. Sections IV and V present our empirical methodology and our main results. Section VI presents robustness checks and Section VII concludes.

II. UK LIQUIDITY REGULATION

The financial crisis of 2007-08 exposed the inadequacy of existing liquidity regulation. Liquidity problems in funding markets resulted in a run on Northern Rock and caused widespread liquidity hoarding across the entire banking system that eventually resulted in the Bank of England intermediating flows within the financial sector in 2008. In this section we outline the recent history of liquidity regulation in the UK, highlighting important elements for our identification strategy.

Before the 1980s, a central focus of bank regulators had been on various liquidity ratios. George Blunden, the first Chairman of the Basel Committee on Banking Standards (BCBS) and head of banking supervision at the Bank of England stated in 1975 that "… the [Basel] Committee's main objective was to help ensure bank solvency and liquidity." (p.317 Goodhart, 2011).

During the 1980s, however, the emphasis on liquidity ratios waned. Monetary policy implementation became more centred on short-term interest rates and less on liquidity ratios. As Goodhart (2011) notes, "If one takes the twenty years from 1967 until 1987, both capital and liquidity ratios were declining sharply in most countries. If one takes the next twenty years from 1987 until mid-2007, capital ratios recovered, but liquidity ratios continued to plummet." Goodhart (2011) goes on to discuss that a key reason for the neglect of liquidity regulation relative to solvency regulation was the absence of banking liquidity crises during this period.

At the time of the 2007-08 financial crisis, liquidity regulation in the UK consisted of three different regimes depending on the type of financial institution. The Sterling Stock Liquidity Regime applied to the major sterling clearing banks. It required banks to hold a stock of Bank of England eligible assets to meet wholesale sterling outflows over the next five days and cover 5% of maturing retail deposits withdrawable over the same period. Allowable certificates of deposit could be used to offset wholesale sterling liabilities by up to 50% with a 15% haircut. The Mismatch Liquidity Regime applied to all other banks which included most foreign banks operating in the UK. Under the Mismatch Liquidity Regime, the FSA reviewed bank cashflows to determine the required stock of liquid assets. Liquid assets were defined as assets having regularly quoted prices which are regularly traded and can be readily sold for cash. The Building Society Regime required building societies to hold 3.5% of liabilities in high quality marketable assets, which extended beyond the Bank of England's

eligible collateral list to include commercial paper from Sterling Stock banks. In addition, some UK branches of non-resident banks received Global Liquidity Concessions (GLC) which transferred day-to-day supervision of liquidity to the home state regulator.

In early 2007, prior to the financial crisis, the FSA initiated a review of existing liquidity regulation. During the second half of 2007, there was a significant reduction in short-term money market liquidity which caused severe funding difficulties for many banks. These liquidity problems in funding markets added extra impetus to the existing review with the FSA publishing Discussion Paper (07/7) in December 2007, examining the liquidity requirements of banks and building societies (FSA, 2007). The discussion paper outlined preliminary ideas for the reform of UK liquidity regulation. The paper also indicated that liquidity regulation would be extended to a wider range of banks.

One year later the FSA published Consultation Paper (08/22) which outlined a new quantitative Individual Liquidity Guidance (ILG) requirement that would require banks to hold a sufficient stock of high quality liquid assets to meet a hypothetical stress scenario (FSA, 2008). It anticipated that the ILG would be tougher than existing regulation and that banks would need to hold a higher quantity and quality of liquid assets, including a greater proportion of assets held in the form of eligible high-quality central bank liabilities or government debt. Also banks would need to be less reliant on short-term wholesale funding, especially from foreign counterparts and it would provide greater incentives for firms to attract a higher proportion of retail time-deposits.

Importantly for the identification strategy in this paper, the Consultation Paper explained that the ILG would be applied at the legal entity level ie subsidiary/branch level. It also outlined two types of modifications for legal entities that would exempt legal entities from the quantitative liquidity requirements: Whole-firm Liquidity Modifications and Non-UK Intragroup Liquidity Modifications. We call these two types of modifications ILG exemptions. In our empirical analysis, entities that were granted ILG exemptions and entities that were not explicitly set the firm-specific quantitative ILG target ratios form the control group while those that had been set specific ILG target ratios, the treatment group. The Consultation Paper stated that it expected the vast majority of foreign branches to apply for an exemption. However, feedback from banks documented in Policy Statement (09/16) indicate that considerable uncertainty about the FSA's policy for granting and the scope of ILG exemptions persisted until the final policy announcement in Q3 2009 (FSA, 2009).

The ILG rules require banks to hold a sufficient stock of high quality liquid assets (HQLA) to withstand an acute bank specific funding shock lasting 2 weeks and a less acute but more generalised funding shock lasting 3 months. Analogous to the LCR, the ILG can be summarised by the following ratio

$$ILG\ ratio = \frac{High\ quality\ liquid\ assets}{Net\ stressed\ outflows} > X\% \qquad (1)$$

where X is the minimum firm-specific target set by the FSA. Eligible HQLA under the ILG consists of unencumbered high quality government debt securities, reserves in the form of sight deposits with a central bank and securities issued by designated multilateral banks.

Table 1 presents the on balance sheet cash inflow and liability rollover benchmark assumptions used to compute net stressed outflows under the ILG. In the first two weeks, the ILG stress assumes 0% rollover rates for maturing wholesale funding and 10-20% outflow rates for retail deposits of all maturities. Also, in the first two weeks, the ILG stress scenario assumes banks are unable to access foreign exchange markets. It therefore requires that the currency composition of HQLA matches the currency of net stressed outflows. Under the ILG requirement, banks also need to hold HQLA to meet off-balance sheet liability outflows and outflows that would be triggered by credit rating downgrades.

Conceptually, the ILG is similar to the Basel III Liquidity Coverage Ratio (LCR) as it requires banks to hold a minimum quantity of unencumbered HQLA to meet a scenario of net stressed outflows caused by disruption in wholesale funding markets. Key differences between the two are the LCR's 30 day stress duration and somewhat looser definition of eligible HQLA.

The Policy Statement also announced that the ILG would be introduced on 1st June 2010 for Sterling Stock banks and the standard Individual Liquidity Adequacy Standards (ILAS) building societies, 1st October for banks under the existing Liquidity Mismatch Regime and banks and building societies subject to the simplified ILAS and 1st November 2010 for investment firms and branches. This timetable was followed during the implementation period.

III. DATA

Our dataset is mainly constructed from entity level statistical returns collected for the production of the Bank of England's monetary statistics. Because the ILG regulation is applied at the legal entity level (e.g. branch or subsidiary) this data source accurately captures the entity subject to the regulation unlike data collected at the consolidated bank-level. However, because many of the legal entities considered are not separately capitalised, interpreting the full impact of liquidity regulation on the liability structure is not possible. We do however, control for the effects of bank capitalisation in our regression by using the ratio of Tier 1 capital to risk-weighted assets of the entity's consolidated banking group.

For banks that were granted UK Intragroup Liquidity Modifications which allowed them to pool liquidity across some of their UK entities, we aggregate the entity level statistical data into groups that are defined as separate entities for UK liquidity regulation (we call these entities *banks* hereinafter). Our entity-level data are derived from three specific forms. *Form BT* covers basic balance sheet information and has the largest coverage of more than 300 banks. However, the information on the composition of UK loans and deposits is limited, only recording loans and deposits to the non-bank sector. To analyse the impact of the ILG on loans and deposits to the non-financial sector, which excludes non-bank financial firms such as pension funds and insurance companies, we use *Form BE,* which has more limited coverage of around 100 larger banks. *Form PL* contains information about the interest income and interest payable by banks and has the most restrictive coverage among the three forms. *Forms PL* and *BE* are used to calculate the average interest rate on UK non-financial loans and the average interest rate on UK non-financial deposits.

We analyse the impact of the ILG on sterling balance sheets for two reasons. First, the ILG requires that the currency composition of its liquidity buffer is matched to the currency composition of net outflows in the initial two week stress. If a bank does not have sufficient sterling HQLA to meet sterling outflows, our dataset would capture this constraint because a bank would need to change the size or composition of its sterling balance sheet to meet the ILG. Second, by focussing on sterling balance sheets we analyse the impact of regulation on domestic credit supply, an area of particular interest to policy makers that typically have only domestic mandates The Data Appendix shows the list of dependent variables and explains the data sources used in this analysis.

(Insert Figure I here)

To fix the timeline of events, **Figure I** shows the evolution of HQLA for banks in the treatment and control groups prior to and after the implementation of the ILG. In 2008, the mean share of HQLA to total sterling assets were very similar in banks that would become subject to the ILG regulation and those that would be granted exemptions. During 2009, when the FSA finalised the key details of the tougher ILG requirements and uncertainty remained about the granting of ILG exemptions, the mean share of HQLA to total assets in both the treatment and control groups increased at a similar rate to around 4%. However, in early 2010, soon after the FSA had clarified which banks would be subject to the requirement and which would receive exemptions, a persistent divergence emerged between the two groups. Mean HQLA for banks subject to the ILG increased to 8% of total assets by Q4 2010, while mean HQLA for banks with ILG exemptions remained virtually unchanged. Between Q1 2011 and Q1 2012 banks subject to the ILG increased HQLA by a further 3 percentage points as more banks received specific quantitative ILG targets from the FSA.[1] The evolution of HQLA to total assets suggests that before the ILG, the behaviour of banks in both the treatment and control groups was broadly similar and that when the ILG was introduced it had a significant impact on banks in the treatment group relative to banks in the control group.

(Insert Table II here)

In 2010/Q1 just before the introduction of the ILG, our sample consists of 171 banks after truncations, of which 90 are subject to the ILG while 81 received ILG exemptions.[2] The distribution of key variables of the ILG and non-ILG banks in Q1 2010 are summarised in **Table II** shows that the size distribution, given by log total assets of ILG banks and non-ILG banks prior to the ILG was broadly similar except for the 90th percentile which shows that there are larger banks in the treatment group. The distribution of Tier 1 capital shows that capital is in general higher in ILG banks compared to non-ILG banks. Turning to balance sheet composition, the distribution of HQLA to total assets across the two groups is broadly similar. However, ILG banks have a greater share of loans to UK non-banks and smaller share of short-term intra-financial loans than non-ILG banks.

[1] There was a second source of heterogeneity because supervisors staggered the setting of ILG ratios across banks due to the strain on resources during this period. Unfortunately we were unable to obtain the exact timing when individual ILG ratios were set for each bank.

[2] To eliminate extreme banks, a bank is truncated if the data is from: (i) a small bank, i.e. UK sterling assets less than £100m; (ii) a bank which doubled/halved UK sterling assets from the previous year; or (iii) a bank that has a ratio of sterling assets to liabilities greater than 200% or less than 50%. In addition for the interest rate estimations, a bank is truncated if the average interest rate change over any quarter is greater than 200bps.

There are some differences on the liability side: ILG banks have a greater share of funding from UK non-bank deposits and a smaller share of non-UK deposits funding than non-ILG banks. Overall, these descriptive statistics indicate that there are differences in the concentration of the UK businesses between ILG banks and non-ILG banks. Below we discuss our regression adjustment method to control for the different concentration of UK business when estimating the average treatment effect. We also perform additional robustness checks to determine the sensitivity of our results to these differences.

IV. Estimation Model

To analyse the behavioural reaction of banks to a tightening of liquidity regulation, we use the local projection method of Jordà (2005) to compute estimates of the *h*-step ahead cumulative average treatment effect on the outcome variables of interest. In effect, the local projection method computes regression-adjusted difference-in-difference estimates that collapse the time series information into a "pre"- and "post"-period for each *h*-step-ahead. Therefore, it follows one of the approaches proposed by Bertrand, Duflo and Mullainathan (2004) to address serial correlation bias of t-statistics in differences-in-difference estimation.

Denote $y_{i,t}$ an outcome variable of interest, say the share of HQLA to total assets in bank i at time t. Let $ILG_{i,t}$ be the random policy variable that takes on two values, d_1 when bank i is subject to ILG regulation in period t and d_0 if it is not. In addition we consider the possibility that there is a k_x dimensional vector $X_{i,t-1}$ known in period $t-1$ or earlier which could be relevant predictors of the policy variable $ILG_{i,t}$. In particular, we assume that policy is determined by $ILG_{i,t} = f(X_{i,t-1}, e_{i,t})$ where $e_{i,t}$ is an idiosyncratic source of random variation.

A potential outcome is given by $y_{i,t+h}(d_j) - y_{i,t-1}$, the change in the observed outcome variable $y_{i,t+h} - y_{i,t-1}$ would have taken if $ILG_{i,t} = d_j$ for all possible realisations $d_j \in D$, (j=0,1). In the context of our application, the difference $y_{i,t+h} - y_{i,t-1}$ refers to the cumulative change in the outcome between period $t-1$ and $t+h$; for example, the cumulative change in the share of HQLA to total assets. The causal effect of the ILG is defined as the unobservable random variable given by the difference, $(y_{i,t+h}(d_1) - y_{i,t-1}) - (y_{i,t+h}(d_0) - y_{i,t-1})$. Notice that $y_{i,t-1}$ is only used to benchmark the cumulative change and it is observed before the introduction of the ILG.

The observed outcomes are given by the following latent variables model,

$$y_{i,t+h} - y_{i,t-1} = \sum_{d_j \in D} y_{i,t+h}(d_j) 1\{ILG_{i,t} = d_j\} - y_{i,t-1} \quad (2)$$

As discussed in section II, because selection into the treatment and control groups was not entirely the result of random experimentation we make the following selection-on-observables assumption (sometimes called conditional ignorability or conditional independence assumption),

$$\left(y_{i,t+h}(d_j) - y_{i,t-1}\right) \perp ILG_{i,t} | X_{i,t-1} \text{ for all } h \geq 0 \text{ and for all } d_j \quad (3)$$

This assumption states that adjusting for differences in a fixed set of observable covariates $X_{i,t-1}$, removes biases in the comparison between treated and control units. This conditional ignorability assumption plays an important role in our identification strategy. Under assumption (3), and further assuming that a regression control strategy suffices to do the appropriate conditioning, the average causal effect of a policy intervention d_1 relative to the baseline d_0 on the outcome variable at time $t+h$, given by

$$E\left[\left(y_{i,t+h}(d_1) - y_{i,t-1}\right) - \left(y_{i,t+h}(d_0) - y_{i,t-1}\right)\right] \quad (4)$$

can be calculated by the local projection

$$y_{i,t+h} - y_{i,t-1} = \alpha^h + \theta^h ILG_{i,t} + \gamma^{h\prime} X_{i,t-1} + \varepsilon_{i,t+h} \quad \text{for } h = 0,1, \ldots, H \quad (5)$$

assuming the conditional mean can be linearly approximated. We can then write

$$E\left[\left(y_{i,t+h}(d_1) - y_{i,t-1}\right) - \left(y_{i,t+h}(d_0) - y_{i,t-1}\right)\right] \quad (6)$$

$$= E\left[E\left(y_{i,t+h} - y_{i,t-1} | d_1 ; X_{i,t-1}\right) - E\left(y_{i,t+h} - y_{i,t-1} | d_0 ; X_{i,t-1}\right)\right]$$

$$= \theta^h (d_1 - d_0)$$

Note that the average treatment effect, θ^h can be easily estimated using OLS in expression (5). The local projection directly conditions on observables (under the assumption of linearity) and facilitates the computation of (6).

Our empirical strategy is to estimate, one-by-one, the average treatment effect of the ILG along the different dimensions by which banks can adjust. This analysis along multiple dimensions allows us to not only examine the impact of the regulation on specific balance sheet components but also to provides a complete picture of how the overall asset and liability management choices of banks were affected by the ILG.

IV.A SELECTION OF CONDITIONING VARIABLES

As discussed above, to estimate the average treatment effect, we make the selection-on-observables assumption (3) to control for the fact that selection of banks into the ILG treatment group was not random but rather largely determined by bank type. To operationalise the selection-on-observables assumption we estimated probit regressions predicting selection into the treatment group for the 1023 possible combination of the 10 covariates we considered and used the Akaike Information Criterion to select the optimal set of controls $X_{i,t-1}$ that predict selection into the treatment group.[3]

(Insert Table III here)

Table III lists the vector of controls $X_{i,t-1,}$ considered and the estimated probit coefficients for the optimal prediction model, which consist of the following variables at the entity level: size (measured by log total sterling assets), the ratio of Tier 1 capital to risk-weighted assets of the consolidated parent of the entity; exposure to the short-term wholesale market (measured by share of short-term intra-financial loans to total assets and the share of short-term wholesale funding to total liabilities); the UK focus of the entity (measured by the share of non-UK deposits to total liabilities and share of UK non-bank deposits to total liabilities); and the pre-ILG trends in balance sheet growth and rates of change (measured by asset growth between 2008/Q3 and 2009/Q3 and the growth between 2008/Q4 and 2009/Q4).

For the full sample, the probit regression results show that the share of short-term intra-financial loans, short-term wholesale funding, non-UK deposits and UK non-bank deposits predict treatment at the 1% level, while pre-treatment asset growth and Tier 1 capital ratios predict treatment at the 5% and 10% levels respectively. The share of HQLA to total assets is not a significant variable predicting selection into ILG treatment which shows that the pre-existing HQLA position of a bank was not an important factor predicting treatment. We also find that the share of UK non-bank loans to total assets is driven out from the optimal prediction model by the share of UK non-bank deposits.

Because UK banks and foreign branches are likely to have different business models, our selection-on-observables assumption (3) might still not be fully satisfied despite conditioning our regression these observables differences. Therefore, in the robustness test section we limit our dataset to only non-UK owned banks which have more similar business

[3] Changing the criteria to the Bayesian Information Criterion alters the preferred set of control variables but does not change our main results.

models. The second column of Table 1 shows that once our dataset is restricted to non-UK banks, treated banks are much more similar to those with ILG exemptions. In this restricted dataset, only the share of wholesale funding is significantly different between the two groups at the 5% level and asset growth preceding the ILG implementation at the 10% level.[4]

IV.B ESTIMATING THE AVERAGE TREATMENT EFFECT ON BANK INTEREST RATES

Some extra care is needed to analyse the average treatment effect of the ILG on bank interest rates because data on interest rates are averages over baskets of heterogeneous assets (liabilities). Differences in the initial composition of baskets between the treatment and control groups can contaminate estimates of the ILG impact on the average interest rate receivable (payable) on the overall balance sheet of a bank. To see this, note that the definition of the average interest rate receivable on a basket of bank assets (or similarly a basket of bank liabilities) is given by

$$R_{i,t} \equiv \sum_{i=1}^{N} a_{i,t} r_{i,t}$$

where, $R_{i,t}$ is the average interest rate on the basket of assets (liabilities), $a_{i,t}$ is the share of each asset (liability) on the balance sheet, $r_{i,t}$ the interest rate on each asset (liability) and N is the number of assets with different interest rates. The change in the average interest rate receivable on the basket between period t and $t+h$ can be written as,

$$\Delta R_{i,t+h} = \sum_{i=1}^{N} \Delta r_{i,t+h} a_{i,t} + \sum_{i=1}^{N} \Delta a_{i,t+h} r_{i,t} + \sum_{i=1}^{N} \Delta a_{i,t+h} \Delta r_{i,t+h} \qquad (7)$$

where $\Delta x_{t+h} = x_{t+h} - x_{t.}$ Equation (7) shows that the change in the average interest rate on the basket of assets can be decomposed into the sum of the interest rate changes holding the asset shares constant (within-asset component) and the sum of the share changes holding the initial interest rates constant (between-asset component) and the product of changes in asset shares and interest rates.

Because of the systematic differences in the initial composition of assets and liabilities in the treatment and control groups (**Table II**), equation (7) indicates that the

[4] The similarity in structure of non-UK owned subsidiaries (that were subject to the ILG) and branches (that were mostly exempt from the ILG), is consistent with results in Aiyar, Calomiris and Wieladek (2014) who show that the size and sectoral composition of exposures to the UK non-financial private corporations in non-UK subsidiaries operating in the UK and foreign branches were broadly similar.

overall change in the average interest rate on a basket of assets $\Delta R_{i,t+h}$ would be influenced by differences in the pre-ILG asset (liability) composition $(a_{i,t})$ or interest rates $(r_{i,t})$ in the treatment and control groups, which are presumably independent of the ILG treatment. To minimise this concern we restrict our analysis to estimating the change in the average interest rates on the narrowest asset (liability) baskets $(\Delta r_{i,t})$ that the data allow, which are the average interest rates on UK non-financial loans and UK non-bank deposits.

V. Baseline Results

For all our results we use 2010/Q1 as our pre-ILG period *t*, which is just before the ILG was first introduced for large depository banks (1st June 2010) and around the time the identity of the banks that would receive ILG exemptions was fully clarified. In our baseline results we use we use 2012/Q1 as the baseline post-ILG period because the Bank of England's Financial Policy Committee recommended a loosening of the ILG in mid-2012 and the Bank of England announced the Funding for Lending Scheme.[5] In the robustness tests, we present results for different *h* from 2010/Q2 to 2012/Q1 to test the sensitivity of our results to the selection of "post"-treatment date. We also present results excluding conditioning variables, the standard difference-in-difference estimator, to show how our estimated baseline results change with the addition of conditioning variables.

V.A Average Treatment Effect of the ILG on Bank Assets

The first column of **Table IV** presents estimates of the average treatment effect of the ILG on the growth rate of total assets. The insignificant and very small coefficient on the ILG term shows that the introduction of the ILG did not have a significant impact on the overall size of bank balance sheets, relative to non-ILG banks.

(Insert Table IV here)

Nevertheless, the second and third columns of **Table IV** show that the introduction of the ILG had a significant impact on the composition of bank assets. The second column shows that banks subject to the ILG increased their share of HQLA to total assets by over 12 percentage points. Approximately 75 percent of the increase in HQLA was in central bank reserves, with only 25 percent in government T-bills and gilts. The equal and opposite sign

[5] See http://www.fsa.gov.uk/library/communication/statements/2012/fpc.shtml for more details.

on the ILG coefficient shown in the third column of the **Table IV** indicates that the increase in HQLA was fully offset by a decrease in short-term intra-financial loans (e.g. unsecured and secured lending to other monetary and financial institutions).

The final two columns of **Table IV** present estimates of the ILG impact on bank lending to the non-bank sector. The fourth column shows that the introduction of the ILG did not have a statistically significant impact on the ratio of UK non-bank loans to total assets. To assess the impact on lending to the non-financial sector, ie the impact on the quantity of real economy lending, the final column uses the smaller sample of banks that report the more granular *BE Form* that provides this split. It shows that the ILG did not have an impact on the share of UK non-financial loans to total assets. Combined with the finding that the introduction of the ILG did not affect the size of total bank assets, our results suggest the quantity of bank lending to the UK non-financial sector was unaffected by the introduction of tougher liquidity regulation.

The coefficients on the control variables in the upper panel of **Table IV** show they are soaking up the impact of pre-treatment bank characteristics on the dependent variables. For example, consistent with a period of wholesale funding market stress, banks which had a greater share of short-term intra-financial loans experienced lower balance sheet growth, accumulated more HQLA and reduced their holdings of short-term intra-financial loans. Also better capitalised banks, experienced stronger balance sheet growth, accumulated less HQLA, made more use of short-term intra-financial loans, and extended more lending to the non-financial sector.

The lower panel of **Table IV**, which presents estimates excluding conditioning variables, shows that the broad story remains unaltered: insignificant change in bank balance sheet size, one-to-one substitution from short-term intra-financial loans to HQLA and no impact on lending to the non-bank and non-financial sectors. The conditioning variables do, however, increase the estimated size of the substitution towards HQLA from short-term intra-financial loans.

A by-product of our variable-by-variable regression approach is that it allows us to check the overall consistency of the results. As shown in **Table IV** (and in **Figure III** which will be explained in the later section), the positive impact of the ILG on the share of HQLA and the negative impact on the share of short-term intra-financial loans almost fully cancel out with each other, while the share of real economy loans of the two groups remain very

stable. The effects on the asset shares from our separate regressions add up to zero without imposing this by assumption.

Given the fact that HQLA, short-term intra-financial loans and UK non-bank loans account for almost all of total sterling assets for ILG banks, for our result on real-economy loans to be biased due to unobserved heterogeneous demand shifts by non-bank borrowers, there would also need to be the same sized bias in exactly the opposite direction in our regressions for shares of HQLA and/or short-term intra-financial loans for the overall change in the asset shares to sum to zero. This would essentially require almost perfect negative correlation between the unobserved heterogeneous demand shifts by borrowers of real-economy loans and that of other bank assets which is very unlikely. By the above reasoning, we conclude that our findings are not seriously biased by possible heterogeneous demand shifts for loans by borrowers of banks in the treatment and control groups.

V.B AVERAGE TREATMENT EFFECT OF THE ILG ON BANK LIABILITIES

(Insert Table V here)

The first column of **Table V** estimates the average treatment effect of the ILG on the share of bank funding from UK non-bank deposits, considered relatively stable under the ILG. We find that in response to the ILG, banks significantly increased their share of funding from UK non-bank deposits by around 7.5 percentage points relative to banks in the control group. The second column of Table V uses the more granular *BE Form* reported by a subset of banks to test whether this increase was driven by higher UK non-financial deposits rather than increased non-bank financial firms such as insurance companies or pensions funds. Consistent with the finding for UK non-bank deposits we estimate that the share of UK non-financial deposits to total liabilities increased by 5.7 percentage points. The point estimates in the third column of **Table V** indicate that ILG banks decreased their share of less stable funding from short-term wholesale markets. Similarly, point estimates indicate that ILG banks reduced funding from non-UK deposits (fourth column). This substitution is consistent with the design of the ILG which penalised short-term wholesale funding and non-resident deposits compared to domestic funding sources. Although neither the impact on short-term wholesale funding nor non-UK deposits is statistically significant, the total decrease in the share of funding from these two sources is close to the increase in funding from UK non-bank deposits.

V.C AVERAGE TREATMENT EFFECT OF THE ILG ON INTEREST RATES

(Insert Table VI here)

We estimate that the ILG had an insignificant impact on the average interest rate on non-financial loans (**Table VI,** first column), although the point estimate indicates that the average interest rate on non-financial loans increased by 14 basis points in ILG banks. Unfortunately, we do not have data on the average interest rates on other bank asset classes. However, because loans to non-financials are likely to be the asset class where banks have the most pricing power due the heavy dependence on private information, it is likely that the ILG would have had a smaller impact on the interest rates of more marketable assets that make up the rest of the balance sheet.

Turning to the impact of the ILG on the average interest rates payable on bank liabilities, the second column of **Table VI** shows that the average interest rate payable on UK non-financial deposits was broadly unaffected by the ILG. Given the significant shift in bank funding towards UK non-financial deposits in ILG banks, it is somewhat surprising that they managed to attract such a significant increase in non-financial deposit funding without a significantly increasing the average interest rate on deposits relative to banks with exemptions.

Our admittedly limited results on the interest rate impact of the ILG suggest that it had little impact on bank interest rates. Therefore, the overall impact of liquidity regulation on bank profitability is likely to have been driven by the asset substitution towards HQLA and from the substitution of bank funding towards UK non-bank deposits.

V.D INTERACTION BETWEEN LIQUIDITY REGULATION AND BANK CAPITAL

To examine the interaction between the tightening of liquidity regulation and bank capital, we extend our baseline regression specification by including an interaction term between the ILG treatment variable and the regulatory Tier 1 capital ratio of the entity's consolidated banking group in 2009, the year prior to the ILG's introduction. Overall, we find little evidence of any significant interaction between the impact of the ILG and bank capitalisation.

(Insert Table VII here)

The first column **Table VII** shows that our baseline regression results on the ILG's impact on balance sheet growth is broadly unaffected, with both the ILG dummy and interaction with Tier 1 capital being insignificant. Similarly there is almost no impact from including the interaction term on the ILG impact on the accumulation of HQLA and reduction in short-term intra-financial loans with point estimates on the ILG dummy variable remaining significant and broadly unchanged while Tier 1 capital interaction terms with the ILG are insignificant. We also do not find any impact on our estimates of the ILG's impact on UK non-bank loans. However, the inclusion of the interaction term does change our estimates of the ILG impact on UK non-financial loans that requires careful interpretation. The significant negative coefficient on the interaction between the ILG dummy and capital ratio could be interpreted as suggesting that the ILG had a greater impact on non-financial lending in better capitalised banks. However, the significant and similar sized coefficient on the uninteracted Tier 1 capital ratio term indicates that it is rather better capitalised non-ILG banks which increased lending to the UK non-financial sector. While the reaction of ILG banks, which is given by the sum of the Tier 1 capital ratio and (Tier 1 capital ratio x ILG) coefficients suggests that the impact of the ILG was largely independent of bank Tier 1 capital in ILG banks. Furthermore, the very large positive and significant coefficient on the ILG term indicates that there is no evidence that the ILG depressed bank lending to non-financials, consistent our baseline regression results.

We find little impact from the inclusion of the Tier 1 capital ratio interaction term on the liability categories. The coefficients on the interaction term are insignificant in all the regressions and the coefficient of the ILG impact on UK non-bank deposits remains positive and significant, although slightly smaller than our baseline regression. However, the ILG dummy variable on UK non-financial deposits does not remain significant but the size remains consistent with our baseline results.

VI. Robustness Tests

In this section we examine the robustness of our baseline results. During our estimation window when the ILG was introduced there were significant stresses in the banking sector. We conduct rolling regressions over the ILG treatment window to check the robustness of the baseline results to our choice of treatment window. Also, given the non-random selection into the treatment group by bank entity type – which largely reflects the UK

focus of UK banks, we re-estimate our baseline regressions excluding UK banks from our dataset, comparing the impact of the ILG on treated foreign subsidiaries relative to foreign branches with ILG exemptions. We also considered the interaction between liquidity regulation and bank capitalisation. We did not find significant interaction effects. The results are available in the online appendix.

VI.A ROLLING REGRESSIONS

In **Figures II to V** we present estimates of the average treatment effect from rolling regressions which move the "post" ILG date *h* by one quarter at a time between 2010/Q2 to 2012/Q2. To consistently find significance over treatment windows of different lengths is a particularly demanding test, given the finding by Betrand, Duflo and Mullainathan (2004) that time aggregation into just a "pre" and "post" period has low power.

To show both the overall trend change for each dependent variable as well as the difference between the treatment and control groups, **Figures II to V**, present estimates evaluated at the sample average value of each control. The red diamonds denote the average changes of the ILG banks from pre-ILG level (2010/Q1) for each left-hand side variable considered. The blue balls denote the change of the non-ILG banks over the same period. The difference between red diamonds and blue balls is the estimated average treatment effect of the ILG. The blue bars show the 95% confidence intervals of the ILG dummy variable. When the blue ball falls within the blue bar, the impact is not statistically significant at the 5% level. Our baseline regression estimates of the ILG impact are given by the final observation in 2012/Q1, the quarter before the Bank of England's Financial Policy Committee loosened the ILG in mid-2012 and announced the introduction of the Funding for Lending Scheme.

(Insert Figure II here)

Figure II shows how log total assets of ILG banks and the control group evolved after the ILG was introduced in 2010/Q2. It shows that the evolution was on average largely flat for both groups and the differences between the two groups, which measure the impact of the ILG, never became statistically significant during the estimation period.

(Insert Figure III here)

Figure III summarises the evolution in bank asset composition. The top left panel highlights the smooth increase in HQLA as a share of total assets relative to the control group

over the treatment period. Due to the data limitations in our treatment identification we have assumed that all ILG banks were subject to the ILG from 2010/Q2.[6] In fact, the majority of ILG banks only became officially subject to the ILG in October 2010 (e.g. banks under the previous Liquidity Mismatch Regime and smaller building societies) and some of those banks were formally set their ILG ratios after 2010/Q4. The observed gradual increase in HQLA is consistent with the gradual introduction of ILG requirements.

The top-left panel of **Figure III** also allows us to examine the contribution of QE to the accumulation of HQLA in banks. At various points between 2009 and 2012, the Bank of England conducted purchases of UK gilts from the private sector through the quantitative easing programme, mostly from non-banks financed by the creation of central bank reserves.[7] At some point these newly created central bank reserves must be deposited at a bank with reserve accounts at the Bank of England. One may be concerned that the impact of the ILG on HQLA might be overestimated due to the effect of quantitative easing (QE) asset purchases mechanically increasing central bank reserves in the banking system. This would be the case if the following three conditions are satisfied. First, QE tends to concentrate liquid assets in the banking sector. Second, banks which have reserve accounts at the Bank of England are mostly ILG banks. Third, the timing of the ILG introduction and QE asset purchases are closely correlated. Data show the third condition is not satisfied. The majority of the estimated impact on HQLAs was observed sufficiently far *after* the first round of asset purchases ended in January 2010, yet *prior* to the second round of asset purchases in 2011/Q4. For this reason, we do not think that there were asymmetric effects from the QE programme on the two groups during our estimation period although we do think that the two groups were equally affected by the elastic supply of excess reserves.

The top-right panel shows that a similarly smooth and offsetting decrease in the share of short-term wholesale loans in ILG banks compared to the control group, which remained broadly flat. The two lower panels of **Figure III** show the share of UK non-bank and non-financial loans remained largely unchanged for both groups, which is consistent with the baseline results discussed in the previous section.

(Insert Figure IV here)

On the liability side, **Figure IV** confirms that the ILG caused banks to increase their reliance on UK non-bank deposits with the impact being greater towards the end of the

[6] Our ILG/Non-ILG identifiers are based on banks' ILG status at the beginning of October 2012.
[7] See Mclaren, Banerjee and Latto (2014) for more details.

treatment period. For short-term wholesale funding, the dynamics suggest that ILG banks initially decreased their share of short-term wholesale funding, with a significant treatment effect between 2010/Q4 and 2011/Q2, but that once they had accumulated sufficient HQLA they increased their use of wholesale funding, resulting in an insignificant change by the end of our treatment window. The rolling regressions also indicate that ILG banks decreased funding from non-UK deposits which are considered less stable under the ILG.

(Insert Figure V here)

The left-hand panel of **Figure V** shows rolling regressions estimates of the ILG impact on the average interest rate on UK non-financial loans. It shows that the evolution was on average largely flat for both groups and the differences between the two groups, which measure the impact of the ILG, never became statistically significant during the estimation period. For the average interest rate on UK non-financial deposits our rolling regressions also indicate no clear trend differences.

VI.B NON-UK BANKS

Given the non-random selection into the treatment group by bank entity type, which **Tables II and III** showed largely reflected the UK focus of banks, we re-estimate our baseline regressions excluding UK banks from our dataset. These regressions compare the impact of the ILG on treated foreign subsidiaries compared to foreign branches with exemptions which are more similar in bank business models as shown by the probit regression in **Table III**. Although excluding UK banks reduces our sample size from 160 to 89 banks, it is striking that the estimated average treatment effect of the ILG of non-UK banks in **Table VIII** is virtually identical to those of our baseline in **Tables IV and V** which include UK banks. For example, our baseline results indicate that the ILG increased the share of HQLA to total assets by 12.1 percentage points, while in the sample which only considers non-UK banks, the estimated increase in HQLA is 12.5 percentage points, well within measures of dispersion of these estimates. The almost identical results across each balance sheet component suggest that our conditioning variables are effective at addressing bias concerns from non-random selection into the ILG treatment.

VII. CONCLUSION

This study empirically investigates how banks responded to tighter liquidity regulation in the United Kingdom. We use the heterogeneous implementation of the Individual Liquidity Guidance (ILG) regulation in the United Kingdom in 2010 to estimate the average treatment effect of tighter liquidity regulation on banks across a number of dimensions. Overall, we find that banks subject to the ILG did not adjust the size of their balance sheets to meet tighter liquidity regulation but rather altered the composition of both their assets and liabilities. On the asset side, banks significantly increased the share of HQLA to total assets by around 12 percentage points following the introduction of the ILG. We find that adjustment in the share of HQLA to total assets was entirely offset by an equal and opposite reduction in the share of short-term intra-financial loans, with the share of other assets remaining unaffected. On the liability side, ILG banks increased funding from more stable non-bank and non-financial corporation deposits and decreased their reliance on less stable short-term wholesale and non-UK funding.

In terms of the price impact, we do not find strong evidence that tightening liquidity regulation increased the interest rate on loans to the non-financial sector or the interest rate paid on UK non-financial deposits.

Overall, our results suggest that when the tighter liquidity regulation was introduced in the United Kingdom, it was a constraint on the composition of banks' intra-financial sector assets and liabilities. However, we do not find evidence that the introduction of the ILG had a negative impact on bank lending to the non-financial sector, either in terms of the quantity or price of lending. Our finding that liquidity regulation has a significant impact on the interbank market potentially raises a number of future research questions about its impact on monetary and macroprudential policies.

An open question is the influence of operational procedures related to the QE programme on our estimates of the impact of tighter liquidity regulation. Given the significant quantity of remunerated excess reserves in the banking system which could be used as HQLA to meet the ILG requirement, it is possible that in the absence of these facilities banks would have chosen to meet the ILG along different dimensions, relying less on the accumulation of HQLA.

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DATA APPENDIX

Following are the data source and definition of our analysis.

1. Balance sheet data (except for the ratio of tier1 capital to risk-weighted assets): collected from individual bank returns used to compile the Bank's monetary statistics. (*Form BT, BE*). Definitions are found at http://www.bankofengland.co.uk/statistics/Pages/reporters/defs/default.aspx
2. The ratio of Tier1 capital to risk-weighted assets of the entity's consolidated banking group: collected from Bankscope and regulatory returns from the FSA (*FSA003*).
3. Interest rate data: constructed from interest rate receivable and payable divided by the stock of UK non-financial loans (private non-financial corporations (PNFC), individuals and others) and UK non-financial deposits (PNFCs, individuals and others) at the beginning of the period. Both the numerators and the denominators are collected from individual bank returns used to compile the Bank's monetary statistics. (*Form PL, BE*). Definitions are found at http://www.bankofengland.co.uk/statistics/Pages/reporters/defs/default.aspx
4. Banks' exemption status on the ILG regulation is collected from a regulatory database. Lists of rule modifications granted for individual banks are publicly available and found at *Prudential Sourcebook for Banks, Building Societies and Investment Firms (Waivers)*: www.fca.org.uk/static/fca/documents/waivers/bipru-waivers.pdf

The *boxcodes* used for the calculation of the balance sheet variables (except for the ratio of tier1 capital to risk-weighted assets) are as follows:

Total sterling assets: BT£40
Total sterling liabilities: BT£20
HQLA: Cash + T-bills & Gilts (BT£21+BT£26A+ BT£32D)
Short-term intra-financial loans: Market loans + Reverse repos ex. public sectors (BT£23 +BT£30B +BT£30C +BT£30D +BT£30H +BT£30J)
UK non-bank loans: BT£29D
UK non-financial loans: BE£29DA2 +BE£29DB2 +BE£29DA3A +BE£29DA3B +BE£29DB3A1 +BE£29DB3A2 +BE£29DB3A3 +BE£29DB3A4 +BE£29DB3B
Short-term wholesale funding: Deposits from the UK Monetary Financial Institutions + Certificate of deposits and commercial paper issued + Repos ex. public sectors (BT£2B +BT£2C +BT£2D +BT£3B +BT£3C +BT£3D +BT£4 +BT£5A +BT£6B +BT£6C +BT£6D +BT£6H +BT£6J)
UK non-bank deposits: BT£2H+BT£3H
UK non-financial deposits: BT£2H+BT£3H-BE£2H1-BE£3H1-BE£2H4-BE£3H4
Non-UK deposits: BT£2J+BT£3J
Interest receivable from UK non-financial loans: PL£1BJ +PL£1BK
Interest payable for UK non-financial deposits: PL£2BJ+PL£2BK

TABLE I ILG NET STRESSED OUTFLOW CALIBRATION

Asset inflows recognised	2 week inflow	3 month inflow
Lending to credit institutions	100%	100%
Own account security cashflows	100%	100%
Reverse repo cash flow	100%	100%
All other inflows not recognised		

On balance sheet liability rollover recognised[1]	2 week rollover	3 month rollover[2]
Repo: non-eligible high quality securities	0%	90%
Repo: ABS, covered bonds, high quality corporate bonds and equities in major indices	0%	75%
Repo: Other securities	0%	30%
Primary issuance – senior securities	0%	40%
Primary issuance – dated subordinated securities	0%	25%
Primary issuance – structured notes	0%	60%
Covered bonds	0%	25%
Group entities	0%	0%
UK credit institutions, non-credit financial institutions governments, central banks and supranations	0%	40%
Non-UK credit institutions	0%	35%
SSPE liability cash flows	0%	40%
Conditional liabilities pre-trigger contractual profile	0%	75%
Large non-financial deposit – Type A	0%	50%
Large non-financial deposit – Type B	77.5%	77.5%
SME deposits	77.5%	77.5%
Client / brokerage free cash	25%	N/A
Principal FX cash flows (including currency swaps)	FX markets closed	FX markets open

	Outflows – all maturities	
Retail deposits – Type A	20%	20%
Retail deposits – Type B	10%	10%

[1] In addition, the ILG outflows also cover off balance sheet items and outflows due to credit downgrades. See http://www.bankofengland.co.uk/publications/Documents/other/pra/policy/2013/ilgannex.pdf for more details.

[2] Approximate 3-month liability rollover rates from Abraham (2010).

TABLE II Distribution of key variables by group (2010/Q1)

ILG banks: 90 banks						
	mean	90%tile	75%tile	median	25%tile	10%tile
Total assets (in log)	7.20	10.08	8.47	6.60	5.72	5.15
Tier I capital adequacy ratio	15.3%	21.5%	17.0%	14.0%	11.5%	10.1%
Asset composites (% share to the total assets)						
HQLAs	5.3%	11.6%	8.0%	2.9%	0.0%	0.0%
Short-term intra-financial loans	27.0%	54.0%	36.5%	22.5%	10.7%	3.6%
UK non-bank loans	55.5%	77.0%	74.1%	66.4%	41.4%	10.4%
Liability composites (% share to the total liabilities)						
Short-term wholesale funding	4.4%	11.4%	6.1%	2.5%	0.0%	0.0%
Non-UK deposits	9.7%	40.4%	7.0%	0.6%	0.1%	0.0%
UK non-bank deposits	67.1%	90.7%	86.0%	80.8%	54.3%	11.7%

Non-ILG banks: 81 banks						
	mean	90%tile	75%tile	median	25%tile	10%tile
Total assets (in log)	7.42	9.39	8.77	7.39	6.24	5.33
Tier I capital adequacy ratio	12.0%	16.3%	13.0%	10.7%	9.2%	8.3%
Asset composites (% share to the total assets)						
HQLAs	5.8%	20.6%	0.3%	0.0%	0.0%	0.0%
Short-term intra-financial loans	37.2%	93.9%	67.4%	26.3%	7.6%	1.2%
UK non-bank loans	38.3%	76.5%	60.4%	39.5%	14.2%	2.0%
Liability composites (% share to the total liabilities)						
Short-term wholesale funding	14.9%	48.8%	20.3%	8.0%	0.2%	0.0%
Non-UK deposits	37.5%	67.6%	55.5%	35.2%	15.0%	4.1%
UK non-bank deposits	26.5%	60.2%	40.2%	20.3%	7.7%	1.4%

TABLE III Probit regression of ILG treatment prediction

Dependent variable	ILG treatment dummy			
	Full sample		Non-UK banks only	
ln(£assets)	0.128		0.141	
	(0.089)		(0.121)	
Tier I capital adequacy ratio	4.627	*	4.375	
	(2.494)		(3.234)	
HQLA/total assets	Excluded in optimal model			
Short-term intra-financial loans /total assets	-1.326	***	-5.779	
	(0.465)		(2.344)	
UK non-bank loans/total assets	Excluded in optimal model			
Short-term wholesale funding/total liabilities	-4.045	***	-0.674	**
	(1.527)		(0.637)	
Non-UK deposits/total liabilities	-1.572	***	-0.674	
	(0.610)		(0.637)	
UK non-bank deposits/total liabilities	1.914	***	0.410	
	(0.507)		(0.693)	
£assets growth (08q3-09q3)	1.381	**	0.838	
	(0.643)		(0.716)	
£assets growth (08q4-09q4)	-1.108		-1.486	*
	(0.727)		(0.870)	
Const	-1.235		-1.600	
	(0.912)		(1.234)	
Pseudo r2	0.438		0.182	
AIC	151.02		108.17	
N	171		100	

Standard errors in the parentheses, *** indicates significance at the 1% level; ** at the 5% level; * at the 10% level.

TABLE IV Baseline ILG impact on the asset size and asset shares

With control variables

	Δln(total assets)		As a share of total assets							
			HQLA		Short-term intra-financial loans		UK non-bank loans		UK non-financial loans (BE)	
ILG	-0.005		0.121	***	-0.123	***	0.000		-0.017	
	(0.078)		(0.031)		(0.044)		(0.023)		(0.035)	
ln(£assets)	-0.035	***	-0.004		0.010	*	0.000		0.002	
	(0.012)		(0.005)		(0.005)		(0.004)		(0.008)	
Tier I capital	0.469		-0.194		0.241		-0.048		0.032	
adequacy ratio	(0.310)		(0.156)		(0.228)		(0.089)		(0.243)	
Short-term intra-	-0.046		0.129	***	-0.227	***	0.062	**	0.023	
financial loans/TA	(0.107)		(0.044)		(0.063)		(0.026)		(0.049)	
Short-term wholesale	0.001		0.018		-0.020		0.030		-0.013	
funding/TL	(0.251)		(0.108)		(0.141)		(0.089)		(0.147)	
Non-UK deposits/TL	-0.237		-0.035		0.083		-0.013		-0.044	
	(0.155)		(0.049)		(0.078)		(0.048)		(0.067)	
UK non-bank	-0.155		-0.100	*	0.102		0.045		0.010	
deposits/TL	(0.111)		(0.051)		(0.075)		(0.041)		(0.072)	
£assets growth	0.335	*	-0.010		0.103		-0.072		0.054	
(08q3-09q3)	(0.188)		(0.046)		(0.066)		(0.054)		(0.054)	
£assets growth	0.122		-0.122	**	0.007		0.121	**	-0.038	
(08q4-09q4)	(0.204)		(0.058)		(0.076)		(0.050)		(0.063)	
Const	0.346	**	0.049		-0.087		-0.031		-0.007	
	(0.149)		(0.058)		(0.073)		(0.047)		(0.089)	
r2	0.184		0.284		0.243		0.093		0.031	
N	160		160		160		160		85	

*** indicates significance at the 1% level; ** at the 5% level; * at the 10% level. Standard errors in the parentheses are the White robust standard errors. TA=total assets, TL=total liabilities.

Without control variables

	Δln(total assets)	As a share of total assets				
		HQLA		Short-term intra-financial loans	UK non-bank loans	UK non-financial loans (BE)
ILG	0.037	0.064	***	-0.061 **	0.008	0.001
	(0.050)	(0.018)		(0.026)	(0.016)	(0.020)
Const	-0.011	0.011		-0.022	-0.004	-0.002
	(0.044)	(0.012)		(0.018)	(0.014)	(0.017)
r2	0.004	0.072		0.034	0.002	0.000
N	160	160		160	160	85

*** indicates significance at the 1% level; ** at the 5% level; * at the 10% level. Standard errors in the parentheses are the White robust standard errors.

TABLE V Baseline ILG impact on liability shares

With control variables	As a share of total liabilities			
	UK non-bank deposits	UK non-financial deposits (BE)	Short-term wholesale funding	Non-UK deposits
ILG	0.076 **	0.057 **	-0.018	-0.044
	(0.030)	(0.023)	(0.023)	(0.028)
ln(£assets)	-0.004	0.006 **	0.019 ***	-0.001
	(0.004)	(0.003)	(0.006)	(0.005)
Tier I capital	0.083	0.210	0.172	-0.113
adequacy ratio	(0.113)	(0.138)	(0.116)	(0.096)
Short-term intra-	0.003	0.005	0.078 **	-0.085 **
financial loans/TA	(0.041)	(0.035)	(0.038)	(0.041)
Short-term wholesale	0.023	0.056	-0.357 **	0.036
funding/TL	(0.087)	(0.053)	(0.157)	(0.099)
Non-UK deposits/TL	-0.082	-0.032	0.052	-0.124 *
	(0.066)	(0.037)	(0.050)	(0.066)
UK non-bank	-0.179 ***	-0.081 **	0.012	0.029
deposits/TL	(0.062)	(0.038)	(0.041)	(0.041)
£assets growth	-0.084	-0.018	-0.016	0.115 **
(08q3-09q3)	(0.058)	(0.029)	(0.070)	(0.048)
£assets growth	0.116	-0.076	0.091	-0.140 **
(08q4-09q4)	(0.094)	(0.054)	(0.074)	(0.055)
Const	0.075	-0.086 **	-0.161 **	0.078
	(0.060)	(0.034)	(0.071)	(0.063)
r2	0.122	0.290	0.203	0.142
N	160	85	160	160

*** indicates significance at the 1% level; ** at the 5% level; * at the 10% level. Standard errors in the parentheses are the White robust standard errors. TA=total assets, TL=total liabilities.

Without control variables	As a share of total liabilities			
	UK non-bank deposits	UK non-financial deposits (BE)	Short-term wholesale funding	Non-UK deposits
ILG	0.021	0.035	-0.006	0.012
	(0.020)	(0.014)	(0.022)	(0.020)
Const	-0.012	-0.031 ***	0.004	-0.017
	(0.018)	(0.012)	(0.021)	(0.020)
r2	0.008	0.075	0.001	0.003
N	160	85	160	160

*** indicates significance at the 1% level; ** at the 5% level; * at the 10% level. Standard errors in the parentheses are the White robust standard errors.

TABLE VI Impact on the average interest rates

With control variables		
	Average interest rate (bps)	
	Average interest rate on UK non-financial loans	Average interest rate on UK non-financial deposits
ILG	13.9	9.4
	(40.8)	(17.3)
ln(£ total assets)	-10.6	4.1
	(7.4)	(3.0)
Tier I capital adequacy ratio	144.4	-76.5
	(120.0)	(84.0)
Short-term intra-financial loans/TA	-14.7	11.0
	(69.2)	(28.3)
Short-term wholesale funding/TL	52.7	45.9
	(76.8)	(42.3)
Non-UK deposits/TL	-21.9	32.9
	(55.9)	(31.7)
UK non-bank deposits/TL	-87.9 *	21.8
	(50.0)	(29.8)
£assets growth (08q3-09q3)	-6.4	-73.7 **
	(55.8)	(28.3)
£assets growth (08q4-09q4)	11.0	25.2
	(54.6)	(27.9)
Const	121.4 *	-48.7
	(61.8)	(39.5)
r2	0.139	0.223
N	51	51

*** indicates significance at the 1% level; ** at the 5% level; * at the 10% level. Standard errors in the parentheses are the White robust standard errors. TA=total assets, TL=total liabilities.

Without control variables		
	Average interest rate (bps)	
	Average interest rate on UK non-financial loans	Average interest rate on UK non-financial deposits
ILG	-22.3	3.0
	(20.8)	(10.4)
Const	22.5	10.9
	(15.2)	(8.3)
r2	0.022	0.002
N	51	51

*** indicates significance at the 1% level; ** at the 5% level; * at the 10% level. Standard errors in the parentheses are the White robust standard errors.

TABLE VII ILG impact on non-UK banks

With control variables

	Δln(£ total assets)	As a share of total assets				As a share of total liabilities			
		HQLA	Short-term intra-financial loans	UK non-bank loans	UK non-financial loans (BE)	UK non-bank deposits	UK non-financial deposits (BE)	Short-term wholesale funding	Non-UK deposits
ILG	-0.039	0.125 ***	-0.136 **	0.015	-0.027	0.076 **	0.044 **	-0.036	-0.016
	(0.094)	(0.042)	(0.061)	(0.031)	(0.046)	(0.035)	(0.017)	(0.023)	(0.032)
ln(£ total assets)	-0.064 ***	-0.009	0.018	0.000	0.013	0.000	0.018 ***	0.035 ***	0.000
	(0.024)	(0.010)	(0.012)	(0.008)	(0.020)	(0.009)	(0.006)	(0.012)	(0.010)
Tier I capital adequacy ratio	1.280	-0.245	0.156	-0.274 *	0.259	-0.021	0.131	0.593	-0.190
	(0.810)	(0.191)	(0.375)	(0.162)	(0.809)	(0.303)	(0.288)	(0.364)	(0.259)
Short-term intra-financial loans/TA	-0.057	0.140 **	-0.257 ***	0.083 **	-0.011	0.016	-0.026	0.082	-0.101 *
	(0.144)	(0.053)	(0.073)	(0.034)	(0.058)	(0.055)	(0.030)	(0.053)	(0.052)
Short-term wholesale funding/TL	0.119	0.017	-0.024	0.018	-0.015	0.033	0.039	-0.426 **	0.068
	(0.290)	(0.119)	(0.152)	(0.101)	(0.153)	(0.093)	(0.047)	(0.163)	(0.112)
Non-UK deposits/TL	-0.122	-0.051	0.099	-0.033	-0.052	-0.049	-0.006	0.049	-0.148 **
	(0.156)	(0.056)	(0.087)	(0.056)	(0.073)	(0.066)	(0.031)	(0.060)	(0.072)
UK non-bank deposits/TL	-0.134	-0.112	0.128	0.005	0.016	-0.204 ***	-0.096	0.046	0.053
	(0.170)	(0.071)	(0.103)	(0.056)	(0.113)	(0.075)	(0.063)	(0.067)	(0.064)
£assets growth (08q3-09q3)	0.361	-0.037	0.137 *	-0.089	0.049	-0.098	-0.007	-0.029	0.148 ***
	(0.224)	(0.048)	(0.082)	(0.056)	(0.075)	(0.065)	(0.025)	(0.072)	(0.051)
£assets growth (08q4-09q4)	0.087	-0.094	-0.038	0.158 ***	-0.035	0.149	-0.091	0.107	-0.181 ***
	(0.249)	(0.063)	(0.089)	(0.055)	(0.083)	(0.115)	(0.066)	(0.096)	(0.063)
Const	0.403 *	0.097	-0.137	0.004	-0.115	0.051	-0.159 **	-0.324 **	0.076
	(0.240)	(0.094)	(0.119)	(0.073)	(0.195)	(0.094)	(0.059)	(0.124)	(0.105)
r2	0.227	0.324	0.278	0.109	0.044	0.127	0.445	0.286	0.194
N	89	89	89	89	49	89	49	89	89

*** indicates significance at the 1% level; ** at the 5% level; * at the 10% level. Standard errors in the parentheses are the White robust standard errors. TA=total assets, TL=total liabilities.

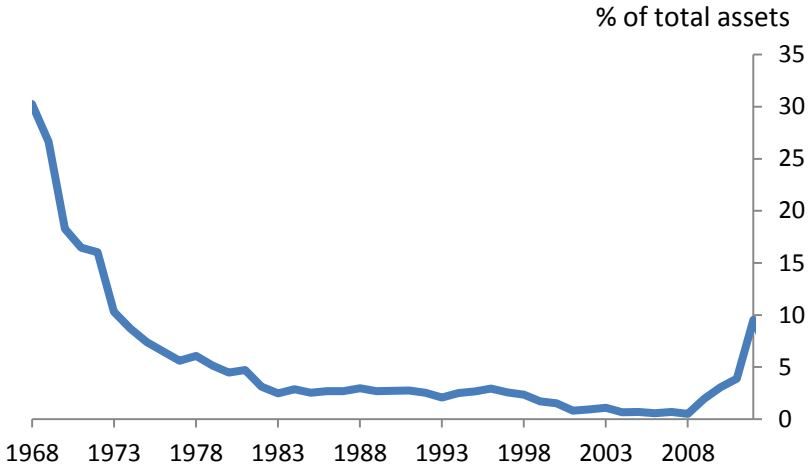
TABLE VIII ILG impact on non-UK banks

With control variables

		As a share of total assets				As a share of total liabilities			
	Δln(£ total assets)	HQLA	Short-term intra-financial loans	UK non-bank loans	UK non-financial loans (BE)	UK non-bank deposits	UK non-financial deposits (BE)	Short-term wholesale funding	Non-UK deposits
ILG	-0.039	0.125 ***	-0.136 **	0.015	-0.027	0.076 **	0.044 **	-0.036	-0.016
	(0.094)	(0.042)	(0.061)	(0.031)	(0.046)	(0.035)	(0.017)	(0.023)	(0.032)
ln(£ total assets)	-0.064 ***	-0.009	0.018	0.000	0.013	0.000	0.018 ***	0.035 ***	0.000
	(0.024)	(0.010)	(0.012)	(0.008)	(0.020)	(0.009)	(0.006)	(0.012)	(0.010)
Tier I capital adequacy ratio	1.280	-0.245	0.156	-0.274 *	0.259	-0.021	0.131	0.593	-0.190
	(0.810)	(0.191)	(0.375)	(0.162)	(0.809)	(0.303)	(0.288)	(0.364)	(0.259)
Short-term intra-financial loans/TA	-0.057	0.140 **	-0.257 ***	0.083 **	-0.011	0.016	-0.026	0.082	-0.101 *
	(0.144)	(0.053)	(0.073)	(0.034)	(0.058)	(0.055)	(0.030)	(0.053)	(0.052)
Short-term wholesale funding/TL	0.119	0.017	-0.024	0.018	-0.015	0.033	0.039	-0.426 **	0.068
	(0.290)	(0.119)	(0.152)	(0.101)	(0.153)	(0.093)	(0.047)	(0.163)	(0.112)
Non-UK deposits/TL	-0.122	-0.051	0.099	-0.033	-0.052	-0.049	-0.006	0.049	-0.148 **
	(0.156)	(0.056)	(0.087)	(0.056)	(0.073)	(0.066)	(0.031)	(0.060)	(0.072)
UK non-bank deposits/TL	-0.134	-0.112	0.128	0.005	0.016	-0.204 ***	-0.096	0.046	0.053
	(0.170)	(0.071)	(0.103)	(0.056)	(0.113)	(0.075)	(0.063)	(0.067)	(0.064)
£assets growth (08q3-09q3)	0.361	-0.037	0.137 *	-0.089	0.049	-0.098	-0.007	-0.029	0.148 ***
	(0.224)	(0.048)	(0.082)	(0.056)	(0.075)	(0.065)	(0.025)	(0.072)	(0.051)
£assets growth (08q4-09q4)	0.087	-0.094	-0.038	0.158 ***	-0.035	0.149	-0.091	0.107	-0.181 ***
	(0.249)	(0.063)	(0.089)	(0.055)	(0.083)	(0.115)	(0.066)	(0.096)	(0.063)
Const	0.403 *	0.097	-0.137	0.004	-0.115	0.051	-0.159 **	-0.324 **	0.076
	(0.240)	(0.094)	(0.119)	(0.073)	(0.195)	(0.094)	(0.059)	(0.124)	(0.105)
r2	0.227	0.324	0.278	0.109	0.044	0.127	0.445	0.286	0.194
N	89	89	89	89	49	89	49	89	89

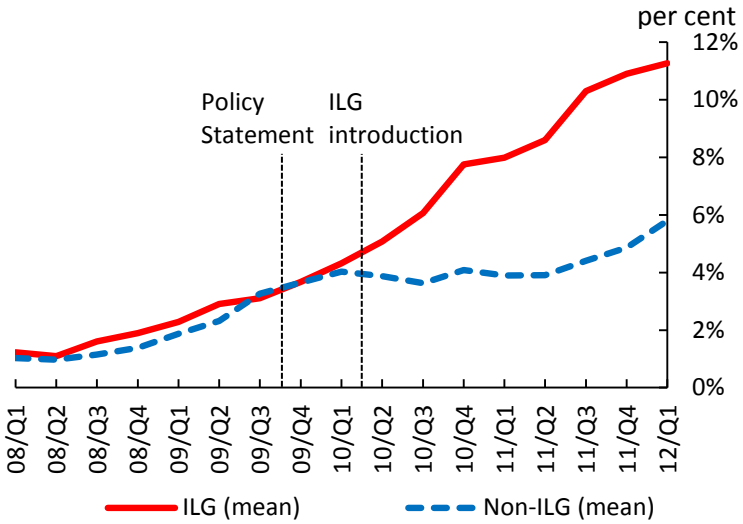
*** indicates significance at the 1% level; ** at the 5% level; * at the 10% level. Standard errors in the parentheses are the White robust standard errors. TA=total assets, TL=total liabilities.

FIGURE I Sterling liquid assets relative to total asset holdings of UK banking sector[(a)]



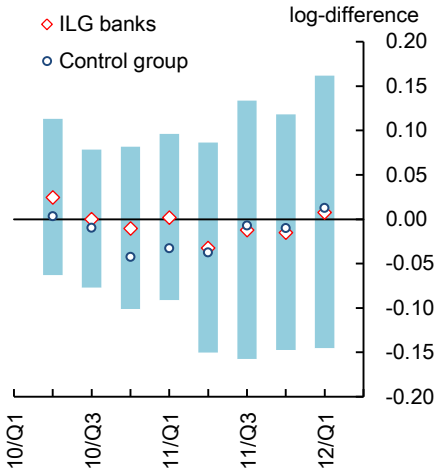
Sources: Bank of England and Bank calculations
(a) Cash + Bank of England balances + money at call + eligible bills + UK gilts

FIGURE II Sterling HQLA relative to total assets in ILG and non-ILG banks[(a)]



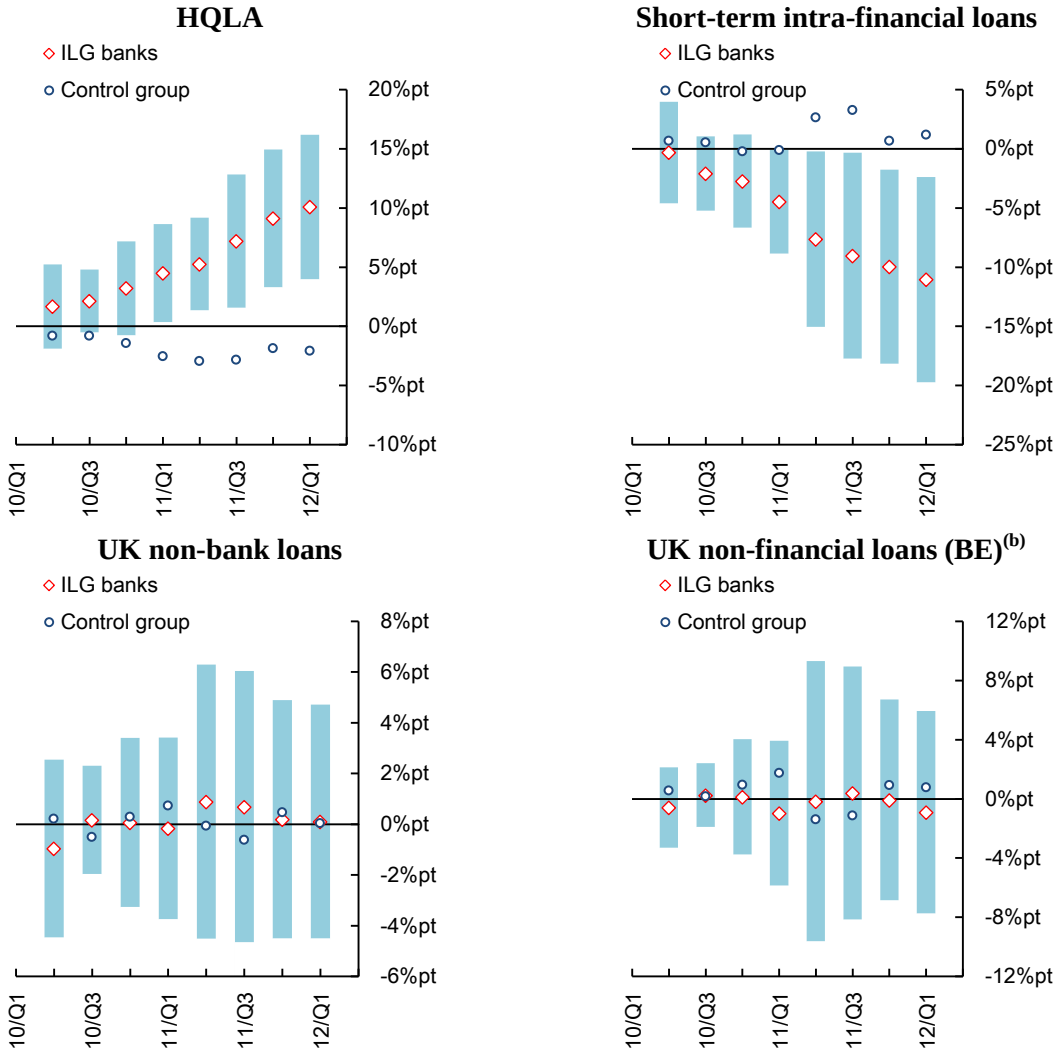
Sources: Bank of England and authors' calculations
(a) HQLA = Cash + T bills + UK gilts. See the data appendix.

FIGURE III Rolling regression results for ILG impact on log total assets[(a)]



(a) Red diamonds denote the average changes of the ILG banks from pre-ILG period to post-ILG period and blue balls denote those of the non-ILG banks. Differences between red diamonds and blue balls are the average ILG impacts and blue bars show their 95% confidence intervals. Where the blue ball falls on the blue bar, the impact is not statistically significant at the 5% level.

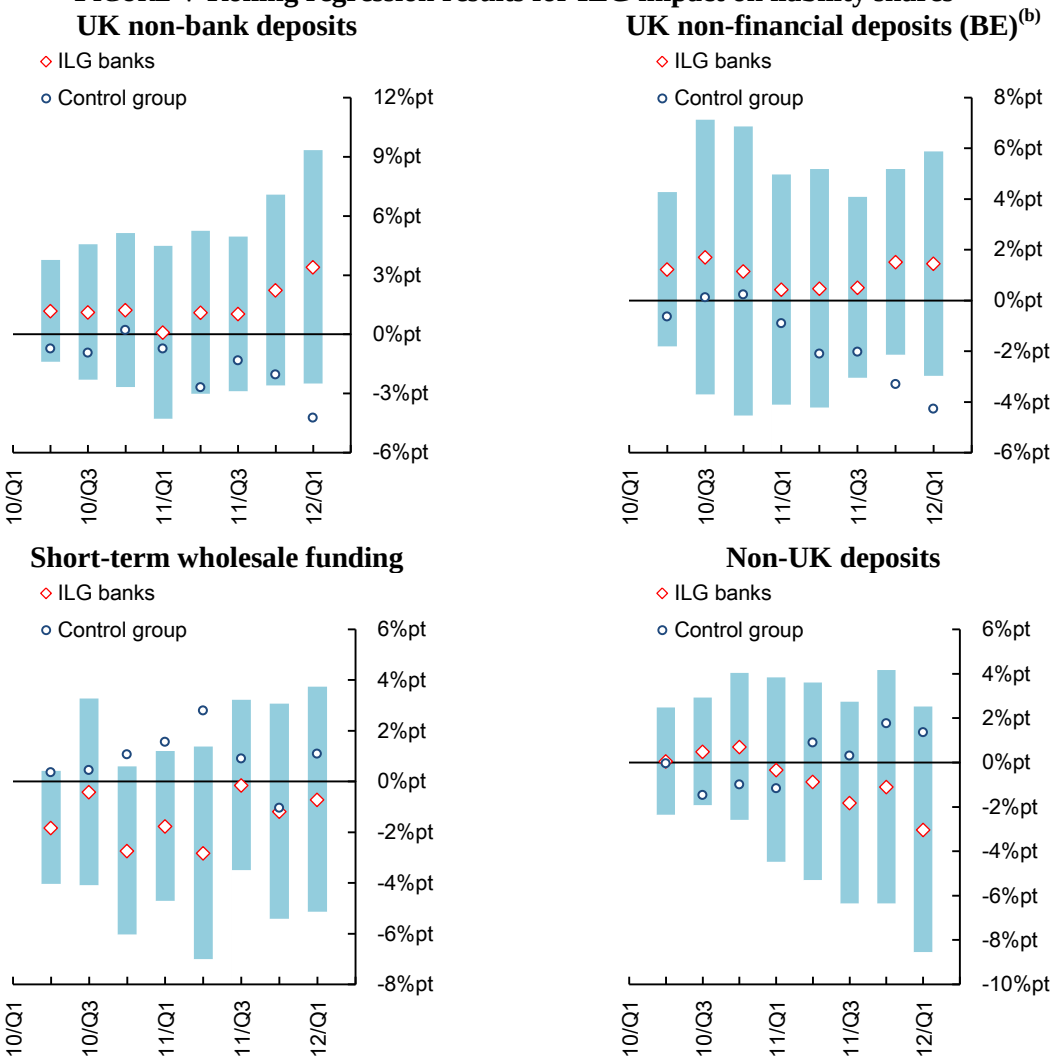
FIGURE IV Rolling regression results for ILG impact on asset shares[a]



(a) Red diamonds denote the average changes of the ILG banks from pre-ILG period to post-ILG period and blue balls denote those of the non-ILG banks. Differences between red diamonds and blue balls are the average ILG impacts and blue bars show their 95% confidence intervals. Where the blue ball falls on the blue bar, the impact is not statistically significant at the 5% level.

(b) Due to the data limitation, sample is substantially smaller and tilted to larger banks.

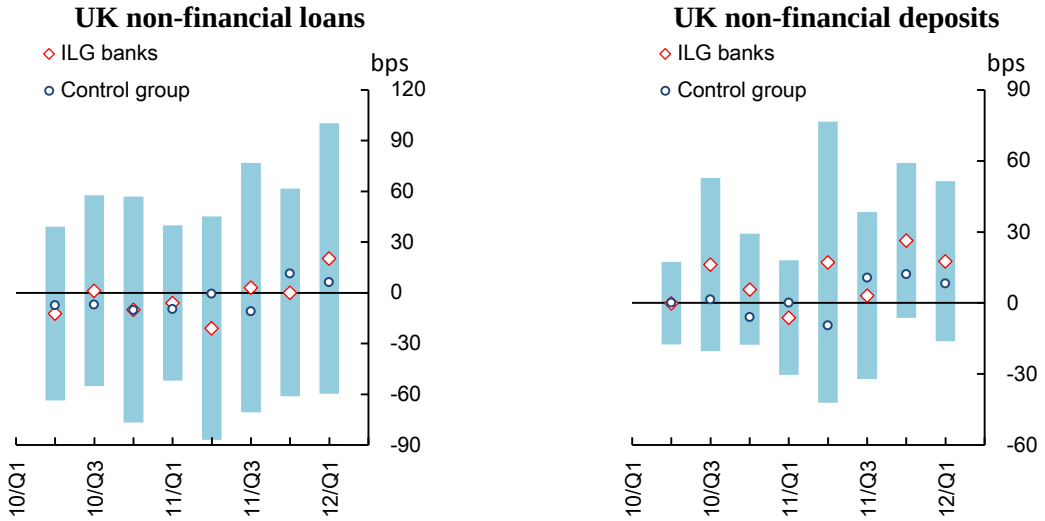
FIGURE V Rolling regression results for ILG impact on liability shares[a]



(a) Red diamonds denote the average changes of the ILG banks from pre-ILG period to post-ILG period and blue balls denote those of the non-ILG banks. Differences between red diamonds and blue balls are the average ILG impacts and blue bars show their 95% confidence intervals. Where the blue ball falls on the blue bar, the impact is not statistically significant at the 5% level.

(b) Due to the data limitation, sample is substantially smaller and tilted to larger banks.

FIGURE VI Rolling regression results for ILG impact on average interest rates[(a)]



(a) Red diamonds denote the average changes of the ILG banks from pre-ILG period to post-ILG period and blue balls denote those of the non-ILG banks. Differences between red diamonds and blue balls are the average ILG impacts and blue bars show their 95% confidence intervals. Where the blue ball falls on the blue bar, the impact is not statistically significant at the 5% level.