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Liquidity transformation, collateral assets and counterparties

Calebe de Roure and Nick McLaren

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Calebe de Roure[(1)] and Nick McLaren[(2)]

Abstract

We investigate how counterparties' characteristics, and the collateral they use, interact with their demand for liquidity in the Bank of England's (BoE) operations. Between 2010 and 2016 there was regular usage of two BoE facilities: Indexed Long-Term Repos (ILTR) and the Funding for Lending Scheme (FLS). Using BoE proprietary data, we show that participation in ILTR is not skewed towards riskier counterparties, and is instead consistent with safe counterparties using the facilities to meet their liquidity needs. Collateral assets used for FLS are less liquid, since almost all assets are loan portfolios. Riskier and larger institutions are more likely to pre-position collateral in the FLS, but these counterparties do not subsequently draw upon FLS more than others do. Overall, our study points to no systemic misincentives; rather banks react to incentives in the manner intended by the policy objectives. Our results support the view that the central bank can provide market liquidity without absorbing undue risks onto its balance sheet.

Key words: Money demand, collateral assets, counterparties.

JEL classification: E41, E58, G21, G28.

(1) Reserve Bank of Australia. Email: derourec@rba.gov.au
(2) Bank of England. Email: nick.mclaren@bankofengland.co.uk

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Bank of England, Threadneedle Street, London, EC2R 8AH
Email publications@bankofengland.co.uk

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1 Introduction

In the aftermath of the Global Financial Crisis, central banks have increased the size and scope of their lending activity, to safeguard financial stability and support the real economy. Central bank lending operations are typically secured (repo) transactions, in which the central bank sets the interest rate and the eligible collateral assets. Counterparties draw liquidity according to these conditions. Hence, the increase in central bank lending has led to greater focus on the characteristics of counterparties and their collateral assets. In this article, we address the interaction between demand for central bank liquidity, collateral assets and the characteristics of counterparties. Our aim is to understand how different liquidity facilities incentivise participation by different counterparties and their use of different collateral assets. Understanding this interaction is crucial for the design of central bank lending operations, and managing the associated risks to the central bank balance sheet.

In the United Kingdom, the Bank of England (BoE) offers liquidity insurance through a number of facilities, aimed to enhance financial stability and facilitate the transmission of monetary policy by safeguarding market liquidity. The most frequently used is the Index Long-term Repo (ILTR) facility. In addition, in 2012 in response to broadly flat output for over two years despite already extremely accommodative monetary policy, the BoE together with HM Treasury designed a facility, called the Funding for Lending Scheme (FLS) which provides term funding for banks at rates below the market, in order to boost credit provision to the real economy. In all of these facilities, BoE lending is collateralised. The BoE attaches a risk-based haircut to each collateral asset and banks can borrow up to the haircut adjusted value of their collateral. The BoE's risk management function therefore includes reviewing the credit worthiness of counterparties, valuing collateral assets and setting appropriate haircuts on these assets.[1] [2] In order to understand the relation between liquidity demand and the conditions set by the BoE on its counterparties and eligible collateral assets, we analyse whether certain types of collateral assets are disproportionally used, and whether the use the BoE's facilities is skewed towards certain types of bank characteristics. To do this, we relate counterparties' liquidity demand to their balance sheet and the collateral assets.

In this study, we find no evidence of a systematic transfer of credit risk from the private sector to the BoE. In fact, our results support the view that central banks can provide market liquidity without absorbing undue risks onto their balance sheet. Our key finding is important for the current debate within the central banking community as it shows that, when appropriate risk management is in place, central bank lending operations can be offered against a broader range of eligible collateral without detrimental effects on its balance sheet. Offering this form of liquidity and collateral transformation may help

[1] Valuation of assets is especially relevant for illiquid assets, for which there is no observable market value.

[2] In this setup, the BoE is exposed to financial risks only if *simultaneously* the counterparty defaults and the collateral asset defaults or falls in value by more than the haircut imposed.

improve liquidity in financial markets and support financial stability.

In our analysis, we divide liquidity demand into demand for the BoE's regular liquidity insurance operations (primarily the ILTR) and demand for the FLS. To this end, we use the administrative setup of the BoE as a quasi-natural experiment, where the two collateral pools have separate structures within the BoE.[3] As a result we can uniquely identify which collateral was used for each liquidity facility.[4] We use this setup to link differences in both liquidity facilities to different preference in collateral usage and counterparty type. The distinction between both liquidity facilities is important because, as explained further in Section 2, each facility provides a different form of liquidity transformation. The ILTR provides counterparties with cash (central bank reserves) for a period of 6 months. Whereas FLS provides counterparties with Treasury bills, for a term of up to four years. Thus, banks are likely to use these facilities for different purposes, and they are complements rather than substitutes.

Comparing both collateral pools, we find that the FLS pool is larger, riskier and less diversified than the liquidity insurance collateral pool.[5] This difference likely arises in part from the different fee and maturity structures of the operations (discussed in more detail in Section 2). The ILTR fee increases for less liquid collateral. FLS, on the other hand, has a flat fee structure for all collateral types, which favours the use of less liquid collateral assets. Furthermore, because the maturity of the FLS is much longer than the ILTR, counterparties have an incentive to use less liquid assets in operations with longer maturity. For both reasons, FLS incentivises use of less liquid collateral assets.

For each liquidity facility, we examine two layers of liquidity demand. The first layer is the amount of collateral deposited in the collateral pool, adjusted by the haircut. This captures a firm's action *before* their need for liquidity is identified. This haircut-adjusted value represents the maximum amount of liquidity a counterparty can subsequently draw from the BoE if required. The BoE does not charge a fee for pledging collateral, but the act of pledging collateral is not costless from a counterparty's perspective. Marketable collateral assets have the opportunity cost of not being able to be pledged elsewhere or traded, and non-marketable collateral (i.e. loan pools) assets have maintenance costs similar to those of securitisation.[6] Thus, counterparties incurring this cost do so as a form of insurance in case of a future liquidity shock and need to access BoE facilities. In other words, the size of the collateral pool reflects counterparties' expected liquidity needs and their risk aversion. We define the second layer as the actual liquidity demand which arises *after* a liquidity need is identified, i.e. it is the amount of liquidity a counterparty subsequently draws from the facility. Both layers are economically relevant because they

[3]The separation of the two collateral pools was due to technical reasons at the time. More recently, both pools have been merged.

[4]Collateral pools are accounts at the BoE, where banks deposit collateral assets before they can be used in BoE operations.

[5]Even when controlling for differences in collateral liquidity, we find that FLS collateral assets are riskier.

[6]Similar to securitisation, loans pools are special purpose vehicles normally set in form of trusts and incur structuring, servicing and legal costs.

represent different aspects of liquidity demand. The first layer reflects an evaluation of liquidity need *ex-ante* and the second is an evaluation *ex-post* of actual liquidity needs.

Analysing the two layers of liquidity insurance demand, we find that relatively healthier counterparties (with more equity and lower loan write-off rates) are more likely to have non-zero collateral pools for use in the Bank's regular liquidity facilities, such as the ILTR. Amongst those, counterparties who experienced larger deposit outflows during the quarter are more likely to draw upon the ILTR. These results are consistent with the view that safe counterparties draw on liquidity insurance when liquidity is needed, which is the policy objective. Turning to the assets used as collateral in these operations, we find counterparties prefer to use liquid collateral assets initially, but larger liquidity demands are associated with less liquid collateral pools. This result is consistent with the view that counterparties use higher quality collateral assets first, and then turn to less liquid assets only if they need to expand their collateral usage. That is what we would expect given the higher fee charged on less liquid collateral.

ILTR operations are conducted through uniform price auctions, in which all participants pay the cut-off rate. This setup should incentivize smaller and less specialized institutions to participate. The fact that we find the opposite effect, i.e., that larger institutions participate more, suggests that this self-selection is linked to counterparties' characteristics rather than the design of the central bank operations.

Analysing the demand for FLS, we find that all banks that deposit collateral in the FLS pool subsequently draw upon them, i.e., the first and second layer of liquidity demand are the same in this case. On the counterparty dimension, we find that riskier counterparties (less profitable banks with higher loan write-off rates, albeit with more equity) are more likely to participate in the FLS. However, when looking into their drawing sizes, we find that riskier counterparties do not borrow substantially more than other counterparties. Thus, we cannot infer that FLS gives incentives to relatively weaker counterparties to borrow more. On the collateral dimension, we find no evidence that the demand for FLS liquidity increases on collateral risk. In part this result is related to the fact that about 90% of the FLS collateral pool consists of collateral type C, which is already the collateral type with the highest haircut. In this sense, a further increase in collateral risk is not possible.

Our results point to a lack of self-selection of riskier counterparties in the FLS facility. This could be related to the fact that the intention of the policy was to provide funding liquidity at rates below the market. If this rate is sufficiently low all participants would participate regardless of their risk profile. Although we perform tests to understand whether self-selection happens also in periods in which market rates and FLS rate were close, the results are not conclusive due to the small sample size. Hence, we acknowledge that the lack of self-selection in FLS may have reasons beyond BoE risk management, namely the incentives from the facility design.

Despite the fact that collateral frameworks are a long established aspect of central banks' lending operations, relatively little research has been done in this area. Without addressing collateral frameworks specifically, Nyborg and Östberg (2014) show that loosening conditions in the money market affects stock market returns, order imbalances, and market liquidity. To the extent central bank liquidity lines improve money market conditions, this implies that changes in a central bank's framework (e.g. changes in eligibility or haircuts) could have real effects. In fact, Van Bekkum et al. (2017) show that lowering the eligibility threshold for RMBS in Europe led to an increase in lending activity and a reduction in interest rates in the Netherlands. Both papers highlight that central bank liquidity transformation can have real effects.

However, both Drechsler et al. (2016) and Fecht et al. (2016) argue that because of the ECB is mandated to impose similar haircuts across its member states, some member states received haircuts which were more favourable relative to market pricing, and so counterparties could systematically use those assets to access ECB liquidity on more favourable terms. Hence, central bank liquidity provision may entail an unintended transfer of risk to the central bank balance sheet. This can be avoided provided the risk management policy is designed in a manner which minimises mis-incentives in the cross section of collateral assets or counterparties. Our study complements the literature by presenting one case where risk management policies appear to have avoided mis-incentives, which suggests that enhanced central bank liquidity transformation can be welfare improving.

Our study is closely related to Fecht et al (2016). They look into similar variables in the ECB context and find evidence for a "Systemic Arbitrage", where riskier banks pledge riskier collateral assets. They argue that the ECB collateral framework does not price the correlation risk between counterparty and collateral, which would otherwise be priced in private markets. Our study considers a single-country setup and finds somewhat different results. We find no evidence for such an arbitrage opportunity in the UK context.

This study proceeds as following. In the next section, we describe the BoE liquidity facilities, its collateral framework and counterparties. In Section 3, we report our empirical findings for both the ILTR and the FLS. Section 4 concludes.

2 The Bank of England's Liquidity Facilities, Eligible Collateral and Counterparties

The BoE offers a range of liquidity facilities, each designed for different purposes. As well as the ILTR and FLS, this also includes the Contingent Term Repo Facility, Discount Window Facility, Operational Standing Facilities, and intraday liquidity for clearing banks. In this paper we focus on the FLS and ILTR, as these were the two facilities which were used regularly between 2010 and 2016. As outlined below, these are complementary facilities, since they offer different forms of liquidity transformation and have different maturities. The Contingent Term Repo Facility is an emergency liquidity facility that the BoE can activate in response to actual or prospective market-wide stress of an exceptional nature.

It has been activated only once, in the summer of 2012 during the European Debt Crisis. We do not cover the Contingent Term Repo Facility in this study because we focus on facilities which have been used routinely throughout the period.

The Discount Window Facility is a bilateral on-demand facility. It is aimed at institutions experiencing a firm-specific or market-wide shock. It allows counterparties to borrow highly liquid assets in return for less liquid collateral in potentially large size and for a variable term. The BoE publishes the amount drawn in this facility with a 5 quarter lag. No usage of this facility has been reported to date. See Bank of England (2015) for detailed description of the BoE's liquidity facilities.

Next, we describe the BoE collateral framework and its counterparties. An interesting feature of the BoE collateral framework is that, for operational reasons, collateral for FLS and ILTR operations was held in two separate pools until September 2016. This differentiation was related to the fact that the FLS program that was launched jointly with HM Treasury and intended to be temporary, whereas the ILTR is one of the BoE's permanent liquidity facilities. Both facilities accepted all types of eligible collateral (A, B, and C - type C of collateral was introduced in March 2012). In September 2016, both pools were merged into one.[7] Hence, we can use this administrative setup as a quasi-natural experiment and analyse the collateral assets used for each liquidity facility separately.

In the remainder of this section of the paper, we outline the Bank of England's liquidity facilities and present statistics for both pools, followed by its collateral framework, and lastly we describe the counterparties with access to the BoE's liquidity facilities.

2.1 The Bank of England's Collateral Framework

The BoE defines three sets of eligible collateral: Level A collateral comprises high-quality, highly liquid sovereign securities; Level B collateral comprises high-quality liquid collateral, including other sovereign, supranational, mortgage and corporate bonds; and Level C comprises less liquid securitisations, own-name securities and portfolios of loans (see Appendix for a list of those collateral assets).

Collateral assets used in operations with the BoE are held in collateral pools, which are special purpose vehicles in the form of trusts. The BoE applies a haircut, h, on the value of assets in the collateral pool, P; the haircut adjusted value of the collateral pool, V, is the maximum amount a bank can borrow.

$$V = (1 - h)P \tag{1}$$

The main tools of risk management of the BoE are assessment of counterparties' credit worthiness, collateral valuation and the haircut – supplemented with stress tests of col-

[7] What we refer to throughout the study as the liquidity insurance collateral pool or ILTR collateral pool is formally called the Single Collateral Pool within the BoE. Prior to the pools being merged, collateral assets in this pool could be used in any transaction with the BoE apart from FLS. However, during the period in question the only facilities activated were the Indexed Long-Term Repo and the Contingent Term Repo Facility. Hence, for simplicity, we refer to it as the ILTR collateral pool.

lateral adequacy. Assets that have no observable liquid market are valued internally by the BoE. Once a security is deposited at the BoE it cannot be used for other purposes in private markets (e.g. repo, security lending), even if the counterparty has no outstanding borrowing from the BoE.[8] For this reason, counterparties incur an opportunity cost when they deposit collateral assets at the BoE. Note that for regulatory purposes, when counterparties deposit collateral assets at the BoE but do not draw liquidity upon them, these assets count normally as part of counterparties' balance sheet, and so for example can be counted towards their holdings of high quality liquid assets where appropriate.

2.2 Indexed Long-Term Repos

The market-wide Indexed Long-Term Repo (ILTR) operations are aimed at banks, building societies and broker-dealers with a predictable need for liquid assets. The ILTR facility is the only permanent BoE facility that has been regularly used since its introduction and thus is the focus of our study. It is usually offered monthly in the form of a uniform price auction and funds have six month maturities.[9] Both parameters in the auction, price and rate, are flexible and depend on the offers received in the auction and the Bank's supply schedule. The rate charged in ILTR lending is indexed to the BoE's policy rate. Banks bid by submitting a nominal amount and a spread to the policy rate, expressed in basis points against a specific collateral set (A, B or C). The minimum bid size is £5 Mn, and the minimum spread for borrowing using collateral type A is 0 bps, B is 5 bps, and C 15 bps. Therefore borrowing against less liquid collateral assets is more expensive. Borrowers receive sterling cash and settlement is t+2.

To understand the usage of BoE facilities as a form of liquidity insurance, we analyse both banks' use of the ILTR collateral pool and their actual ILTR drawings, in the period from 2010Q1 to 2016Q3. In the BoE, collateral assets are divided in 52 categories, which each fall within three broad classification groups: collateral type A, B or C. Haircuts are set according to the granular collateral categories. We obtained proprietary data on each counterparty's ILTR collateral pool, with the amount held of each category and the haircut applied to each one of the 52 categories. We use the haircut as an indicator of the riskiness of the collateral pool.[10] From the 52 categories the BoE use internally, we calculate the Herfindal index. This index takes values between 0 and 1 and indicates how concentrated the collateral pool is.

We analyse banks' demand for ILTR liquidity in two layers. First, the size of the collateral pool is measured as the haircut adjusted value of pledged collateral assets divided by total assets, $\frac{\sum(1-h_i)\text{pledged}_{ib}}{\text{TA}_b}$, where h_i is the haircut on collateral type i, pledged_{ib} is

[8]Although the BoE does not charge a fee for pledging collateral, it is therefore not a costless action. Even assets that have no use in secondary markets as unsecuritised loans are costly to pledge, as banks have legal and auditing costs similar to securitisations.

[9]Around the EU Referendum vote, between June and September 2016, auctions were weekly. Weekly auctions were introduced again in 2019 as a precautionary step ahead of the UK's potential withdrawal from the EU.

[10]Here, we refer to default and liquidity risk.

the amount of collateral pledged by bank b of collateral type i, and TA_b is bank's b total assets. Second, we analyse banks actual drawing of ILTR liquidity as share of total assets, $\frac{\text{drawing}_b}{\text{TA}_b}$, where drawing_b is the total liquidity amount bank b draws from the BoE.

Table 1 presents the descriptive statistics for the ILTR collateral pool and ILTR liquidity uptake. The mean size of banks' ILTR collateral pool is 2.32% of their total assets and banks draw on average 0.81%. The ILTR pool average haircut is 11.33%, and its Herfindal index is 78.5.

Table 1: **Descriptive statistics for ILTR collateral pool variables.** Quarterly data by bank. Values presented in the table reflect the collateral pool values in auction settlement dates (t+2). *Drawing/TA* is the amount a given bank draws upon ILTR as share of its balance sheet, *Size/TA* is the haircut adjusted value of collaterals over total assets, *Haircut* is the haircut applied on the complete collateral pool of a given bank, HHI is the collateral pool Herfindal index, which gives how concentrated a collateral pool of a given bank is. Period 2010Q1-2016Q3. Source: Bank of England.

ILTR Collateral Pool	Mean	Std. Error	1pcl	25pcl	50pcl	75pcl	99pcl	# Obs
Drawing/TA (%)	0.81	1.32	0.00	0.04	0.22	1.01	6.05	358
Size/TA (%)	2.32	5.20	0.00	0.09	0.40	2.20	20.04	703
Haircut (%)	11.33	11.01	0.49	2.58	7.59	18.00	45.66	703
HHI (%)	78.51	26.08	25.24	53.04	99.75	100	100	703

2.3 The Funding for Lending Scheme

The Funding for Lending Scheme (FLS) was launched over the summer of 2012 by the Bank of England and HM Treasury. It is designed to incentivise banks and building societies to boost their lending to UK households and businesses. Specifically, banks and building societies are offered funding conditional on their lending activity. Both the maximum allowance and the interest rate depend on the amount counterparties lend to the real economy. By reducing funding costs, the FLS was intended to boost the supply of credit flowing into the real economy. In November 2013, in light of improvements in market conditions for mortgages and other consumer credit, these forms of lending were no longer counted towards FLS drawing limits. Similarly, when the BoE announced in late 2014 that the FLS program would remain in place until 2016 (and then subsequently extended until January 2018), it also announced that only lending to small and medium sized enterprises would be eligible, given the improved market borrowing conditions for large firms.

Although the total amount of funding available through the FLS is limited by counterparties' lending allowance, it is accessible every business day and borrowers receive Treasury bills on the same day ("t+0"). Funding is provided at rates below market rates and for an extended period (up to 4 years maturity).[11] The fee is flat at 0.25% for all types of collateral.[12] FLS has no minimum borrowing amount. In contrast to the liquidity insurance facilities, FLS provides Treasury bills rather than central bank reserves. Hence, if BoE counterparties need cash, they must engage in a further transaction exchanging these Treasury bills for cash.[13]

Table 2 presents the collateral variables for the FLS pool. The mean size of the FLS pool is 6.43% of the counterparty's balance sheet and the mean drawing size is 4.24%. Counterparties seem to have a preference to overcollateralization, probably to avoid needing to provide additional collateral in the case of margin calls.[14] For both layers of liquidity demand, the FLS pool is substantially larger than the ILTR pool. Also, the haircut level is very different. The average haircut is 27.87%. FLS is not only larger and riskier, it is also more concentrated in type of assets, and its Herfindal index is 89.6.

Table 2: **Descriptive statistics for FLS collateral pool variables.** Quarterly data by bank. Values presented in the table reflect the collateral pool values in auction settlement dates (t+2). *Drawing/TA* is the amount a given bank draws upon ILTR as share of its balance sheet, *Size/TA* is the haircut adjusted value of collaterals over total assets, *Haircut* is the haircut applied on the complete collateral pool of a given bank, HHI is the collateral pool Herfindal index, which gives how concentrated a collateral pool of a given bank is. Period 2010Q1-2016Q3. Source: Bank of England.

FLS Collateral Pool	Mean	Std. Error	1pcl	25pcl	50pcl	75pcl	99pcl	# Obs
Drawing/TA (%)	4.24	3.25	0.01	1.83	3.68	5.74	13.43	528
Size/TA (%)	6.43	4.26	0.05	3.05	5.99	8.91	17.64	528
Haircut (%)	27.87	10.90	4.64	20.46	26.97	35.93	51.66	528
HHI (%)	89.62	18.17	37.23	85.94	100	100	100	528

In order to formalize the comparison of the haircut level across the collateral pools, we look specifically at observations where a given bank has collateral assets deposited in both pools simultaneously (204 observations). This avoids the results being driven by banks self-selecting themselves into one of the pools for different reasons. We run a simple t-test of whether the haircut of the FLS pool and the haircut of the ILTR collateral pool are

[11] In contrast to the ILTR where early repayment is not possible, for the FLS borrowers do not have to wait to maturity to unwind the transaction.

[12] Given the different maturity of the borrowing, it is not appropriate to directly compare the cost of the ILTR and the FLS. Nonetheless, it should be noted that for borrowing for a 6 month period, the FLS would be strictly more expensive than the ILTR (if allocated at the minimum spreads). Consider a repo using T-bills as collateral where banks apply zero haircut and zero counterparty risk added, the interest rate of such transaction would be Bank Rate, 0.75% as of January 2017. To consider the full cost of FLS borrowing we would add this value to the FLS fee of 0.25pp, which adds up to 1.0%. ILTR costs Bank Rate plus the collateral spread of 0.15pp, which currently totals 0.9% in the case of collateral type C.

[13] In fact, the BoE's sterling operations desk reported that some counterparties engaged in both the FLS and ILTR operations simultaneously to complete their liquidity transformation needs.

[14] This may also reflect the fact that for groups of loans within a firm's collateral pool, they are required to encumber the entire group of loans, even if borrowing only a portion of this value.

different, where H_0: mean(diff) = 0 and $H_1 > 0$, and diff=haircut$_{FLS}$−haircut$_{SCP}$. The t-value is 14.3. In other words, the mean of the FLS pool haircut is significantly higher than the mean of the ILTR pool haircut at the 1% confidence level. Thus, we conclude that the FLS pool has higher haircuts than the ILTR pool i.e. on average it includes less liquid, riskier assets.

In order to narrow down the relative risk incentives of both collateral pools further, we compare the haircut of the subset of collateral assets that belong only to the collateral type C. Since most assets used as collateral in category C are unsecuritised loan portfolios, this comparison tests if counterparties have a preference to systematically deposit loans with certain risk characteristics in different pools. As before H_0: mean(diff) = 0 and $H_1 > 0$, and diff=haircut$_{FLS}$−haircut$_{SCP}$. The t-value is 8.14. Thus, we conclude that not only are the assets in the FLS pool typically riskier than those in the ILTR pool, but also even within the type C collateral used, counterparties prefer to use less liquid collateral in the FLS.[15]

2.4 The Dynamics of Liquidity Facilities

In order to understand the relative importance of both liquidity facilities over time, we present *Figure 1* showing the liquidity uptake of each facility over time.

The ILTR was widely used from its introduction until the beginning of 2012 when bids and the amounts allocated dropped substantially. Its usage picked up again between February 2016 and July 2016. The CTRF was activated once, during the European Debt Crisis, and used by a handful of banks. The FLS was announced in July 2012. FLS usage increased relatively quickly and then decreased towards the end of the observation window, when another facility was created with a similar operational setup: the Term Funding Scheme. The Term Funding Scheme was designed to reinforce the transmission of the policy rate cuts to those interest rates actually faced by households and businesses by providing term funding to banks at rates close to Bank Rate (Bank of England (2016)).[16]

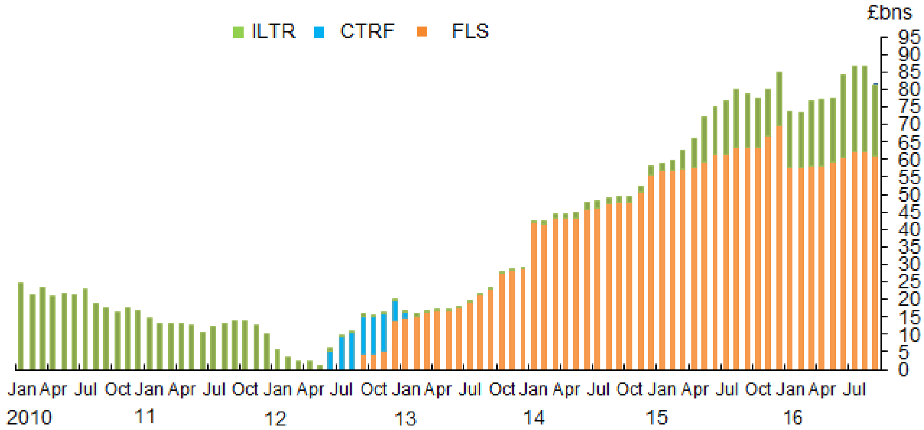
2.5 The Bank of England's Counterparties

Of the 189 Sterling Monetary Framework participants (as of January 2017) which includes participants eligible to participate in the ILTR, 136 are eligible to participate in the Discount Window Facility and thus eligible to register as counterparties in the FLS. Since the analysis uses information on counterparties' balance sheets, we exclude from the sample CCPs and broker-dealers because their balance sheets are structured substantially differently from commercial banks. Thus, we are left with 128 counterparties. In this group there are: 38 building societies, 32 branches of foreign banks and 58 UK licensed

[15] Note that, in this context, this captures both default risk and also duration risk. Counterparties may prefer to pledge loans with longer maturity in the FLS because its maturity is longer.

[16] We do not cover Term Funding Scheme in this study because its introduction was at the end of our observation window (2010Q1-2016Q3).

Figure 1: **Bank of England's Liquidity Provision.** Y-Axis represents outstanding amounts in billion £. ILTR: Indexed Long Term Repo, CTRF: Contingent Term Repo Facility, FLS: Funding for Lending. Source: Bank of England (2016).



banks (including subsidiaries of foreign banks).

From the Prudential Regulation Authority, we obtained quarterly balance sheet data for 88 banks (50 UK banks and 38 building societies). From the data provider SNL Financial, we obtained data for 18 banks (17 branches of foreign banks and 1 UK bank), mainly in quarterly format. 4 banks have only annual data available, which is therefore interpolated into quarterly frequency. Bank groups with more than one active UK bank license are aggregated into one entity (four cases). Thus, we obtained data on 106 banks (unbalanced panel, missing data for some quarters for some banks) and after accounting for aggregations this leaves a sample of 102 banks.

We follow Fecht et al. (2011) in the use of counterparty variables. To represent counterparties' size we use total asset defined as '000 £ and used in logs in the estimations. To represent counterparties' profitability we use return on equity (profitability), $ROE_b = \frac{\text{return}_b}{\text{equity}_b}$, where return is counterparties' earnings in a given quarter and equity refers to counterparties' total equity capital in that same quarter.[17] We capture counterparties' liquidity needs using customers deposit flow,$\Delta D_b = \frac{deposit_b}{TA_b}$, which is the change in deposits over total assets in a given quarter. To represent counterparties' credit worthiness we use the equity ratio, $ER_b = \frac{\text{equity}}{TA_b}$, which is banks' equity capital over total assets. Lastly, we estimate counterparties' riskiness using the proportion of a bank's loan portfolio they expect to write-off due to defaults, $WR_b = \frac{\text{writeoff}_b}{\text{outstanding lending}_b}$.[18]

Table 3 presents the summary statistics for the counterparty balance sheet variables. The sample is populated by several small and mid-sized counterparties and a few very large ones, which can be seen by the difference between the median and mean of counterparties'

[17]Equity is owners' residual that is paid after all the claims have been paid and would include the paid in capital raised through stocks, retained earnings and other equity related adjustments. This information is reported by the companies in their balance sheet.

[18]Write-offs are provisions banks need to write off their balance sheets when they expect a loan to default, normally when payments are overdue by more than 90 days .

Table 3: **Descriptive Statistics Bank Variables.** Total Assets (TA) is a measure of banks' size and defined in '000 £, return on equity (ROE) is a measure of banks' profitability and defined as $ROE_b = \frac{\text{return}_b}{\text{equity}_b}$, equity ratio (ER) is a measure of bank's soundness and is defined as banks' equity capital over total assets, $ER_b = \frac{\text{equity}}{TA_b}$, write-offs (WR) is a measure of bank's risk and is defined as provisions banks need to write off their balance sheets when they expect a loan to default, normally when payments are overdue by more than 90 days, $WR_b = \frac{\text{writeoff}_b}{\text{outstanding lending}_b}$. Δ Deposit(ΔD) is a measure of counterparties' liquidity defined as the change in customer's deposits over total assets, $\Delta D_b = \frac{deposit_b}{TA_b}$. Period 2010Q1-2016Q3. Source: PRA and SNL.

	Mean	Std. Error	1pcl	25pcl	50pcl	75pcl	99pcl	# obs
Total Assets	1.88×10^8	4.07×10^9	120,574	556,977	3,065,500	9.36×10^7	1.68×10^9	2,711
ROE (%)	0.56	8.54	-22.73	0.24	1.14	2.44	10.36	2,706
Eq. Ratio (%)	7.66	5.12	1.50	4.92	6.84	8.86	22.47	2,711
Write-off(%)	0.33	0.79	-0.12	0.007	0.06	0.27	4.40	2,697
ΔDeposit(%)	0.96	8.68	-8.81	-0.55	0.48	2.04	17.11	2,606

size. Return on equity is on average 0.56%. The mean bank receives inflows of deposits of about 1% of its total assets every quarter. The mean equity ratio is almost 8% and write-offs 0.33%.

3 Empirical Evaluation

In this section, we relate counterparty and collateral characteristics to central bank liquidity demand. Our objective is to understand whether there are systemic incentives favouring some counterparties over others, or incentives to use some collateral assets over others. The administrative setup of the BoE collateral pools during this period allows us to relate different liquidity facilities (i.e. ILTR and FLS) to collateral characteristics, and allows us to understand how different policy designs can affect counterparties' behaviour.

Our set of regressions is divided in three parts. First, we estimate the probability that a counterparty has a non-zero collateral pool, i.e. it actively participates in the BoE collateral framework, the first layer of liquidity demand (Section 3.1). Second, we investigate the probability that a counterparty draws liquidity from the BoE given that it has a non-zero collateral pool, the second layer of liquidity demand (Section 3.2). Third, we condition the sample on counterparties participating in the collateral framework and analyse what incentivises counterparties to increase the size of their collateral pool and the amount of liquidity subsequently drawn (Section 3.3). The estimations are performed twice, for ILTR and for FLS. Note that although we compare the results for ILTR and FLS, we expect there to be differences due to their different policy objectives.

Both the first and second parts focus on the binary choice for demand liquidity. To do this we use a logit model to estimate the probability that banks will demand liquidity. The logit model is estimated both with and without fixed effects, using jack-knife correction as proposed by Fernandez-Val and Weidner (2016), in the time and bank dimensions. The third part investigates how much liquidity banks demand as a share of their balance sheet. Using a panel data model, estimated with OLS. In all estimations, standard errors are clustered by counterparty.

3.1 The Choice to Deposit Collateral

Our left-hand side variable, in this section, is a dummy variable that takes the value one if banks deposit collateral assets in their BoE account and zero otherwise. To put the magnitude of our results in context, the unconditional probability of participation, i.e. the average value of our dummy, is 22% for the ILTR collateral pool and 18% for the FLS collateral pool.

ILTR pool

Table 4 presents the result for the probability model related to whether counterparties deposit collateral in the ILTR pool and in the FLS pool. The left-hand variable is a dummy that takes the value one if a bank has a non-zero collateral pool and zero otherwise. The explanatory variables are the bank characteristic variables previously described. Collateral variables are not present in this estimation because they are defined only for non-zero pools. Each estimation is presented in two forms: with and without fixed effects. We focus on the results with fixed-effects because they control for all other time invariant banks' characteristics. The results without fixed-effects are presented to demonstrate the robustness of the key findings.

In *Table 4*, the fourth column (AME Participation) gives the average marginal effect for our preferred specification: an estimation using fixed effects in the counterparty and time dimensions. Log total assets is positively related to the size of the collateral pool with significance at the 1% level: an increase in size of one standard error (SE) would result in a 2.6% increase in the probability of depositing collateral assets in ILTR pool. An increase in return on equity by one SE relates to a decrease in the probability of participation -0.04%. A one SE increase in the equity ratio relates to a 0.5% higher probability of having a non-zero collateral pool.

Table 4: **Probability that the Collateral Pool is Non-zero.** This table relates banks characteristics to the decision to deposit collateral assets at the BoE. Left-hand variable is a dummy that takes the value one if a bank has a non-zero collateral pool and zero otherwise. TA: log total assets, ROE: return on equity, ER: equity ratio, WR: write-off, and ΔD change in deposits. Estimation is a logit model and fixed effects refer to jackknife correction as proposed by Fernández-Val and Weidner (2016). Standard errors are clustered at the bank dimension.

	ILTR Collateral Pool				FLS Collateral Pool			
	w/o Fixed Effects		Fixed Effects		w/o Fixed Effects		Fixed Effects	
	Coef. Participation	AME Participation	Coef. Participation	AME Participation	Coef. Participation	AME Participation	Coef. Participation	AME Participation
$\log(TA_{t-1})$	0.93***	0.93***	4.12***	0.27***	0.53**	0.53**	-2,408.45***	0.94***
	(0.11)	(0.11)	(0.58)	(0.04)	(0.21)	(0.21)	(2.12)	(0.32)
ROE_{t-1}	-0.00	-0.00	-0.10***	-0.005***	-0.00	-0.00	30.98***	-0.01***
	(0.01)	(0.01)	(0.01)	(0.00)	(0.02)	(0.02)	(0.05)	(0.00)
ER_{t-1}	0.72***	0 .72***	3.08***	0.15***	0.62***	0.62***	-1,569.12***	0.03*
	(0.16)	(0.16)	(0.18)	(0.01)	(0.23)	(0.23)	(0.47)	(0.02)
ER^2_{t-1}	-0.03***	-0.03***	-0.14***	-0.01***	-0.02**	-0.02**	74.64***	-0.00
	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)	(0.02)	(0.00)
WR_{t-1}	-0.98***	-0.98***	-2.45***	-0.13***	-0.32	-0.32	462.42***	-0.00
	(0.25)	(0.25)	(0.33)	(0.01)	(0.42)	(0.42)	(0.75)	(0.02)
ΔD_t	0.33	0.33	3.85***	0.15***	0.007	0.007	-10.39***	0.007**
	(0.69)	(0.69)	(0.60)	(0.03)	(0.02)	(0.02)	(0.05)	(0.003)
Bank FE	No	No	Yes	Yes	No	No	Yes	Yes
Time FE	No	No	Yes	Yes	No	No	Yes	Yes
Pseudo R^2	0.15	0.15	0.61	0.61	0.02	0.02	0.42	0.42
Obs	2506	2506	1707	1707	1527	1527	655	655
# Banks	101	101	68	68	101	101	39	39

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Write-off is our measure of banks' riskiness. A one SE increase in loan book write-offs are related to a 0.1% lower chance of participation. This result remains significant if we substitute write-offs with other measures of risk, such as the leverage ratio or implied CDS.[19] Lastly, high deposit inflow is associated with greater likelihood of participation: a one SE increase in deposits leads to a 1.3% higher probability of participation in the ILTR pool.

In summary, the results for the ILTR pool show that larger banks with more equity, lower write-offs and greater deposit inflow (albeit with lower profitability) are more likely to participate in the BoE collateral framework. In other words, Table 4 paints a picture of safe banks participating in the liquidity insurance scheme. The fact that ILTR is a uniform price auction should incentivize smaller banks to participate as it avoids winner's curse problems. Nevertheless our findings suggest that larger banks use the facility proportionally more. This suggests that it is not the facility design that incentivizes participation but banks' characteristics.

FLS Pool

Table 4 suggests a different picture for FLS than for ILTR. In its last column, we show the average marginal effect for our preferred specification for FLS liquidity demand. An increase of one SE in log total assets is associated with an increase of 9% in the probability that a bank participates in the FLS pool. A decrease in the return on equity by one SE relates to a decrease in the participation probability of -0.09%. A one SE increase in equity relates to a 0.15% higher probability of having a non-zero collateral pool. A one SE increase in deposits corresponds to a 0.06% higher probability of participation in the FLS pool.

In summary, larger counterparties, which are less profitable, with more equity, and greater deposit inflow are more likely to participate. The main difference between the results for the ILTR and the FLS is the counterparty risk variable, which is not significant for the FLS. This suggests that, in contrast to the ILTR pool, participation in the FLS pool is not negatively related to counterparties' write-off rate.

Our results in this section suggest that the only characteristic that has a different role in determining which counterparties participate in the ILTR and FLS pools, is counterparties' riskiness. Whereas in the ILTR pool there is a self-selection of relatively healthier counterparties, no self-selection of this type appears to happen in the FLS pool.

There are several differences in the design of the liquidity facilities that could lead to different incentives to deposit collateral in the pool. First, the maturity of FLS is up to 4 years whereas the ILTR is 6 months. Second, the ILTR delivers central bank reserves whereas FLS delivers T-bills, implying that an FLS counterparty needs to engage in a further repurchase agreement to transform its T-bills into cash. Third, the ILTR is

[19] As an alternative specification we estimated all regressions provided in this study using both the leverage ratio and implied 5 year CDS provided by Bloomberg.

allocated through an auction process, whereas the FLS can be drawn in a non-competitive manner, as long as the counterparty has not reached its FLS borrowing limit. As discussed in the next section, only a subset of counterparties actually draw liquidity in the ILTR using the collateral they have deposited. Therefore, on the margin, banks (particularly smaller entities) might prefer to avoid any perceived costs involved in developing the capability and expertise to participate in the ILTR auctions. Fourth, the ILTR auction usually takes place once a month and delivery is t+2, whereas FLS can be drawn upon every day with same day delivery.

3.2 The Choice to Draw Liquidity

In this section, we examine to what extent counterparties with a non-zero collateral pool actually draw upon it. In the ILTR pool, 56% of the non-zero pools observations actually draw liquidity in the ILTR. The large share of deposits without withdrawals reflects the main purpose of this facility: insurance against unexpected liquidity needs. In contrast, 99% of all observations with a non-zero FLS pool do actually draw upon them.[20] In other words, the two layers of liquidity demand are the same for the FLS. Since drawing from the FLS is effectively deterministic given participation in the FLS pool, we focus only on the ILTR pool in this section.

We restrict the dataset to retain only observations for which counterparties have a non-zero ILTR pool. We estimate a logit model, where the left-hand side variable is a dummy that takes the value one if, in a given month, the counterparty draws upon the ILTR and zero otherwise. In this set of estimations we can relate liquidity demand, counterparties *and* collateral assets, since the estimations are conditional on non-zero collateral pools.

Table 5 presents the results. The last column presents the average marginal effect for our preferred specification of the logit estimation, using fixed effects in the counterparty and time dimension. One SE higher haircut is linked to a -0.11% ($= -0.01$*11.01, i.e. estimated coefficient in *Table 5* multiplied by its SE presented in *Table 1*) lower probability of drawing on liquidity in the ILTR. Similarly, a one SE higher Herfindahl index is related to a -0.26% lower probability of drawing liquidity in the ILTR. One SE increase in log total assets is associated with an increase of 52% in the probability that a counterparty draws liquidity.[21] A one SE higher equity ratio relates to a 0.26% ($= -1.53^{*}5.12 + 0.11^{*}(5.12)^2$, i.e. estimated coefficients in *Table 5* multiplied by its SE presented in *Table 3*) higher probability of drawing liquidity. A one SE increase in deposits corresponds to a -0.26% probability of drawing on the ILTR. In summary, larger counterparties with more equity and less liquidity, using less risky and more diversified collateral pools, are more likely to

[20]This is expected since there is no reason to deposit collateral in the FLS pool, unless the counterparty intends to use the scheme. The 1% difference is due to a lag between collateral deposit and funds withdraw.

[21]Due to the restricted sample size for this particular estimation, the coefficient of total assets may be somewhat overestimated. So we do not place a lot of weight on the precise magnitude of this estimate. Consistent with that, the size of the effect is much smaller for the estimation without fixed effects presented in the same table.

draw upon the ILTR.

Table 5: **Probability of Drawing upon ILTR, conditional on non-zero collateral pool.** Estimation conditional on Collateral/TA>0. Haircut: haircut, HHI: Herfindahl Index for collateral concentration, TA: log total assets, ROE: return on equity, ER: equity ratio, WR: write-off, and ΔD change in deposits. Estimation is a logit model and fixed effects refer to jackknife correction as proposed by Fernández-Val and Weidner (2016). Standard errors are clustered at the bank dimension.

	w/o Fixed Effects		Fixed Effects	
	Coef. Drawing	AME Drawing	Coef. Drawing	AME Drawing
Haircut_t	-0.04**	-0.04**	-5.27***	-0.01***
	(0.02)	(0.02)	(0.03)	(0.00)
HHI_t	-0.05***	-0.05***	25.13***	-0.01***
	(0.01)	(0.01)	(0.02)	(0.00)
$\log(\text{TA}_{t-1})$	0.75**	0.75**	-3,067.3***	5.54***
	(0.31)	(0.31)	(3.20)	(0.25)
ROE_{t-1}	-0.01	-0.01	-151.8***	-0.00
	(0.04)	(0.04)	(0.77)	(0.00)
ER_{t-1}	-1.53***	-1.53***	-1,203.12***	0.64***
	(0.51)	(0.51)	(1.37)	(0.05)
ER^2_{t-1}	0.11***	0.11***	37.31***	-0.01**
	(0.03)	(0.03)	(0.09)	(0.00)
WR_{t-1}	1.91**	1.91**	-2,834.2***	-0.20
	(0.94)	(0.94)	(2.73)	(0.17)
ΔD_t	0.13	0.13	-43.21***	-0.03***
	(0.08)	(0.08)	(0.12)	(0.00)
Bank FE	No	No	Yes	Yes
Time FE	No	No	Yes	Yes
Pseudo R^2	0.41	0.41	0.64	0.64
Obs	577	577	239	239
# Banks	64	64	17	17

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Combining the results from the first layer of ILTR demand with these ones paints the picture of healthy counterparties with reduced liquidity (coming from deposit outflows) drawing upon the liquidity insurance. The fact that collateral risk (haircut) is negatively related to the probability of drawing upon the liquidity insurance, suggests that using collateral type A is preferable to types B and C, i.e. banks prefer to use safer collateral assets if possible. This result is likely to be linked to the fee structure of the ILTR operation. Using collateral assets type B, banks have to pay a 5bps higher fee than for collateral type A. Using collateral assets type C, banks have to pay a 15bps higher fee than collateral type A. This fee structure appears to be steep enough to give banks incentives to use collateral type A in the first instance.

3.3 The Size of the Collateral Pool and Drawing Amounts

In this section, we investigate the variables influencing the size of the liquidity demand. The dependent variables, collateral/TA and drawing/TA, are the pool size over total asset and drawing amount over total assets. The collateral pool size is calculated taking into account the haircut adjustment. In this form, we capture the actual borrowing capacity of each counterparty, scaled by its size, which is the first layer of liquidity demand. The drawing amount captures the realised liquidity need of each counterparty and so represents the second layer of liquidity demand. The estimations are performed using ordinary least squares with fixed effects in the bank and time dimensions. Standard errors are clustered at the bank dimension.

ILTR Pool

Table 6 presents the results for the ILTR pool. The three columns on the left represent the first layer of liquidity demand and the three on the right the second layer. As before, we focus our interpretation on the columns with time and counterparty fixed effects.

For the first layer (collateral/TA), we find that no counterparty characteristic is a statistically significant explanatory variable of liquidity demand. Conversely, when looking at collateral characteristics, we find that both variables are significant: pool size and amount drawn are positively related to collateral risk. A one SE larger haircut is associated with a 0.44% larger collateral pool. A one SE larger haircut is related to 0.11% larger liquidity drawing. Larger collateral pools are more diversified, but larger liquidity drawings are not related to more diversified collateral pools. A one SE increase in the Herfindal index relates to 0.01% larger collateral pool.

For the second layer (drawing/TA), the only significant variable is haircut. A one SE larger haircut is associated with a 0.11% larger drawing. That is, larger ILTR drawing use collateral with higher haircuts.

Our results suggest that larger collateral pools (the first layer of liquidity demand) tend to be more diversified pools with higher haircuts, i.e., on average they include less liquid collateral assets. This result is consistent with the view that banks first pledge more liquid collateral assets, and then as they increase their use of the BoE's liquidity insurance, they use less liquid assets.

FLS Pool

Table 7 shows the results for the FLS pool. As before we focus our interpretation on the columns with time and counterparty fixed effects. More diversified pools are associated with smaller collateral pools (1.1 times smaller for a one SE increase in the Herfindahl

Table 6: **Size of ILTR Liquidity Demand.** This table relates the size of liquidity demand to characteristics banks and collateral characteristics. Estimations (I)-(III) represent the first layer of liquidity demand, the size of the collateral pool. Estimations (IV)-(VI) represent the second layer of liquidity demand, the amount of liquidity draw upon. Haircut: haircut, HHI: Herfindahl Index for collateral concentration, TA: log total assets, ROE: return on equity, ER: equity ratio, WR: write-off, and ΔD change in deposits. OLS panel data estimation using fixed-effects. Standard errors are clustered at the bank dimension.

	(I) Collateral/TA	(II) Collateral/TA	(III) Collateral/TA	(IV) Drawing/TA	(V) Drawing/TA	(VI) Drawing/TA
Haircut_t	0.05***	0.05**	0.04**	0.02**	0.02*	0.01*
	(0.02)	(0.02)	(0.02)	(0.00)	(0.00)	(0.00)
HHI_t	-0.05***	-0.04**	-0.04**	-0.01*	-0.01*	-0.00
	(0.02)	(0.02)	(0.02)	(0.00)	(0.00)	(0.00)
$\log(\text{TA}_{t-1})$	-0.49***	4.74*	2.40	-0.02***	0.14	0.03
	(0.10)	(2.39)	(1.62)	(0.00)	(0.09)	(0.08)
ROE_{t-1}	-0.01	0.01	0.02	-0.00	-0.00	0.00
	(0.01)	(0.03)	(0.02)	(0.00)	(0.00)	(0.00)
ER_{t-1}	0.47**	0.73	-0.23	0.21	0.34	-0.19
	(0.24)	(0.44)	(0.89)	(0.02)	(0.02)	(0.02)
ER^2_{t-1}	-0.03***	-0.02	0.01	-0.01**	-0.00	-0.00
	(0.01)	(0.02)	(0.03)	(0.00)	(0.00)	(0.00)
WR_{t-1}	-0.59**	-0.32	0.02	-0.04	0.27	0.24
	(0.25)	(0.28)	(0.25)	(0.00)	(0.02)	(0.2)
ΔD_t	0.10	0.05	0.02	0.00	0.00	-0.00
	(0.07)	(0.07)	(0.07)	(0.00)	(0.00)	(0.00)
Bank FE	No	Yes	Yes	No	Yes	Yes
Time FE	No	No	Yes	No	No	Yes
Adjusted R^2	0.273	0.427	0.478	0.250	0.623	0.658
Observations	633	616	616	353	352	352

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

index), and less FLS uptake (0.55 times smaller for a one SE increase in the Herfindahl index). Counterparties with one SE larger total assets have a pool size 26 times larger than the mean counterparty. But drawings are not significantly larger for larger counterparties. Similarly, counterparties with one SE higher equity ratio have 6.3 times larger collateral pools, but drawings are not significantly different. Counterparties with loans write-offs one SE higher also have 0.74 times larger collateral pools, although again drawings are not significantly larger for those counterparties. In summary, larger counterparties, with more equity and higher write-offs, using more diversified collateral portfolio, tend to have larger collateral pools. Larger FLS drawings are associated with less diversified collateral pools, but are not significantly related to counterparty risk.

Table 7: **Size of FLS Liquidity Demand.** This table relates the size of liquidity demand to characteristics banks and collateral characteristics. Estimations (I)-(III) represent the first layer of liquidity demand, the size of the collateral pool. Estimations (IV)-(VI) represent the second layer of liquidity demand, the amount of liquidity draw upon. Haircut: haircut, HHI: Herfindahl Index for collateral concentration, TA: log total assets, ROE: return on equity, ER: equity ratio, WR: write-off, and ΔD change in deposits. OLS panel data estimation using fixed-effects. Standard errors are clustered at the bank dimension.

	(I) Collateral/TA	(II) Collateral/TA	(III) Collateral/TA	(IV) Drawing/TA	(V) Drawing/TA	(VI) Drawing/TA
$Haircut_t$	0.03	0.04	0.04	-0.00	-0.00	0.00
	(0.03)	(0.03)	(0.03)	(0.00)	(0.00)	(0.00)
HHI_t	-0.04***	-0.04***	-0.04***	-0.04***	-0.04*	-0.02*
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
$\log(TA_{t-1})$	-0.57**	2.73***	2.71**	-0.02*	0.26	-0.02
	(0.23)	(0.99)	(1.02)	(0.01)	(0.16)	(0.11)
ROE_{t-1}	0.01	-0.01	-0.02	0.00	0.00	-0.00
	(0.03)	(0.03)	(0.02)	(0.00)	(0.00)	(0.00)
ER_{t-1}	1.22***	1.60***	1.45***	0.84**	1.13**	0.44
	(0.35)	(0.45)	(0.51)	(0.32)	(0.41)	(0.61)
ER^2_{t-1}	-0.04***	-0.04***	-0.04**	-0.02***	-0.03**	-0.00
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
WR_{t-1}	0.38	1.16**	0.93**	-0.01	0.07*	0.07
	(0.41)	(0.43)	(0.44)	(0.04)	(0.03)	(0.05)
ΔD_t	-0.00	0.00	-0.00	-0.00	0.00	-0.00
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
Bank FE	No	Yes	Yes	No	Yes	Yes
Time FE	No	No	Yes	No	No	Yes
Adjusted R^2	0.354	0.820	0.825	0.116	0.630	0.718
Observations	521	520	520	521	520	520

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Linking our results to our research question, we find no evidence that banks' riskiness is interconnected with liquidity uptake; in *Table 6* we find no evidence that counterparty risk is associated with ILTR demand. In *Table 7*, we find that write-off is significant for the first layer of FLS demand but in column VI, we find that it is not related to the second layer of FLS demand. The haircut variable, on the other hand, is positive and significant for the ILTR pool (*Table 6*), which suggests that larger pools tend to include riskier collateral assets. As previously described, this result appears to be linked to the fact that banks start with a core of liquid collateral assets and as they increase their collateral pool they add less liquid assets. Thus, we find no evidence that liquidity uptake with the BoE is linked either to riskier banks or to riskier collateral assets.[22]

4 Robustness Checks

To check the empirical validity of our main results we present two sets of additional estimations. First, we address possible multicollinearity between variables in Table 4. To show that variables have individual explanatory power over the decision to have a non-zero collateral pool, we introduce each variable separately into the regression. Table A1 in the Appendix shows the results for ILTR, and Table A2 for FLS. With respect to ILTR, although the coefficients have slightly different magnitudes, the statistical significance remains unchanged. With respect to FLS, the only variable that remains unchanged is ROE. The fact that coefficients change their significance suggests that they are jointly valid but not individually significant. This is consistent with the view that self-selection of riskier banks does not take place in the FLS facility.

Second, we address the definition of our dependent variables in Table 4. Both in ILTR and FLS the dependent variable is defined as one for non-zero collateral pools and zero for pools with no collateral. However, if the decision to have a non-zero collateral pool is serially correlated, our results could be biased. Self-selection is not an issue with FLS because all deposits of collateral were accompanied by a drawing. Thus, the decision to deposit is clearly related to the drawing in the same period and not to an action in the previous period. Thus, we focus on the serial correlation of ILTR.

To check that regardless of the serial correlation, the results remain unchanged we provide an alternative specification. We define the dependent variables as taking the value one when banks increase the size of their collateral pool, i.e. when they deposit more collateral, and zero otherwise. Table A3 in the Appendix shows the results. Although the coefficients have slightly different magnitudes the statistical and economic significances remain unchanged. This suggests that serial correlation is not driving the ILTR results.

5 Conclusion

Liquidity transformation by central banks can take many forms. Traditionally it has involved transforming liquid collateral assets (e.g. sovereign bonds) into even more liquid assets (e.g. cash). But it can also involve transformation of less liquid collateral assets (e.g. unsecuritalised loan portfolios) into more liquid assets (e.g. cash or treasury bills).

Liquidity insurance, in the form of the BoE's ILTR facility, acts by providing liquidity transformation from a wide range of eligible collateral assets into the most liquid asset,

[22] We also have performed estimations using the interaction term between the haircut and write-off variables. The interaction variable is insignificant in all specifications.

central bank reserves, for a term of 6 months. The Funding for Lending Scheme acts in a different part of the liquidity transformation scale. In FLS, counterparties can also use a wide range of eligible collateral assets and receive a more liquid asset in return, Treasury bills, for a term of up to 4 years. In practice the different design and purposes of these facilities has led counterparties to typically use less liquid collateral for the FLS relative to the ILTR. In this dimension, both liquidity lines are complementary.

Our study finds no evidence for mis-incentives resulting from the BoE collateral framework. Counterparties with deposit outflows and greater liquidity need seem to be the ones making greater use of the ILTR, which is the objective of the liquidity insurance policy. Although riskier counterparties seem to pre-position more collateral for usage in FLS, they do not draw upon FLS funding significantly more than others. Thus, we find no evidence that riskier counterparties have stronger incentives to use either of the liquidity facilities. Collateral usage in ILTR operations typically starts with more liquid collateral assets, and then as the size of the demand increases the use of less liquid assets gradually increases. FLS operations are almost entirely collateralised by unsecuritised loan portfolios. For both facilities, the composition of collateral assets follows the relative incentives of the liquidity transformation operations. The lack of mis-incentives suggests that the BoE is able to appropriately account for risk and liquidity differences between collateral assets when setting its haircuts.

Our results suggest that the BoE's acceptance of a range of more risky assets as collateral and enhanced liquidity transformation is a public good. The fact that illiquid collateral assets, such as uncollateralized loan portfolios, are not accepted in the private interbank market but have no detrimental effect on the BoE balance sheet, suggests that the monetary authority can act in an area of the liquidity transformation scale that private actors cannot. Whether this justifies a public provision of liquidity remains open for future research.

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Appendix

Eligible Collateral Assets at the Bank of England

The Bank of England collateral framework is divided into three types of collateral assets according to their market liquidity. **Collateral type A** is the most liquid type and is composed of: Gilts; Sterling Treasury bills; HM Government debt denominated in US dollar, Canadian dollar and Euro; Bank of England securities; sovereign and central bank debt from Canada, France, Germany, the Netherlands and the United States. **Collateral type B** is the intermediary liquidity category and is composed of: sovereign and central bank debt from Australia, Austria, Belgium, Denmark, Finland, Ireland, Italy, Japan, Luxembourg, New Zealand, Norway, Portugal, Slovenia, Spain, Sweden, and Switzerland in Sterling, Euro or US dollar; international organizations securities denominated in Sterling US dollar, Canadian dollar and Euro; G10 government guaranteed agency bonds; HM Government debt in other currencies; HM Government sukuk bonds; HM Government guaranteed bank debt; FHLMC, FNMC, and FHLB securities; UK and Dutch (AAA) RMBS; UK, French, German, and Spanish (AAA) covered bonds; UK, US, EEA (AAA) ABS, credit cards, auto and equipment leases; US (AAA) ABS, consumer and student credit; Non-UK government guaranteed bank debt; portfolios of senior corporate bonds and commercial paper issued by non-financial companies in UK, US, and EEA. **Collateral type C** is the least liquid category and is composed of: UK, EEA RMBS rated A- or better; UK, US, EEA covered bonds rated A- or better; UK, US, EEA ABS rated A- or better; UK, US, EEA CMBS rated A- or better; UK, US, EEA securitised portfolios of SME loans and corporate bonds; UK, US, EEA ABCP rated A1 or better; portfolio of corporate bonds and commercial paper issued by non-financial corporates; non-UK government guaranteed bank debt; individual loans that meet certain criteria.

Table A 1: **Probability that the ILTR Collateral Pool is Non-zero, Variables Introduced Separately.** This table relates banks characteristics to the decision to deposit collateral assets at the BoE introducing one variable at time. Left-hand variable is a dummy that takes the value one if a bank has a non-zero collateral pool and zero otherwise. TA: log total assets, ROE: return on equity, ER: equity ratio, WR: write-off, and ΔD change in deposits. Estimation is a logit model and fixed effects refer to jackknife correction as proposed by Fernández-Val and Weidner (2016). Standard errors are clustered at the bank dimension.

	AME Participation	AME Participation	AME Participation	AME Participation	AME Participation
$\log(\text{TA}_{t-1})$	0.13^{***}				
	(0.05)				
ROE_{t-1}		-0.003^{***}			
		(0.0006)			
ER_{t-1}			0.09^{***}		
			(0.008)		
ER^2_{t-1}			-0.005^{***}		
			(0.0002)		
WR_{t-1}				-0.09^{***}	
				(0.02)	
ΔD_t					0.002^{***}
					(0.0003)
Bank FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.55	0.54	0.54	0.55	0.53
Obs	1458	1458	1458	1458	1458
# Banks	58	58	58	58	58

Table A 2: **Probability that the FLS Collateral Pool is Non-zero, Variables Introduced Separately.** This table relates banks characteristics to the decision to deposit collateral assets at the BoE introducing one variable at time. Left-hand variable is a dummy that takes the value one if a bank has a non-zero collateral pool and zero otherwise. TA: log total assets, ROE: return on equity, ER: equity ratio, WR: write-off, and ΔD change in deposits. Estimation is a logit model and fixed effects refer to jackknife correction as proposed by Fernández-Val and Weidner (2016). Standard errors are clustered at the bank dimension.

	AME Participation	AME Participation	AME Participation	AME Participation	AME Participation
$\log(TA_{t-1})$	0.35				
	(0.27)				
ROE_{t-1}		-0.009***			
		(0.003)			
ER_{t-1}			-0.04***		
			(0.016)		
ER^2_{t-1}			0.00		
			(0.00)		
WR_{t-1}				0.20***	
				(0.04)	
ΔD_t					0.003
					(0.002)
Bank FE	Yes	Yes	Yes	Yes	Yes
Time Fe	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.71	0.57	0.57	0.56	0.56
Obs	655	655	655	655	655
# Banks	39	39	39	39	39

Table A 3: **Alternative Specification Probability that the ILTR Collateral Pool is Non-zero.** This table relates banks characteristics to the decision to deposit collateral assets at the BoE. Left-hand variable is a dummy that takes the value one if a bank has a non-zero collateral pool and zero otherwise. TA: log total assets, ROE: return on equity, ER: equity ratio, WR: write-off, and ΔD change in deposits. Estimation is a logit model and fixed effects refer to jackknife correction as proposed by Fernández-Val and Weidner (2016). Standard errors are clustered at the bank dimension.

	w/o Fixed Effects		Fixed Effects	
	Coef. Drawing	AME Drawing	Coef. Drawing	AME Drawing
$\log(TA_{t-1})$	0.51***	0.51***	1.65***	0.12**
	(0.07)	(0.07)	(0.62)	(0.05)
ROE_{t-1}	-0.01	-0.01	-0.04***	-0.002***
	(0.01)	(0.01)	(0.01)	(0.0007)
ER_{t-1}	0.32***	0.32***	1.27***	0.08***
	(0.12)	(0.12)	(0.11)	(0.007)
ER^2_{t-1}	-0.01**	-0.01**	-0.06***	-0.004***
	(0.005)	(0.005)	(0.001)	(0.0001)
WR_{t-1}	-0.70***	-0.70***	-0.64***	-0.056***
	(0.19)	(0.19)	(0.23)	(0.015)
ΔD_t	-0.002	-0.002	0.047***	0.003***
	(0.007)	(0.007)	(0.006)	(0.0004)
Bank FE	No	No	Yes	Yes
Time FE	No	No	Yes	Yes
Pseudo R^2	0.13	0.13	0.37	0.37
Obs	2,506	2,506	1,596	1,596
# Banks	101	101	64	64

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$