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John Thanassoulis, Irem Erten and Ioana Neamtu

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Centre for Economic Policy Research
33 Great Sutton Street, London EC1V 0DX, UK
Tel: +44 (0)20 7183 8801
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Abstract

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JEL Classification: G12, G18, G21

Keywords: Ring-fencing

John Thanassoulis - john.thanassoulis@wbs.ac.uk
Warwick Business School, University of Warwick, CEPR, UK Competition and Markets Authority and CEPR

Irem Erten - Irem.Erten@wbs.ac.uk
Warwick Business School, University of Warwick

Ioana Neamtu - Ioana.Neamtu@bankofengland.co.uk
Bank of England

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Irem Erten †, Ioana Neamțu ‡, John Thanassoulis §

October 12, 2022

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†Warwick Business School, University of Warwick, Irem.Erten@wbs.ac.uk

‡Bank of England, Ioana.Neamtu@bankofengland.co.uk

§Warwick Business School, University of Warwick, CEPR, John.Thanassoulis@wbs.ac.uk

1 Introduction

What happens to risk in the banking system when the government breaks banking groups into separate subsidiaries? Within the regulatory context, to legally deconstruct a firm and reallocate risk across its subsidiaries is called ring-fencing (Schwarcz (2013)). The UK is one of the few countries that implemented ring-fencing following the Independent Commission on Banking in the UK.[1] We empirically study the impact of this structural separation on interest rates in the UK repo market.

The effects of structural reforms on bank risk are far from being understood, and the deeper question of how ring-fencing impacts bank resilience and financial stability remains open. We aim to tackle these gaps in the academic literature. To the best of our knowledge, this paper is the first to study how bank risk is affected by ring-fencing using the short-term money markets. This is especially important given the fact that regulators increasingly consider structural reforms promote financial stability. [2]

The structural separation enacted in the UK is novel and the market's view of it has yet to be studied. The ring-fencing legislation was enacted to ensure that deposit taking institutions would be protected from risks from the non-ring-fenced banks, as well as ensure that they are more easy to supervise but also to resolve, due to this reparability and their treatment as Domestic Systemically Important Banks. [3] The initial report which proposed them described it as follows:

> "The objective of such a ring-fence would be to isolate those banking activities where continuous provision of service is vital to the economy and to a bank's customers. This would be in order to ensure, first, that such provision could not be threatened ..."
> Emphasis added, Vickers (2011), p11.

Taken at face value this suggests that regulation, and if necessary a government guarantee, should ensure that a ring-fenced bank (RFB) was, and should be seen to be, less risky. Whether this means that the non-RFB (nRFB) within the same banking group is therefore more risky or not is an open question we will address.

Furthermore, the complexity of banking groups can make it difficult to monitor banks, assess their interlinkages with the rest of the financial system, and so reduce the effectiveness of the financial regulation. Breaking them up into separate subsidiaries may reduce this complexity and make it easier for regulators to rapidly intervene in times of

[1] See Vickers (2011). The EU had a similar report, the Liikanen report (Liikanen, 2012). It also recommended a form of ring-fencing. This was not however finally implemented within the EU.

[2] For example the Volker rule, the Liikanen report and the UK Ring Fencing regime all had the effect of singling out some activities through a structural separation. The specific location of the 'fence' within the banking group differed in each of these cases.

[3] In 2021, the UK ring-fenced subsidiaries represented 25% of the UK banking system by total asset size.

stress, for example by bailing out only the systematically important parts of the bank. This would also reduce the scope of the *too-big-to-fail* problem as the rest of the bank could be separately sold or be left to fail. Whether these different effects on the RFB and nRFB subsidiaries occur is, as yet, unproven. Further how these two effects at the subsidiary level net out at the group level, either to increase or reduce overall group wide risk, is also (as yet) unclear.

There is a second possibility. The ring-fence by design prevents the free transfer of trades across the banking group. Therefore the ability of a bank to net off trades will be reduced. This potentially causes diversification benefits to be lost (Kashyap et al. (2002)), and perhaps also increases the risk of the RFB as the volatility of earnings may become larger. Some economists have also pointed out that under the ring-fencing framework, banks may simply become inclined to take greater risks inside the fence (Acharya, 2014). A further force pushing towards making RFBs more risky is that their assets become focused on the domestic economy. In the case of the UK (as opposed to the US) this corresponds to a comparatively concentrated market.[4] It is possible that the wider market will perceive such a bank as more, not less, risky.

In this paper, we study a unique policy reform in the UK that requires banks with domestic deposits above a £25 billion threshold to convert into bank holding companies with two legally distinct entities: the ring-fenced bank (RFB) and non-ring-fenced bank (nRFB). The main distinction between these two subsidiaries is that the ring-fenced part would be the "safe" subsidiary, by being the only one allowed to accept deposits, and excluded from a list of activities classified as "risky" by the regulator (see Britton et al. (2016)). The reform essentially consists of imposing a separate legal and financial structure on these two different parts of the bank holding group, leaving other bank characteristics, such as size and capitalization unchanged. Thus, we see it as an excellent laboratory to study the implications.

The key feature of our study is that we use a confidential and unique database of sterling-denominated repo transactions to establish a real-time measure of the price of risk in the market. Our data allows us to observe, on a granular and high-frequency basis, the near-universe of sterling-denominated repo transactions collateralised by UK gilt collateral. Not only is the repo market one of the core sources of funding for banks in the UK, but it is also a major source of overnight cash investment for a large variety of financial intermediaries. For identification we exploit the stylized fact from the UK repo market that counterparties switch across dealers within very short time periods, both to meet their liquidity needs and to make short-term cash investments. This allows us to systematically account for any time-varying confounders, and compare, for the same counterparty, the risk perception and price of liquidity across similar dealers in very similar transactions within very short time periods.

[4]See Fred St Louis data on 5-Bank Asset Concentration for UK and US.

In the first part of the paper, we investigate the risk perception third parties have of the RFB group as evidenced by the interest rate third parties require the RFB group to pay to be lent cash in the repo markets. We compare the repo lending by the same counterparty to the ring-fenced dealers relative to other dealers. We control for the loan type by including variables covering the time period of the loan and the associated haircut. We capture also the business model of the bank by controlling for bank identities. And perhaps most powerfully we have client by day fixed effects so that we are in effect looking at differences manifesting across all clients on every day.

We document that the ring-fenced dealers can borrow in the overnight repo market at 0.85 bps lower rates (approx 2.5% less) as compared to other dealer banks. This is consistent with a hypothesis that third party clients (the repo investors) perceive the ring-fenced dealers to be safer after the reform. We document that this reduction in the repo rates, which we call the ring-fencing bonus, becomes even larger during times of market uncertainty and financial crisis, as exemplified by the Covid-19 crisis. Our results are consistent with counterparties undertaking a flight to safety, represented we find, by the perceived lower risk of RFB groups.

We document that this reduction in perceived risk has a valid foundation in that it is explained by bank-specific risk variables such as the Z-score. We argue that this implies that a Too Vital To Fail effect is not in evidence.

We also document that the reduced riskiness of the RFB group is driven by the RFB subsidiary. The nRFB subsidiary, we show, is not seen by third parties as more risky to an economically meaningful extent; we cannot in general rule out the null that the borrowing costs of the nRFB are unchanged by the advent of the ring-fencing regime.

In the second part of the paper, we explore whether the RFB group has a reduced risk appetite which manifests by demanding higher interest rates of third parties for the loan of cash in a (reverse) repo transaction. In theory such an increase in interest charged may be due to regulation, or it may be due to cost effects of ring-fencing which are created by the restriction of synergy benefits which arise from ring-fencing (e.g. DeYoung and Torna (2013)).

To study this, we look at the impact of ring-fencing on reverse repo transactions. We document that the RFB groups charge higher rates to lend cash in repo transactions relative to other banking groups. To be more specific, we find that the same counterparty on the same day must pay higher rates to borrow from the ring-fenced dealer as compared to other dealers. The effects are robust to the addition of bank balance sheet characteristics, counterparty type, and trade characteristics such as the size and haircut of the repo transaction.

We document that the increase demanded in the reverse repo rates, we argue, by ring-fencing is stronger for the dealers that have weaker capitalization. We also find that the increase in the cost of borrowing cash is higher for counterparties with whom the

dealers trade with less frequently, suggesting that the banks are less likely to alter their risk appetite with their relationship borrowers. We also document that the increase in the price charged for cash is raised for the RFB subsidiary even during times of economic stress such as the coronavirus lockdowns.

We contribute to two lines of literature. The paper is primarily linked to the literature on the implications of the organizational and funding structure of banks on their risk taking. The empirical evidence is mixed. For example, Cornett et al. (2002) investigate the impact of allowing U.S. commercial banks to conduct investment-banking activities with Section 20 subsidiaries. They find that the introduction of Section 20 subsidiaries is associated with an increase in performance due to the revenues from non-commercial-banking activities with no significant increase in risk. In contrast, Caprio et al. (2007) document that engaging in diverse activities leads to a reduction in the market valuation of financial conglomerates. They argue that this is likely due to the agency problems in the financial conglomerates, and that the economies of scope are not sufficiently large to offset the diversification discount. We contribute to this literature by studying the features of a leading example of structural separation – the ring-fencing reform in the UK. We also contribute by using prices from overnight and short duration interbank markets which allow risks in real time to be separated from long-term strategy considerations which affect equity valuations.

Second, we add to the literature on the implications of macroprudential regulations on the repo market. The literature in this area is surprisingly scarce. Previous literature has studied the unintended consequences of capital regulation on the repo market. For example, several papers argue that the leverage ratio discourages banks from undertaking low-margin activities, making it costlier to provide liquidity in the repo market (Allahrakha et al., 2018; Kotidis and Van Horen, 2018). We contribute to this literature by investigating the impact of structural reforms on the repo market. We document that ring-fencing has implications for the pricing of liquidity in the short-term money markets: while the repo investors perceive the ring-fenced banks as safer, the price of liquidity increases for the repo counterparties.

The paper consists of the following parts. We first discuss the Institutional details of the repo market and the ring-fencing reform. We next describe the data we use in the form of the Sterling Money Market. There then follows a discussion of the empirical design and strategy proposed. The empirical results and discussion follow. We then conclude.

2 Institutional Details

2.1 The Gilt repo market

A repurchase agreement (repo) is a form of short-term borrowing where one party sells securities at a given price to a counterparty with an accompanying agreement to repurchase the securities at a specified price at a pre-determined time in the future. For the party that sells the securities and repurchases them in the future (cash borrower), the transaction is a repo. While for the party that buys the securities and resells them later (cash lender), the transaction is a reverse repurchase agreement, known as a reverse repo. It follows therefore that if bank i conducts a repo with bank j then bank i receives cash and is a borrower.[5]

The interest rate charged by bank j to lend cash to bank i will depend upon how risky bank i is perceived to be by third parties such as bank j. The riskier bank i is, the greater the interest rate the lending bank j will require in return for its loan. This paper exploits this insight to use market data to identify the risk with which RFBs and nRFBs are perceived.

The repo markets play a key role in the allocation of short-term capital in the financial system of the UK, Europe and the US on a day-to-day basis. The repo market allows market participants to meet their short-term need for cash, while at the same time providing a low-risk vehicle allowing excess cash to be invested overnight or for other short durations.[6] In the UK most of the repo market uses gilts, that is UK Government bonds, as the collateral security. As of 2016, the notional size of the outstanding UK repo and reverse repo transactions amounted to the equivalent of USD $900 billion (BIS CGFS (2017)). This made the UK the fourth largest repo market in the world.

Understanding the repo market is of value even beyond the insights on bank governance and risk which we extract. As repo is the major source of short-term funding for both bank and non-bank intermediaries, it is of first-order importance for the transmission of monetary policy.

In the UK 80% of gilt repo transactions are overnight, and 85% are with counterparties headquartered in the UK. The trades that take place between dealers are referred to as dealer-to-dealer and account for roughly 30% of the repo transactions. In dealer-to-client transactions dealers trade with a variety of counterparties – for example, hedge funds, pension funds, insurance companies, asset managers and money market mutual funds.

The trades can be settled either on a bilateral or trilateral basis, or cleared via a central counterparty (CCP). [7] In a trilateral trade, a bank acts as a market maker between the

[5] A study of the UK repo market is available in Hüser et al. (2021).

[6] Banks must maintain a cash position in the balance sheet by regulation. As this cash does not earn a return banks actively manage their cash position using Treasury operations on a daily basis.

[7] A CCP is a centralised clearing entity which prevents the parties facing counterparty default risk.

two parties, while in a bilateral trade dealers and clients directly trade with each other. Unlike the U.S., where a large segment of the repo market is settled on a trilateral basis, the trilateral segment of the gilt market is very small accounting for less than 5% of the repo transactions. We note that a significant part (30%) of the dealer-to-dealer trades in the UK gilt repo market clear and settle on the CCP.

2.2 Ring-fencing

As a response to the 2008 financial crisis, the Independent Commission on Banking (ICB) proposed banking reforms to reduce risk and moral hazard in the banking system.[8] After draft legislation in 2012, the 2013 Financial Services (Banking Reform) Act in turn required large banks to ring-fence their retail banking from their investment and international banking operations. The goal of this separation is to protect the retail banks from the risks and failures of other businesses at the banking group level (Britton et al., 2016). It is also part of the broader agenda to reduce the negative externalities of bank failures on UK taxpayers.

Under the new regime, UK banking groups with more than £25 billion of "core" (retail and Small and Medium Size Enterprises (SMEs)) deposits were obliged to restructure their businesses under the Ring-Fencing Transfer Scheme (RFTS) during 2017-2018. They placed their retail and small business deposit-taking activities under common oversight which went on to become ring-fenced subsidiaries during the course of 2019. Prohibited activities had to be moved outside the ring-fence and formed the nRFB. The legislation requires financial, management, and operational separation between the RFB and the rest of the banking group. That is, the RFB is expected to be financially independent from other members and hold enough capital to absorb shocks without relying on the financial support of other affiliates within the banking group (see Britton et al. (2016)). The activities which are exclusively allowed in the nRFB include operations outside the EEA, dealing in investments as principal, commodities trading, and exposure to financial institutions. Nonetheless, both RFBs and nRFBs are allowed to have exposures to building societies and other RFBs, sell simple derivatives to corporates, building societies and other RFBs, and hedge liquidity, interest rates, currency, commodity and credit risks for their own activities. Firms were able to decide where they wanted to place the activities open to both nRFB and RFB, leading to larger or smaller RFBs and so implicitly different business models.[9]

Since January 2019 the ring fencing regime has been operational. Beyond the legal structural change, RFBs are subject to a tighter regulatory regime than a regular bank subsidiary. This is because RFBs need to operate more independently than they would

[8] See Final Report of ICB (Vickers, 2011).

[9] Further details are available in the Ring-fencing and Proprietary Trading Independent Review (Skeoch, 2022)

otherwise as part of a banking group. A key objective of the national regulator with respect to ring-fencing is to minimise the risk that the failure of a RFB or of a nRFB could affect the continuity of core services provision.[10] Examples of these limitations include that RFBs need to meet prudential requirements such as capital adequacy and liquidity adequacy assessments on a standalone basis, and they have limited ability to transfer collateral or debt in the form of equity ("double leverage") between affiliates in the group and the RFB (PRA, 2016b,a). The RFB can also be subject to an additional System Risk Buffer (SRB) capital requirement, and has enhanced reporting requirements.[11]

3 Data

Our primary database is the confidential Sterling Money Market (SMM) database which the Bank of England acquires via enforced regulatory disclosure obligations on UK banks. The SMM database used in this study covers the period from September 2016 to November 2021. The SMM database available to us includes the near-universe of the secured sterling-denominated transactions backed against gilt collateral. The active dealers are predominantly banks. These dealer banks contract with a variety of clients, as noted above. All trades in the SMM database have maturities of one year or less, with 80% of them being overnight. Only transactions above £1 million are reported by the dealer banks and so are included in the SMM database.

This database has unique features which allow for much finer inference than has been possible before. We can observe the detailed characteristics of the trades between dealers and counterparties on the repo market on a day-to-day basis. Since the counterparties often switch across dealers within very short time intervals, we can compare, for the same counterparty and at the same time whether there are any consistent differences in the perception counterparties have of a given dealer or type of dealer (e.g. group contains a RFB subsidiary). Focusing on the same counterparty on the same day also allows us to systematically account for any time-varying macroeconomic confounding factors over time. In the supervisory repo data of other countries such as Target2 and Fedwire, the counterparty identities are often unavailable, leading researchers to resort to matching algorithms (e.g. Furfine (2001)).

We take several steps to clean the data. First, in common with other papers using bank trade data (see Kotidis and Van Horen (2018)), we exclusively focus on the dealer-client segment. This is for at least two reasons. Firstly in dealer-to-dealer transactions, the parties often take the role of a market maker and trade on behalf of an unknown third party. As our core interest is the pricing of risk in the repo market we would be

[10] See the Prudential Regulation Authority (PRA) objectives in respect to ring-fencing from CP 25/16 (PRA, 2016b).

[11] See Systemic Risk Buffer Rates and PRA Ring-fencing for further details.

unsure of who the observed risk related to. Secondly, most dealer-to-dealer trades are settled on a CCP which removes counterparty credit risk. We also exclude intra-group transactions, such as internal trades between the subsidiaries of the same group, and trilateral repo transactions. In both cases this is because such trades do not allow us to extract a clear signal of the perceived riskiness of the RFB or nRFB. We remain therefore with all dealer-to-client transactions.

From the universe of dealer-to-client transactions we exclude the repo transactions with States, government entities, trusts, and non-financial counterparties. The different business models of these entities would weaken our identification. In a similar vein, we drop the modest number of repo transactions with variable rates, pool, and multiple collateral because of the likely difference and complexity of the underlying pricing models. Finally, since our goal is to estimate the differential rates for the same counterparty across dealers, we only include transactions where the counterparty name is available. That excludes a minority of transactions where the counterparty name is not provided, for example due to privacy laws. We also aggregate the clients to a parent entity level to capture, for each counterparty, the firm-specific determinants of repo market activity. This cleaning process leaves us with 2.377 million observations covering the period between August 2015 and August 2021. Dealer banks will both borrow and lend cash from the financial institutions remaining in the sample: money market mutual funds, pension funds, hedge funds and the like.

The SMM database provides us with the details of the repo transactions, such as the repo rate, volume, maturity, and haircut.[12]

Our key variable of interest is the repo rate. The repo rate is the interest rate at which the repo transaction takes place, *i.e.* the rate offered to the dealer j who receives short-term cash from a client i. Similarly, the repo volume is the total repo volume accepted by the dealer j from the client i. The maturity captures the duration of the contract and so the term of the repo loan.

In our analysis we control for macro-economic and bank-specific variables that will likely influence the repo rate. From Capital IQ we collect bank-specific variables such as bank size, capitalization, and the bank's liquidity coverage ratio. The empirical banking literature has noted that these variables affect the price of credit supplied (Acharya et al., 2022). In addition to controlling for these terms, we use these variables to construct various bank-specific risk measures such as the Z-score and distance-to-default (Altman, 2013). We complement collateral data with gilt-specific daily price data from Eikon. Finally we extract macroeconomic controls, such as inflation and GDP, from the Office of National Statistics, and data on overnight interest rates is sourced from the Bank of

[12]The securities provided by the cash borrower (bank i) in return for the short-term cash act as collateral. These securities provide protection to the cash lender, and would be sold in the event of default to allow bank j to be made whole. Bank j lends less cash to bank i than the market value of the securities that i provides. This reduction is known as the haircut.

England.

4 Empirical Design

4.1 *Repo transactions and Risk Perception*

The objective of the first part of our study is to investigate the impact of ring-fencing on the risk perception third parties have of ring-fenced banks. We study the interest rates at which third parties are willing to lend to ring fenced banking groups as expressed in daily repo transactions. These repo interest rates represent the cost of acquiring liquidity (i.e. cash) to a bank and so are of independent importance.

During the study period, there were 24 active banks in the UK repo market, which we refer to as dealers.[13] The ring-fencing legislation requires banks with over £25 billion in domestic deposits to implement a ring-fence, separating their deposit taking bank (RFB) into a separate subsidiary with other activities being combined into the nRFB. As a result of this deposit threshold, seven banking groups in the UK have been ring-fenced [14]Some of the reporting banks in our sample have both RFB and NRFB subsidiaries, giving us a natural treatment and control group for comparison.

If repo investors perceive the ring-fenced banking group to be less risky, we would expect, other things equal, the client to be willing to lend cash at a lower interest rate to RFB groups as compared to the rate demanded of non-RFB groups. Cash lending occurs through repo transactions. Therefore we would expect the interest rate on repo transactions in which the RFB impacted group borrows cash to be lower relative to the interest rate the client demands of other dealer banking groups that are exempt from the ring fencing reform.

There are at least two reasons a banking group containing a RFB may be seen by third parties as less risky than other banking groups, controlling for bank specific variables such as business model. Firstly, it is possible that supervision of RFB groups involves closer monitoring as the extra RFB rules need additional supervision, and as a result the ability to resolve the ring-fenced entity is more secure. Alternatively, it is possible that third parties perceive the RFB status as a signal of an implicit government guarantee. In support of this latter hypothesis we note that the initial rationale for establishing a ring-fence in the first place was because retail banking was declared as being '*crucial to the economy*'.[15]

[13]Due to confidentiality reasons we cannot list the repo transacting banks, but they are large international firms. A subset of our sample is found on the list of dealers conventionally used from The Gilt market makers (see (Kotidis and Van Horen, 2018; Hüser et al., 2021; Gerba and Katsoulis, 2021)).

[14]The groups subject to ring-fencing can be found at Bank of England - Jan 2022.

[15]See the discussion below at Section 5.1.3 and also Independent Commission on Banking, Final Report, Vickers (2011) p11.

There are however also reasons to believe that there will be no change in third party perceptions of overall RFB group risk. This would be the case if the RFB subsidiary were a small part of the banking group and so had limited impact at a group level. Alternatively any implicit support for the RFB from the regulator might be taken by the market as declaring a lack of support for the nRFB which might net out into no, or even a worse view of the whole RFB group.

To test the hypothesis that RFB groups receive lower interest rates to borrow, we run the following baseline specification on repo transactions:

$$repo_{ijt} = \beta_1 \times ring\text{-}fencing_{jt} + \beta \times X_{ijt} + dealer_j FE + counterparty_i \times day_t \ FE + \epsilon_{ijt}. \quad (1)$$

The dependent variable in this specification, $repo_{ijt}$ is the interest rate paid by dealer banking group j to receive cash from client i on date t. The specification we describe here is also used to extend the analysis to study other non-price channels of adjustment to ring-fencing in the paper such as the volume of ring-fencing or the haircuts demanded.[16]

We define the indicator variable $ring\text{-}fencing_{jt}$ as one if the dealer banking group j contains an operational RFB subsidiary at time t, and zero otherwise. Our central hypothesis is that ring-fencing reduces the perceived risk of a dealer banking group in the eyes of outside investors, therefore $\beta_1 < 0$.

To control for client risk and collateral demanded, we include counterparty fixed effects as in Khwaja and Mian (2008). For the same counterparty, we compare the cash lending to the dealer banking groups subject to ring-fencing with other similar dealers, and by $counterparty_i \times day_t$ fixed effects we capture any short-term variations in the risk and collateral demand at the counterparty level on any given day. That is, we compare the repo transactions of the same counterparty on the same day across banking groups containing RFBs and ones that do not contain RFBs. The richness of this specification means that business model differences between types of counterparty (e.g. hedge fund, pension fund, insurance company, or money market mutual fund) are controlled for by virtue of the $counterparty_i \times day_t$ fixed effects.

The variables contained in X_{ijt} control for haircut size to ensure that we compare equivalently covered repo borrowing. In some specifications, we control for other trade characteristics such as the size and maturity of the repo transaction, collateral maturity, and the standard deviation of the collateral price. Collectively these controls ensure that any changes at the time of the ring-fence in the maturity or collateral included in repo transactions cannot be the cause of our results. In addition we control for quarterly bank balance-sheet characteristics at the group level such as total size, capitalisation, and the liquidity coverage ratio. We control for time-varying macroeconomic conditions using

[16] In these specifications we use the log of total volume of the repo extended to the client i from dealer j to study volumes. The haircut analysis uses the percentage haircut variable.

overnight policy rates, monthly GDP, and inflation. The dealer fixed effects ($dealer_j$) controls for any difference in business models between banks, and so implicitly also captures differences in retail deposits that firms may take. The variable ϵ_{ijt} is our error term. We cluster standard errors at the cash lender level to account for the fact that changes in repo lending terms are correlated across cash lenders.

The empirical results follow in subsequent sections. In settings where we find that third parties do see ring-fenced banking groups as less risky, as evidenced by their lending to the RFB groups at lower rates, we conduct two further tests to establish more precisely why third parties are willing to lend more cheaply.

Our first subsequent step is to separate out the effect at the subsidiary level, and so drill down beneath the group level. We therefore aim to distinguishing between third party perceptions of the RFB versus the nRFB subsidiary. Our data allows us to observe the repo transactions reported separately by the RFB and nRFB.[17]

Since repo is one type of activity allowed both inside and outside of the ring-fence as long as it is for liquidity purposes (and not market-making), our setting helps us analyse the heterogeneity of the effects across the two subsidiaries. To test for this, we saturate the specification (1) by interacting ring-fencing with RFB and nRFB:

$$\begin{aligned} repo_{ijt} = & \beta_1 \times ring\text{-}fencing_{jt} \times RFB_{jt} + \beta_2 \times ring\text{-}fencing_{jt} \times nRFB_{jt} \\ & + \beta \times X_{ijt} + dealer_j \ FE + counterparty_i \times day_t \ FE + \epsilon_{ijt}. \end{aligned} \tag{2}$$

In (2) the variable RFB_{jt} is one if the cash is received in the repo by the RFB subsidiary, and zero otherwise. The index jt in (2) therefore denotes data at the subsidiary level and not the consolidated group level. Thus, specification (2) allows us to compare counterparties' views of riskiness of the RFB subsidiary and the remaining nRFB subsidiary as compared to groups which are not affected by the ring-fencing regulations in the UK. We hypothesise that it is the RFB which drives the reduced risk perception of third parties:

$$\beta_1 < 0.$$

We are more agnostic as to third parties' perception of the riskiness of the subsidiary outside the ring-fence, the nRFB. If the nRFB is denied the promise of an implicit bailout then it might be seen as riskier than would otherwise be the case. This would cause third parties to demand higher rates: $\beta_2 > 0$. In the null however $\beta_2 = 0$ which would hold if there was not a regulatory bleed across to the nRFB part of the group.

[17]For example, Barclays is a UK-incorporated bank with the subsidiaries consolidated under the name of Barclays Group Plc. Since March 2018, Barclays set up a ring-fenced bank, Barclays Bank UK Plc. (BBUKPLC) as a wholly-owned subsidiary of Barclays Group. The ring-fenced entity includes Personal Banking, Business Banking, Barclaycard Consumer UK businesses, and Wealth & Investments that provides financial products and services to UK clients. The non-ring-fenced entity is called Barclays Bank Plc. and includes international and investment banking businesses.

Our second investigation is to assess whether any interest rate reduction afforded to the RFB group is justified by objective risk metrics. If not then this is potentially evidence of an implicit government guarantee: the RFB is Too Vital To Fail (TVTF).[18] To achieve this we add bank-specific risk measures such as Z-score (capturing balance sheet risk) and distance-to-default (market implied) to the core specification (1). If the reduced interest rate demanded of RFB groups is justified by objective risk statistics then the reduction should be explained by the risk measures, and so leave the coefficient β_1 in (1) as insignificant. If however, despite controlling for bank risk, the interest rate reduction remains significant, then the leading explanation would be that a TVTF effect may be in evidence.

We finally perform a battery of robustness checks to ensure that the effects we document are not driven by any bank-level confounding factors that may differentially have affected ring-fenced versus other dealers. For example, we confirm our results hold when we restrict the control group to a propensity-score matched group of banks selected by the bank size, or when we restrict the sample only to banks with a significant amount of sterling deposits.

4.2 *Reverse Repo Transactions and Risk Appetite*

In this section of the analysis we explore whether the risk appetite of the ring-fenced banking groups have been affected by the structural regulatory intervention they have been subject to. We do not wish to pre-empt our results, but if we found through the analysis of Section 4.1 that third parties view RFBs as less risky, in this second part of our study we investigate the possible justifications for such third party views. The SMM Database allows us to study the RFB groups' risk appetite as we can study the interest rate that RFB groups demand to lend cash in a (reverse) repo transaction.

We first therefore seek to establish if, *ceteris paribus*, a RFB group lends cash more expensively than non-ring-fenced banking groups. If a RFB group had a reduced risk appetite then such an increased interest rate charge applied to third parties would follow. We note that there may be other reasons why a RFB group may lend more expensively beyond risk appetite. We will explain and explore those subsequently.

First therefore we investigate whether ring-fencing impacts the price at which a RFB group lends cash, i.e. the price at which it is willing to supply liquidity in reverse repo transactions to the market. We run the following specification on the reverse repo transactions:

$$reverse\ repo_{ijt} = \beta_1 \times ring\text{-}fencing_{jt} + \beta \times X_{ijt} + dealer_j\ FE + counterparty_i \times day_t\ FE + \epsilon_{ijt}. \tag{3}$$

[18] This approach parallels that of Acharya et al. (2022).

The estimation equation (3) is similar to that used in (1) except for the dependent variable: *reverse repo*$_{ijt}$. This dependent variable is the interest rate on the reverse repo transaction in which dealer j provides cash to (i.e. lends to) client i on date t. We reiterate that the control variables X_{ijt} include haircut size and in some specifications the size and maturity of the transaction, collateral maturity, and the standard deviation of the collateral price. Thus we ensure that the lending offered by the RFB group which is being compared is *ceteris paribus* to the comparators.

Our central hypothesis is that ring-fencing increases the price which the RFB group demands of borrowers for liquidity. This would follow if we establish that in (3)

$$\beta_1 > 0. \tag{4}$$

Note we once again use the richness of our data set to include the *counterparty*$_i \times$ *day*$_t$ fixed effects so that we can compare lending rates between RFB groups and groups unimpacted by ring-fencing to the same client on the same day. If (4) holds then we can seek to establish the mechanism behind the increased price demanded for credit by a RFB group. To this end we undertake three major further analyses.

The first investigation is to establish if the increased price for credit in reverse repos is demanded by each (UK) subsidiary within the RFB group, or the driver is purely the RFB subsidiary. To test this we proceed analogously to (2) and conduct the following analysis at the subsidiary rather than the group level:

$$\begin{aligned} \textit{reverse repo}_{ijt} =& \beta_1 \times \textit{ring-fencing}_{jt} \times \textit{RFB}_{jt} + \beta_2 \times \textit{ring-fencing}_{jt} \times \textit{nRFB}_{jt} \\ &+ \beta \times X_{ijt} + \textit{dealer}_j \ \textit{FE} + \textit{counterparty}_i \times \textit{day}_t \ \textit{FE} + \epsilon_{ijt}. \end{aligned} \tag{5}$$

Equation (5) establishes that the RFB subsidiary is demanding higher prices to lend cash in the repo market if $\beta_1 > 0$. Equation (5) also allows us to extract the impact of ring fencing on the subsidiary outside the ring-fence boundary, the nRFB, through the sign of β_2.

If we find that the RFB group charges more for lending then, before we can conclude that the subsidiary has a lower risk appetite, we must consider first whether the price might be due to supply and demand dynamics or due to cost pressures. If the RFB group reduces the amount of cash it is willing to lend through reverse repo transactions then the increased price demanded by the RFB group for its loans may be a result of the RFB group walking up its residual demand curve. Such a reduction in volumes could be due to regulatory pressure to maintain greater balance sheet liquidity for example. To explore

this we adapt (3) to study volumes:

$$\ln\left[\textit{reverse repo volume}_{ijt}\right] = \beta_1 \times \textit{ring-fencing}_{jt} + \beta \times X_{ijt} + \textit{dealer}_j \ FE + \textit{counterparty}_i \times \textit{day}_t \ FE + \epsilon_{ijt}. \tag{6}$$

Our hypothesis in test (6) is that the RFB group reduces its overall supply of cash to the repo market, and so is able to charge a higher rate on sums lent: $\beta_1 < 0$ to capture the volume reduction. If we fail to find this effect then any increase in the price of lending detected via estimation (3) is not explained by a potential liquidity hoarding effect.

The third avenue we explore is to address whether the increased prices demanded by the RFB to lend cash (if that is evidenced) can be explained by increased costs. The ring-fencing rules create a "wall" in the middle of the banking group across which capital and trades cannot freely flow. The ability for banks to net a position in the RFB assets against a position held in the nRFB is reduced. It follows that the regulatory capital requirement in both the RFB and nRFB subsidiaries is therefore higher than otherwise. And this raises bank costs (see also Kashyap et al. (2002)).

If this cost argument holds then the increased price for credit should only appear on non-nettable transactions. A nettable transaction is one which has a reverse position being taken at the same time under certain conditions. The net exposure is reduced under a nettable transaction, and this in turn reduces the capital required as a result of financial regulations such as the leverage ratio cap. [19,20] The non-nettable transactions become more expensive from a capital perspective when the LR requirement is closer to being binding, as otherwise the impact should be limited due to capital fungibility at legal entity level.

To study whether cost pressures created by ring-fencing explain the higher price of lending in the repo market we augment the baseline specification to the one given in (7) in which we interact the $\textit{ring-fencing}_{jt}$ dummy with the indicator $\textit{non-nettable}_{ijt}$ that takes one if the transaction is not nettable and zero otherwise. We capture the impact of LR ratio by explicitly controlling for it too.

$$\textit{reverse repo}_{ijt} = \beta_1 \times \textit{ring-fencing}_{jt} + \beta_2 \times \textit{ring-fencing}_{jt} \times \textit{non-nettable}_{ijt} + \beta \times X_{ijt} + \textit{dealer}_j \ FE + \textit{counterparty}_i \times \textit{day}_t \ FE + \epsilon_{ijt}. \tag{7}$$

[19]Nettable and non-nettable repo transactions affect differently the bank balance sheet, and implicitly the leverage ratio (LR). A non-nettable transaction pair of repo and reverse repo is double counted in the Leverage Ratio (LR), while a nettable pair is only counted once. See Neamtu and Vo (2021) for a theoretical analysis, and Kotidis and Van Horen (2018); Gerba and Katsoulis (2021) for empirical work where these differences are analysed.

[20]Here, a nettable reverse repo transaction occurs if the banking subsidiary has an equivalent repo position with the same counterparty on the same day. This is by design and not by chance, as the originating banks have multiple desks issuing repos and reverse repos.

If cost pressures explain the higher price of a loan from a RFB group, and these cost pressures exist for non-nettable, but not for nettable trades, then we would expect to see

$$\beta_2 > 0.$$

4.3 The Ring-Fencing Bonus in times of Market Stress

Our final set of analyses explores whether any ring-fencing bonus we find is reinforced in times of market stress, or becomes less pronounced. We defer discussion of these tests to later in the paper as the approach mirrors the empirical strategy discussed above and augmented by time dummies to isolate the effect on banks during times of market stress. The stress times we explore occur due to Covid lockdown measures enacted by the UK authorities. Our hypothesis is that any ring-fencing bonus remains present whatever the market conditions, and so also during the most perilous moments for the UK banking system.

5 Empirical Results

In this section we outline our three key results: (i) the perception by third parties of RFB risk, as measured via borrowing costs (repo transactions); (ii) the risk appetite of RFBs as measured via lending costs (reverse repo); (iii) sensitivity to exogenous shocks (price variation during the Covid 19 crisis).

5.1 The Ring-fencing Bonus

5.1.1 Evidence from the repo transactions on risk perception

We first study whether repo investors perceive ring-fenced banking groups as less risky, *ceteris paribus*, after the imposition of the ring-fence. As discussed above, on the one hand ring-fencing focuses supervisory attention on the RFB, facilitates resolution and may be a signal of enhanced government support. The net result would be a safer banking group. On the other hand, the structural separation into separate subsidiaries may erode the diversification benefits across different types of business operations and reduce the ability of the banking group to smooth liquidity shocks. If the first effects dominate and repo investors perceive the ring-fenced banks to be safer, than we would expect them to lend to the ring-fenced banks at lower rates relative to other banks after the imposition of the fence.

We test this hypothesis by running the specification (1). The results are presented in Table 1. We see that across all specifications, the difference-in-difference term (Treated

× Event) is negative, and statistically significant. [21] This suggests that the interest rate at which repo counterparties are willing to lend to the banking groups which have been ring-fenced has declined. In Column 1, the baseline specification suggests that the same counterparty on the same day lends cash at 0.885 basis points (2.5% in relative terms) lower to a ring-fenced dealer bank relative to the unaffected dealer banks after the ring-fencing. This decline is robust to the dealer fixed effects that control for the time-invariant bank specific characteristics such as business model and liquidity management (columns 2 – 4). In Columns 4 and 5, accounting for the size of the transaction and collateral characteristics such as maturity, haircut, and price volatility leaves the coefficient of interest largely unchanged and so still negative and significant. Collectively the results support the leading interpretation that the repo investors see banking groups containing a RFB as being less risky after the risk-fence. This reduced perception of risk translates into a group-wide reduction in the cost of borrowing: a ring-fencing bonus.

The large data set which we can study allows us to deliver a tight estimation of the price reduction counterparties are willing to offer RFB groups when lending cash. An implication of counterparty x day fixed effects is that the reductions are offered by the largest clients who sometimes conduct repo transactions with multiple banks in one day. We explore whether this price reduction is present and measurable in even the smallest counterparty clients in the robustness section. This robustness check is offered for completeness as Table 1 has already established that from the largest clients (conducting the most trades), the RFB group benefits from significantly lower costs of borrowing cash.

5.1.2 Has ring-fencing made the nRFB more risky?

A live concern is that the perceived risk reduction enjoyed by the ring-fenced group is due to the RFB itself, whilst the nRFB (in the same banking group but outside the risk-fence) is perceived as less safe and more risky.[22] As we noted above and will explore below, the public announcements around the implementation of the ring-fence highlighted the criticality of domestic retail banking infrastructure. An implication some might draw is therefore that the nRFB is less critical to the domestic economy. Perhaps therefore third parties see the nRFB as a more risky proposition, shorn (if the RFB has one) of a government guarantee, and so driving up its cost of borrowing.

To study this we run the baseline specification by interacting the ring-fencing dummy with the RFB and nRFB indicators, respectively. We report the results in Panel B of Table 1. We show that when banking groups subject to ring-fencing face an average reduction in their borrowing rates after the regulatory change, the effects are mainly due

[21] In equation (1) this was denoted $ring - fencing_{jt}$.

[22] See for example Ervin (2018) who argues that the reduced access to deposit capital can make the international part of the bank more risky.

Table 1: **Ring-fencing and repo**

This table reports the impact of ring-fencing on the repo rates at the level of the banking groups. The bottom of the table provides information about fixed-effects, and the level of clustering. Standard errors correct for clustering at the lender-level, and are reported in parentheses. ***, ** and * indicate statistical difference from zero at the 1%, 5% and 10% levels, respectively. Period: 2015-2021.

Repo rate	(1)	(2)	(3)	(4)	(5)
Treated × Event	-0.00885***	-0.01806***	-0.00671**	-0.0047**	-0.00855***
	(0.00118)	(0.00309)	(0.00317)	(0.00237)	(0.00271)
bank rate			0.27567***	0.27739***	0.23538***
			(0.01153)	(0.01269)	(0.01222)
log(assets)			0.03505**	0.02883**	0.00318
			(0.01536)	(0.01425)	(0.01308)
leverage ratio			0.00928***	0.0113***	0.00265***
			(0.00143)	(0.00198)	(0.00063)
ROA			0.00014	-0.0002	0.0017***
			(0.00068)	(0.00077)	(0.00051)
liquidity coverage ratio			-0.00022*	-0.00026**	-0.00032***
			(0.00013)	(0.00012)	(0.00009)
loans/deposits			0.00036	0.00023	0.00035*
			(0.00034)	(0.00031)	(0.00019)
haircut				-0.00022***	-0.00011*
				(0.00006)	(0.00006)
log(amount)				0.00002	0.00059*
				(0.00055)	(0.00033)
log(maturity)					0.01664***
					(0.00146)
high price volatility					0.01552***
					(0.00126)
N	2377823	1521702	836883	836877	577728
R^2	0.95	0.95	0.95	0.95	0.96
CounterpartyxDay FE	Yes	Yes	Yes	Yes	Yes
Counterparty Type FE	Yes	Yes	Yes	Yes	Yes
Dealer FE	No	Yes	Yes	Yes	Yes
Credit rating FE	No	No	Yes	Yes	Yes
Dealer Controls	No	No	Yes	Yes	Yes
Macro Controls	No	No	Yes	Yes	Yes
Deal Controls	No	No	No	Yes	Yes

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

Panel B: RFB versus nRFB

This table reports the impact of ring-fencing on the repo rates by RFB and nRFB, separately. The bottom of the table provides information about fixed-effects, and the level of clustering. Standard errors correct for clustering at the lender-level, and are reported in parentheses. ***, ** and * indicate statistical difference from zero at the 1%, 5% and 10% levels, respectively. Period: 2015-2021.

Repo rate	(1)	(2)	(3)	(4)	(5)
Treated × Event × RFB	-0.02216***	-0.03529***	-0.02392***	-0.02107***	-0.02287***
	(0.00088)	(0.003)	(0.00263)	(0.00182)	(0.00221)
Treated × Event × nRFB	-0.00232***	-0.00617***	0.0005	0.00191**	0.00216***
	(0.00061)	(0.00196)	(0.00139)	(0.00089)	(0.00072)
bank rate			0.27837***	0.27935***	0.23839***
			(0.01274)	(0.01356)	(0.01361)
log(assets)			0.03471**	0.03204**	0.00938
			(0.01672)	(0.01607)	(0.0154)
leverage ratio			0.01292***	0.01442***	0.00741***
			(0.00231)	(0.00285)	(0.00183)
ROA			-0.00124	-0.00139*	0.0004
			(0.00076)	(0.00081)	(0.00056)
liquidity coverage ratio			-0.00024**	-0.00027**	-0.00036***
			(0.00012)	(0.00011)	(0.00008)
loans/deposits			0.00035	0.00027	0.00045**
			(0.00034)	(0.00032)	(0.00021)
haircut				-0.00014***	-0.00004
				(0.00005)	(0.00005)
log(amount)				-0.00004	0.00054*
				(0.00053)	(0.00031)
log(maturity)					0.01617***
					(0.00159)
high price volatility					0.01546***
					(0.00123)
N	2377823	1521702	836883	836877	577728
R^2	0.95	0.95	0.95	0.95	0.96
CounterpartyxDay FE	Yes	Yes	Yes	Yes	Yes
Counterparty Type FE	Yes	Yes	Yes	Yes	Yes
Dealer FE	No	Yes	Yes	Yes	Yes
Credit rating FE	No	No	Yes	Yes	Yes
Dealer Controls	No	No	Yes	Yes	Yes
Macro Controls	No	No	Yes	Yes	Yes
Deal Controls	No	No	No	Yes	Yes

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

to the RFB rather than the nRFB. The impact on the nRFB is either very small or statistically insignificant in columns 1 – 5. Note however in Panel B of Table 1 that the coefficient measuring the impact on the RFB ($Treated \times Event \times RFB$) is negative and significant in all specifications. Thus the RFB bank within the group enjoys lower rates when it needs to borrow cash.

These results suggest that while the average reduction on the repo rates at the banking group level is due to the RFB, the rest of the banking group does not, at present, face a material adverse impact on its costs of borrowing.

Panel C: Transfer versus implementation

This table reports the impact of ring-fencing on the repo rates at the level of the banking groups after the ring-fencing asset transfer and the regulatory implementation, respectively. The bottom of the table provides information about fixed-effects, and the level of clustering. Standard errors correct for clustering at the lender-level, and are reported in parentheses. ***, ** and * indicate statistical difference from zero at the 1%, 5% and 10% levels, respectively. Period: 2015-2021.

Repo rate	(1)	(2)	(3)	(4)	(5)
Treated × *Transfer*	-0.01095***	-0.01775***	-0.00488	-0.00375	-0.00586
	(0.00162)	(0.00305)	(0.00513)	(0.00457)	(0.00405)
Treated × *Implementation*	-0.00815***	-0.01837***	-0.00802***	-0.0054***	-0.01056***
	(0.00105)	(0.00321)	(0.00178)	(0.00092)	(0.00171)
bank rate			0.27586***	0.27747***	0.23561***
			(0.01144)	(0.01255)	(0.01223)
log(assets)			0.03299*	0.02779*	0.00029
			(0.01731)	(0.01646)	(0.01427)
leverage ratio			0.0079***	0.01061***	0.00057
			(0.00269)	(0.0036)	(0.00134)
ROA			0.00016	-0.00018	0.00173***
			(0.00068)	(0.00079)	(0.00048)
liquidity coverage ratio			-0.00025	-0.00027*	-0.00035***
			(0.00015)	(0.00015)	(0.00011)
loans/deposits			0.00036	0.00023	0.00036**
			(0.00033)	(0.0003)	(0.00017)
haircut				-0.00022***	-0.00011
				(0.00006)	(0.00007)
log(amount)				0.00002	0.00059*
				(0.00056)	(0.00033)
log(maturity)					0.01661***
					(0.00145)
high price volatility					0.01554***
					(0.00126)
N	2377823	1521702	836883	836877	577728
R^2	0.95	0.95	0.95	0.95	0.96
CounterpartyxDay FE	Yes	Yes	Yes	Yes	Yes
Counterparty Type FE	Yes	Yes	Yes	Yes	Yes
Dealer FE	No	Yes	Yes	Yes	Yes
Credit rating FE	No	No	Yes	Yes	Yes
Dealer Controls	No	No	Yes	Yes	Yes
Macro Controls	No	No	Yes	Yes	Yes
Deal Controls	No	No	No	Yes	Yes

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

Panel D: Ring-fencing and repo with market risk measures

This table reports the impact of ring-fencing on the repo rates at the level of the banking groups, controlling for market-based measures of risk such as the Z-score and distance-to-default. The bottom of the table provides information about fixed-effects, and the level of clustering. Standard errors correct for clustering at the lender-level, and are reported in parentheses. ***, ** and * indicate statistical difference from zero at the 1%, 5% and 10% levels, respectively. Period: 2015-2021.

reverse repo rate	(1)	(2)	(3)	(4)
Treated × *Event*	-0.00119	0.00011	-0.00189	-0.00054
	(0.00307)	(0.00204)	(0.00281)	(0.00178)
bankrate	0.23372***	0.23389***	0.23465***	0.23484***
	(0.01118)	(0.01106)	(0.01058)	(0.01045)
log(assets)	-0.00893	-0.01102	-0.01065	-0.01319
	(0.02136)	(0.02036)	(0.02179)	(0.02070)
leverage ratio	0.00996***	0.01026***	0.01066***	0.01103***
	(0.00270)	(0.00282)	(0.00283)	(0.00297)
ROA	0.00173**	0.00178**	0.00155*	0.00159*
	(0.00087)	(0.00081)	(0.00089)	(0.00084)
liquidity coverage ratio	-0.00006	-0.00010	-0.00004	-0.00008
	(0.00015)	(0.00013)	(0.00015)	(0.00013)
loans/deposits	0.00004	0.00000	-0.00001	-0.00006
	(0.00034)	(0.00031)	(0.00036)	(0.00033)
haircut		-0.00012		-0.00013
		(0.00008)		(0.00008)
z-score	-0.00004***	-0.00005***		
	(0.00001)	(0.00001)		
distance-to-default			0.00155***	0.00160***
			(0.00008)	(0.00010)
N	702809	702803	702809	702803
R^2	0.95	0.95	0.95	0.95
Counterparty × Day FE	Yes	Yes	Yes	Yes
Counterparty Type FE	Yes	Yes	Yes	Yes
Dealer FE	Yes	Yes	Yes	Yes
Credit rating FE	Yes	Yes	Yes	Yes
Dealer Controls	Yes	Yes	Yes	Yes
Macro Controls	Yes	Yes	Yes	Yes
Deal Controls	No	Yes	No	Yes

Impact of ring-fencing on (reverse) repo pricing

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

5.1.3 Economic risk reduction or government guarantee?

In this section we turn to the question of whether the risk reduction third parties perceive is caused by changes in economic and supervisory fundamentals or is due to some inferred government guarantee.

Recall that the report which established the basis for ring fencing in the UK made clear that retail banking was vital, as we noted in the quote from the Independent Commission of Banking recorded in the Introduction.[23] This raises the possibility that third parties see RFBs as safer as they infer the government will bail them out if needed due to their importance for the domestic economy. If this hypothesis is true then RFBs need not be any safer in terms of objective economic fundamentals, but may instead enjoy a perceived enhanced probability of government support.

We study this question in two ways. We first investigate at which point in time the ring-fencing reform impacts the repo borrowing rates in Panel C of Table 1. We create two dummy variables. The first is the ring-fencing *transfer* that takes one after the UK courts approve the creation of the RFB for a given group. The second dummy variable is *implementation*, an indicator variable that is one after the ring-fencing start date on January 2019. If a perceived declaration of government guarantee is the cause of the perceived risk reduction then we would expect the legal entity approved by the courts and the regulator to benefit immediately from this perceived safety. This would imply that the costs of borrowing through repos should be lower for the RFB group after court approval. This is studied in the first row of Panel C of Table 1. In Column 1 and 2, we show that dealer banks subject to ring-fencing appear to borrow at lower rates relative to unaffected dealers following the approval of the ring-fencing transfer. However, in Column 3 to 5, our most detailed specifications with the counterparty, trade, and collateral controls, we find that the impact of ring-fencing on the repo rates becomes insignificant after court approval but before implementation.

Rather, we observe from columns 3 to 5 that only after the implementation of the ring-fencing as an economic reality does the RFB group enjoy lower borrowing rates from counterparties. This suggests that the ring-fencing had first to be implemented before the reduction in the repo rates and risk perception occurred. Hence, ring-fencing appears to lower risk due to economic fundamentals and not due to an inferred assumption of a government guarantee.

A further outcome of the results of Panel C of Table 1 is to offer evidence that anticipation of the introduction of the ring-fence did not alter the perception third parties had of the ring-fenced bank risks. If there had been anticipation effects then we would have expected to see the results manifest by the earliest date – that of court approval. However we don't find any effect on interest rates demanded of the RFB group until

[23]The ICB, Independent Commission on Banking, see Vickers (2011).

actual implementation of the ring fence, ie the later date of January 2019. This suggests that any anticipation effects are small.

To further support our interpretation for our key result that ring-fencing lowered risk, we construct two risk measures, Z-score and distance to default, and we incorporate them into our baseline specification in Panel D of Table 1. Columns 1 and 2 consider the Z-score, and Columns 3 and 4 study distance-to-default.[24] As in Acharya et al. (2022) we therefore seek to capture all reasonable economic drivers of the price of risk in a repo transaction outside of the mere fact that the regulator has declared an entity vital for the economy through its RFB status. We show that in all specifications the impact of ring-fencing on repo rates is no longer present when we control for the market-based measures of bank risk. This suggests that the reduction in the cost of repo is a by-product of real economic fundamentals in the form of bank risk.

5.1.4 Ring-fencing bonus and borrowing below market rates

In this section we explore whether RFB groups are seen as so safe that third parties are willing to lend cash at below markets rates to these entities. Such low costs of borrowing for a ring-fence banking group open up capital arbitrage possibilities if the cost of borrowing falls below the rate at which the Central Bank pays interest on excess reserves. This would allow the RFB to generate extra profit.

In the short-term funding markets, banks can engage in the near risk-free interest-on-excess-reserves arbitrage (IOER). For example, within the context of the U.S. unsecured wholesale funding markets, Keating and Macchiavelli (2017) and Anderson et al. (2021) document that global banks could obtain unsecured, and short-term, dollar funding to hold as reserves at the Federal Reserve, so gaining the spread between the IOER rate and their cost of short-term funding. With a similar logic, a difference between the overnight repo rate and the rate on IOER can potentially result in arbitrage.

In the repo market, repo rates can even become negative when the cash lenders become willing to pay a premium to obtain collateral securities in high demand (Hempel et al., 2021). These types of collateral are called *special collateral* and the transactions are known as special repo. In such transactions, the cash lenders in the repo transaction effectively pay a positive interest rate to the cash borrower, who therefore makes a near risk-free gain.

[24]The literature has used a variety of measures based on the market and accounting data to capture bank risk. Book-based measures of risk include the Z-score. The Z-score is inversely related to the probability of bank insolvency and captures the distance from insolvency (Roy, 1952). It is calculated as the return on assets plus the capital asset ratio divided by the standard deviation of asset returns. Separately, distance to default is a market-based measure and is based on the Kealhofer - Merton - Vasicek (KMV) model. There, we derive the banks' asset value and asset volatility from equity value and equity volatility using daily observed share prices. The distance to default is calculated as the expected value of the banks' assets, taking (maturity-adjusted) debt into account, and divided by asset volatility over a 1 year horizon.

We look at the likelihood of interest rates charged to RFB groups in repo transactions dropping sufficiently below (i) the Bank rate and (ii) 0, to create additional gains for the RFBs in the short term money market in Table 2.

Table 2: **Did ring-fencing lead to arbitrage capital?**

This table reports the impact of ring-fencing using a a linear probability model with similar specifications to (1), on the likelihood of having potential arbitrage capital: Repo rate < Bank rate and Repo rate < 0, respectively. The bottom of the table provides information about fixed-effects, and the level of clustering. Standard errors correct for clustering at the lender-level, and are reported in parentheses. ***, ** and * indicate statistical difference from zero at the 1%, 5% and 10% levels, respectively. Period: 2015-2021.

Dependent variable:	**Repo rate < Bank rate**		**Repo rate < 0**	
	(1)	(2)	(3)	(4)
Treated × Event	0.07951***	0.06115***	0.03407***	0.02690***
	(0.00444)	(0.00706)	(0.00524)	(0.00327)
bank rate		0.34422***		0.02172
		(0.02108)		(0.01458)
log(assets)		-0.27759***		-0.55140***
		(0.03322)		(0.06219)
leverage ratio		-0.03489***		-0.01664
		(0.00719)		(0.01993)
ROA		0.01885***		-0.02443***
		(0.00091)		(0.00233)
liquidity coverage ratio		0.00036***		-0.00208***
		(0.00010)		(0.00044)
loans/deposits		0.00651***		-0.00740***
		(0.00090)		(0.00150)
N	1521702	836883	1521702	836883
R^2	0.47	0.48	0.40	0.44
CounterpartyxDay FE	Yes	Yes	Yes	Yes
Counterparty Type FE	Yes	Yes	Yes	Yes
Dealer FE	Yes	Yes	Yes	Yes
Credit rating FE	Yes	Yes	Yes	Yes
Dealer Controls	No	Yes	No	Yes
Macro Controls	No	Yes	No	Yes

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

In Column 1 and 2, we construct a linear probability model with similar specifications to (1), where the dependent variable is a dummy that takes 1 if the rate on the repo transaction is below the Bank rate and zero otherwise. We find that for the ring-fenced banking groups, the repo rates are 6 percentage points more likely to fall below the Bank rate for the same counterparty in the same day after ring-fencing relative to other banks. This leads to potential additional margins, similar to the "arbitrage" described in Anderson et al. (2021). The effect is both large and statistically significant. In a similar vein, we replace the dependent variable with a dummy variable that takes one if the transaction on the repo rate is negative, that is the RFB group is being paid to hold cash in return for its government bonds, in Column 3 and 4. In both columns, we find

that the impact of ring-fencing on the likelihood of getting a negative repo rate is around 3 percentage points which is also statistically significant. Hence, after the ring-fencing reform, the repo rates for the affected banks are more likely to fall so low compared to the non-ring-fenced groups that they could end up below the Bank rate or become negative. Hence, ring-fencing increases the availability of potential margin gains in the repo market, leading to a near risk-free gain for the affected banks.

5.1.5 What happens to the ring-fencing bonus in stress times? Covid-19 Case Study

Unlike deposits, which are often insured, short-term wholesale funding such as repo can become an unstable source of funding for banks (for example, Pérignon et al. (2018)). Fragilities in the short-term wholesale funding market can lead to sudden stops and dry-ups, resulting in substantial reductions in credit supply (Iyer et al., 2014).[25] Thus, the impact of ring-fencing on the sensitivity of banks' repo borrowing to actual periods of market stress deserves particular attention.

In this section of the paper, we study whether the ring-fencing premium survives, or even becomes more pronounced, during periods of enhanced financial distress and market uncertainty. We anticipate that the ring-fencing bonus we have identified is likely to become more pronounced in stress times for two reasons. We established in Section 5.1.3 that the perception of reduced risk enjoyed by the RFB is likely due to enhanced supervision and improved resolution, and not due to TVTF implicit guarantees. During stress times, such as the recent Covid emergency, these features of supervision and resolution are likely, we believe, to be robust. Thus, we anticipate the impact of the ring-fencing reform on the market risk-perception to remain during times of financial distress.

To test this we focus on the Covid outbreak in 2020. Our hypothesis is that the repo investors continue to distinguish between the ring-fenced and non-ring-fenced banks when they lend cash in short-term money markets during times of financial stress. We restrict the period to after 2019 and we run our panel bank FE regression where we interact the RFB group dummy with the different periods running up to and following the Covid-19 shock. We document the results in cols 1-2 of Table 3. In all our specifications, the differential cost of the repo borrowing remains negative and statistically significant throughout the Covid period. This reveals that third parties continue to see the RFB group, and the RFB subsidiary as low risk; third parties continue to be willing to lend cash to the RFB group at lower rates. We then plot our coefficients of interest and

[25]Such concerns have led regulators to address the reliance on the short-term wholesale funding, for example through the Basel III Liquidity Coverage Ratio (LCR). The LCR requires banks to hold a minimum stock of high-quality liquid assets (HQLA) to at least match the expected net cash outflows during a 30-day stress scenario and penalizes the use of unsecured wholesale funding. See BIS (2013).

their relative confidence intervals at the 95% level of significance in Graph 3. The third period on the x-axis corresponds to the first Covid lockdown in March 2020. The graph documents that the reduction in borrowing costs enjoyed by the RFB group expands in magnitude in March 2020. This indicates that the effect of ring-fencing on the ring-fenced Bank Holding Group (BHG) dealers almost doubles relative to our baseline estimate. We also find that the magnitude of our coefficient of interest on the ring-fenced bank dummy drifts back to our baseline estimate in the months following the initial Covid lockdown. This is perhaps expected as macroeconomic uncertainty declined. All these results are consistent with our leading hypothesis that the third-party investors perceive the ring-fenced banks as safer, and that the ring-fencing bonus becomes quantitatively more substantial temporarily in the times of market stress.

Second, we attempt to understand whether the time-variation in the ring-fencing bonus during the Covid period hides different dynamics in perceived risk within the RFB and nRFB arms of the ring-fenced banks. To this end, we split the ring-fence coefficient into two separate dummies to capture the RFB and nRFB subsidiaries of the BHG. We interact these coefficients with separate indicators that correspond to different periods of the Covid-19 shock in 2020. We report the result in Table 4. In all our specifications in Column 1 and 2 which concern the repo transactions, the ring-fencing bonus is negative and statistically significant in the months leading up to and following the Covid-19 shock. The RFB subsidiary it is apparent drives the observed behaviour during the period at the group level. On the other hand, when we investigate the ring-fencing bonus for the nRFB arm of the ring-fenced bank during Covid, we find that the coefficient of interest on the nRFB does also go down, temporarily initially with some reversal later. This suggests that even the nRFB subsidiary gained some ring-fencing bonus during the period of market stress, and was seen by third parties as (perhaps weakly) less risky than banks unaffected by ring-fencing.

These findings suggest that short-term money market investors continue to perceive the ring-fenced banks as safe even (or perhaps particularly) during the crisis episodes. A recent body of empirical literature has shown that during times of financial distress, any risk perception related to the probability of government bail-out matters to a greater extent than bank fundamentals (O'Hara and Shaw, 1990; Gropp et al., 2011; Dam and Koetter, 2012; Brewer and Jagtiani, 2013; Acharya et al., 2022). The novelty of our result is that the macroprudential structural reforms such as ring-fencing have a similar impact on the market safety perception in the short-term money markets.

One question that arises from this analysis is whether the reduction in the risk perception after the imposition of the fence is concentrated on the repo market, or whether the ring-fenced banks are perceived to be safer in the short-term money markets generally. To test this hypothesis, we extend the analysis in specification (1) to other deposits in Table 5 and we run a panel FE specification where the dependent variable takes log(total

Table 3: **Covid Shock and Ring-fencing**

This table reports the differential response of repo rates to Covid market stress. Column 1-2 (3-4) run a bank FE panel specification on (reverse) repo transactions where the treated dummy is interacted with indicators corresponding to different months in 2020 for the months leading up to and following the UK Covid lockdown. The bottom of the table provides information about fixed effects, and the level of clustering. Standard errors correct for clustering at the lender-level and are reported in parentheses. ***, ** and * indicate statistical difference from zero at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)
treated × *Jan 2020*	-0.00912***	-0.00541**	-0.00174	0.01322
	(0.00176)	(0.00254)	(0.00508)	(0.00742)
treated × *Feb 2020*	-0.00945***	-0.00424	-0.00320	0.01597**
	(0.00157)	(0.00275)	(0.00381)	(0.00724)
treated × *Mar 2020*	-0.01892***	-0.01294***	-0.00964	0.01003
	(0.00407)	(0.00385)	(0.00673)	(0.01038)
treated × *Apr 2020*	-0.01746***	-0.03067***	0.00837	0.02861***
	(0.00274)	(0.00300)	(0.00548)	(0.00567)
treated × *May 2020*	-0.01353***	-0.02147***	0.00117	0.01757***
	(0.00122)	(0.00233)	(0.00288)	(0.00412)
treated × *June 2020*	-0.01756***	-0.02221***	0.00346	0.02328***
	(0.00293)	(0.00312)	(0.00348)	(0.00582)
treated × *July 2020*	-0.01384***	-0.02021***	0.00523	0.01064
	(0.00284)	(0.00065)	(0.00392)	(0.00640)
treated × *Aug 2020*	-0.01028***	-0.00415***	0.00128	0.00196
	(0.00191)	(0.00076)	(0.00255)	(0.00349)
N	858009	226428	858009	850415
R^2	0.95	0.96	0.95	0.95
Counterparty × Day FE	Yes	Yes	Yes	Yes
Counterparty Type FE	Yes	Yes	Yes	Yes
Dealer/Credit rating FE	Yes	Yes	Yes	Yes
Macro Controls	Yes	Yes	Yes	Yes
Dealer/Deal Controls	No	Yes	No	Yes

Table 4: **Covid Shock: Ring-fencing and RFB/nRFB**

This table reports the differential response of repo rates to Covid market stress. Column 1-2 (3-4) run a bank FE panel specification on (reverse) repo transactions where the RFB and nRFB dummies are interacted with the series of the dummy variables corresponding to different months in 2020 for the months leading up to and following the UK Covid lockdown. The bottom of the table provides information about fixed effects, and the level of clustering. Standard errors correct for clustering at the lender-level and are reported in parentheses. ***, ** and * indicate statistical difference from zero at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)	(4)
RFB × Jan 2020	-0.05239***	-0.04881***	0.01051*	0.01241*
	(0.00297)	(0.00309)	(0.00509)	(0.00701)
nRFB × Jan 2020	-0.00043	-0.00059	-0.00316	-0.00311
	(0.00177)	(0.00193)	(0.00533)	(0.00535)
RFB × Feb 2020	-0.05483***	-0.05443***	0.00784*	0.00745*
	(0.00501)	(0.00453)	(0.00380)	(0.00422)
nRFB × Feb 2020	-0.00199**	-0.00227***	-0.00461	-0.00443
	(0.00078)	(0.00085)	(0.00404)	(0.00403)
RFB × Mar 2020	-0.09607***	-0.09632***	-0.01276*	-0.01198
	(0.00645)	(0.00554)	(0.00720)	(0.00721)
nRFB × Mar 2020	-0.00934	-0.00955	-0.01276*	-0.01198
	(0.00577)	(0.00591)	(0.00720)	(0.00721)
RFB × Apr 2020	-0.07510***	-0.07545***	0.04972***	0.04819***
	(0.00394)	(0.00367)	(0.00887)	(0.00910)
nRFB × Apr 2020	-0.00106	-0.00106	0.00381	0.00434
	(0.00274)	(0.00283)	(0.00594)	(0.00605)
RFB × May 2020	-0.05556***	-0.05581***	0.04573***	0.04850***
	(0.00318)	(0.00303)	(0.01140)	(0.01144)
nRFB × May 2020	-0.00249	-0.00250	-0.00307	-0.00277
	(0.00201)	(0.00194)	(0.00309)	(0.00307)
RFB × June 2020	-0.03654***	-0.03676***	0.02932***	0.03199***
	(0.00216)	(0.00205)	(0.00898)	(0.00867)
nRFB × June 2020	-0.01220***	-0.01196***	0.00084	0.00114
	(0.00247)	(0.00240)	(0.00329)	(0.00329)
RFB × July 2020	-0.02076***	-0.02054***	0.02576***	0.02538***
	(0.00133)	(0.00104)	(0.00788)	(0.00831)
nRFB × July 2020	-0.01215***	-0.01177***	0.00306	0.00311
	(0.00303)	(0.00286)	(0.00451)	(0.00439)
RFB × Aug 2020	-0.00568***	-0.00595***	0.01726**	0.01572*
	(0.00057)	(0.00050)	(0.00637)	(0.00764)
nRFB × Aug 2020	-0.01173***	-0.01181***	-0.00065	-0.00061
	(0.00268)	(0.00269)	(0.00267)	(0.00277)
N	858009	226428	858009	850415
R^2	0.95	0.96	0.95	0.95
Counterparty × Day FE	Yes	Yes	Yes	Yes
Counterparty Type FE	Yes	Yes	Yes	Yes
Dealer/Credit rating FE	Yes	Yes	Yes	Yes
Macro Controls	Yes	Yes	Yes	Yes
Dealer/Deal Controls	No	Yes	No	Yes

wholesale funding), log(customer deposits), log(bank deposits), and log(other deposits), respectively. We also let *treated* denote the bank subject to the ring-fencing reform, and Covid is an indicator variable taking one for 2020, *i.e.*, the first-year of the pandemic outbreak. The total wholesale funding denotes the sum of the customer deposits, bank deposits, other deposits, and any other short-term funding or long-term debt borrowing.

In Column 1 of Table 5, we find that the ring-fenced banking groups obtain 15.18 % points more total wholesale funding relative to other banks during the first-year of the Covid-19 pandemic, again supporting the view that ring-fenced banks are perceived to be safer. When we look at the differential impact of Covid-19 for different types of deposits, we find that there is no differential change for customer deposits (Column 2), which is not surprising since the majority of retail deposits are likely to be insured. However, the ring-fenced banks have collected a significantly larger amount of bank deposits (Column 3) and other types of deposits (Column 4) during the Covid outbreak relative to other banks. This again suggests that the ring-fencing bonus remains not confined to the repo market but broadly arises due to improved risk perception in a variety of funding markets.

Table 5: **Covid Shock: Ring-fencing and wholesale/deposit funding**

This table reports the differential response of the wholesale funding and deposits of the ring-fenced banks to the Covid market stress during 2020, *i.e.*, the first year of the Covid outbreak. The bottom of the table provides information about fixed-effects, and the level of clustering. Standard errors correct for clustering at the lender-level, and are reported in parentheses. ***, ** and * indicate statistical difference from zero at the 1%, 5% and 10% levels, respectively. Period: 2015-2021.

Dependent variable:	**log(wholesale funding)**	**log(customer deposits)**	**log(bank deposits)**	**log(other deposits)**
	(1)	(2)	(3)	(4)
covid	-2.0794***	-0.1598***	-0.0314	0.1239
	(0.0796)	(0.0196)	(0.1006)	(0.0930)
covid × *treated*	0.1518**	-0.0529	0.3965***	0.5164***
	(0.0673)	(0.0381)	(0.0808)	(0.0704)
N	497643	377587	192457	206153
R^2	0.9017	0.9908	0.9310	0.9325

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

In conclusion we have shown that third parties do perceive RFB groups as safer and so worthy of a low interest rate for them to borrow cash. This interest rate can be so low that it triggers the creation of potential additional margins, in the form of 'capital arbitrage' opportunities against IOER at the Central Bank. The nRFB entity within the same group is not perceived to be more risky in general, and in stress times may inherit some of the perceived safety of the RFB subsidiary.

5.2 Do ring-fenced banks have a lower risk appetite?

In this part of the paper, we examine whether the evidence suggests that the ring-fencing bonus is warranted by the risk-taking behaviour of the ring-fenced banks. To this end, we take two steps. We first study the risk-taking of banks under the scope of ring-fencing in reverse repo transactions. Second, we analyse accounting data and test whether it

supports the view that the affected banks become safer after the ring-fencing reform.

5.2.1 Evidence from reverse repo transactions

In this part of the paper, we investigate the impact of ring-fencing on the risk appetite of banking groups. To evidence this we analyse the changes in the price of liquidity in reverse repo transactions. That is we look for changes in the price RFBs demand from borrowers before they are willing to lend cash. We explore this by investigating the rates at which the dealer banks choose to lend cash in the short-term repo markets after the imposition of the fence.

Our analysis relies on the observation that *ceteris paribus*, a greater risk aversion on behalf of the repo dealers would lead to larger spreads in repo lending. Repo lenders would require greater reimbursement for the risks they run. Paligorova and Santos (2017) use a similar line of reasoning and document that U.S. banks with greater risk appetite have charged lower rates in corporate loans during periods of low interest rates. They argue that a stronger risk appetite has led banks to under-price corporate loan risk, requiring lower credit risk premia relative to the other banks.

We run our diff-in-diff baseline specification (3) on the subset of reverse repo transactions. As noted in Section 4.2 we include dealer fixed effects to account for the time-invariant characteristics of banks such as liquidity management and collateral demand. We also add *counterparty* $\times$ *day* fixed effects to control for the borrower quality at a daily level. Our tests therefore compare the change in the cost of repo provided by the ring-fenced dealer banks relative to other dealers for the same counterparty in the same day after ring-fencing.

Table 6 reports the results of this analysis. We see that in all specifications, the interest rate demanded by banking groups with RFBs inside when entering reverse repos has increased. This is apparent as the interaction term ($Treated \times Event$) in Table 6 is positive and significant at the 1% level. In the specifications without including dealer fixed effects, Column 1 shows that controlling for the counterparty and trade day, the ring-fenced dealers provide repo at 1.43 basis points (4% in relative terms) higher relative to the unaffected dealers after the implementation of ring-fencing. Once again, we emphasise that this is not driven by differences in the business model effect as the result holds even if the dealer fixed effects or controls are present (columns (2)-(5)). Furthermore, when we incorporate trade-level controls and account for collateral characteristics such as maturity and haircut in columns (4) and (5), the results remain quantitatively similar.

Our leading interpretation for this result is that the ring-fencing reform leads banks to become more risk-averse in their liquidity provision, and this is manifested by a demand for a higher price to assume the risks of lending cash. This reduction in risk appetite can for example happen because of heightened regulatory attention. Or could be that

Table 6: **Ring-fencing and reverse repo**

This table reports the impact of ring-fencing on the reverse repo rates at the level of the banking groups. The bottom of the table provides information about fixed-effects, and the level of clustering. Standard errors correct for clustering at the lender-level, and are reported in parentheses. ***, ** and * indicate statistical difference from zero at the 1%, 5% and 10% levels, respectively. Period: 2015-2021.

reverse repo rate	(1)	(2)	(3)	(4)	(5)
Treated × Event	0.01428***	0.01603***	0.01837**	0.01833**	0.01376**
	(0.00502)	(0.00418)	(0.00757)	(0.00791)	(0.00527)
bank rate			0.30409***	0.30378***	0.29161***
			(0.0514)	(0.05106)	(0.05416)
log(assets)			-0.0157	-0.015	0.0027
			(0.05112)	(0.0505)	(0.05163)
leverage ratio			0.00334	0.00332	0.0077
			(0.00612)	(0.00622)	(0.00625)
ROA			-0.00048	-0.00051	-0.00139
			(0.00132)	(0.00134)	(0.00137)
liquidity coverage ratio			-0.00016	-0.00016**	-0.00007
			(0.0001)	(0.00007)	(0.0001)
loans/deposits			0.00035	0.00036	0.00027
			(0.00048)	(0.00046)	(0.0004)
haircut			0.00001	-0.00016*	
			(0.00013)	(0.00008)	
log(amount)				-0.00116	0.00048
				(0.00133)	(0.00113)
log(maturity)					0.01357***
					(0.00158)
high price volatility					0.02044***
					(0.00304)
N	2378160	1510811	789360	789348	543872
R^2	0.94	0.94	0.94	0.94	0.95
CounterpartyxDay FE	Yes	Yes	Yes	Yes	Yes
Counterparty Type FE	Yes	Yes	Yes	Yes	Yes
Dealer FE	No	Yes	Yes	Yes	Yes
Credit rating FE	No	No	Yes	Yes	Yes
Dealer Controls	No	No	Yes	Yes	Yes
Macro Controls	No	No	Yes	Yes	Yes
Deal Controls	No	No	No	Yes	Yes

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

under the structural separation, the bank has less ability to exploit the economies of scope for example in relation to netting. A RFB group might be trading with the same counterparty during the same day but if the trades were with subsidiaries separated by the ring-fence the bank would not be able to net out the trades. In a similar vein, if repo and reverse repo trades are spread out over two separate subsidiaries, there may be fewer opportunities to exploit various synergies such as collateral rehypothecation. Most importantly, the two separate subsidiaries in the ring-fenced banking group must trade at arm's length after the reform, naturally reducing the ability of the bank to exploit internal capital markets to smooth liquidity shocks. Any of these effects would explain the reduced RFB group risk appetite.

One might wonder if this risk appetite result is driven by a reduced risk appetite on

the part of the RFB subsidiary only. To test for this possibility, we run the specification (5) which interacts the term ($Treated \times Event$) with RFB and nRFB, respectively in Table 6, Panel B. In all the specifications considered, the nRFB also charges a higher interest rate when entering a reverse repo transaction after ring-fencing when compared to the control of banking groups which do not contain a ring-fence in the group. This result suggests that the increase in the cost of provision, which we interpret as a reduction in risk appetite, extends beyond the RFB to encompass the entire banking group.

We also document, in Panel C, that the effects appear after the implementation of ring-fencing, as opposed to the asset transfer. This result implies that only when the structural ring fencing changes are implemented does the RFB group behave as if it has a lower risk appetite. The results documented in the three panels of Table 6 are therefore consistent with the repo results of Table 1 which captured that third parties see RFB groups as less risky than peers unaffected by the ring fencing regulations.

We conclude this subsection by noting that a concern regulators may have is that the banking groups subject to ring-fencing may reduce their liquidity provision in the repo market after the ring-fence. That is, a reduced risk appetite might not just mean lending in reverse repos is more expensive, but it might mean RFB groups reduce their supply of liquidity into the market. To test this, we replace the dependent variable with the reverse repo volume and we run our baseline specification (3). We report our results in Table 7. Across all specifications, our coefficient of interest is very small and statistically insignificant. Thus, we find no evidence that the affected dealers lend smaller volumes in the repo market, controlling for the counterparty in the same trading day. Ring-fencing has not, as far as we can detect, reduced the supply of cash into repo markets from affected banks, but it has made this cash more expensive.

Table 7: **Ring-fencing and reverse repo amount**

This table reports the impact of ring-fencing on the reverse repo volumes at the level of the banking groups. The bottom of the table provides information about fixed-effects, and the level of clustering. Standard errors correct for clustering at the lender-level, and are reported in parentheses. ***, ** and * indicate statistical difference from zero at the 1%, 5% and 10% levels, respectively. Period: 2015-2021.

log(reverse repo amount)	(1)	(2)	(3)	(4)	(5)
Treated × Event	-0.00385	0.03424	-0.00755	-0.00842	0.00478
	(0.0631)	(0.05626)	(0.05366)	(0.05682)	(0.05224)
bank rate			-0.24932	-0.17462	-0.48852
			(0.26219)	(0.27826)	(0.28815)
log(assets)			0.7066**	0.68426**	0.44228
			(0.26879)	(0.2489)	(0.2693)
leverage ratio			0.00943	0.00565	0.06654
			(0.06738)	(0.0695)	(0.05961)
ROA			-0.02616	-0.02572	-0.03355
			(0.01993)	(0.02036)	(0.02285)
liquidity coverage ratio			0.00365**	0.00386**	0.00428*
			(0.00156)	(0.00163)	(0.00205)
loans/deposits			0.00695*	0.00734*	0.00379
			(0.00368)	(0.00374)	(0.0039)
haircut				0.0007	0.00072
				(0.00104)	(0.00145)
deal rate				-0.25572	0.10927
				(0.24988)	(0.28524)
log(maturity)					-0.0644
					(0.03791)
high price volatility					-0.13161*
					(0.06531)
N	2378160	1510811	789360	789348	543872
R^2	0.12	0.14	0.16	0.16	0.17
CounterpartyxDay FE	Yes	Yes	Yes	Yes	Yes
Counterparty Type FE	Yes	Yes	Yes	Yes	Yes
Dealer FE	No	Yes	Yes	Yes	Yes
Credit rating FE	No	No	Yes	Yes	Yes
Dealer Controls	No	No	Yes	Yes	Yes
Macro Controls	No	No	Yes	Yes	Yes
Deal Controls	No	No	No	Yes	Yes

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

5.2.2 Heterogeneity

We now refine our investigation as to the characteristics of ring-fenced banking groups which see the greatest change in their risk appetite. We do this by studying the heterogeneity of the price effect across bank dealers with different balance sheet characteristics in terms of size, liquidity, and capitalization. To this end, we sort banks into buckets of different levels of size, liquidity, and capitalization in a one-year rolling window. We define a bank as small if the bank has a size smaller than the country median within a given year. In a similar vein, we classify a bank as illiquid (low capital) if its liquidity

Panel B: RFB versus nRFB

This table reports the impact of ring-fencing on the reverse repo rates by RFB and nRFB, separately. The bottom of the table provides information about fixed-effects, and the level of clustering. Standard errors correct for clustering at the lender-level, and are reported in parentheses. ***, ** and * indicate statistical difference from zero at the 1%, 5% and 10% levels, respectively. Period: 2015-2021.

reverse repo rate	(1)	(2)	(3)	(4)	(5)
Treated × *Event* × *RFB*	0.02801***	0.02833***	0.02322*	0.02353*	0.01978**
	(0.0044)	(0.00689)	(0.01227)	(0.01246)	(0.00835)
Treated × *Event* × *nRFB*	0.01532***	0.01767***	0.01614*	0.01635*	0.0098*
	(0.00471)	(0.00432)	(0.00838)	(0.00901)	(0.00528)
bank rate			0.30465***	0.30444***	0.29268***
			(0.05156)	(0.0512)	(0.05395)
log(assets)			-0.013	-0.01159	0.00342
			(0.05215)	(0.05153)	(0.05217)
leverage ratio			0.00353	0.0037	0.00685
			(0.00629)	(0.00655)	(0.00567)
ROA			-0.00042	-0.00047	-0.0013
			(0.00154)	(0.00157)	(0.00142)
liquidity coverage ratio			-0.0001	-0.00011	-0.00002
			(0.00011)	(0.00009)	(0.00008)
loans/deposits			0.00038	0.00039	0.00027
			(0.00048)	(0.00046)	(0.0004)
haircut				-0.00002	-0.00017*
				(0.00013)	(0.00008)
log(amount)				-0.00117	0.00047
				(0.00133)	(0.00113)
log(maturity)					0.01356***
					(0.00156)
high price volatility					0.02051***
					(0.00307)
N	2378160	1510811	789360	789348	543872
R^2	0.94	0.94	0.94	0.94	0.95
CounterpartyxDay FE	Yes	Yes	Yes	Yes	Yes
Counterparty Type FE	Yes	Yes	Yes	Yes	Yes
Dealer FE	No	Yes	Yes	Yes	Yes
Credit rating FE	No	No	Yes	Yes	Yes
Dealer Controls	No	No	Yes	Yes	Yes
Macro Controls	No	No	Yes	Yes	Yes
Deal Controls	No	No	No	Yes	Yes

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

coverage ratio (capital ratio) is lower than country median at a given time. We then augment our baseline specification (3) by interacting the $Treated \times Event$ dummies with these indicator variables in a triple-diff-and-diff setting.

Table 8 reports the results of this analysis. We first explore the banks' liquidity position as a potential explanation for our results on reduced risk appetite. It may be the case that after ring-fencing, liquidity constraints such as liquidity regulatory ratios become more binding, leading the banking groups to become more inclined to hoard liquidity. In Column 1, we find that the effects are not related to liquidity, as illiquid dealers are no more likely than more liquid banks to charge higher rates for repo provision after ring-fencing.

Panel C: Transfer versus implementation

This table reports the impact of ring-fencing on the reverse repo rates at the level of the banking groups after the ring-fencing asset transfer and the regulatory implementation, respectively. The bottom of the table provides information about fixed-effects, and the level of clustering. Standard errors correct for clustering at the lender-level, and are reported in parentheses. ***, ** and * indicate statistical difference from zero at the 1%, 5% and 10% levels, respectively. Period: 2015-2021.

reverse repo rate	(1)	(2)	(3)	(4)	(5)
Treated × *Transfer*	0.007*	0.0105**	0.0127	0.0128	0.0108
	(0.0036)	(0.0038)	(0.0087)	(0.0088)	(0.0064)
Treated × *Implementation*	0.0164**	0.0212***	0.0229***	0.0229**	0.0164***
	(0.0059)	(0.0046)	(0.0074)	(0.0081)	(0.0052)
bank rate			0.3033***	0.303***	0.2911***
			(0.0519)	(0.0515)	(0.0546)
log(assets)			-0.0108	-0.0099	0.0052
			(0.051)	(0.0506)	(0.0517)
leverage ratio			0.0075	0.0075	0.01*
			(0.006)	(0.0064)	(0.0055)
ROA			-0.0005	-0.0005	-0.0014
			(0.0012)	(0.0012)	(0.0014)
liquidity coverage ratio			-0.0001	-0.0001	0
			(0.0001)	(0.0001)	(0.0001)
loans/deposits			0.0004	0.0004	0.0003
			(0.0005)	(0.0004)	(0.0004)
haircut				0	-0.0002*
				(0.0001)	(0.0001)
log(amount)				-0.0011	0.0005
				(0.0013)	(0.0011)
log(maturity)					0.0136***
					(0.0015)
high price volatility					0.0204***
					(0.0031)
N	2378160	1510811	789360	789348	543872
R^2	0.94	0.94	0.94	0.94	0.95
CounterpartyxDay FE	Yes	Yes	Yes	Yes	Yes
Counterparty Type FE	Yes	Yes	Yes	Yes	Yes
Dealer FE	No	Yes	Yes	Yes	Yes
Credit rating FE	No	No	Yes	Yes	Yes
Dealer Controls	No	No	Yes	Yes	Yes
Macro Controls	No	No	Yes	Yes	Yes
Deal Controls	No	No	No	Yes	Yes

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

Column 2 shows that the size of the dealer bank has no explanatory power in explaining the impact on the price of liquidity. As documented in previous research, smaller banks are more responsive to shocks to their funding structure, in part due to greater informational asymmetries which they suffer from in external financing. The result we find suggests that the effects on risk appetite are likely not due to size. This is perhaps not surprising, since we find that the ring-fenced banking groups are able to borrow at lower rates relative to other dealers in the short-term repo markets after the imposition

of the ring-fence, and any informational asymmetries are overcome by the transparency required by ring-fence implementation.

Table 8: **Heterogeneity**

This table reports the heterogenous impact of ring-fencing on the reverse repo rates by dealer-bank-specific characteristics. The bottom of the table provides information about fixed-effects, and the level of clustering. Standard errors correct for clustering at the lender-level, and are reported in parentheses. ***, ** and * indicate statistical difference from zero at the 1%, 5% and 10% levels, respectively. Period: 2015-2021.

	(1)	(2)	(3)	(4)
Treated	0.00019	0.00872	0.02516	0.04902
	-0.03103	-0.02001	-0.03548	-0.07356
Treated × *Event*	0.01962***	0.02184***	0.00835	0.0046
	-0.00611	-0.00657	-0.00736	-0.00617
Treated × *Event* × *illiquid*	-0.00785			
	-0.00896			
Treated × *Event* × *Small*		-0.00982		
		-0.0093		
Treated × *Event* × *low capital*			0.01392***	
			-0.00395	
Treated × *Event* × *weak relation*				0.01772**
				-0.00619
bank rate	0.30275***	0.30323***	0.30471***	0.3001***
	-0.04841	-0.05087	-0.05091	-0.04142
log(assets)	-0.02158		-0.01181	-0.01731
	-0.05129		-0.04969	-0.03199
leverage ratio	0.0057	0.0054		-0.00369
	-0.00581	-0.00585		-0.00484
ROA	-0.00125	-0.00117	-0.00004	-0.00002
	-0.00147	-0.0016	-0.00137	-0.00162
loans/deposits	0.00034	0.00035	0.00055	-0.00003
	-0.00047	-0.0005	-0.00062	-0.00029
haircut	-0.00001	0	0.00002	-0.00004
	-0.00012	-0.00013	-0.00013	-0.00014
log(amount)	-0.00111	-0.00116	-0.00114	-0.00005
	-0.00133	-0.00134	-0.00134	-0.00122
liquidity coverage ratio		-0.00012	-0.0001*	-0.00005
		-0.00007	-0.00005	-0.00016
N	796613	789348	789348	1081100
R^2	0.94	0.94	0.94	0.95
CounterpartyxDay FE	Yes	Yes	Yes	Yes
Counterparty Type FE	Yes	Yes	Yes	Yes
Dealer FE	Yes	Yes	Yes	Yes
Credit rating FE	Yes	Yes	Yes	Yes
Dealer Controls	Yes	Yes	Yes	Yes
Macro Controls	Yes	Yes	Yes	Yes
Deal Controls	Yes	Yes	Yes	Yes

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

Third, we explore, in Column 3, the heterogeneity of the risk appetite result arising

from the ring-fence regulation across bank dealers with different levels of capitalization. We show that the increase in the cost of reverse repo is more pronounced for weakly capitalized banks. The differential increase in the rate on reverse repo transactions is 1.392 percentage points larger for banks with weaker capitalization. This also lends further support to our leading interpretation that the increase in the price of liquidity captures the reduction in the risk appetite of the banking groups. It is likely that banks with weaker levels of capitalization have less ability to withstand unexpected shocks, and thereby become more risk-averse in their liquidity provision.

We finally also explore the heterogeneity of the effects by the cross-sectional variation across the repo counterparties. A large body of literature has shown that banks are less likely to pass through the cost of financial and regulatory frictions to their relationship borrowers, preferring to extract rents from more transactional clients. Consistent with this body of empirical evidence, we define an indicator variable *weak relation* that is one if the number of transactions between the dealer and counterparty is less than the median number of bilateral reverse repo transactions in the repo market segment. We then augment the baseline specification with this indicator variable and report our findings in Column 4 of Table 8.

The results state that the increase in the cost of repo provision is more pronounced for counterparties with whom the dealer banks transact less frequently. The differential impact on these types of counterparties is around 1.772 percentage points larger. This suggests that banks are less likely to increase the price of the offered repo with their frequent borrowers with whom they enjoy a banking relationship. It has been argued that Basel III is designed to encourage greater relationship lending as the net stable funding weights make a distinction between stable and unstable corporate deposits. The effect of the ring-fence is, we find, consistent with this aim.

5.2.3 What happens to the risk-appetite in stress times? Covid-19 Shock

Our next suite of results explores whether the risk appetite of the ring-fenced banks remains reduced even during periods of extreme market stress, such as the Covid crises periods. We observed in Section 5.1.5 that the perception of third parties that RFB groups were safer was preserved, and potentially strengthened, during times of market stress such as presented by Covid. Here we explore if the behaviour of the ring fence banking groups justifies this view. Ring-fencing is new and the covid shock unprecedented, therefore it is possible for clients to mis-judge ring fenced banks. We study here if this occurs.

We replicate our analysis on reverse repo transactions. We report our panel FE regression with the time and ring-fenced-bank interaction dummies in Columns 3-4 of Table 3. We also plot the coefficients on the interaction terms in Graph 4. We find that the ring-fencing coefficient is insignificant throughout Covid in Column 3, though

we still estimate an impact on the reverse repo rates of a magnitude that is similar to our baseline specification when we control for dealer and trade characteristics. In times of market stress there is a general withdrawal of reverse repo lending, leading to higher prices. We find that the reduced risk-appetite in times of market stress was market wide; the RFB groups do not reduce their risk-appetite by a statistically significant amount on top of that general effect. When we separately investigate the differential response of the RFB and nRFB entities to Covid in Columns 3-4 of Table 4 we uncover that there is a statistically significant reduction in the risk appetite of the RFB subsidiary at the height of the Covid crisis (April –July 2020) which is stastically greater than that pertaining to banks generally at the time. The nRFB entity has no such effect, and so when aggregated together at the group level explains the lack of statistically significant effect described above.

5.2.4 Is the ring-fencing bonus supported by the accounting data?

As discussed our results from Table 1 suggest that the banking groups subject to ring-fencing are perceived to be safer. The discussion in Section 5.2.1 suggests that ring-fenced groups do adjust their behaviour as if they have a reduced risk appetite. We now explore balance-sheet data to test whether these results are supported by objective economic fundamentals. If the banks subject to ring-fencing were to become safer after the reform, we would expect them to build up higher levels of liquidity, excess reserves, and capitalization after the reform due to the fence.

We test this conjecture with a differences-in-differences analysis analogous to (1) or (3) using balance sheet data as the dependent variable in Table 10. In Column 1, we use as dependent variable the interbank ratio, calculated as money lent to other banks divided by money borrowed from other banks. We find that after the structural reform, the banks subject to ring-fencing reduce their interbank ratios dramatically by 24.57 percentage points (50% in relative terms), suggesting that they become net holders of cash in the short-term money markets. This is also consistent with our previous findings that following the imposition of the fence, banks become more risk averse in their liquidity holdings. We established in Table 7 that the volume of cash lent did not significantly change. Therefore the volume of cash accepted from third parties rose. This is consistent with the safety others see in the RFB and the opportunity for the RFB to conduct IOER arbitrage.

[Table 10]

In Column 2, we replace the dependent variable with the natural logarithm of cash and central bank reserves. We show that ring-fencing leads banks to increase their cash levels by 37% after the imposition of the ring-fence relative to other banks. We also find

in Column 3 that the results are robust to using, as the dependent variable, the ratio of the total cash and Central Bank reserves to total assets. Hence, as the banks reduce their interbank lending ratios, they build up their liquidity and excess reserves.

Finally, we study the capitalization ratio. The capital asset ratio has been used in the empirical banking literature as a measure of bank risk-taking (for example, Laeven and Levine (2009)). First, a higher capitalization ratio, holding the asset risk fixed, offers greater protection against losses, and reduces the risk of bank failures (Keeley, 1990). Second, traditional banking theory argues that for a value-maximizing bank, the incentives to increase asset risk decline as the level of capital goes up Furlong and Keeley (1987, 1989). In Column 4 of Table 10, we document that the banking groups subject to ring-fencing increase their capitalization by 1.82 percentage points relative to other banks.

Taken collectively, the results are consistent with our main conjecture that following ring-fencing, banks are seen as safer and this is because they both become objectively safer and because they reduce their risk appetite.

6 Further Robustness Checks

We conclude this study with some further robustness checks.

Our main analysis heavily relies on a differences-in-differences approach and so we need to test for pre-trends and ensure the two groups are comparable, and the driver was indeed the ring-fencing reform.

The ring-fencing reform imposes a ring-fence on the banking groups with above £25 billion deposits, giving us a treatment and control group. In Table 9, we report the pre-treatment characteristics of these banks. We show that in Panel A, the banks in the treatment and control group are broadly similar in terms of size, total deposits, total equity, ROA, cost-to-income, liquidity coverage ratio, Tier 1 Capital Ratio, and price-to-book. In subsequent robustness checks we restrict the sample to sterling-deposit-taking banks and match our treatment and control groups based on a rich set of pre-treatment-bank characteristics and using a series of different propensity-score matching techniques. We report these bank characteristics in Panel B of Table 9. We find that our empirical results remain both quantitatively and qualitatively similar.

The Figure 1 shows that roughly 25% of the entire trades by notional GBP at group level are done in the RFB entity, andthat there is no material change in the volume of the repo transactions done at group level after the ring-fencing regime went into place.

We also test for the possibility that there were pre-trends or changes in risk perception running up to the ring-fencing implementation. We run a Granger type dynamic panel regression test with lag and lead coefficients relative to the event period - the ring-fencing

implementation in January 2019. [26] In graph A from Figure 2 we adjust our baseline specification (1) replacing the main explanatory $ring - fencing_{jt}$ by a series of variables which take the value 1 for an RFB exposed group at each of 2 yearly leads and 2 yearly lags before and after the implementation date. In essence we estimate the parameter of interest β_1 for each year before and after implementation. This is a test of pre-trend as we explore if RFB status had any effect on interest rates demanded before the implmentation of the ring-fence; and we test if the effects we have found are long-lived after teh implementation of the ring-fence. Graph A of Figure 2 shows that while the coefficients for the pre-event period are all insignificant, the coefficients on the post-event period are all significant at the 5% level. This analysis therefore supports that there were no pre-trends, and the post-event dynamic coefficients show that the ring-fencing reform has persistent effects.

Graph B from Figure 2 replicates the analysis where volumes are the dependent variable. Here we find no significant impact on volumes pre- or post- reform, suggesting that ring-fencing had primarily a price, and not a volume impact. This is consistent with our finding that volumes were not affected by ring-fencing presented in tables 7 and 11.

An important aspect to consider is the well-known empirical finding that the leverage ratio (LR) has had a first-order negative impact on the repo volumes (Allahrakha et al., 2018; Kotidis and Van Horen, 2018). [27]This insight is relevant as repo borrowing (i.e. receiving cash) increases the size of the balance sheet, requiring capital under the non-risk weighted LR ratio despite being a low-margin activity. [28] It is theoretically possible that because of ring-fencing, affected banking groups become particularly constrained by the leverage ratio. If this were the case then lending would be more expensive for the bank and so this could explain our reverse repo results. Such a concern fails to explain the altered risk perception of third parties. Nevertheless, for completeness we document that there is no volume effect associated with the repo results. To do so we replicate our baseline specification (1) by replacing the dependent variable with the trade volume in Table 11. We show that in all columns, the coefficient of interest is statistically insignificant, suggesting that ring-fencing did not reduce the repo volumes. We believe that this also reduces the possibility that the leverage ratio may be at work.

[Table 11]

[26]See the text-book discussion in Angrist and Pischke (2009) §5.2, especially around equation (5.2.6)

[27]Allahrakha et al. (2018) show that after the implementation of LR, the U.S. dealers reduced their use of repo borrowing. Relatedly, Kotidis and Van Horen (2018) document that LR had a negative impact on the repo borrowing in the dealer-client gilt repo market. Macchiavelli and Pettit (2021) on the other hand, document that the liquidity coverage (LCR) ratio led the repo dealers to extend the maturity of repo backed by the lower quality collateral and build up larger stocks of Treasury securities. The focus of our paper is to investigate the implications of ring-fencing in the repo market.

[28]There is no balance sheet impact from reverse repo (i.e. cash lending), Kotidis and Van Horen (2018).

Evidence that the differential impact of the leverage ratio is not behind our results can be sought directly from repo rates. We exploit the fact that the LR capital charge does not apply if the transactions are nettable (BIS CGFS, 2017). A repo and a reverse repo transaction are nettable if they are transacted with the same counterparty on the same day, with the same transaction amount, and subject to the same settlement and maturity dates. Although netting multiple transactions is pervasive in the trades cleared by the CCP, they are also prevalent in the bilateral dealer-client markets (Gerba and Katsoulis, 2021). We consider the nettable feature of repo transactions in Table 12 and we test, in Column 1 and 2, the impact of ring-fencing on the nettable and non-nettable transactions respectively. Both columns show that the RFBs still receive repo cash at more attractive terms after the ring-fencing whether we focus on nettable or non-nettable transactions suggesting that our lead interpretation holds irrespective of the leverage ratio.

[Table 12]

We also consider the concern that the repo rates may differ for transactions with longer settlement dates. If the affected banks were to borrow at shorter maturity after the ring-fencing, this may partially explain the decline in the repo rates. To tackle this concern, we control for the maturity of the repo transaction in the regressions and we further consider this issue in Table 12. In particular, we compare the overnight repo transactions of the ring-fenced banks with the same counterparty with those that settle over longer durations. In the Columns 3 and 4 of Table 12, we find that whatever the maturity, RFB groups borrow cash at lower prices in the repo market both overnight or for longer periods.

7 Conclusion

Following the great financial crisis, many regulators have proposed more drastic and radical approaches than capital and liquidity requirements to mitigate the too-big-to-fail problem and increase the resilience of the financial system. One prominent approach has been to impose structural reforms that require banking groups to ring-fence their banking operations. How to best restructure the banking system remains an open question for both economists and regulators. Empirical research is largely silent on the impact of ring-fencing on the risk perception and risk appetite of the affected banking group and its separate subsidiaries.

In this paper, we focus on the UK ring-fencing reform (Vickers, 2011) that splits banks into two legally distinct subsidiaries: RFB and nRFB. Such ring-fencing can, it is argued, help in resolving the key deposit taking banking subsidiary whilst giving the regulator the option to wind up the other parts of the banking group. We empirically study the impact of this deconstruction on interest rates which banks are charged by informed

counterparties and at which they lend. We argue that the former captures third party views of the riskiness of RFB, while the latter captures their risk appetite.

We uncover the existence of a ring-fencing bonus, *i.e.* evidence that ring-fencing is perceived by third parties as insulating the RFB subsidiary from risk. Third parties are therefore willing to lend cash to these entities at lower rates than otherwise. We find that there is no significant impact on the perceived riskiness of the nRFB. The RFB, we find, remains as committed to the repo market, but it provides liquidity at a higher price. We further document that the ring-fenced banks reduce their risk-taking, and build up their capital and liquidity buffers after the fence. The ring-fencing bonus is, we find, durable; affected banks were more resilient to the Covid-19 outbreak relative to other banks. The evidence collectively suggests that structural reforms to tackle the too-big-to-fail problem may have substantial effects on risk in the banking system.

We are able to rule out cost and supply effects as alternative explanations for our results. There is no evidence that ring-fence banks reduce their supply of liquidity into the market, making a supply-side explanation unlikely. The costs of providing repo to a bank are affected by its own cost of capital, which in turn can be affected by changes in the leverage ratio. We note that not all repo transactions expand the balance sheet – nettable ones do not. And yet we show that the ring-fencing bonus applies irrespectively to the nettable status of the repo.

We therefore conclude that third parties see ring fenced groups as safer and that this safety is predominantly enjoyed by the ring fenced subsidiary. The non-ring fenced subsidiary is not however exposed to higher costs of liquidity, or seen as less safe, to any economically meaningful extent.

Table 9: **Ring fencing: pre-treatment covariates**

This table reports the pre-treatment covariates for the ring-fenced and other bank dealers. Panel A reports these characteristics for the full sample of the bank dealers in the UK gilt market. Panel B reports the pre-treatment characteristics for a matched control group among the UK-sterling deposit taking dealers based on the pre-treatment bank characteristics. The matching is obtained using the nearest-neighbor matching with the probit method.

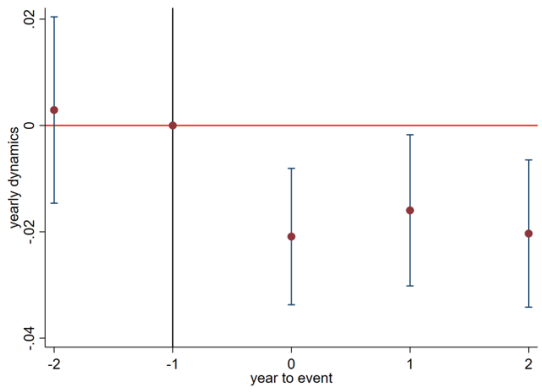
	(1)	(2)
Full Sample	**Treated**	**Control**
log(deposits)	20.11453	19.77794
log(equity)	2.03863	1.990218
log(assets)	20.82985	20.41599
ROA	0.339509	0.44471
Cost to income	66.78169	66.19216
Liquidity Coverage Ratio	136.9673	136.8957
Tier1 Cap Ratio	16.40367	15.47427
Price-to-Book	90.92577	112.8208
Propensity-score-matched sample	**Treated**	**Control**
log(deposits)	20.11453	19.69782
log(equity)	2.03863	1.896897
log(assets)	20.82985	20.68357
ROA	0.339509	0.298579
Cost to income	66.78169	77.38653
Liquidity Coverage Ratio	136.9673	152.2295
Tier 1 Cap Ratio	16.40367	16.3542
Price-to-Book	90.92577	89.40085

Figure 1: **Repo volumes and share in RFBs**

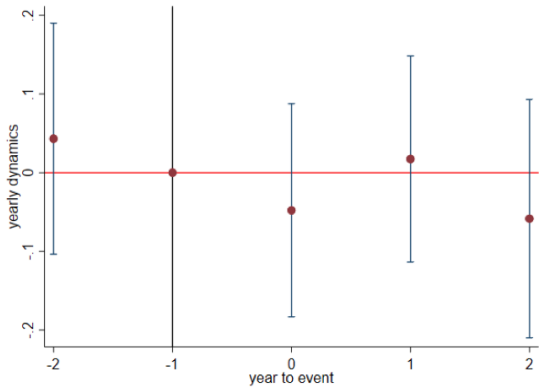
This figure reports the total repo volumes in the UK repo market. The left-hand-side panel reports the share of the total number of trades and notional GBP performed by the RFB entity of the ring-fenced banks (%) after the reform. The right-hand-side panel documents the total volume of the repo trading for the ring-fenced and other bank dealers separately for the period 2016-2021.

Figure 2: Rate and volume dynamics pre- and post-implementation

Graph A displays the coefficients and confidence intervals estimated for the baseline specification 1 adjusted to include lead and lag dummy variables interacted with RFB group status in a dynamic Granger test for pre-trends (Angrist and Pischke, 2009). While Graph A uses the repo rate as the dependent variable, Graph B uses the natural log of transaction volume as dependent variable. On the x-axis, 0 refers to 2019 as implementation year of ring-fencing, running from 2017 (-2) to 2021 (2). Both sets of estimates control for dealer, pair (dealer-counterparty), and year fixed effects.



Graph A – coefficients and CI based on repo rate as dep. var.



Graph B – coefficients and CI based on volumes as dep. var.

Table 10: **Is the ring-fencing bonus warranted?**

This table reports the impact of ring-fencing on the long-term balance-sheet characteristics at the level of the banking groups. The bottom of the table provides information about fixed-effects, and the level of clustering. Standard errors correct for clustering at the lender-level, and are reported in parentheses. ***, ** and * indicate statistical difference from zero at the 1%, 5% and 10% levels, respectively. Period: 2015-2021.

Dependent variable:	**Interbank ratio**	**log(Cash & CB Reserves)**	**Cash & CB Reserves /Assets**	**Capital ratio**
	(1)	(2)	(3)	(4)
Event	0.0797	-0.0314	0.0204***	28.80*
	(12.91)	(0.0518)	(0.00191)	(15.05)
Treated × *Event*	-24.57**	0.371***	0.0134**	1.828**
	(11.37)	(0.123)	(0.00617)	(0.779)
N	165697	484987	504025	131998
R^2	0.508	0.948	0.690	0.739
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes

Table 11: **Ring-fencing and repo volumes**

This table reports the impact of ring-fencing on the repo volumes at the level of the banking groups. The bottom of the table provides information about fixed-effects, and the level of clustering. Standard errors correct for clustering at the lender-level, and are reported in parentheses. ***, ** and * indicate statistical difference from zero at the 1%, 5% and 10% levels, respectively. Period: 2015-2021.

log(repo amount)	(1)	(2)	(3)	(4)	(5)
Treated × *Event*	0.06607	0.0364	-0.01718	-0.03786	-0.02155
	(0.05468)	(0.03403)	(0.06648)	(0.06431)	(0.07048)
bank rate			-0.35352***	-0.37272**	-0.56816***
			(0.1174)	(0.15977)	(0.10148)
log(assets)			0.40853***	0.47225***	0.45623***
			(0.14317)	(0.1227)	(0.08487)
leverage ratio			-0.12075	-0.14211*	-0.05473
			(0.07896)	(0.07623)	(0.05669)
ROA			0.02274***	0.02619***	-0.00419
			(0.00356)	(0.00385)	(0.00386)
liquidity coverage ratio			-0.00214**	-0.00176**	-0.00093
			(0.00096)	(0.00088)	(0.00076)
loans/deposits			-0.00495***	-0.00362***	-0.00452**
			(0.00092)	(0.00081)	(0.00178)
haircut				0.0023***	0.00116
				(0.00046)	(0.00086)
deal rate				0.00575	0.20352**
				(0.16511)	(0.09452)
log(maturity)					-0.05108**
					(0.02095)
high price volatility					-0.07486***
					(0.02163)
N	2377823	1521702	836883	836877	577728
R^2	0.17	0.18	0.18	0.18	0.2
CounterpartyxDay FE	Yes	Yes	Yes	Yes	Yes
Counterparty Type FE	Yes	Yes	Yes	Yes	Yes
Dealer FE	No	Yes	Yes	Yes	Yes
Credit rating FE	No	No	Yes	Yes	Yes
Dealer Controls	No	No	Yes	Yes	Yes
Macro Controls	No	No	Yes	Yes	Yes
Deal Controls	No	No	No	Yes	Yes

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

Table 12: **Netting and maturity**

This table reports the heterogenous impact of ring-fencing on the repo rates at the level of the banking groups for different levels of maturity and nettability. The bottom of the table provides information about fixed-effects, and the level of clustering. Standard errors correct for clustering at the lender-level, and are reported in parentheses. ***, ** and * indicate statistical difference from zero at the 1%, 5% and 10% levels, respectively. Period: 2015-2021.

Repo rate	(1)	(2)	(3)	(4)
Treated × *Event*	-0.01824***	-0.00662**	-0.01576***	-0.00675***
	(0.00292)	(0.00315)	(0.00161)	(0.00059)
Treated × *Event* × *Overnight*			-0.00903***	-0.00622***
			(0.00054)	(0.00045)
bank rate		0.26423***		0.23049***
		(0.00711)		(0.04611)
log(assets)		0.04035***		0.05175***
		(0.01091)		(0.01498)
leverage ratio		0.00966***		0.01120***
		(0.00143)		(0.00215)
ROA		0.00008		-0.00016
		(0.00074)		(0.00049)
liquidity coverage ratio		-0.00021*		-0.00013*
		(0.00012)		(0.00008)
loans/deposits		0.00040		0.00054***
		(0.00032)		(0.00019)
N	1449627	793976	1342793	738328
R^2	0.95	0.94	0.96	0.95
CounterpartyxDay FE	Yes	Yes	Yes	Yes
Counterparty Type FE	Yes	Yes	Yes	Yes
Dealer FE	Yes	Yes	Yes	Yes
Credit rating FE	No	Yes	No	Yes
Dealer Controls	No	Yes	No	Yes
Macro Controls	No	Yes	No	Yes
Deal Controls	Yes	Yes	Yes	Yes

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

Figure 3: **Effects on repo transactions during Covid-19**

We run our baseline bank panel FE specification on repo transactions by restricting our data to the period after 2019. The graph presents the coefficients and confidence intervals on the interaction between different months of the coronavirus period in 2020 with (i)- top panel - ring-fenced banking holding group (BHG); (ii) bottom left panel - the RFB arm of the ring-fenced banking group; (iii) bottom right panel - the nRFB arm of the ring-fenced banking group. Estimates from (ii) and (iii) come from a panel specification of the RFB and nRFB dummies interacted with the different month periods during the coronavirus shock.

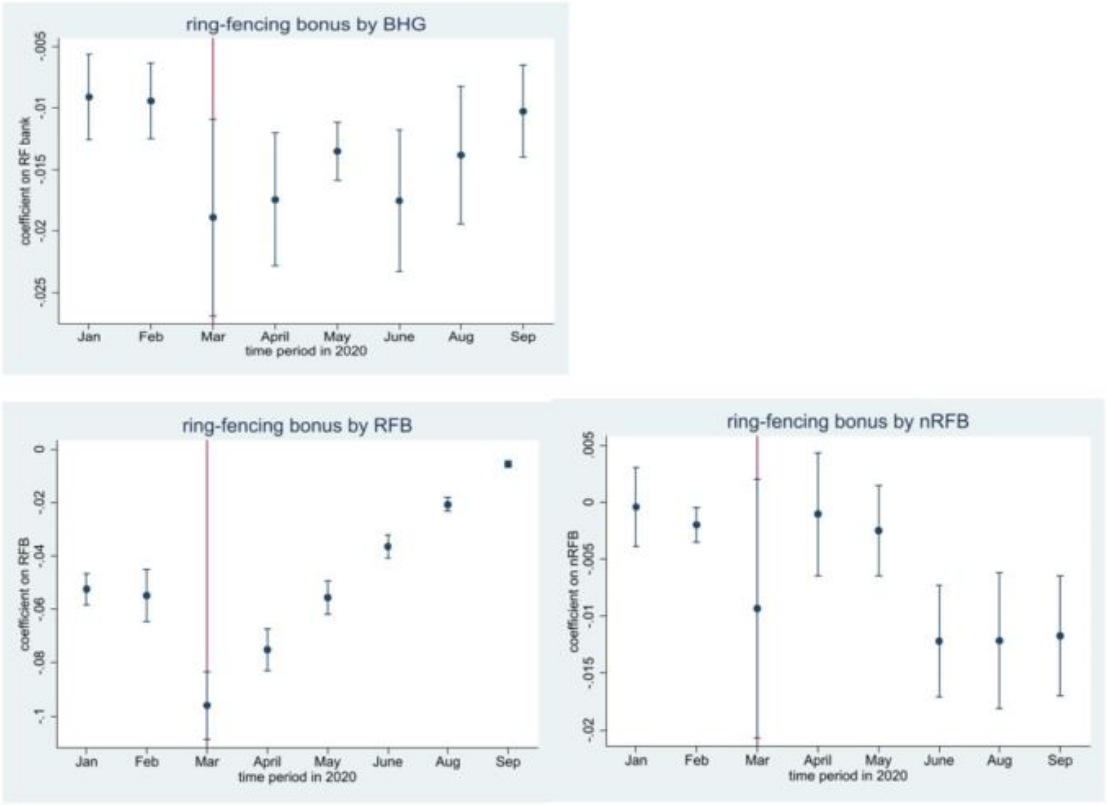
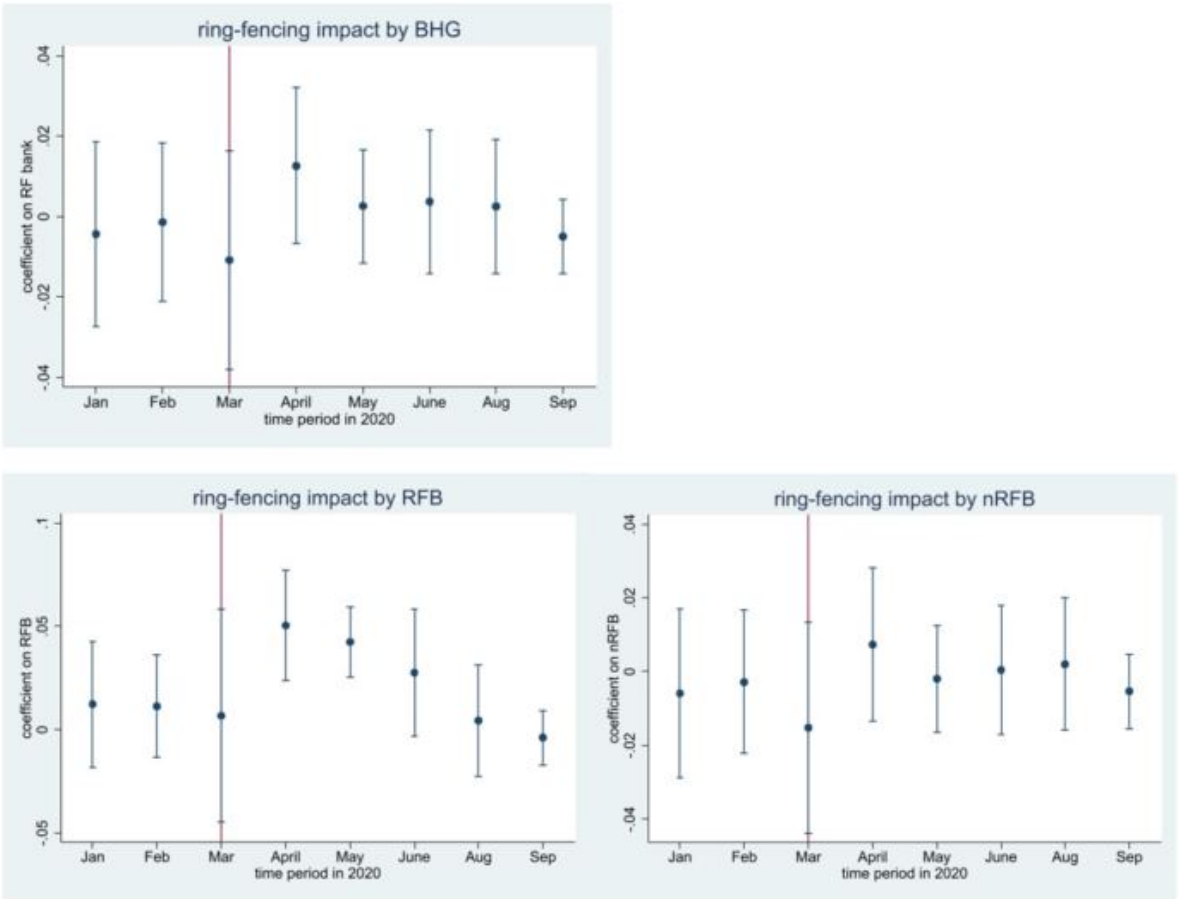


Figure 4: **Effects on reverse repo transactions during Covid-19**

We run our baseline bank panel FE specification on reverse repo transactions by restricting our data to the period after 2019. The graph presents the coefficients and confidence intervals on the interaction between different months of the coronavirus period in 2020 with (i)- top panel - ring-fenced banking holding group (BHG); (ii) bottom left panel - the RFB arm of the ring-fenced banking group; (iii) bottom right panel - the nRFB arm of the ring-fenced banking group. Estimates from (ii) and (iii) come from a panel specification of the RFB and nRFB dummies interacted with the different month periods during the coronavirus shock.



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