Separating Retail and Investment Banking: Evidence from the UK*

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Abstract

The idea of separating retail and investment banking remains controversial. Exploiting the introduction of UK ring-fencing requirements, we document novel implications for credit supply, competition, and risk-taking via a funding structure channel. By preventing retail deposits from funding capital market activities, this separation leads universal banks to rebalance towards mortgage lending and away from supplying corporate credit lines and underwriting services. By redirecting the benefits of deposit funding towards the retail market, this rebalancing reduces the cost of household credit, without eroding lending standards. However the rebalancing also increases mortgage market concentration and risk-taking by smaller banks via competition effects.

Keywords: Bank regulation, Universal banking, Mortgages, Syndicated lending, Competition.

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Whether "traditional" banking services to households and SMEs should be separated from "non-traditional" market-based activities has been debated since at least the Glass-Steagall Act of 1933. But global consensus remains elusive. In Europe and Canada, banking groups can operate as integrated "universal banks," whereas they must split their retail and investment banking activities into separate subsidiaries in the US and Japan. The global financial crisis reignited this debate but left these divergences open. And recently, prominent US regulators and politicians — including Joe Biden — have renewed calls for stronger "structural separation," while others have expressed scepticism.[1]

In this paper, we uncover a new mechanism through which structural separation affects credit supply, competition, and risk-taking in previously undocumented ways. When universal banks are required to separate their retail and investment banking activities, they are unable to use retail deposits to support capital market activities. To the extent that retail deposits benefit from a safety or liquidity premium — for example, due to deposit insurance or households' preference for liquidity — this constraint can change the relative funding costs of different activities, and hence affect universal banks' incentives to engage in them.

Exploiting a major regulatory reform in the UK, and using loan-level data for identification, we show that this "deposit funding channel" causes universal banks to reduce their provision of corporate credit lines and loan underwriting services, and to increase their domestic retail lending. This rebalancing reduces interest rates and maturity premia in the retail credit market, without eroding lending standards. But the rebalancing also has knock-on effects in the wider retail banking system with more ambiguous implications for competition and financial stability. As they redirect the benefits of deposit funding to the retail credit market, large universal banks outcompete smaller lenders,

[1] After the crisis, the US adopted a limited separation with the Volcker Rule, while EU governments rejected the more far-reaching Liikanen proposals. The 2016 Republican and Democratic presidential platforms both included proposals to impose stricter separation between commercial and investment banking, as did the 2020 Democratic platform. In 2017, Senators Elizabeth Warren and John McCain submitted a "21st Century Glass-Steagall" bill, and FDIC Vice Chairman Thomas Hoenig (2017) proposed that core and non-core activities be "partitioned" into separately managed and capitalized affiliates, whereas Yellen (2017) expressed scepticism.

which exacerbates concentration in this market. Faced with this increased competitive pressure, smaller banks respond by rebalancing their lending towards higher-yielding but riskier retail loans.

To our knowledge, ours is the first empirical study of a separation between the deposit-taking and capital market activities of universal banks, and of the impact of structural separation policies for both retail and corporate borrowers. To date, existing literature has mostly focused on universal banks' ability to combine loan and underwriting services to large corporates.[2] In contrast there has been little empirical research on the funding of universal bank activities. This is despite questions around the potential for the benefits of deposit funding to accrue to capital market activities playing an important role both in recent regulatory proposals (Vickers, 2012; Liikanen, 2012; Hoenig, 2017) and in past debates about the relaxation of Glass-Steagall (Saunders and Walter, 1994; Kroszner, 1998; Barth et al., 2000). Similarly, while the implications of structural separation for large corporate borrowers and securities investors are well documented, little is known about the impact on retail credit — despite the large role played by modern universal banks in retail markets. Our paper fills both of these gaps.

An important obstacle to identifying the impact of separating deposit-taking from investment banking is that plausibly exogenous shocks to universal banks' structures are rare.[3] We address this challenge by examining the introduction of UK "ring-fencing" requirements in 2019 — described as "one of the largest ever reforms to the structure of the UK banking industry" (Proudman, 2018). Ring-fencing requires banking groups with more than £25 billion of retail deposits to split their retail and investment banking activi-

[2]One key concern behind the Glass-Steagall Act was that this combination created conflicts of interest and allowed banks to dupe securities investors. Among others, Kroszner and Rajan (1994), Puri (1994, 1996), and Gande et al. (1997) reject this concern empirically. Instead, later research emphasises that combining loan and non-loan activities creates informational economies of scope, which lowers firms' borrowing costs (Drucker and Puri, 2005; Neuhann and Saidi, 2018). White (1986) documents evidence against the idea that banks with securities affiliates were more fragile during the Great Depression, another key motive for Glass-Steagall. A broader literature on universal banks studies issues around diversification, economies of scope, and internal capital markets (among others, Campello (2002) and Laeven and Levine (2007)).

[3]Most of the existing literature compares different types of bank before and after Glass-Steagall or its weakening in the 1990s. One exception is Akiyoshi (2019), who exploits the break-up of a Japanese bank to investigate the impact of access to universal bank services on the valuation of corporates.

ties into legally separate subsidiaries: the Ring-Fenced Bank (RFB), where retail deposits must be held, and the Non-Ring Fenced Bank (NRFB), where investment banking must be housed. The legislation also restricts banks' ability to "undo" this separation via intragroup loans and other contracts. Combined, these requirements effectively transform large UK banking groups from European-style integrated universal banks into structures closer to US Bank Holding Companies, where deposit-taking and capital market activities are split across subsidiaries.

This separation creates a substantial shock to the matching between retail deposits and different universal bank activities. Relative to the pre-ring-fencing funding structure, the share of retail deposits in the funding mix of the RFB increases by 18 percentage points on average, whereas it falls by 45 percentage points in the NRFB. In addition, there is substantial variation around this average impact, since affected banks differ in their prior exposure to activities that cannot be funded with deposits under the legislation. Exploiting this variation across affected banks means that we do not need to rely on a binary comparison of banks above and below the £25 billion threshold.

Another key advantage of our set-up is that our loan-level data allow us to also exploit variation in the impact of the funding shock within the same bank and time period. Ring-fencing legislation was passed in 2013 but only came into force from the start of 2019. We can therefore exploit the idea that, when a bank originates a loan in a given period between these dates, the extent to which it would anticipate the impact of ring-fencing on the funding cost of the loan should vary with the loan's maturity. For example, a one-year loan originated in January 2017 would no longer be on the balance sheet when ring-fencing is implemented in 2019, and would therefore be unlikely to be affected by the restructuring. On the other hand, a four-year loan originated at the same time would be transferred to either the RFB or the NRFB after two years. At this point, the share of deposits in the funding mix would increase for a loan transferred to the RFB, and decrease for a loan transferred to the NRFB. To the extent that deposits and wholesale funding are imperfect substitutes, these future changes in funding mix should affect the

terms on which the bank originates the loan. And the strength of this anticipatory effect should be increasing in the fraction of the loan's maturity that falls after January 2019.

Combining this variation across and within banks allows us to estimate the effect of ring-fencing on lending while including a rich set of fixed effects to control for a wide range of potentially confounding factors. In particular, we can include bank-time fixed effects to control for other factors potentially influencing bank behaviour, such as other changes in bank regulation and the Brexit referendum. We can also control for confounding demand-side factors through location-time or borrower-time fixed effects (Khwaja and Mian, 2008).

We take this idea to the data using granular loan-level datasets for two major credit markets between 2010 and 2019, representing the activity of affected banking groups on both sides of the fence: the UK residential mortgage market (for the RFB side), and the global syndicated lending market (for the NRFB side).

We find that ring-fencing has economically large, opposite effects on credit supply in these two markets. On the RFB side, a one-standard-deviation (22pp) increase in deposit funding as a result of ring-fencing is associated with a 20 basis point reduction in the interest rates on mortgages originated after ring-fencing, and with a 3.3pp increase in the bank's market share for a given mortgage product. Consistent with our interpretation that this increase in mortgage credit supply is driven by the deposit funding channel, we find larger effects for longer-maturity mortgages, in line with theories suggesting synergies between stable deposit funding and maturity transformation (Hanson et al., 2015; Drechsler et al., 2018). In contrast, we do not find evidence that the reduction in interest rates is larger for mortgages with high loan-to-value (LTV) ratios, unlike what theories about the moral hazard implications of universal banks' access to retail deposits would suggest (Boyd et al., 1998; Freixas et al., 2007). That is, the increase in mortgage credit supply is not accompanied by a reduction in lending standards, limiting potential financial stability concerns (Mian et al., 2013).

Conversely, on the NRFB side, a one-standard-deviation (11pp) decrease in deposit

funding is associated with a 6% reduction in syndicated loan size (intensive margin) and a 15% reduction in the number of syndicated loans in which the bank participates (extensive margin). Consistent with the results being driven by changes in the funding mix, the reduction in syndicated lending is larger for loans that are more likely to be retained (and hence funded to maturity) by the originator (credit lines and non-leveraged loans). That said, we also find that the reduction in deposit funding not only affects activities known to offer synergies with deposit-taking, such as credit lines (Kashyap et al., 2002; Gatev and Strahan, 2009), but also loan underwriting. We also find that the reduction in syndicated lending is larger for loans to non-UK borrowers, consistent with the idea that banks have informational advantages with respect to domestic borrowers (Giannetti and Laeven, 2012).

Overall our results are consistent with industry commentary arguing that ring-fencing has caused large UK banks to increase mortgage lending (Financial Times, 2019a) and reduce syndicated lending (Reuters, 2017). While our main analysis focuses on these two markets for identification reasons, we also observe a broader rebalancing towards retail assets and away from investment banking assets during the run-up to ring-fencing implementation at the start of 2019 (Figure 3).

After estimating the direct effects of ring-fencing on universal banks subject to the reform, we consider spillover effects on the wider market. The banks subject to ring-fencing hold dominant positions in the UK mortgage market. This suggests two potential implications of their increased mortgage lending. First, it is likely to lead to increased market concentration. We verify this by constructing a regional measure of exposure to increased credit supply from ring-fenced banks, based on their historical lending footprints. Consistent with our prior, we find that market concentration increases in regions more exposed to the increased credit supply. Second, increased lending by ring-fenced banks is likely to lead to reductions in the market shares and profit margins of smaller banks that are out of scope of ring-fencing but which draw much of their income from the domestic mortgage market, potentially putting their business models under pressure. We therefore examine

whether unaffected banks behave differently if they are operating in regions more exposed to increased competitive pressure from ring-fenced banks. Consistent with the franchise value model of Keeley (1990), we find that unaffected banks that are exposed in this way increase their risk-taking, by cutting the rates on high-LTV (riskier) mortgages more, and increasing the share of high-LTV mortgages in their lending portfolios.

Contributions to existing literature Our main contribution is to a large literature debating the implications of structural separation of universal banks. Existing empirical studies have mostly focused on the ability of universal banks to combine lending and underwriting services, and its implications for corporate borrowers and securities investors (among others, see Kroszner and Rajan (1994); Puri (1994, 1996); Gande et al. (1997); Drucker and Puri (2007)).[4] We expand this literature in three main directions. First, we focus on the funding structure of universal banks, in particular their ability to combine retail deposit-taking and capital market activities. Second, we study the implications of structural separation not only for capital markets but also for retail lending.[5] Third, we estimate not only the impact of structural separation on universal banks themselves, but also spillover effects on their competitors.

These new perspectives provide novel insights on several questions central to this literature. First, existing research suggests that structural separation increases the cost of credit for large corporate borrowers, for example by preventing synergies between lending and underwriting (Calomiris, 2000; Drucker and Puri, 2005; Yasuda, 2005; Neuhann and Saidi, 2018; Akiyoshi, 2019). Our findings highlight an additional mechanism through which structural separation can reduce corporate credit supply: banks' inability to fund capital market activities with deposits. We also show that the reduction in corporate credit supply is mirrored by an increase in retail credit supply, as the re-allocation of

[4] Laux and Walz (2009) and Lóránth and Morrison (2012) study the theoretical implications of the cross-selling of loan and non-loan products by universal banks. Several recent papers have also examined the impact of the Volcker Rule on bond market liquidity (Bessembinder et al., 2018; Bao et al., 2018; Dick-Nielsen and Rossi, 2019).

[5] Hakenes and Schnabel (2014) and Shy and Stenbacka (2017) investigate the theoretical effects of separating retail and investment banking for retail customers, but empirical evidence is scarce.

the benefits of deposit funding to the retail credit market reduces the cost of credit for consumers.

Second, we provide new perspectives on the impact of structural separation on competition and market structure. Gande et al. (1999) show that preventing banks from entering the corporate debt underwriting market reduces competition in this market. Our finding that ring-fencing causes universal banks to retrench from capital markets complements this idea, and suggests that access to retail deposits is one source of competitive advantage for banks in this market.[6] We further extend the literature by showing that ring-fencing increases the concentration of retail credit markets, as the redeployment of retail deposits towards these markets leads universal banks to outcompete smaller banks. This suggests that, over the longer term, structural separation might also have anti-competitive effects in retail credit markets. It also challenges the idea that structural separation can significantly mitigate the risk of universal banks being too-big-to-fail or too politically powerful (Zingales, 2012).

Third, several theoretical papers suggest that, by preventing universal banks from extending the benefits of deposit insurance to capital market activities, structural separation could reduce moral hazard and risk-taking (Chen and Mazumdar, 1997; Boyd et al., 1998; Kwast and Passmore, 2000; Pennacchi, 2006; Freixas et al., 2007; Farhi and Tirole, 2017). Our results suggest that preventing retail deposits from being used to support capital market activities incentivises banks to rebalance towards retail lending, which is often considered less risky by proponents of structural separation (King, 2009; Liikanen, 2012). However we also find that this effect might be offset in part by the indirect consequences of this rebalancing for the risk-taking incentives of smaller banks.

We also add to the literature on what is "special" about banks relative to nonbanks. Consistent with existing papers, we find evidence suggesting synergies between deposit-taking and the supply of illiquid loans (Hanson et al., 2015; Drechsler et al., 2018; Choud-

[6] A related recent empirical literature studies the benefits to nonbanks from being affiliated with commercial banks; see for instance Fang et al. (2013) and Franzoni and Giannetti (2019). We add to this research by documenting the particular role of access to retail *deposits* in this context.

hary and Limodio, 2018; Carletti et al., 2019; Li et al., 2019) and credit lines (Kashyap et al., 2002; Pennacchi, 2006; Gatev and Strahan, 2006, 2009; Gatev et al., 2009; Acharya and Mora, 2015). However, our results suggest that deposit funding can also benefit investment banking activities. This suggests that the traditional specialisation by commercial banks (financed by deposits) and nonbanks (financed through wholesale markets) observed until recently in countries such as the US is not only a product of economic forces such as these entities' natural comparative advantages (Strahan, 2012; Hanson et al., 2015), but also of regulatory choices (Farhi and Tirole, 2017). Finally, we contribute to the literature on internal capital markets in financial conglomerates (Campello, 2002; Franzoni and Giannetti, 2019; Gil-Bazo et al., 2020; Fecht et al., 2020). We show that preventing universal banks from allocating deposit funding to investment banking reduces their provision of capital market services.

The remainder of the paper is structured as follows. Section 1 describes the UK ring-fencing regulation. Section 2 discusses the shock to universal banks' funding structures, relevant theories, and our identification strategy. We describe our datasets in Section 3. Section 4 presents loan-level results on rebalancing by universal banks from syndicated lending to mortgage lending, and Section 5 presents results on spillover effects in the mortgage market. Section 6 concludes.

1 The UK ring-fencing regulation

In June 2010, the UK government established the Independent Commission on Banking (ICB) "to consider structural and related non-structural reforms to the UK banking sector to promote financial stability and competition" (ICB, 2011). Chaired by Sir John Vickers, the ICB published its final report in September 2011. One of the report's key recommendations was that core UK retail activities should be ring-fenced — that is, that taking deposits from, and providing overdrafts to, individuals and SMEs should be carried out in separate subsidiaries to wholesale and investment banking activities. The

ICB judged that this would: make it easier to resolve banks that get into trouble without requiring taxpayer support; insulate vital retail banking services from external financial shocks; and curtail implicit government guarantees, thus reducing risks to the sovereign, and reducing incentives for excessive risk-taking by reducing the expectation of bail-outs.

Timing and scope The government accepted the majority of the ICB's proposals on ring-fencing. Draft legislation was published in October 2012, and became law in December 2013 as part of the Financial Services (Banking Reform) Act 2013. The law specified that the requirements would come into effect on 1 January 2019, and apply to banking groups with more than £25 billion of retail deposits. Building societies are exempt. In practice, five banking groups were required to restructure: Barclays, HSBC, Lloyds Banking Group, Royal Bank of Scotland, and Santander UK. These groups completed their restructuring in 2018, ahead of the January 2019 deadline.

The legislation The legislation requires banking groups to house their domestic retail businesses in ring-fenced banks (RFBs) that are legally separate from entities that carry out wholesale and investment banking activities (NRFBs). To do so, the legislation first specifies "core activities" that can only be carried out by RFBs. These include making and receiving payments, taking deposits, and providing overdrafts for individuals and SMEs. Second, it specifies "excluded activities" that cannot be performed by RFBs. These include proprietary trading in securities, commodities and derivatives; having exposures to financial institutions other than building societies and other RFBs; having operations outside the European Economic Area (EEA); underwriting securities; and buying securitisations of other financial institutions.

Banking groups retain flexibility over where to place activities that are neither core nor excluded, including corporate and mortgage lending. In practice, the affected banking groups have chosen to place the entirety of their residential mortgage lending within their RFBs, and have generally placed their syndicated lending within their NRFBs.

The legislation, and associated rules set by the Prudential Regulation Authority (PRA), also impose several requirements to ensure that RFBs are sufficiently independent and insulated from other entities in their banking groups. For example, the RFB must meet regulatory capital and liquidity requirements on its own; have independent governance; and manage any exposures to NRFBs within its group on third-party and arm's length terms. These requirements ensure that ring-fencing cannot be "undone" via intragroup contracts.[7]

2 Ring-fencing and deposit funding: Theory and identification

Ring-fencing implies that retail deposits can only be used to fund assets in the ring-fenced bank (RFB) and cannot fund assets in the non-ring-fenced bank (NRFB), which must instead rely on wholesale funding. This constraint results in a substantial shock to the funding structure of different assets held by the affected banks.

For illustration, Figure 1 shows the balance sheet of a stylised universal bank subject to ring-fencing. At the group level, 80% of the bank's assets are mortgages, while 20% are assets associated with investment banking, funded 60% by deposits and 40% by wholesale funding (we ignore equity for simplicity). Before ring-fencing (left panel), all assets and liabilities are held in the same entity, and so the retail funding ratio of both mortgages and investment banking is 60%. After ring-fencing (right panel), the group must restructure into two separate legal entities. Retail deposits and mortgages are housed in the RFB, while investment banking must be housed in the NRFB. The retail funding share of mortgages therefore increases to 75%, while the retail funding share of

[7] See Britton et al. (2016) for more detail. The UK ring-fence is similar to the US Bank Holding Company approach in that it allows universal banks to engage in both retail and investment banking, but in separate, self-sufficient subsidiaries. Most of the more recent structural separation proposals share a similar middle-ground approach, and are often motivated partly by a similar objective to prevent the benefits associated with deposit-taking being extended to investment banking. Appendix A compares the UK ring-fence with regulations and reform proposals in the US and Europe in more detail.

investment banking falls to zero.

In practice, across the five banks affected by ring-fencing, the retail funding share of assets held within the RFB (primarily retail lending) increases by 18 percentage points on average, whereas the retail funding share of assets held in the NRFB (wholesale and investment banking) falls by 45 percentage points. Our main aim in this paper is to test how this funding shock affects the asset allocation of banks subject to the reform.

2.1 Theory

The constraint on deposit funding introduced by ring-fencing has the potential to alter the behaviour of universal banks to the extent that retail and wholesale funding are imperfect substitutes. Several theories suggest that this might be the case. In particular, household preferences for liquidity (Stein, 2012), deposit insurance (Stein, 1998), and market power in deposit markets (Drechsler et al., 2017) might reduce the cost of retail deposits relative to wholesale funding.[8] Assuming that these reduced funding costs would be shared across the bank's assets absent ring-fencing, redirecting deposits entirely to RFB assets would reduce the cost of funding RFB assets and increase the cost of funding NRFB assets. All else equal, this would incentivise banks to rebalance their activities towards RFB assets and away from NRFB assets.

However the degree to which this "deposit funding channel" would affect different asset classes is uncertain. Theories stressing the benefits of deposit funding for maturity transformation and liquidity risk management suggest that any rebalancing would mainly affect activities known to benefit from such synergies, such as providing long-term loans (Hanson et al., 2015; Drechsler et al., 2018) and credit lines (Kashyap et al., 2002). Meanwhile, theories stressing the risk-insensitive nature of deposits, and its impact on moral hazard, suggest that the rebalancing would affect risky activities, potentially in-

[8]Some sources of short-term wholesale funding (such as short-term wholesale deposits and repo) might carry lower interest rates than retail deposits. However these funding sources are likely to be significantly flightier than retail deposits. Deposit funding might also be more expensive than wholesale funding when the central bank policy rate is negative (Heider et al., 2019). This not the case in our study, as the Bank of England's policy rate remains above zero throughout our sample period.

cluding a broad range of investment banking activities (Freixas et al., 2007; Boyd et al., 1998).[9] These arguments underscore the importance of empirically testing the deposit funding channel and its impact across different asset classes.

2.2 Identification strategy

In order to estimate the impact of the deposit funding channel — that is, the impact of the change in funding structure as a result of ring-fencing on a bank's lending behaviour across different markets — we estimate regressions with the following general form:

$$\text{Loan}_{i,l,t} = \beta \left(\Delta\text{Retail funding}_i \times \%(\text{Post})_{l,t}\right) + \text{Controls}_{i,l,t} + \epsilon_{i,l,t}, \tag{1}$$

where $\text{Loan}_{i,l,t}$ is the price or volume of loan l originated by bank i at time t, and $\Delta\text{Retail funding}_i \times \%(\text{Post})_{l,t}$ is our main measure of the impact of ring-fencing on funding structure. Our main interest is in estimating the coefficient β.

Our specification is a modified difference-in-differences regression designed to address two key identification challenges: the fact that the legislation only affects the largest banks in our sample; and that it gives affected banks several years to comply, meaning there are no obvious 'pre' and 'post' periods.[10]

ΔRetail funding$_i$ Our first explanatory variable measures the strength of the deposit funding channel across banks. For banks that have less than £25 billion of retail deposits, $\Delta\text{Retail funding}_i$ is defined to be zero, because these banks are not subject to ring-fencing and so do not need to restructure. For banks above the threshold, $\Delta\text{Retail funding}_i$ measures the extent to which the retail funding share of assets in the RFB (NRFB) increases (decreases) as a result of ring-fencing. For RFBs, we compute the increase in retail funding as the difference between the retail funding ratio of the RFB and the retail

[9] Chan et al. (1992) and Freixas and Rochet (1998) show that regulators are unlikely to be able to price deposit insurance fairly with respect to risk.

[10] The size distribution of UK banks does not lend itself to a sharp comparison of banks closely above or below the £25 billion threshold.

funding ratio of the group:

$$\Delta\text{Retail funding}^{\text{RFB}} = \frac{\text{RFB retail deposits}}{\text{RFB total assets}} - \frac{\text{Group retail deposits}}{\text{Group total assets}}$$

For NRFBs, we simply compute the decrease in retail funding as equal to the retail funding ratio of the group, because the retail funding ratio of the NRFB is zero by definition; that is:

$$\Delta\text{Retail funding}^{\text{NRFB}} = \frac{\text{Group retail deposits}}{\text{Group total assets}}$$

For the stylised universal bank in Figure 1, for instance, the retail funding ratio is 60% for the group, 75% for the RFB, and 0% for the NRFB. Therefore $\Delta\text{Retail funding}_i^{\text{RFB}}$ is 15pp, and $\Delta\text{Retail funding}_i^{\text{NRFB}}$ is 60pp. In our sample, $\Delta\text{Retail funding}_i^{\text{RFB}}$ and $\Delta\text{Retail funding}_i^{\text{NRFB}}$ are 18pp and 45pp on average, respectively.

One advantage of our measure is that it varies substantially across the treated banks, which means that we do not have to rely on a binary comparison of affected and unaffected banks. For example, $\Delta\text{Retail funding}^{\text{RFB}}$ is relatively small for retail-focused banking groups, because these groups have relatively few prohibited activities; therefore, the RFB balance sheet will be relatively similar to that of the group, and so its funding structure will change little. Meanwhile, $\Delta\text{Retail funding}^{\text{RFB}}$ is larger for a group with substantial exposure to prohibited activities such as investment banking, because this group's RFB will be substantially smaller than the original group, meaning that there will be a large increase in the deposit funding share of RFB assets.

One limitation of our measure is that $\Delta\text{Retail funding}_i$ is only observed once ring-fencing is implemented. We must therefore compute the variable using end-2018 data. We are unable to compute the ratio earlier than this because the RFBs and NRFBs did not exist as distinct legal entities before this point, and so did not report separate balance sheets. We address associated endogeneity concerns with controls (see Section

2.3) and by instrumenting ΔRetail funding$_i$ using predictors measured before the ring-fencing legislation was passed (see Section 2.4).

$\%(\textbf{Post})_{l,t}$ Ring-fencing legislation was passed in December 2013 but only entered into force in January 2019, giving banks several years to restructure. This means that there is no obvious treatment date. If we used December 2013 as treatment date, we would likely overestimate the extent to which banks anticipate the reform. Conversely, if we used January 2019 as treatment date, we would ignore the possibility for banks to anticipate the impact of the legislation.

To address this issue, our second explanatory variable takes advantage of our loan-level data to exploit variation in the extent to which banks should anticipate the impact of ring-fencing across individual loans and time periods. Specifically, we exploit the idea that, when a bank originates a loan before ring-fencing requirements become binding in January 2019, it will consider the degree to which that particular loan will be affected by the expected future change in funding structure. Loans that mature before January 2019 will no longer be on the balance sheet once ring-fencing is implemented, and so the terms of these loans are unlikely to be affected by the restructuring. On the other hand, loans that mature after January 2019 will be affected by the restructuring. In particular, mortgages will be transferred to the RFB (and therefore experience an increase in deposit funding), while syndicated loans will be transferred to the NRFB (and so experience a decrease in deposit funding). To the extent that deposits and wholesale funding are imperfect substitutes, these anticipated future changes in funding mix upon implementation should affect the terms on which the bank originates loans before implementation. And the strength of this effect should be increasing in the fraction of the loan's maturity that falls after January 2019.

In line with this idea, $\%(\text{Post})_{l,t}$ is defined as the proportion of the loan's maturity that falls after January 2019. This measures the extent to which the loan will sit on the post-implementation (RFB or NRFB) balance sheet and will therefore be affected by the

change in funding mix. Variation in the value of this variable across loans is illustrated in Figure 2. For example, for a five-year loan originated in January 2017, this variable is equal to 60%; for loans that mature before January 2019, it is equal to zero; and for loans originated after January 2019, it is equal to 100%.[11]

2.3 Main threats to identification

One key challenge for identification is that the run-up to ring-fencing coincides with a number of other developments that might affect the lending behaviour of UK banks, such as the 2016 Brexit referendum and other regulatory changes. In addition, our bank-level treatment measure (ΔRetail funding$_i$) might be correlated with a range of balance-sheet and business-model characteristics, and these might affect lending decisions irrespective of ring-fencing.

A key benefit of our identification strategy is that it exploits variation not only across banks (ΔRetail funding$_i$) but also across loans within the same bank and time period (%(Post)$_{l,t}$). Therefore, our general model (1) can include bank-time fixed effects to control for a wide range of confounding supply-side factors, including Brexit and other regulatory changes. For some confounding factor to nonetheless bias our estimates, it would therefore need to vary not only *across* banks in a way that correlates with ΔRetail funding$_i$, but also *within* banks in a way that correlates with %(Post)$_{l,t}$. We discuss several specific potential sources of bias in more detail in Appendix B.

Another challenge is that our key estimate might be biased by confounding demand-side developments. For example, borrower preferences for different loan maturities might change over time, and this might be correlated with banks' lending decisions. In addition to using bank-time fixed effects to control for supply-side factors, we therefore also use a range of additional fixed effects and controls to control for confounding demand-side

[11] We define %(Post)$_{l,t}$ to be equal to zero for mortgages originated before December 2013, when ring-fencing legislation was finalised. The results are very similar if we instead set %(Post)$_{l,t}$ to zero for mortgages originated before September 2011 (when ring-fencing was proposed by the ICB) or before October 2012 (when draft legislation was published). This is natural because very few UK mortgages have maturities beyond five years.

factors. These controls differ across the mortgage and syndicated lending regressions, so we discuss them below in Sections 4.2 and 4.3.

2.4 Instrumental variable approach

An additional challenge is that $\Delta\text{Retail funding}_i$ is only observed at end-2018, after the affected banks completed their restructuring and first published RFB and NRFB balance sheets. This raises two potential endogeneity concerns.

First, most of the loans in our sample were originated before restructuring. A change in a bank's lending behaviour before 2018 could therefore affect the post-2018 change to its funding mix as measured by $\Delta\text{Retail funding}_i$, raising the possibility of reverse causality. Second, banks had some flexibility over which assets to place in the RFB and NRFB (see Section 1). Therefore, in theory, banks could exert some influence over the extent to which their funding mix would change in 2018.[12]

We address these concerns by instrumenting $\Delta\text{Retail funding}_i$ using variables determined in 2011, before ring-fencing legislation was proposed. In doing so, we only exploit the variation in $\Delta\text{Retail funding}_i$ that predates banks' ability to anticipate the reform, and so is credibly unaffected by reverse causality and by banks' potential control over how to restructure.

The variable we seek to instrument ($\Delta\text{Retail funding}_i$) is zero for all banks not subject to ring-fencing, and varies between zero and one for banks subject to the reform. To capture these two dimensions, we use two instruments. Our first instrument is an indicator variable equal to one for banks that have more than £25 billion of retail deposits in 2011, and zero otherwise ($I(>25)_{2011}$). A bank that exceeds this threshold in 2011 is very likely to do so in subsequent years; this indicator is therefore a strong predictor of whether or not a bank will be subject to ring-fencing.

The second instrument is the ratio of the bank's non-interest income to total oper-

[12] All else equal, a banking group that chooses to place a higher share of its assets in the RFB would experience a lower increase in deposit funding in the RFB.

ating income (NII ratio), measured in 2011 ($\%(\text{NII})_{2011}$). A bank's NII ratio is strongly correlated with its prior exposure to investment banking activities prohibited by the legislation, and thus with the extent to which it would be required to restructure. Banks with low NII ratios derived most of their income from lending, and therefore did not need to substantially restructure their businesses to meet ring-fencing requirements. On the other hand, banks with high NII ratios derived much of their income from excluded activities such as investment banking, and therefore needed to restructure more substantially. As a result, assets held in their RFBs experienced a larger increase in the retail funding share.

For our instruments to fail the exclusion restriction, two criteria must be met. First, our instruments must impact banks' lending decisions through mechanisms other than their effect on $\Delta\text{Retail funding}_i$. Second, these alternative mechanisms must not be controlled for by other variables in the regression.

Several mechanisms are likely to meet the first condition. For instance, our instruments are correlated with a bank's size and business model, and these factors might influence lending decisions in a number of ways unrelated to ring-fencing. For example, larger and better diversified banks might be able to offer cheaper mortgages.

However, because our regressions include an extensive set of fixed effects and controls, it is more challenging to think of alternative mechanisms that will also meet the second condition. For instance, alternative mechanisms related to size and business model are mechanically controlled for by bank-time fixed effects. Our regressions also control for the interaction between $\%(\text{Post})_{l,t}$ and a range of balance-sheet characteristics; this mitigates the concern that a bank's willingness to provide loans of different maturities could be correlated with factors such as its size, capitalisation, and liquidity. We also control for a range of demand-side sources of exclusion-restriction violations via further fixed effect and/or controls (explained further in Sections 4.2 and 4.3). Finally, we evaluate further potential violations of the exclusion restriction through additional tests in Appendix B.

3 Data and sample construction

To implement our identification strategy, we combine three data sources.

Mortgage lending Our analysis of the mortgage market uses the Product Sales Database (PSD), a confidential regulatory loan-level dataset covering the universe of residential mortgage originations in the UK. The PSD is collected by the UK Financial Conduct Authority (FCA) and extends back to 2005. For each loan, the dataset provides the identity of the lender, and information on mortgage characteristics (including origination date, volume, initial interest rate, fixation period, loan-to-value (LTV) ratio, loan-to-income ratio (LTI) ratio, and term), the borrower (including age, income, and credit history), and the property (including its location). The dataset does not record whether the mortgage is retained or sold by its originator. Unlike in the US, however, the vast majority of mortgages are retained during our sample period.

We focus on vanilla fixed-rate mortgages originated between January 2010 and June 2019 (we exclude observations before 2010 in order to avoid the effects of the financial crisis, and because there were several bank mergers in 2009). Summary statistics for this sample are provided in Table 1. The sample consists of over four million loans. Around 34% of mortgagors are home movers and around 28% are first-time buyers. The average loan is around £140,000 and has a 66% LTV ratio.

The large majority of UK mortgages have a "fixation period" of between two and five years.[13] During this period, there is typically a substantial early repayment charge; and after the fixation period ends, the mortgage typically reverts to a floating reset rate that is significantly higher than the rates available on new mortgages. The vast majority of borrowers thus tend to remortgage around the time that the fixation period ends (Cloyne et al., 2019). For simplicity, we thus refer to the fixation period as "maturity" in the rest of the paper.

[13]Some mortgages with fixation periods of up to ten years are available, but thirty-year fixed-rate mortgages as seen in the US are very rare.

Syndicated lending We obtain transaction-level data on global syndicated loan originations from Thomson Reuters LPC's DealScan for the sample period 2010 – 2018. DealScan provides detailed information on individual loan issuances, including the identity of the borrower and the lenders in the syndicate, as well as details such as the loan type (typically term loan or credit line), loan amount, maturity, and interest rate. We consolidate borrowers and lenders at the ultimate parent level and, following Roberts (2015), drop observations that are likely to be amendments to existing loans. Summary statistics for this dataset are reported in Table 2.

Bank balance sheets We use quarterly regulatory balance sheet and income statement data from the Bank of England to estimate banks' funding structures before and after ring-fencing implementation, and to construct bank-level controls.

4 Main results

In this section, we estimate how the change in funding mix induced by ring-fencing affects banks' behaviour.

4.1 Preliminary evidence

Before turning to our loan-level analysis, we consider aggregate trends in balance sheet allocation and loan prices. Figure 3 shows average changes in the balance sheet shares allocated to three broad asset classes between ring-fencing legislation being finalised (2013) and implemented (2019): household loans, corporate loans (including loans to both SMEs and large corporates), and investment banking assets (defined as trading positions in bonds, equities, and derivatives).

The charts suggest that banks affected by ring-fencing significantly rebalanced their activities towards RFB assets and away from NRFB assets in the run-up to ring-fencing implementation (Panel A). The balance sheet allocation to household loans (which all

affected banks have placed in the RFB and so can continue to be funded by retail deposits) increases notably, while investment banking assets (which must be placed in the NRFB and so cannot be funded by retail deposits) drop sharply. Corporate loans, which can be placed on either side of the fence, also decline, albeit to a smaller extent. Meanwhile, we observe no such rebalancing for banks unaffected by the reform (Panel B).

Aggregate trends in mortgage prices provide further preliminary evidence that banks affected by ring-fencing increased their mortgage credit supply. Figure 4 plots average quoted spreads for common UK mortgage products. It shows that spreads fell substantially in the years leading up to ring-fencing implementation across all major market segments (Panel A), and that this trend was largely driven by banks subject to ring-fencing (Panel B).

Industry commentary is consistent with these aggregate trends. Several banks have argued that, by requiring deposits to fund domestic retail lending, ring-fencing has contributed to a "price war" in the UK mortgage market (Financial Times, 2019a). Ring-fencing is also reported to have caused UK banks to retrench from syndicated lending (Reuters, 2017).

We now seek to isolate the role of ring-fencing in driving this rebalancing from potential confounding factors using the identification strategy described in Section 2.2.

4.2 Mortgage lending

Specification To test how ring-fencing affects banks' mortgage lending behaviour, we estimate the following variant of our general model (1):

$$\text{Spread}_{i,l,t} = \beta \left(\Delta\text{Retail funding}_i^{\text{RFB}} \times \%(\text{Post})_{l,t} \right) + \text{Controls}_{i,l,t} + \epsilon_{i,l,t}, \tag{2}$$

where $\text{Spread}_{i,l,t}$ is the initial interest rate spread on mortgage l originated by bank i in month t, measured as the interest rate minus the maturity-matched OIS rate. Our main explanatory variable $\Delta\text{Retail funding}_i^{\text{RFB}}$ is the increase in bank i's retail funding

share upon implementation of ring-fencing; and $\%(\text{Post})_{l,t}$ is the proportion of mortgage l's fixation period that falls after January 2019 (see Section 2.2). If the increased retail funding share of RFB assets (such as mortgages) makes these activities more attractive to the bank, then β should be negative — that is, mortgage spreads should decrease with exposure to ring-fencing.

We include bank-month fixed effects to control for confounding supply-side factors. We also include maturity-LTV-month fixed effects to control for mortgage demand and credit conditions at the time of origination. These are essentially product-month fixed effects because UK mortgages are typically highly standardised and priced based on maturity and LTV only.[14] To construct these fixed effects, we measure the mortgage maturity (fixation period) in months, and assign each mortgage to one of ten LTV buckets.[15] While the standardised nature of UK mortgages mitigates concerns about unobserved borrower quality, we also add property location-month fixed effects in our most conservative specifications, in order to control for changes in local economic conditions.[16] Finally, we include bank-maturity-LTV fixed effects to control for time-invariant determinants of a bank's behaviour in a given product category.

We include several loan-level control variables: LTV ratio;[17] LTI ratio; mortgage term; log(loan value); borrower age; and indicator variables for first-time buyers, home movers, borrowers with an impaired credit history, and brokered loans.[18] Finally, we include a vector of quarterly bank-level control variables interacted with $\%(\text{Post})_{l,t}$: log(total assets); return on assets; cash / total assets; capital / risk-weighted assets; and wholesale funding / total assets. These control variables are demeaned and lagged by one quarter.

[14] That is, unlike in the US, other factors such as loan-to-income ratio (LTI) and borrower credit history have only a limited impact on pricing, so long as the borrower qualifies for the product. See Benetton et al. (2018) and Robles-Garcia (2019) for evidence. Relatedly, UK borrowers typically pay the rates that banks advertise, unlike in the US where contracted mortgage rates often differ substantially from advertised rates (Bhutta et al., 2019).

[15] The LTV buckets are 0-50, 50-60, 60-65, 65-70, 70-75, 75-80, 80-85, 85-90, 90-95, 95-100.

[16] We measure property location at the electoral ward level (LAU2). There are around 10,000 electoral wards in the UK. The average population of a ward is therefore around 6,000, which is slightly smaller than the average population of US ZIP codes.

[17] This controls for any residual variation in pricing *within* the ten LTV buckets.

[18] Around 70% of mortgages in the UK are originated via brokers. This allows banks to lend in areas where they have few branches (Robles-Garcia, 2019).

Mortgage spreads results The estimated results from six variants of equation (2) are reported in Table 3. The parameter estimate for our main coefficient of interest β is negative and significant at the 1% confidence level across all specifications. That is, consistent with our main hypothesis, banks more affected by ring-fencing offer lower rates for mortgages with maturities extending further past the implementation date.

The estimated effect is economically significant. For most specifications, the estimate of β is around 0.9. Comparing mortgages originated after ring-fencing (for which $\%(\text{Post})_{l,t} = 1$) to mortgages that mature before ring-fencing (for which $\%(\text{Post})_{l,t} = 0$), a one-standard-deviation (22 percentage point) increase in ΔRetail funding$_i^{\text{RFB}}$ is therefore consistent with a reduction in the spread of around 20 basis points. For comparison, the standard deviation of interest rate spreads over the sample period is 97 basis points (Table 1).

The main result is robust to including different sets of fixed effects, allowing us to rule out a number of alternative explanations. First, the inclusion of bank-month fixed effects (column 1) mitigates the concern that banks are not comparable across dimensions other than their exposure to ring-fencing, for example due to other changes in bank regulation or the Brexit referendum. Second, the inclusion of maturity-LTV-month fixed effects suggests that our result is not explained by changes in borrowers' preferences across maturities, or by changes in industry-level lending standards. Third, the inclusion of bank-maturity-LTV fixed effects indicates that our result is not driven by factors related to bank specialisation across maturities or borrower risk (Benetton, 2017). Fourth, adding property location-month fixed effects (columns 4 and 6) has very little impact on our key coefficient, suggesting that unobserved trends in borrower demand, quality, or composition are unlikely to explain our results.

The result is robust to adding control variables at the bank level (column 2) and loan level (column 3), suggesting that differences in bank characteristics or borrower composition are unlikely to explain the result. The main parameter estimate is also very stable across OLS and IV specifications with similar controls and fixed effects. This

suggests that our key result is not biased by reverse causality, nor by treated banks' (limited) ability to choose how to restructure (see Section 2.4). The instruments are strong, with first-stage Kleibergen-Paap F-statistics above 40. We discuss a broader range of potential alternative explanations and exclusion restriction violations in Appendix B.

Market shares Next, we test whether the decrease in mortgage spreads associated with ring-fencing translates into relatively higher mortgage volumes. To do so, we aggregate mortgage lending volumes by bank, origination quarter, and product (where product is defined by the combination of maturity quarter and LTV bucket). We then estimate regressions of the following form:

$$\text{Market share}_{i,j,t} = \beta \left(\Delta\text{Retail funding}_i^{\text{RFB}} \times \%(\text{Post})_{j,t} \right) + \text{Controls}_{i,j,t} + \epsilon_{i,j,t}, \qquad (3)$$

where $\text{Market share}_{i,j,t}$ is the market share of bank i in product j in quarter t. Our explanatory variable $\Delta\text{Retail funding}_i^{\text{RFB}} \times \%(\text{Post})_{j,t}$ is as defined in equation (2). $\text{Controls}_{i,j,t}$ includes bank-quarter fixed effects; bank-product fixed effects; and the interaction of the five bank-level controls used in equation (2) with $\%(\text{Post})_{j,t}$.[19]

The results reported in Table 4 provide robust evidence that banks more affected by ring-fencing originate relatively larger mortgage volumes, and so gain market share at the expense of competitors. Our baseline estimate (column 1) suggests that a one-standard-deviation (22pp) increase in the retail funding ratio as a result of ring-fencing is associated with an increase in market share of around 3.3 percentage points. This result is robust to adding bank-level control variables (column 2) and to estimating the relationship using instrumental variables (column 3).

The dependent variable in equation (3) is constructed by dividing bank i's lending volume in product j by total lending in product j. This normalisation means that the estimates in columns 1 – 3 of the table assign equal weight to all products. However some

[19]The sample period for these regressions begins in January 2015, because mortgage maturities (necessary for computing market shares at the maturity level) are not always reported prior to 2015.

products are substantially more common than others (for example, most mortgages have two-year or five-year maturity), meaning that increased market shares in these products would be stronger evidence of increased credit supply overall. We therefore re-estimate the equation by WLS, weighting by total lending in the product. The positive relationship between exposure to ring-fencing and market share is robust to this weighting (column 4), including when estimated using instrumental variables (column 5).

4.3 Syndicated lending

The results above establish that an increase in the deposit funding of the RFB is associated with an expansion of mortgage lending. We now investigate whether a decrease in the deposit funding of the NRFB leads to a retrenchment from capital market activities.

To test this idea, we focus on the global syndicated lending market, primarily because the availability of loan-level data allows us to use a within-bank identification strategy analogous to that for mortgages. One caveat is that unlike UK mortgages, a substantial share of syndicated loans are sold by the originator, and so might be less affected by the change in funding structure caused by ring-fencing. We mitigate this issue by exploring characteristics that are known to correlate with the propensity for the loan to be retained.

Specification In a typical syndicated loan, the borrower takes out a "package" that includes several individual loan "facilities" (principally term loans and credit lines). Importantly, facilities are extended by multiple lenders to the same borrower. This allows us to perform a within-borrower analysis and hence control for unobserved borrower characteristics in line with Khwaja and Mian (2008). We estimate the following regression:

$$\text{Log(Loan size)}_{i,l,t} = \beta \left(\Delta\text{Retail funding}_i^{\text{NRFB}} \times \%(\text{Post})_{l,t} \right) + \text{Controls}_{i,l,t} + \epsilon_{i,l,t}, \quad (4)$$

where $\text{Log(Loan size)}_{i,l,t}$ is the log of the amount of credit extended by bank i in loan facility l during month t.[20] $\Delta\text{Retail funding}_i^{\text{NRFB}}$ is the amount by which bank i's retail funding share (for NRFB assets) decreases upon implementation of ring-fencing, and $\%(\text{Post})_{l,t}$ is the proportion of the loan maturity period that falls after January 2019 (see Section 2.2).

As in our mortgage regressions, the set of control variables includes bank-month fixed effects to control for confounding supply-side factors. In addition, we include loan facility fixed effects to control for all observed and unobserved borrower and loan characteristics, including the borrower's credit demand.

One caveat is that this specification only exploits variation in lending quantities conditional on participation in the loan (intensive margin). In addition, bank-level lending quantities are often unobserved in DealScan. We therefore complement the intensive margin analysis with an extensive margin analysis by estimating the regression:

$$\text{Log(Number loans)}_{i,j,t} = \beta \left(\Delta\text{Retail funding}_i^{\text{NRFB}} \times \%(\text{Post})_{j,t}\right) + \text{Controls}_{i,j,t} + \epsilon_{i,j,t}, \quad (5)$$

where $\text{Log(Number loans)}_{i,j,t}$ is the log of the number of loans with maturity j in which bank i participates in quarter t. The vector of control variables includes bank-quarter fixed effects to control for confounding supply-side factors, and maturity-quarter fixed effects to control for trends in credit demand.

Results The results are reported in Table 5 (intensive margin) and Table 6 (extensive margin).[21] We find that a one-standard-deviation (11 percentage point) decrease in deposit funding is associated with a 6% decrease in loan size conditional on participation (Table 5, column 1) and a 15% reduction in the number of loans in which the bank participates (Table 6, column 1). That is, universal banks respond to a loss of deposit funding by reducing their supply of syndicated loans.

[20] We sum over loan facilities of the same type and with the same maturity in the same package.

[21] These tables show OLS results only. Instrumental variable results are very similar and reported in Appendix C.

This finding is consistent with existing evidence about the benefits of deposit funding for the provision of syndicated credit.[22] And it cannot be explained by a loss of informational synergies between lending and underwriting (Drucker and Puri, 2005; Neuhann and Saidi, 2018), because ring-fencing allows universal banks to continue to provide both corporate lending and securities underwriting services, and places no restriction on information flows between these activities (other potential alternative explanations are discussed in Appendix B).

We next decompose this effect across the main categories of syndicated loan. The coefficient of interest is negative and significant for both term and non-term loans (principally credit lines) (column 2); leveraged and non-leveraged loans (column 3);[23] and lead arranger and participant tranches (column 4). In other words, ring-fencing is not only associated with a lower supply of those activities known to offer synergies with deposit-taking, such as credit lines (Kashyap et al., 2002; Gatev and Strahan, 2009), but also with activities that make greater use of technologies typically associated with investment banking, such as lead arrangement.

If the negative relationship between ring-fencing and credit supply is driven by the change in funding structure, then we would expect it to be stronger for loans that are more likely to be retained, and hence funded to maturity by the originator. We therefore test whether this is the case. While DealScan does not record whether a loan is retained or sold, we exploit the fact that term loans and leveraged loans are more likely to be sold (Ivashina and Sun, 2011; Blickle et al., 2020). Consistent with our prior, the effect is substantially larger for non-term loans (column 2) and non-leveraged loans (column 3), for both the intensive and extensive margins. The statistics reported on the last row confirm that these differences are statistically significant (with the exception of non-leveraged loans for the intensive margin).

[22] Paligorova and Santos (2017) show that banks relying less on insured deposits originate shorter-maturity loans. Irani and Meisenzahl (2017) show that banks reliant on wholesale funding were more likely to sell loan shares during the 2007-08 crisis.

[23] Following Bruche et al. (2020), we define a loan as leveraged if it is secured and has a spread of 125bp or higher.

An important question for assessing the overall impact of ring-fencing requirements on UK credit supply is whether the reduction in syndicated lending is focused on loans to UK or foreign borrowers. The results in column 5 indicate that the reduction in lending is larger for foreign borrowers relative to UK borrowers (although we do observe a statistically significant negative effect for both groups on the extensive margin). This is consistent with the idea that UK banks are better able to extract surplus from UK borrowers due to informational advantages, and with existing evidence on home bias in global syndicated lending markets (Carey and Nini, 2007).

4.4 Heterogeneous impacts

The results above establish that universal banks affected by ring-fencing increase their mortgage lending and reduce their syndicated lending, suggesting that ring-fencing incentivises a rebalancing towards asset classes that can still be funded with retail deposits. These results are consistent with theories where deposit funding is attractive relative to wholesale funding, for instance due to deposit insurance, household preferences for liquidity, or market power. However, as explained in Section 2.1, different theories about the implications of deposit funding for credit supply provide different predictions about where the effect is likely to be strongest. We therefore consider how the impact of ring-fencing varies across loans.

We first consider mortgage lending. Theories emphasising synergies between deposit-taking and maturity transformation (Hanson et al., 2015; Drechsler et al., 2018) suggest that the increase in credit supply would be larger for *longer-term* loans. Theories emphasising the moral hazard implications of deposit insurance would instead predict that, by redirecting risk-insensitive funding from the NRFB to the RFB, ring-fencing should lead to a larger increase in credit supply for *higher-risk* loans (Freixas et al., 2007). Increased availability of deposit funding might also incentivise riskier lending due to agency problems within the bank (Acharya and Naqvi, 2012).

To explore these ideas, we expand equation (2) by interacting our main coefficient $\Delta\text{Retail funding}_i^{\text{RFB}} \times \%(\text{Post})_{l,t}$ first with an indicator variable for long-maturity loans (defined as maturity greater than two years), and then with an indicator variable for high-LTV loans (defined as LTV greater than 90%). The results using these triple interactions are reported in Table 7, where the different columns again include different combinations of control variables and fixed effects. Columns 1 – 3 show that the negative impact of ring-fencing on mortgage spreads is larger for longer-term loans, consistent with synergies between deposit-taking and long-term lending. On the other hand, across all specifications, the coefficient estimate on the high-LTV triple interaction is small and statistically insignificant (columns 4 – 6). In other words, we find no evidence that ring-fencing causes treated banks to reduce the risk-sensitivity of their mortgage pricing. Table 8 reports consistent results using mortgage market shares as the dependent variable.

Our syndicated lending results are broadly in line with these results for mortgages. The finding that the reduction in lending is larger for credit lines than for term loans (column 2 of Tables 5 and 6) provides support for the idea that there are synergies between providing on-demand liquidity in the form of both deposits and credit lines (Kashyap et al., 2002). Meanwhile, the larger reduction in lending for lower-risk loans (compared to leveraged loans) provides little support for the idea that removing risk-insensitive deposit funding from the NRFB leads to reduced risk-taking in syndicated lending.[24]

5 Indirect effects on competition

In the previous section, we established that banks more affected by ring-fencing rebalance towards the domestic retail market by reducing mortgage spreads, and hence gain mortgage market shares. In this section, we first examine how this rebalancing impacts

[24]Given that these differences in the strength of the impact across syndicated loans are also consistent with stylised facts about the degree to which loans are retained by the originator (see Section 4.3), we can only interpret them as indicative evidence regarding the theories discussed here.

mortgage market structure, and then consider spillover effects on the behaviour of banks not directly affected by ring-fencing.

5.1 Market structure

The UK mortgage market is very concentrated, with the five banks subject to ring-fencing accounting for around two-thirds of total volume. Any increase in the market shares of these banks is therefore likely to be associated with an increase in market concentration. To verify this, we compute the Herfindahl-Hirschman Index (HHI) at the level of local markets, and test whether concentration increases more in local markets more exposed to the effects of ring-fencing.

We define a local market as the combination of property location and product, where property location is measured at the district level,[25] and product is defined as the combination of maturity (measured in quarters) and LTV bucket. We then exploit two sources of variation in the exposure of a given market to the increased credit supply from treated banks: one at the product level, and one at the district level.

First, our results in Section 4.2 show that treated banks increase credit supply more for mortgages with maturities extending further past the ring-fencing implementation date. To capture this effect, we therefore use %(Post), measured at the product level, in line with our baseline regressions.

Second, we exploit the idea that the increase in credit supply due to ring-fencing is likely to be larger in districts where treated banks have a larger historical presence. This follows from the fact that there is a substantial degree of persistence in banks' geographical lending footprints over time. To illustrate this persistence, we regress bank market shares in 2018 (measured at the district level) on market shares in 2011, plus bank fixed effects. The results are shown in Table 9. When we measure market shares using all loans, the estimated coefficient is 0.424 (column 1), and highly statistically significant. When we instead use either non-brokered loans (column 2) or brokered loans (column

[25]There are 390 districts (LAU1) in our sample.

3), we see that the persistence is primarily driven by non-brokered loans, suggesting that branch presence is an important factor (Robles-Garcia, 2019).

Given this persistence, we can use banks' 2011 market shares in a district to construct a proxy for the district's exposure to ring-fencing. For each district, we compute the 2011 market shares for each bank, and use these to construct the weighted average of ΔRetail funding$_i^{\text{RFB}}$. That is, for district g, we compute:

$$\text{Exposure}_g = \sum_{i=1}^{N} \text{Market share}_{i,g}^{2011} \times \Delta\text{Retail funding}_i^{\text{RFB}}. \tag{6}$$

We use non-brokered loans to compute the market shares, because these exhibit more geographical persistence. Results are similar if we instead use all loans. We then run regressions of the form:

$$\text{HHI}_{g,j,t} = \beta \left(\text{Exposure}_g \times \%(\text{Post})_{j,t}\right) + \alpha_{j,t} + \delta_{g,t} + \gamma_{g,j} + \epsilon_{g,j,t}, \tag{7}$$

where g indexes districts, j indexes products (defined by maturity quarter and LTV bucket), and t indexes origination quarters. To further mitigate endogeneity concerns associated with ΔRetail funding$_i^{\text{RFB}}$, we follow a similar approach to our baseline regression by instrumenting Exposure$_g$ using weighted averages of the two instruments for ΔRetail funding$_i^{\text{RFB}}$ discussed in Section 2.4.

The results in Table 10 suggest that markets more exposed to ring-fencing experience a larger increase in concentration. The estimated coefficient is similar across different sets of fixed effects, and both OLS and IV regressions. Specifically, a one-standard-deviation (3.5pp) increase in geographical exposure to ring-fencing is associated with an increase in the HHI of around 3.2% of one standard deviation.

5.2 Competitors' response

Increased credit supply by large banking groups is likely to put pressure on the profitability of smaller banks that are out of scope of ring-fencing but draw much of their income from the domestic mortgage market. To understand how this affects the behaviour of smaller banks, we follow a similar approach to Section 5.1. Specifically, we exploit the idea that the competitive pressure created by ring-fencing should differ (i) across mortgage maturities and time periods, because treated banks increase credit supply more for mortgages with maturities extending further past the ring-fencing implementation date; and (ii) across geographies, due to persistent heterogeneities in the geographical lending footprints of treated banks.

To capture the geographical dimension, we compute the following variable for each competitor bank i:

$$\text{Exposure}_i = \sum_{g=1}^{G} \text{Portfolio share}_{i,g}^{2011} \times \text{Exposure}_g, \tag{8}$$

where $\text{Portfolio share}_{i,g}^{2011}$ is the proportion of bank i's 2011 mortgage lending portfolio originated in district g; and Exposure_g is district g's exposure to ring-fencing, as estimated in equation (6). We then drop the banks directly affected by ring-fencing from our sample, and for the remaining banks we estimate the model:

$$\text{Spread}_{i,l,t} = \beta \left(\text{Exposure}_i \times \%(\text{Post})_{l,t}\right) + \text{Controls}_{i,l,t} + \epsilon_{i,l,t}, \tag{9}$$

where the set of control variables is the same as used in equation (2).

The regression results for model (9) are reported in Table 11, columns 1 and 2. The estimate of β is statistically insignificant, suggesting that competitors more exposed to increased competition from ring-fenced banks do not systematically reduce mortgage spreads across all products.

In columns 3 – 6, we test whether more exposed competitors respond to ring-fencing

differently across different product types. In column 3, we find some evidence that more exposed competitors relatively reduce mortgage spreads on longer-maturity mortgages (maturity greater than two years), but this effect is economically small and not robust to including location-time fixed effects (column 4). However in columns 5 and 6 we find that more exposed competitors significantly reduce their spreads on high-LTV mortgages (LTV greater than 90%) relative to lower LTV mortgages. That is, more exposed competitors respond to increased competition from ring-fenced banks by reducing the risk-sensitivity of their mortgage pricing. The parameter estimate is around -6, suggesting that a one-standard-deviation (3.3pp) increase in Exposure_i is associated with a reduction in the spread on high-LTV mortgages (relative to other mortgages) of around 20 basis points.

In order to test whether this reduced risk-sensitivity in mortgage pricing translates into riskier mortgage portfolios, we estimate:

$$\begin{aligned} \text{Portfolio share}_{i,j,t} &= \beta \left(\text{Exposure}_i \times \%\left(\text{Post}\right)_{j,t} \right) \\ &+\gamma \left(\text{Exposure}_i \times \%\left(\text{Post}\right)_{j,t} \times \text{High LTV}_j \right) + \text{Controls}_{i,j,t} + \epsilon_{i,j,t}, \end{aligned} \tag{10}$$

where $\text{Portfolio share}_{i,j,t}$ is bank i's mortgage lending volume in product j (defined by the combination of maturity quarter and LTV bucket) in quarter t, divided by bank i's total mortgage lending volume in quarter t. $\text{Controls}_{i,j,t}$ includes product-quarter fixed effects; bank-product fixed effects; and the interaction of the five bank-level controls used in equation (2) with $\%(\text{Post})_{j,t}$.

The results for this regression are reported in Table 12. As for the market share regressions in Table 4, we consider both unweighted and weighted estimators. Since equation (10) is estimated at the bank-product level, and the dependent variable is normalised by the bank's total lending volume, the unweighted estimators do not fully reflect differences in the relative economic importance of different banks. In contrast, weighting observations by the bank's total lending volume in the quarter allows us to put more weight on banks that account for a larger share of loans. When we estimate the model using OLS

or unweighted IV (columns 1 – 3), the estimate of γ is positive but insignificant. When we instead use weighted estimators (columns 4 and 5), the estimate of γ is positive and statistically significant, indicating that more exposed competitors increase the share of riskier mortgages in their portfolios.

The finding that smaller banks rebalance towards higher-risk mortgages in response to ring-fencing is consistent with industry reports (Financial Times, 2019b). It is also consistent with the model of Keeley (1990): competitive pressure from ring-fencing might reduce the franchise value of smaller banks, and hence incentivise increased risk-taking.

6 Discussion and conclusions

The global financial crisis has led to broad international consensus about the need to increase banks' capitalisation, liquidity, and resolvability. In contrast, there remain striking differences across jurisdictions around whether to separate deposit-taking from market-based activities. Recent proposals in the US to reinstate Glass-Steagall-type regulations provide renewed impetus to understanding the implications of structural separation for universal banks' activity mix and risk-taking, as well as broader competitive impacts. However, little empirical research sheds direct light on these issues.

This paper fills this gap by studying a recent UK reform that prevents large banking groups from operating as fully integrated universal banks, as is allowed in Europe and Canada. Instead the reform forces these groups to split their retail deposit-taking and investment banking activities into separate subsidiaries, similarly to US Bank Holding Companies. We show that this "ring-fencing" leads to a large shock to the funding structures of assets housed on either side of the fence, as banks are prevented from using retail deposits to fund capital market activities. In response, universal banks rebalance their activities towards retail lending and away from capital markets. This rebalancing reduces the price and increases the quantity of domestic mortgages, whereas it reduces the provision of liquidity insurance and underwriting services to large corporates. The rebal-

ancing has important knock-on effects on the wider retail banking system: concentration increases in the mortgage market, and smaller banks out of scope of the reform respond to the increased competitive pressure by increasing the riskiness of their mortgage lending.

By documenting the role of deposit funding for universal banking, and by studying both the retail and capital market businesses of universal banks, our findings highlight several important consequences of structural separation that have received little attention so far in the academic or policy debates.

First, by redirecting the benefits of deposit funding to retail credit markets, separating deposit-taking from investment banking can reduce the cost of credit for consumers. The cheaper credit is not concentrated in the higher-risk segment of the mortgage market, limiting financial stability concerns related to rising household indebtedness (Mian et al., 2013). The expansion of consumer credit is mirrored by a reduction in credit supply to large corporates. The net welfare effects of this rebalancing are uncertain, and likely to depend on broader macroeconomic conditions and on corporates' ability to switch lenders. However, we note that the reduction in corporate credit is mainly focused on lending to foreign borrowers, who are less likely to be reliant on relationships with domestic banks. And by allowing the investment banking subsidiary to continue to perform corporate lending, this form of structural separation can preserve the synergies between lending and securities underwriting identified by existing literature.[26]

Second, however, our results suggest more ambiguous impacts on competition in the retail credit market over the longer term. By reducing the ability of smaller banks to compete, structural separation leads to more concentrated markets. Indeed, ring-fencing is reported to have already contributed to the exit of smaller lenders from the UK mortgage market (Financial Times, 2019a). The increased market power of large banks could lead to more expensive credit and reduced quality of service over the longer term; alternatively, increased concentration might simply reflect less efficient banks leaving the

[26] A comprehensive assessment of the overall implications for credit conditions would also require evidence on SME lending. Unfortunately, granular data on SME lending are unavailable, limiting our ability to identify the impact of ring-fencing in this market.

market. The increased market share of large banks in the retail credit market also casts doubt on the idea that structural separation significantly reduces the risk that universal banks become too-big-to-fail (King, 2009; Hoenig, 2017; Warren, 2017).

Our results also question the idea that structural separation unambiguously improves financial stability. On the one hand, the increased retail focus by universal banks should reduce their exposure to international and capital market shocks — a key motive of most structural separation proposals. On the other hand, this rebalancing leaves the supply of retail credit more exposed to the health of a few large lenders with increased exposures to domestic shocks. And by indirectly encouraging smaller banks to take more risk, structural separation might increase these smaller banks' vulnerability to shocks, and hence reduce their ability to continue lending during an economic downturn.

Finally, our results provide support for a key premise underlying many proposals for structural reform: that the benefits of retail deposits partly accrue to universal banks' capital market activities (ICB, 2011; Liikanen, 2012; Hoenig, 2017).[27] This suggests that the specialisation by commercial banks and investment banks observed in countries such as the US might be a product not only of natural comparative advantages (Strahan, 2012; Hanson et al., 2015), but also of regulatory choices.

[27] In contrast, opponents of structural separation have often argued that preventing universal banks from enjoying these benefits would reduce their international competitiveness (Wilmarth, 2009).

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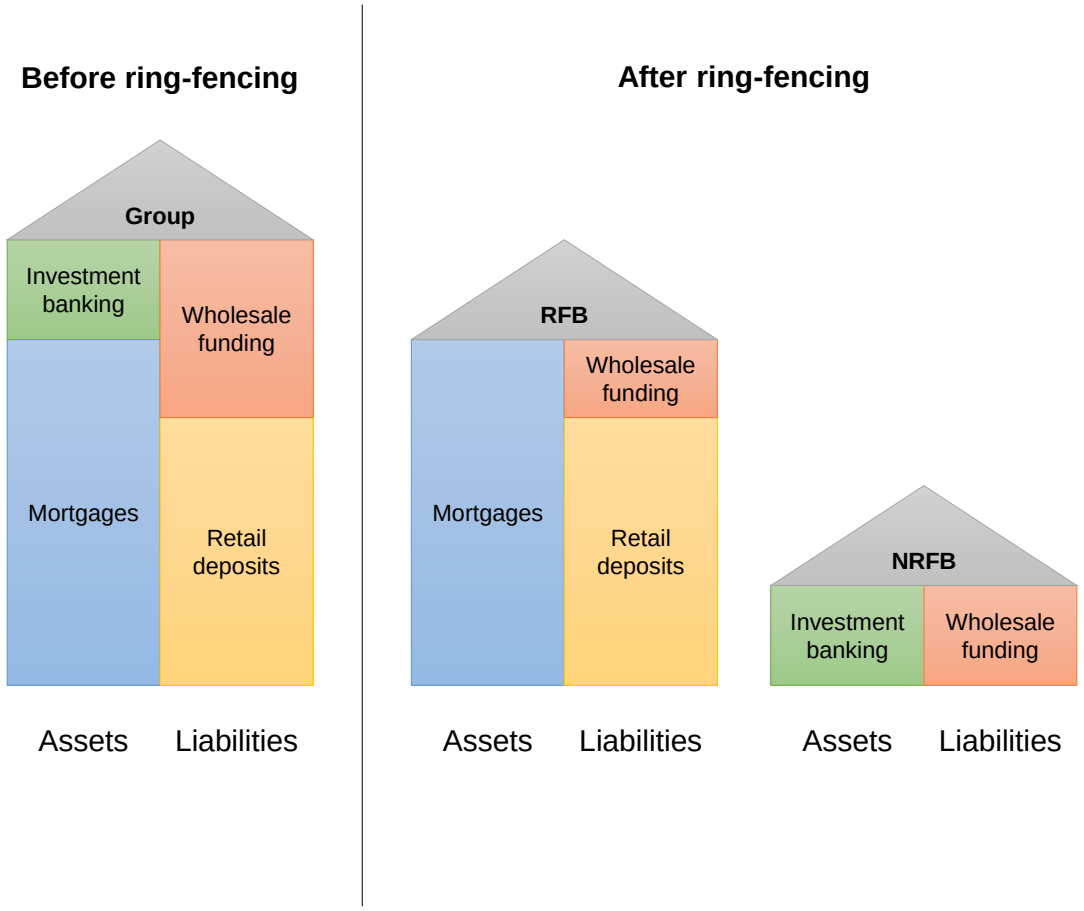
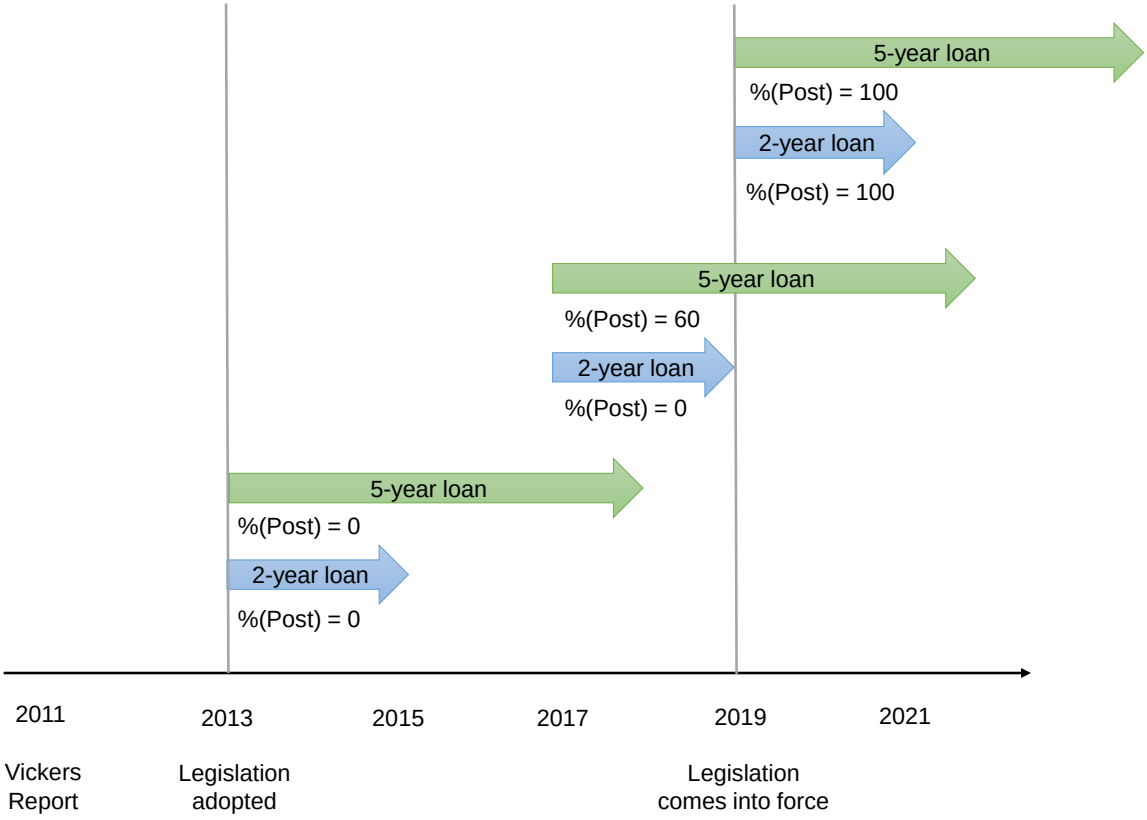
Figure 1: Stylised banking group before and after ring-fencing



Notes: The figure illustrates the balance sheet of a stylised banking group subject to ring-fencing requirements. The left panel shows the banking group before ring-fencing. All assets and liabilities are held in the same legal entity. The right panel shows the banking group after ring-fencing, when the group has restructured into two separate legal entities. Retail deposits and mortgage lending are housed in the ring-fenced bank (RFB), while investment banking is housed in the non-ring-fenced bank (NRFB).

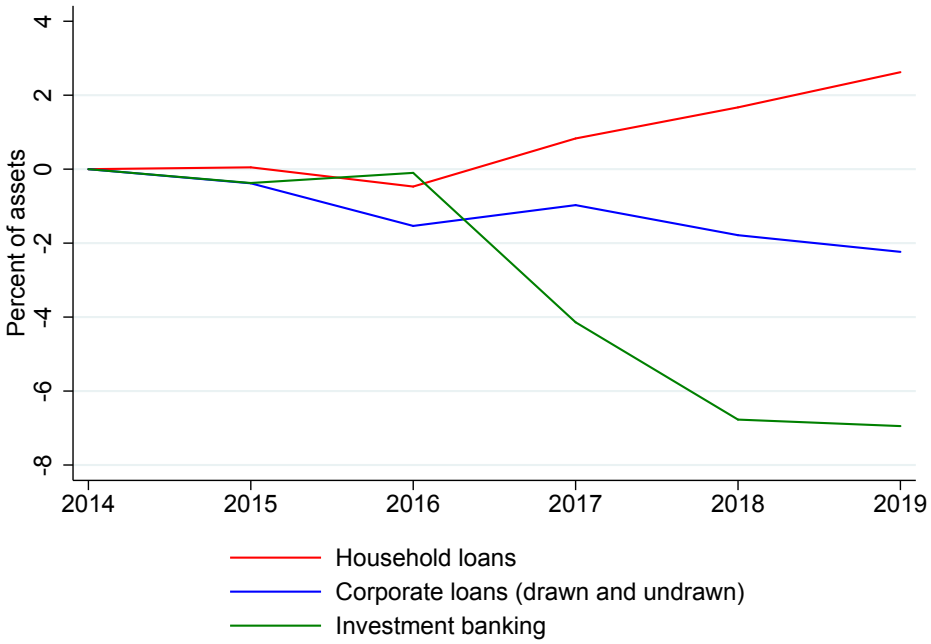
Figure 2: Impact of ring-fencing across time and loans (%(Post))



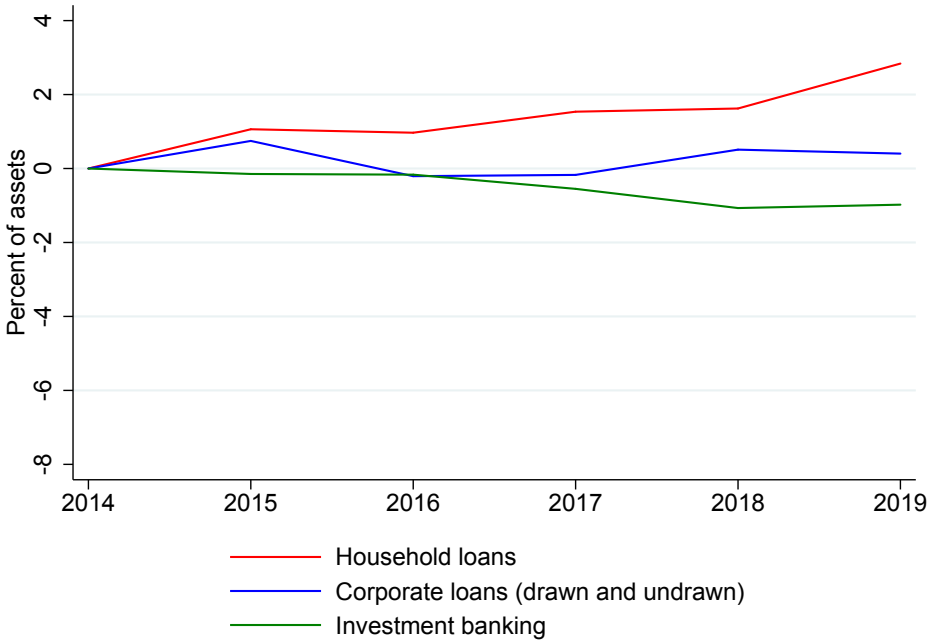
Notes: The figure illustrates how the impact of ring-fencing on funding structure varies across loans with different maturities and origination dates. Each arrow represents a loan, extending from its origination date to its maturity date. The label inside the arrow corresponds to the loan's maturity (fixation period for mortgages). The label below the arrow shows the corresponding value of %(Post), defined as the proportion of the loan's maturity that falls after January 2019, when ring-fencing requirements come into effect.

Figure 3: Changes in balance sheet allocation

(A) Affected banks



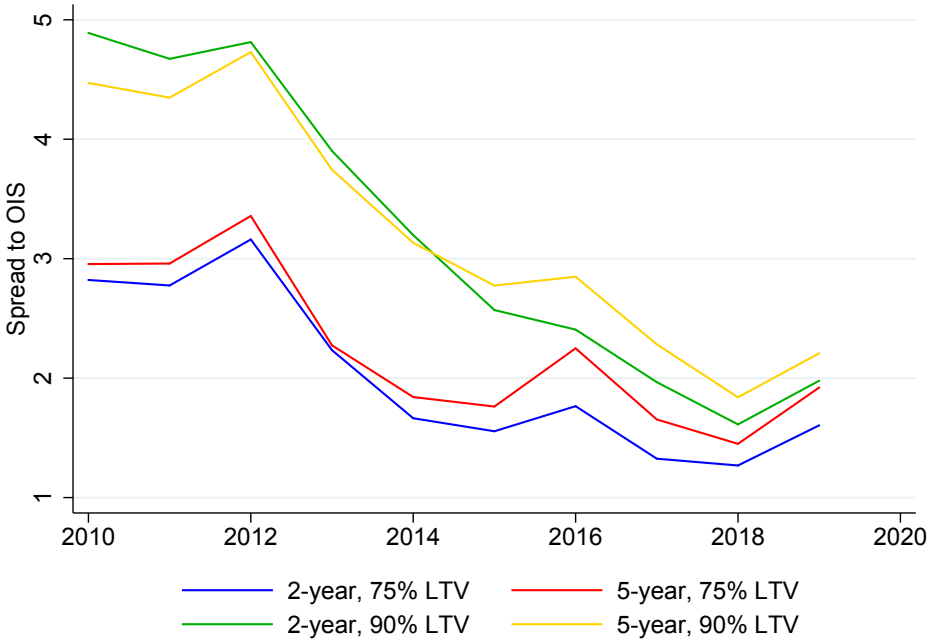
(B) Unaffected banks



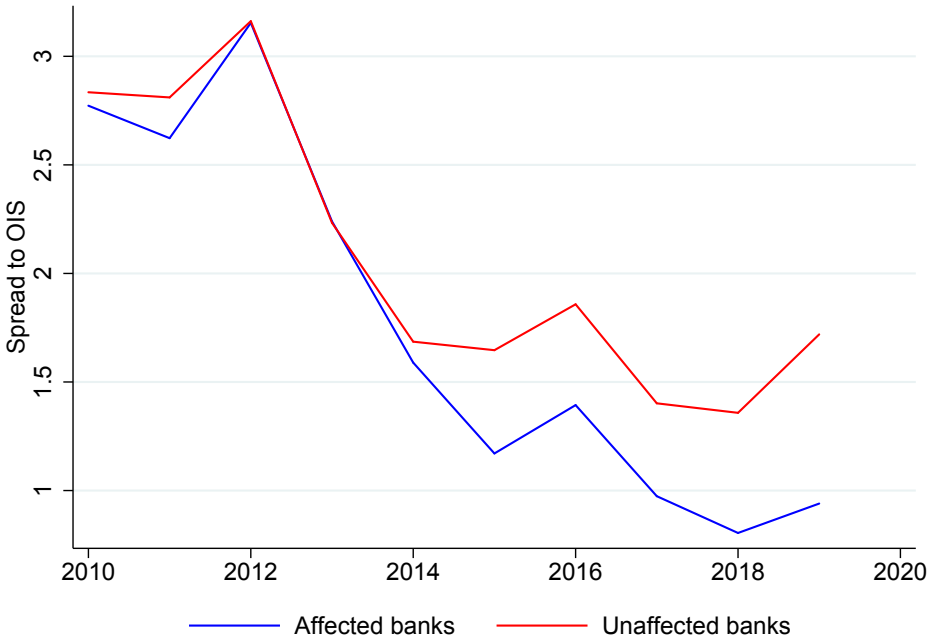
Notes: The charts show cumulative changes in selected asset classes from 2014 to 2019. Panel A shows averages across banks subject to ring-fencing. Panel B shows averages across other banks. Only banks that report group-level FINREP data for the full sample period are included. 'Investment banking' refers to the sum of debt securities, equity securities, and derivatives held for trading. Annual frequency.
Source: Bank of England.

Figure 4: Average quoted mortgage spreads

(A) Average spreads by product



(B) Average spreads for 2-year, 75% LTV mortgages



Notes: The charts show quoted mortgage spreads (averages across lenders). Panel A shows spreads for several major mortgage products, averaged across all lenders. Panel B shows spreads for 2-year, 75% LTV mortgages, averaged across banks subject to ring-fencing (blue line) and other lenders (red line). Annual frequency.
Sources: Moneyfacts, Bank of England.

Table 1: Summary statistics for mortgage market regressions

	Observations	Mean	Std Dev	p25	p50	p75
Dependent variables						
Interest rate spread (percent)	4,588,093	1.87	0.97	1.17	1.62	2.36
Market share	242,347	0.015	0.060	0	0	0
Herfindahl-Hirschman Index (HHI)	590,587	0.659	0.327	0.347	0.587	1.000
Portfolio share (competitor banks)	37,819	0.029	0.077	0.001	0.006	0.027
Measures of exposure to ring-fencing						
ΔRetail funding$_i^{\text{RFB}}$ (treated banks)	5	0.182	0.216	-	-	-
District exposure$_g$	390	0.114	0.035	0.092	0.118	0.137
Competitor exposure$_i$	58	0.103	0.033	0.092	0.110	0.121
%(Post)	4,588,093	0.370	0.388	0.000	0.250	0.760
Loan-level controls						
Maturity (months)	4,588,093	38.6	19.8	24	26	60
Loan-to-value ratio (LTV)	4,588,093	66.4	21.5	52.5	72.3	85.0
Loan-to-income ratio (LTI)	4,577,450	3.09	1.07	2.31	3.15	3.95
Mortgage term (months)	4,588,093	273	106	204	300	360
Log(Loan value)	4,588,093	11.8	0.7	11.4	11.9	12.3
Borrower age (years)	4,588,093	38.4	9.9	31	37	45
First-time buyer indicator	4,588,093	0.275	0.446	0	0	1
Home mover indicator	4,588,093	0.342	0.475	0	0	1
Council buyer indicator	4,588,093	0.010	0.101	0	0	0
Impaired credit history indicator	4,588,093	0.004	0.066	0	0	0
Brokered indicator	4,588,093	0.701	0.458	0	1	1
Long maturity indicator	4,588,093	0.435	0.496	0	0	1
High LTV indicator	4,588,093	0.076	0.265	0	0	0
Bank-level controls						
Log(Total assets)	4,545,940	12.6	1.5	12.3	13.3	13.5
Return on assets	4,545,782	0.004	0.005	0.002	0.004	0.007
Cash / Total assets	4,545,940	0.078	0.031	0.056	0.078	0.096
Capital / Risk-weighted assets	4,546,590	0.187	0.066	0.146	0.166	0.205
Wholesale funding / Total assets	4,545,940	0.272	0.120	0.187	0.268	0.341

Notes: The table shows summary statistics for the variables used in the mortgage regressions.

Table 2: Summary statistics for syndicated lending regressions

	Observations	Mean	Std Dev	p25	p50	p75
Dependent variables						
Log(Loan size)	155,915	2.11	2.57	0.92	2.87	3.91
Log(Number loans)	1,168,600	0.119	0.428	0	0	0
Measures of exposure to ring-fencing						
ΔRetail funding$_i^{\text{NRFB}}$ (treated banks)	5	0.454	0.107	-	-	-
%(Post)	155,915	0.168	0.267	0.000	0.000	0.310
Facility-level variables						
Term loan indicator	155,915	0.513	0.500	0	1	1
Leveraged loan indicator	155,915	0.265	0.441	0	0	1
Lead arranger indicator	155,915	0.535	0.499	0	1	1
UK borrower indicator	155,915	0.030	0.171	0	0	0

Notes: The table shows summary statistics for the variables used in the syndicated lending regressions. A loan is defined as leveraged if it is secured and has a spread of 125bp or higher.

Table 3: Effect of ring-fencing on mortgage spreads

Dependent variable:	Interest rate spread$_{i,l,t}$					
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	OLS	OLS	IV	IV
ΔRetail funding$_i^{\text{RFB}} \times$ %(Post)$_{l,t}$	-0.461***	-1.011***	-0.859***	-0.817***	-0.955***	-0.938***
	(0.157)	(0.163)	(0.136)	(0.137)	(0.184)	(0.184)
Loan-level controls	No	No	Yes	Yes	Yes	Yes
Bank-level controls	No	Yes	Yes	Yes	Yes	Yes
Bank-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Maturity-LTV-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Bank-maturity-LTV fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Location-month fixed effects	No	No	No	Yes	No	Yes
Observations	4,570,771	4,528,616	4,518,056	4,324,803	4,518,056	4,324,803
R^2	0.824	0.820	0.846	0.867	-	-
First-stage F-statistic	-	-	-	-	43.3	46.0

Notes: The table shows loan-level regression results for equation (2). i indexes banks, l indexes loans, and t indexes origination months. The dependent variable is the interest rate spread (over OIS) on loan l originated by bank i in month t. ΔRetail funding$_i^{\text{RFB}}$ is the increase in bank i's retail funding share upon implementation of ring-fencing. %(Post)$_{l,t}$ is the proportion of loan l's maturity that falls after January 2019. Bank-level controls are interactions between %(Post)$_{l,t}$ and one-quarter lags of: log(total assets), return on assets, cash / total assets, capital / risk-weighted assets, and wholesale funding / total assets. Loan-level controls are: LTV; LTI; mortgage term; log(loan value); borrower age; and indicator variables for first-time buyers, home movers, council buyers, borrowers with an impaired credit history, and brokered loans. In columns 5 and 6, ΔRetail funding$_i^{\text{RFB}}$ is instrumented by two variables: an indicator variable equal to one for banks that have more than £25 billion of retail deposits in 2011, and the ratio of non-interest income to total operating income in 2011 (see Section 2.4). The sample period is January 2010 to June 2019. Standard errors are reported in parentheses and clustered by bank. *, ** and *** indicate significance at 10%, 5% and 1%, respectively.

Table 4: Effect of ring-fencing on mortgage product market shares

Dependent variable:	Market share$_{i,j,t}$				
	(1)	(2)	(3)	(4)	(5)
	OLS	OLS	IV	WLS	W2SLS
ΔRetail funding$_i^{\text{RFB}} \times$ %(Post)$_{j,t}$	0.149***	0.216***	0.249***	0.133**	0.168*
	(0.043)	(0.033)	(0.053)	(0.061)	(0.088)
Bank-level controls	No	Yes	Yes	Yes	Yes
Bank-quarter fixed effects	Yes	Yes	Yes	Yes	Yes
Bank-maturity-LTV fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	241,009	204,086	204,086	204,086	204,086
R^2	0.721	0.721	-	0.901	-
First-stage F-statistic	-	-	20.4	-	19.1

Notes: The table shows bank-product-quarter-level regression results for equation (3). i indexes banks, j indexes products (defined by the combination of maturity quarter and LTV bucket), and t indexes origination quarters. The dependent variable is bank i's market share for product j in quarter t. ΔRetail funding$_i^{\text{RFB}}$ is the increase in bank i's retail funding share upon implementation of ring-fencing. %(Post)$_{j,t}$ is the proportion of product j's maturity that falls after January 2019. Bank-level controls are interactions between %(Post)$_{j,t}$ and one-quarter lags of: log(total assets), return on assets, cash / total assets, capital / risk-weighted assets, and wholesale funding / total assets. In columns 4 and 5, observations are weighted by total lending in product j and quarter t (summed across all banks). In columns 3 and 5, ΔRetail funding$_i^{\text{RFB}}$ is instrumented by two variables: an indicator variable equal to one for banks that have more than £25 billion of retail deposits in 2011, and the ratio of non-interest income to total operating income in 2011 (see Section 2.4). The sample period is 2015:Q1 to 2019:Q2. Standard errors are reported in parentheses and clustered by bank. *, ** and *** indicate significance at 10%, 5% and 1%, respectively.

Table 5: Effect of ring-fencing on syndicated lending – Intensive margin

Dependent variable:	Log(Loan size)$_{i,l,t}$				
	(1)	(2)	(3)	(4)	(5)
	OLS	OLS	OLS	OLS	OLS
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{l,t}$	-0.520***				
	(0.186)				
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{l,t} \times$ Term loan$_l$		-0.367**			
		(0.171)			
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{l,t} \times$ Non-term loan$_l$		-0.584***			
		(0.172)			
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{l,t} \times$ Leveraged loan$_l$			-0.416**		
			(0.185)		
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{l,t} \times$ Non-leveraged loan$_l$			-0.550**		
			(0.220)		
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{l,t} \times$ Lead arranger$_{i,l}$				-0.420***	
				(0.158)	
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{l,t} \times$ Participant$_{i,l}$				-0.717***	
				(0.197)	
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{l,t} \times$ UK borrower$_l$					-0.185
					(0.204)
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{l,t} \times$ Foreign borrower$_l$					-0.606***
					(0.208)
Difference between coefficients		-0.217*	-0.135	-0.297**	-0.421**
		(0.114)	(0.229)	(0.132)	(0.192)
Bank-month fixed effects	Yes	Yes	Yes	Yes	Yes
Loan facility fixed effects	Yes	Yes	Yes	Yes	Yes
Bank-category fixed effects	-	Yes	Yes	Yes	Yes
Observations	139,779	139,157	139,602	139,653	139,710
R^2	0.968	0.968	0.968	0.974	0.968

Notes: The table shows regression results for equation (4). i indexes banks, l indexes loan facilities, and t indexes origination months. The dependent variable is the log of the amount of credit extended by bank i in loan facility l in month t. ΔRetail funding$_i^{\text{NRFB}}$ is the amount by which bank i's retail funding share decreases upon implementation of ring-fencing. %(Post)$_{l,t}$ is the proportion of loan l's maturity that falls after January 2019. Bank-category fixed effects are the interaction between bank indicator variables and indicator variables for: term loans (column 2), leveraged loans (column 3), lead arranger tranches (column 4), and UK borrowers (column 5). A loan is defined as leveraged if it is secured and has a spread of 125bp or higher. "Difference between coefficients" shows the difference between the parameter estimates in the column, with standard errors in parentheses. The sample period is January 2010 to March 2018. All regressions in this table are estimated by OLS; IV regressions are shown in Appendix C. Standard errors are reported in parentheses and clustered by bank. *, ** and *** indicate significance at 10%, 5% and 1%, respectively.

Table 6: Effect of ring-fencing on syndicated lending – Extensive margin

Dependent variable:	Log(Number loans)$_{i,j,c,t}$				
	(1)	(2)	(3)	(4)	(5)
	OLS	OLS	OLS	OLS	OLS
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{j,t}$	-1.359***				
	(0.486)				
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{j,t} \times$ Term loan$_c$		-0.651**			
		(0.263)			
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{j,t} \times$ Non-term loan$_c$		-1.114***			
		(0.415)			
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{j,t} \times$ Leveraged loan$_c$			-0.419**		
			(0.195)		
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{j,t} \times$ Non-leveraged loan$_c$			-1.239***		
			(0.435)		
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{j,t} \times$ Lead arranger$_c$				-0.958***	
				(0.331)	
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{j,t} \times$ Participant$_c$				-0.935**	
				(0.415)	
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{j,t} \times$ UK borrower$_c$					-0.735***
					(0.272)
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{j,t} \times$ Foreign borrower$_c$					-1.005***
					(0.354)
Difference between coefficients		-0.463***	-0.820***	0.023	-0.270*
		(0.175)	(0.275)	(0.162)	(0.160)
Bank-quarter fixed effects	Yes	Yes	Yes	Yes	Yes
Maturity-quarter fixed effects	Yes	-	-	-	-
Maturity-quarter-category fixed effects	-	Yes	Yes	Yes	Yes
Bank-category fixed effects	-	Yes	Yes	Yes	Yes
Observations	1,168,600	2,337,200	2,337,200	2,337,200	2,337,200
R^2	0.411	0.335	0.340	0.332	0.404

Notes: The table shows regression results for equation (5). i indexes banks, j indexes loan maturities (measured in quarters), c indexes loan categories, and t indexes origination quarters. The dependent variable is the log of the number of loans with maturity j in category c in which bank i participates in quarter t. ΔRetail funding$_i^{\text{NRFB}}$ is the amount by which bank i's retail funding share decreases upon implementation of ring-fencing. %(Post)$_{j,t}$ is the proportion of the loan maturity that falls after January 2019. Loan categories are: term / non-term (column 2), leveraged / non-leveraged (column 3), lead arranger / participant (column 4), UK borrower / foreign borrower (column 5). A loan is defined as leveraged if it is secured and has a spread of 125bp or higher. "Difference between coefficients" shows the difference between the parameter estimates in the column, with standard errors in parentheses. The sample period is 2010:Q1 to 2018:Q1. All regressions in this table are estimated by OLS; IV regressions are shown in Appendix C. Standard errors are reported in parentheses and clustered by bank. *, ** and *** indicate significance at 10%, 5% and 1%, respectively.

Table 7: Effect of ring-fencing on mortgage spreads – by maturity and risk

Dependent variable:	Interest rate spread$_{i,l,t}$					
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	OLS	OLS	OLS	OLS
ΔRetail funding$_i^{\text{RFB}} \times$ %(Post)$_{l,t}$	-0.446***	-0.848***	-0.829***	-0.460***	-0.861***	-0.817***
	(0.160)	(0.138)	(0.126)	(0.153)	(0.137)	(0.138)
ΔRetail funding$_i^{\text{RFB}} \times$ %(Post)$_{l,t} \times$ Long maturity$_l$	-0.248*	-0.297**	-0.297**			
	(0.146)	(0.122)	(0.120)			
ΔRetail funding$_i^{\text{RFB}} \times$ %(Post)$_{l,t} \times$ High LTV$_l$				-0.020	0.026	-0.007
				(0.136)	(0.117)	(0.120)
Bank-level controls	No	Yes	Yes	No	Yes	Yes
Loan-level controls	No	Yes	Yes	No	Yes	Yes
Bank-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Maturity-LTV-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Bank-maturity-LTV fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Location-month fixed effects	No	No	Yes	No	No	Yes
Observations	4,570,771	4,518,056	4,324,803	4,570,771	4,518,056	4,324,803
R^2	0.824	0.846	0.867	0.824	0.846	0.867

Notes: The table shows loan-level regression results for equation (2). i indexes banks, l indexes loans, and t indexes origination months. The dependent variable is the interest rate spread (over OIS) on loan l originated by bank i in month t. ΔRetail funding$_i^{\text{RFB}}$ is the increase in bank i's retail funding share upon implementation of ring-fencing. %(Post)$_{l,t}$ is the proportion of loan l's maturity that falls after January 2019. Long maturity$_l$ is equal to one for mortgages with maturity greater than two years, and zero otherwise. High LTV$_l$ is equal to one for mortgages with loan-to-value ratio greater than 90%, and zero otherwise. Bank-level controls are interactions between %(Post)$_{l,t}$ and one-quarter lags of: log(total assets), return on assets, cash / total assets, capital / risk-weighted assets, and wholesale funding / total assets. Loan-level controls are: LTV; LTI; mortgage term; log(loan value); borrower age; and indicator variables for first-time buyers, home movers, council buyers, borrowers with an impaired credit history, and brokered loans. The sample period is January 2010 to June 2019. Standard errors are reported in parentheses and clustered by bank. *, ** and *** indicate significance at 10%, 5% and 1%, respectively.

Table 8: Effect of ring-fencing on mortgage product market shares – by maturity and risk

Dependent variable:	Market share$_{i,j,t}$			
	(1)	(2)	(3)	(4)
	OLS	OLS	OLS	OLS
ΔRetail funding$_i^{\text{RFB}} \times$ %(Post)$_{j,t}$	0.111***	0.177***	0.157***	0.223***
	(0.035)	(0.026)	(0.052)	(0.044)
ΔRetail funding$_i^{\text{RFB}} \times$ %(Post)$_{j,t} \times$ Long maturity$_j$	0.137**	0.137**		
	(0.056)	(0.057)		
ΔRetail funding$_i^{\text{RFB}} \times$ %(Post)$_{j,t} \times$ High LTV$_j$			-0.055	-0.055
			(0.103)	(0.103)
Bank-level controls	No	Yes	No	Yes
Bank-quarter fixed effects	Yes	Yes	Yes	Yes
Bank-maturity-LTV fixed effects	Yes	Yes	Yes	Yes
Observations	241,009	204,086	241,009	204,086
R^2	0.722	0.721	0.721	0.721

Notes: The table shows bank-product-quarter-level regression results for equation (3). i indexes banks, j indexes products (defined by the combination of maturity quarter and LTV bucket), and t indexes origination quarters. The dependent variable is bank i's market share for product j in quarter t. ΔRetail funding$_i^{\text{RFB}}$ is the increase in bank i's retail funding share upon implementation of ring-fencing. %(Post)$_{j,t}$ is the proportion of product j's maturity that falls after January 2019. Long maturity$_j$ is equal to one for products with maturity greater than two years, and zero otherwise. High LTV$_j$ is equal to one for products with loan-to-value ratio greater than 90%, and zero otherwise. Bank-level controls are interactions between %(Post)$_{j,t}$ and one-quarter lags of: log(total assets), return on assets, cash / total assets, capital / risk-weighted assets, and wholesale funding / total assets. The sample period is 2015:Q1 to 2019:Q2. Standard errors are reported in parentheses and clustered by bank. *, ** and *** indicate significance at 10%, 5% and 1%, respectively.

Table 9: Persistence of local mortgage market shares over time

Dependent variable:	2018 market share$_{i,g}$		
	(1)	(2)	(3)
	All loans	Non-brokered loans	Brokered loans
2011 market share$_{i,g}$	0.424***	0.470***	0.199**
	(0.067)	(0.058)	(0.089)
Bank fixed effects	Yes	Yes	Yes
Observations	38,318	38,318	38,318
R^2	0.938	0.912	0.918

Notes: The table shows results from bank-district-level regressions of 2018 market shares on 2011 market shares. i indexes banks and g indexes districts. Market share is defined as bank i's mortgage origination volume in district g divided by total mortgage origination volume in district g. Standard errors are reported in parentheses and clustered by bank. *, ** and *** indicate significance at 10%, 5% and 1%, respectively.

Table 10: Effect of ring-fencing on mortgage product market concentration

Dependent variable:	$\text{HHI}_{g,j,t}$			
	(1)	(2)	(3)	(4)
	OLS	OLS	OLS	IV
$\text{Exposure}_g \times \%\,(\text{Post})_{j,t}$	0.355***	0.343***	0.303***	0.300***
	(0.037)	(0.081)	(0.080)	(0.083)
Maturity-quarter fixed effects	Yes	Yes	-	-
LTV-quarter fixed effects	Yes	Yes	-	-
Maturity-LTV-quarter fixed effects	No	No	Yes	Yes
District-quarter fixed effects	No	Yes	Yes	Yes
District-maturity-LTV fixed effects	Yes	Yes	Yes	Yes
Observations	574,297	574,297	573,933	573,933
R^2	0.696	0.701	0.705	-
First-stage F-statistic	-	-	-	4077.3

Notes: The table shows market-quarter-level regression results for equation (7). g indexes districts, j indexes mortgage products (defined by the combination of maturity quarter and LTV bucket), and t indexes origination quarters. The dependent variable is the Herfindahl-Hirschman Index (HHI) for product j in district g in quarter t. Exposure_g is district g's exposure to ring-fencing, defined as the volume-weighted average of $\Delta\text{Retail funding}_i^{\text{RFB}}$ across banks active in the district in 2011 (see equation (6)). $\%(\text{Post})_{j,t}$ is the proportion of product j's maturity that falls after January 2019. In column 4, Exposure_g is instrumented by volume-weighted averages of the two instruments for $\Delta\text{Retail funding}_i^{\text{RFB}}$ discussed in Section 2.4. The sample period is 2015:Q1 to 2019:Q2. Standard errors are reported in parentheses and clustered by district. *, ** and *** indicate significance at 10%, 5% and 1%, respectively.

Table 11: Effect of ring-fencing on mortgage spreads for banks not subject to ring-fencing

Dependent variable:	Interest rate spread$_{i,l,t}$					
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	OLS	OLS	OLS	OLS
Exposure$_i$ × %(Post)$_{l,t}$	2.252	2.775	1.526	2.216	3.194	3.678*
	(1.898)	(1.907)	(1.882)	(1.946)	(1.937)	(1.965)
Exposure$_i$ × %(Post)$_{l,t}$ × Long maturity$_l$			-1.279*	-0.909		
			(0.708)	(1.016)		
Exposure$_i$ × %(Post)$_{l,t}$ × High LTV$_l$					-5.834***	-6.622***
					(1.177)	(1.677)
Bank-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Loan-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Maturity-LTV-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Bank-maturity-LTV fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Location-month fixed effects	No	Yes	No	Yes	No	Yes
Observations	1,376,607	1,129,671	1,376,607	1,129,671	1,376,607	1,129,671
R^2	0.878	0.907	0.878	0.907	0.878	0.907

Notes: The table shows loan-level regression results for equation (9). The sample consists only of banks not subject to ring-fencing requirements. i indexes banks, l indexes loans, and t indexes origination months. The dependent variable is the interest rate spread (over OIS) on loan l originated by bank i in month t. Exposure$_i$ is bank i's exposure to the effects of ring-fencing, based on its mortgage lending portfolio in 2011 (see equation (8)). %(Post)$_{l,t}$ is the proportion of loan l's maturity that falls after January 2019. Long maturity$_l$ is equal to one for mortgages with maturity greater than two years, and zero otherwise. High LTV$_l$ is equal to one for mortgages with loan-to-value ratio greater than 90%, and zero otherwise. Bank-level controls are interactions between %(Post)$_{l,t}$ and one-quarter lags of: log(total assets), return on assets, cash / total assets, capital / risk-weighted assets, and wholesale funding / total assets. Loan-level controls are: LTV; LTI; mortgage term; log(loan value); borrower age; and indicator variables for first-time buyers, home movers, council buyers, borrowers with an impaired credit history, and brokered loans. The sample period is January 2010 to June 2019. All regressions in this table are estimated by OLS; IV regressions are shown in Appendix C. Standard errors are reported in parentheses and clustered by bank. *, ** and *** indicate significance at 10%, 5% and 1%, respectively.

Table 12: Effect of ring-fencing on mortgage portfolio shares for banks not subject to ring-fencing

Dependent variable:	Portfolio share$_{i,j,t}$				
	(1)	(2)	(3)	(4)	(5)
	OLS	OLS	IV	WLS	W2SLS
Exposure$_i$ × %(Post)$_{j,t}$	-0.037	-0.091	-0.086	-0.046	-0.037
	(0.117)	(0.137)	(0.116)	(0.030)	(0.025)
Exposure$_i$ × %(Post)$_{j,t}$ × High LTV$_j$	0.227	0.202	0.085	0.173***	0.144***
	(0.162)	(0.153)	(0.131)	(0.0621)	(0.036)
Bank-level controls	No	Yes	Yes	Yes	Yes
Maturity-LTV-quarter fixed effects	Yes	Yes	Yes	Yes	Yes
Bank-maturity-LTV fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	30,756	30,592	30,592	30,592	30,592
R^2	0.691	0.658	-	0.858	-
First-stage F-statistic	-	-	717.2	-	1263.5

Notes: The table shows bank-product-quarter-level regression results for equation (10). The sample consists only of banks not subject to ring-fencing requirements. i indexes banks, j indexes products (defined by the combination of maturity quarter and LTV bucket), and t indexes origination quarters. The dependent variable is the share of product j in bank i's mortgage lending portfolio in quarter t. Exposure$_i$ is bank i's exposure to the effects of ring-fencing, based on its mortgage lending portfolio in 2011 (see equation (8)). %(Post)$_{j,t}$ is the proportion of product j's maturity that falls after January 2019. High LTV$_j$ is equal to one for products with loan-to-value ratio greater than 90%, and zero otherwise. Bank-level controls are interactions between %(Post)$_{j,t}$ and one-quarter lags of: log(total assets), return on assets, cash / total assets, capital / risk-weighted assets, and wholesale funding / total assets. In columns 4 and 5, observations are weighted by bank i's total mortgage lending in quarter t (summed across all products). The sample period is 2015:Q1 to 2019:Q2. Standard errors are reported in parentheses and clustered by bank. *, ** and *** indicate significance at 10%, 5% and 1%, respectively.

INTERNET APPENDIX

A Comparison with other policies

The UK ring-fencing legislation lies between two opposite approaches to regulating the relationship between deposit-taking and investment banking: full separation (for instance under narrow banking or the original 1933 Glass-Stegall Act), and full integration (for instance under the universal banking model prevalent in Europe and Canada).

Glass-Steagall prohibited commercial banks — that is, entities issuing insured deposits — from engaging in a range of investment banking activities such as securities underwriting and trading, as well as from affiliating with entities engaged in those activities.

In line with this "separation" approach, the UK ring-fence seeks to separate retail and investment banking into financially and operationally self-sufficient entities. But similarly to the "integration" approach, these entities are still allowed to belong to the same group. However, the ring-fenced subsidiary's exposures to the non-ring-fenced subsidiary are limited quantitatively via large exposures regulation, as well as through the requirement that these exposures must be treated as arm's length transactions.

This "middle ground" approach makes the UK ring-fencing close to the "structured universal banking" approach that characterises US regulation (Vickers, 2014). Glass-Steagall provisions were gradually relaxed from the 1960s. From 1986, commercial banks were allowed to affiliate with a securities firm under the umbrella of a bank holding company. However, these companies' bank and nonbank activities must remain in separate and financially self-sufficient subsidiaries. In addition, cross-exposures between bank and nonbank entities remained limited via Sections 23A and 23B of the Federal Reserve Act and Regulation W. This remained the case when the 1999 Gramm-Leach-Bliley Act further relaxed Glass-Steagall provisions by allowing deposit-takers, securities firms, and insurance firms to affiliate under a Financial Holding Company.

The Dodd-Frank Act amends the pre-crisis structured universal banking model by forbidding banks and their affiliates from engaging in proprietary trading and from spon-

soring hedge funds and private-equity funds (Volcker Rule), as well as by extending the reach of Section 23A regulation. This limits deposit-takers' ability to support nonbank affiliates' tri-party repo market activities, which was allowed during the crisis.

Despite sharing a common middle ground approach, UK ring-fencing differs from the US post-crisis structured universal banking in several dimensions. First, the scope of activities prohibited under the two regulatory regimes differs. The Volcker Rule fully bans deposit-taking entities from engaging in (or affiliating with entities engaged in) proprietary trading, whereas ring-fencing allows deposit-taking and proprietary trading to be performed by different subsidiaries in the same group. On the other hand, the UK ring-fence prohibits the deposit-taking subsidiary from performing a wider range of investment-banking activities (including underwriting and market-making). Second, under UK ring-fencing, the bank and nonbank subsidiaries must have separate management boards, providing further operational independence.

These differences might partly explain recent calls to implement a UK-style ring-fence in the US. For instance, the bipartisan "21st Century Glass-Steagall" bill sponsored in 2017 by Elizabeth Warren and John McCain (among others) seeks to limit depository institutions' ability to engage in a range of investment banking activities extending well beyond proprietary trading. Proposals suggesting a stricter separation between commercial and investment banking were also submitted as part of debates around the Dodd-Frank Act, without success, for example the 2009 "Banking Integrity Act." Inspired in part by the UK ring-fence, FDIC Vice Chairman Thomas Hoenig (2017) proposes a "partition" of depository and investment banks into separately capitalised intermediate holding companies with separate management and boards. Treasury Secretary Mnuchin said that such plans were "one of the things we could consider" (Financial Times, 2017), which some observers took to mean that he was looking for a "British makeover for US banks" (Wall Street Journal, 2017).

Since the global financial crisis, legislators in other jurisdictions have also proposed structural reforms aimed at better insulating retail banking from investment banking (see

Financial Stability Board (2014) for a fuller discussion). Most of these plans, including the recommendations from the Liikanen (2012) report, followed a similar "middle ground" approach and did not require a full separation.

B Threats to identification: Further discussion

Our key finding is that the impact of ring-fencing on funding structures leads affected banks to rebalance their activities towards RFB activities such as domestic mortgage lending, and away from NRFB activities such as global syndicated lending. Our preferred interpretation is that these results are driven by a *deposit funding channel*: wholesale funding is an imperfect substitute for retail deposits, so preventing banking groups from using retail deposits to fund NRFB activities makes NRFB activities less attractive and RFB activities more attractive.

We can rule out a range of other potential explanations for our results because our granular data and identification strategy allow us to exploit variation in the strength of this channel both across banks (ΔRetail funding$_i$) and within banks (%(Post)$_{l,t}$). This allows us to use bank-time fixed effects to control for a wide range of confounding developments that could coincide with the run-up to ring-fencing, even those whose impact might differ across banks and time. We also report additional results that support our interpretation. In particular, the rebalancing is stronger for assets more likely to benefit from the stability of retail deposit funding, such as longer-term mortgages and syndicated loans that are more likely to be retained by the originator.

For an alternative channel to explain our baseline (OLS) results, it would therefore need to meet three criteria: (i) it would need to vary across banks in a way that is correlated with ΔRetail funding$_i$; (ii) it would need to vary across loan maturities and time in a way that is correlated with %(Post)$_{l,t}$; and (iii) it would need to have opposite effects in the mortgage and syndicated lending markets. For this alternative channel to also lead to a violation of the exclusion restriction in our IV regressions, it should additionally be correlated with our two instruments for ΔRetail funding$_i$.

As discussed in Section 2.3, several developments might have affected bank lending behaviour in the run-up to ring-fencing, including the 2016 Brexit referendum and other regulatory developments such as changes in capital requirements. However it is unclear

that these would meet all three of the criteria above. For example, is not clear why the Brexit referendum would only affect those UK banks with more than £25bn in deposits (criterion i), nor why its impact should vary with a loan's maturity and distance between origination and January 2019 (criterion ii).

That said, one general challenge is that ring-fencing could affect banks through mechanisms other than the deposit funding channel. In the remainder of this section we therefore discuss three groups of potential alternative explanations for our results in more detail. Where a channel satisfies all three criteria, we report results of additional tests that control for the channel.

Unaffected channels

The first group of potential alternative explanations comprises mechanisms that have been discussed by the literature on universal banking, but are not affected by the UK ring-fencing legislation.

A number of studies emphasise information spillovers between lending to large firms and underwriting these firms' securities, and the potential for resulting conflicts of interest (Kroszner and Rajan, 1994; Puri, 1996), cross-selling benefits (Laux and Walz, 2009), or positive synergies (Calomiris, 2000; Kanatas and Qi, 2003; Drucker and Puri, 2005; Yasuda, 2005; Neuhann and Saidi, 2018; Akiyoshi, 2019). The ring-fencing reform does not affect these information spillovers because it allows banks to place their underwriting and wholesale lending businesses on the same side of the ring-fence (the NRFB), and all affected banks have chosen to do that in practice.

The regulation also permits corporate deposits to be housed in the NRFB. Therefore, ring-fencing does not affect information synergies between deposit-taking and corporate lending, whereby a bank gains "inside" information about a borrower from being able to observe its deposit balance history (Fama, 1985; Black, 1975).

Symmetric channels

The second group of channels consists of mechanisms that are potentially affected by ring-fencing, but would have directionally similar impacts on RFB and NRFB lending, and so cannot explain the fact that we find opposite results for mortgage and syndicated lending.

Existing literature proposes several mechanisms through which large, diversified conglomerates might differ from smaller, more specialised institutions.[28] On the one hand, conglomerates might benefit from economies of scale and scope; diversification across a range of products and geographies might mitigate idiosyncratic risks; and internal capital markets might better enable conglomerates to allocate funding to profitable investment opportunities. On the other hand, conglomerates might face more severe agency frictions; and there might be a "dark side of diversification," with internal capital markets leading to inefficient cross-subsidisation across business areas.

By forcing universal banks to split into smaller and less diversified subsidiaries, ring-fencing could lead to an increase or decrease in lending through these mechanisms. However the reduction in size and diversification, and the restrictions on internal capital markets, would be felt by both the RFB and NRFB. So such mechanisms would be unable to explain our finding that RFB lending increases while NRFB lending decreases.

Asymmetric channels

The third group of channels comprises mechanisms that are potentially affected by ring-fencing, and that might have directionally opposite effects across the RFB and NRFB, and so could potentially explain our findings.

One potential alternative explanation for our main result is the impact of ring-fencing on **wholesale funding costs**. Ring-fencing might lead to a decrease in RFB wholesale funding costs and an increase in NRFB wholesale funding costs, for two reasons. First,

[28] Among others, see Stein (1997); Campello (2002); Laeven and Levine (2007); Goetz et al. (2013, 2016).

authorities might consider the services provided by RFBs (such as payment services, deposit-taking, and lending to households and SMEs) to be more important than those provided by NRFBs. By making it easier to resolve or bail-out the RFB and NRFB separately, ring-fencing could therefore increase the perceived probability that RFB debtholders would be bailed out in the event of stress (because this would not imply a parallel bail-out of investment banking or foreign activities), while increasing the perceived probability that the NRFB would be resolved or allowed to fail (because this would not lead to disruption of RFB services). Second, ring-fencing might reduce (increase) investors' perceived probability that the RFB (NRFB) would fail, because its assets and funding might be perceived to be safer (riskier). These factors suggest that ring-fencing could cause a rebalancing from NRFB to RFB activities via the impact on wholesale funding costs, rather than the deposit funding channel.

However, this impact might be offset by several countervailing factors. Restructured groups might decide to allocate capital and liquidity across subsidiaries to offset the underlying change in risk profile. The increase (decrease) in the RFB's (NRFB's) share of insured deposits would tend to decrease (increase) the position of the RFB's (NRFB's) wholesale creditors in the creditor hierarchy. And the size and interconnectedness of some NRFBs might still result in a high perceived probability of government support. In line with these offsetting factors, the major credit rating agencies generally rate RFBs higher than NRFBs, but the difference is generally small (less than one notch, on average).

That said, we control for this channel by computing the difference between the RFB credit rating and the group credit rating.[29] As for $\Delta\text{Retail funding}_i$, we measure this difference at the end of 2018, and interact it with $\%(\text{Post})_{l,t}$. The results for equation (2) including this additional control variable are reported in Table B.1, columns 1 and 2. The coefficient on our main variable of interest ($\Delta\text{Retail funding}_i^{\text{RFB}} \times \%(\text{Post})_{l,t}$)

[29]Rather than the observed group credit rating, we use the asset-weighted average of the RFB and NRFB credit ratings. This is because the observed group credit rating is also affected by the proportion of debt that is issued from the group rather than the subsidiaries, because for UK banks, debt issued from the group is junior to debt issued from the subsidiaries ("structural subordination").

remains statistically significant and of a similar magnitude to our baseline results.

A second potential confounding factor is the impact of ring-fencing on capital requirements. UK banks are subject to two capital requirements: a risk-weighted capital requirement, and a leverage ratio requirement, which is designed to be risk-insensitive. On average, RFB assets (such as mortgages and SME loans) carry higher risk-weights than NRFB assets (such as reverse repo). This means that ring-fencing tends to make the **risk-weighted capital requirement** more binding for RFBs and less binding for NRFBs. Assuming that equity is more expensive than other forms of funding, this would predict a rebalancing away from retail lending and towards capital market activities — the opposite of what we find.

However, for the same reason, ring-fencing tends to make the **leverage ratio requirement** less binding for RFBs and more binding for NRFBs. This channel would incentivise a rebalancing from NRFB to RFB assets, and so could potentially explain our main results. To control for this channel, we compute the difference between the RFB regulatory leverage ratio and the group regulatory leverage ratio as of 2019:Q1, and interact this difference with $\%(\text{Post})_{l,t}$. Our main result is robust to including this additional control variable (Table B.1, columns 3 and 4).

UK banks are also subject to liquidity regulation through the **liquidity coverage ratio** (LCR). The LCR requires banks to hold a sufficient stock of high-quality liquid assets (HQLA) to meet potential funding outflows in stress. Assets that qualify as HQLA typically have low returns and so are costly to hold. Since wholesale funding is typically treated by the LCR as flightier than retail deposits, ring-fencing tends to increase the HQLA requirement for NRFBs while decreasing it for RFBs, leading to increased costs for NRFBs and reduced costs for RFBs. This would potentially incentivise a rebalancing from NRFB activities to RFB activities, in line with our main results. To control for this channel, we interact $\%(\text{Post})_{l,t}$ with the difference between the RFB LCR and group LCR as of 2019:Q1. Again, our main result is robust to including this additional control variable (Table B.1, columns 5 and 6).

Table B.1: Effect of ring-fencing on mortgage spreads – Alternative channels

Dependent variable:	Interest rate spread$_{i,l,t}$					
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	IV	OLS	IV	OLS	IV
ΔRetail funding$_i^{\text{RFB}} \times$ %(Post)$_{l,t}$	-0.746***	-0.719***	-0.981***	-0.938***	-0.678***	-0.787***
	(0.144)	(0.128)	(0.122)	(0.112)	(0.134)	(0.144)
ΔCredit rating$_i^{\text{RFB}} \times$ %(Post)$_{l,t}$	0.509***	0.512***				
	(0.052)	(0.053)				
ΔLeverage ratio$_i^{\text{RFB}} \times$ %(Post)$_{l,t}$			0.514***	0.502***		
			(0.086)	(0.099)		
ΔLCR$_i^{\text{RFB}} \times$ %(Post)$_{l,t}$					-0.013***	-0.012***
					(0.003)	(0.003)
Bank-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Loan-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Maturity-LTV-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Bank-maturity-LTV fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Location-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,324,803	4,324,803	4,324,803	4,324,803	4,324,803	4,324,803
R^2	0.867	-	0.867	-	0.867	-
First-stage F-statistic	-	166.0	-	807.7	-	50.8

Notes: The table shows loan-level regression results for equation (2), with additional control variables. i indexes banks, l indexes loans, and t indexes origination months. The dependent variable is the interest rate spread (over OIS) on loan l originated by bank i in month t. ΔRetail funding$_i^{\text{RFB}}$ is the increase in bank i's retail funding share upon implementation of ring-fencing. %(Post)$_{l,t}$ is the proportion of loan l's maturity that falls after January 2019. ΔCredit rating$_i^{\text{RFB}}$ is the difference between the RFB credit rating and the group credit rating as of end-2018. ΔLeverage ratio$_i^{\text{RFB}}$ is the difference between the RFB regulatory leverage ratio and the group regulatory leverage ratio as of 2019:Q1. ΔLCR$_i^{\text{RFB}}$ is the difference between the RFB liquidity coverage ratio (LCR) and the group LCR as of 2019:Q1. Bank-level controls are interactions between %(Post)$_{l,t}$ and one-quarter lags of: log(total assets), return on assets, cash / total assets, capital / risk-weighted assets, and wholesale funding / total assets. Loan-level controls are: LTV; LTI; mortgage term; log(loan value); borrower age; and indicator variables for first-time buyers, home movers, council buyers, borrowers with an impaired credit history, and brokered loans. In columns 2, 4 and 6, ΔRetail funding$_i^{\text{RFB}}$ is instrumented by two variables: an indicator variable equal to one for banks that have more than £25 billion of retail deposits in 2011, and the ratio of non-interest income to total operating income in 2011 (see Section 2.4). The sample period is January 2010 to June 2019. Standard errors are reported in parentheses and clustered by bank. *, ** and *** indicate significance at 10%, 5% and 1%, respectively.

C Additional robustness tests

Table C.1: Effect of ring-fencing on syndicated lending – Intensive margin (IV)

Dependent variable:	Log(Loan size)$_{i,l,t}$				
	(1)	(2)	(3)	(4)	(5)
	IV	IV	IV	IV	IV
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{l,t}$	-0.542***				
	(0.202)				
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{l,t} \times$ Term loan$_l$		-0.378**			
		(0.179)			
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{l,t} \times$ Non-term loan$_l$		-0.604***			
		(0.187)			
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{l,t} \times$ Leveraged loan$_l$			-0.417**		
			(0.189)		
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{l,t} \times$ Non-leveraged loan$_l$			-0.580**		
			(0.240)		
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{l,t} \times$ Lead arranger$_{i,l}$				-0.440**	
				(0.174)	
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{l,t} \times$ Participant$_{i,l}$				-0.734***	
				(0.207)	
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{l,t} \times$ UK borrower$_l$					-0.187
					(0.208)
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{l,t} \times$ Foreign borrower$_l$					-0.634***
					(0.228)
Difference between coefficients		-0.225*	-0.163	-0.294**	-0.447**
		(0.115)	(0.235)	(0.132)	(0.200)
Bank-month fixed effects	Yes	Yes	Yes	Yes	Yes
Loan facility fixed effects	Yes	Yes	Yes	Yes	Yes
Bank-category fixed effects	-	Yes	Yes	Yes	Yes
Observations	139,779	139,157	139,602	139,653	139,710
First-stage F-statistic	2960.5	10279.1	4244.5	1331.1	3820.7

Notes: The table shows instrumental variable regression results for equation (4). i indexes banks, l indexes loan facilities, and t indexes origination months. The dependent variable is the log of the amount of credit extended by bank i in loan facility l in month t. ΔRetail funding$_i^{\text{NRFB}}$ is the amount by which bank i's retail funding share decreases upon implementation of ring-fencing. This is instrumented by two variables: an indicator variable equal to one for banks that have more than £25 billion of retail deposits in 2011, and the ratio of non-interest income to total operating income in 2011 (see Section 2.4). %(Post)$_{l,t}$ is the proportion of loan l's maturity that falls after January 2019. Bank-category fixed effects are the interaction between bank indicator variables and indicator variables for: term loans (column 2), leveraged loans (column 3), lead arranger tranches (column 4), and UK borrowers (column 5). A loan is defined as leveraged if it is secured and has a spread of 125bp or higher. "Difference between coefficients" shows the difference between the parameter estimates in the column, with standard errors in parentheses. The sample period is January 2010 to March 2018. Standard errors are reported in parentheses and clustered by bank. *, ** and *** indicate significance at 10%, 5% and 1%, respectively.

Table C.2: Effect of ring-fencing on syndicated lending – Extensive margin (IV)

Dependent variable:	Log(Number loans)$_{i,j,c,t}$				
	(1)	(2)	(3)	(4)	(5)
	IV	IV	IV	IV	IV
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{j,t}$	-1.352***				
	(0.470)				
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{j,t} \times$ Term loan$_c$		-0.713***			
		(0.265)			
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{j,t} \times$ Non-term loan$_c$		-1.297***			
		(0.445)			
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{j,t} \times$ Leveraged loan$_c$			-0.481**		
			(0.201)		
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{j,t} \times$ Non-leveraged loan$_c$			-1.423***		
			(0.456)		
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{j,t} \times$ Lead arranger$_c$				-1.030***	
				(0.337)	
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{j,t} \times$ Participant$_c$				-1.126**	
				(0.466)	
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{j,t} \times$ UK borrower$_c$					-0.782***
					(0.274)
ΔRetail funding$_i^{\text{NRFB}} \times$ %(Post)$_{j,t} \times$ Foreign borrower$_c$					-1.134***
					(0.355)
Difference between coefficients		-0.584***	-0.942***	-0.096	-0.352**
		(0.202)	(0.288)	(0.210)	(0.153)
Bank-quarter fixed effects	Yes	Yes	Yes	Yes	Yes
Maturity-quarter fixed effects	Yes	-	-	-	-
Maturity-quarter-category fixed effects	-	Yes	Yes	Yes	Yes
Bank-category fixed effects	-	Yes	Yes	Yes	Yes
Observations	1,168,600	2,337,200	2,337,200	2,337,200	2,337,200
First-stage F-statistic	3403.9	39.0	39.0	39.0	39.0

Notes: The table shows instrumental variable regression results for equation (5). i indexes banks, j indexes loan maturities (measured in quarters), c indexes loan categories, and t indexes origination quarters. The dependent variable is the log of the number of loans with maturity j in category c in which bank i participates in quarter t. ΔRetail funding$_i^{\text{NRFB}}$ is the amount by which bank i's retail funding share decreases upon implementation of ring-fencing. This is instrumented by two variables: an indicator variable equal to one for banks that have more than £25 billion of retail deposits in 2011, and the ratio of non-interest income to total operating income in 2011 (see Section 2.4). %(Post)$_{j,t}$ is the proportion of the loan maturity that falls after January 2019. Loan categories are: term / non-term (column 2), leveraged / non-leveraged (column 3), lead arranger / participant (column 4), UK borrower / foreign borrower (column 5). A loan is defined as leveraged if it is secured and has a spread of 125bp or higher. "Difference between coefficients" shows the difference between the parameter estimates in the column, with standard errors in parentheses. The sample period is 2010:Q1 to 2018:Q1. Standard errors are reported in parentheses and clustered by bank. *, ** and *** indicate significance at 10%, 5% and 1%, respectively.

Table C.3: Effect of ring-fencing on mortgage spreads for banks not subject to ring-fencing (IV)

Dependent variable:	Interest rate spread$_{i,l,t}$					
	(1)	(2)	(3)	(4)	(5)	(6)
	IV	IV	IV	IV	IV	IV
Exposure$_i$ × %(Post)$_{l,t}$	2.209	2.665	1.074	1.603	3.001	3.384*
	(1.844)	(1.837)	(1.871)	(1.908)	(1.906)	(1.895)
Exposure$_i$ × %(Post)$_{l,t}$ × Long maturity$_l$			-1.680***	-1.520**		
			(0.593)	(0.739)		
Exposure$_i$ × %(Post)$_{l,t}$ × High LTV$_l$					-4.714***	-4.886***
					(1.089)	(1.572)
Bank-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Loan-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Maturity-LTV-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Bank-maturity-LTV fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Location-month fixed effects	No	Yes	No	Yes	No	Yes
Observations	1,376,607	1,129,671	1,376,607	1,129,671	1,376,607	1,129,671
First-stage F-statistic	2223.1	2348.9	624.7	517.4	1114.1	1318.1

Notes: The table shows loan-level instrumental variable regression results for equation (9). The sample consists only of banks not subject to ring-fencing requirements. i indexes banks, l indexes loans, and t indexes origination months. The dependent variable is the interest rate spread (over OIS) on loan l originated by bank i in month t. Exposure$_i$ is bank i's exposure to the effects of ring-fencing, based on its mortgage lending portfolio in 2011 (see equation (8)). %(Post)$_{l,t}$ is the proportion of loan l's maturity that falls after January 2019. Long maturity$_l$ is equal to one for mortgages with maturity greater than two years, and zero otherwise. High LTV$_l$ is equal to one for mortgages with loan-to-value ratio greater than 90%, and zero otherwise. Bank-level controls are interactions between %(Post)$_{l,t}$ and one-quarter lags of: log(total assets), return on assets, cash / total assets, capital / risk-weighted assets, and wholesale funding / total assets. Loan-level controls are: LTV; LTI; mortgage term; log(loan value); borrower age; and indicator variables for first-time buyers, home movers, council buyers, borrowers with an impaired credit history, and brokered loans. The sample period is January 2010 to June 2019. Standard errors are reported in parentheses and clustered by bank. *, ** and *** indicate significance at 10%, 5% and 1%, respectively.