Bank Capital Regulation and Derivatives Clearing*

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Abstract

As part of the post global financial crisis reforms, regulators introduced a leverage ratio requirement, a minimum capital requirement over a bank's total exposures. We assess the consequences of this requirement for derivative clearing services to clients, which creates exposures for the dealers, by exploiting its earlier introduction in the United Kingdom and detailed confidential transaction and portfolio data. UK dealers reduce their client clearing business following the introduction of the requirement, particularly dealers with lower capital positions and for longer-term derivatives; they are also more likely to end client relationships. Capital regulation might indirectly limit access to clearing services.

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1 Introduction

The regulatory response to the 2008–09 global financial crisis has been characterised by a shift towards multi-polar regulation (Haldane (2015)), that is, the imposition of multiple regulatory constraints. This new regulatory framework emphasises the importance of not only understanding the effects and consequences of new regulatory tools, but also how they interact with one another. In isolation, some of these reforms may bring strong benefits; however, when considered as part of a package, their efficacy might be lower than expected or they might even give rise to unintended consequences.

One such reform is the leverage ratio (LR) requirement on banks. The LR requires banks to finance their exposures with a minimum amount of capital—in particular, Tier 1 capital—independent of riskiness. This requirement complements the existing risk-based capital regulation, which does impose different capital requirements depending on the riskiness of banks' assets. The LR was introduced to guard against model and gaming risk.[1]

At around the same time, G20 leaders pledged to reform over-the-counter (OTC) derivatives markets with the goal of reducing systemic risk. To do so, regulators introduced mandatory central clearing for the most liquid types of derivative transactions—that is, these derivatives need to be cleared through a central counterparty (CCP). Importantly, only dealers typically access the CCP directly, and hence any non-dealer that is subject to the obligation has to seek clearing services from a dealer.

When dealers provide clearing services to clients, they develop an exposure which has to be capitalised. In the risk-based capital requirement, the margin exchanged—both initial and variation margin—reduces the exposure of the dealer and hence the resulting capital requirement. In the LR framework, however, initial margin cannot be used to reduce the exposure. Therefore, in this type of transaction, the LR, rather than the risk-weighted capital

[1] See Behn et al. (forthcoming) for empirical evidence of the limits of risk-based regulation.

requirement, is the more costly constraint. In other words, dealers offering clearing services to clients will see their leverage exposure measure—the denominator of the LR—increase, and hence will be required to raise more capital.

Does this additional capital render part of the client clearing business unprofitable? The financial industry seems to think so, and even some banks have withdrawn from client clearing in the last few years (Parsons (2017); Cameron and Jaidev (2012); Jaidev (2012); Vaghela (2016)). Indeed, due to the presence of debt overhang costs (Andersen et al. (2018)), positive net present value activities may not be taken because the profit margin is too low. This description fits well with client clearing services, since the trades have low risk thanks to the margin exchanged, and hence the spreads tend to be low too. If the LR has a significant negative impact on client clearing, then regulators might re-assess their cost-benefit analyses as it negatively interacts with other reforms such as clearing obligations.

There are, however, reasons to think that the impact of the LR on client clearing is not that significant. First, although initial margin cannot be used to reduce the exposure, other risk-mitigation techniques, such as netting, can be used. Moreover, the LR applies only at a certain level of consolidation, and it is possible that many dealers are actually not constrained by the LR.[2] Finally, dealers may provide access to clearing services as part of a serial package to clients, and hence there are other profit margins to consider, not just the profit from a cleared derivative transaction, in the decision making process.

This is, hence, an empirical question, and the one we attempt to answer in this paper. We analyse the question by using both UK trade repositories and data collected by the Bank of England on OTC interest rate derivatives cleared at London Clearing House (LCH), the most important clearing house for interest rate swaps. For identification, we analyse the introduction of the leverage ratio requirement in the UK, which anticipated the Basel

[2]This is the case when the Tier 1 capital required in the risk-based framework is higher than the Tier 1 capital required in the LR framework. We follow the regulatory convention of saying that in this case a bank is *constrained* by the *risk-based* framework.

Committee on Banking Supervision timeline by two years, to understand how this regulation affects the provision of clearing services. During 2016 and 2017, UK dealers were subject to the Basel III leverage ratio while non-UK dealers were not; we exclude US dealers from the analysis given their supplementary leverage ratio regulation as well as their domestic mandate to clear transactions.

Our datasets allow us to comfortably cover over 75% of the European interest rate derivatives market since London is by far the largest clearing market in Europe during our sample period. The data from the trade repository includes every single interest rate trade that has passed through the United Kingdom (UK), is denominated in Sterling, or involves a UK entity. We are able to identify each individual trade, the clearing member, client and details of the trade. Moreover, the data from the central counterparty LCH provides information at a daily frequency covering the number of clients for whom clearing members are providing services (for interest rate derivatives). The use of granular data, coupled with the regulatory shocks, facilitates the identification of the supply effects (Jiménez et al. (2017)).

Our results suggest that dealers affected by the LR requirement reduce their willingness to clear derivatives transactions on behalf of their clients. Following the introduction of the LR in the UK, UK dealers reduce their market share on average around 3 percentage points. This result is stronger for UK dealers with lower starting leverage ratios, which highlights the main motive behind the drop. Moreover, the result is weaker—in fact, not economically or statistically significant—for shorter-term derivatives, which carry significantly lower leverage requirements.

We also find substantial heterogeneity with respect to the client sectors that are more affected by the reduced willingness of providing clearing services. Smaller banks and building societies, and hedge funds appear to be the most-affected sectors. Insurance companies and pension funds, on the other hand, do not suffer such a reduction after the introduction of the LR.

Dealer-client relationships are less likely to be observed after the introduction of the LR for UK dealers. This is particularly true when we control for the demand of clearing services by using Client×Quarter fixed effects (FE) or even Client×Currency×Quarter or Client×Product×Quarter FE. Even though the R^2 jumps from 4.8% to 84.2%, the negative coefficient stays highly statistically significant and, if anything, becomes more negative. A quarter-by-quarter analysis shows that the negative association between dealer-client relationships and UK dealers only appears from 2016Q1 onwards, thus reinforcing the evidence on the role of the LR.

This negative result is driven both by a higher likelihood of ending existing dealer-client relationships as well as a lower likelihood of starting new ones. UK dealers are more likely to end a relationship after the introduction of the LR, even after controlling for pre-trends. On the other hand, they are less likely to start new relationships, although this happens also in the earlier period, possibly due to anticipation. Analysing the total number of clients at dealer level, we find a substantial reduction for UK dealers after the regulation compared to non-UK dealers.

The results found in this paper are consistent with claims that the LR might increase the cost of providing clearing services in the OTC derivatives market, pushing some dealers to reduce these services. Therefore, we document a potentially unintended consequence of the LR that might conflict with other objectives of the regulatory framework.

We contribute to several strands of the literature. We add to the growing set of papers that empirically analyse the post-crisis bank capital framework (Trebbi and Xiao (2019), Adrian et al. (2017), Acosta-Smith et al. (forthcoming), Brei and Gambacorta (2016), Bicu-Lieb et al. (2020), Kotidis and Horen (2018)). While there is some evidence that the bank capital framework is negatively affecting market liquidity and the provision of financial services by dealers, the matter is far from settled. We show that a key financial contract, interest rate derivatives, is less likely to be provided after the introduction of the LR.

We also contribute to the literature on the optimal design and regulation of the OTC derivatives market (Culp (2010), Duffie and Zhu (2011), and Ghamami and Glasserman (2017), Cenedese et al. (2020)). Closest to our paper is Cenedese et al. (2021), which also explores the introduction of the UK leverage ratio but focuses on the pricing effect on currency derivatives. Our paper instead studies the interest rate derivatives market—a market that is currently under madatory central clearing—and focuses on the effects at the extensive margin, i.e., dealer-client relationships that disappear due to the regulation, and the heterogeneity of such effects. We show that important steps towards improving liquidity and transparency of OTC derivative markets, such as central clearing, can be impeded by other parts of the financial regulatory framework.

The rest of the paper is organised as follows. Section 2 describes the centrally cleared derivatives market and the LR requirement. Section 3 describes the data. Section 4 discusses the methodology and presents some summary statistics. Second 5 presents our results. Section 6 concludes.

2 Client clearing and the leverage ratio

The costs and infrastructure requirements to be a clearing member of a generic CCP are significant and are, in practice, only justifiable for entities with a substantial derivatives business. For this reason, entities that wish to centrally clear derivative transactions usually prefer to enter into a client relationship with one or more CCP clearing members. So roughly speaking, client clearing involves a market participant becoming a client of a clearing member (i.e., dealer) in order to access a CCP to clear its derivative transactions.

A CCP authorised or recognised under EMIR (European Market Infrastructure Regulation) imposes stringent membership costs and operational requirements on its clearing members. Membership is restricted to large institutions because any losses of the CCP aris-

ing from the default of a clearing member will be mutualised among all members.[3] For this reason, each clearing member considers the financial strength of all other members before joining a CCP. An eligible counterparty that only engages in limited derivatives trading will find it impractical or undesirable to become a clearing member, preferring instead to obtain access to the CCP by way of a clearing broker which guarantees the performance of the client vis-à-vis the CCP. That is, it will become a client of an existing clearing member of the CCP. In summary, the client enters into a client transaction with its clearing member, who then simultaneously enters into another transaction with the CCP. Across our sample period, LCH Swapclear had between 40 and 46 (out of 103/105) clearing members offer clearing services to their clients.

This interacts with the leverage ratio requirement (LR) in the following way. According to the Basel III LR framework (Basel Committee on Banking Supervision (2014)), a clearing broker must "calculate its related leverage ratio exposure resulting from the guarantee [of its client's cleared derivative trade] as a derivative exposure ... [i.e.] as if it had entered directly into the transaction with the client." As a result, the LR framework effectively treats a dealer as a direct party to the cleared derivative trade with its client. Hence the clearing firm's exposure is greater than it otherwise would be as an intermediary and financial guarantor for that trade. By treating the clearing broker as its client's counterparty, the LR framework precludes the clearing firm from reducing its derivatives exposure by the collateral posted by the client. This is the case even if such collateral is held by the relevant CCP (which is effectively the client's true counterparty) and is legally and operationally segregated, thus not available for the dealer to use as leverage.[4]

As a consequence, dealers affected by the LR may deleverage since they may be short

[3]This would occur if the CCP is holding insufficient collateral.

[4]In addition, the dealer also incurs a default fund exposure capital charge. This component is based on the risk that the dealer's contribution to the CCP's default fund would be tapped in the event of the failure of other clearing members. This exposure however does not count towards the leverage exposure measure to avoid double-counting.

of capital and raising it externally could be expensive. Faced with higher capital charges, dealers could drop some of their clients. These clients in turn may then temporarily lose access to the derivative market, precluding them from hedging part of their risks. Overall, this reduced availability of clearing services may run counter to the globally endorsed goal of promoting clearing to address systemic risk.

3 Data

In September 2009, in response to the global financial crisis, G20 leaders agreed that OTC derivatives transactions should be reported to trade repositories by the end of the following business day so that they could be collected and analysed by the respective regulatory authorities. The post-trade disclosure of derivatives transactions opened up a whole new range of possibilities for policy analysis and research. The ability to observe trading activity allows one to identify the reaction of market participants to the implementation of reforms so as to assess their efficacy. This is particularly useful for policy makers who use derivatives data to extract information about market expectations before a market event (e.g., default of an institution) or a policy event (e.g., short-term interest rate expectations).

The Bank of England's access to trade reports is as per the conditions stated in EMIR under Article 2 of Commission Delegated Regulation (EU) No 151/2013. This means that we can access reports related to client clearing activities in the interest rate derivatives markets between clearing members and their clients on: a) trades cleared by a CCP supervised by the Bank of England; b) trades where one of the counterparties is a UK entity; c) trades where one of the counterparties is supervised by the Bank of England; and d) aggregated position data for all derivative contracts referencing Sterling.

We analyse the interest rate derivatives markets data in the EU as it is one of the largest segments of the derivatives market. Moreover, it is an important market for hedging purposes

for a large number of institutions. We focus our analysis on the quarters before and after the introduction of the leverage ratio—2015Q4 and 2016Q1— with the data provided by the Depository Trust & Clearing Corporation (DTCC) trade repository. The data contains only reports related to client activities of London Clearing House (LCH) Swapclear's clearing members for interest rate trades including all the most liquid interest rate products. On a daily basis Swapclear clears an average of $3 trillion in interest-rate derivatives, including 75% of all the centrally cleared contracts on euro-denominated interest rate derivatives. However, we focus our analysis only on the client activities, which amount to an average of $900 billion.

To enrich our dataset, we also use proprietary data from LCH Swapclear, which includes information on the identity of the clients and on the portfolio value of all house and client portfolios between January 2014 and April 2017. We keep only client portfolios for our analysis. Each observation corresponds to a dealer - client - currency - date portfolio. In other words, we know, for each day, the market value of the cleared portfolio.

It should be noted that although Swapclear is the biggest clearing house covering interest rate derivatives, there are 59 other CCPs included in the UK trade repository data that can be used to make these trades. However, Swapclear's clearing members tend to concentrate their activity through one CCP in order to benefit from netting effects. For this reason, trades between Swapclear and its clearing members, and uncleared trades among those clearing members, account for 90% of the total gross notional outstanding in our dataset.

We match the proprietary and the trade repository data with institutions' balance-sheet data so that we have bank level information for each clearing member that offers client clearing services. The banks' balance-sheet data, at a semi-annual frequency starting in 2015, is obtained from confidential Bank of England regulatory returns data.[5]

[5]In calculating the LR, in case there is no LR information for a dealer, we compute the LR measure as a ratio between tier 1 capital and total assets.

4 Methodology and Descriptive statistics

4.1 Methodology

In order to study how an LR requirement affects dealers' willingness to clear derivative transactions on behalf of their clients, we exploit the early introduction of this regulation in the United Kingdom.[6] We take those dealers that have a binding regulatory LR requirement as *affected* banks. In our dataset, this corresponds to the biggest seven UK banks since the Bank of England acted in advance of the Basel III implementation timeline (Bank of England (2015)).[7] All other dealers—except US ones, as we explain in the next section—are part of the control group.

The introduction of the LR requirement as a mandatory requirement for the biggest seven UK banks in January 2016 marked an important milestone in the UK implementation of the LR requirement and operated in advance to the global Basel III implementation timeline. In response to the global financial crisis, the Basel Committee on Banking Supervision (BCBS) decided to introduce a non-risk based LR requirement to the capital framework. This marked a step change in the design of capital regulation, and was scheduled to begin as a mandatory requirement in January 2018. The Bank of England, however, decided to act in advance of the Basel III implementation timeline, and instead introduced the LR as a mandatory requirement two years earlier in January 2016. This mandatory requirement applied to the biggest seven UK banks.[8] As a result, it created differences between these UK LR *affected* dealers, and all others who did not have an LR mandatory requirement.

Specifically in respect to client clearing, the LR introduction in January 2016 marked the first point in which leverage *affected* dealers were no longer allowed to offset initial margin

[6] Appendix Table A4 details the timeline since the first proposal by the BCBS; the table is taken from Bicu-Lieb et al. (2020).

[7] Since the LR requirement applies at a group level, we consider treated all subsidiaries whose parent is a UK big seven bank.

[8] HSBC, RBS, Lloyds, Santander UK, Barclays, Standard Chartered, and Nationwide.

from their capital requirement. This was a step-change in their calculations, and of particular use for our identification strategy, it only affected UK banks.

4.2 Sample selection

4.2.1 Period

We study the period 2015Q1–2016Q1 in our main analysis, although we also show some results outside this period. There are several reasons why we focus on this period. One reason is the introduction, in May 2016, of frontloading requirements for the clearing obligation—forcing dealers to centrally-clear new client transactions for big clients by December 2016; this regulatory change clouds the identification of the introduction of the leverage ratio requirement. Moreover, in June 2016, the UK voted to exit the European Union, which was followed by some stress in financial markets. Therefore, we focus on 2016Q1 as our post period.

In order to minimise confounders, we use either 2015Q4 (for transaction-level data) or 2015Q1 (for portfolio-level data) as the pre period. We use a longer period for the portfolio-level specification since this is stock rather than new transactions data.

4.2.2 Dealers

In order to obtain a better identification of the effect of the LR, we exclude two main sets of dealers from the analysis. The first set are US dealers, since during the period of our analysis they are subject to the clearing obligation. This means that some dealers in the control group would be increasing their client clearing activity due to their home regulation and could be a confounding factor of our results.

We also exclude some US subsidiaries of European banks. The reason is that these subsidiaries moved a large volume of activity from the US subsidiary of LCH to the UK

clearing house in the first half of 2015. This increase could be related to the incoming regulation, since this would facilitate netting some exposures. Nevertheless, this affects our identification strategy, which relies on the earlier introduction of the LR in the UK. Since the movement of clients appears to be coordinated with LCH, we exclude those subsidiaries from the main analysis.

4.3 Empirical approach

We explore the window around the policy shocks to see how *affected* dealers react to the introduction of the LR. We are able to compare behaviour after the shock to how dealers act previously, and against control group dealers that are not affected by the LR. This difference-in-differences approach, in which due to our granular dataset we are also able to see both dealer and client entities, allows us to identify the impact of the LR both on the willingness of dealers to clear transactions in terms of volume, but also in terms of the clients they drop or take on.

Dealer market share specifications

For the trade repository data, we use the following specification:

$$m_{d,t} = \beta_1 \cdot \text{Post}_t \times \text{UK dealer}_d + \beta_2 X_{d,t-1} + \alpha_d + \alpha_t + \varepsilon_{d,t} \tag{1}$$

where $m_{d,t}$ is the market share of dealer d in week t; Post_t is a dummy variable equal to 1 if the date is after the policy shock, i.e., after the 1st of January 2016, 0 otherwise; UK dealer_d is a dummy variable equal to 1 if the dealer is affected by the LR, 0 otherwise; $X_{d,t-1}$ is a matrix with other dealer-level controls; α_d and α_t are dealer and week FE respectively. If the LR has a negative impact on client clearing, we would expect $\beta_1 < 0$.

The information provided by the trade repository allows us to explore some derivatives-

level heterogeneity. In particular, we use the following specification to understand how the previous effects depend on the maturity of the derivative transactions.

$$\begin{aligned} m_{d,m,t} = \beta_1 \cdot \text{Post}_t \times \text{UK dealer}_d \\ +\beta_2 \cdot \text{Post}_t \times \text{UK dealer}_d \times \text{Short-term}_m + \beta_3 X_{d,t-1} + \alpha_d + \alpha_m + \alpha_t + \varepsilon_{d,m,t} \end{aligned} \tag{2}$$

Where $m_{d,m,t}$ is the market share of dealer d in maturity bucket m during week t.

Portfolio-level specifications

We use the information of individual cleared client portfolios by dealers to better understand how dealer-client relationships are affected after the introduction of the LR. Even if UK dealers engage in fewer transactions after the introduction of the regulation, it is crucial to understand whether this makes them less likely to serve clients. In order to study this question, we use specification 3.

$$\text{Rel}_{d,i,t} = \beta_1 \cdot \text{Post}_t \times \text{UK Dealer}_d + \beta_2 \cdot \text{X}_{d,t-1} + \gamma_{d,i} + \gamma_{i,t} + \varepsilon_{d,i,t} \tag{3}$$

The dependent variable is $\text{Rel}_{d,i,t}$, a dummy that equals 1 if dealer d clears for client i in quarter t, 0 otherwise. Importantly, this variable is only defined by dealer-client pairs that *do* exist at some point in our sample. The main coefficient of interest is β_1, which shows whether the likelihood of clearing derivatives for clients changes after the introduction of the LR for UK dealers. We add other time-varying dealer controls in $X_{d,t-1}$ (Size, LR, Tier 1 capital ratio, and Lending/TA), and we allow the effect of these controls to vary after the introduction of the UK LR.

Crucially, this specification allows us to include dealer and client-quarter FE. Dealer FE controls for any time-invariant differences in clearing activity by dealers. Client×Quarter FE controls for time-varying differences in the demand for clearing services by clients. This

means that the analysis when using these sets of FE is restricted to clients served by at least two different dealers, and the identification of the key coefficient comes from clients served by at least one UK and one non-UK dealer. We further disaggregate the data to control for different currencies or different types of interest rate derivatives by using Client×Currency×Quarter and Client×Product×Quarter FE.

We compare 2015Q1 ($\text{post}_t = 0$) and 2016Q1 ($\text{post}_t = 1$) in the main analysis. We do this for several reasons. Looking beyond 2016Q1 would bring potential confounding effects coming from the clearing mandate (frontloading requirements for clients start in May 2016) and the Brexit referendum (23th June 2016). Moreover, using these quarters we can compare the same months, which reduces noise from different reporting windows. Furthermore, as we are analysing a stock measure, focusing on quarter-by-quarter change would not give us enough variation. Regardless of these advantages, we also show the coefficients for the period 2014Q1–2016Q4.

It is also relevant to explore whether affected dealers are more likely to drop existing clients or restrict the intake of new ones after the regulation is introduced. In order to do so, we run specification 4.

$$End/New_{d,i} = \beta_1 \cdot \text{UK Dealer}_d + \beta_2 \cdot \text{X}_d + \gamma_i + \varepsilon_{d,i} \tag{4}$$

In the first case, the dependent variable is $\text{End}_{d,i}$, a dummy variable that equals 1 if a dealer-client relationship that existed in 2015Q1 does not exist anymore in 2016Q1, 0 otherwise—i.e., if an existing relationship in 2015Q1 is still present in 2016Q1. In second case, the dependent variable is $\text{New}_{d,i}$, a dummy variable equal to 1 if a dealer-client relationship that exists in 2016Q1 does not exist in 2015Q1, 0 otherwise. Therefore, the samples are restricted to relationships that exist in 2015Q1 (for $\text{End}_{d,i}$) or 2016Q1 (for $\text{New}_{d,i}$). Identification comes from the use of Client FE, which allows us to compare the same client and

to assess whether affected banks are more likely to drop them or less likely to acquire them as a new client.

We modify the specification to give it a panel structure with two periods, one that compares 2014Q1 and 2015Q1, and the other one that compares 2015Q1 and 2016Q1 like in the previous specification. This is shown in specification 5. This allows us to control for pre-trends since we also consider the period before the regulation is introduced.

$$End/New_{d,i,t+1} = \beta_1 \cdot \text{Post}_t \times \text{UK Dealer}_d + \beta_2 \cdot \text{X}_{d,t-1} + \gamma_d + \gamma_{i,t} + \varepsilon_{d,i,t} \tag{5}$$

Finally, we explore whether the number of clients at bank level changes. We do so by running specification 6.

$$\Delta Clients_{d,t} = \beta_1 \cdot \text{Post}_t \times \text{UK Dealer}_d + \beta_2 \cdot \text{X}_{d,t-1} + \gamma_d + \gamma_t + \varepsilon_{d,t} \tag{6}$$

Where the dependent variable is $\Delta\text{Clients}_{d,t}$ is the annual change in the number of clients, again looking at two periods: pre-policy (2014Q1–2015Q1) and post-policy (2015Q1–2016Q1).

4.4 Descriptive statistics

Our dataset focuses on the number of daily transactions and the number of clearing member clients over a period characterised by low and stable interest rates. This allows us to focus specifically on the link between changes in the regulation, and activity in the derivatives market over the period of our dataset.

Table 1 shows the summary statistics of transaction-level data from the EMIR trade data repositories for our sample. At the top, we show the percentage of transactions by group (affected and non-affected dealers), by sector (Banks, Funds, Hedge Funds, Insurers,

Non-financials, Pension funds, and Others), and by quarter (2015Q1 and 2016Q1). The percentage of trades increases for the non-affected group, consistent with the push towards more central clearing, and it is suggestive that non-affected dealers increase their transaction share compared to affected dealers. At the bottom, we show the percentage of trades for the same groups and sectors over two time spans around the shock (3-month and 6-month). The overaching shares across groups by extending the time period stays fairly stable, so reassures our use of a 3-month time horizon around the shock in our regressions.

Table 2 shows the summary statistics of portfolio-level data from LCH for our sample. At the top, we show the number of dealer-client relations by group (i.e., affected and non-affected dealers) and by quarter (2014Q1, 2015Q1, and 2016Q1). The number of relationships increases for both groups, consistent with the push towards more central clearing in anticipation of the clearing obligation. Nevertheless, the relations for non-affected dealers increases much faster than those for affected dealers. Although this is just suggestive evidence, it is consistent with affected dealers becoming less willing to clear for clients due to the introduction of the LR. At the bottom, we show the variables $\text{End}_{b,i}$ and $\text{New}_{b,i}$ for the two groups. $\text{End}_{b,i}$ denotes the likelihood that a dealer-client relationship in 2015Q1 disappears in 2016Q1. $\text{New}_{b,i}$ computes the likelihood that a dealer-client relationship in 2016Q1 did not exist four quarters before. Affected dealers are more likely to end a relationship with a client and less likely to begin a new one after the LR is introduced.

We plot the number of clients served by each group in Figure 4. The number of clients for both groups, UK and non-UK dealers, is increasing throughout the sample, albeit at different speeds: the clients for the latter group increase much faster. Importantly, the number of clients for UK dealers is basically flat during the second half of 2015 and the first quarter of 2016; it only starts increasing again once frontloading requirements for the clearing obligation become binding (May 2016). This evolution is very consistent with dealers managing the provision of client clearing services in order to prevent reductions in their leverage ratio.

Finally, Figure 2 shows a boxplot with the maturities of the trades across each month. The median maturity does not show any clear trend throughout this sample period.

5 Results

5.1 Market shares results

Table 3 shows the results from specification 1. In column (1), without FE, we find that affected dealers lose market share after the LR is introduced, although the coefficient is not statistically significant. In column (2), however, once we introduce Dealer FE, the coefficient becomes stronger and statistically significant. Adding Week FE (column (3)) and dealer controls interacted with the Post_t dummy (column (4)) does not alter the result. Quantitatively, the coefficient suggests that UK dealers reduce their (weekly) market share by 2.9 percentage points in the quarter after the LR requirement is introduced. In column (5), we add a triple interaction with the ex-ante dealer leverage ratio: when comparing UK dealers, the LR requirement affects dealers with better capital positions less.

In Table 4, we explore the coefficient stability following Oster (2019). Given how the coefficient of our interaction of interest behaves as we add FE, this test suggests that further controlling for unobservables would increase the magnitude of the coefficient (column β_{adj}). Moreover, in order for the bias-adjusted coefficient to be 0, the relative importance of unobservables compared to the controls (including Dealer FE) would need to be orders of magnitude higher (column $\hat{\delta}$). All in all, these results suggest that the coefficient is robust.

In Table 5, we explore the heterogeneity of the previous results in terms of contract maturity, as noted in specification 2. Since the LR requirement depends on the potential future exposure of the derivative, and this exposure is increasing in maturity, we would expect that the negative effect of the regulation on market shares is mitigated at shorter

maturities. In particular, the calculation of the leverage exposure jumps for maturities over one year and even more for maturities over five years in the case of interest rate derivatives. The dependent variable in this table, then, is the weekly market share of dealer d by maturity bucket—less than 1 year, between 1 to 5 years, and more than 5 years. In columns (1) and (2), we repeat the previous regressions (Table 3, columns (4) and (5)) but now with the different dependent. The results are consistent. In column (3), we show that the negative results are coming from derivatives with underlying maturities over 1 year. In columns (4) and (5), we add an additional interaction with maturity bucket between 1 and 5 years. The results suggest that the negative effect of the leverage ratio regulation is concentrated in longer-term derivatives, and this effect is no longer significant for maturities below 5 years and, especially, maturities below 1 year (the lack of significance for the coefficient of the triple interaction with the maturity bucket below 1 year can be explaned by the small number of such transactions).

An important consideration to evaluate the consequences of this policy is whether it affects some client sectors more than others. We show these results in Table 6. In columns (1) to (7), we split the sample by sector. In column (8), we use triple interactions with client sector dummy variables—with the omitted sector being "Other financials". Smaller banks and building societies (column (1)) and hedge funds (column (3)) appear to be particularly affected. Insurance companies and pension funds, on the other hand, do not seem to suffer from such a reduction. Column (8) confirms that the mentioned client sectors are more affected by the introduction of the regulation.

The results from the market shares specifications point to the negative impact of the LR regulation on the provision of clearing services. Consistent with the design of the regulation, the effect is weaker for dealers with better capital positions and for shorter-term derivatives. Smaller banks and building societies appear to be some of the most affected clients.

5.2 Portfolio-level results

Dealer-client relations

Table 7 shows the results for specification 3; that is, it compares dealer-client pairs in 2015Q1 (pre-policy) and 2016Q1 (post-policy).[9] Column (1) shows the regression with the minimum controls; column (2) introduces Client FE; column (3) adds Dealer FE; and column (4) adds the dealer controls interacted with the Post_t variable. The coefficient of interest is negative and, apart from column (1), significant at least at 10%. The coefficient in column (4), for instance, suggests that UK dealers were 16.3 percentage points less likely to be providing clearing services to clients.

The approach up to column (4), however, assumes, that client demand for clearing services is similar between UK and non-UK dealers as well as before and after the policy. This assumption may not be correct. Given the granularity of the data—in particular, the fact that we observe every single client served by each dealer—we can introduce Client×Time FE. This allows us to control for changes in the demand for clearing services of clients. The coefficient becomes stronger, although this is due to the different sample: these fixed effects keep only clients with two or more dealer relationships.[10] Furthermore, adding Client×Dealer FE (column (6)) does not change the result.

We further control for demand at client-currency and client-derivative type by using Client×Currency×Quarter and Client×Product×Quarter in columns (7) and (8). The coefficient is if anything stronger, suggesting that the previous results are not driven by clients simply obtaining different types of derivative contracts—interest-rate swaps vs. forward-rate agreements, for instance—or different currencies.

The negative coefficient of $\text{Post}_t \times \text{UK dealer}_d$ appears to be rather stable. We again

[9] Table 7 shows only the main coefficient of interest; we report the full results in Appendix Table A2.

[10] Appendix Table A3 shows the results keeping the sample constant: the coefficient is always negative and statistically significant.

apply the Oster (2019) test and show the results in Table 8. Comparing the coefficient in columns (1) and (6) in Appendix Table A3, we can see that they barely change even though the R-squared goes from 4.8% to 84.2%, and actually become stronger. Therefore, adjusting the estimated coefficient in a situation where we fully explain the variability of the dependent variable slightly increases the absolute value of said coefficient. Given the R-squared in the last column of Table 7, unobservables would need to be much more important than observables—which include Dealer and Client×Time FE—to drive the bias-adjusted coefficient to 0; in the last column, we see that they would need to be almost 40 times as important to explain the dependent variable.

The previous results focus on the comparison between 2015Q1 to 2016Q1. Nevertheless, it could be the case that we are picking up something else that happens on these specific quarters. Moreover, it is possible that there is some anticipation, since UK dealers knew that the leverage ratio would be implemented in January 2016. In order to study this issue, we run a specification with Client×Time and Client×Dealer FE but for each quarter between 2014Q1 and 2016Q4 and interacting UK dealer$_d$ with quarter dummy variables.

We plot the resulting coefficients in Figure 5. The dots correspond to the point estimates, while the dashed lines show the 90% confidence interval. We set 2015Q1 as the base quarter. The only coefficients that are significant are for quarters from 2016Q1 onwards, consistent with the timing of the policy. Earlier quarters tend to be higher than later quarters, and this is also consistent with some anticipation of the policy; nevertheless, we only observe a clear downwards jump in 2016Q1.

Ending and starting relations

We present the results of specification 4 in Table 9, columns (1) (End$_{d,i}$) and (4) (New$_{d,i}$). The coefficient in column (1) for UK Dealer$_d$ suggests that UK dealers are more likely to

withdraw services to clients between 2015Q1 and 2016Q1. The magnitude of the coefficient is high. Note, however, that to achieve identification, we are using Client FE: in other words, we are looking at clients that in 2015Q1 are served by two or more dealers, and ask whether UK dealers are more likely to cut the relationship than non-UK delaers in 2016Q1. This reduces the sample substantially.

Columns (2)–(3) and (5)–(6) show the results of specification 5. These results control for pre-trends by comparing changes between 2015Q1 and 2016Q1 (post) with changes between 2014Q1 and 2015Q1. We show that affected dealers are more likely to drop clients after the policy is introduced, although the coefficients in columns (2) and (3) are smaller than the coefficient in column (1) suggesting some anticipation. Importantly, we do not see a difference in the likelihood of acquiring new clients after the regulation compared to the period before. This is consistent with dealers anticipating the introduction of the leverage ratio and refusing to take on new clients way in advance of such introduction.

Number of clients

How do the number of clients change for UK dealers after the policy? Table 10 shows the results of specification 6. Column (1) does not include fixed effects or controls; column (2) introduces Dealer FE; column (3) adds dealer controls, and column (4) includes these controls interacted with Post_t. The dealer-client results obtained in the previous tables translate into fewer clients for affected dealers: after the introduction of the UK leverage ratio, UK dealers have over 14 fewer clients as compared to non-UK dealers, using the coefficient in column (4). Given the fact that the total number of clients is around 100–150 for UK dealers in the period that we study, this is economically meaningful.[11].

To summarise, the results from the portfolio-level data suggest that UK dealers pull back from clearing services to clients when the regulation is introduced, with some anticipation

[11] As discussed in Section 4.2, we use a reduced sample that allows for a cleaner identification.

in particular by deciding to take fewer new clients as compared to unaffected dealers. These results therefore are consistent with the previous results using the trade repository data: the leverage ratio introduction had a negative impact on the provision of client clearing services.

6 Conclusions

This paper investigates the impact of the leverage ratio (LR) requirement for dealers on client clearing activity in the interest rate derivatives markets. We exploit two unique datasets, one at transaction- and the other at portfolio-level, together with the earlier introduction of the leverage ratio in the UK, to identify how this regulation affects client clearing activity. We find that UK dealers reduce the volume of client transactions they are willing to clear, as well as the number of clients, compared to unaffected ones, after the introduction of the regulation. The paper thus indicates that the leverage ratio can disincentivise client clearing intermediation.

If some institutions lose access to the cleared market, this may have negative implications for their daily activity. If they find it more difficult to implement hedging strategies, they might seek alternative riskier or more expensive hedging strategies. Or if they are able to use the non-centrally cleared market, it will be necessary to post higher levels of collateral to novate their contracts (International Swaps and Derivatives Association (2013)).

Importantly, our paper does not attempt to quantify the net benefits of the LR. We instead analyse a particular segment, and a full cost-benefit analysis would entail a broader study of the financial system and the economy as a whole. Since the LR is independent of risk, it provides a guardrail against model risk and measurement error which can affect the risk-based capital ratio. While quantifying the net benefit of the LR is beyond the scope of this paper, our results indicate that the LR can affect client clearing in interest rate derivatives markets. As such, policies to improve access for end users may be warranted.

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Tables

Table 1: Summary statistics—Trade repository data

Group	Share of transactions by type of dealer and counterparty sector			
	2015Q1	2016Q1	15Q4–16Q1	15Q3–16Q2
UK dealers	56.28%	21.55%	26.36%	30.03%
Non-UK dealers	43.72%	78.45%	73.64%	69.97%
Banks	32.76%	41.02%	39.96%	38.21%
Funds	34.41%	18.45%	19.09%	20.56%
Hedge Funds	7.00%	19.00%	19.70%	18.80%
Insurers	5.88%	14.39%	12.93%	11.86%
Non-financials	1.46%	0.64%	0.6%	0.83%
Pension funds	4.56%	1.02%	1.09%	1.60%
Others	13.93%	5.48%	6.62%	8.14%
Total	9,267	19,676	38597	82731

Note: The EMIR trade data repositories were not a reliable source of data in 2014. "Others" institutions include central banks, government agencies, trading services, other financials, and unclassified firms.

Table 2: Summary statistics—Portfolio data

Group	Number of dealer-client relations		
	2014Q1	2015Q1	2016Q1
UK dealers	116	150	161
Non-UK dealers	90	133	227
Total	206	283	388

	End 15Q1–16Q1	New 15Q1–16Q1
UK dealers	24.00%	29.19%
Non-UK dealers	21.80%	54.19%

This table presents the summary statistics regarding the number of clients for which dealers clear transactions during our sample period.

Table 3: Dealer market share

Variables	← Market share$_{d,t}$ →				
	(1)	(2)	(3)	(4)	(5)
Post$_t$×UK Dealer$_d$	-1.838	-2.988*	-3.010*	-2.938**	-12.52**
	(1.460)	(1.591)	(1.677)	(1.399)	(5.213)
Post$_t$×UK Dealer$_d$×LR$_{d,t}$					2.121*
					(1.023)
Observations	341	335	335	335	335
R^2	0.005	0.727	0.727	0.733	0.735
Dealer FE		Yes	Yes	Yes	Yes
Week FE			Yes	Yes	Yes
Dealer controls				Yes	Yes

This table presents results of equation 1. The dependent variable is the market share of dealer d in week t, defined as the share of total market transactions that the dealer d clears in week t. The sample for these regressions is 2015q4 to 2016q1. Post$_t$ is a variable that equals 1 for the period after the leverage ratio introduction in the UK (2016q1), 0 otherwise. UK Dealer$_d$ is a variable that equals 1 if the parent of the dealer is a UK bank, 0 otherwise. LR$_{d,t}$ is the leverage ratio of dealer$d$ at time t, defined as Tier 1 capital over Total Assets. The other controls are defined in Appendix Table A1. All regressions are estimated using ordinary least squares. Robust standard errors are clustered at dealer and week level, reported in parentheses.***: Significant at 1% level; **: significant at 5% level; *: significant at 10% level.

Table 4: Dealer market share: Coefficient stability of Post$_t$×UK Dealer$_d$

β	δ	R_{max}	β_{adj}	$\lvert\hat{\delta}\rvert$
-2.938	1	0.80	-3.039	29.0
-2.938	1	0.90	-3.190	11.6
-2.938	1	1.00	-3.341	7.3

This table shows the stability of the coefficient of Post$_t$×UK Dealer$_d$ reported in Table 3 to unobserved variation across dealer-client-quarter. Column (4) shows adjusted estimates of β based on Oster (2019) assuming equal degree of selection between observables and unobservables ($\delta = 1$). Column (5) shows the estimates of the relative importance of unobservable characteristics relative to the observed controls that would imply a bias-adjusted coefficient (β_{adj}) of 0.

Table 5: Dealer market share—by maturity

Variables	← Market share$_{d,m,t}$ →				
	(1)	(2)	(3)	(4)	(5)
Post$_t$×UK Dealer$_d$	-0.943**	-5.309**	-0.943**	-1.654**	-6.280**
	(0.438)	(2.178)	(0.438)	(0.726)	(2.343)
Post$_t$×UK Dealer$_d$×LR$_{d,t}$		0.984*			1.030*
		(0.490)			(0.494)
Post$_t$×UK Dealer$_d$×Maturity<1 year$_m$			1.560	1.542	1.526
			(1.523)	(1.556)	(1.560)
Post$_t$×UK Dealer$_d$×Maturity<5 years$_m$				1.167*	1.263*
				(0.584)	(0.609)
Observations	769	769	769	769	769
R^2	0.535	0.537	0.535	0.536	0.537
Dealer controls	Yes	Yes	Yes	Yes	Yes
Dealer FE	Yes	Yes	Yes	Yes	Yes
Week FE	Yes	Yes	Yes	Yes	Yes
Marturity FE	Yes	Yes	Yes	Yes	Yes

This table presents results of equation 2. The dependent variable is the market share of dealer d in week t for maturity m, defined as the share of total transactions of maturity m that the dealer d clears in week t. Maturity m is defined in three buckets: less than 1 year; 1-5 years; and greater than 5 years. The sample for these regressions is 2015q4 to 2016q1. Post$_t$ is a variable that equals 1 for the period after the leverage ratio introduction in the UK (2016q1), 0 otherwise. UK Dealer$_d$ is a variable that equals 1 if the parent of the dealer is a UK bank, 0 otherwise. LR$_{d,t}$ is the leverage ratio of dealer d at time t, defined as Tier 1 capital over Total Assets. Maturity<Xyear$_m$ is a variable that equals 1 for the dealer market share for maturity m, 0 otherwise. The other controls are defined in Appendix Table A1. All regressions are estimated using ordinary least squares. Robust standard errors are clustered at dealer and week level, reported in parentheses.***: Significant at 1% level; **: significant at 5% level; *: significant at 10% level.

Table 6: Dealer market share—by sectors

Variables	← Market share$_{d,j,t}$ →							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post$_t$×UK Dealer$_d$	-5.533*	-2.105	-4.332*	1.600	-11.61	3.675	0.431	0.884
	(2.972)	(3.625)	(2.037)	(3.492)	(14.78)	(5.375)	(10.22)	(0.789)
Post$_t$×UK Dealer$_d$×Bank$_j$								-3.379*
								(1.862)
Post$_t$×UK Dealer$_d$×Fund$_j$								-1.379
								(0.862)
Post$_t$×UK Dealer$_d$×HF$_j$								-2.491**
								(1.162)
Post$_t$×UK Dealer$_d$×Insur.$_j$								0.099
								(0.285)
Post$_t$×UK Dealer$_d$×NFC$_j$								-1.111
								(1.026)
Post$_t$×UK Dealer$_d$×PF$_j$								1.269
								(2.014)
Observations	288	215	141	149	73	107	72	1,231
R^2	0.609	0.525	0.894	0.762	0.551	0.575	0.484	0.240
Sector	Banks	Funds	HF	Insur.	NFC	OF	PF	All

The dependent variable is the market share of dealer d in week t for the sector j, defined as the share of total transactions to sector j that the dealer d clears in week t. Sector j is split by: Banks; Funds; Hedge Funds (HF); Insurers; Non-financials (NFCs); Other financials (OFs); and Pension Funds (PFs). The sample for these regressions is 2015q4 to 2016q1, except for column (5) which is extended by one month either side due to lack of observations. Post$_t$ is a variable that equals 1 for the period after the leverage ratio introduction in the UK (2016q1), 0 otherwise. UK Dealer$_d$ is a variable that equals 1 if the parent of the dealer is a UK bank, 0 otherwise. Sector$_j$, where Sector $\in \{Bank, Fund, HF, \dots\}$, is a variable that equals 1 for the dealer market share for sector j, 0 otherwise. The other controls are defined in Appendix Table A1. All regressions are estimated using ordinary least squares. Robust standard errors are clustered at dealer and week level, reported in parentheses.***: Significant at 1% level; **: significant at 5% level; *: significant at 10% level..

Table 7: Dealer-client relations

Variable	← Dealer-Client relationship$_{d,i,t}$ →							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post$_t$×UK Dealer$_d$	-0.140	-0.111*	-0.081**	-0.163***	-0.353**	-0.353**	-0.478***	-0.425***
	(0.086)	(0.059)	(0.032)	(0.037)	(0.152)	(0.159)	(0.118)	(0.081)
Observations	2,081	2,057	2,056	2,056	422	422	884	792
R^2	0.027	0.710	0.729	0.731	0.681	0.842	0.693	0.775
Dealer controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Client FE		Yes	Yes	Yes	-	-	-	-
Dealer FE			Yes	Yes	Yes	-	-	-
Post$_t$×Dealer controls				Yes	Yes	Yes	Yes	Yes
Client×Quarter FE					Yes	Yes	-	-
Client×Dealer FE						Yes	Yes	Yes
Client×Currency×Quarter FE							Yes	
Client×Product×Quarter FE								Yes

This table presents the results of equation 3. The dependent variable is a dummy variable that equals 1 if dealer d is clearing for client i in quarter t, 0 otherwise. This variable is defined by any dealer-client pair that appear in our full sample (2014m1 - 2017m4). The sample period for these regressions is 2015q1 and 2016q1. The data has a structure at dealer-client-quarter (columns 1-6), dealer-client-currency-quarter (column 7), and dealer-client-product-quarter (column 8) level. Post$_t$ is a variable that equals 1 for the period after the leverage ratio introduction in the UK (2016q1), 0 otherwise. UK Dealer$_d$ is a variable that equals 1 if the parent of the dealer is a UK bank, 0 otherwise. The other controls are defined in Appendix Table A1. All regressions are estimated using ordinary least squares. Dealer controls, dealer controls interacted, and fixed-effects are included ("Yes"), spanned by other fixed-effects ("-"), or not included. Robust standard errors are clustered at parent-quarter level are reported in parentheses. ***: Significant at 1% level; **: significant at 5% level; *: significant at 10% level.

Table 8: Dealer-client relations: Coefficient stability of Post$_t$×UK Dealer$_d$

β	δ	R_{max}	β_{adj}	$\lvert\hat{\delta}\rvert$
-0.353	1	0.90	-0.356	107.4
-0.353	1	0.95	-0.359	57.7
-0.353	1	1.00	-0.362	39.4

This table shows the stability of the coefficient of Post$_t$×UK Dealer$_d$ reported in Table A3 to unobserved variation across dealer-client-quarter. Column (4) shows adjusted estimates of β based on Oster 2019 assuming equal degree of selection between observables and unobservables ($\delta = 1$). Column (5) shows the estimates of the relative importance of unobservable characteristics relative to the observed controls that would imply a bias-adjusted coefficient (β_{adj}) of 0.

Table 9: Ending and beginning dealer-client relations

Variable	←	$\text{End}_{d,i,t}$	→	←	$\text{New}_{d,i,t}$	→
	(1)	(2)	(3)	(4)	(5)	(6)
UK Dealer_d	0.497**			-0.365**		
	(0.208)			(0.157)		
$\text{UK Dealer}_d \times \text{Post}_t$		0.213***	0.389**		-0.074	0.146
		(0.067)	(0.156)		(0.060)	(0.200)
Observations	64	333	84	71	481	123
R^2	0.657	0.608	0.747	0.546	0.665	0.790
Dealer controls	Yes	Yes	Yes	Yes	Yes	Yes
Client FE	Yes	Yes	-	Yes	Yes	-
Quarter FE	-	Yes	-	-	Yes	-
Dealer FE		Yes	Yes		Yes	Yes
Client×Quarter FE			Yes			Yes

This table presents the results of equation 4 (columns 1 and 4) and equation 5 (columns 2–3 and 5–6). The sample period is 2016Q1 (c. 1 and 4) and 2015Q1–2016Q1 (c. 2–3 and 5–6). In c. 1–3, the dependent variable is a dummy variable that equals 1 if dealer d clears for client i in 2015q1 but does not clear in 2016q1, 0 otherwise. In c. 4-6, the dependent variable is a dummy variable that equals 1 if dealer d clears for client i in 2016q1 but did not clear in 2015q1, 0 otherwise. UK Dealer_d is a variable that equals 1 if the parent of the dealer is a UK bank, 0 otherwise. Post_t is a variable that equals 1 for the period after the leverage ratio introduction in the UK (2016q1), 0 otherwise. The other controls are defined in Appendix Table A1. All regressions are estimated using ordinary least squares. Dealer controls and client fixed-effects are included ("Yes") or not included. Robust standard errors are clustered at parent level are reported in parentheses. ***: Significant at 1% level; **: significant at 5% level; *: significant at 10% level.

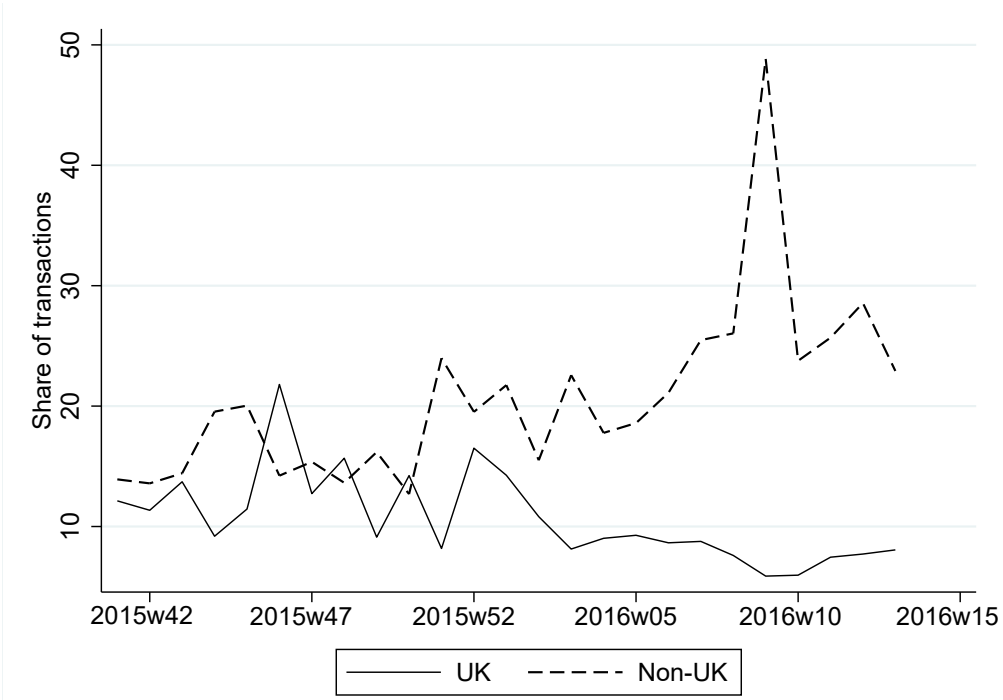
Table 10: Change in the number of clients

Variables	$\leftarrow \Delta\text{Clients}_{d,t} \rightarrow$			
	(1)	(2)	(3)	(4)
$\text{Post}_t \times \text{UK Dealer}_d$	-5.983	-6.463**	-6.424*	-14.34**
	(5.592)	(3.061)	(3.650)	(5.131)
UK Dealer_b	3.650			
	(4.610)			
Post_t	1.955	2.263*	2.889	2.089
	(1.256)	(1.126)	(1.777)	(2.007)
Observations	53	48	46	46
R^2	0.047	0.789	0.799	0.850
Dealer FE		Yes	Yes	Yes
Dealer controls			Yes	Yes
Dealer controls interacted				Yes

This table presents the results of specification 6. The dependent variable the change in the number of clients that dealer d clears through LCH in quarter t compared to four quarters before. The sample period includes 2014Q1, 2015Q1, and 2016Q1. Post_t is a variable that equals 1 for the period after the leverage ratio introduction in the UK (2016Q1), 0 otherwise. UK Dealer_d is a variable that equals 1 if the parent of the dealer is a UK bank, 0 otherwise. The other controls are defined in Appendix Table A1. All regressions are estimated using ordinary least squares. Dealer controls, dealer controls interacted, and fixed-effects are included ("Yes"), spanned by other fixed-effects ("-"), or not included. Robust standard errors are clustered at parent-quarter level are reported in parentheses. ***: Significant at 1% level; **: significant at 5% level; *: significant at 10% level.

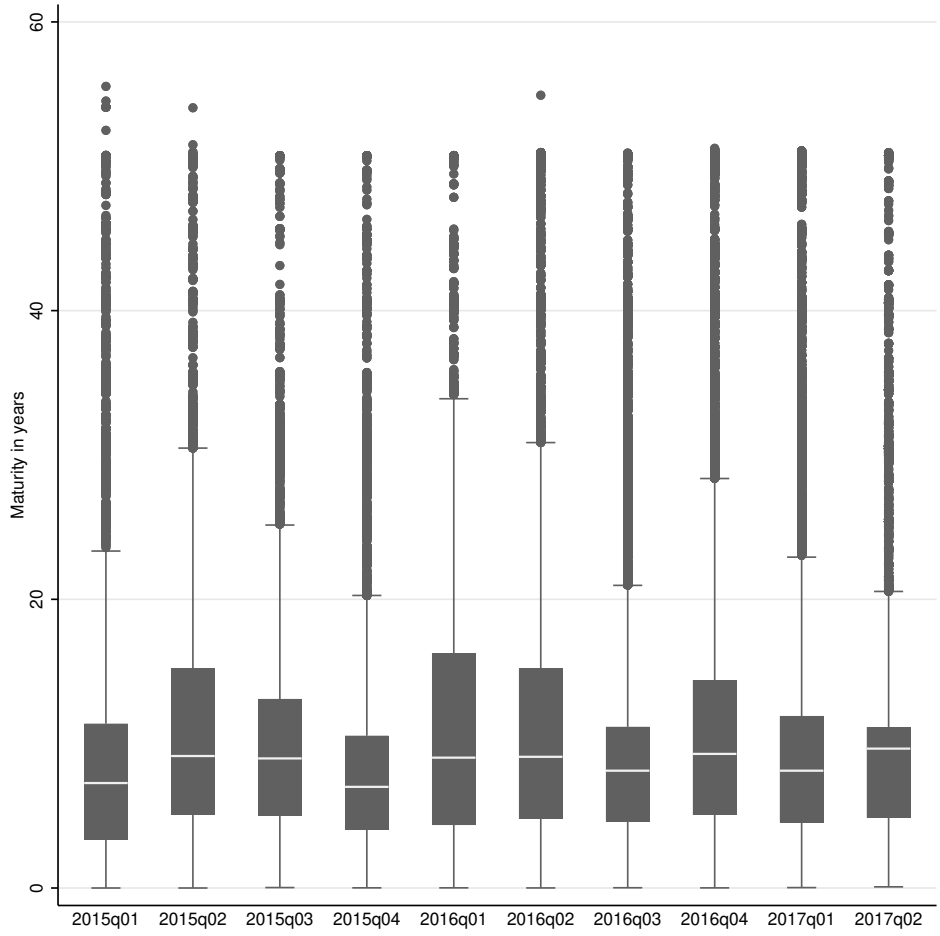
Figures

Figure 1: Share of client derivative transactions



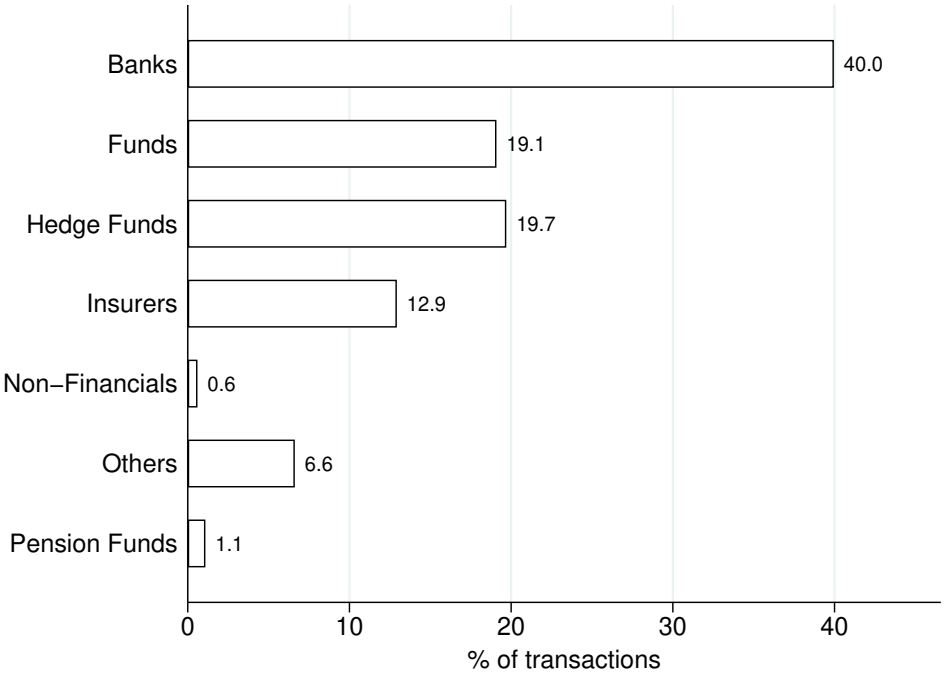
This figure shows the evolution of the share of client derivative transactions for UK and non-UK dealers. The leverage ratio requirement becomes legally binding in January 2016 in the UK. The shares do not add up to 100% since we exclude from the sample US dealers as well as some US subsidiaries of European banks. See the discussion in section 4.2.2.

Figure 2: Maturity of the contracts reported in the EMIR data across time



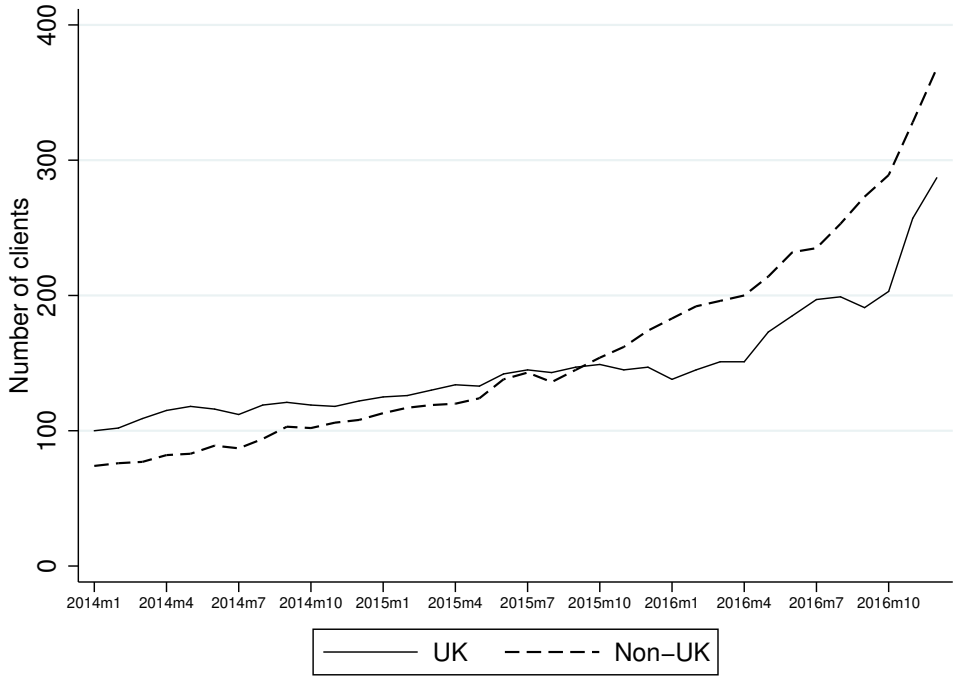
This figure shows the distribution of the maturity of the client derivative transactions for the period 2015Q1 to 2017Q2.

Figure 3: Share of transactions by the sector of the clients



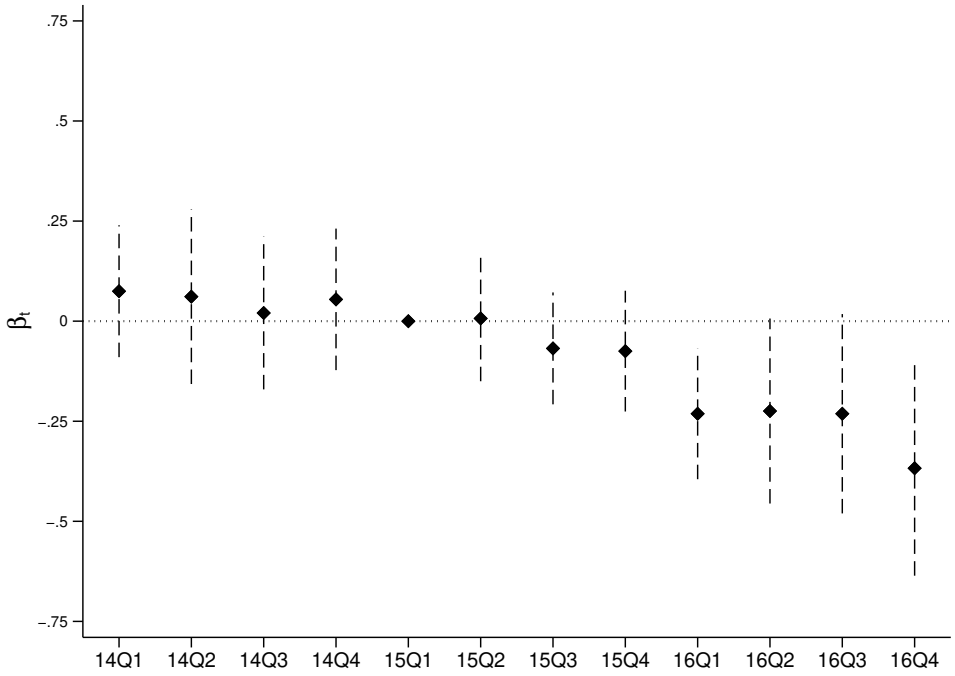
This figure shows the share of the counterparty sector for client derivative transactions during the period 2015Q4 ti 2016Q1. The numbers correspond to the ones showed in Table 2, column 3 for the different sectors.

Figure 4: Number of clients



This figure shows the evolution of the number of clients for UK and non-UK dealers. The leverage ratio requirement becomes legally binding in January 2016 in the UK. Front-loading requirements and clearing obligations for clients start in May 2016 and December 2016, respectively.

Figure 5: Dealer-client relationships



The figures above show the estimated coefficients of the interaction of UK Dealer$_d$ (a binary variable equal to 1 if the parent of the dealer is a UK bank, 0 otherwise) and the full set of time(quarter)-dummies (excluding 2015Q1, the reference time-period). The dependent variable is a dummy variable that equals 1 if dealer b is clearing for client i in quarter t, 0 otherwise. This variable is defined by any dealer-client pair that appear in our full sample (2014m1 - 2017m4). The sample for this regressions is from 2014Q1 to 2016Q4. The regression is estimated using ordinary least squares and includes Client×Quarter and Dealer×Client fixed-effects.

APPENDIX

Table A1: Dealer controls

Variable	Description	Source
Size	Logarithm of total assets	Bank of England regulatory returns / S&P Capital IQ Pro
Tier 1 ratio	Tier 1 capital over risk-weighted assets	Bank of England regulatory returns / S&P Capital IQ Pro
Leverage ratio	Tier 1 capital over leverage exposure measure or total assets	Bank of England regulatory returns / S&P Capital IQ Pro
Lending	Total credit over total assets	Bank of England regulatory returns / S&P Capital IQ Pro

This table shows the dealer controls used in the different specifications.

Table A2: Dealer-client relations: full list of coefficients

Variable	← Dealer-Client relationship$_{d,i,t}$ →					
	(1)	(2)	(3)	(4)	(5)	(6)
Post$_t$×UK Dealer$_d$	-0.140	-0.111*	-0.0808**	-0.163***	-0.353**	-0.353**
	(0.0862)	(0.0592)	(0.0315)	(0.0366)	(0.152)	(0.159)
Size$_{d,t-1}$	0.00273	0.0861	0.438	0.00285	1.427*	1.427
	(0.0406)	(0.0948)	(0.330)	(0.283)	(0.838)	(1.028)
LR$_{d,t-1}$	-0.0606	-0.0120	0.0584	0.0228	0.0361	0.0361
	(0.0510)	(0.0565)	(0.0439)	(0.0537)	(0.153)	(0.168)
Tier 1$_{d,t-1}$	0.0175*	-0.0101	-0.0357***	-0.0413***	-0.0354	-0.0354
	(0.00897)	(0.0166)	(0.0114)	(0.00988)	(0.0481)	(0.0594)
Lending$_{d,t-1}$	0.222	0.791	-1.043	-1.419	-0.971	-0.971
	(0.188)	(0.481)	(1.192)	(1.073)	(1.761)	(1.765)
Post$_t$×Size$_{d,t-1}$				0.0511**	0.0574	0.0574
				(0.0240)	(0.105)	(0.0640)
Post$_t$×LR$_{d,t-1}$				0.0793***	0.206*	0.206
				(0.0257)	(0.121)	(0.138)
Post$_t$×Tier 1$_{d,t-1}$				0.00393	-0.00506	-0.00506
				(0.00719)	(0.0272)	(0.0249)
Post$_t$×Lending$_{d,t-1}$				0.189	-0.237	-0.237
				(0.247)	(0.863)	(0.596)
UK Dealer$_d$	0.190**	0.0920				
	(0.0864)	(0.138)				
Observations	2,081	2,057	2,056	2,056	422	422
R^2	0.027	0.710	0.729	0.731	0.681	0.842
Client FE		Yes	Yes	Yes	-	-
Dealer FE			Yes	Yes	Yes	-
Client×Quarter FE					Yes	Yes
Client×Dealer FE						Yes

This table presents the results of equation 3 showing the full set of coefficients. The dependent variable is a dummy variable that equals 1 if dealer b is clearing for client i in quarter t, 0 otherwise. This variable is defined by any dealer-client pair that appear in our full sample (2014m1 - 2017m4). The sample for these regressions is 2015q1 and 2016q1. Post$_t$ is a variable that equals 1 for the period after the leverage ratio introduction in the UK (2016q1), 0 otherwise. UK Dealer$_d$ is a variable that equals 1 if the parent of the dealer is a UK bank, 0 otherwise. The other controls are defined in Appendix Table A1. All regressions are estimated using ordinary least squares. Dealer controls, dealer controls interacted, and fixed-effects are included ("Yes"), spanned by other fixed-effects ("-"), or not included. Robust standard errors are clustered at parent-quarter level are reported in parentheses. ***: Significant at 1% level; **: significant at 5% level; *: significant at 10% level.

Table A3: Dealer-client relations: restricted sample

Variable	← Dealer-Client relationship$_{d,i,t}$ →					
	(1)	(2)	(3)	(4)	(5)	(6)
Post$_t$×UK Dealer$_d$	-0.308*	-0.290*	-0.256***	-0.562***	-0.353**	-0.353**
	(0.152)	(0.152)	(0.0572)	(0.0402)	(0.152)	(0.159)
Observations	422	422	422	422	422	422
R^2	0.048	0.465	0.556	0.567	0.681	0.842
Dealer controls	Yes	Yes	Yes	Yes	Yes	Yes
Client FE		Yes	Yes	Yes	-	-
Dealer FE			Yes	Yes	Yes	-
Dealer controls interacted				Yes	Yes	Yes
Client×Quarter FE					Yes	Yes
Client×Dealer FE						Yes

This table presents the results of equation 3 keeping the sample constant with the inclusion of fixed effects. The dependent variable is a dummy variable that equals 1 if dealer b is clearing for client i in quarter t, 0 otherwise. This variable is defined by any dealer-client pair that appear in our full sample (2014m1 - 2017m4). The sample for these regressions is 2015q1 and 2016q1. Post$_t$ is a variable that equals 1 for the period after the leverage ratio introduction in the UK (2016q1), 0 otherwise. UK Dealer$_d$ is a variable that equals 1 if the parent of the dealer is a UK bank, 0 otherwise. The other controls are defined in Appendix Table A1. All regressions are estimated using ordinary least squares. Dealer controls, dealer controls interacted, and fixed-effects are included ("Yes"), spanned by other fixed-effects ("-"), or not included. Robust standard errors are clustered at parent-quarter level are reported in parentheses. ***: Significant at 1% level; **: significant at 5% level; *: significant at 10% level.

Table A4: Leverage ratio timeline

Date	Jurisdiction	Summary
December 16, 2010	BCBS	BCBS proposes a 3% regulatory leverage ratio (disclosure from 2015, minimum requirement from 2018).
December 6, 2011	UK	FPC recommends that FSA encourage banks to disclose their leverage ratios not later than the beginning of 2013; FSA implements this by asking large UK banks to publish their leverage ratios in their 2012 annual reports and on a bi-annual basis thereafter.
June 7, 2012	US	Proposed rule on new capital framework for large US banks, including draft supplementary leverage ratio.
June 20, 2013	UK	Results of capital shortfall exercise published; large UK banks with a CET1 leverage ratio below 3% required o submit plans to reach this level.
July 2, 2013	US	Final sule on supplementary leverage ratio (full implementation from 2018), and proposal on enhanced supplementary leverage ratio.
November 29, 2013	UK	PRA issues supervisory expectation that eight major UK banks and building societies meet a 3% leverage ratio by January 2014.
March 1, 2014	EU	PRA-regulated firms start to report regulatory leverage ratios through COREP on the basis of month-end balance sheets.
April 8, 2014	US	Final rule on enhanced supplementary leverage ratio (full implementation from 2018).
July 11, 2014	UK	FPC consultation paper on the design of the UK leverage ratio framework; FPC considers applying the framework to all PRA-regulated firms.
October 31, 2014	UK	FPC review of the leverage ratio framework published; review recommends that the framework apply only to major UK banks and building societies.
July 2010, 2015	UK	PRA consultation paper on implementing the UK leverage ratio framework.
December 1, 2015	UK	PRA published finalised UK leverage ratio framework.
January 1, 2016	UK	Large UK banks and building societies become subject to a formal minimum regulatory leverage ratio requirement.
January 1, 2018	EU	All PRA regulated firms become subject to a 3% minimum leverage ratio under CRD IV.

This table presents the key dates of the development of the UK and other jurisdictions' leverage ratio requirement, taken from Bicu-Lieb et al. (2020).