Trade in Services under Regulatory Barriers: Evidence from UK Banking

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Abstract

Barriers to trade in services remain poorly understood. This paper investigates how regulatory barriers affect cross-border lending and deposit-taking by banks. We build a theoretical framework of banking across borders to model how trade costs shape trade in banking services. We test the predictions of the model using changes in regulations due to the UK's withdrawal from the EU. Using bilateral data from the Bank for International Settlements and confidential bank-level data from the Bank of England, we find that UK-resident banks substantially reduced lending to and deposit-taking from EEA countries after Brexit, with some effects observed after the referendum itself. Banks that lost the ability to provide services across the EEA without additional authorisation reduced their stocks of loans to and deposits from EEA countries by about 45 percent more than banks that did not have such authorisation when UK was a part of EU, relative to their activities with non-EEA countries. Moreover, banks with higher pre-referendum exposure to the EEA had lower lending and deposit-taking with the EEA after the referendum. We find limited evidence of multinational banks successfully circumventing the new barriers by using foreign affiliates. These results demonstrate the critical role of regulatory access in shaping the pattern of banking across borders and trade in services.

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1 Introduction

Services trade is becoming increasingly important for growth and employment (Baldwin 2024, Roy & Sauvé 2023),[1] and account for a rising share of global trade.[2] Yet, how trade policy shapes barriers to trade in services remain under-researched and poorly understood. Services trade is not subject to tariffs, but instead faces a wide range of non-tariff barriers. Among these, regulatory barriers have substantially added to trade costs for services,(Benz & Jaax 2020)[3], highlighting the need to understand such barriers and their implications.

Banking is one of the most important traded services. It is a core component of financial services - the most traded sector globally - and cross-border lending constitutes a substantial share of banks' balance sheets[4]. The banking sector is unique among services in its role in financing firms, intermediating savings, and facilitating payments across borders. Disruptions in international banking relationships therefore generate ripple effects that extend beyond finance, influencing investment, capital allocation, and ultimately productivity. Yet, the sector faces substantial trade barriers arising from regulatory requirements –the Services Trade Restrictiveness Index (STRI) for commercial banking is well above the average across all sectors, indicating considerable scope for liberalisation (OECD 2023).

This paper provides new evidence on the effect of regulations on trading in banking services. We exploit the UK's departure from the European Economic Area (EEA) to estimate how barriers to banking services affect cross-border lending and deposit-taking (together referred to as intermediation). We find that the increase in barriers had a substantial negative impact on banks' lending to and deposit-taking from EEA. Moreover, we find no evidence of an increase in activity of affiliates in the EEA to substitute for the fall in cross-border activity due to barriers. This disintegration of regulatory harmonisation led to large reductions in trade in banking. The effects exceeded and preceded the impact Brexit had on demand for these banking services from the real economy, and could not be replaced by activities through affiliates located in countries whose regulations remained harmonised.

Brexit has been the most significant episode of economic disintegration in the recent past,

[1] Baldwin (2024) shows that services-export-led growth, defined as value-added exports growing faster than GDP, is booming. Roy & Sauvé (2023) show that jobs linked to services-exports have been increasing.

[2] The share of services in total trade reached 27.2% in 2024 (see `https://www.wto.org/english/res_e/statis_e/world_trade_statistics_e.htm`), up from 16% in 1980 (Baldwin et al. 2024).

[3] Benz & Jaax (2020) estimate average trade costs of regulatory barriers to cross-border services trade, expressed as percentage or total trade value or ad valorem equivalents, for different sectors to be between 57% to 255%.

[4] Cross-border lending accounts for around one-third of total assets of the UK banking sector.

which marked UK's withdrawal from the European Union (EU) following the referendum on 23 June 2016. Trade relations that were once largely free are now governed by a range of barriers, most of which are non-tariff in nature. Following the referendum held on 23 June 2016, both UK and EEA banks anticipated tighter regulatory constraints on cross-border market access, amid uncertainty about the precise form of these restrictions. For instance, banks established in EEA countries and with appropriate authorisation, can provide services to EEA entities cross-border and through branches – a system called passporting. Soon after the referendum, the expectation was that the UK would no longer be a part of the passporting system after Brexit. However, there were still uncertainties about the new arrangement. The new trade arrangement confirmed these expectations, leaving banks on both sides of the Channel to rely on national regimes of market access. Given the UK's position as the world's largest centre for cross-border lending and borrowing (TheCityUK 2023), and the EEA as one of its principal counterpart markets, assessing the consequences of these changes is particularly important.

We use stocks of loans to and deposits by partner countries as measures of banks' cross-border activities. We motivate our empirical analysis using a simple model of banking trade, in which banks provide cross-border intermediation services subject to trade frictions. The demand for loans and the supply of deposits depend on interest rates, which banks choose to maximise profits. The model predicts that increase in barriers to banking reduces cross-border lending and deposit-taking with country raising barriers. More subtly, the model shows how Brexit has ambiguous effects on banking trade with non-EEA countries due to equilibrium adjustments that operate through the bank's capital constraints.

We test the predictions from our theoretical framework in the data. We use the Locational Banking Statistics database of the Bank for International Settlements (BIS-LBS) for country-level, bilateral stocks of loans and deposits. To analyse the impact at the bank-level we use confidential statistical data from the Bank of England. We obtain stocks of loans and deposits for all banks in the UK, with substantial non-resident activity.[5] In addition to reporting stocks for each partner country, banks provide the information by the sector of the counterparty, allowing for analysis of impact on activity with the non-financial sector (the primary sector to which intermediation services are provided) but also with other banks and intragroup entities. Our analysis spans the period 2014 to mid-2024.

Our first empirical analysis uses the BIS-LBS data to compare changes in lending and deposit-taking for the UK versus other countries. We analyse changes both following

[5]Banks with equivalent of £300 million or more of external claims or liabilities, respectively, report information.

the referendum in June 2016 and after the introduction of the new trade arrangement in January 2021. We estimate an event-study specification of a gravity equation, with country-pair fixed effects to focus on changes in exports by country-pair and importer-time fixed effects to absorb time-varying demand shocks. We find that UK's cross-border banking with an average EEA country fell substantially relative to exports of other countries, while activities with non-EEA remained unchanged, consistent with our theoretical predictions. Loans fell a few quarters after the referendum while stocks of deposits fell when the barriers come into effect. The response of lending before the barriers increase highlights the uncertainties surrounding continuity of contracts and the new regime for trade. Deposits, that can be relatively easily withdrawn, responded once the barriers were imposed. These findings also suggest that the reduction in intermediation services provided by the UK to the EEA is not explained by global trends in cross-border banking, and can be attributed changes in UK-EU relations.

We extend our analysis to individual banks in the UK to understand the drivers of the aggregate results. We focus on the loss of passporting –a regulation change expected to cause significant financial sector disintegration. Passporting allows financial firms authorised in one EEA member country to provide services in other EEA countries, either cross-border or through branches, with minimal additional authorisation. We define sets of banks established in the UK that were affected and unaffected by loss of passporting to measure their relative impact on UK loan and deposit stocks. When the UK was a member of the EU, banks incorporated in the UK could provide services into EEA, and EEA banks could operate branches in the UK, through passporting. In contrast, UK branches of non-EEA banks never had passporting rights and provided lending and deposit-taking services to EEA based on regulations under national regimes of individual EEA countries. Under the new trade arrangement, UK banks that previously used passporting rely on national regimes as well. We find that banks that lost passporting authorisation have a 40-50% additional fall in stocks of loans to and deposits from the non-financial sector in countries in the EEA, relative to their value in 2016Q1 and relative to banks without passporting authorisation and activities with non-EEA countries. While the additional fall is unsurprising, the magnitude of the relative effect suggests that regulatory barriers after loss of passporting had a significant impact on cross-border service provision.

Next, we study how banks adjusted to the new trade barriers by estimating how banks with higher exposure to the EEA before the referendum were affected. We measure pre-referendum exposure to the EEA for loans and deposits separately, as the average share of activity with the EEA in total cross-border activity of the bank in 2014 and 2015. It captures both the importance of the EEA market for a bank and the extent to which it was affected by the change in barriers. We find that a one standard deviation higher EEA exposure is associated with approximately 30% lower lending to and deposit-taking

from EEA, and this effect starts after the referendum itself. This suggests that these banks scaled back their activity in anticipation of rising frictions instead of taking steps to maintain access to an important foreign market. Following the referendum, banks more exposed to the EEA also show higher deposit-taking from non-EEA countries, indicating that these banks sought to diversify their funding sources in response to rising frictions.[6,7] Overall, our results suggest that the size of the UK's banking activity has fallen since the Brexit vote in 2016, showing how regulation can undermine trade arising from comparative advantage in fundamentals.

Multinational banks with operations in the UK may adjust to higher UK-EU trade barriers by shifting banking activity to their affiliates within the EEA.[8] To assess whether this happened following Brexit, we estimate the impact on lending and deposit-taking of UK banks with banks in the same company-group (henceforth intragroup) located in other countries. We find that banks that lost passporting authorisation reduced their lending to intragroup banks in EEA significantly, relative to those that did not have the authorisation, suggesting that intragroup activity were not used to transfer capital to restricted markets and that cross-border barriers mattered in such transactions as well.

To further investigate if there was instead an expansion of banking affiliates of the company to access the market with increased barriers, we use Historical Orbis to obtain information on all intragroup banks under the same ultimate owners as the UK banks, located in other countries, over the period of our analysis. We find that there is an increase in the number of foreign affiliates in the EEA. However, intragroup affiliates located in the EEA did not increase their lending or deposit-taking activities.[9]

Our evidence on the international organisation of banks to avoid trade barriers suggests that while there was some expansion of affiliates in the EEA, this has not led to increase in banking activity. These findings have two main implications. First, the ability of affiliates to circumvent barriers and access markets is limited. Second, a country's sector - with its established networks and efficiency - is not easily substitutable by that of another country, within the global market, particularly in highly interconnected industries, and depends heavily on country-specific sectoral characteristics.

[6]We note that our analysis so far has used different controls and thereby gives different results on activities with non-EEA, which are not inconsistent.

[7]We also study the impact on UK banks' lending to and deposit-taking from banks and financial corporations in partner countries, which albeit not intermediation, are exports of the banking sector and, in addition to providing liquidity to banks, can be alternates for lending to non-financial sector (Kerl & Niepmann 2015). UK banks that lost passporting did not increase lending to other banks in the EEA. In fact, there is a significant decline in deposits from banks in the EEA and a significant decline in both lending and deposit-taking from financial corporations in EEA relative to UK-banks that did not have passporting authorisation.

[8]An extensive literature (Helpman et al. 2004, Antràs & Yeaple 2014, Antràs et al. 2024) investigates how multinational firms respond to trade barriers by reorganising activity through foreign affiliates.

[9]This lending and deposit-taking is with non-banking entities and could be domestic or cross-border.

Our study provides another example of what complex regulatory barriers to services look like. The impact of changes in access to the EEA market on the role of UK's financial sector in the world economy and of London as a leading financial center was a big concern before and after the referendum (Cassis 2018). Our analysis shows that not only did the barriers have a negative impact on export of banking services of the UK, they were large in magnitude. Moreover, we also find some effects of anticipation and uncertainty after the referendum. This is in contrast with the findings in the literature, on other goods and services.

Bevington et al. (2019) predicted that a free trade agreement similar to the Trade and Cooperation Agreement would reduce UK-EU trade by one-third, with a fall in total UK trade by 13%, but subsequent evidence points to smaller effects. Freeman et al. (2024) find that UK's export to EU, relative to UK's export to the rest of the world, fell by about 10% and the corresponding imports fell by around 20%, resulting in overall decreases in total UK exports and imports of 6.4% and 3.1%, respectively.[10] For services, Bhalotia et al. (2025) construct measures of barriers to trade in services and investment in the TCA and find that UK's export of services affected by these barriers declined by 15.8% relative to other bilateral trade flows, with no substantial effect after the referendum. They estimate a fall in UK services exports by 4-5%.[11] Despite expectations of increased barriers and uncertainty, trade in goods and services with the EU did not decline till the TCA came into effect. This discrepancy between predicted and estimated effects in the literature so far is striking, and raises questions on whether non-tariff barriers, which were the core of the new UK-EU trade arrangement, have the impact initially expected. The absence of the banking sector in official surveys[12] has implied that this sector is largely omitted in firm-level studies. Our study contributes to filling this gap by being the first to study the banking sector in the context of Brexit[13] and highlighting the banking sector as one where post-Brexit regulatory barriers have had a particularly pronounced effect. Moreover, unlike Breinlich et al. (2020) and Breinlich & Magli (2024), who find that UK firms increasingly relied on local affiliates to serve the EU market after 2016, we find that the banking sector has responded differently, with increase in the number of affiliates in EEA but no significant increase in activity of affiliates.

This paper contributes to several strands of literature. A growing, but still limited, body

[10] Kren & Lawless (2024) use EU's trade with the rest of the world as the control group instead and find higher reductions in exports and imports of UK to EU, 16% and 24% respectively.

[11] While Bhalotia et al. (2025) include barriers to banking services in their measure, they are limited to the ones included in Annex 19 of the Trade and Cooperation Agreement and the data they use treats the financial sector as an aggregate.

[12] See https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/articles/uktradeinservicesbyindustrycountryandservicetype/2016to2018

[13] Dhingra & Sampson (2022) provide a review of the research on Brexit, extending beyond the impact on trade.

of work examines the impact of non-tariff barriers on trade in services. Some studies focus on the role of trade agreements and policies on services trade (Borchert et al. 2017, Breinlich et al. 2018, Dhingra et al. 2023)[14], while others analyse how firms establish foreign affiliates to circumvent barriers in industries like information and communications technology (Adarov & Ghodsi 2023) and professional services (Conteduca & Kazakova 2021). This paper extends this literature by examining banking services - a sector often excluded due to limited data availability but economically important both directly and through its role in supporting other industries. Banking also has characteristics that are unique compared to other services, thereby requiring separate attention - for instance, deposit-taking services involves the consumer receiving the service and the monetary return. Our analysis further contributes to understanding complex regulatory barriers. For instance the passporting framework in financial services represents the broader principle of free provision of services, which extends to other contexts, including the temporary migration programmes analysed by Munoz (2023). Additionally, the data that we build allows us to study different channels through which banks may adapt to increased barriers (interbank activity, intragroup adjustments), and add to the evidence on the use of local affiliates to access markets restricted by trade barriers. Our results emphasise that trade barriers of the kind and scale as the ones we study can have sizeable impact and change the scope of response of firms.

This paper also contributes to the literature on trade in banking services and international banking integration. Research in this literature has often focused on role of characteristics and macro-prudential policies of home or host countries in determining banks' foreign activities (Berger 2007, Frost et al. 2017, Hills et al. 2017, Lloyd et al. 2023). We provide empirical evidence of the impact of changes in bilateral barriers to cross-border banking on exports and presence of affiliates. Like Niepmann (2015, 2023), we take the view of trade in banking services, rather than that of cross-border lending or foreign ownership which are more common in this literature. While their focus is on the structural determinants of global bank organization, our paper examines how regulatory barriers affects banks' cross-border lending and deposit-taking in practice. We test the proposition in Kerl & Niepmann (2015) that lending to non-banking firms and interbank lending are substitutes, but find that under regulatory barriers of the kind we find in the Brexit episode, interbank activities cannot make up for lost lending to non-financial sector. While papers like Lehner (2009), Buch et al. (2014) discuss role of banks' efficiency in determining choice of entry into foreign markets and de Blas & Russ (2010) analyse the consequences of entry of foreign banks in a market, we study how banks use their international organisation to cope with changes in trade barriers. Additionally, we extend the work of Berg et al. (2021) that examine changes in UK syndicated loan market after the Brexit referendum,

[14] Francois & Hoekman (2010) provide a review of earlier literature.

covering the period until December 2018, by using a broader definition of loans and a longer time period.

The rest of the paper is divided into five sections. Section 2 discusses measurement of cross-border banking and variables we use for our analysis. Section 3 describes the change in regulations and barriers to export of banking service and the timeline. Section 4 provides a theoretical framework to examine the impact of changes in trade barriers on cross-border activities of banks. Section 5 describes the data used for the empirical analysis, and Section 6 presents the reduced-form evidence. Section 7 provides a summary of the results and scope for future research.

2 Measuring trade in banking services

Banks provide intermediation services i.e. provide loans and take deposits, to local (or resident) entities as well as to non-residents entities, i.e. cross-border. Banks charge for these services either explicitly, in the form of commissions and fees, or implicitly, in the form of an interest margin. These charges for cross-border provision of these services measure export. The stocks of deposits taken and loans provided represent the volume behind these exports.[15]

While the explicit charges can be directly charged and reported by banks, the implicit charges are calculated in national accounts and Balance of Payments using an indirect measure, called Financial Intermediation Services Indirectly Measured (FISIM).[16] FISIM uses a reference rate, which represents the pure cost of borrowing funds, eliminating risk premium and excluding any intermediation service cost. The reference rate is calculated as the interest charged on loans to and offered to deposits from other financial intermediaries.[17] FISIM on loans provided by banks (loan assets for the banks) is the difference between the interests received and the interest cost of funds calculated at the reference rate on stock of loans. FISIM on deposits received by banks (deposit liabilities of the banks) is the difference between the interest payable at the reference rate on the stock of deposits and the actual interest payable to depositors.[18] Note that depositors receive both the monetary interest and the service from the bank. The depositors accept a lower interest rate than the risk-free reference rate because they use the service provided by the

[15]This idea of trade value and trade volume is a generalisation of Philippon (2015), which discusses provision of financial services, more broadly, domestically.

[16]The FISIM method is defined in Chapter 14 of the European System of Accounts 2010 (European Commission & Eurostat 2021).

[17]Financial intermediaries include deposit-taking monetary financial institutions and other financial intermediaries like special credit and mortgage lenders.

[18]The formula broadly is $(r_L - r_r)S_L + (r_D - r_r)S_D$, where r_L and r_D are the interest rates on loans and deposits respectively, r_r is the reference rate, S_L and S_D are stocks of loans given and deposits taken.

bank. Because of the way the reference rate is defined, FISIM is calculated for deposits taken and loans provided to counterparty entities other than financial intermediaries.[19] The interest margins for both loans and deposits do not vary partner country.[20] Therefore, variation by partner country in FISIM is only coming from variation in stocks of loans and deposits by partner country.

Official Balance of Payments statistics of the UK (ONS Pink Book) suggests that the share of fees and commissions in total exports by UK monetary financial institutions (MFI)[21] is 15-20% (part of which includes explicit charges for lending and deposit-taking services), while FISIM is 25-30% (Appendix A.1 provides details). Therefore, FISIM constitutes a larger share of exports and yet FISIM variation by partner country is only due to variation in stocks. Additionally, while fees and commissions may have a fixed component, a part of it scales with the amount of loans or deposits. The focus of this paper is to understand how changes regulatory barriers imposed by a trading partner impacts trade of a banks in a country, and the key variation that we explore is by partner country. Therefore, instead of the standard measures of exports of banking services, we use stocks of loans and deposits as our main variable to study trade in banking services.

3 Contextual Background

Brexit Timeline: The UK was a member of the EU (and its predecessor) for over forty years before voting to leave the Union in a referendum held in June 2016.[22] There were no immediate changes in the UK's relationship with the EU or the rest of the world. However, it did shift expectations to reduced openness with the EU and increased policy uncertainty, as the referendum was not backed by any guidance over the timeline of Brexit and the future of UK-EU relations. After multiple debates, dialogues and voting on deals over the next four years, the Withdrawal Agreement that was finally agreed involved UK's exit from the single market and customs union, and trade relationship based on a free trade agreement. UK left the EU on 31 January, 2020, after which it entered a transition period lasting until end of 2020. There were no change in UK-EU trade relation in this transition period. The new trade arrangement and UK-EU Trade and Cooperation Agreement (TCA) came into effect provisionally on 1 January 2021 and entered into full force on 1 May 2021.

[19] Taking deposits from and providing loans to financial intermediaries is not considered intermediation service. However, these do show up as other services exports of the banking sector.

[20] The variation in reference rate is by currency.

[21] MFIs include deposit taking corporations (or what we refer to as banks), money market funds and central bank.

[22] The referendum was pledged by the leader of the Conservative Party during the campaign for the election in 2015.

Regulatory changes in the banking sector: The UK's banking sector was highly integrated with that of other EEA countries when the UK was a member of the EU. The advantage that the UK banking sector had built over decades[23] meant London was the European headquarters for the sector[24]. Under EU-membership, UK was a part of the EEA financial passporting system. The passporting system permits banks and financial services companies that are authorised in any EEA state to trade freely in any other member country with minimal additional authorisation, based on the assumption that banks and financial services firms authorised anywhere in the EU will have met the same standards. When part of the EU, UK banks with appropriate authorisation could provide lending and deposit-taking services to entities in other EEA countries either cross-border or by establishing a branch under preferential terms (Shalchi 2021). These included banks established in the UK (including subsidiaries of other EEA and non-EEA banks). However, branches in the UK of banks of third countries (non-EEA) did not have passporting rights, i.e. while they could provide services in UK, they could not use this authorisation to freely provide services cross-border to other EEA countries.[25]

From January 2021, UK was reclassified as a third country by the EU. In the financial sector, this led to changes in the way UK-based firms could provide services in the EEA. For instance, UK-based firms were no longer able to provide services in the EEA via passporting. This change was expected soon after the UK voted to leave the EU in the referendum (Browning 2019). UK leaving the EU implied that cross-border provision of banking services depended on national regimes for licensing, reverse solicitation etc., thereby increasing non-tariff barriers to trade. Countries like Germany, Netherlands, Ireland and Luxembourg have a more open and expansive national licensing regimes, while Portugal, Sweden and Italy are much more closed off. However, countries were relatively consistent in restricting services to small businesses and retail customers (UK Finance 2017*b*).

Even when national regimes allow for cross-border provision of lending or deposit-taking, for all practical purposes, they still remain difficult. For instance, reverse solicitation allows banks to provide services that clients solicit, however, this remains an ineffective and inefficient alternative. For instance, banks are unable to offer better-suited financial products to the client, as there are often strict rules on non-solicitation. For some countries, lending is not a regulated activity and can be provided from third countries, however, large businesses may require complementary services with lending (for e.g. risk management products) which may be restricted. Deposit-taking, in general, has more restrictions under national regimes. Additionally, the new requirements the UK banks were

[23] Bush et al. (2014) discuss how comparative advantage, clustering, path dependence and implicit government subsidy led to the UK banking sector becoming as big as it has.

[24] See the speech The Future of the European Financial Services Market

[25] These regulations are set under Capital Requirements Directive IV.

subject to increased the need to establish commercial presence that are more independent than branches.

Absence of other provisions to cross-border banking: The TCA included few provisions from trade in financial services[26] and did not contain adequate alternate provisions to negate or reduce the impact of the change in passporting. There were no arrangements of equivalence for these services either, where market access is obtained on the principle that countries where firms are based have regimes that are 'equivalent' in outcome. Most core banking activities are not subject to an equivalence regime providing access to the single market (Deslandes et al. 2019), and equivalence falls short of passporting and can be withdrawn at any time.[27] However, the UK has granted equivalence to the EEA in 22 areas of financial services after the end of the transition period. Other initiatives like the Memorandum of Understanding on financial services, which was signed in 2023 and the joint EU-UK Financial Regulatory Forum has facilitated discussion of regulatory patterns, however, there have been no substantial impact on aligning regulations or improving market access.

Comprehensive understanding of frictions UK banks face due to Brexit requires a deeper understanding of banking regulations and legal frameworks. Overall, however, the UK's withdrawal from the EU has increased trade barriers for UK banks accessing the EEA market, thereby raising trade costs to cross-border banking. It has also intensified the need to establish a commercial presence, which itself is more costly, as branches may no longer meet the necessary regulatory requirements. This paper focuses on the former changes. Additionally, rather than examining country-level regulatory barriers, the analysis concentrates on EEA-wide changes, since variations in national systems and interdependencies within financial services introduce additional layers of complexity to direct regime comparisons.

The trends in stocks of loans to and deposits from EEA, as shown in Figure 1, points to a potential effect of increased trade costs. It shows changes in aggregate stocks of loans provided and deposits taken by UK banks, to/from non-banking entities in EEA and non-EEA countries, over time using data from the Locational Banking Statistics, Bank for International Settlements (BIS-LBS).[28] Trend in stocks of loans given to EEA

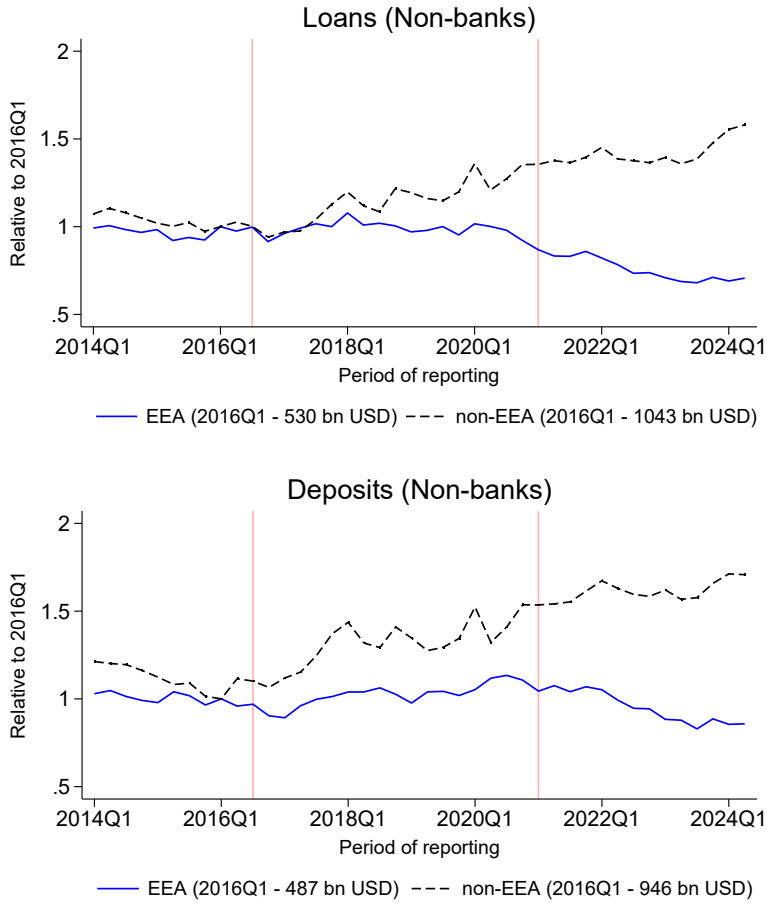
[26]These provisions are common to trade in financial services and cover Market Access, National Treatment and Most Favoured Nation

[27]Equivalence has only been provided for UK clearing houses for derivatives transactions. This was valid till June 2022 but has been extended since. The other area of equivalence has been recognition of a UK Central Securities Depository (CSD) for settlement of (mainly) Irish securities until the end of June 2021.

[28]As discussed in Section 2, transactions with financial intermediaries may not involve providing a service, and should be excluded for the purpose of our study and the BIS-LBS database contains stocks for export to non-banks. However, they may still include non-bank financial intermediaries that we cannot exclude in these data. Appendix A.6 shows the corresponding figures for stocks of loans from

and non-EEA, relative to their 2016Q1 values, diverge a few periods after the referendum (2016Q3), with the stocks for EEA falling. Deposits from EEA and non-EEA were falling initially, however after the referendum, deposits from non-EEA increase faster than from EEA, and deposits from the EEA start falling after the new trade arrangement between UK and EU comes into effect (2021Q1). We use our theoretical framework and empirical analysis to determine how these trends are driven by an increase in trade barriers to banking services.

Figure 1: Stocks of Loans to and Deposits from Non-banking entities in EEA and non-EEA, by UK



Source: Authors' calculation using BIS-LBS data.
Note: The first vertical line denotes the referendum (2016Q3) and the second the new trade arrangement between UK and EU coming into effect (2021Q1).

4 Theoretical Framework

Intermediation services provided by banks covers lending and deposit-taking by banks. To understand how changes in trade barriers affect activities of banks – not only with the country that increased barriers for cross-border activities, but also other partner countries

and deposits to all entities.

– we provide a theoretical framework that studies banks' profit maximisation problem. We test the propositions of the model empirically using data on UK-resident banks in the subsequent sections.

4.1 Economic Environment

There are three countries in the world: UK (B), EEA (E) and non-EEA (R). Each country has three types of entities - a continuum of banks b, a representative firm f and a representative depositor d.[29]

The amount of loan that the representative firm of country i takes from a bank b is a decreasing function of the interest rate charged by the bank. The demand for loans is given by:

$$l_{bi} = \alpha_{Li} r_{Lbi}^{-\sigma} \tag{4.1}$$

where α_{Li} is a constant and is the aggregate demand parameter, r_{Lbi} is the (gross) interest rate and σ is the elasticity of demand with respect to the interest rate.[30]

Depositors put their savings with banks to earn interest. The amount of deposit that the representative depositor of country i gives to bank b is an increasing function of the gross interest rate paid by the bank. The supply of deposits is given by:

$$s_{bi} = \alpha_{Di} r_{Dbi}^{\theta} \tag{4.2}$$

where α_{Di} is a constant and is the aggregate supply parameter, r_{Dbi} is the (gross) interest rate and θ is the elasticity of demand with respect to the interest rate.[31]

Lastly, the economies have banks, that provide loans to firms and take deposits from depositors, both domestically and cross-border. We focus on UK-resident banks. Each bank has an efficiency in monitoring the loans and in attracting deposits (say through advertising or in competing with other banks), denoted by a_b. This efficiency is drawn from a distribution, and the parameters of the distribution vary with nationality of the bank and its incorporation status in the UK. We assume that the cost of monitoring

[29]The depositor is a saver or capital owner. In the data, about 70% of deposits from the non-financial sector come from non-financial corporations, who could own surplus capital.

[30]The downward sloping demand curve can be micro-founded on a CES demand for loans, where firms demand a variety of loans, that have different features like associated facilities, geography etc. In such case, α_{Li} represents the aggregate demand and σ the elasticity of substitution.

[31]Here again, the curve can be micro-founded on a CES-demand for deposit services by depositors, where depositors want to save in different varieties of accounts. For this, we exploit the fact that the price of an asset has an inverse relation with its interest rate.

loans or of getting deposits is decreasing in efficiency and increasing in amount of loan or deposit i.e.

$$c_{Lb} = \frac{l_{bi}}{a_b}; \quad c_{Db} = \frac{s_{bi}}{a_b} \tag{4.3}$$

UK-resident banks can also provide their services cross-border. If a UK bank lends to a firm in country j, then it incurs a fixed cost of χ^L_{Bj}. There is an additional variable cost, which increases the monitoring cost for loans by a factor of τ_{Bj}, where $\tau_{Bj} > 1$ (or alternatively reduces the efficiency of the bank when providing services to E rather than to domestic entities). If a UK bank raises deposits from country j then it incurs a fixed cost of χ^D_{Bj}. There is also a higher variable cost of providing deposits by a factor of t_{Bj}, where $t_{Bj} > 1$. The fixed costs are such that $\chi^L_{ij} < \chi^B_{ij}$, representing more regulations that banks are subject to when taking deposits.

UK's withdrawal from the EEA and the subsequent trade barriers change the fixed and variable cost of providing services to the EEA. We begin with the initial assumption that the costs incurred by UK-resident banks are such that the fixed and variable costs for providing services cross-border to EEA is lower than the corresponding costs for non-EEA. However, the trade barriers increase the cost for providing service to EEA, while costs for non-EEA remain unchanged. The changes in regulatory barriers can be modeled as an increase in fixed and variable costs. If UK banks have to apply for licenses from a country, it would incur a fixed cost, whereas provision through reverse solicitation would incur additional costs for each loan or deposit service provided, increasing the variable cost of serving the EEA market.

4.2 Bank's profit maximisation

The profit of bank b from providing service in all markets is:

$$\begin{aligned}
\max_{\{r_{Lbi}\}_i, \{l_{bB}\}_i, \{r_{DbB}\}_i, \{s_{bB}\}_i} \pi_b = {} & r_{LbB} l_{bB} + r_{LbE} l_{bE} + r_{LbR} l_{bR} - \frac{(l_{bB} + \tau_{BE} l_{bE} + \tau_{BE} l_{bR})}{a_b} \\
& - r_{DbB} s_{bB} - r_{DbE} s_{bE} - r_{DbR} s_{bR} - \frac{(s_{bB} + t_{BE} s_{bE} + t_{BR} s_{bR})}{a_b} \\
& - \chi^L_{BE} - \chi^L_{BR} - \chi^D_{BE} - \chi^D_{BR} \\
s.t. \quad & l_{bB} + l_{bE} + l_{bR} \leqslant s_{bB} + s_{bE} + s_{bR} \\
& l_{bi} = \alpha_{Li} r^{-\sigma}_{Lbi}, \quad s_{bi} = \alpha_{Di} r^{\theta}_{Dbi} \ \ \forall \ \ i \in \{B, E, R\}
\end{aligned} \tag{4.4}$$

Here, the first three terms are the interest and principal on loans given, the next three are

the variable costs associated with lending, the three after are the interest and principle paid on deposits that the bank has collected and the next three are the variable costs for deposit-taking. The last set of terms represent the fixed costs associated with cross-border service provision. There are additional constraints that all interest rates are $\geqslant 1$ but look at cases when interest rates are > 1.

Profit maximising bank then sets that interest rates such that:

$$r_{Lbi} = \frac{\sigma}{\sigma - 1}\left(\lambda + \frac{\tau_{Bi}}{a_b}\right); \quad \forall \ \ i \in \{B, E, R\}$$
$$r_{Dbi} = \frac{\theta}{\theta + 1}\left(\lambda - \frac{t_{Bi}}{a_b}\right); \quad \forall \ \ i \in \{B, E, R\}$$

where $\lambda > 0$ is the lagrange multiplier for the resource constraint of the bank and $\tau_{BB} = t_{BB} = 1$. The solution suggests that $r_{Lbi} \geqslant r_{Dbi}$. The lagrange multiplier represents the marginal increase in profit from a marginal increase in deposits, and denotes the indirect effects that a change in variable costs. The interest rates are functions of the respective elasticity, the efficiency of the bank, the additional cost of provide service to the country cross-border and the lagrange multiplier.[32] The solution to the bank's profit maximisation is obtained by solving for λ in the resource constraint of the bank, given by:

$$\left(\frac{\sigma}{\sigma - 1}\right)^{-\sigma}\left[\alpha_{LB}\left(\lambda + \frac{1}{a_b}\right)^{-\sigma} + \alpha_{LE}\left(\lambda + \frac{\tau_{BE}}{a_b}\right)^{-\sigma} + \alpha_{LR}\left(\lambda + \frac{\tau_{BR}}{a_b}\right)^{-\sigma}\right]$$
$$= \left(\frac{\theta}{\theta + 1}\right)^{\theta}\left[\alpha_{DB}\left(\lambda - \frac{1}{a_b}\right)^{\theta} + \alpha_{DE}\left(\lambda - \frac{t_{BE}}{a_b}\right)^{\theta} + \alpha_{DR}\left(\lambda - \frac{t_{BR}}{a_b}\right)^{\theta}\right]$$

4.3 Impact of trade barriers

In this subsection, we examine the impact of increase in the variable trade cost for providing services to the EEA (E) (see further details in Appendix A.2.).

Proposition I: An increase in the variable trade cost of providing loans to E leads to an increase in the interest rate charged on the loan (r_{LbE} increases) and a fall in lending (l_{bE} decreases).

[32]To interpret the expressions for interests, we note that if we remove the constraint, i.e. if $\lambda = 0$, then the interest is the markup over marginal cost, like in CES. The constraint adds another cost to the bank, with λ added to the expression.

$$\begin{aligned} \frac{dr_{LbE}}{d\tau_E} &= \frac{\sigma}{\sigma-1}\left(\frac{d\lambda}{d\tau_{BE}}+\frac{1}{a_b}\right) > 0 \\ \frac{dl_{bE}}{d\tau_{BE}} &= -\sigma\alpha_{LE} r_{LbE}^{-\sigma-1}\frac{dr_{LbE}}{d\tau_{BE}} < 0 \end{aligned} \tag{4.5}$$

On the first line, the second term represents the direct effect of an increase in variable trade cost on the interest rate. The first term represents the indirect effect that operates through the resource constraint. Due to increase in trade cost, lending to E falls, and this reduces total lending by the bank. The resource constraint then becomes slack, i.e. the bank has excess deposits. This decreases the additional benefit of increasing deposits further i.e. $d\lambda/d\tau_{BE} < 0$. Since having excess deposits is not optimal for the bank, it will push the interest on loans to E down so that the loan increases. However, this indirect effect is smaller than the direct effect since the excess deposits can be reduced by increasing lending in other markets or reducing deposits. Overall, the interest on loans increases.

Proposition II: An increase in variable trade cost of taking deposits from E leads to a decrease in the interest rate offered for the deposit (r_{DbE} decreases) and a fall in deposits (s_{bE} decreases).

$$\begin{aligned} \frac{dr_{DbE}}{dt_{BE}} &= \frac{\theta}{\theta+1}\left(\frac{d\lambda}{dt_{BE}}-\frac{1}{a_b}\right) < 0 \\ \frac{ds_{bE}}{dt_{BE}} &= \theta\alpha_{DE} r_{DbE}^{\theta-1}\frac{dr_{DbB}}{dt_{BE}} < 0 \end{aligned} \tag{4.6}$$

Again, regarding the first line, the second term represents the direct effect of an increase in variable trade cost on the interest rate. The first term represents the indirect effect that operates through the resource constraint. Due to increase in trade cost, deposits from E falls, and this reduces total deposits of the bank. The resource constraint then becomes tighter, i.e. the bank will be giving out loans in excess of deposits. This increases the additional benefit of increasing deposits further i.e. $d\lambda/d\tau_{BE} > 0$. Since having a deficit of deposits is not optimal for the bank, it will push the interest on deposits from E up so that deposit increases. However, this indirect effect is smaller than the direct effect since the excess loans can be reduced by increasing deposits from other markets or reducing lending. Overall, the interest on deposits decreases.

Proposition III: Simultaneous increases in variable trade costs of lending to and taking deposits from E have an ambiguous effect on lending and deposit-taking with other partner countries.

As discussed under Proposition I, an increase in the variable trade cost on lending to E decreases lending to E, and this leads to excess deposits with the bank. As a result the bank will increase lending to other markets and decrease deposits from all markets. On the other hand, Proposition II suggests that an increase in variable trade cost on deposit-taking from E decreases deposits from E which leads to a deficit in deposits. The bank will then reduce lending to all markets and increase deposits from B and R. These opposing effects of the increase in the variable trade cost on the two services provided by banks imply that the net effect on lending and deposit-taking from other markets is ambiguous. The effect depends on parameters such as the elasticity of demand and supply, aggregate demand and supply, efficiency of the bank as well as on the trade costs. This also implies that a simultaneous increase in variable cost of lending and deposit-taking leads to larger decreases in lending to E and deposit-taking from E. An increase in the variable trade cost on lending to E reduces deposits from E and this reinforces the direct effect of the increase in variable cost on deposit-taking, and similarly for lending.

These propositions form the basis for our empirical analysis. While the prime focus of this paper is tge activity of UK banks with EEA, it is also important to study if there were any substitutions to other markets, and if the impact of the trade cost of lending or deposit-taking dominates the other. Moreover, the framework suggests that estimating the effect of lending and deposit-taking with EEA relative to non-EEA may not be appropriate when determining the impact of barriers due to Brexit since these barriers have spillovers on activity with non-EEA.

5 Data

To measure the cross-border intermediation activity of UK banks, we use data from two different sources: country-level bilateral stocks of loans and deposits from the Bank for International Settlements (BIS)[33] and bank-level stocks of loans and deposits and income from cross-border activities from the Bank of England (henceforth BoE).

Locational Banking Statistics database of the BIS (BIS-LBS):

Bank for International Settlements (2025) contains stocks of loans provided and deposits taken by resident banks (based on the location of the banking office) that are interna-

[33]We also use data on claims (including loans and other assets of resident banks from non-resident entities) and liabilities (including deposits and other liabilities of resident banks to non-resident entities) for robustness.

tionally active, from or to non-resident counterparties.[34, 35] The dataset we use, with the required level of granularity, consists of 31 reporting countries and over 200 partner countries. The BIS-LBS capture around 95% of all cross-border banking activity.[36]

Statistical bank-level data from the Bank of England (BoE):

We use confidential statistical data collected by the Bank of England from deposit-taking institutions resident in the UK, on their domestic as well as non-resident activities, reported for each partner country. Data is collected through different forms that financial institutions satisfying specific reporting criteria provide information on.[37] This data is the backbone of the UK official data on the banking sector activity, including banking sector trade published by the Office for National Statistics (ONS). The data we use starts from 2014 (the year since the data has been collected consistently) and comprises quarterly information up to the most recent quarter available (quarter 2 of year 2024 for now).[38]

Banks with substantial non-resident activities report stocks of claims and liabilities for each partner country, currency of transaction and sector of the counterparty entity (households, governments, non-financial corporations, deposit-taking corporations in the same company-group, other deposit-taking corporations, or other financial entities), by quarter.[39] When reporting claims, the banks separately report "loans" which includes loans and advances, finance leases and claims under sale and repurchase agreements, bills and ECGD lending. Reporting liabilities includes "deposits" which sums up sight and time deposit liabilities and liabilities under sale and repurchase agreements. We discuss the coverage of the BoE data on stocks of deposits and loans, and compare it to BIS-LBS in Appendix A.3. The Bank of England data on stocks is similar to that of the UK in the

[34]Deposits include transferable deposits, interbank positions and repurchase agreements. Loans include installment loans, hire-purchase credit, loans to finance trade credit, financial leases and repurchase agreements. Data is reported on an unconsolidated basis. They include banks intragroup positions with subsidiaries and other legal entities that are part of the same banking group, as well as inter-office positions with their non-resident branches, but they exclude inter-office positions with banks resident branches.

[35]The database contains information for stocks for different currencies, parent country, sector, types of reporting banks etc., however we use the subset for which UK data is available. Therefore, the data we use is deposits and loans (and total liabilities and claims for robustness) reported by all resident banks of any parent nationality, for each reporting country, for transactions in any currency, that are cross-border, split by partner country. The data contains total stocks of deposits from and loans to all sectors of non-resident entities (which include households, governments, non-financial corporations, banks etc.) in the partner country, as well as stocks where the non-resident entities are non-banks.

[36]Details of the data and coverage are available at: https://data.bis.org/topics/LBS.

[37]Information power of the Bank of England, and the consequences of failure to provide correct information, is specified in The Bank of England Act, 1998.

[38]The time-period of data for analysis will be restricted to 2024 since new measures on cross-border activities from third countries was announced by the ECB in 2024, which could affect banks' activities.

[39]Banks submit separate forms for claims and liabilities. Banks with an equivalent of £300 million or more of external claims report information on claims, and with an equivalent of £300 million or more of external liabilities report information on liabilities. These thresholds have remained unchanged over the period of analysis.

BIS dataset, factoring for differences in currencies of reporting. Banks also report stocks of claims and liabilities corresponding to domestic activities (i.e. where the counterparty entity is a resident of the UK), although information by counterparty sector is much more aggregated which restricts usage of this data for analysis.[40] We use quarterly information in our analysis.

In addition to information on stocks, UK-resident banks also report income received from cross-border activities to the Bank of England. These are used to measure official trade statistics. Banks report these either annually or quarterly, based on criteria stated by the Bank of England.[41] Additionally, some of exports to each partner country is calculated or imputed. Overall, variables on income from exports that we use include:

- Fees and commissions – income from arrangement of loans and advances, current account services, management of portfolio of securities, other financial and non-financial services etc., reported by resident banks for each partner country.
- FISIM – implicit revenue received by banks for lending and deposit-taking services. This variable is calculated using a method similar to that discussed in section 2.
- Intragroup fees and Cost recharges – income from non-resident intragroup entities for loans and advances, current account services, investment banking, advisory, brokerage and underwriting etc., as well as other intragroup services and cost recharges of centrally managed services[42], reported by partner country.

Our bank-level dataset includes information on imports by UK-resident banks as measured by fees and commission paid and payments to other entities of the company group for their services. However, these are only a part of import of banking services as these services could be imported by non-banks in the UK. Our analysis of imports is limited.

Historical Orbis:

We complement the bank-level data with data from Historical Orbis, to study the changes in activities of intragroup entities of the UK banks.[43] We obtain information on the global

[40]Stocks related to entities constituting the non-financial sector is reported by banks with substantial resident activities. Banks for which loans provided to and deposits taken from residents other than monetary financial institutions (banks and building societies) and the public sector exceeds £1 billion report a breakdown of deposits and loans for the non-financial sector. More aggregated stocks of loans to and deposits from resident entities is available for all banks, which is used to allocate stocks to the non-financial sector for banks that do not explicitly report these stocks.

[41]The criteria is that receipts from or payments to non-resident (in the form of income as listed below or profit share in branches/subsidiaries) should exceed a threshold. This threshold was increased substantially in 2020 and reduced in 2024. The threshold is chosen such that the data collected by the Bank of England covers about 90-95% of the total non-resident activity of these receipts or payments. Therefore, even with the changes in threshold the data captures a consistent share of total activity.

[42]Example: reporting entity recharging non-resident entities for purchases like software made by reporting country but used by these other intragroup entities as well

[43]We identify UK banks using archives of the official list of Banks the PRA regulates, including both

ultimate owner of the UK bank, and through that, on the branches and subsidiaries within the group. Information includes characteristics of entities like legal form, type of entity, size category, as well as employment, total assets etc. We select intragroup entities that are classified as "Banks" in Orbis.

6 Empirical Evidence

Our empirical analysis determines how non-resident activities of UK banks changed due to UK's decision to leave the EU (i.e. from 2016Q3) and the subsequent changes in barriers to trade when the new trade arrangement between UK and EU came into effect (from 2021Q1). A discussion of changes in exports of banking services of the UK (as measured by FISIM and fees and commissions) is included in Appendix A.4.

6.1 Aggregate Stocks of Deposits and Loans

We examine if these changes in stocks of loans to and deposits from EEA as seen in Figure 1 are specific to the UK and hence can be driven by change in trade barriers, or if they reflect changes due to shocks that affect the banking sector globally. We run an event-study regression as specified below on deposits and loans (separately), using data from all reporting countries in the BIS-LBS data.

$$\begin{aligned} ln(stock_{ijt}) = &\sum_{k \neq 2016Q1} \beta_1^k \left(k_t \times EEA_j \times UK_i\right) + \sum_{k \neq 2016Q1} \beta_2^k \left(k_t \times UK_i\right) \\ &+ \delta ln(exchange\_rate_{it}) + \alpha_{ij} + \alpha_{jt} + \varepsilon_{ijt} \end{aligned} \tag{6.1}$$

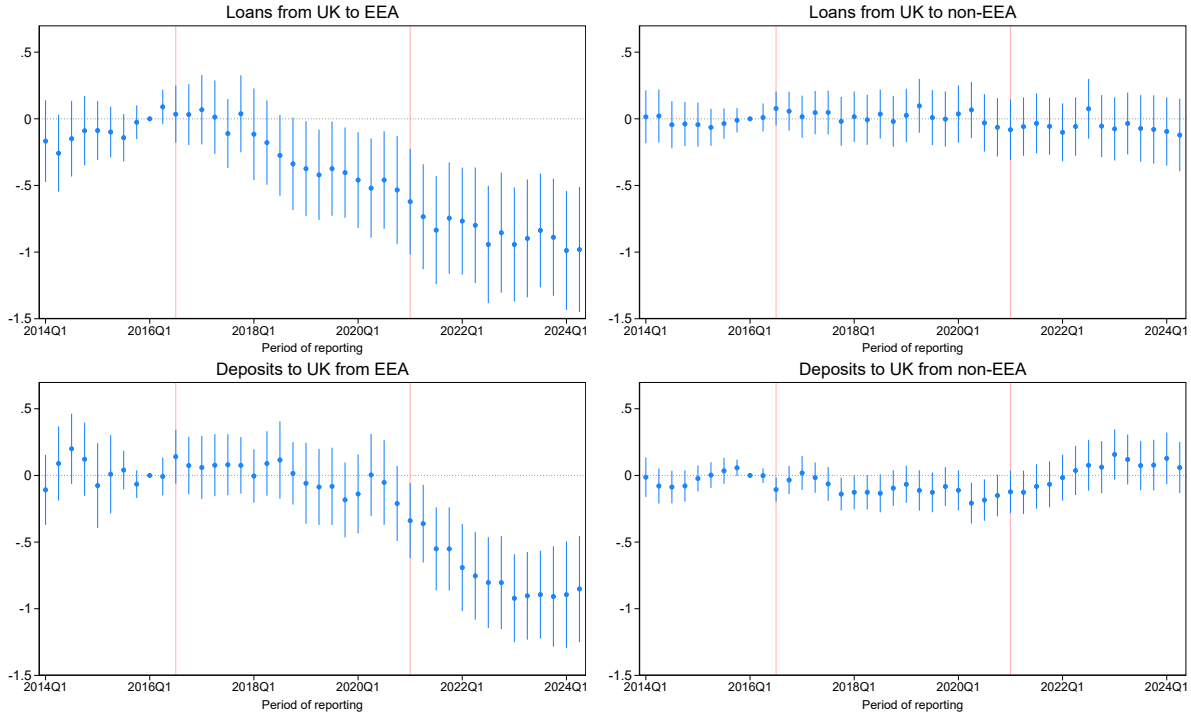
where i = exporter of service (i.e. lender or deposit-taker), j = importer of service (i.e. borrower or depositor), t = quarter. $k_t = \mathbb{1}\{t = k\}$, $UK_i = \mathbb{1}\{i = UK\}$, $EEA_j = \mathbb{1}\{j \in EEA\}$, $stock_{ijt} = deposits\_stock_{ijt}$ or $loans\_stock_{ijt}$. Since the dataset reports stocks in dollars, we include the exchange rate of the currency of the exporter with the dollar as control. We include country-pair fixed effects, as is common in gravity regressions, to focus on changes in exports by country-pair, and importer-time fixed effects to account

incorporated entities and branches of foreign banks. This list provides LEI identifiers for current banks incorporated in the UK. We find identifiers for the remaining incorporated entities (that exited before the PRA started publishing LEIs) using the Companies House register. For branches, using archives, we can back out EEA branches as those that used to be able to use passporting. We look for the identifier of their direct parent in the EUCLID (European) list of authorised banks, where we get LEIs. For the remaining branches, we use the US FFI list where we get GIINs of their direct parents. We map Companies House registered numbers, LEIs and GIINs to BvD IDs in Orbis. This way, we manage to find unique identifiers for all banks in our data.

for time-varying demand shocks. We cluster the standard errors by country-pair.[44]

Figure 2 shows the coefficients β_1^k and β_2^k for the event-study regressions on loans and deposit with non-bank counterparties. It shows changes in loans provided or deposits held by UK resident banks where the partner country is either in the EEA or not in the EEA, relative to 2016Q1 (which we take as base period) and to other exporters (non-UK).[45] The stocks of loans to non-banking entities in an average EEA country compared to non-EEA country falls significantly starting a few periods after the referendum, when banks started to expect changes in cross-border banking to EEA. We see a similar fall in stocks of deposits from non-banks in an EEA country compared to non-EEA country after the new trade barriers come into effect in 2021Q1 relative to 2016Q1 and to other exporters (non-UK). The stocks of loans to and deposits from EEA by UK banks have an additional fall by 55-60% relative to their baseline value in 2016Q1 compared to changes in cross-border stocks of other country-pairs.

Figure 2: Event Study - Loans to and deposits from non-banks (BIS-LBS)



Notes: Estimation uses BIS-LBS data to estimate Eq. 6.1, with log of loans to and deposits from non-banking entities, by country exporting service (i.e. lender or deposit-taker), country importing service (i.e. borrower or depositor) and quarter, as dependent variables in top two and bottom two graphs respectively. Red line at 2016Q3 indicates first quarter after Referendum and at 2021Q1 indicates first quarter after new trade arrangement came into effect. Country-pair and importer-time fixed effects are included. Blue dots are the coefficients and the bars are the 95% confidence intervals, with standard errors, clustered by country-pair.

[44]Our results on β_1^k stay the same if we include exporter-time fixed effects, remove UK as exporter and EEA as importer in the sample and include terms for EEA exports to UK, as well.

[45]We take 2016Q1 instead of 2016Q2 as the base because banks reported stocks at the end of June 2016, potentially after the referendum, when exchange rates were already affected.

However, there is no significant change in lending or deposit-taking to non-banking entities in a non-EEA country by the UK when compared to other exporting countries. Deposit-taking from non-EEA falls after the referendum and subsequently increases after 2021Q1, however, these are not consistently statistically significant.

The aggregate data, therefore, suggests a fall in cross-border intermediation by UK banks to EEA that is not due to global trends or global shocks. This indicates that exports of banking services of the UK was affected by changing trade relations with the EEA. These results are consistent with Propositions I and II of our theoretical framework. The event study also suggests that the rise in stocks of loans to and deposits from non-EEA in Figure 1 is in line with global trends. Proposition III of our theoretical framework had stated that the impact on activity with non-EEA is ambiguous, and the estimates here suggest that the effects of the two trade costs negate each other on net, on the aggregate. The impact on loans starts after the referendum, while on deposits is when the new trade arrangement comes into effect. Loans are typically longer-term contracts, compared to deposits, which can be terminated easily. Following the referendum, there were uncertainties about the future of cross-border service provision, as well as status of existing contracts.[46] The uncertainty and anticipation of increased barriers led to banks reducing the loans the extended to EEA. To quantify these changes, assuming the spillovers of Brexit on cross-border banking of other countries to be small, stocks of loans to EEA fall by close to 300 bn dollars between 2016Q1 and 2024Q1.

These results on aggregate stocks motivates investigation of activities of individual banks and the drivers of the aggregate trends.

6.2 Bank-level outcomes

Next, we use the bank-level data to determine how UK-resident banks were impacted by the change in trade relations in banking between UK and EEA, and the role of the characteristics of banks in the impact. We first use the stocks of loans to and deposits from non-resident households, non-financial corporation and government, which we henceforth refer to as the non-financial sector. Therefore, in contrast to the BIS data for non-banks, this excludes financial corporations.[47]

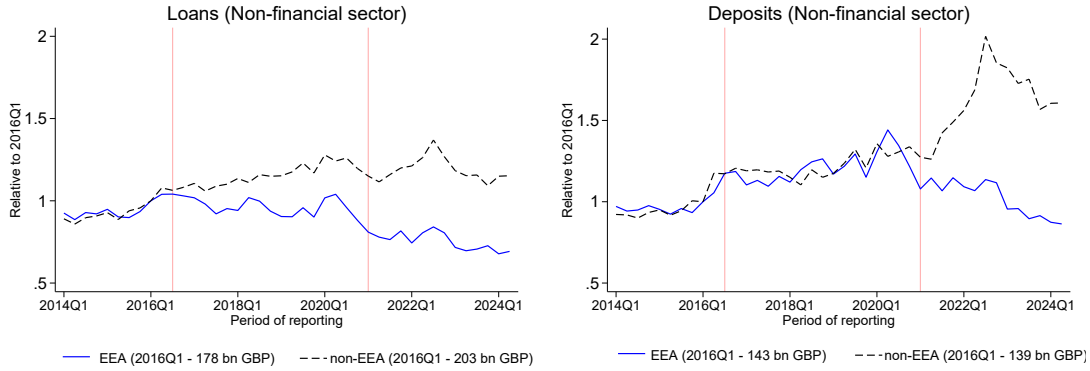
Figure 3 shows stocks of cross-border loans to and deposits from non-financial sectors in EEA and non-EEA by UK-resident banks, relative to their 2016Q1 values. Consistent with the results on aggregate stocks, stocks of loans diverge after the referendum, while

[46] This is discussed in UK Finance (2017*a*).

[47] Ideally, we would have included financial corporations other than financial intermediaries. Despite having data on financial corporations, we are unable to obtain stocks corresponding to financial intermediaries separately and exclude all of the financial sector from our analysis. Due to this, the stocks going forward differ from the stocks corresponding to non-banks in the BIS-LBS.

the trends for stocks of deposits diverge close to the new trade arrangement between UK and EU coming into effect in 2021Q1. Stocks of both are increasing for non-EEA and decreasing for EEA.[48]

Figure 3: Stocks of loans to and deposits from non-financial sector by UK banks (BoE)



Source: Authors' calculation using BoE data.
Note: The first vertical line denotes the referendum (2016Q3) and the second the new trade arrangement between UK and EU coming into effect (2021Q1).

These trends are stark and have considerable volatility from one period to another (partly due to impact on saving and borrowing due to Covid-19 and the fiscal and monetary policies adopted by countries to contain an economic downturn and control subsequent inflation). We structure our bank-level analysis to determine the role of regulatory barriers in driving these trends and how other activities of UK banks are changing.

6.2.1 Impact of Passporting

UK's withdrawal from the EEA introduced frictions to cross-border activities of banks. These frictions varied for banks with different characteristics. So far, our analysis has studied how stocks changed after referendum and after Brexit, however, to provide more concrete evidence on the impact of increased regulatory barriers, we study the loss of passporting or EEA-wide authorisation to provide service, one of the most significant changes faced by the financial sector[49].

UK-resident bank could be one of three types. The first is banks incorporated in the UK - these banks could have a UK national ultimate owner, or be a incorporated legal entity of a company of any other nationality. The second is branch of EEA bank (this includes branches operating when passporting was permitted and those with supervisory run-off

[48]The sharp peak in the graphs for non-EEA in both deposits and loans is due a sharp depreciation of the pound relative to the dollar in 2022Q2. This depreciation was due to fiscal policy measures proposed in the period that were subsequently withdrawn. This exchange rate is relevant here as lending and deposit-taking by UK-resident banks in currencies other than the pound is converted to pounds by banks when reporting to the Bank of England.

[49]In September 2016, 5,500 UK-authorised firms (which includes entities other than banks as well) were passporting their authorisations into Europe.

after the withdrawal[50]) and the third is branch of a non-EEA bank[51], and we refer to this characteristic as incorporation status.[52] Until the end of 2020, banks incorporated in the UK could have used the authorisation they had obtained from the UK to provide services to EEA. Branches of EEA banks were using their authorisation obtained from their home country to set up a branch and access the UK market, i.e. they used passporting as well. However, UK branches of non-EEA banks did not have EEA-wide authorisation and relied on national regimes of EEA countries applicable to non-EEA countries to provide services cross-border i.e. they did not have passporting.[53]

We study how lending and deposit-taking activities of banks incorporated in the UK or UK branches of EEA banks change when compared to activities of UK branches of non-EEA banks, thereby comparing the change in activities of banks that lost passporting to activities of banks that did not have passporting when UK was a member of the EU, to estimate the impact of regulatory barriers. The period of our study includes aggregate shocks like Covid-19. Additionally, Brexit itself led to other changes that could affect banking activities, for instance, EEA firms reducing demand for banking services from the UK due to less trade in goods and other services with the UK. These shocks affected all UK banks. Moreover, there were no significant changes in national regimes for cross-border banking in EEA countries in the period of Brexit, which is what UK-resident banks relied on for cross-border activity.[54,55] Figures 15 and 16 in Appendix A.7 show

[50]Supervisory Run-Off allows UK branches of EEA banks to wind down their UK regulated activities in an orderly manner.

[51]This refers to branches of banks that are not incorporated in the UK or EEA. Banks incorporated outside the UK or EEA can be authorised to operate a branch in the UK.

[52]We classify banks using their status as listed by the UK regulator (PRA) as of June 2025, April 2019 and June 2015 (362 banks identified). A bank is incorporated in the UK (184 banks) if it has the status "Banks incorporated in the UK authorised to accept deposits" in any of the years (we do not observe any changes in status). It is identified as a UK branch of an EEA bank (81 banks) if it was classified as "Banks incorporated in the EEA entitled to accept deposits through a branch in the UK" in 2015 or 2019, or as "Banks incorporated in the EEA authorised to accept deposits through a branch in the UK while in Supervised Run Off (SRO)" in 2025. It is otherwise identified as a non-EEA branch (92 banks). We exclude banks that are classified as "Banks authorised in the EEA entitled to establish branches in the UK but not to accept deposits in the UK" in 2015 or 2019, and there are 5 such banks.

[53]This is stated in recital 23 of CRD IV.

[54]The regulations that UK branches of EEA banks were subject to were more complex. They could apply to a Temporary Permissions Regime, that allowed them to operate as branch in the UK based on their previous passport for three years, but they were expected to obtain full authorisation within this period if they wished to continue to operate in the UK. There is however, lack of clarity in the extent to which this allowed EEA branches in the UK to perform cross-border lending and deposit-taking with EEA entities. We group these banks with incorporated banks, as banks that lost passporting and continued cross-border activity with the EEA based on national regime of importing country. We argue that despite using previous passport, the Temporary Permission Regime would have changed the incentives UK branches of EEA banks to continue to operate the branch and increased costs of operation. We perform robustness checks to account for this, and also note that the cross-border activities of these banks are much smaller than the other two categories of banks (accounting for 17% and 13% of cross border stocks of loans to and deposits from non-financial sector in 2016Q1.

[55]Changes in regulations for cross-border banking into EEA entered into force in July 2024 and will be effective from january 2026. We restrict our period of analysis to 2024Q2 to avoid including impact

that banks that did not have passporting did provide cross-border services to the EEA (share in stocks of loans and deposits is 33% and 46% rspectively). Moreover, cross-border activities of these banks are falling after the new trade arrangement between UK and EU came into effect which could be due to aggregate shocks and other demand-driven forces, as well as integration within the UK banking network. We do not observe which banks are using their passporting authorisation specifically in providing services to EEA in the data, but instead use information on which banks could use passporting, assuming that a bank wanting to serve the EEA market would use this authorisation to minimise costs.

We estimate an event-study, to see how stocks of loans and deposits of banks that were subject of regulatory barriers responded, and to check for any pre-trends, given by:

$$\ln(stock_{bjt}) = \sum_{k \neq 2016Q1} \beta_1^k (k_t \times PassAuth_b \times EEA_j) + \sum_{k \neq 2016Q1} \beta_2^k (k_t \times PassAuth_b) + \alpha_{bj} + \alpha_{jt} + \varepsilon_{bjt} \tag{6.2}$$

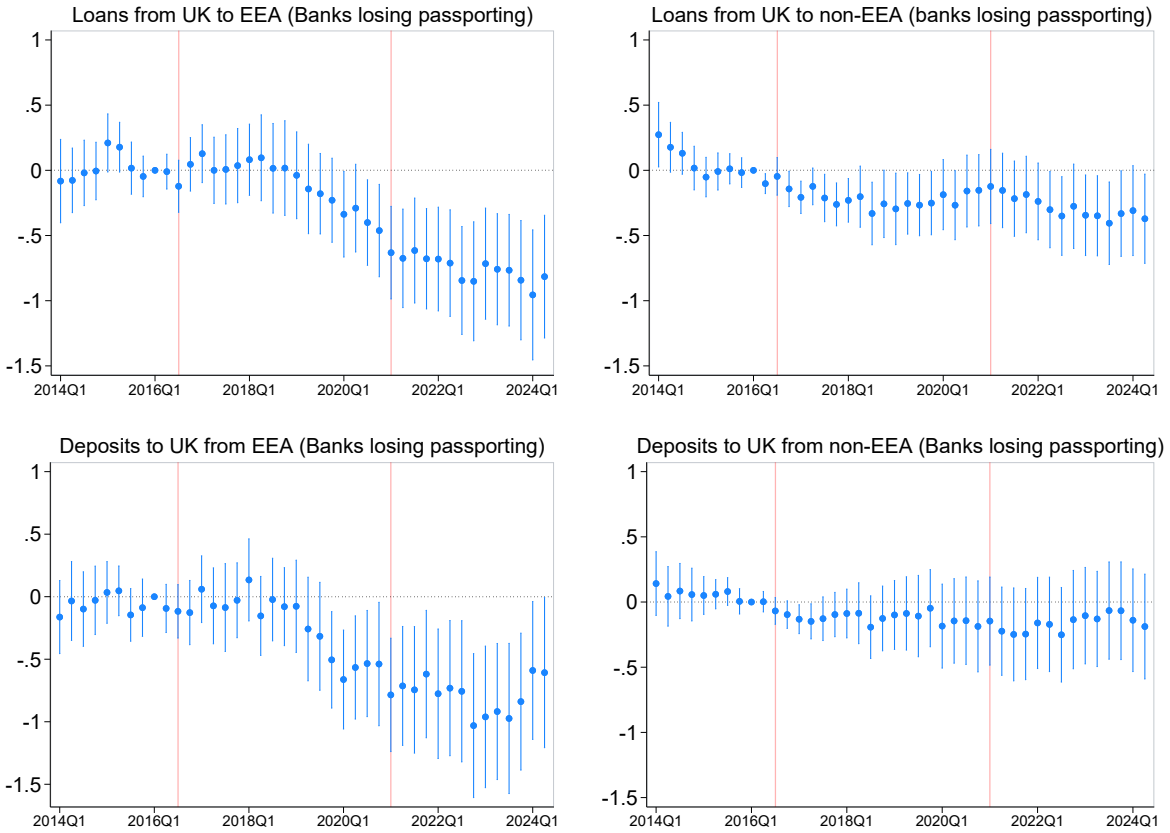
where b = bank, j = partner country (i.e. country of borrower or depositor), t = quarter, $PostRefer_t = \mathbb{1}\{t \geqslant 2016Q3\}$, $Post21_t = \mathbb{1}\{t \geqslant 2021Q1\}$ $PassAuth_b = 1$ if bank is incorporated or is a branch of an EEA bank and 0 if it is a branch of a non-EEA bank. We include bank-country fixed effects to focus on changes in exports by a bank to a country, and country-time fixed effects to account for time-varying demand shocks. Since increased barriers with EEA can have an impact on activity with non-EEA as well, as discussed in our framework, we separate the effect on non-EEA and thereby do not include bank-time fixed effects. We cluster standard errors by bank.

Figure 4 shows the coefficients β_1^k (left) and β_2^k (right) for the regressions with stocks of loans (top) and stocks of deposits (bottom) as dependent variables. We find that lending and deposit-taking by banks that lost passporting were not significantly different from the banks that did not have passporting, before the referendum. Stocks of loans to and deposits from EEA countries fall significantly for banks that lost passporting, relative to their value in 2016Q1 (the base period) and relative to banks that did not have passporting and activities with non-EEA countries. In both cases, the fall starts a few periods before the barriers get implemented, indicating banks responding in anticipation.

Additionally, there is a small decline in stocks of loans to non-EEA relative to banks that did not have passporting. Figure 15 in Appendix A.7 shows that this relative decline is due to increase in lending to non-EEA by banks that did not have passporting and

of these changes.

Figure 4: Event Study - Loans to and deposits from non-resident, non-financial sector - by passporting



Notes: Estimation uses Bank of England data to estimate Eq. 6.2, with log of loans to and deposits from non-financial sector, by bank, country and quarter, as dependent variables in top two and bottom two graphs respectively. Red line at 2016Q3 indicates first quarter after Referendum and at 2021Q1 indicates first quarter after new trade arrangement came into effect. Bank-country and country-time fixed effects are included. Blue dots are the coefficients and the bars are the 95% confidence intervals, with standard errors, clustered by country-pair.

loans stocks to non-EEA of banks that lost passporting remaining unchanged after the referendum. There is no relative change in stocks of deposits from non-EEA when banks lose passporting. This is consistent with the spillovers on activities with non-EEA that we have discussed so far - there are none or limited indirect effects.

We also run the corresponding triple-difference regression, with the same fixed effects and clustering:

$$\begin{aligned}\ln(stock_{bjt}) =& \beta_1(PostRefer_t \times PassAuth_b \times EEA_j) + \beta_2(PostRefer_t \times PassAuth_b) \\ &+ \beta_3(Post21_t \times PassAuth_b \times EEA_j) + \beta_4(Post21_t \times PassAuth_b) \\ &+ \alpha_{bj} + \alpha_{jt} + \varepsilon_{bjt}\end{aligned} \tag{6.3}$$

β_1 and β_3 show the additional percentage change in stocks of loans to and deposits from EEA by banks that lost passporting, in the two periods, relative to banks that did not have this authorisation and activities with non-EEA. β_2 and β_4 show the additional percentage change in lending to or deposit-taking from non-EEA by banks that lost passporting, after the referendum and after loss of passporting respectively, relative to banks that did not have passporting.

Table 1: UK banks' loans to and deposits from non-resident, non-financial sector - by passporting

	(1)	(2)
	ln(Loans)	ln(Deposits)
PostRefer×PassAuth	-0.245**	-0.169
	(0.102)	(0.108)
PostRefer×PassAuth×EEA	-0.116	-0.148
	(0.119)	(0.138)
Post21×PassAuth	-0.064	-0.043
	(0.098)	(0.112)
Post21×PassAuthr×EEA	-0.627***	-0.550**
	(0.132)	(0.213)
Fixed Effects:		
Bank-Country	Yes	Yes
Country-Time	Yes	Yes
Observations	200190	242396

Notes: Estimation uses BoE data to estimate Eq. 6.3, with log of loans to and deposits from non-financial sector in a partner country, by quarter, by UK bank, as dependent variables in columns (1) and (2) respectively.$PostRefer_t = 1$ from 2016Q3 onwards, $Post21_t = 1$ from 2021Q1 onwards, $EEA_j = 1$ if lending or deposit-taking is with an EEA country, $PassAuth_b = 1$ if bank can use passporting i.e. is incorporated in the UK or is a branch of an EEA bank. Bank-partner country and time-partner country fixed effects are included. Standard errors, clustered by bank, are in parentheses.$***$, $**$ and $*$ indicate significance at 1%, 5% and 10% respectively.

Table 1 shows that loans to as well as deposits from an EEA country by banks that could no longer use passporting had fallen by more than those by UK branches of non-EEA banks and stocks corresponding to non-EEA countries, relative to their 2016Q1 values, after passporting was lost in 2021Q1. This additional impact is statistically significant and implies a lower stock by 40-50%. As in the event study, there is a small decline in stocks of loans to non-EEA after the referendum for banks affected by regulatory barriers, relative to banks unaffected by changes in regulations.

Tables 12-17 in Appendix A.7 discusses robustness checks. Removing the years of Covid-19 and high inflation (i.e. 2020-2022) or adjusting for other changes in the banking sector,

like changes in ring-fencing regulations in 2018, does not affect our results. In our main specification, the interaction of time dummies with incorporation status allows us to see the impact of the loss of passporting on non-EEA activities. Using a more restricted set of fixed effects, by including bank-time fixed effects, does not change the magnitude of the effects, and the coefficients remain significant at the 5% significance level for loan and 10% significance level for deposits. Removing UK branches of EEA banks for our analysis, for which changes in regulations are more complex, also does not change our results substantially.

We also investigate two other dimensions that can explain the results. We estimate changes in number of countries that a bank provides services to, as with increase in trade costs, banks may withdraw from some EEA markets. Table 18 in Appendix A.7 shows that banks that lost passporting reduced the number of countries in operated in non-EEA„ thereby scaling down activities, with an additional reduction in number of countries in EEA that it provided loans to, after the referendum itself, relative to banks that did not have passporting. Lastly, banks report stocks by the currency of the loan or deposit (converted in pounds). We aggregate across currencies in our analysis, but there may be concerns that decline in activity of UK banks may be due to changes in exchange rates due to Brexit and the pound becoming less attractive. Table 19 shows that lending or deposit-taking in pounds for banks that lost passporting did not reduce compared to other currencies and relative to banks that did not have passporting authorisation.

Therefore, while in the paper so far we have broadly argued that changes in cross-border intermediation activities of UK banks were largely due to changes in barriers to cross-border banking, estimating the differential effects based on passporting authorisation of individual banks provides concrete evidence on this. The bank-level data therefore allows us to study dimensions that would not be possible on aggregate and/or publicly available data.

6.2.2 Exposure to EEA

Having focused on a specific barrier, we take a broader view, to account for other barriers that may have been imposed on cross-border banking to EEA due to Brexit. We continue with the analysis of changes after the referendum and the new trade arrangement coming into effect, with time fixed effects absorbing aggregate shocks. To analyse the impact further, and determine which banks drive the falling trends in export of intermediation service to EEA, we look at banks that had EEA as a major export destination pre-Referendum. We create a measure of the importance of the EEA market in exports of the individual banks as the average of the share of stocks corresponding to exports to EEA

in total export stocks, over the eight quarters in 2014 and 2015[56] for the non-financial sector ($PreEEAExp$). This measure is constructed separately for deposits and loans ($PreEEAExpL$ and $PreEEAExpD$ respectively).[57] Figure 17 in Appendix A.8 shows the stocks of loans and deposits corresponding to exports to EEA and non-EEA, for banks with below median (low) pre-referendum share of EEA in stocks and those with above median (high) shares, where median of $PreEEAExpL$ is 41.39% and of $PreEEAExpD$ is 41.99% (summary statistics for these average shares is in Table 20 in Appendix A.8).

To quantify these changes, we run the below regression:

$$\begin{aligned}\ln(stock_{bt}) =& \beta_1 \left(PostRefer_t \times PreEEAExp_b\right) + \beta_2 \left(Post21_t \times PreEEAExp_b\right) \\ &+ \alpha_b + \alpha_t + \varepsilon_{bt}\end{aligned} \tag{6.4}$$

where b = bank, t = quarter, $PostRefer_t = \mathbb{1}\{t \geqslant 2016Q3\}$, $Post21_t = \mathbb{1}\{t \geqslant 2021Q1\}$ and $PreEEAExp$ differs for loans and deposits, and is a continuous measure. We include time fixed effects to absorb trends in stocks that are common for all banks, and bank fixed effects to absorb time-invariant bank characteristics. Standard errors are clustered at the bank-level. This regression is run for loans and deposits separately, with the corresponding pre-referendum share of EEA in stock. The dependent variable takes the value of stocks corresponding to EEA, stocks corresponding to non-EEA and total stocks of activity with partner countries, for a bank b, at time t.

Table 2 shows the output for the regression on loans. Column 1 shows that banks with a higher share of EEA in stocks of loans in the pre-referendum period do not take more or less loans from the non-financial sector in any partner country either after the referendum or after the trade barriers come into effect. However, banks with a higher initial EEA share in stocks had relatively lower lending to the EEA after the referendum, and reduce it even further after the new trade barriers come into effect (Column 2). A one standard deviation higher exposure is associated with 30% lower lending to EEA after the referendum and a further reduction of 24% after 2021. We do not observe an export substitution for loans when banks have a higher share of EEA in stock of lending, as the coefficients in Column 3 are not significant. And while EEA activity declines, and non-EEA doesn't increase, total activity declines but this decline isn't significant.

For deposit-taking services services (as shown in Table 3), again banks with a higher

[56] We use this average rather than the first period of our data to include banks that get added to the dataset in the period before the referendum.

[57] We use separate exposure measures because, with separate thresholds for reporting lending and deposit-taking activities, some banks may report one or the other, and in combining them, we may lose banks.

Table 2: Banks' loans to EEA and non-EEA - share of EEA in stocks before Referendum

	(1)	(2)	(3)
	Aggregate		
ln(Loans)	(EEA + non-EEA)	EEA	non-EEA
PostRefer×PreEEAExpL	-0.004	-0.010**	0.003
	(0.003)	(0.004)	(0.003)
Post21×PreEEAExpL	-0.004	-0.008*	-0.000
	(0.005)	(0.004)	(0.004)
Fixed Effects:			
Bank	Yes	Yes	Yes
Time	Yes	Yes	Yes
Observations	6170	5813	5931

Notes: Estimation uses BoE data to estimate Eq. 6.4, with log of loans to non-financial sector in all partner countries, EEA and non-EEA, by quarter, by UK bank, as dependent variables in columns (1), (2) and (3) respectively. $PostRefer_t = 1$ from 2016Q3 onwards, $Post21_t = 1$ from 2021Q1 onwards, $PreEEAExpL$ is the share of stocks of loans to EEA in total stocks of loan to non-financial sector in partner countries, averaged over the eight quarters in 2014 and 2015. Bank and time fixed effects are included. Standard errors, clustered by bank, are in parentheses.$***$, $**$ and $*$ indicate significance at 1%, 5% and 10% respectively.

share of EEA in deposits stocks do not respond any differently in their total deposit-taking from the non-financial sector in partner countries. However, banks with higher share of EEA in stocks before the referendum have a lower stock of deposits from the EEA after the referendum and this effect is statistically significant (Column 2). There is no additional effect after 2021. Banks with higher share of EEA in stocks increase deposits taken from non-EEA after the referendum, the same period when they reduce their stocks for EEA (Column 3). Table 3 suggests that banks that provided more deposit-taking service to EEA before the referendum reduced their service to EEA and increased it to non-EEA after the referendum. One standard deviation increase in exposure to EEA in deposit-taking is associated with a 35% lower stocks of deposits from EEA. So, in the case of deposits, EEA activity declines and non-EEA increases, such that the two effects compensate each other and total activity doesn't change. Most of the effects are seen after the referendum, suggesting that more exposed banks were responding to the expectations that exporting would become more restrictive.

Therefore, we find that instead of incurring the costs of maintaining access to an important market, banks are moving away from it as they expect barriers to increase. Tables 21 and 22 in Appendix A.8 show the output for a similar regression when banks are categorised as having high and low share of EEA in stocks before the referendum, and our conclusions are similar. Dropping observations for the years 2020 and 2021, years of the Covid-19 pandemic, gives similar results. Using a balanced sample and adjusting for ring-fencing also gives similar results.

Table 3: Banks' deposits from EEA and non-EEA - share of EEA in stocks before Referendum

	(1)	(2)	(3)
	Aggregate		
ln(Deposits)	(EEA + non-EEA)	EEA	non-EEA
PostRefer×PreEEAExpD	-0.000	-0.010***	0.008***
	(0.002)	(0.003)	(0.003)
Post21×PreEEAExpD	0.001	-0.000	0.005
	(0.003)	(0.005)	(0.005)
Fixed Effects:			
Bank	Yes	Yes	Yes
Time	Yes	Yes	Yes
Observations	5832	5377	5620

Notes: Estimation uses BoE data to estimate Eq. 6.4, with log of deposits from non-financial sector in all partner countries, EEA and non-EEA, by quarter, by UK bank, as dependent variables in columns (1), (2) and (3) respectively. $PostRefer_t = 1$ from 2016Q3 onwards, $Post21_t = 1$ from 2021Q1 onwards, $PreEEAExpD$ is the share of stocks of deposits from EEA in total stocks of deposits from non-financial sector in partner countries, averaged over the eight quarters in 2014 and 2015. Bank and time fixed effects are included. Standard errors, clustered by bank, are in parentheses.***, ** and * indicate significance at 1%, 5% and 10% respectively.

Next, we investigate if there were implications for domestic activities of these banks as well. We combine the stocks corresponding to partner countries with loans to and deposits from the non-financial sector in the UK. We run the regression Equation 6.4 on total (domestic + cross-border) and domestic stocks (i.e. corresponding to UK-residents counterparties) to analyse if banks that have a higher share of EEA in stocks of exports reduce their overall lending and deposit-taking activity, i.e. shrink in their activity, or if they increase their domestic activity instead.[58]

Table 4 shows the output for the regression for loans. UK banks that had a higher share of EEA in its export stocks of loans have lower lending to UK's non-financial sector after the referendum and after the trade barriers come into effect, but these reductions are not statistically significant (Column 2). However, such banks have lower loans provided to all countries after the referendum (and a further fall due to changes in trade arrangement but this is statistically insignificant), as shown in Column 1. Therefore, banks more exposed to the EEA reduced lending to UK-residents as well as to the EEA (as seen in Column 2 of Table 2). For deposits (Table 5), banks that have a higher share of EEA in stocks of deposit do not take significantly less deposits from the non-financial sector in the UK (Column 2) either after the referendum or the new trade arrangement coming into effect.

[58]Here the exposure is the same as those in Tables 2 and 3, i.e. it is the share of EEA in stocks corresponding to exports. We do not add domestic stocks in the calculation of $PreEEAExpL$ and $PreEEAExpD$, as the data on domestic activity is more aggregated and had to be obtained through apportioning across sectors. We therefore keep the usage of the data to the minimal.

Table 4: Banks' loans to All countries and UK - share of EEA in stocks before Referendum

	(1)	(2)
ln(Loans)	Total	UK
PostRefer×PreEEAExpL	-0.009**	-0.004
	(0.005)	(0.005)
Post21×PreEEAExpL	-0.004	-0.003
	(0.003)	(0.003)
Fixed Effects:		
Bank	Yes	Yes
Time	Yes	Yes
Observations	6686	6601

Notes: Estimation uses BoE data to estimate Eq. 6.4, with log of loans to non-financial sector in all countries (including UK) and UK, by quarter, by UK bank, as dependent variables in columns (1) and (2)respectively. $PostRefer_t = 1$ from 2016Q3 onwards, $Post21_t = 1$ from 2021Q1 onwards, $PreEEAExpL$ is the share of stocks of loans to EEA in total stocks of loan to non-financial sector in partner countries, averaged over the eight quarters in 2014 and 2015. Bank and time fixed effects are included. Standard errors, clustered by bank, are in parentheses.$***$, $**$ and $*$ indicate significance at 1%, 5% and 10% respectively.

Table 5: Banks' deposits from All countries and UK - share of EEA in stocks before Referendum

	(1)	(2)
ln(Deposits)	Total	UK
PostRefer×PreEEAExpD	-0.003	-0.002
	(0.002)	(0.003)
Post21×PreEEAExpD	-0.001	-0.002
	(0.002)	(0.003)
Fixed Effects:		
Bank	Yes	Yes
Time	Yes	Yes
Observations	6685	6560

Notes: Estimation uses BoE data to estimate Eq. 6.4, with log of deposits from non-financial sector in all countries (including UK) and UK, by quarter, by UK bank, as dependent variables in columns (1) and (2) respectively. $PostRefer_t = 1$ from 2016Q3 onwards, $Post21_t = 1$ from 2021Q1 onwards, $PreEEAExpD$ is the share of stocks of deposits from EEA in total stocks of deposits from non-financial sector in partner countries, averaged over the eight quarters in 2014 and 2015. Bank and time fixed effects are included. Standard errors, clustered by bank, are in parentheses.$***$, $**$ and $*$ indicate significance at 1%, 5% and 10% respectively.

In total (including both activity with residents and non-residents), deposit-taking is lower for a UK-resident bank that took more of its deposits from the EEA before the referendum, but this is not statistically significant.

6.2.3 Impact on activities with other financial entities

Cross-border activities of banks include lending and deposit-taking with other banks (both within and outside the company group) and other financial institutions. While these have been largely excluded so far, to focus on export on intermediation services to the non-financial sector, activities with these other sectors of the economy are crucial for banks and international flows. In addition to being important in and of themselves, banks' activities with these other sectors are interconnected with activities with the non-financial sector, often used as substitutes to access markets.[59] The question is - do these activities respond differently to the cross-border activities with the non-financial sector, when there are barriers imposed on them. Figure 13 in Appendix A.6 shows the coefficients from the event study regression (Equation 6.1) for total stocks of loans given and deposits taken by UK banks to/from EEA, and the results are similar to the ones we observe for the non-financial sector only, suggesting that activities with other banks did not compensate for the fall in activities with the non-financial sector.

In this section, we focus on financial institutions excluding intragroup banks (which we will discuss in more detail in the next subsection). Using the regression specification in 6.3, we find in Column (1) of Table 6 that banks that could use passporting before Brexit did not change their lending activities with other banks in the EEA when compared to banks that did not access EEA markets via passporting. Moreover, deposits taken by such banks reduces substantially after Brexit, again in relative terms, as given in Column (2). Additionally, these banks reduce the loans given and deposits taken from other financial corporations in the EEA relative to the banks that could not access the EEA market freely.[60]

While regulations may differ between service provision to the non-financial sector and the financial sector, an episode like Brexit introduces frictions that affects all trade, even if to different degrees. As discussed earlier, deciphering details of all the barriers is difficult, but our results suggest that barriers to banking affect exports to not only the non-financial sector, but also to other financial institutions. Moreover, the impact of the barriers dominate any incentive to use these transactions as substitute to providing

[59] Kerl & Niepmann (2015) study the extent of the substitution between lending to firms and lending to the interbank market.

[60] When we look at the response of banks more exposed to EEA in their lending or deposit-taking with the non-financial sector when lending or taking deposits from other banks and financial corporations in Tables 23-26 in Appendix A.8, we do not find any significant impact of the increased exposure, suggesting that these banks did not use interbank channels to access the market that they were withdrawing from.

Table 6: Banks' loans to and deposits from non-resident banks (excluding intragroup) and other financial corporations - by passporting

	(1)	(2)	(3)	(4)
	Non-group Banks		Financial Corporations	
	ln(Loans)	ln(Deposits)	ln(Loans)	ln(Deposits)
PostRefer×PassAuth	-0.161	-0.174	-0.165	-0.187
	(0.145)	(0.136)	(0.195)	(0.173)
PostRefer×PassAuth×EEA	-0.171	0.085	0.023	-0.119
	(0.157)	(0.198)	(0.273)	(0.198)
Post21×PassAuth	-0.025	-0.121	-0.196	0.107
	(0.124)	(0.110)	(0.158)	(0.170)
Post21×PassAuth×EEA	-0.277	-0.518**	-0.748***	-0.798***
	(0.184)	(0.204)	(0.239)	(0.298)
Fixed Effects:				
Bank-Country	Yes	Yes	Yes	Yes
Country-Time	Yes	Yes	Yes	Yes
Observations	142676	100801	57065	82276

Notes: Estimation uses BoE data to estimate Eq. 6.3, with log of loans to and deposits from other banks and financial corporations in a partner country, by quarter, by UK bank, as dependent variables in columns (1)-(2) and (3)-(4) respectively.$PostRefer_t = 1$ from 2016Q3 onwards, $Post21_t = 1$ from 2021Q1 onwards, $EEA_j = 1$ if lending or deposit-taking is with an EEA country, $PassAuth_b = 1$ if bank can use passporting i.e. is incorporated in the UK or is a branch of an EEA bank. Bank-partner country and time-partner country fixed effects are included. Standard errors, clustered by bank, are in parentheses.$***$, $**$ and $*$ indicate significance at 1%, 5% and 10% respectively.

services to the non-financial sector.

6.3 Impact on intragroup activities

A large literature on multinationals propose that firms use local affiliates to circumvent trade barriers, when the gains from avoiding trade costs exceed the cost of maintaining presence in multiple markets.[61] Banks are no different. With the banking sector dominated by large multinational corporations, this channel can be used by banks to keep business within the group, when business can be retained by a particular subsidiary.

The new trade arrangement between the UK and the EU restricted UK-resident banks' abilities to provide services cross-border or through branches, increasing cost of providing services cross-border and of setting up affiliates in the form of branches. To access the EEA markets, the company-group of the UK-resident banks would have to increase their presence in the EEA. This expansion can be through establishing new entities (extensive margin) or increase capacity of existing affiliates (intensive margin). Additionally,

[61] See Helpman et al. (2004).

expansion of the group in another country may be through an increase in activity of UK banks with intragroup entities in the EEA. We investigate this by studying cross-border activity of UK banks with intragroup entities in the EEA, and the activity of intragroup entities in the EEA.

6.3.1 Stocks of Loans and Deposits

First, we study the stocks of loans to and deposits from intragroup entities of the UK banks in the EEA. Like other lending and deposit-taking activities, these are also subject to increased trade barriers. However, UK banks could use intragroup lending and deposit-taking to increase capacity of intragroup entities in the EEA to access the market directly. To examine which effect dominates, we investigate how banks that could provide services to EEA via passporting responded to changes in barriers compared to banks that they did not have such authorisation. Table 7 shows a large, negative and statistically significant impact on lending to EEA by banks that lost passporting authorisation relative to those that did not have the EEA-wide access. Deposits from EEA for these banks did not respond any differently than banks that always had barriers to cross-border banking.

Table 7: Banks' loans to and deposits from non-resident, intragroup banks - by passporting

	(1) ln(Loans)	(2) ln(Deposits)
PostRefer×PassAuth	-0.516***	-0.417**
	(0.186)	(0.172)
PostRefer×PassAuth×EEA	0.361	0.251
	(0.300)	(0.295)
Post21×PassAuth	0.208	-0.102
	(0.198)	(0.135)
Post21×PassAuth×EEA	-1.014***	-0.208
	(0.330)	(0.319)
Fixed Effects:		
Bank-Country	Yes	Yes
Country-Time	Yes	Yes
Observations	43121	49849

Notes: Estimation uses BoE data to estimate Eq. 6.3, with log of loans to and deposits from intragroup banks in a partner country, by quarter, by UK bank, as dependent variables in columns (1) and (2) respectively.$PostRefer_t = 1$ from 2016Q3 onwards, $Post21_t = 1$ from 2021Q1 onwards, $EEA_j = 1$ if lending or deposit-taking is with an EEA country, $PassAuth_b = 1$ if bank can use passporting i.e. is incorporated in the UK or is a branch of an EEA bank. Bank-partner country and time-partner country fixed effects are included. Standard errors, clustered by bank, are in parentheses.$***$, $**$ and $*$ indicate significance at 1%, 5% and 10% respectively.

Again, taking a broader view of barriers, we estimate Equation 6.4 in Table 8, using exposure to the non-financial sector in the EEA, and testing whether banks for which EEA was an important market to provide intermediation service to final borrowers and depositors increased their intragroup activity instead. Here too, we do not see evidence of banks using intragroup lending and deposit-taking as a substitute to access final customers directly, and are impacted by barriers to trade.

Table 8: Banks' loans to and deposits from EEA and non-EEA - share of EEA in stocks before Referendum

	(1)	(2)	(3)	(4)
	ln(Loans)	(PreEEAExpL)	ln(Deposits)	(PreEEAExpD)
	EEA	non-EEA	EEA	non-EEA
PostRefer×PreEEAExp	0.004	-0.012**	-0.004	0.004
	(0.006)	(0.006)	(0.005)	(0.004)
Post21×PreEEAExp	-0.001	-0.002	-0.001	-0.004
	(0.008)	(0.004)	(0.006)	(0.004)
Fixed Effects:				
Bank	Yes	Yes	Yes	Yes
Time	Yes	Yes	Yes	Yes
Observations	4271	5292	3724	4951

Notes: Estimation uses BoE data to estimate Eq. 6.4, with log of loans to and deposits from intragroup banks in EEA and non-EEA, by quarter, by UK bank, as dependent variables in columns (1), (2) and (3) respectively. $PostRefer_t = 1$ from 2016Q3 onwards, $Post21_t = 1$ from 2021Q1 onwards, $PreEEAExpL$ is the share of stocks of loans to EEA in total stocks of loans to non-financial sector in partner countries, averaged over the eight quarters in 2014 and 2015, $PreEEAExpD$ is the share of stocks of deposits from EEA in total stocks of deposits from non-financial sector in partner countries, averaged over the eight quarters in 2014 and 2015. Bank and time fixed effects are included. Standard errors, clustered by bank, are in parentheses.$***$, $**$ and $*$ indicate significance at 1%, 5% and 10% respectively.

6.3.2 Activities of other intragroup entities

So far, we have investigated how exports of banks in a country that has barriers imposed by a partner country, respond, and we have largely seen a decline in cross-border activities due to barriers. However, loss of activity of the UK bank doesnt not necessarily imply loss of business for the banking group, as banks may leverage their international organisation to continue to provide services to the restricted market. This raises a few questions. Is the loss due to barriers to banking sector of the country or to the banking groups, and should trade policy take this into account? Does the multinational structure imply that individual firms are more resilient than a sector of a country, or does the structure has its limitations in circumventing trade barriers in activities like banking?

To investigate this, we collect information from Historical Orbis on the structure of banks in the UK and the activities of other entities in the company-group. We obtain informa-

tion on all banks that share the same global ultimate owner (GUO) with the UK bank[62], which includes, the country of the intragroup entity, the incorporation date, the type of the intragroup entity (bank, financial corporation, insurance company etc), legal form (branch, private limited company) and some financial information. We restrict our study to the intragroup entities that are banks, in line with the focus on banking intermediation.

First, we look at the extensive margin, i.e. the number of intragroup entities established in a country, and determine if there was an expansion in the intragroup entities of UK banks that were subject to trade barriers. We again use the example of passporting.[63] Since multiple UK banks can have the same GUO, we assign incorporation status of UK banks to the GUO - if any of the UK banks linked to the GUO is incorporated in the UK or UK branch of EEA bank, then the company has at least one bank that suffered from loss of passporting, and thereby the GUO is assigned the status having passporting authorisation before 2021.

We run the following regression:

$$\begin{aligned}\ln(count_{\hat{b}jt}) =& \beta_1 \left(PostRefer_t \times PassAuth_{\hat{b}} \times EEA_j\right) + \beta_2 \left(PostRefer_t \times PassAuth_{\hat{b}}\right) \\ &+ \beta_3 \left(Post21_t \times PassAuth_{\hat{b}} \times EEA_j\right) + \beta_4 \left(Post21_t \times PassAuth_{\hat{b}}\right) \\ &+ \alpha_{\hat{b}t} + \alpha_{jt} + \varepsilon_{\hat{b}jt}\end{aligned} \tag{6.5}$$

where $\hat{b}$ = GUO, t = year and j = country in which intragroup entity is located, $PostRefer_t = \mathbb{1}\{t \geqslant 2017\}$, $Post21_t = \mathbb{1}\{t \geqslant 2021\}$ and $PassAuth_{\hat{b}} = 1$ if at least one UK bank under the GUO is incorporated or a branch of an EEA bank. $count_{\hat{b}jt}$ is the number of intragroup entities under the GUO $\hat{b}$ in country j in time t. We take the log of the count since number of entities would depend on the size of the country. We include GUO-time fixed effects to account for company-level trends over time and location-time fixed effects to account for evolutions in markets of a country.

Table 9 shows that relative to companies where all UK banking entities did not have passporting authorisation before Brexit, companies which had banks affected by passporting expanded their presence in the EEA countries after the referendum itself, in anticipation of future changes in ability of the UK entity to access EEA market. There were no further expansions after the barriers came into effect. This suggests that multinational banks restructured due to barriers.

[62]We use global utlimate owners that hold 50% or more of the banks, although the list doesnt differ much if we take owners with share of 25% or more in the bank.

[63]We cannot use the exposure measure created from the BoE data together with information from Historical Orbis due to data handling instructions.

Table 9: Number of intragroup entities - by passporting

	(1) ln(count)
PostRefer×PassAuth	-0.048
	(0.073)
PostRefer×PassAuth×EEA	0.204***
	(0.075)
Post21×PassAuth	0.004
	(0.038)
Post21×PassAuth×EEA	-0.000
	(0.046)
Fixed Effects:	
GUO-Country	Yes
Country-Year	Yes
Observations	16682

Notes: Estimation uses Historical Orbis data to estimate Eq. 6.5, with log of number of intragroup entities in a country, by quarter, by GUO, as dependent variables. $PostRefer_t = 1$ from 2017 onwards, $Post21_t = 1$ from 2021 onwards, $EEA_j = 1$ if intragroup entity is located in an EEA country, $PassAuth_{\hat{b}} = 1$ if GUO has atleast one bank that is incorporated in the UK or is a branch of an EEA bank. GUO-time and location-time fixed effects are included. Standard errors, clustered by GUO, are in parentheses.***, ** and * indicate significance at 1%, 5% and 10% respectively.

Lastly, we look at the intensive margin i.e. was there an increase in assets or employment of intragroup entities of UK banks, again using passporting. We note here that the financial information of entities is available for mainly the large entities. While not entirely representative, the sample would capture banks to which business from the UK could be transferred. We also adjust for this by finding, for an intragroup entity, the nearest entity in the ownership structure for which financial information is available and take the consolidated accounts of that entity. We run the following regression:

$$\begin{aligned}\ln(y_{\tilde{b}t}) =& \beta_1 \left(PostRefer_t \times PassAuth_{\hat{b}} \times EEA_j\right) + \beta_2 \left(PostRefer_t \times PassAuth_{\hat{b}}\right) \\ &+ \beta_3 \left(Post21_t \times PassAuth_{\hat{b}} \times EEA_j\right) + \beta_4 \left(Post21_t \times PassAuth_{\hat{b}}\right) \\ &+ \alpha_{\tilde{b}} + \alpha_{\hat{b}t} + \alpha_{jt} + \alpha_{\hat{b}j} + \varepsilon_{\tilde{b}t}\end{aligned} \tag{6.6}$$

where $\hat{b}$ = GUO, $\tilde{b}$ intragroup entity under GUO, t = year and j = country in which intragroup entity is located, $PostRefer_t = \mathbb{1}\{t \geqslant 2017\}$, $Post21_t = \mathbb{1}\{t \geqslant 2021\}$, $EEA_j = 1$ if entity is located in in a France, Germany, Ireland, Luxembourg or Netherlands (countries that have a large financial sector and were said to benefit most from relocation of banks from the UK) and $PassAuth_{\hat{b}} = 1$ if at least one UK bank under the GUO is incorporated or a branch of an EEA bank. $y_{\tilde{b}t}$ = total assets, loans to non-banking entities (domestic or cross-border) and deposits from non-banking entities (domestic or cross-border).[64] We include intragroup entity fixed effect[65] to account for time-invariant characteristics of the entity, GUO-time fixed effects to account for company-level trends over time, location-time fixed effects to account for evolutions in markets of a country and GUO-location fixed effects to obtain changes within a location of a company group.

Table 10 takes unconsolidated accounts of entities for which financial information is available. Relative to intragroup entities of UK banks that did not have passporting authorisation, we find that intragroup entities of UK banks that faced significant barriers, located in an EEA country, did not see a substantial increase in assets either after the referendum or after the new trade arrangement came into effect. We do not observe any significant increase in lending or deposit taking by these banks either.

Table 10: Assets, Loans and Deposits of intragroup entities - by passporting

	(1) ln(Assests)	(2) ln(Loans)	(3) ln(Deposits)
PostRefer × PassAuth × EEA	-0.110	-0.081	0.057
	(0.177)	(0.270)	(0.327)
Post21 × PassAuth × EEA	0.248	-0.515	0.077
	(0.186)	(0.417)	(0.250)
Fixed Effects:			
Affiliate	Yes	Yes	Yes
GUO-Year	Yes	Yes	Yes
Country-Year	Yes	Yes	Yes
GUO-Country	Yes	Yes	Yes
Observations	12708	11102	9932

Notes: Estimation uses Historical Orbis data to estimate Eq. 6.6, with log of unconsolidated assets, loans and deposits of intragroup entities in a country, by quarter as dependent variables. $PostRefer_t = 1$ from 2017 onwards, $Post21_t = 1$ from 2021 onwards, $EEA_j = 1$ if intragroup entity is located in a France, Germany, Ireland, Luxembourg or Netherlands, $PassAuth_{\hat{b}} = 1$ if GUO has atleast one bank that is incorporated in the UK or is a branch of an EEA bank. Intragroup entity, GUO-time, location-time and GUO-location fixed effects are included. Standard errors, clustered by intragroup entity, are in parentheses.$***$, $**$ and $*$ indicate significance at 1%, 5% and 10% respectively.

[64] These loans and deposits exclude repos.

[65] Results do not change if we use entity-guo-location fixed effects instead.

Table 11 takes the consolidated accounts to account for missing accounts of entities, particularly branches. We continue to find no evidence of multinational banks successfully using their international organisation to retain markets.

Table 11: Assets, Loans and Deposits of intragroup entities (consolidated accounts) - by passporting

	(1) ln(Assests)	(2) ln(Loans)	(3) ln(Deposits)
PostRefer × PassAuth × EEA	-0.743*	1.362	-0.185
	(0.430)	(1.149)	(0.497)
Post21 × PassAuth × EEA	-0.543	-1.103	-0.513
	(0.340)	(0.789)	(0.363)
Fixed Effects:			
Affiliate	Yes	Yes	Yes
GUO-Year	Yes	Yes	Yes
Country-Year	Yes	Yes	Yes
GUO-Country	Yes	Yes	Yes
Observations	7175	5894	5118

Notes: Estimation uses Historical Orbis data to estimate Eq. 6.6, with log of unconsolidated assets, loans and deposits of intragroup entities in a country, by quarter as dependent variables. Columns (3) and (4) include consolidated accounts of nearest owner for which financial accounts are available, to account for missing financial information for some entities. $PostRefer_t = 1$ from 2017 onwards, $Post21_t = 1$ from 2021 onwards, $EEA_j = 1$ if intragroup entity is located in a France, Germany, Ireland, Luxembourg or Netherlands, $PassAuth_{\hat{b}} = 1$ if GUO has atleast one bank that is incorporated in the UK or is a branch of an EEA bank. Intragroup entity, GUO-time, location-time and GUO-location fixed effects are included. Standard errors, clustered by intragroup entity, are in parentheses.$***$, $**$ and $*$ indicate significance at 1%, 5% and 10% respectively.

Overall, we see that there is some expansion in capacity of intragroup entities in the EEA, through increased trade with UK banks, increase in the number of entities and employment, but we do not observe an increase in intragroup lending or deposit-taking, or an increase in assets of entities in the EEA. This suggests that while banks made some changes to their structure in response to barriers to trade from the UK establishment, or even its anticipation, there has not being any substantial increase in banking activities of these banks in the EEA. We dont find substantial evidence of banks capturing markets through their EEA entities, raising questions about the possibilities of circumventing barriers through affiliates and the ease with which the network and efficiency of the banking sector of a country can be substituted with the banking sector of another country or set of countries.

7 Conclusion

This paper studies the impact of barriers on trade in services by focusing on the banking sector, a key service sector. It discusses the kind of regulatory barriers services like banking can be subject to, and how these barriers affect different activities of banks. We find that trade barriers reduce lending and deposit-taking to country for which barriers increase, and these effects can be substantial. UK's activity with EEA reduced, relative to global trends, with the loss of the EEA-wide passporting authorisation reducing lending and deposit-taking of UK banks with EEA by 40-50%. relative to banks that did not have such authorisation. Banks more exposed to EEA had larger reductions in activity with EEA –one standard deviation increase in exposure is associated with 30% lower stocks for EEA. Our theoretical framework suggests that the effects of trade barriers on activities with other countries can be ambiguous, and we find no or small substitution in deposit-taking, none in lending. Additionally, cross-border barriers restrict the use of other adjustment mechanisms like interbank and intragroup lending/deposit-taking – lending and deposit-taking with other financial institutions and intragroup entities in EEA both fell.

The literature on multinationals have shown that companies can use their international organisation to adapt to an increase in barriers imposed on a country, and we test this for UK banks. While companies did expand the number of affiliates in the EEA, we find no evidence of increase in the banking activity of these entities. Therefore, while the UK banking sector reduced cross-border activity with a major trading partner, we do not observe global banks making up for the losses. This suggests that substituting a country which is efficient in a sector through affiliates is difficult and that country-specific sectoral characteristics matter.

This paper provides a first step in the analysis of the impact of regulatory barriers on banking services. While the complexity of banking systems makes quantification of barriers by individual countries complicated, this remains an avenue for future research. It would also provide scope for a more precise estimation of impact on the sector. Additionally, a general equilibrium framework will allow study of impact on the UK as well as EEA banking sector.

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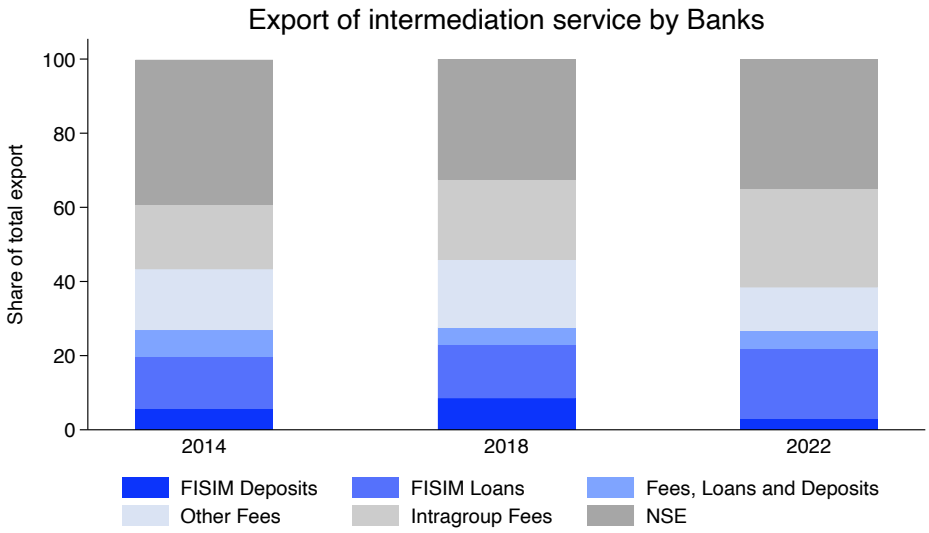
Appendix

A.1 Exports of services by monetary financial institutions

Exports of monetary financial institutions, as in the Balance of Payments, comprises revenue generated in the form of FISIM on loans and deposits, fees and commission charged on services provided (like loans and advances, current account services, management of portfolio of securities etc.), intragroup fees and cost recharges and net spread earnings (income from dealing activities, i.e. difference between price paid by the bank and price in the open market, reported only on aggregate but apportioned to partner countries using the split from fees and commissions). Figure 5 shows the share of each component. We calculate the share of fees from lending and deposit-taking activity in total fees and commissions earned from non-residents, across banks in the Bank of England data, and use this share to obtain the part of fees and commission that can be attributed to intermediation services. Overall, we find that 25-30% of the exports of monetary financial institutions are from lending and deposit-taking activities.

Figure 5: Components of services exports by monetary financial institutions



Source: Authors' calculation using UK Balance of Payments 2024.

A.2 Impact of trade barriers: Details

A.2.1 Increase in cost of providing loans to E

The effect of increased cost on the shadow value of deposit is:

$$\frac{d\lambda}{d\tau_{BE}} = -\frac{\sigma\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}\alpha_{LE}\left(\lambda+\frac{\tau_{BE}}{a_b}\right)^{-\sigma-1}\frac{1}{a_b}}{\left[\begin{array}{c}\sigma\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}\left[\alpha_{LB}\left(\lambda+\frac{1}{a_b}\right)^{-\sigma-1}+\alpha_{LE}\left(\lambda+\frac{\tau_{BE}}{a_b}\right)^{-\sigma-1}+\alpha_{LR}\left(\lambda+\frac{\tau_{BR}}{a_b}\right)^{-\sigma-1}\right] \\ +\theta\left(\frac{\theta}{\theta+1}\right)^{\theta}\left[\alpha_{DB}\left(\lambda-\frac{1}{a_b}\right)^{\theta-1}+\alpha_{DE}\left(\lambda-\frac{t_{BE}}{a_b}\right)^{\theta-1}+\alpha_{DR}\left(\lambda-\frac{t_{BR}}{a_b}\right)^{\theta-1}\right]\end{array}\right]} < 0$$

Therefore, the change in interest on loans to E due to increase in trade cost is:

$$\frac{dr_{LbE}}{d\tau_{BE}} = \frac{\sigma}{\sigma-1}\left(\frac{d\lambda}{d\tau_{BE}}+\frac{1}{a_b}\right)$$

$$= \frac{\sigma}{\sigma-1}\frac{1}{a_b}\left[-\frac{\sigma\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}\alpha_{LE}\left(\lambda+\frac{\tau_{BE}}{a_b}\right)^{-\sigma-1}}{\left[\begin{array}{c}\sigma\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}\left[\alpha_{LB}\left(\lambda+\frac{1}{a_b}\right)^{-\sigma-1}+\alpha_{LE}\left(\lambda+\frac{\tau_{BE}}{a_b}\right)^{-\sigma-1}+\alpha_{LR}\left(\lambda+\frac{\tau_{BR}}{a_b}\right)^{-\sigma-1}\right] \\ +\theta\left(\frac{\theta}{\theta+1}\right)^{\theta}\left[\alpha_{DB}\left(\lambda-\frac{1}{a_b}\right)^{\theta-1}+\alpha_{DE}\left(\lambda-\frac{t_{BE}}{a_b}\right)^{\theta-1}+\alpha_{DR}\left(\lambda-\frac{t_{BR}}{a_b}\right)^{\theta-1}\right]\end{array}\right]}+1\right]$$

$$> 0$$

This reduces lending to E:

$$\frac{dl_{bE}}{d\tau_{BE}} = -\sigma\alpha_{LE}r_{LbE}^{-\sigma-1}\frac{dr_{LbE}}{d\tau_{BE}} < 0 \qquad \left(since\ \frac{dr_{LbE}}{d\tau_{BE}} > 0\right)$$

The impact of interest and loans to other countries is:

$$\frac{dr_{Lbi}}{d\tau_{BE}} = \frac{\sigma}{\sigma-1}\frac{d\lambda}{d\tau_{BE}} < 0; \quad \frac{dl_{bi}}{d\tau_{BE}} = -\sigma\alpha_{Li}r_{Lbi}^{-\sigma-1}\frac{dr_{Lbi}}{d\tau_{BE}} > 0 \quad \forall\ i \in \{B,R\}$$

$$\frac{dr_{Dbi}}{d\tau_{BE}} = \frac{\theta}{\theta+1}\frac{d\lambda}{d\tau_{BE}} < 0; \quad \frac{ds_{bi}}{d\tau_{BE}} = \theta\alpha_{Di}r_{Dbi}^{\theta-1}\frac{dr_{Dbi}}{d\tau_{BE}} < 0 \quad \forall\ i \in \{B,E,R\}$$

A.2.2 Increase in cost of taking deposits from E

The effect of increased cost on the shadow value of deposit is:

$$\begin{aligned}\frac{d\lambda}{dt_{BE}} &= \frac{\theta\left(\frac{\theta}{\theta+1}\right)^{\theta}\alpha_{DE}\left(\lambda-\frac{t_{BE}}{a_b}\right)^{\theta-1}\frac{1}{a_b}}{\left[\begin{array}{c}\sigma\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}\left[\alpha_{LB}\left(\lambda+\frac{1}{a_b}\right)^{-\sigma-1}+\alpha_{LE}\left(\lambda+\frac{\tau_{BE}}{a_b}\right)^{-\sigma-1}+\alpha_{LR}\left(\lambda+\frac{\tau_{BR}}{a_b}\right)^{-\sigma-1}\right]\\ +\theta\left(\frac{\theta}{\theta+1}\right)^{\theta}\left[\alpha_{DB}\left(\lambda-\frac{1}{a_b}\right)^{\theta-1}+\alpha_{DE}\left(\lambda-\frac{t_{BE}}{a_b}\right)^{\theta-1}+\alpha_{DR}\left(\lambda-\frac{t_{BR}}{a_b}\right)^{\theta-1}\right]\end{array}\right]}\\ &> 0\end{aligned}$$

Therefore, the change in interest on deposits from E due to increase in trade cost is:

$$\begin{aligned}\frac{dr_{DbE}}{dt_{BE}} &= \frac{\theta}{\theta+1}\left(\frac{d\lambda}{dt_{BE}}-\frac{1}{a_b}\right)\\ &= \frac{\theta}{\theta+1}\frac{1}{a_b}\left[\frac{\theta\left(\frac{\theta}{\theta+1}\right)^{\theta}\alpha_{DE}\left(\lambda-\frac{t_{BE}}{a_b}\right)^{\theta-1}}{\left[\begin{array}{c}\sigma\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}\left[\alpha_{LB}\left(\lambda+\frac{1}{a_b}\right)^{-\sigma-1}+\alpha_{LE}\left(\lambda+\frac{\tau_{BE}}{a_b}\right)^{-\sigma-1}+\alpha_{LR}\left(\lambda+\frac{\tau_{BR}}{a_b}\right)^{-\sigma-1}\right]\\ +\theta\left(\frac{\theta}{\theta+1}\right)^{\theta}\left[\alpha_{DB}\left(\lambda-\frac{1}{a_b}\right)^{\theta-1}+\alpha_{DE}\left(\lambda-\frac{t_{BE}}{a_b}\right)^{\theta-1}+\alpha_{DR}\left(\lambda-\frac{t_{BR}}{a_b}\right)^{\theta-1}\right]\end{array}\right]}-1\right]\\ &< 0\end{aligned}$$

This reduces deposits from E:

$$\frac{ds_{bE}}{dt_{BE}} = \theta\alpha_{DE}r_{DbE}^{\theta-1}\frac{dr_{DbB}}{dt_{BE}} < 0 \qquad \left(since\ \frac{dr_{DbB}}{dt_{BE}} < 0\right)$$

The impact of interest and loans to other countries is:

$$\frac{dr_{Dbi}}{dt_{BE}} = \frac{\theta}{\theta+1}\frac{d\lambda}{dt_{BE}} > 0; \quad \frac{ds_{bi}}{dt_{BE}} = \theta\alpha_{Di}r_{Dbi}^{\theta-1}\frac{dr_{Dbi}}{dt_{BE}} > 0 \quad \forall\ i \in \{B, R\}$$

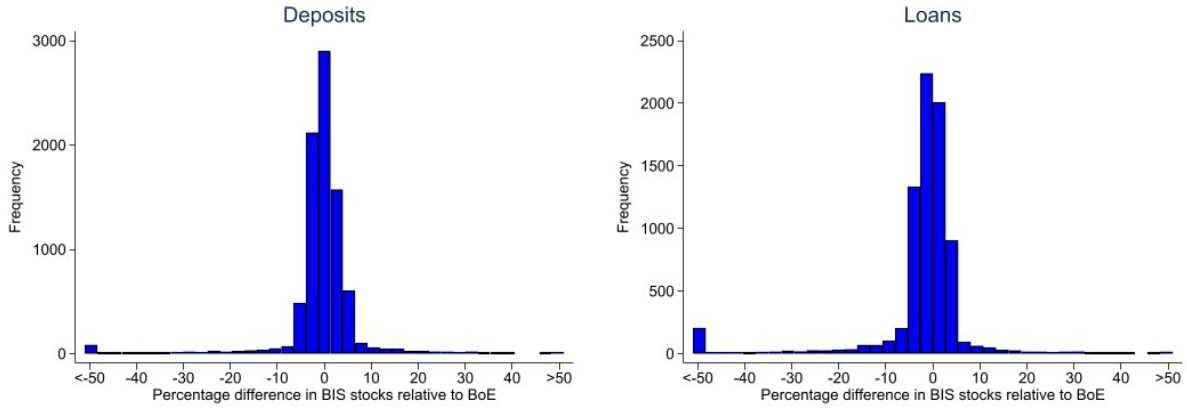
$$\frac{dr_{Lbi}}{dt_{BE}} = \frac{\sigma}{\sigma-1}\frac{d\lambda}{dt_{BE}} > 0; \quad \frac{dl_{bi}}{dt_{BE}} = -\sigma\alpha_{Li}r_{Lbi}^{-\sigma-1}\frac{dr_{Lbi}}{dt_{BE}} < 0 \quad \forall\ i \in \{B, E, R\}$$

A.3 Coverage of BoE bank-level data

We compare the values of stocks in the BoE data, aggregated to the level of partner country and quarter, with equivalently aggregated data of the BIS-LBS for the UK, to learn about the coverage of the BoE data. The BoE data is reported in pounds, irrespective of the currency in which the transaction had taken place[66], while BIS-LBS is reported in dollars. While we convert the BoE data to dollars, the stocks in the datasets may differ due to the difference in exchange rate being used. For loans 82% of the observations across the two datasets differ by atmost ± 5%, and about 90% of the observations differ by atmost ± 10%. The match is better for deposits. Figure 6 shows the frequency of difference in stocks, compared across the two datasets, by observation (i.e. at partner country and quarter level) for the UK i.e.

$$Percentage\ difference\ in\ stock\ = \frac{BoE\_stock - BISLBS\_stock}{BoE\_stock} \times 100$$

Figure 6: Comparing BoE and BIS-LBS stocks for UK



Source: Authors' calculation using BIS-LBS and BoE data.

Note that most components of stocks are common between the BoE and the BIS-LBS data (loans and advances, finance leases, repurchase agreements etc.), there are some (like bills) that are not common. However, this does not lead to substantial over- or under-reporting of stocks in one dataset relative to the other.

BIS-LBS also contains information for non-bank counterparty sector. Since FISIM, which is the main component of export value of these services, does not include deposits from and loans to financial intermediaries including banks, we conduct our analysis for non-banks as well.[67] We compare the BIS-LBS data, aggregated to the level of partner country

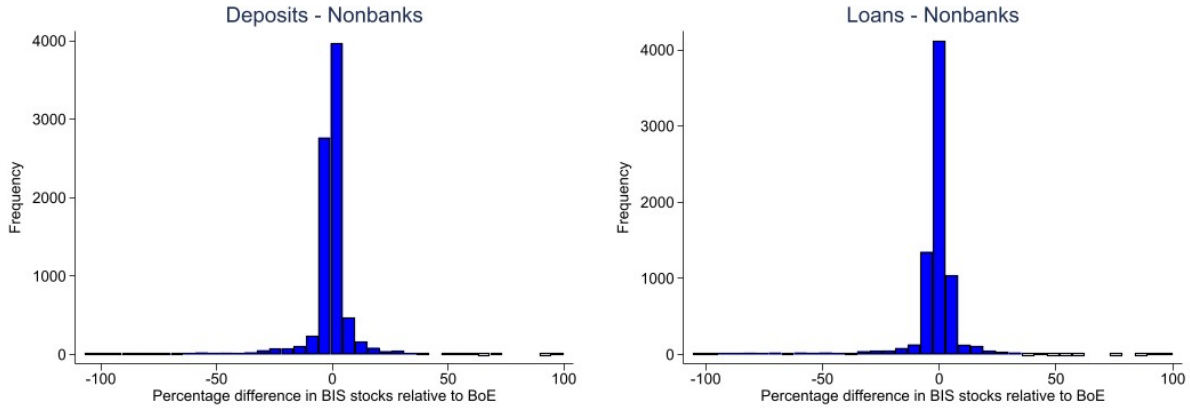
[66]Outstanding liabilities and assets in currencies other than sterling should be converted into sterling at the middle market spot rate pertaining in the London market at 4pm London time on the last working day of the London market in the period covered by the report, as stated in the General Notes and Definitions for reporting.

[67]Breakdown of stocks by partner country is not available in BIS-LBS for other counterparty sectors

and quarter, with stocks constructed for Non-banks in the BoE data (where non-banks include households, non-financial corporations, general government and other financial corporations).

For loans, 70% of the observations across the two datasets differ by atmost ± 5%, and about 75% of the observations differ by atmost ± 10%. The match is better for deposits. Figure 7 shows the frequency of difference in stocks, compared across the two datasets, by observation (i.e. at partner country and quarter level) for the UK (measure same as above).

Figure 7: Comparing BoE and BIS-LBS stocks corresponding to Non-banks for UK



Source: Authors' calculation using BIS-LBS and BoE data.

We note that the stocks of loans and deposits obtained from BIS-LBS and the BoE data includes repurchase agreements, but the stocks used by the ONS to calculate FISIM does not. We include repurchase agreements in the stocks for our analysis for three reasons. First, repurchase agreements may have a FISIM components and the reason for ONS to remove it is to maintain consistency is FISIM calculation over time. Stocks by counterparty entity was not available previously, and since repurchase agreements are largely used for transaction between financial intermediaries, removing repurchase agreements from the stocks was a way to remove stocks corresponding to the financial intermediaries. With more granular data available by counterparty entity now, elimination of repurchase agreement for this purpose is not needed. Second, stocks for repurchase agreements are not reported separately for each partner country. To remove them for our analysis, we will have to assume a distribution of repurchase agreements across countries, and this imputation may compromise the data. Third, our aim is not to reconstruct FISIM but to understand how service provision changed with trade barriers.

Additionally, the stocks of loans from the BoE data that we use includes bills, which does

when UK is the reporting country, so this is the closest we can get to our analysis of the non-financial sector.

not generate FISIM. We are unable to remove bills from the stocks because these are not reported separately by the banks for each partner country and sector. However, bills would only constitute a small component of of the stocks for the non-financial sector.

A.4 Export by UK-resident banks

FISIM as well as some components of fees and commission capture charges from deposit-taking and lending. However, since the interest received for loans and interest paid for deposits are not reported for partner country, FISIM is calculated on aggregate and then apportioned to different partner countries using stocks of loans and deposits.[68] Moreover, banks do not report fees and commissions and intragroup fees by component for each partner country, but provide a breakdown of the components on aggregate. Appendix A.5 discusses the share of income from intermediation service in total fees and commission. Nevertheless, we use the sum of FISIM and fees and commission as proxies for export of banking service.

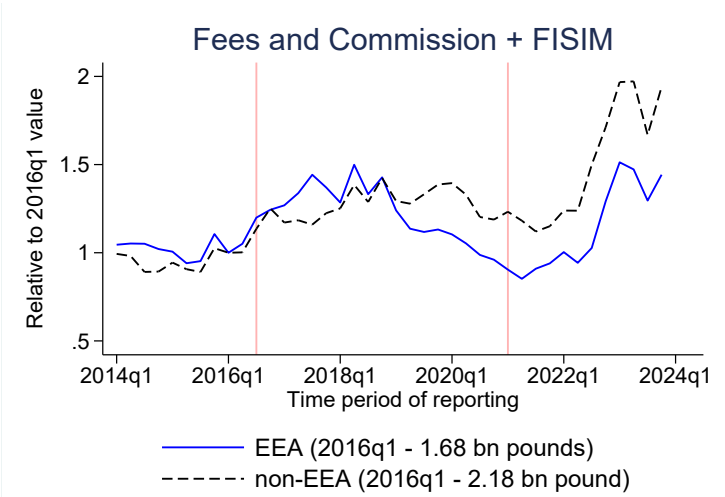
Figure 8 shows how our proxy of exports (sum of Fees and Commissions and FISIM) evolves over time, towards EEA and non-EEA partner countries. The figure suggests no visible impact of the referendum (2016Q3) nor the new trade arrangement (2021Q1) on the differential trends in UK exports to the two country groups. This suggests that the uncertainty after the referendum or the new trade relationship with the EEA, that introduced more trade barriers, has had no effect on exports by UK-resident banks to EEA compared to non-EEA partner countries. The large increase in exports after 2022 is driven by an increase in FISIM, which in turn is due to an increase in interest rates.[69]

However, these trends require further explanation before concluding that barriers had no effect. For this we split our proxy of export of banking services into Fees and Commission and FISIM in Figure 9. While initially export, as measured by fees and commission, for the EEA and non-EEA follow the same trend, they diverge in the period between the referendum (2016Q3) and the new trade relation between the UK and EU (2021Q1). Exports to non-resident non-intragroup entities, are falling for both EEA and non-EEA but the fall is larger for EEA. On the other hand, export measured by FISIM, are nearly equal for EEA and non-EEA in our reference period of 2016Q1 and the changes over time for these two country groups are nearly equal. This is largely driven by the mathematical formula for calculating FISIM (which multiplies difference between interest payable/receivable and the reference rate with total stocks) and the apportioning (which uses country-level

[68] This is consistent with the methodology used for official statistics of the UK for FISIM.

[69] Interest rates increased as monetary policy responded to high inflation over the period. That led to an increase in the reference rate but as there is an imperfect pass-through from the reference to the actual loan and deposit rates this led to a temporary increase in FISIM.

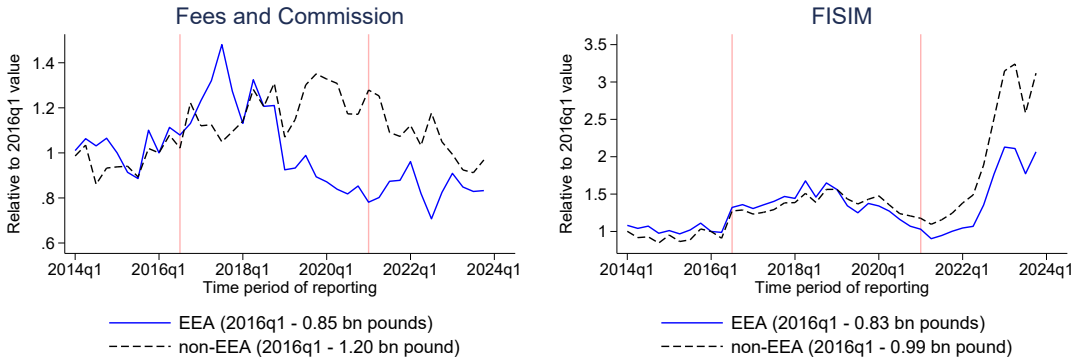
Figure 8: Exports by UK banks (FISIM + Fees and Commissions)



Source: Authors' calculation using BoE data.
Note: The first vertical line denotes the referendum (2016Q3) and the second the new trade arrangement between UK and EU coming into effect (2021Q1).

stocks).[70] The gap between the trends for EEA and non-EEA after normalisation to 2016Q1 reflects the evolution of stocks of deposits and loans. The widening of the gap after 2021Q1 indicates a large divergence in changes in stocks of activity with EEA compared to non-EEA. It is this divergence that we study in detail to understand the impact on cross-border activity of banks.

Figure 9: Exports by UK-resident banks - Fees and Commission, FISIM



Source: Authors' calculation using BoE data.
Note: The first vertical line denotes the referendum (2016Q3) and the second the new trade arrangement between UK and EU coming into effect (2021Q1).

[70]Note that the FISIM calculation here excludes repo in loans and deposits to be consistent with aggregate trade statistics of the UK.

A.5 Explicit charges for deposit-taking and lending services to non-residents

A.5.1 Fees and Commission

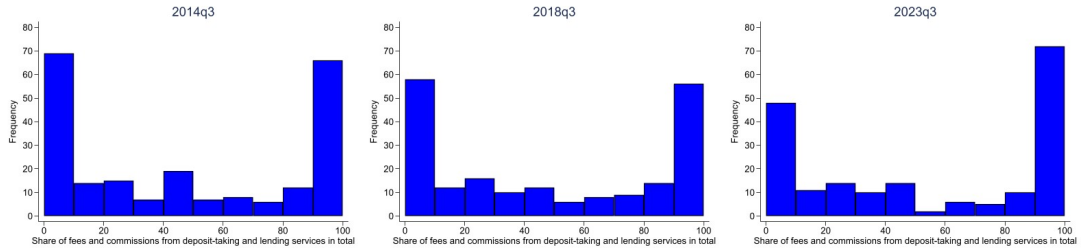
Fees and commissions constitute a substantial share of the total value of exports of UK's banking sector. This includes income from arrangement of loans and advances, current account services, management of portfolio of securities and other financial and non-financial services. Although banks report fees and commission for partner country, they do not report what part of this income is received for each of the different services provided, for partner country. However, the banks separately report fees and commissions received from non-resident entities, by service provided:

1. Investment management and securities
2. Loans, advances, commitment and utilisation services - This includes reservation fees, early redemption fees, switching fees or any ongoing servicing fees, as well as participation or front-end fees and underwriting, commitment, facility and utilisation fees for euronote facilities[71]
3. Derivatives instruments provided to non-residents
4. Current account services
5. Other financial services - For e.g. fees receivable for guarantees payable under break clauses, fees for administering loans on behalf of other lenders
6. Non-financial services - For e.g. e.g. executor and trustee services, computer bureau services

Figure 10 shows the number of firms by share of fees and commissions from providing deposit-taking and lending services (2+4 above) in total fees and commissions received from non-resident entities. The figure shows three periods - before the referendum (2014q3), after the referendum but before UK's exit from the EU (2018q3) and after the new trade arrangement between UK and EU comes into effect (2023q3). There are a total of 365, 367 and 334 banks in the three periods, respectively, in our dataset. For all three periods, for most UK banks, fees and commissions explicitly charged for deposit-taking and lending services account for either none or all of the fees and commissions. There is no substantial difference in the distribution of firms across the shares over time, after taking into account changes in number of banks. Therefore, are results are not driven by a few banks exporting service.

[71] These are facilities were a syndicate of banks underwrites the issuance of a short-term negotiable notes, providing them with access to funds

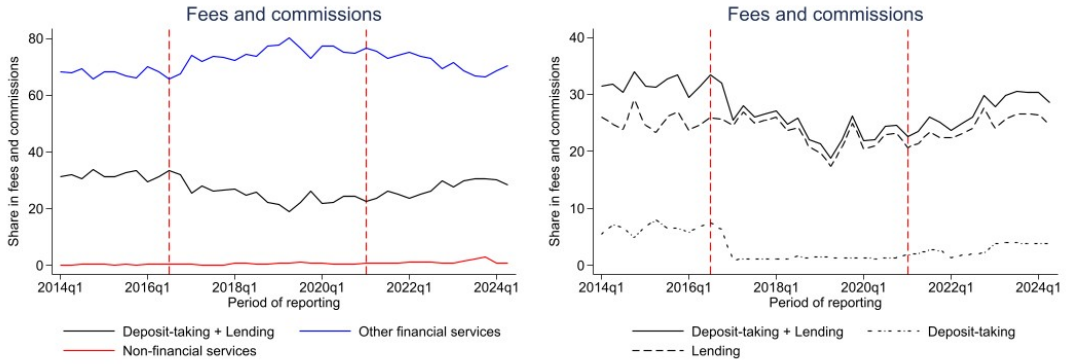
Figure 10: Number of banks by share of fees and commissions from deposit-taking and lending exports



Source: Authors' calculation using BoE data.

Figure 11 shows the share of the different components of fees and commissions, aggregated across UK-banks, over time. Here, other financial services includes 1,3 and 5 above. The shares of the different services exported by UK-resident banks in total export value remains constant over time. Share of fees and commissions from exporting deposit-taking and lending services is 27% on average over the period of analysis. Nearly all of the fees and commissions from intermediation services is from lending services. A caveat here is that fees and commission from deposit-taking and lending services can be charged to other banks and financial intermediaries, and even to intragroup banks (when they can separate these charges from other charges). However, our measure of export should ideally exclude charges from deposit-taking and lending to these entities as they may not have a service component. Due to data limitations, we are unable to separate fees and commissions by sector. Additionally, an argument can be made that since deposit-taking and lending to banks and financial intermediaries does not have a service component, explicit charges on them would be small.

Figure 11: Share of components of fees and commissions



Source: Authors' calculation using BoE data.
Note: The first vertical line denotes the referendum (2016Q3) and the second the new trade arrangement between UK and EU coming into effect (2021Q1).

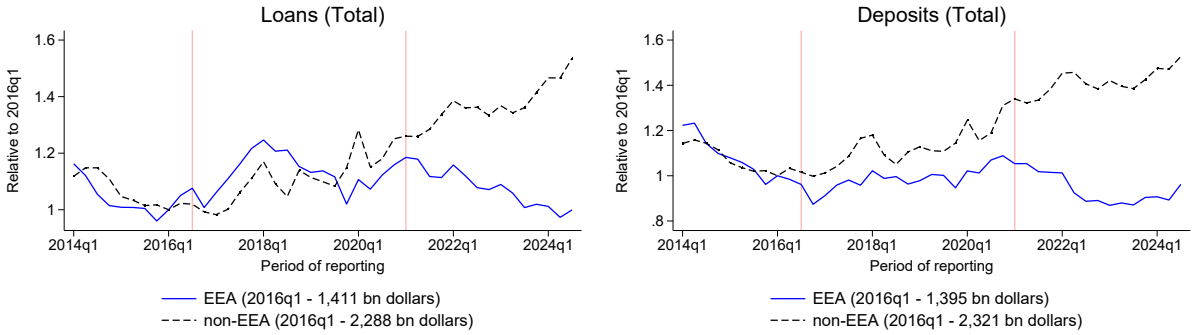
A.5.2 Reporting of explicit charges

We note that not all UK-resident banks report these explicit charges for each partner country. Moreover, some banks report this information quarterly, while other report annually. To measure export of all UK-resident banks by partner country, data for non-reporters are imputed, and this may be used in the aggregate data of UK exports. Our analysis uses only reported values. To measure export quarterly, we allocate annually reported values to each quarter equally. We do not include any imputed values in our analysis, but are results hold when we include them.

A.6 Stocks of Cross-border Loans and Deposits of UK banks

The analysis in Section 6.1 looks at loans and deposits corresponding to non-banks. To provide an overview of how these variables evolve across all entities that banks servce, we look at changes in aggregate stocks of deposits taken and loans provided by UK-resident banks, from/to EEA and non-EEA countries, over time due to changes in UK-EU trade relations, using the BIS-LBS data. Figure 12 shows the stocks corresponding to the lending and deposit-taking services exported by the UK, relative to their 2016Q1 value (Figure 14 using the BoE data). The graphs show that the trend in stocks for EEA and non-EEA were similar initially, however, loans provided to EEA decreased while that to non-EEA increased a few periods after the referendum Additionally, the rise is stocks of deposits is faster for non-EAA than EEA after the referendum (2016Q3). The stock of deposits falls with the new trade barriers (2021Q1).

Figure 12: Stocks of loans provided and deposits taken by UK (BIS-LBS)

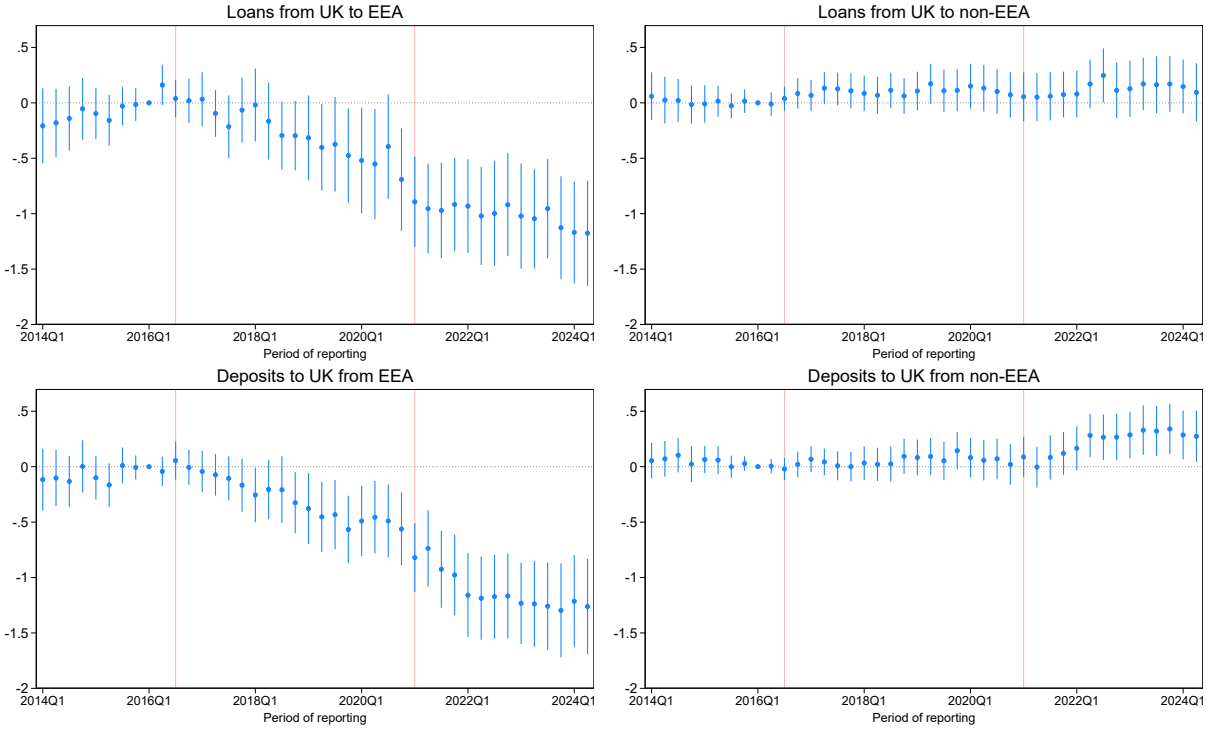


Source: Authors' calculation using BIS-LBS.
Note: The first vertical line denotes the referendum (2016Q3) and the second the new trade arrangement between UK and EU coming into effect (2021Q1).

Figure 13 shows the coefficients β_1^k and β_2^k for the event-study regression (Equation 6.1) on total loans to and deposits from all counterparty entities. We see a relative fall in stocks of loans UK resident banks provide to an EEA country, starting a few periods before the new trade arrangement is implemented. There are small increases in lending to a non-EEA country by UK-resident banks compared to other exporting countries,

however, these increases are not consistently significant. The stock of deposits of UK resident banks taken from an average EEA country falls after the referendum, relative to 2016Q2 and controlling for other exporters' trends. Interestingly, there is also a significant relative increase in deposits that UK resident banks take from a non-EEA country after 2021Q1, but the increase in small in magnitude.

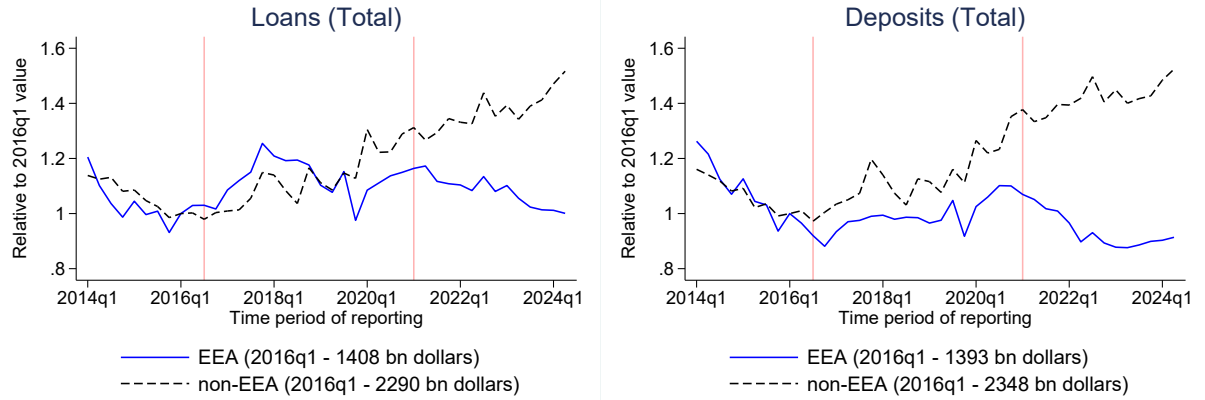
Figure 13: Event Study - Loans to and Deposits from All Entities (BIS-LBS)



Notes: Estimation uses BIS-LBS data to estimate Eq. 6.1, with log of loans to and deposits from all sectors, by country exporting service (i.e. lender or deposit-taker), country importing service (i.e. borrower or depositor) and quarter, as dependent variables in top two and bottom two graphs respectively. Red line at 2016Q3 indicates first quarter after Referendum and at 2021Q1 indicates first quarter after new trade arrangement came into effect. Country-pair and importer-time fixed effects are included. Blue dots are the coefficients and the bars are the 95% confidence intervals, with standard errors, clustered by country-pair.

Figure 14 shows the stocks of deposits from and loans to non-residents by UK banks, aggregated from bank-level BoE data. Banks report these values in pounds and we convert them to dollars, to compare with BIS-LBS and to take changes in exchange rate into account. The trends in this figure is similar to the trends in Figure 12, which also speaks to the coverage of the BoE data.

Figure 14: Stocks of Loans to and Deposits from non-residents (BoE)



Source: Authors' calculation using BIS-LBS.
Note: The first vertical line denotes the referendum (2016Q3) and the second the new trade arrangement between UK and EU coming into effect (2021Q1).

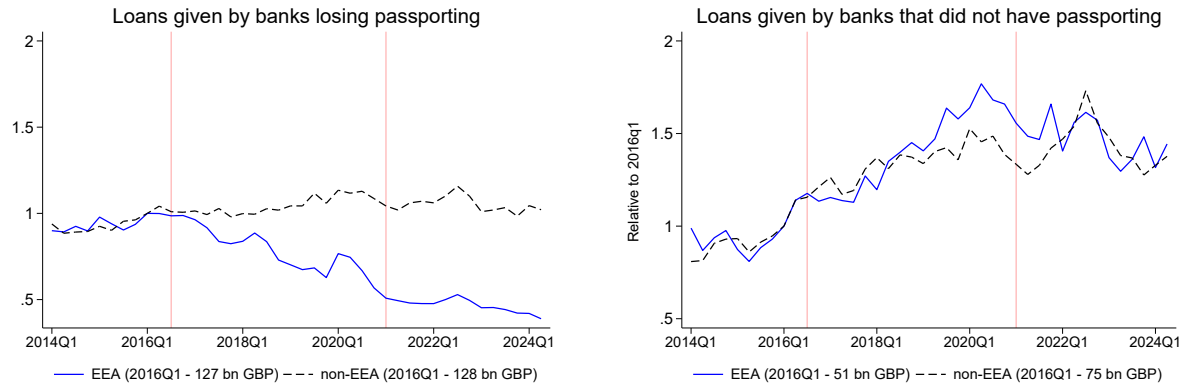
A.7 Impact of Passporting: Robustness

A.7.1 Stocks of loans and deposits based on passporting authorisation

Figure 15 shows the trend in stocks of loans to EEA and non-EEA by banks that lost passporting (left) i.e. banks incorporated in the UK and UK branches of EEA banks, and banks that did not have passporting when UK was a member of EU (right) i.e. UK branches of non-EEA banks. We see that a larger share of stocks of loans in the UK banking sector is held by banks that were passporting before the new trade arrangement came into effect. Moreover, aggregate trends in 3 is largely driven by banks that lost passporting. We find that there is a fall in stocks of loans to EEA by banks that did not have passporting which capture aggregate effects and changes in the real economy that affect demand for loans, along with impact due to integration within the UK banking network.

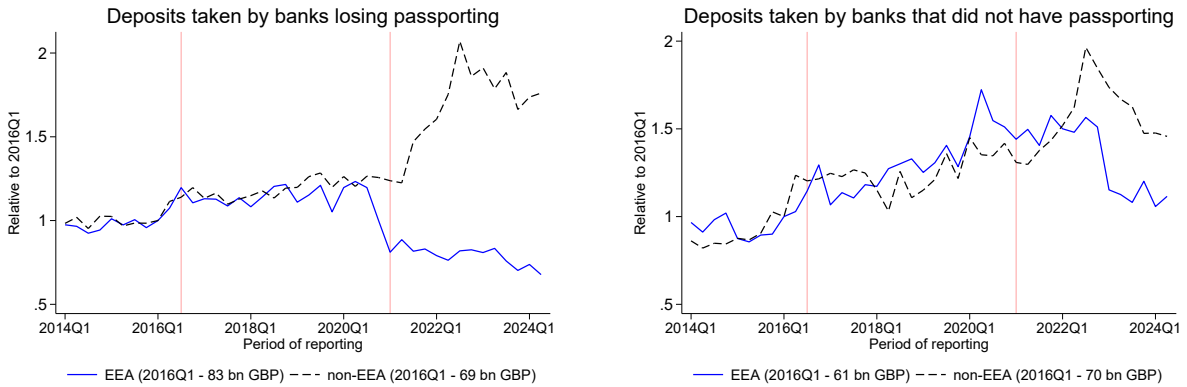
Figure 16 shows corresponding trends for stocks of deposits taken by UK banks. We see that share of deposit stocks are more equal between the two types of banks. Again, aggregate trends in 3 is largely driven by banks that lost passporting, and there are fall in deposits from EEA for banks that did not have passporting.

Figure 15: Loans to the non-financial sector - by passporting



Source: Authors' calculation using BIS-LBS.
Note: The first vertical line denotes the referendum (2016Q3) and the second the new trade arrangement between UK and EU coming into effect (2021Q1).

Figure 16: Deposits from the non-financial sector - by passporting



Source: Authors' calculation using BIS-LBS.
Note: The first vertical line denotes the referendum (2016Q3) and the second the new trade arrangement between UK and EU coming into effect (2021Q1).

A.7.2 Robustness Checks

The sample period of our analysis includes Covid-19 (2020-2021) which was a large global shock. This period witnessed firms and households taking more loans to sustain business or businesses struggling to keep up, both increase savings as expenditure reduced and decrease in it as some had to dip into their savings. This was followed by a period of high inflation in 2022. These stocks of loans and deposits are mostly affected by large transactions, however, they can be affected. Table 12 excludes these periods and we find no marked difference in our results.

Table 12: UK banks' loans to and deposits from non-resident, non-financial sector - by passporting, removing periods of Covid-19 and high inflation (2020-2022)

	(1) ln(Loans)	(2) ln(Deposits)
PostRefer×PassAuth	-0.245***	-0.150
	(0.093)	(0.094)
PostRefer×PassAuth×EEA	-0.040	-0.050
	(0.114)	(0.126)
Post21×PassAuth	-0.108	-0.008
	(0.141)	(0.156)
Post21×PassAuth×EEA	-0.815***	-0.668**
	(0.185)	(0.270)
Fixed Effects:		
Bank-Country	Yes	Yes
Country-Time	Yes	Yes
Observations	152271	186812

Notes: Estimation uses BoE data to estimate Eq. 6.3, with log of loans to and deposits from non-financial sector in a partner country, by quarter, by UK bank, as dependent variables in columns (1) and (2) respectively. Sample excludes 2020Q1 to 2022Q4, to exclude fluctuations in stocks due to Covid-19 or high inflation. $PostRefer_t = 1$ from 2016Q3 onwards, $Post21_t = 1$ from 2021Q1 onwards, $EEA_j = 1$ if lending or deposit-taking is with an EEA country, $PassAuth_b = 1$ if bank can use passporting i.e. is incorporated in the UK or is a branch of an EEA bank. Bank-partner country and time-partner country fixed effects are included. Standard errors, clustered by bank, are in parentheses.$***$, $**$ and $*$ indicate significance at 1%, 5% and 10% respectively.

Ring-fencing, which came into effect in January 2019, required UK banking groups with more than £25 billion of core retail deposits to ensure the provision of core services (broadly facilities for accepting core retail deposits, and payments and overdrafts relating to core retail deposit accounts) is separate from certain other activities within their groups, such as investment and international banking. This restructuring meant that stocks of loans or deposits could be shifted across entities. To account for this, we obtain the list of banks asked to restructure from the PRA (which is publicly available) and treat all entities within the affected banking group as a single entity, by summing the stocks of loans and deposits. Here too, we find no significant effect, as shown in Table 13

Table 13: UK banks' loans to and deposits from non-resident, non-financial sector - by passporting, accounting for changes due to ring-fencing

	(1) ln(Loans)	(2) ln(Deposits)
PostRefer×PassAuth	-0.237***	-0.136
	(0.091)	(0.098)
PostRefer×PassAuth×EEA	-0.155	-0.143
	(0.120)	(0.142)
Post21×PassAuth	-0.077	-0.032
	(0.099)	(0.115)
Post21×PassAuth×EEA	-0.646***	-0.500**
	(0.133)	(0.214)
Fixed Effects:		
Bank-Country	Yes	Yes
Country-Time	Yes	Yes
Observations	185105	221623

Notes: Estimation uses BoE data to estimate Eq. 6.3, with log of loans to and deposits from non-financial sector in a partner country, by quarter, by UK bank, as dependent variables in columns (1) and (2) respectively. Banks that were affected by ring-fencing regulations are treated as one entity, for each banking group. $PostRefer_t = 1$ from 2016Q3 onwards, $Post21_t = 1$ from 2021Q1 onwards, $EEA_j = 1$ if lending or deposit-taking is with an EEA country, $PassAuth_b = 1$ if bank can use passporting i.e. is incorporated in the UK or is a branch of an EEA bank. Bank-partner country and time-partner country fixed effects are included. Standard errors, clustered by bank, are in parentheses.***, ** and * indicate significance at 1%, 5% and 10% respectively.

We might be concerned about changes in status of banks as EEA branches may be incorporated for example. To account for this, we consolidate the stocks of loans and deposits by banking group. If at least one bank within the group lost passporting, we characterise the group to be affected by the regulatory barrier. We find no significant effect, as shown in Table 14

Table 14: UK banks' loans to and deposits from non-resident, non-financial sector - by passporting, consolidating by banking group

	(1) ln(Loans)	(2) ln(Deposits)
PostRefer× PassAuth	-0.169*	-0.048
	(0.102)	(0.102)
PostRefer× PassAuth ×EEA	-0.140	-0.259
	(0.147)	(0.195)
Post21× PassAuth	-0.098	0.039
	(0.111)	(0.103)
Post21× PassAuth× EEA	-0.473***	-0.476**
	(0.146)	(0.228)
Fixed Effects:		
Bank-Country	Yes	Yes
Country-Time	Yes	Yes
Observations	165567	201176

Notes: Estimation uses BoE data to estimate Eq. 6.3, with log of loans to and deposits from non-financial sector in a partner country, by quarter, by UK bank, as dependent variables in columns (1) and (2) respectively. Banks within the same banking group, as characterised by global ultimate owner is consolidated. $PostRefer_t = 1$ from 2016Q3 onwards, $Post21_t = 1$ from 2021Q1 onwards, $EEA_j = 1$ if lending or deposit-taking is with an EEA country, $PassAuth_b = 1$ if bank can use passporting i.e. is incorporated in the UK or is a branch of an EEA bank. Bank-partner country and time-partner country fixed effects are included. Standard errors, clustered by bank, are in parentheses.$***$, $**$ and $*$ indicate significance at 1%, 5% and 10% respectively.

Entry and exit of banks after the referendum in the sample period may account for apart of our results. To get a better picture of how banks were affected on the intensive margin, we take a subsample of banks that were in our data in before 2016. Table 15 that banks that were already present in the UK before the referendum had an even larger relative impact on loans to and deposits from EEA countries.

Table 15: UK banks' loans to and deposits from non-resident, non-financial sector - by passporting, banks present before referendum

	(1)	(2)
	ln(Loans)	ln(Deposits)
PostRefer×PassAuth	-0.253**	-0.179*
	(0.101)	(0.107)
PostRefer×PassAuth×EEA	-0.115	-0.140
	(0.119)	(0.139)
Post21×PassAuth	-0.057	-0.021
	(0.108)	(0.123)
Post21×PassAuthxEEA	-0.611***	-0.518**
	(0.143)	(0.230)
Fixed Effects:		
Bank-Country	Yes	Yes
Country-Time	Yes	Yes
Observations	182152	222882

Notes: Estimation uses BoE data to estimate Eq. 6.3, with log of loans to and deposits from non-financial sector in a partner country, by quarter, by UK bank, as dependent variables in columns (1) and (2) respectively. Only subsample of banks present in our data in 2014 or 2015 is used. $PostRefer_t = 1$ from 2016Q3 onwards, $Post21_t = 1$ from 2021Q1 onwards, $EEA_j = 1$ if lending or deposit-taking is with an EEA country, $PassAuth_b = 1$ if bank can use passporting i.e. is incorporated in the UK or is a branch of an EEA bank. Bank-partner country and time-partner country fixed effects are included. Standard errors, clustered by bank, are in parentheses.$***$, $**$ and $*$ indicate significance at 1%, 5% and 10% respectively.

Table 16 includes a more restricted set of fixed effects - Bank-time fixed effects are added to account for time-varying bank characteristics. The magnitude of impact are slightly reduced. While the impact on stocks of loans are still significant at 1% significance level, the impact on deposits is significant at 10%. We note that the p-value is 0.051. Further robustness checks, similar to the ones in the appendix, gives coefficients that are significant at the 5% significance level as well.

Table 16: UK banks' loans to and deposits from non-resident, non-financial sector - by passporting, including bank-time fixed effects

	(1)	(2)
	ln(Loans)	ln(Deposits)
PostRefer×PassAuth×EEA	-0.093	-0.077
	(0.124)	(0.140)
Post21×PassAuth×EEA	-0.555***	-0.408*
	(0.130)	(0.228)
Fixed Effects:		
Bank-Country	Yes	Yes
Country-Time	Yes	Yes
Bank-Time	Yes	Yes
Observations	208628	252176

Notes: Estimation uses BoE data to estimate Eq. 6.3, with log of loans to and deposits from non-financial sector in a partner country, by quarter, by UK bank, as dependent variables in columns (1) and (2) respectively. $PostRefer_t = 1$ from 2016Q3 onwards, $Post21_t = 1$ from 2021Q1 onwards, $EEA_j = 1$ if lending or deposit-taking is with an EEA country, $PassAuth_b = 1$ if bank can use passporting i.e. is incorporated in the UK or is a branch of an EEA bank. Bank-partner country, time-partner country and bank-time fixed effects are included. Standard errors, clustered by bank, are in parentheses.$***$, $**$ and $*$ indicate significance at 1%, 5% and 10% respectively.

The regulation changes for UK branches of EEA banks are more complex. While they lost the authorisation to operate in the UK under the new arrangement, temporary regimes were introduced by the UK which allowed these banks to continue to passport for a period of three years, however, there were increased costs as they were expected to move away from their current structure within the period. Moreover, this was for the activity of these banks within the UK. The changes in regulations on these banks providing cross-border services back to EEA is unclear. While in our baseline we include these banks as having lost passporting, with the justification that there was an increase in barriers, that these banks had a lower share in total UK cross-border banking, and that given the small number of banks in the UK, eliminating as many as 20% of banks may not be ideal, Table 17 excludes them from the analysis. Again, the magnitudes of impact are only slightly lower. While the impact of loans is significant at 1% significance level, we note that the p-value for the corresponding coefficient for deposits is 0.05 (with further robustness checks making it significant at the 5% significance level).

Table 17: UK banks' loans to and deposits from non-resident, non-financial sector - by passporting, excluding UK branches of EEA banks

	(1)	(2)
	ln(Loans)	ln(Deposits)
PostRefer×PassAuth	-0.252**	-0.157
	(0.115)	(0.114)
PostRefer×PassAuth×EEA	-0.106	-0.108
	(0.132)	(0.146)
Post21×PassAuth	-0.110	-0.019
	(0.110)	(0.120)
Post21×PassAuth×EEA	-0.601***	-0.441*
	(0.151)	(0.225)
Fixed Effects:		
Bank-Country	Yes	Yes
Country-Time	Yes	Yes
Observations	175939	218907

Notes: Estimation uses BoE data to estimate Eq. 6.3, with log of loans to and deposits from non-financial sector in a partner country, by quarter, by UK bank, as dependent variables in columns (1) and (2) respectively. UK branches of EEA banks are excluded. $PostRefer_t = 1$ from 2016Q3 onwards, $Post21_t = 1$ from 2021Q1 onwards, $EEA_j = 1$ if lending or deposit-taking is with an EEA country, $PassAuth_b = 1$ if bank can use passporting i.e. is incorporated in the UK or is a branch of an EEA bank. Bank-partner country and time-partner country fixed effects are included. Standard errors, clustered by bank, are in parentheses.* * *, ** and * indicate significance at 1%, 5% and 10% respectively.

A.7.3 Alternate channels

An extensive margin of adjustment available to banks is the number of countries they provide service to. With higher regulatory barriers, banks may withdraw from countries with higher costs relative to income, or scale down in non-EEA as well, due to the impact on total resources available (as captured by the resource constraint in our model). Table 18 shows that banks that lost passporting reduced the number of countries they provide service to in non-EEA after the barriers come into effect, relative to banks that did not have passporting. There are additional reductions in the number of EEA countries served, both after the referendum and under the new barriers.

Table 18: Number of countries UK banks provide service to - by passporting

	(1)	(2)
ln(Numb of Countries)	Loans	Deposits
PostRefer×PassAuth	-0.063	0.040
	(0.063)	(0.071)
PostRefer×PassAuth×EEA	-0.173**	0.042
	(0.067)	(0.066)
Post21×PassAuth	-0.129**	-0.142**
	(0.065)	(0.072)
Post21×PassAuth×EEA	-0.157*	-0.022
	(0.081)	(0.075)
Fixed Effects:		
Bank-CountryGroup	Yes	Yes
CountryGroup-Time	Yes	Yes
Observations	13409	12431

Notes: Estimation uses BoE data to estimate Eq. 6.3, with log of number of partner country served in EEA or non-EEA, by quarter, by UK bank,as dependent variables in columns (1) and (2) respectively. $PostRefer_t = 1$ from 2016Q3 onwards, $Post21_t = 1$ from 2021Q1 onwards, $EEA_j = 1$ if lending or deposit-taking is with an EEA country, $PassAuth_b = 1$ if bank can use passporting i.e. is incorporated in the UK or is a branch of an EEA bank. Bank-country group and time-country group fixed effects are included, where country group is EEA or non-EEA. Standard errors, clustered by bank, are in parentheses.$***$, $**$ and $*$ indicate significance at 1%, 5% and 10% respectively.

Banks lend and take deposits in different currencies. When reporting, banks convert all currencies into pound sterling. For our analysis, we have summed across different currencies, however, one concern could be that changes in lending and deposit-taking may vary by currency. Brexit had led to depreciation of the pound, and with ties between UK and EU severing, lending or depositing in pounds may become less attractive. For this, we run a regression similar to Eq. 6.3, where we focus on the impact on lending and deposit-taking to each country group at a time, and estimate if the impact of loss of passporting is any different when lending or deposit-taking is in pounds. Table 19 shows that stocks of loans to or deposits from EEA or non-EEA in pounds do not fall any more than those in other currencies (US dollar, Swiss francs, Japanese yen, Euros and others) for banks that lost passporting, relative to banks that did not have passporting. So regulatory barriers and currency depreciations did not have any significant effect on the activities by currencies. In fact, we find an increase in the stocks of deposits from EEA in pounds, some of which could be due to depreciation of the pound and the currency composition.

Table 19: UK banks' loans to and deposits from non-resident, non-financial sector - by passporting, by currency, for each partner group

	(1) ln(Loans) All	(2) ln(Loans) EEA	(3) ln(Loans) nonEEA	(4) ln(Deposits) All	(5) ln(Deposits) EEA	(6) ln(Deposits) nonEEA
PostRefer × PassAuth	-0.288***	-0.335**	-0.260**	-0.089	-0.240*	-0.054
	(0.103)	(0.130)	(0.109)	(0.095)	(0.136)	(0.101)
PostRefer×PassAuth×GBP	-0.167	-0.174	-0.211	-0.091	-0.126	-0.066
	(0.178)	(0.264)	(0.191)	(0.125)	(0.214)	(0.129)
Post21×PassAuth	-0.151	-0.479***	0.078	-0.094	-0.504***	0.049
	(0.111)	(0.149)	(0.118)	(0.123)	(0.160)	(0.140)
Post21×PassAuth×GBP	-0.108	0.088	-0.311	0.104	0.423**	-0.027
	(0.224)	(0.251)	(0.244)	(0.129)	(0.204)	(0.143)
Fixed Effects:						
Bank-Currency	Yes	Yes	Yes	Yes	Yes	Yes
Currency-Time	Yes	Yes	Yes	Yes	Yes	Yes
Observations	304716	103697	200986	516328	144635	371654

Notes: Estimation uses BoE data to estimate a variation of Eq. 6.3, with log of loans to and deposits from non-financial sector in All countries, EEA or non-EEA, by quarter, by UK bank, and by currency as dependent variables in columns (1) and (2) respectively. $PostRefer_t = 1$ from 2016Q3 onwards, $Post21_t = 1$ from 2021Q1 onwards, $EEA_j = 1$ if lending or deposit-taking is with an EEA country, $PassAuth_b = 1$ if bank can use passporting i.e. is incorporated in the UK or is a branch of an EEA bank. Bank-currency and time-currency fixed effects are included. Standard errors, clustered by bank, are in parentheses.$***$, $**$ and $*$ indicate significance at 1%, 5% and 10% respectively.

A.8 Exposure regressions

To determine whether banks with higher quantities of exports to EEA were more affected by the uncertainties in the future of trade and the higher trade barriers, we measure this initial share of EEA in stocks of deposits from and loans to non-residents. Table 20 provides the summary statistics for these measures. The average bank has about 40-45% of its stocks of deposits and loans from cross-border activity corresponding to the EEA. Banks vary more in the share of EEA in deposit stocks than in loan stocks, although for both deposits and loans, there are some banks that have all their stocks from exporting services to EEA and some have none of their stocks from exporting services to EEA.

Table 20: Summary statistics for Measure of Share of EEA in Stocks before Referendum

	Mean	S.D.	10th Pctl	25th PCtl	Median	75th Pctl	90th Pctl	Min	Max
PreEEAExpD	45.00	35.86	0.19	9.41	41.99	81.17	97.64	0.00	100.00
PreEEAExpL	42.97	30.37	3.75	15.63	41.39	67.66	86.58	0.00	100.00

Figure 17 shows the stocks of loans and deposits corresponding to exports to EEA and non-EEA, for banks with below median (low) pre-referendum share of EEA in stocks and those with above median (high) shares, where median of $PreEEAExpLoan$ is 41.39% and of $PreEEAExpDep$ is 41.99% (summary statistics for these average shares is in Table 20). For banks with low pre-referendum share of EEA in stocks corresponding to exports, we see that both loan and deposit stocks for EEA increase after the referendum and fall after trade barriers come into effect, but these changes are small. For these banks, there is an increase in stocks of deposits from non-EEA after 2021Q1. For banks that had high pre-referendum share of EEA in stocks, both loans and deposit stocks for EEA fall substantially. Loan stocks for non-EEA fall, while deposit stocks rise.

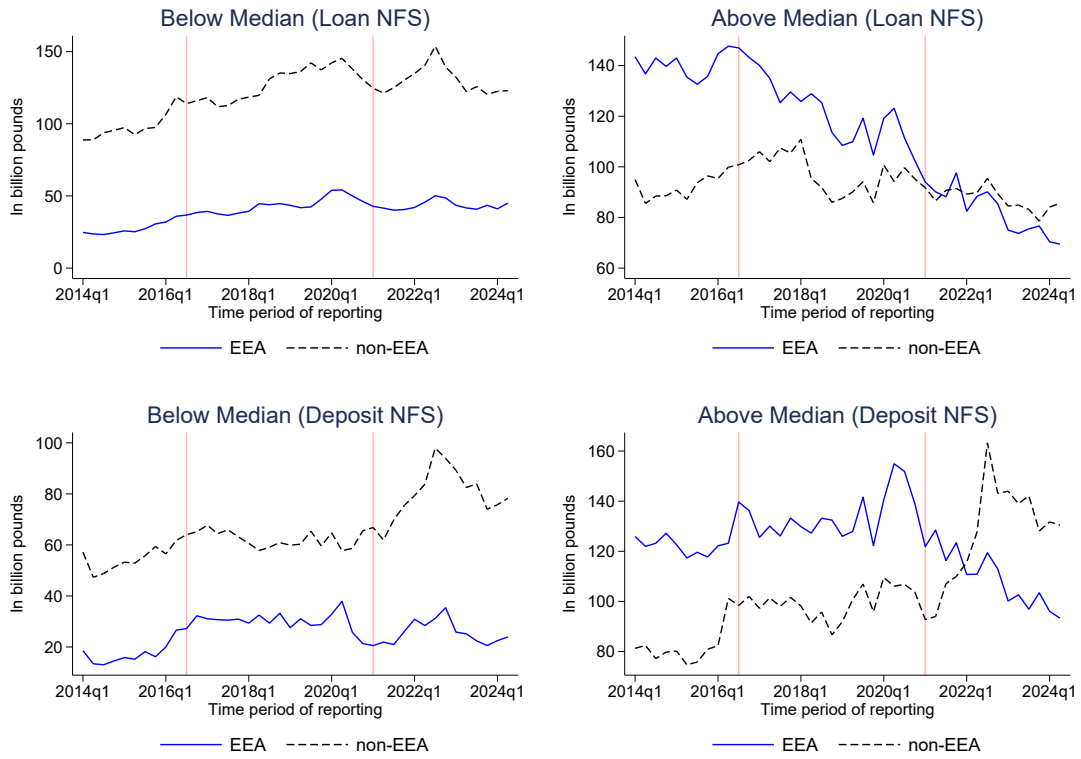
We use the median values to categorise banks as having a high or low share of EEA in their stocks of deposits and loans. $HighPreEEAExp = \mathbb{1}\{PreEEAExp \geqslant median(PreEEAExp)\}$. We run the following regression:

$$\begin{aligned}\ln(stock_{bt}) =& \beta_1 PostRefer_t \times HighPreEEAExp_b + \beta_2 Post21_t \times HighPreEEAExp_b \\ &+ \alpha_b + \alpha_t + \varepsilon_{bt}\end{aligned} \tag{A.1}$$

We run this regression for stocks of loans and deposits separately, and on stocks corresponding to EEA only, non-EEA only and total stocks from/to non-residents.

For lending services (as shown in Table 21), banks with above median share of EEA in loan stocks before the referendum have a fall in total stocks of loans to non-residents

Figure 17: Stocks, by low and high share of EEA in stocks corresponding to exports



Source: Authors' calculation using BIS-LBS.
Note: The first vertical line denotes the referendum (2016Q3) and the second the new trade arrangement between UK and EU coming into effect (2021Q1).

after the referendum. These banks reduce their lending to the EEA after the referendum, and reduce it even further after the new trade barriers come into effect (Column 2). We do not observe an export substitution for loans when banks have above median share of EEA in stock of lending, as the coefficients in Column 3 are insignificant.

Table 22 shows the output for the regression on deposits. Column 1 shows that banks with above median share of EEA in stocks do not have more or less change in stocks after the referendum or after the trade barriers come into effect compared to banks with below median share of EEA in stocks. However, banks with high share of deposits from EEA before the referendum have a lower stock of deposits from the EEA after the referendum relative to banks with lower share of EEA in stocks and this effect is statistically significant (Column 2). There is no additional effect after 2021. Banks with above median share of EEA in stocks increase deposits taken from non-EEA after the referendum, the same period when they reduce their stocks for EEA (Column 3), as well as after the new trade arrangement.

Table 21: Banks' loans to EEA and non-EEA - share of EEA in stocks before Referendum

ln(Loans)	(1) Aggregate	(2) EEA	(3) non-EEA
PostRefer×HighPreEEAExpL	-0.285*	-0.534***	-0.065
	(0.154)	(0.167)	(0.174)
Post21×HighPreEEAExpL	-0.162	-0.367*	-0.073
	(0.206)	(0.211)	(0.193)
Fixed Effects:			
Bank	Yes	Yes	Yes
Time	Yes	Yes	Yes
Observations	6170	5813	5931

Notes: Estimation uses BoE data to estimate Eq. A.1, with log of loans to non-financial sector in all partner countries, EEA and non-EEA, by quarter, by UK bank, as dependent variables in columns (1), (2) and (3) respectively. $PostRefer_t$ = 1 from 2016Q3 onwards, $Post21_t$ = 1 from 2021Q1 onwards, $HighPreEEAExpL$ takes the value 1 if the share of stocks of loans to EEA in total stocks of loan to non-financial sector in partner countries, averaged over the eight quarters in 2014 and 2015 is above the median, and 0 otherwise. Bank and time fixed effects are included. Standard errors, clustered by bank, are in parentheses.***, ** and * indicate significance at 1%, 5% and 10% respectively.

Table 22: Banks' deposits to EEA and non-EEA - share of EEA in stocks before Referendum

ln(Deposits)	(1) Aggregate	(2) EEA	(3) non-EEA
PostRefer×HighPreEEAExpD	-0.008	-0.582***	0.438***
	(0.141)	(0.204)	(0.152)
Post21×HighPreEEAExpD	0.184	0.055	0.463*
	(0.224)	(0.298)	(0.253)
Fixed Effects:			
Bank	Yes	Yes	Yes
Time	Yes	Yes	Yes
Observations	5832	5377	5620

Notes: Estimation uses BoE data to estimate Eq. A.1, with log of deposits to non-financial sector in all partner countries, EEA and non-EEA, by quarter, by UK bank, as dependent variables in columns (1), (2) and (3) respectively. $PostRefer_t$ = 1 from 2016Q3 onwards, $Post21_t$ = 1 from 2021Q1 onwards, $HighPreEEAExpL$ takes the value 1 if the share of stocks of deposits to EEA in total stocks of deposits to non-financial sector in partner countries, averaged over the eight quarters in 2014 and 2015 is above the median, and 0 otherwise. Bank and time fixed effects are included. Standard errors, clustered by bank, are in parentheses.***, ** and * indicate significance at 1%, 5% and 10% respectively.

We use the exposure measure for the non-financial sector to estimate if hgiher exposure to the non-financial sector in the EEA incentivises banks to use alternate channels like interbank transactions or lending and deposit taking through the financial corporations. Tables 23 to 26 do not provide any evidence of this.

Table 23: Banks' loans EEA and non-EEA - share of EEA in stocks before Referendum, other banks

	(1) Aggregate	(2)	(3)
ln(Loans)	(EEA + non-EEA)	EEA	non-EEA
PostRefer×PreEEAExpL	0.000	0.001	0.002
	(0.004)	(0.005)	(0.004)
Post21×PreEEAExpL	-0.006	-0.006	-0.008*
	(0.004)	(0.004)	(0.004)
Fixed Effects:			
Bank	Yes	Yes	Yes
Time	Yes	Yes	Yes
Observations	6406	5948	6251

Notes: Estimation uses BoE data to estimate Eq. 6.4, with log of loans to other banks in all partner countries, EEA and non-EEA, by quarter, by UK bank, as dependent variables in columns (1), (2) and (3) respectively. $PostRefer_t = 1$ from 2016Q3 onwards, $Post21_t = 1$ from 2021Q1 onwards, $HighPreEEAExpL$ takes the value 1 if the share of stocks of loans to EEA in total stocks of loans to non-financial sector in partner countries, averaged over the eight quarters in 2014 and 2015 is above the median, and 0 otherwise. Bank and time fixed effects are included. Standard errors, clustered by bank, are in parentheses.$***$, $**$ and $*$ indicate significance at 1%, 5% and 10% respectively.

Table 24: Banks' deposits EEA and non-EEA - share of EEA in stocks before Referendum, other banks

	(1) Aggregate	(2)	(3)
ln(Deposits)	(EEA + non-EEA)	EEA	non-EEA
PostReferxPreEEAExpL	0.003	0.003	0.001
	(0.005)	(0.005)	(0.005)
Post21xPreEEAExpL	-0.003	-0.003	-0.003
	(0.005)	(0.007)	(0.004)
Fixed Effects:			
Bank	Yes	Yes	Yes
Time	Yes	Yes	Yes
Observations	4436	3658	3995

Notes: Estimation uses BoE data to estimate Eq. 6.4, with log of deposits to other banks in all partner countries, EEA and non-EEA, by quarter, by UK bank, as dependent variables in columns (1), (2) and (3) respectively. $PostRefer_t = 1$ from 2016Q3 onwards, $Post21_t = 1$ from 2021Q1 onwards, $HighPreEEAExpL$ takes the value 1 if the share of stocks of deposits to EEA in total stocks of deposits to non-financial sector in partner countries, averaged over the eight quarters in 2014 and 2015 is above the median, and 0 otherwise. Bank and time fixed effects are included. Standard errors, clustered by bank, are in parentheses.$***$, $**$ and $*$ indicate significance at 1%, 5% and 10% respectively.

Table 25: Banks' loans EEA and non-EEA - share of EEA in stocks before Referendum, other financial corporations

	(1)	(2)	(3)
	Aggregate		
ln(Loans)	(EEA + non-EEA)	EEA	non-EEA
PostRefer×PreEEAExpL	0.003	0.003	0.001
	(0.005)	(0.005)	(0.005)
Post21×PreEEAExpL	-0.003	-0.003	-0.003
	(0.005)	(0.007)	(0.004)
Fixed Effects:			
Bank	Yes	Yes	Yes
Time	Yes	Yes	Yes
Observations	4436	3658	3995

Notes: Estimation uses BoE data to estimate Eq. 6.4, with log of loans to other financial corporations in all partner countries, EEA and non-EEA, by quarter, by UK bank, as dependent variables in columns (1), (2) and (3) respectively. $PostRefer_t = 1$ from 2016Q3 onwards, $Post21_t = 1$ from 2021Q1 onwards, $HighPreEEAExpL$ takes the value 1 if the share of stocks of loans to EEA in total stocks of loans to non-financial sector in partner countries, averaged over the eight quarters in 2014 and 2015 is above the median, and 0 otherwise. Bank and time fixed effects are included. Standard errors, clustered by bank, are in parentheses.$***$, $**$ and $*$ indicate significance at 1%, 5% and 10% respectively.

Table 26: Banks' deposits EEA and non-EEA - share of EEA in stocks before Referendum, other banks

	(1)	(2)	(3)
	Aggregate		
ln(Deposits)	(EEA + non-EEA)	EEA	non-EEA
PostRefer×PreEEAExpD	-0.004	-0.006	-0.003
	(0.005)	(0.005)	(0.006)
Post21×PreEEAExpD	-0.000	0.004	0.001
	(0.004)	(0.006)	(0.006)
Fixed Effects:			
Bank	Yes	Yes	Yes
Time	Yes	Yes	Yes
Observations	4750	4011	4412

Notes: Estimation uses BoE data to estimate Eq. 6.4, with log of deposits to financial corporations in all partner countries, EEA and non-EEA, by quarter, by UK bank, as dependent variables in columns (1), (2) and (3) respectively. $PostRefer_t = 1$ from 2016Q3 onwards, $Post21_t = 1$ from 2021Q1 onwards, $HighPreEEAExpL$ takes the value 1 if the share of stocks of deposits to EEA in total stocks of deposits to non-financial sector in partner countries, averaged over the eight quarters in 2014 and 2015 is above the median, and 0 otherwise. Bank and time fixed effects are included. Standard errors, clustered by bank, are in parentheses.$***$, $**$ and $*$ indicate significance at 1%, 5% and 10% respectively.