Trade in Banking Services under Regulatory Barriers: Evidence from the UK

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Abstract

While services are increasingly flowing across borders, little is known about barriers to trade in services. This paper investigates how changes in regulatory barriers affect banks' trade in intermediation services i.e. lending and deposit-taking. We build a theoretical framework of banking across borders, to derive predictions on the effects of increases in trade costs on trade in banking services with different countries. We test the propositions using changes in regulations due to United Kingdoms withdrawal from the European Union. 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 2016 referendum itself. The decline in intermediated stocks was especially large for banks that lost EEA-wide authorization relative to those that did not have such authorisation when UK was a part of EU (more than 50% decline), or for banks that had a higher share of their activity with the EEA before the referendum. These effects are evident not only in activities with the non-financial sector, but also with other financial institutions, suggesting barriers disrupted both direct and indirect provision of services. Finally, we explore whether multinational banks used affiliates to circumvent barriers but find limited evidence of increased activity of local entities, despite the increased number of intragroup entities in the EEA. These results emphasize the critical role of regulatory access in shaping the pattern of banking across borders and the performance of the sector.

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1 Introduction

Trade barriers have long stood among the primary instruments eroding international economic integration. Discussions and research on trade barriers have largely centered on tariffs - a focus that has intensified under the Trump administration - yet non-tariff barriers remain a substantial and understudied channel through which trade policy shapes the global economy. Non-tariff barriers are particularly salient in the context of services, where tariffs are largely absent but regulatory restrictions play a central role. The importance of services trade has risen markedly in recent decades. The share of services in total trade has been steadily increasing (Baldwin et al. 2024), reaching 27.2% in 2024[1]. Services-export-led growth is booming (Baldwin 2024)[2] and jobs linked to services-exports have been increasing (Roy & Sauvé 2023). Such patterns underscore that barriers to services trade carry weighty implications for economic outcomes.

Among traded services, banking occupies a particularly important position. 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 (for instance, around one-third of total assets of UK banking sector). 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 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 focuses on banks' cross-border intermediation activities - lending and deposit-taking and examines how higher barriers imposed by a trading partner affect banks' operations across all markets. To study this, we leverage the changes in regulations on United Kingdom's (UK) cross-border banking with the European Economic Area (EEA) due to Brexit. Brexit has been the most significant episode of economic disintegration in the recent past, which marked UK's withdrawal from the European Union (EU) following the referendum in 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, both UK and EEA banks anticipated tighter regulatory constraints on cross-border market access, amid uncertainty about the precise form of these restrictions. The new trade arrangement confirmed these expectations, introducing significant new regulatory barriers to cross-border banking between the UK and the EEA. 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

[1] See https://www.wto.org/english/res_e/statis_e/world_trade_statistics_e.htm.

[2] Defined as value-added exports growing faster than GDP, including ICT-enabled services trade.

important.

We first discuss the complexities of measuring of export of intermediation, and motivate the use of stocks of loans to and deposits from partner countries as measures of banks' cross-border activities. The main focus is on activity with the non-financial sector, but we also discuss intragroup[3] and interbank activities, separately, as well. We develop a theoretical framework, with three countries, in which banks provide intermediation services both domestically and across borders. Loan demand from firms and deposit supply from depositors depend on the interest rates charged and offered (respectively) by banks, who maximise profits from intermediation. The model predicts that banks reduce cross-border lending and deposit-taking vis-á-vis the country that raises barriers. When a trading partner simultaneously restricts both lending and deposit-taking, however, the effects on banks engagement with a third country are ambiguous. We test these trade patterns in the data.

We estimate the impact of increase in barriers, as well as anticipation and uncertainty after the referendum, on cross-border activities of banks. Using an event-study in a gravity-style regression and cross-country data on stocks from the Bank for International Settlements, we show that relative to cross-border lending and deposit-taking of other countries' banking sector with non-banking entities in trading partners, UK's activities with EEA fell substantially due to increased barriers, while activities with non-EEA remained unchanged. This pattern suggests that the reduction in intermediation services provided by the UK to the EEA is not explained by global trends in cross-border banking.

To understand the drivers of these aggregate results we extend our analysis to the response of individual banks in the UK, using confidential data from the Bank of England. We begin our analysis by looking at services provided to the non-financial sector (non-financial corporations, households and governments), which constitutes the primary component of intermediation services. 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. When UK was a member of the EU, banks incorporated in the UK could passport their authorisation into EU, and UK branches of EEA banks used passporting to operate in the UK. 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 50-60% additional fall in stocks of loans to and deposits from the non-financial sector in the EEA, relative to banks without passporting authorisation. While the additional fall is unsurprising, the magnitude of the relative effect suggests that regulatory barriers after loss of passporting,

[3]Intragroup refers to entities within the same larger company

had a significant impact on cross-border service provision.

The regulatory changes in the banking sector were complex and this warrants a broader view of the barriers. Specifically, we examine how banks with higher exposure to the EEA in their total cross-border activity before the referendum were affected. Pre-referendum exposure to the EEA captures both the importance of the EEA market for a bank and the extent to which it was affected by change in barriers. We find that a higher exposure to EEA by one standard deviation is associated with approximately 30% lower lending to and deposit-taking from EEA, and this effect starts after the referendum itself. This suggests that instead of taking steps to maintain access to an important foreign market, these banks scaled back their activity in anticipation of rising frictions. 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.

Banks lend to and take deposits from other non-resident banks as well. While outside our narrow measure of intermediation exports, these cross-border interbank transactions are themselves exports of the banking sector and, in addition to providing liquidity to banks, can be alternates for lending to non-financial sector.[4] We examine how higher barriers impacted lending and deposit-taking of UK banks with other banks and financial institutions in other countries. We find that these other activities to EEA do not increase after passporting is lost. 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 institutions in EEA relative to UK-banks that did not have passporting authorisation. Moreover, banks more exposed to EEA in their cross-border lending or deposit-taking with the non-financial sector do not increase interbank activities, indicating that these alternate channels may not be sufficient to maintain market access.

An extensive literature[5] investigates how multinational firms respond to trade barriers by reorganising activity through foreign affiliates. As a leading global financial center, UK hosts nearly all large multinational banks. The analysis so far has studied the response of banks in the UK, and shows that UK banking sector's cross-border activity did suffer due to regulatory barriers. We investigate whether this loss is restricted to the banking sector of the country facing barriers, and if the banking groups could leverage their international organisation to continue to access restricted markets. Lending and deposit-taking among banks in the same company-group (henceforth intragroup) but in different countries can transfer resources to expand intermediation in local markets. However, 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, indicating that increased barriers to cross-border activity dominated the use of intragroup activity to access restricted markets.

[4]See Kerl & Niepmann (2015) for a study of interbank lending and lending to non-banking firms as substitutes.

[5]See Helpman et al. (2004), Antrás & Yeaple (2014),Antrás et al. (2024)

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 while there is an increase in the number of foreign affiliates in the EEA, for banks in the UK and especially those that lost passporting, there is no significant increase in the assets or loans to and deposits from non-banking entities by affiliates located in the EEA. These evidence suggest that, while there were attempts by companies to increase the capacity of affiliates in the EEA, this has not led to an 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 countrys 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.

Our study provides another example of what complex regulatory barriers to services look like and shows the substantial impact it has on trade. Regulatory divergences lay at the core of the change in UK and EU trade-relations across all sectors, as trade in goods remained tariff-free and quota-free. In the absence of clear guidance on the timing of Brexit or the future framework of UKEU relations, expectations of increased barriers and uncertainty surrounding them affected firms' behaviour after the referendum itself. Estimates suggested that the UK economy was around 2-3% smaller at the end of 2019 compared to if the referendum had resulted in UK remaining in EU. Agencies such as the Office for Budget Responsibility assumed that the volume of UK imports and exports would be approximately 15% lower than under continued EU membership.[6] However aggregate trade with the EU did not decline till the implementation of the TCA (Steinberg 2019, Freeman et al. 2024).

While 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%, subsequent evidence points to smaller effects. Using firm-level data and accounting for changes in measurement of UK-EU trade, 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.[7] For services, Bhalotia et al. (2025) construct measures of barriers to trade in services and investment in the TCA and using bilateral services trade data, find the 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%.

This discrepancy between predicted and estimated effects is striking, and raises questions

[6] See https://obr.uk/box/how-are-our-brexit-forecasting-assumptions-performing/.

[7] Kren & Lawless (2024) use EU's trade with the rest of the world instead and find higher changes in exports and imports, 16% and 24% respectively.

on whether non-tariff barriers have the impact initially expected. 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 estimates on the change in UK's cross-border banking activity are large in their magnitude and indicate that barriers in this sector have been particularly binding. Moreover, we also find some effects of anticipation and uncertainty after the referendum. While Bhalotia et al. (2025) include barriers to banking services in their measure, they are limited to the ones included in Annex 19 and the data they use treats the financial sector as an aggregate. The absence of the banking sector in official surveys[8] has implied that this sector is largely omitted in firm-level studies. Our study contributes to filling this gap, highlighting the banking sector as one where post-Brexit regulatory barriers have had a particularly pronounced effect.

This paper contributes to several strands of literature. A growing, but still limited, body 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).[9], 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. Lastly, by being the first to look at the impact of changes in barriers to banking services between UK and EEA, we also contribute to the literature on the impact of Brexit (Dhingra & Sampson (2022) provide a review of the research on Brexit, extending beyond the impact on trade).

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

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

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

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, this 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, 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 the 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. [10]

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).[11] FISIM uses a reference rate, which represents the pure cost of borrowing funds, eliminating risk premium and

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

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

excluding any intermediation service. The reference rate is calculated as the interest charged on loans to and offered to deposits from other financial intermediaries.[12] 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.[13] 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 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.[14] The interest margins for both loans and deposits do not vary partner country.[15] Therefore, variation by partner country in FISIM is due to stocks of loans and deposits.

Official Balance of Payments statistics of the UK (ONS Pink Book) suggests that share in total exports by UK monetary financial institutions (MFI)[16] of fees and commissions is 15-20% (part of which includes explicit charges for lending and deposit-taking services) and of FISIM is 25-30%. Therefore, FISIM constitutes a larger share of exports and variation by partner country is 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.[17] 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

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

[13]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.

[14]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.

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

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

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

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.

Regulatory changes in the banking sector: The UK's banking sector was highly integrated with that of other EEA countries when UK was a member of the EU. The advantage that the UK banking sector had built over decades[18] had lead to London being the European headquarters for the sector.[19]. 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.[20]

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).

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 ineffi-

[18] 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.

[19] See https://www.gov.uk/government/speeches/the-future-of-the-european-financial-services-market

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

cient 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 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[21], broadly 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.[22] 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).[23] Trend in stocks of loans given to EEA and non-EEA, relative to

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

[22] 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.

[23] As discussed in Section 2, transactions with financial intermediaries may not involve providing a service,

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 increase in trade barriers to banking services.

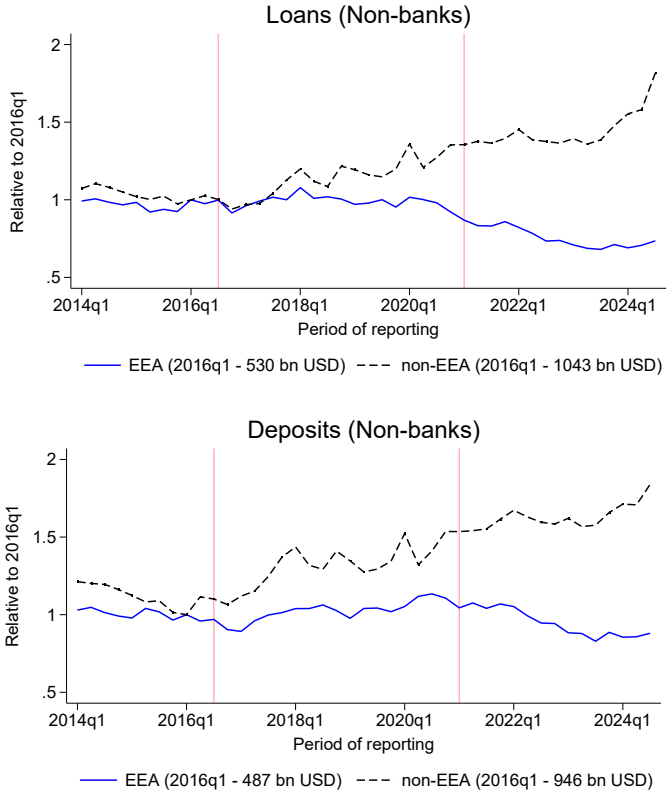


Figure 1: Stocks of Loans to and Deposits from Non-banking entities in EEA and non-EEA, by UK (BIS-LBS)

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 country that increased barriers for cross-border activities, but also other partner countries, 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.

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.5 shows the corresponding figures for stocks of loans from and deposits to all entities

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.[24]

The amount of loan that the representative firm of country i takes from a bank b is a decreasing function of the gross 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.[25]

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.[26]

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 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

[24]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.

[25]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.

[26]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.

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 or establishing a subsidiary in EEA is lower than the corresponding costs for non-EEA. However, the trade barriers increase the cost for EEA such that cost of cross-border activity and establishing subsidiary increases, while costs for non-EEA remain unchanged. Future iterations of the model would capture an increased cost of establishing an affiliate in the EEA, and the choice of the bank to provide services cross-border versus through the affiliate.

4.2 Bank's profit maximisation

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

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

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.[27] 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 service with E. (Further details in Appendix A.1.)

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

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

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

[27] 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.

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 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, here 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 increase variable trade cost of lending to and taking deposits from E has ambiguous effect on lending and deposit-taking with other partner countries.

As discussed under Proposition I increase in variable trade cost on lending to E decreases lending to E, and this leads to excess deposit 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 increase in variable trade cost on the two services provided by banks implies that the net effect on lending and deposit-taking from other markets is ambiguous. The effect depends on the parameters like elasticity of demand and supply, aggregate demand and supply, efficiency of the bank as well as on the trade costs. This also implies that 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 variable trade cost on lending to E reduces deposits from E and this reinforces the direct effect of increase in variable cost on deposit-taking, and

similarly for lending.

These propositions form the basis for our empirical analysis. While the prime focus is on 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 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)[28] 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):

This dataset contains stocks of loans provided and deposits taken by resident banks (based on location of the banking office) that are internationally active, from or to non-resident counterparties.[29, 30] 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.[31]

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.[32] This data is the backbone of

[28] 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.

[29] 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.

[30] 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.

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

[32] 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.

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).[33]

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.[34] 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.2. The Bank of England data on stocks is similar to that of the UK in the 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.[35] 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 trade statistics. Banks report these either annually or quarterly, based on criteria stated by the Bank of England.[36] 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.

[33]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.

[34]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.

[35]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.

[36]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.

- 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[37], 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. We obtain information on the global 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.3.

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.

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

$$ln(stock_{ijt}) = \alpha + \sum_{k=2014Q1}^{2024Q2} \beta_1^k \left(k_t \times EEA_j \times UK_i\right) + \sum_{k=2014Q1}^{2024Q2} \beta_2^k \left(k_t \times UK_i\right) + \delta ln(exchange\_rate_{it}) + \alpha_{ij} + \alpha_{jt} + \varepsilon_{ijt} \tag{6.1}$$

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 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 for time-varying demand shocks. We cluster the standard errors by country-pair.[38]

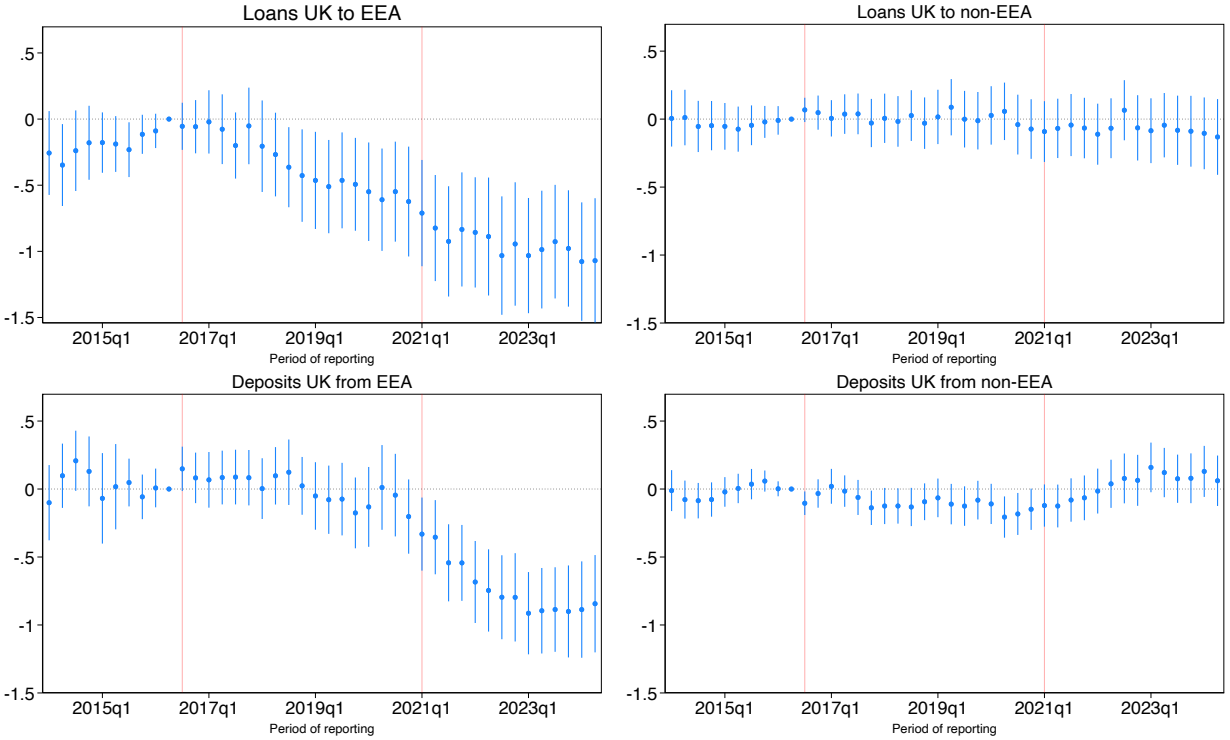
Figure 2 shows the coefficients β_1^k and β_2^k for the event-study regressions on loans and deposit with non-bank counterparties. It shows change in loans provided or deposits held by UK resident banks where the partner country is either in the EEA or not in the EEA, relative to 2016Q2 (which we take as base period) and to other exporters (non-UK). 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 2016Q2 and to other exporters (non-UK).

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 suggested 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, and this is potentially because loans are longer term contracts.

[38] 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.

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.

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. 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, our stocks going forward differ from the stocks corresponding to non-banks in the BIS-LBS.

Figure 3 shows stocks of cross-border loans to and deposits from non-financial sectors of EEA and non-EEA by UK-resident banks, relative to their 2016Q1 values. For loans, stocks diverge after the referendum, while for deposits, the trends diverge close to the new trade arrangement between UK and EU coming into effect in 2021Q1. In addition to the impact of uncertainty and expectation of increased barriers, loans may respond more than deposits before trade barriers come into effect because loans are relatively longer-term contracts and deposit arrangements can be terminated in a shorter time period than loans. Stocks of both

are increasing for non-EEA and decreasing for EEA.[39]

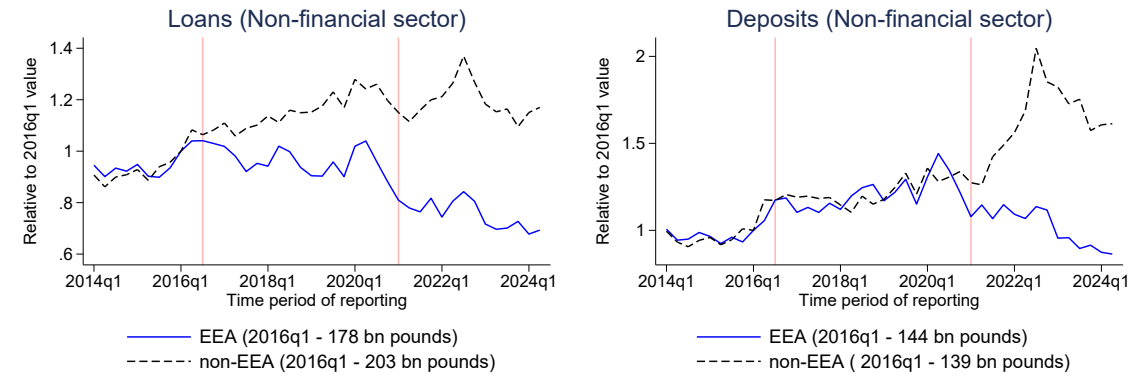


Figure 3: Stocks of loans to and deposits from non-financial sector by UK banks (BoE)

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). This warrants a further investigation banks' activities. We structure our bank-level analysis to determine what drives these trends, how much of these are due to changes in barriers specific to banking services and how are other activities of UK banks changing.

6.2.1 Impact of Passporting

UK's withdrawal from the EEA introduced several 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 frictions, we study a specific barrier - the loss of EEA-wide authorisation to provide service or passporting. While the complexity of regulations on banking makes it difficult to list all possible changes due to UK becoming a third country, loss of passporting is one of the most significant.[40]

UK-resident bank could be one of three types - incorporated in the UK[41], branch of EEA bank (this includes branches operating when passporting was permitted and those with supervisory run-off after the withdrawal[42]) and branch of a non-EEA bank[43], and we refer

[39]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. The exchange rate is relevant for the stocks 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.

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

[41]These banks could have a UK national ultimate owner, or be a incorporated legal entity of a company of any other nationality

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

[43]This refers to branches of banks that are not incorporated in the UK or EEA. Banks incorporated

to this characteristic as incorporation status.[44] Until 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 had passporting rights 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 third countries (like US, Switzerland etc.), i.e. they did not have passporting.

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. To the extent that aggregate shocks (like the Covid-19 pandemic) and other changes due to Brexit (reduced demand for banking services from UK by firms due to less trade in goods and other services) affect the banks uniformly and that there are no significant changes in national regimes for cross-border banking in EEA countries in the period of Brexit (which would affect UK branches of non-EEA banks),[45] the additional impact on stocks of banks with passporting rights after the referendum and Brexit can be interpreted as the impact of loss of passporting. In our data, we do not observe which banks are using their passporting authorisation specifically in providing services to EEA, and our classification is based on access to passporting. The trends of stocks of loans and deposits for banks with different incorporation status is shown in Figures 14 and 15 in Appendix A.6. While we observe a divergence in stocks to EEA compared to non-EEA for banks that had passporting authorisation after the referendum and/or Brexit, there are no substantial divergences for banks that did not have passporting authorisation.

We run the following regression:

$$\begin{aligned}\ln(stock_{bjt}) = \alpha + \beta_1(PostRefer_t \times PassAuth_b) + \beta_2(PostRefer_t \times PassAuth_b \times EEA_j) \\ + \beta_3(Post21_t \times PassAuth_b) + \beta_4(Post21_t \times PassAuth_b \times EEA_j) \\ + \alpha_{bj} + \alpha_{jt} + \varepsilon_{bjt} \quad (6.2)\end{aligned}$$

outside the UK or EEA can be authorised to operate a branch in the UK.

[44] 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 don't observe any status switch in that case). It is identified as an EEA branch (81 banks) if it had the status "Banks incorporated in the UK authorised to accept deposits" in 2015 or 2019, or had the status "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 abstract from banks that are part of the PRA list Annex in 2019 or 2015 "Banks authorised in the EEA entitled to establish branches in the UK but not to accept deposits in the UK", that includes 5 banks.

[45] We find that intermediation activity of UK branches of non-EEA banks with EEA and non-EEA are falling after Brexit, and this could be due to integration within the UK banking network, in addition to country-specific changes in barriers or aggregate shocks.

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. β_1 and β_3 show the additional percentage change in lending to or deposit-taking from non-EEA by banks that had passporting, after the referendum and after loss of passporting respectively, while β_2 and β_4 show the additional percentage change in lending to or deposit-taking from EEA by banks that had passporting, in the two periods, relative to banks that did not have this authorisation. We include bank-destination fixed effects to focus on changes in exports by a bank to a country, and destination-time fixed effects to account for time-varying demand shocks (for instance those that occur due to changes in trade in goods or other services). 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.

Table 1, shows that loans to as well as deposits from an EEA country by banks that could passport their authorisation before Brexit had fallen by more than those by UK branches of non-EEA banks, after passporting was lost in 2021Q1 . This additional impact is statistically significant and implies a lower stock by 50-60%. Appendix A.6 discusses robustness checks. Removing the years of Covid-19 and high inflation (i.e. 2020-2021) 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 loss of passporting authorisation on non-EEA activities of the bank relative to those of banks that did not have passporting authorisation. 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 5% significance level for loan and 10% significance level for deposits. 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. Tables 16 and 17, how that lending or deposit-taking in pounds for banks that lost passporting did not respond any differently to transactions in 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 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.

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

	(1) Loan	(2) Deposit
PostRefer×PassAuth	-0.245**	-0.170
	(0.103)	(0.108)
PostRefer×PassAuth×EEA	-0.112	-0.141
	(0.120)	(0.139)
Post21×PassAuth	-0.079	-0.051
	(0.100)	(0.116)
Post21×PassAuth×EEA	-0.624***	-0.529**
	(0.133)	(0.217)
Observations	208873	252562
Adjusted R^2	0.866	0.834

Notes: Estimation uses BoE data to estimate Eq. 6.2, 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.

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. We create 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[46] for the non-financial sector ($PreEEAExp$). This measure is constructed separately for deposits and loans ($PreEEAExpL$ and $PreEEAExpD$ respectively).[47] Figure 16 in Appendix A.7 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 18 in Appendix A.7).

[46]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.

[47]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.

To quantify these changes, we run the below regression:

$$\ln(stock_{bt}) = \alpha + \beta_1 \left(PostRefer_t \times PreEEAExp_b\right) + \beta_2 \left(Post21_t \times PreEEAExp_b\right) + \alpha_b + \alpha_t + \varepsilon_{bt} \quad (6.3)$$

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 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 insignificant.

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

	(1) Aggregate (EEA + non-EEA)	(2) EEA	(3) 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)
Observations	6170	5813	5931
Adjusted R^2	0.767	0.777	0.791

Notes: Estimation uses BoE data to estimate Eq. 6.3, 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.

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

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

	(1) Aggregate (EEA + non-EEA)	(2) EEA	(3) 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)
Observations	5832	5377	5620
Adjusted R^2	0.806	0.809	0.810

Notes: Estimation uses BoE data to estimate Eq. 6.3, 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.

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 19 and 20 in Appendix A.7 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.

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 6.3 on total stocks and stocks corresponding to UK-residents 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.[48]

Table 4 shows the output for the regression for loans. UK banks that had a higher share of EEA in its stocks of loans to partner countries, 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, the reduced lending of these banks to UK-residents, combined with a lower stock of lending to EEA (as seen in Column 2 of Table 2) leads to reduced lending activity when the importance of EEA in stocks of exports is higher.

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

	(1) Total	(2) UK
PostRefer×PreEEAExpL	-0.009**	-0.004
	(0.005)	(0.005)
Post21×PreEEAExpL	-0.004	-0.003
	(0.003)	(0.003)
Observations	6686	6601
Adjusted R^2	0.808	0.852

Notes: Estimation uses BoE data to estimate Eq. 6.3, 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.

For deposits (Table 5), banks that have a higher share of EEA in stocks of deposit taken from partner country, 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. 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.

[48]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 5: Banks' deposits from All countries and UK - share of EEA in stocks before Referendum

	(1) Total	(2) UK
PostRefer×PreEEAExpD	-0.003	-0.002
	(0.002)	(0.003)
Post21×PreEEAExpD	-0.001	-0.002
	(0.002)	(0.003)
Observations	6685	6560
Adjusted R^2	0.855	0.905

Notes: Estimation uses BoE data to estimate Eq. 6.3, 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.

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.[49] 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 12 in Appendix A.5 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 6.2, 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

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

the EEA relative to the banks that could not access the EEA market freely.[50]

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 Corps.	
	Loan	Deposit	Loan	Deposit
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)
Observations	142676	100801	57065	82276
Adjusted R^2	0.777	0.785	0.760	0.783

Notes: Estimation uses BoE data to estimate Eq. 6.2, 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.

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 services to the non-financial sector.

6.3 Impact on intragroup activities

A large literature on multinational activities 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.[51] 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.

[50]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 21-24 in Appendix A.7, 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.

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

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, expansion of the group in another country may be through 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 again 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 that anticipation of loss of authorisation increased loans to and deposits from EEA after the referendum, these effects are not statistically significant. Instead we find 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.

Again, taking a broader view of barriers, we estimate Equation 6.3 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 7: Banks' loans to and deposits from non-resident, intragroup banks - by passporting

	(1) Loan	(2) Deposit
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)
Observations	43121	49849
Adjusted R^2	0.784	0.818

Notes: Estimation uses BoE data to estimate Eq. 6.2, 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.

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

	(1)	(2)	(3)	(4)
	Loan (PreEEAExpL)		Deposit (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)
Observations	4271	5292	3724	4951
Adjusted R^2	0.777	0.839	0.789	0.796

Notes: Estimation uses BoE data to estimate Eq. 6.3, 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 Intragroup Trade

Banks may interact with intragroup entities through other financial and managerial activities as well. To investigate this, we use intragroup fees and cost recharges (income from non-resident entities of the same company-group 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) as a proxy.[52]

Since access of EEA-resident banks to the UK market was also affected by the changes in trade policy, there may also be an increase in exports of services by EEA-resident entities to UK-resident intragroup banks. Therefore, we use the fees and recharges paid by UK-resident banks on imports from intragroup entities to study this mechanism, as well.

Figure 4 shows the change in intragroup fees and cost recharges received (exports) and paid (imports) by UK-resident banks from/to EEA and non-EEA, relative to their 2016Q1 values. While exports to EEA and non-EEA followed a similar trend initially, there is a large divergence before the trade barriers come into effect. The divergence in imports of services from intragroup entities in EEA compared to non-EEA occurred close to the referendum.

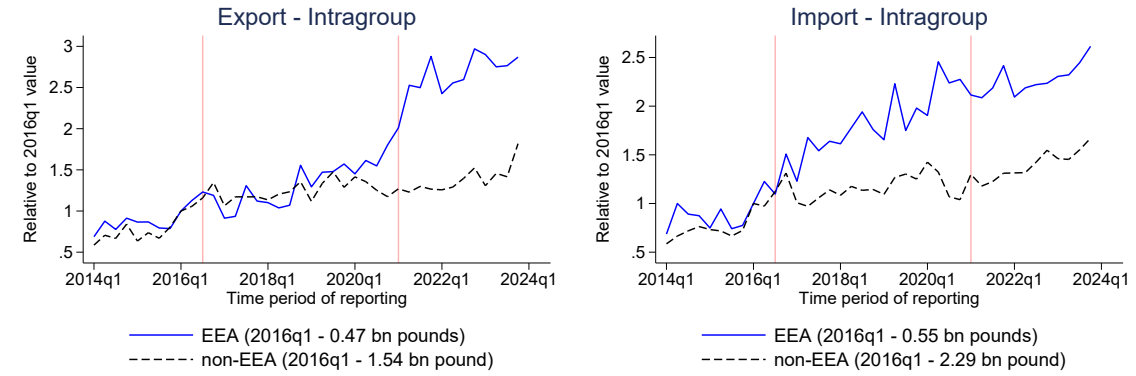


Figure 4: Intragroup trade of UK banks

These two graphs together show that trade of banks with non-EEA changes little as UK's trade relations with the EU changes, but banks trade more with entities within the same company-group in the EEA. This increase is particularly noteworthy given that export of some of the services captured in the variable (like loans and advances, current account services, investment banking, advisory, brokerage and underwriting etc.) are themselves subject to trade barriers. Moreover, these services to non-resident entities other than intragroup banks, in the EEA is falling (as reflected in fall in export to EEA measured by fees and commission in Figure 8)

To quantify this difference in trade with EEA relative to non-EEA after the referendum and the new trade barriers, we run the following regression. Here, we take a broader view of barriers and also account for the fact that our proxy captures a wide range of intragroup activities, and not just banking intermediation, and therefore compare trade with EEA relative to non-EEA.

[52]Unlike stocks, this measure is used in the Balance of Payments directly.

$$\ln(intragroup_{bpt}) = \alpha + \beta_1 \left(PostRefer_t \times EEA_p\right) + \beta_2 \left(Post21_t \times EEA_p\right) + \alpha_{bp} + \alpha_{bt} + \varepsilon_{bpt} \quad (6.4)$$

Note that p refers to partner country here (importer for the export regression and exporter for the import regression). We include bank-partner country fixed effect to control for time-invariant differences in trade of bank b with different partner countries, and bank-time fixed effect to absorb bank-level shocks over time that affect trade with all partner countries. Table 9 shows a significant increase in intragroup fee received from and paid to EEA compared to non-EEA after the trade barriers come into effect. As mentioned in Appendix A.4, we allocate annually reported intragroup fees and cost recharges to each quarter equally in our analysis here.[53]

Table 9: Trade with non-resident intragroup entities

	(1)	(2)
	Export	Import
PostRefer×EEA	-0.081	0.105
	(0.153)	(0.145)
Post21×EEA	0.287**	0.219**
	(0.130)	(0.084)
Observations	24608	23142
Adjusted R^2	0.829	0.833

Notes: Estimation uses BoE data to estimate Eq. 6.4, with log of intragroup fees and cost recharges received from and paid to intragroup entities in a partner country and a 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. Bank-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.

6.3.3 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

[53]This variable can include transfer pricing. As robustness check, we remove partner countries that are classified as tax havens, and our results remain unchanged.

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 information on all banks that share the same global ultimate owner (GUO) with the UK bank[54], 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.[55] 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:

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

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 of evolutions in markets of a country.

Table 10 shows that relative to companies which all UK banks 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

[54] 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.

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

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.

Table 10: Number of intragroup entities - by passporting

	(1)
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)
Observations	16682
Adjusted R^2	0.903

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 taking the consolidated accounts of that entity. We run the following regression

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

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, employment. We include intragroup entity fixed effect[56] 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 of evolutions in markets of a country and GUO-location fixed effects to obtain changes within a location of a company group.

The first two columns of Table 11 only takes unconsolidated accounts of entities for which financial informtion is available, while Columns 3 and 4, adjust for this by taking consolidated accounts of nearest owner. 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 see an increase in employment of the EEA intragroup entities after the referendum, but at the 10% significance level, suggesting some expansion in capacity of these entities, but this affect is not observed when taking the consolidated accounts.

Table 11: Assets and Employment of intragroup entities - by passporting

	(1)	(2)	(3)	(4)
	Unconsolidated		Consolidated	
	Assests	Emp	Assests	Emp
PostRefer×PassAuth×EEA	-0.111	0.199*	-0.472	-0.290
	(0.161)	(0.115)	(0.346)	(0.422)
Post21×PassAuth×EEA	0.249	-0.084	-0.367	-0.371
	(0.205)	(0.110)	(0.361)	(0.436)
Observations	11578	6254	5437	3183
Adjusted R^2	0.954	0.978	0.960	0.969

Notes: Estimation uses Historical Orbis data to estimate Eq. 6.6, with log of assets and employment of intragroup entities in a country, by quarter as dependent variables. Columns (1) and (2) take unconsolidated accounts for entities for which financial information is available. 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. We dont

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

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, a key service sector. It discusses the kind of 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 imposing barrier, and these effects can be substantial. UK's activity with EEA reduced, relative to global trends, loss of EEA-wide authorisation reduced lending and deposit-takig with EEA by 50-60%. More exposed banks 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 effect of trade barriers on activities with other countries can be ambiguous, and we find no or small substitution in deposit-taking, not in lending. Additionally, cross-border barriers can restrict 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 fall. The literature on multinationals have shown companies using their international organisation to adapt to an increase in barriers imposed on a country, and we test this for our banks. We find that, while companies attempt to expand the capacity of their affiliates in the EEA, we do not observe an increase in banking activity of these entities. While there is debate in the literature that multinational firms may be more resilient than a sector in the country, the evidence we have so far is that firms did not gain much either. The paper, thereby addresses a policy question. It shows that regulations and policies for regulatory autonomy and financial stability has substantial consequences for trade and exports of the economy, and the performance of a key sector. In future work, we use the theoretical framework and estimates from the empirical analysis to quantity this impact on the performance of the sector to measure the loss of productivity of the banking sector.

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A Appendix

A.1 Impact of trade barriers: Details

A.1.1 Increase in cost of providing loans to E

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

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

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

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

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.1.2 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.2 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[57], 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 5 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.

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

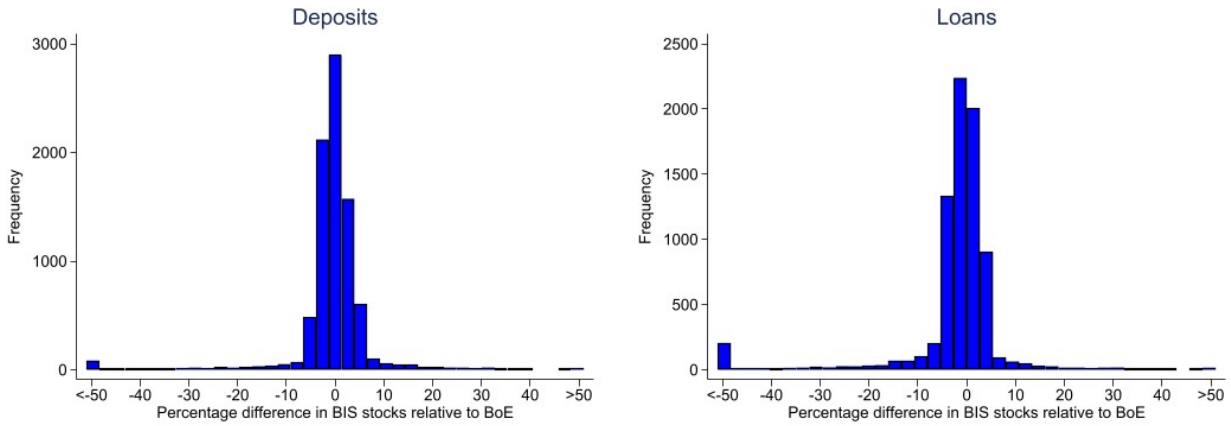


Figure 5: Comparing BoE and BIS-LBS stocks for UK

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

[57]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.

as well.[58] We compare the BIS-LBS data, aggregated to the level of partner country 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 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 (measure same as above).

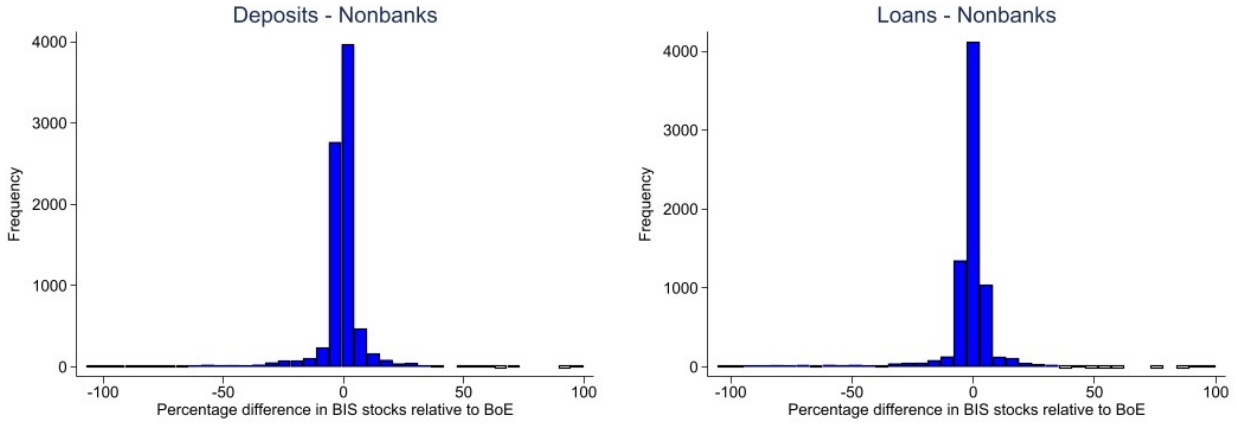


Figure 6: Comparing BoE and BIS-LBS stocks corresponding to Non-banks for UK

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 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

[58]Breakdown of stocks by partner country is not available in BIS-LBS for other counterparty sectors when UK is the reporting country, so this is the closest we can get to our analysis of the non-financial sector.

only constitute a small component of of the stocks for the non-financial sector.

A.3 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.[59] 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.4 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 7 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.[60]

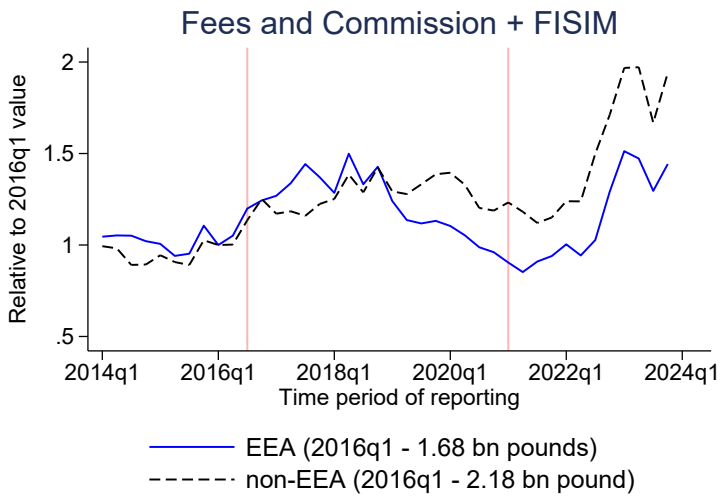


Figure 7: Exports by UK banks (FISIM + Fees and Commissions)

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

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

[60] 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.

and FISIM in Figure 8. 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 stocks).[61] 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.

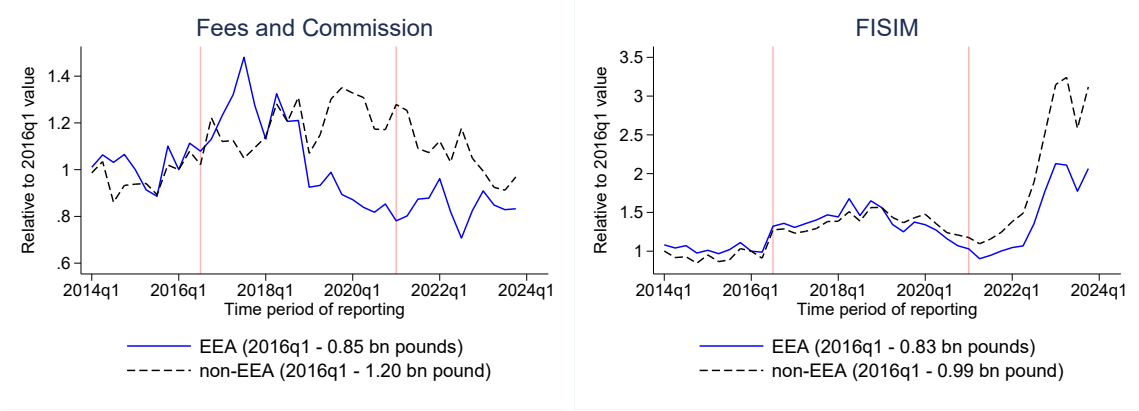


Figure 8: Exports by UK-resident banks - Fees and Commission, FISIM

A.4 Explicit charges for deposit-taking and lending services to non-residents

A.4.1 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

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

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[62]

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 9 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.

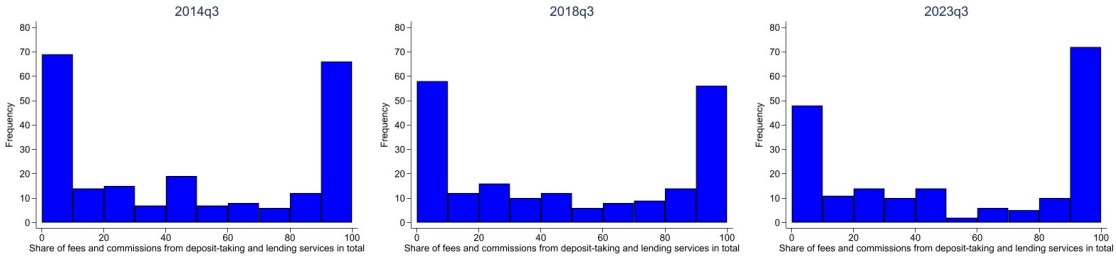


Figure 9: Number of banks by share of fees and commissions from deposit-taking and lending exports

Figure 10 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

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

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.

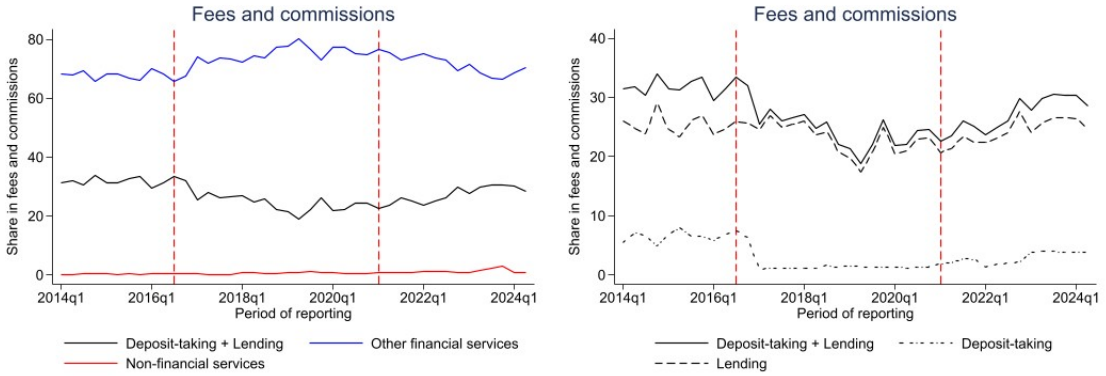


Figure 10: Share of components of fees and commissions

A.4.2 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.5 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 11 shows the stocks corresponding to the lending and deposit-taking services exported by the UK, relative to their 2016Q1 value (Figure 13 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).

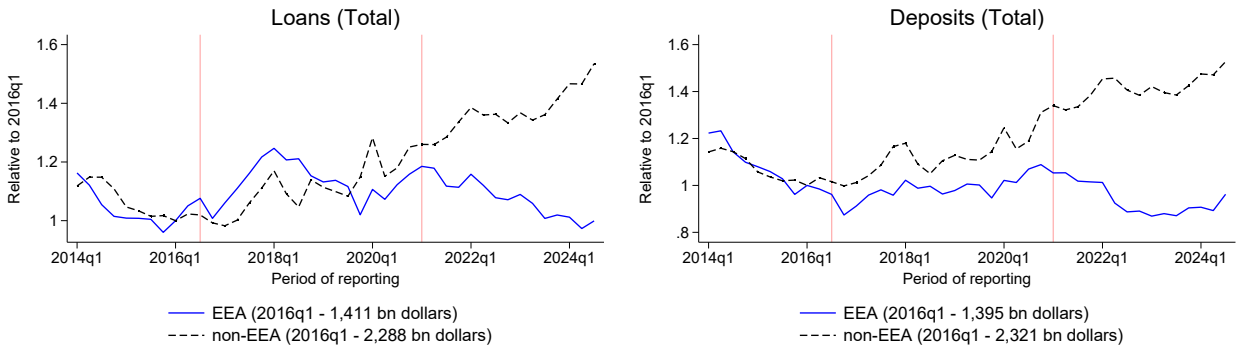
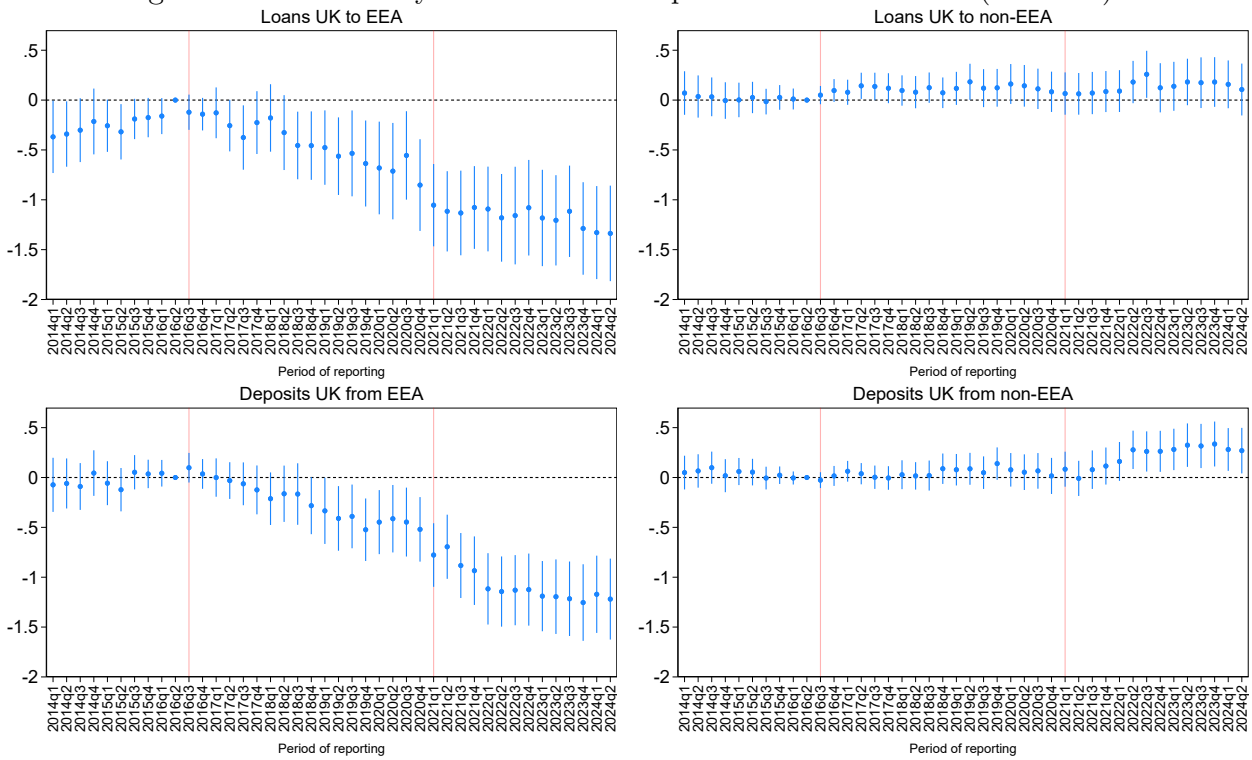


Figure 11: Stocks of loans provided and deposits taken by UK (BIS-LBS)

Figure 12 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 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 11, which also speaks to the coverage of the BoE data.

Figure 12: 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.

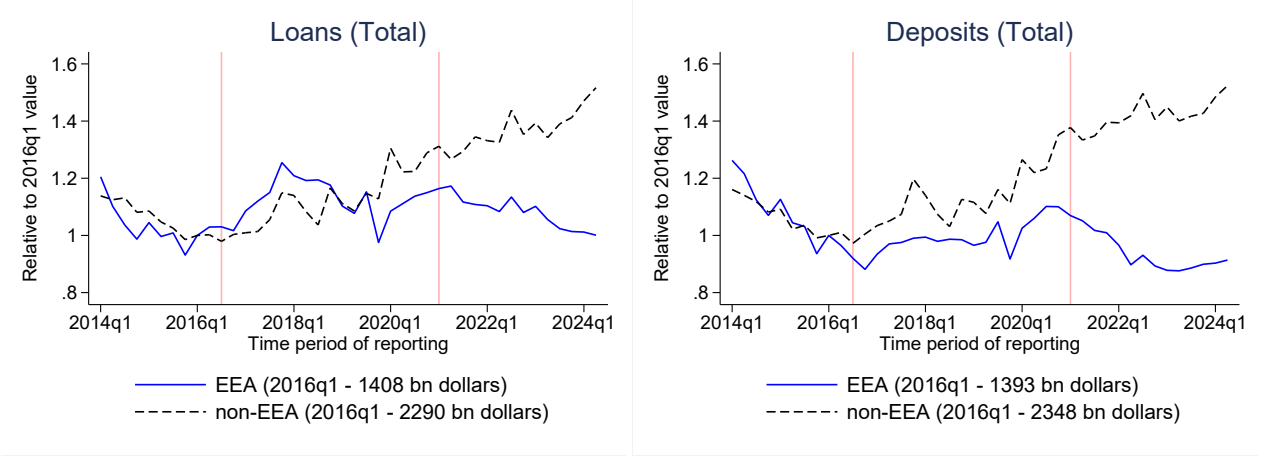


Figure 13: Stocks of Loans to and Deposits from non-residents (BoE)

A.6 Passporting: Robustness

Figure 14: Loans to the non-financial sector - by incorporation status

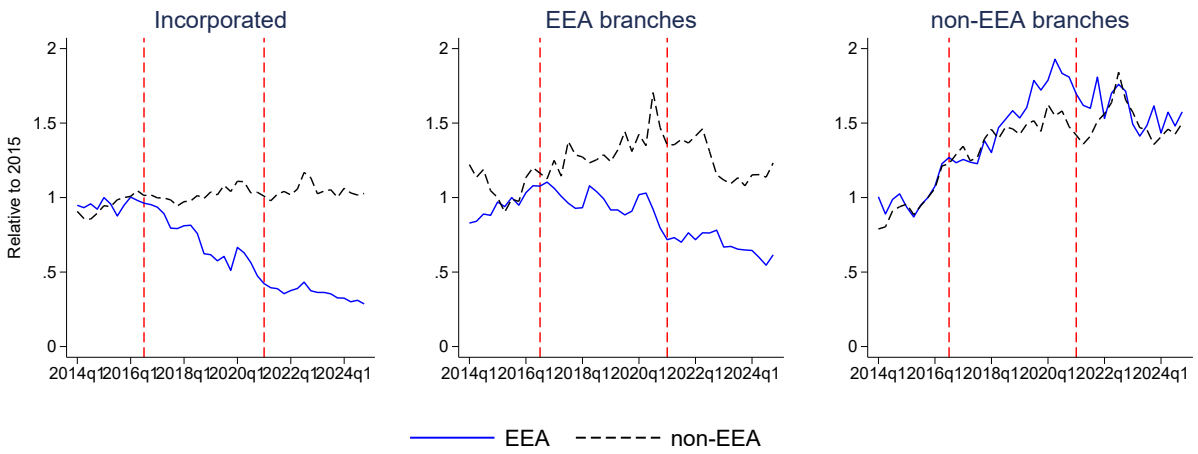
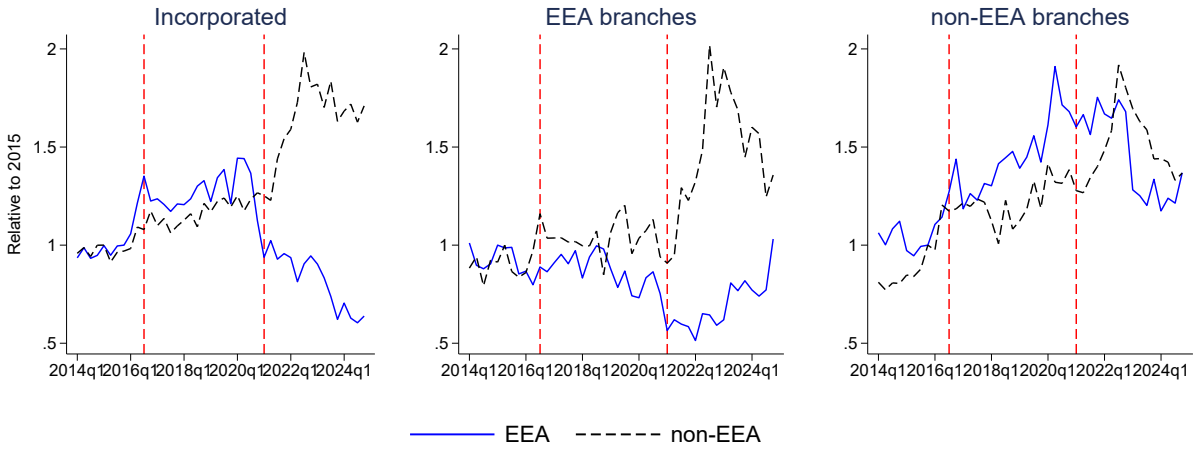


Figure 15: Deposits from the non-financial sector - by incorporation status



	(1) Loan	(2) Deposit
PostReferxPassAuth	-0.245***	-0.150
	(0.093)	(0.094)
PostReferxPassAuthxEEA	-0.040	-0.050
	(0.114)	(0.126)
Post21xPassAuth	-0.108	-0.008
	(0.141)	(0.156)
Post21xPassAuthxEEA	-0.815***	-0.668**
	(0.185)	(0.270)
Observations	152271	186812
Adjusted R^2	0.867	0.838

Table 12: Banks' loans to and deposits from non-resident, non-financial sector - by passporting, removing all periods in 2020, 2021, 2022 (Covid-19 and high inflation)

	(1) Loan	(2) Deposit
PostReferxPassAuth	-0.237***	-0.136
	(0.091)	(0.098)
PostReferxPassAuthxEEA	-0.155	-0.143
	(0.120)	(0.142)
Post21xPassAuth	-0.077	-0.032
	(0.099)	(0.115)
Post21xPassAuthxEEA	-0.646***	-0.500**
	(0.133)	(0.214)
Observations	185105	221623
Adjusted R^2	0.859	0.833

Table 13: Banks' loans to and deposits from non-resident, non-financial sector - by passporting, accounting for ring-fencing changes in 2018 (summing up stocks across entities of a banking group that was ring-fenced

	(1) Loan	(2) Deposit
PostReferxPassAuth	-0.253**	-0.179*
	(0.101)	(0.107)
PostReferxPassAuthxEEA	-0.115	-0.140
	(0.119)	(0.139)
Post21xPassAuth	-0.057	-0.021
	(0.108)	(0.123)
Post21xPassAuthxEEA	-0.611***	-0.518**
	(0.143)	(0.230)
Observations	182152	222882
Adjusted R^2	0.857	0.828

Table 14: Banks' loans to and deposits from non-resident, non-financial sector - by passporting, only those banks that were in the dataset before referendum (may have exited later)

	(1) Loan	(2) Deposit
PostReferxPassAuthxEEA	-0.093	-0.077
	(0.124)	(0.140)
Post21xPassAuthxEEA	-0.555***	-0.408*
	(0.130)	(0.228)
Observations	208628	252176
Adjusted R^2	0.876	0.847

Table 15: Banks' loans to and deposits from non-resident, non-financial sector - by passporting, including bank-time FE

	(1) Loan	(2) Deposit
PostReferxPassAuth	-0.263***	-0.141
	(0.094)	(0.089)
PostReferxPassAuthrxGBP	-0.192	-0.039
	(0.168)	(0.108)
Post21xPassAuth	-0.124	-0.141
	(0.077)	(0.114)
Post21xPassAuthxGBP	-0.135	0.150
	(0.171)	(0.114)
Observations	514909	769591
Adjusted R^2	0.369	0.234

Table 16: Banks' loans to and deposits from non-resident, non-financial sector - by passporting, by currency, collapsing across partner country

	(1) Loan	(2) Loan EEA	(3) Loan nonEEA	(4) Deposit	(5) Deposit EEA	(6) Deposit nonEEA
PostReferxPassAuth	-0.288***	-0.335**	-0.260**	-0.089	-0.240*	-0.054
	(0.103)	(0.130)	(0.109)	(0.095)	(0.136)	(0.101)
PostReferxPassAuthxGBP	-0.167	-0.174	-0.211	-0.091	-0.126	-0.066
	(0.178)	(0.264)	(0.191)	(0.125)	(0.214)	(0.129)
Post21xPassAuth	-0.151	-0.479***	0.078	-0.094	-0.504***	0.049
	(0.111)	(0.149)	(0.118)	(0.123)	(0.160)	(0.140)
Post21xPassAuthxGBP	-0.108	0.088	-0.311	0.104	0.423**	-0.027
	(0.224)	(0.251)	(0.244)	(0.129)	(0.204)	(0.143)
Observations	304716	103697	200986	516328	144635	371654
Adjusted R^2	0.370	0.405	0.394	0.222	0.355	0.219

Table 17: Banks' loans to and deposits from non-resident, non-financial sector - by passporting, by currency, for each partner group

A.7 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 18 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.

	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

Table 18: Summary statistics for Measure of Share of EEA in Stocks before Referendum

Figure 16 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 18 in Appendix **??**). 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:

$$\ln(stock_{bt}) = \alpha + \beta_1 PostRefer_t \times HighPreEEAExp_b + \beta_2 Post21_t \times HighPreEEAExp_b + \alpha_b + \alpha_t + \varepsilon_{bt} \quad \text{(A.1)}$$

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 19), banks with above median share of EEA in loan stocks before the referendum have a fall in total stocks of loans to non-residents after the referendum. These banks reduce their lending to the EEA after the referendum, and reduce

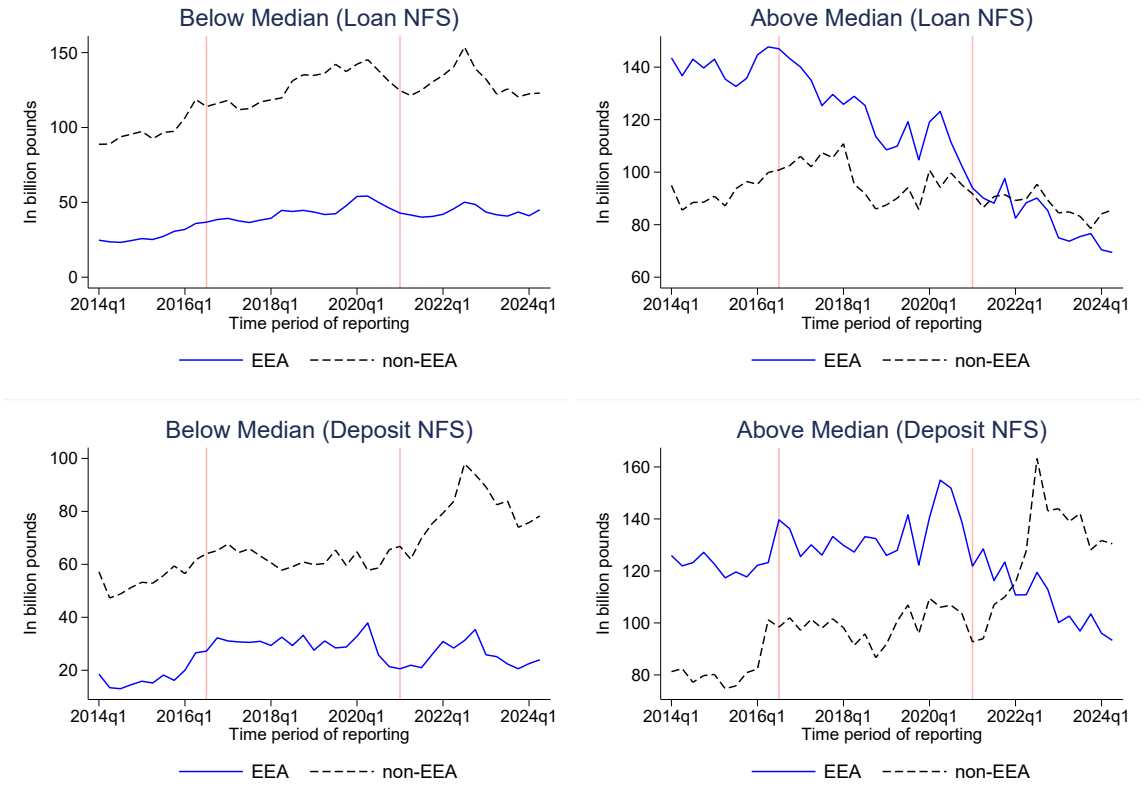


Figure 16: Stocks, by low and high share of EEA in stocks corresponding to exports

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.

	(1) Aggregate	(2) EEA	(3) non-EEA
PostReferxHighPreEEAExpL	-0.285*	-0.534***	-0.065
	(0.154)	(0.167)	(0.174)
Post21xHighPreEEAExpL	-0.162	-0.367*	-0.073
	(0.206)	(0.211)	(0.193)
Constant	13.373***	12.397***	12.729***
	(0.062)	(0.070)	(0.062)
Observations	6170	5813	5931
Adjusted R^2	0.767	0.776	0.791

Table 19: Banks' loans to EEA and non-EEA - share of EEA in stocks before Referendum

Table 20 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.

	(1) Aggregate	(2) EEA	(3) non-EEA
PostReferxHighPreEEAExpD	-0.008	-0.582***	0.438***
	(0.141)	(0.204)	(0.152)
Post21xHighPreEEAExpD	0.184	0.055	0.463*
	(0.224)	(0.298)	(0.253)
Constant	12.553***	11.272***	11.667***
	(0.060)	(0.088)	(0.060)
Observations	5832	5377	5620
Adjusted R^2	0.807	0.808	0.810

Table 20: Banks' deposits from EEA and non-EEA - share of EEA in stocks before Referendum

	(1) Aggregate (EEA + non-EEA)	(2) EEA	(3) non-EEA
PostReferxPreEEAExpL	0.000	0.001	0.002
	(0.004)	(0.005)	(0.004)
Post21xPreEEAExpL	-0.006	-0.006	-0.008*
	(0.004)	(0.004)	(0.004)
Observations	6406	5948	6251
Adjusted R^2	0.834	0.782	0.815

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

	(1) Aggregate (EEA + non-EEA)	(2) EEA	(3) non-EEA
PostReferxPreEEAExpD	0.003	0.004	0.003
	(0.003)	(0.004)	(0.004)
Post21xPreEEAExpD	-0.003	0.001	0.001
	(0.004)	(0.005)	(0.004)
Observations	5234	4150	4786
Adjusted R^2	0.766	0.747	0.784

Table 22: Banks' deposits from EEA and non-EEA - share of EEA in stocks before Referendum, other banks

	(1) Aggregate (EEA + non-EEA)	(2) EEA	(3) 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)
Observations	4436	3658	3995
Adjusted R^2	0.832	0.816	0.834

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

	(1) Aggregate (EEA + non-EEA)	(2) EEA	(3) non-EEA
PostReferxPreEEAExpD	-0.004	-0.006	-0.003
	(0.005)	(0.005)	(0.006)
Post21xPreEEAExpD	-0.000	0.004	0.001
	(0.004)	(0.006)	(0.006)
Observations	4750	4011	4412
Adjusted R^2	0.834	0.821	0.807

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