

Trade in Services under Regulatory Barriers: Evidence from UK Banking

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Motivation

- Services are increasingly important globally
 - Services in total trade increasing (Baldwin et al. 2024); service-exports leading growth, employment (Baldwin 2024, WTO 2024)
- Barriers to trade in services and their impact remain underexplored
- Sector-specific studies can provide insights, e.g. **banking services**
 - Vital part of financial services (most traded service globally, WTO 2019)
 - Reduces financial frictions that constrain economic activities
 - Restrictions due to regulatory reasons and financial stability, but affect trade

This paper

Research Questions:

How do regulatory barriers affect trade in services by banks?

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Analysis:

- Context: UK banking and changes in UK-EEA trade arrangement due to Brexit
- Theoretical framework of banking across borders: examine impact of barriers to cross-border activities
- Empirical estimation:
 - Changes in regulations applicable to UK banks - triple difference approach
 - Cross-border **lending** and **deposit-taking**, by partner country and sector
 - Activities of affiliates located in other countries

Preview of Results

- ① Cross-border activity reduces substantially with regulatory barriers:
 - Loss of passporting $\implies \approx$ **45% reduction** in loans to and deposits from EEA
 - One s.d. higher prior exposure to EEA $\implies \approx$ **30% lower** EEA loans and deposits
- ② Effect of trade barriers on activities with other countries mixed:
 - Theoretical framework - **ambiguous**
 - Empirical evidence - **limited or no substitution**
- ③ Limited evidence that multinational structure preserves activity within group:
 - Number of intragroup entities in EEA **increases**
 - But **no increase** in lending or deposit-taking of affiliates in EEA

Literature

- **Trade in services and non-tariff barriers:**

Adarov & Ghodsi (2023), Hsieh & Rossi-Hansberg (2023), Munoz (2023), Dhingra et al. (2023), Conteduca & Kazakova (2021), Nordås & Rouzet (2017), Francois & Hoekman (2010)

Contribution: Examines an often-excluded sector, extends analysis of regulatory barriers

- **Impact of Brexit on Trade:**

Bhalotia et al. (2025), Du et al. (2025), Breinlich & Magli (2024), Freeman et al. (2024), Gasiorsek & Tamberi (2023), Breinlich et al. (2020), Graziano et al. (2020), Crowley et al. (2019), Van Reenen (2016)

Contribution: Brexit barriers that had substantial negative effect

- **Cross-border banking and international banking integration:**

Imbierowicz et al. (2025), Lloyd et al. (2023), Niepmann (2023), Berg et al. (2021), Frost et al. (2017), Hills et al. (2017), Niepmann (2015), Kerl & Niepmann (2015), Bouvatier & Delatte (2015), Buch et al. (2014), Lehner (2009), Berger (2007)

Contribution: Estimates impact of bilateral changes on trade + multinational activities

Road Map

- Contextual Background
- Theoretical Framework
- Data
- Impact of Barriers on Cross-border Activities
- Activities of Affiliates
- Conclusion

UK banking sector and changes in Barriers

- UK world's largest centre for cross-border banking
- 1/3rd of total banking services exports of UK to EEA

[Other Stats](#)

→ **Under EU-membership:**

[Details](#)

- Banks authorised in an EEA country can serve other EEA countries cross-border or through local branch - Passporting

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→ **After referendum (June 2016):**

- Expected to lose passporting after Brexit
- Uncertainty about future regime

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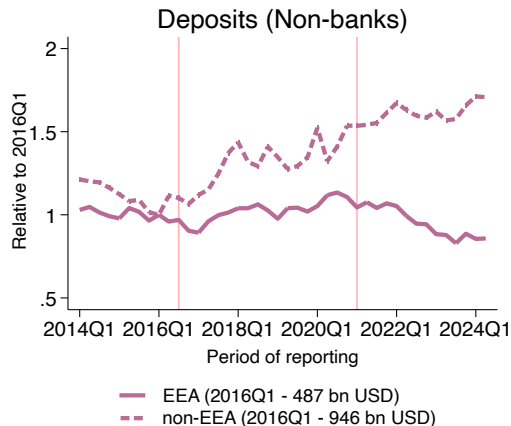
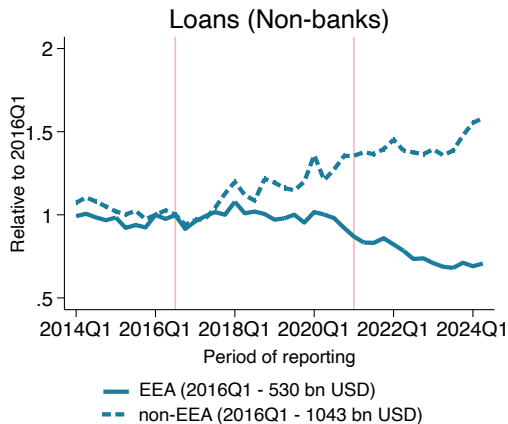
→ **After referendum (June 2016):**

- Expected to lose passporting after Brexit
- Uncertainty about future regime

→ **After exit from EU (January 2021):**

- UK classified as a third country; loss of passporting
- Cross-border service: Each countries' regime for licensing, reverse solicitation etc.

Total stocks of Loans to and Deposits from Non-Residents



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Environment

- Three countries: B (UK), E (EEA) and R (non-EEA)
- Representative firm in country i , demand for loan from bank b :

$$\ell_{bi} = \alpha_i^L (r_{bi}^L)^{-\sigma}$$

- Representative depositor in country i , supply of deposit to bank b :

$$s_{bi} = \alpha_i^D (r_{bi}^D)^\theta$$

- Bank b , resident in B :
 - Provides loans and takes deposits, domestically and cross-border
 - Efficiency a_b (drawn from distribution)

Cost of providing service - domestic and cross-border

- Cost of providing lending or deposit-taking service incurred by bank b :

$$c_{bi}^L = \frac{\ell_{bi}}{a_b}; \quad c_{bi}^D = \frac{s_{bi}}{a_b}$$

- Additional cost of providing cross-border service to $j \in \{E, R\}$
 - Lending: fixed cost χ_{Bj}^L , variable cost $\tau_{Bj}^L > 1$ on c_{bi}^L
 - Deposit-taking: fixed cost χ_{Bj}^D , variable cost $\tau_{Bj}^D > 1$ on c_{bi}^D
- Change in trade barriers - increase in cost of cross-border provision to E

Bank's profit maximisation

$$\max_{\{r_{bi}^L\}_i, \{\ell_{bi}\}_i, \{r_{bi}^D\}_i, \{s_{bi}\}_i} r_{bB}^L \ell_{bB} + r_{bE}^L \ell_{bE} + r_{bR}^L \ell_{bR}$$

Bank's profit maximisation

$$\max_{\{r_{bi}^L\}_i, \{\ell_{bi}\}_i, \{r_{bi}^D\}_i, \{s_{bi}\}_i} r_{bB}^L \ell_{bB} + r_{bE}^L \ell_{bE} + r_{bR}^L \ell_{bR} - \frac{(\ell_{bB} + \tau_{BE}^L \ell_{bE} + \tau_{BR}^L \ell_{bR})}{a_b} - \chi_{BE}^L - \chi_{BR}^L$$

Bank's profit maximisation

$$\begin{aligned} \max_{\{r_{bi}^L\}_i, \{\ell_{bi}\}_i, \{r_{bi}^D\}_i, \{s_{bi}\}_i} & r_{bB}^L \ell_{bB} + r_{bE}^L \ell_{bE} + r_{bR}^L \ell_{bR} - \frac{(\ell_{bB} + \tau_{BE}^L \ell_{bE} + \tau_{BR}^L \ell_{bR})}{a_b} - \chi_{BE}^L - \chi_{BR}^L \\ & - r_{bB}^D s_{bB} - r_{bE}^D s_{bE} - r_{bR}^D s_{bR} \end{aligned}$$

Bank's profit maximisation

$$\begin{aligned}
 \max_{\{r_{bi}^L\}_i, \{\ell_{bi}\}_i, \{r_{bi}^D\}_i, \{s_{bi}\}_i} & r_{bB}^L \ell_{bB} + r_{bE}^L \ell_{bE} + r_{bR}^L \ell_{bR} - \frac{(\ell_{bB} + \tau_{BE}^L \ell_{bE} + \tau_{BR}^L \ell_{bR})}{a_b} - \chi_{BE}^L - \chi_{BR}^L \\
 & - r_{bB}^D s_{bB} - r_{bE}^D s_{bE} - r_{bR}^D s_{bR} - \frac{(s_{bB} + \tau_{BE}^D s_{bE} + \tau_{BR}^D s_{bR})}{a_b} - \chi_{BE}^D - \chi_{BR}^D
 \end{aligned}$$

Bank's profit maximisation

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 & - r_{bB}^D s_{bB} - r_{bE}^D s_{bE} - r_{bR}^D s_{bR} - \frac{(s_{bB} + \tau_{BE}^D s_{bE} + \tau_{BR}^D s_{bR})}{a_b} - \chi_{BE}^D - \chi_{BR}^D \\
 \text{s.t.} \quad & \ell_{bB} + \ell_{bE} + \ell_{bR} \leq s_{bB} + s_{bE} + s_{bR}
 \end{aligned}$$

Bank's profit maximisation

$$\begin{aligned}
 & \max_{\{r_{bi}^L\}_i, \{\ell_{bi}\}_i, \{r_{bi}^D\}_i, \{s_{bi}\}_i} r_{bB}^L \ell_{bB} + r_{bE}^L \ell_{bE} + r_{bR}^L \ell_{bR} - \frac{(\ell_{bB} + \tau_{BE}^L \ell_{bE} + \tau_{BR}^L \ell_{bR})}{a_b} - \chi_{BE}^L - \chi_{BR}^L \\
 & \quad - r_{bB}^D s_{bB} - r_{bE}^D s_{bE} - r_{bR}^D s_{bR} - \frac{(s_{bB} + \tau_{BE}^D s_{bE} + \tau_{BR}^D s_{bR})}{a_b} - \chi_{BE}^D - \chi_{BR}^D \\
 & \text{s.t. } \ell_{bB} + \ell_{bE} + \ell_{bR} \leq s_{bB} + s_{bE} + s_{bR} \\
 & \ell_{bi} = \alpha_i^L \left(r_{bi}^L\right)^{-\sigma}, \quad s_{bi} = \alpha_i^D \left(r_{bi}^D\right)^{\theta} \quad \forall i \in \{B, E, R\}
 \end{aligned}$$

Bank's profit maximisation

$$\begin{aligned}
 \max_{\{r_{bi}^L\}_i, \{\ell_{bi}\}_i, \{r_{bi}^D\}_i, \{s_{bi}\}_i} & r_{bB}^L \ell_{bB} + r_{bE}^L \ell_{bE} + r_{bR}^L \ell_{bR} - \frac{(\ell_{bB} + \tau_{BE}^L \ell_{bE} + \tau_{BR}^L \ell_{bR})}{a_b} - \chi_{BE}^L - \chi_{BR}^L \\
 & - r_{bB}^D s_{bB} - r_{bE}^D s_{bE} - r_{bR}^D s_{bR} - \frac{(s_{bB} + \tau_{BE}^D s_{bE} + \tau_{BR}^D s_{bR})}{a_b} - \chi_{BE}^D - \chi_{BR}^D \\
 \text{s.t.} \quad & \ell_{bB} + \ell_{bE} + \ell_{bR} \leq s_{bB} + s_{bE} + s_{bR} \\
 & \ell_{bi} = \alpha_i^L \left(r_{bi}^L\right)^{-\sigma}, \quad s_{bi} = \alpha_i^D \left(r_{bi}^D\right)^{\theta} \quad \forall i \in \{B, E, R\}
 \end{aligned}$$

Solution:

$$\ell_{bi} = \alpha_i^L \left(\frac{\sigma}{\sigma - 1}\right)^{-\sigma} \left(\lambda + \frac{\tau_{Bi}^L}{a_b}\right)^{-\sigma}, \quad s_{bi} = \alpha_i^D \left(\frac{\theta}{\theta + 1}\right)^{\theta} \left(\lambda - \frac{\tau_{Bi}^D}{a_b}\right)^{\theta}$$

λ = shadow value of deposit

Increase in trade costs for E - Impact on E

- Increase in variable cost on loans ($\tau_{BE}^L \uparrow$) $\implies \ell_{bE} \downarrow$

$$\frac{d\ell_{bE}}{d\tau_{BE}^L} = -\kappa_E^L \left(\lambda + \frac{\tau_{BE}^L}{a_b} \right)^{-\sigma-1} \left(\underbrace{\frac{d\lambda}{d\tau_{BE}^L}}_{\text{Indirect Effect}} + \underbrace{\frac{1}{a_b}}_{\text{Direct Effect}} \right) < 0$$

Increase in trade costs for E - Impact on E

- Increase in variable cost on loans ($\tau_{BE}^L \uparrow$) $\implies \ell_{bE} \downarrow$

$$\frac{d\ell_{bE}}{d\tau_{BE}^L} = -\kappa_E^L \left(\lambda + \frac{\tau_{BE}^L}{a_b} \right)^{-\sigma-1} \left(\underbrace{\frac{d\lambda}{d\tau_{BE}^L}}_{\text{Indirect Effect}} + \underbrace{\frac{1}{a_b}}_{\text{Direct Effect}} \right) < 0$$

- Increase in variable cost on deposits ($\tau_{BE}^D \uparrow$) $\implies s_{bE} \downarrow$

$$\frac{ds_{bE}}{d\tau_{BE}^D} = \kappa_E^D \left(\lambda - \frac{\tau_{BE}^D}{a_b} \right)^{\theta-1} \left(\underbrace{\frac{d\lambda}{d\tau_{BE}^D}}_{\text{Indirect Effect}} - \underbrace{\frac{1}{a_b}}_{\text{Direct Effect}} \right) < 0$$

Increase in trade costs for E - Impact on B, R

- Simultaneous increase in variable costs to $E \implies$ ambiguous effects on ℓ, s for $i \in \{B, R\}$

$$\frac{d\ell_{bi}}{d\tau_{BE}^L} = -\kappa_i^L \left(\lambda + \frac{\tau_{Bi}^L}{a_b} \right)^{-\sigma-1} \frac{d\lambda}{d\tau_{BE}^L} > 0$$

$$\frac{d\ell_{bi}}{d\tau_{BE}^D} = -\kappa_i^L \left(\lambda + \frac{\tau_{Bi}^L}{a_b} \right)^{-\sigma-1} \frac{d\lambda}{d\tau_{BE}^D} < 0$$

Net effect: Depends on parameters in loan demand and deposit supply, variable cost for loans and deposits

[Details](#)
[Deposits](#)

Road Map

- Contextual Background
- Theoretical Framework
- **Data**
- Impact of Barriers on Cross-border Activities
- Activities of Affiliates
- Conclusion

Data

BIS - Locational Banking Statistics:

- Cross-country stocks of loans to and deposits from non-banking entities: 31 reporting countries, over 200 partner countries, quarterly 2014Q1 - 2024Q2

Bank of England statistical data on UK-resident deposit-taking institutions:

- Stocks of loans to and deposits from non-residents: by bank, quarter, partner country, sector of counterparty, for 270 banks, 2014Q1 - 2024Q2
- Incorporation status of banks, nationality of ultimate owner

[No. of Banks](#)[No. of Countries](#)[Stocks Summary Stats](#)

Historical Orbis Database:

- Ownership, affiliated subsidiaries and branches
- Financial history - assets, loans, deposits

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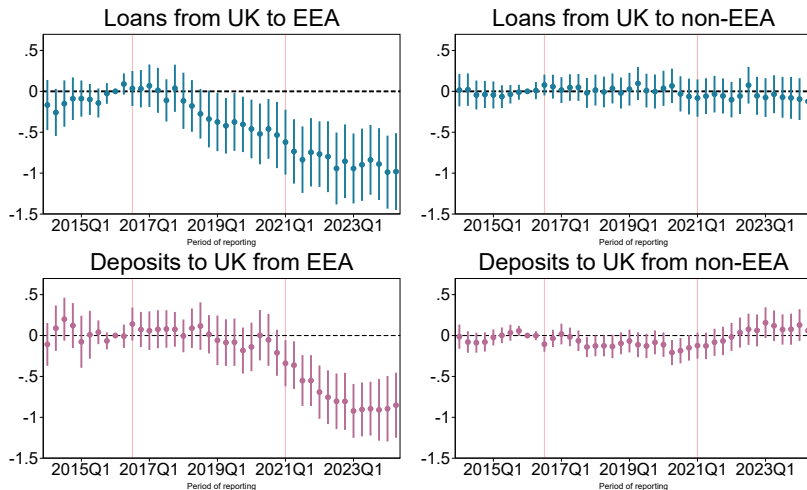
Aggregate stocks - Event Study

- BIS - Locational Banking Statistics: Cross-country stocks of loans given and deposits taken

$$\ln(stock_{ijt}) = \sum_{k \neq 2016Q1} \beta_1^k (k_t \times EEA_j \times UK_i) + \sum_{k \neq 2016Q1} \beta_2^k (k_t \times UK_i) \\ + \delta \ln(exchange_rate_{it}) + \alpha_{ij} + \alpha_{jt} + \varepsilon_{ijt}$$

- i = country giving loan or taking deposit (exporter), j = country taking loan or depositing (importer), t = quarter
- $k_t = \mathbb{1}\{t = k\}$, $UK_i = \mathbb{1}\{i = UK\}$, $EEA_j = \mathbb{1}\{j \in EEA\}$

Event Study: Fall in stocks with EEA, no change with non-EEA



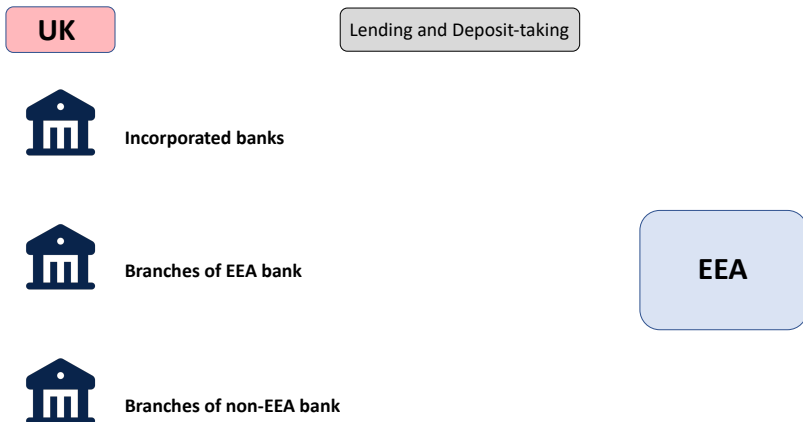
55-60% decline in stocks of loans to and deposits from EEA

Total

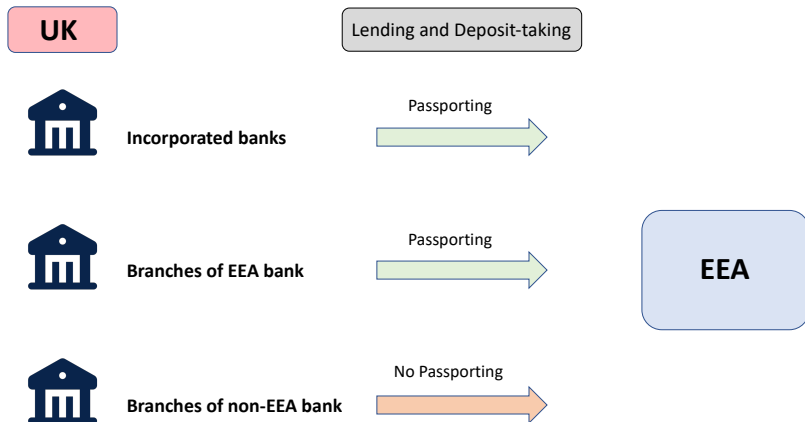
Robustness

Change

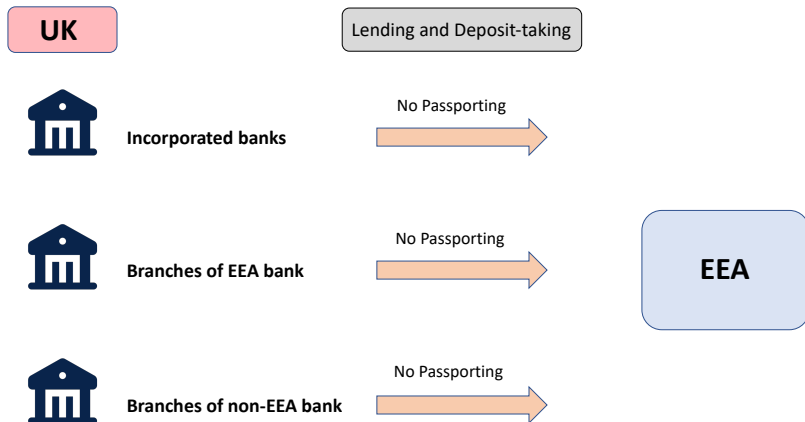
Cross-border banking



Under EU membership – Passporting



New Trade Regime – Loss of Passporting



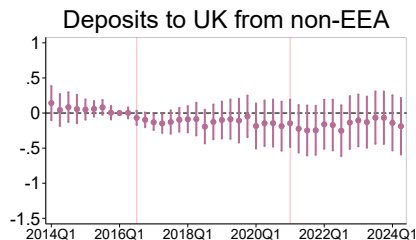
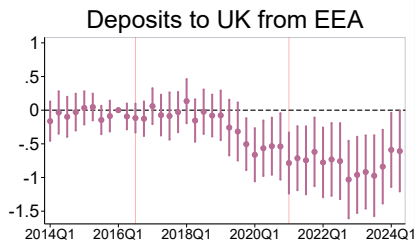
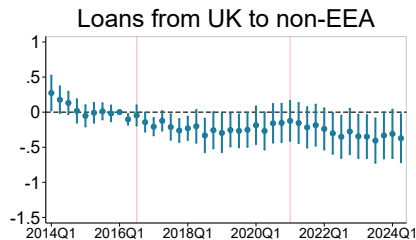
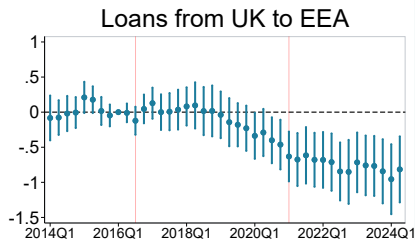
Loss of Passporting - Event Study

- Bank of England data: Bank-level

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

- b = bank, t = quarter, j = partner country, $EEA = \mathbb{1}\{j \in EEA\}$
- $PassAuth_b = 1$ if bank incorporated or branch of EEA bank

Event Study - Loss of Passporting - Fall in stocks with EEA



Loss of Passporting

- Estimate from triple difference specification

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

- $b = \text{bank}$, $t = \text{quarter}$, $j = \text{partner country}$, $EEA = \mathbb{1}\{j \in EEA\}$,
 $PostRefer_t = \mathbb{1}\{t \geq 2016Q3\}$, $Post21_t = \mathbb{1}\{t \geq 2021Q1\}$
- $PassAuth_b = 1$ if bank incorporated or branch of EEA bank

Loss of Passporting - Fall in stocks with EEA

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

Loss of Passporting - Robustness and Other Checks

- Consolidating by banking group by GUO Ringfencing
- Banks operating before referendum In 2014/2015
- Excluding years of Covid-19 Excl. 2020-22
- Number of countries banks provide service to Number
- Currency of lending/deposit-taking GBP vs Others
- Lending/deposit-taking with other banks and financial corporations Other Banks and FCs

Pre-referendum exposure to EEA

- Response of banks to barriers based on exposure to EEA before referendum

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

- b = bank, t = quarter, $PostRefer_t = \mathbb{1}\{t \geq 2016Q3\}$, $Post21_t = \mathbb{1}\{t \geq 2021Q1\}$
- $PreEEAExp$ = average share of EEA in stocks (of deposits or loans, as the case may be), over 2014 and 2015

PreEEAExp

Stocks, by bank-type

More exposed banks reduce lending to EEA

ln(Loans)	EEA	non-EEA
PostRefer \times PreEEAExpL	-0.010** (0.004)	0.003 (0.003)
Post21 \times PreEEAExpL	-0.008* (0.004)	-0.000 (0.004)
Fixed Effects:		
Bank	Yes	Yes
Time	Yes	Yes
Observations	5813	5931

More exposed banks reduce deposits from EEA

ln(Deposits)	EEA	non-EEA
PostRefer \times PreEEAExpD	-0.010*** (0.003)	0.008*** (0.003)
Post21 \times PreEEAExpD	-0.000 (0.005)	0.005 (0.005)
Fixed Effects:		
Bank	Yes	Yes
Time	Yes	Yes
Observations	5377	5620

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Intragroup affiliates and trade barriers

- Firms use local affiliates in foreign countries to avoid trade costs
- Banks could leverage their international organisation to continue to access EEA markets
- Investigate expansion of affiliates and their activities
 - Number of local affiliates in countries with increased barriers
 - Activity of affiliates in countries with increased barriers

Stocks

Stocks Exp

Number of affiliates

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

- \hat{b} = GUO, t = year, j = location of affiliate
- $EEA = \mathbb{1}\{j \in EEA\}$, $PostRefer_t = \mathbb{1}\{t \geq 2017\}$, $Post21_t = \mathbb{1}\{t \geq 2021\}$
- $PassAuth_{\hat{b}} = 1$ if at least one UK bank under GUO had passporting

Increase in number of affiliates in EEA

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

Activities of affiliates in EEA

$$\ln(y_{\tilde{b}t}) = \beta_1 (PostRefer_t \times PassAuth_{\hat{b}} \times EEA_j) + \beta_2 (Post21_t \times PassAuth_{\hat{b}} \times EEA_j) \\ + \alpha_{\tilde{b}} + \alpha_{\hat{b}t} + \alpha_{jt} + \alpha_{\hat{b}j} + \varepsilon_{\tilde{b}t}$$

- $\hat{b} = \text{GUO}$, $\tilde{b} = \text{affiliate}$, $t = \text{year}$ and $j = \text{location of affiliate}$
- $PostRefer_t = \mathbb{1}\{t \geq 2017\}$, $Post21_t = \mathbb{1}\{t \geq 2021\}$
- $EEA_j = 1$ if $j \in \{France, Germany, Ireland, Luxembourg Netherlands\}$
- $PassAuth_{\hat{b}} = 1$ if at least one UK bank under GUO had passporting

No substantial increase in assets or activities of affiliates in EEA

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

- Groups expand intragroup entities, but no increase in activity of entities
 \Rightarrow New entities relatively small

All EEA

Consolidated

DiD

GUO

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Conclusion

- Decline in lending and deposit-taking with non-residents due to regulatory barriers
- Restrictions and policies for regulatory autonomy can have significant consequences for trade
- Efficiency and advantage of a country in a sector makes substituting activities through affiliates difficult

Future work:

- Cross-border banking: General Equilibrium effects, impact on banks in EEA
- Trade in services: Quantify non-tariff barriers, impact on firm-level outcomes like productivity, business investment and aggregate effect on growth

Appendix

UK banking in numbers

- UK financial sector is 8.8% of UK economic output (House of Commons Library), 1/3 employment in banking
- Assets of UK financial system in 2022 around £27 trillion, £14 trillion was held by banks (House of Commons Library), 1/3rd of assets of UK banks in the form of cross-border lending (BoE data)
- Assets of UK banking sector over 4 times the GDP of the country
- UK largest centre for cross border lending and deposit-taking (15-17% share of the world) (BIS-LBS)
- UK largest global net exporter of financial services (trade surplus of \$ 87.2 bn in 2021) (TheCityUK)
- Export of lending and deposit-taking 25-30% of total exports of UK monetary financial institutions (ONS Pink Book)

UK withdrawal from EU: impact on banking services

UK classified as a third country after exit from the EU in January 2021.

- UK-based banks could no longer serve customers across EEA via **passporting**:
 - Freedom to provide services and freedom of establishment under Fourth Capital Requirement Directive
 - In September 2016, 5,500 UK-authorized firms use passporting rights
- Market access could not be obtained through **equivalence**:
 - Most core banking and financial services, like deposit taking, lending, payment and investment services, not subject to equivalence regime (Deslandes et al. 2019).
- **Trade and Cooperation Agreement** does not include provisions for financial services beyond standard MFN (Bhalotia et al. 2025)
- **Memorandum of Understanding** established forum for HMT and EC to discuss regulatory patterns

Measuring cross-border banking

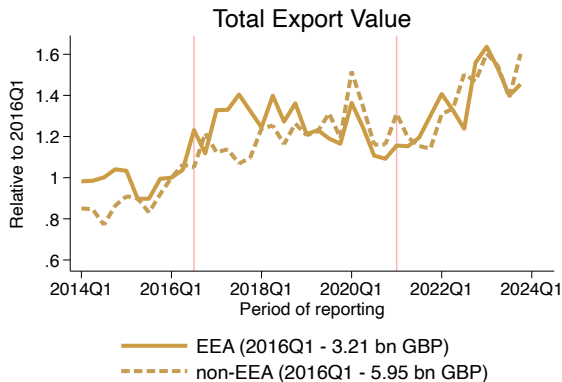
- Export of intermediation (lending and deposit-taking) services by UK-resident banks to non-residents:

[Total Exp](#) [Components](#)

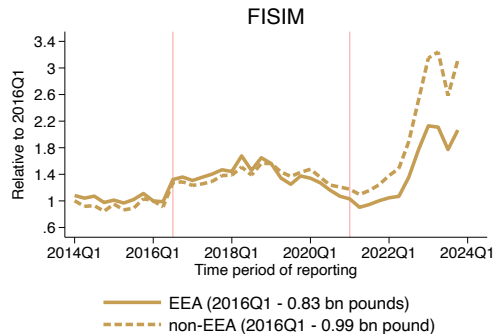
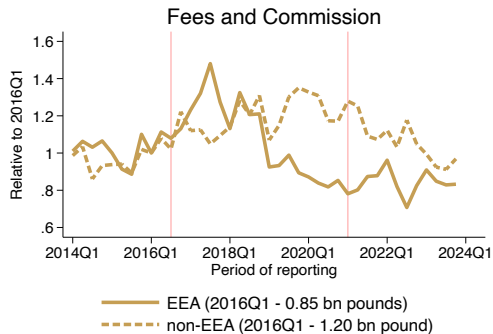
 - Explicit charges - fees and commissions
 - Implicit charges - Financial Intermediation Services Indirectly Measured FISIM = $(r_L - r_r)S_L + (r_r - r_D)S_D$
- FISIM constitute large share of export [Shares](#)
- Variation by partner country largely driven by variation in stocks of loans and deposits by partner country (interest rates vary by currency)
- Focus on stocks of loans to and deposits from non-residents by UK-resident banks
- Stocks restricted to non-financial entities i.e. eliminate transactions that may not represent intermediation services

Total Exports by UK-resident banks

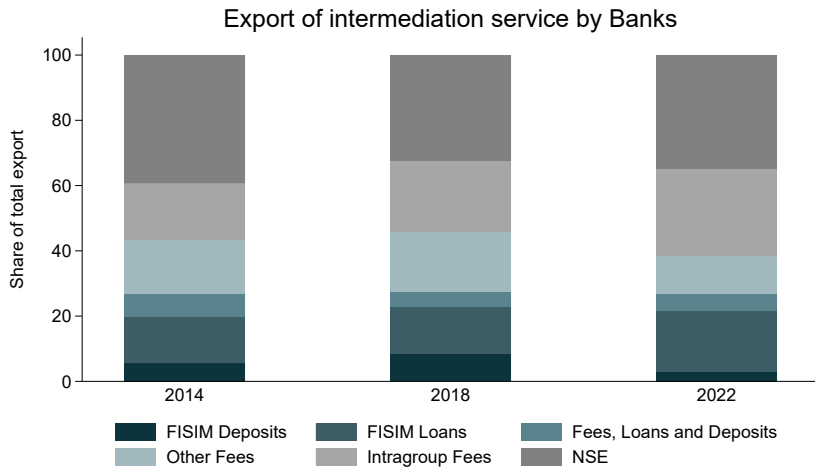
Sum of FISIM, fees and commissions, net spread earnings and transfer pricing



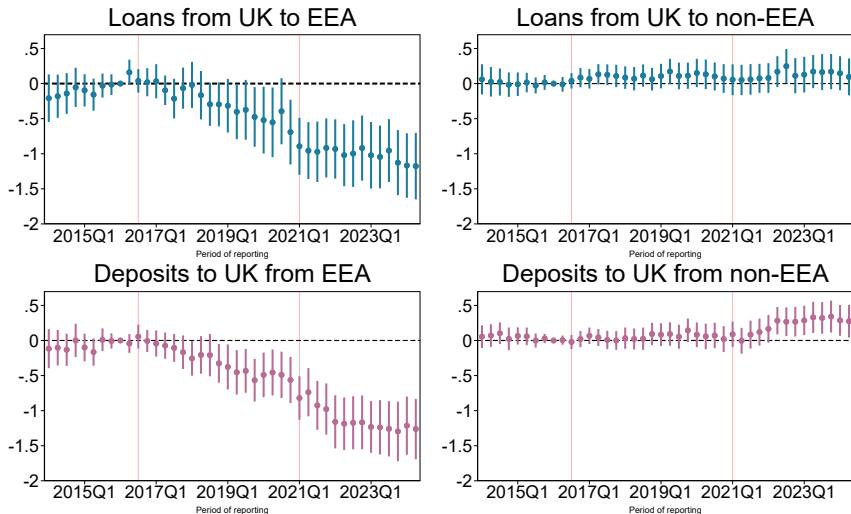
Export - by Components



Export by UK-resident banks - Share of Components



Event Study - Stocks for Non-residents



Event Study - Robustness

Results similar when:

- Include source-time fixed effects
- Remove UK as destination and EEA as source in regression sample
- Estimate regression:

$$\begin{aligned} \ln(stock_{sdt}) = & \sum_{k \neq 2016Q1} \beta_1^k(k_t \times EEA_j \times UK_i) + \sum_{k \neq 2016Q1} \beta_2^k(k_t \times EEA_i \times UK_j) \\ & + \delta \ln(exchange_rate_{it}) + \alpha_{ij} + \alpha_{jt} + \alpha_{it} + \varepsilon_{ijt} \end{aligned}$$

Change in Stocks

- Event study - lending to an EEA country lower by $\approx 60\%$, (relative)
- UK's loans to non-EEA unchanged relative to other countries' cross-border loans
- Therefore, relative to global trends, UK's loans to EEA falls by 60%
- Assumption (strong) - no spillovers to activities of other country pairs
- UK banks' loans to non-banks in EEA in 2016Q1 500 bn USD \implies reduction in loan stocks of 300 bn dollars in 2016 values
- 2% of assets of banking sector in 2016

Increase in trade barriers - Impact on B, R

$$\frac{d\ell_{bi}}{d\tau_{BE}^L} = \kappa_i^L \left(\lambda + \frac{\tau_{Bi}^L}{a_b} \right)^{-\sigma-1} \frac{1}{a_b} \frac{1}{\psi(\lambda)} \sigma \left(\frac{\sigma}{\sigma-1} \right)^{-\sigma} \alpha_E^L \left(\lambda + \frac{\tau_{BE}^L}{a_b} \right)^{-\sigma-1} > 0$$

$$\frac{d\ell_{bi}}{d\tau_{BE}^D} = -\kappa_i^L \left(\lambda + \frac{\tau_{Bi}^L}{a_b} \right)^{-\sigma-1} \frac{1}{a_b} \frac{1}{\psi(\lambda)} \theta \left(\frac{\theta}{\theta+1} \right)^{\theta} \alpha_E^D \left(\lambda - \frac{\tau_{BE}^D}{a_b} \right)^{\theta-1} < 0$$

Net effect depends on σ , θ , α_E^L , α_E^D , τ_{BE}^L and τ_{BE}^D

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Increase in trade barriers - Impact on B , R

- Simultaneous increase in variable costs to E : ambiguous effects on s for $i \in \{B, R\}$

$$\frac{ds_{bi}}{d\tau_{BE}^L} = \kappa_i^D \left(\lambda - \frac{\tau_{Bi}^D}{a_b} \right)^{\theta-1} \frac{d\lambda}{d\tau_{BE}^L} < 0$$

$$\frac{ds_{bi}}{d\tau_{BE}^D} = \kappa_i^D \left(\lambda - \frac{\tau_{Bi}^D}{a_b} \right)^{\theta-1} \frac{d\lambda}{d\tau_{BE}^D} > 0$$

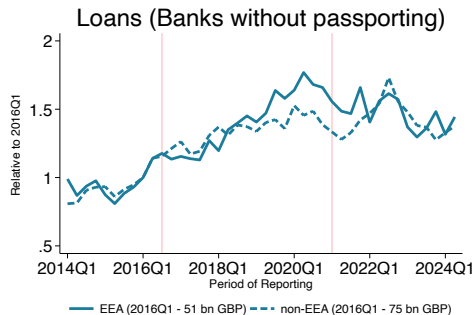
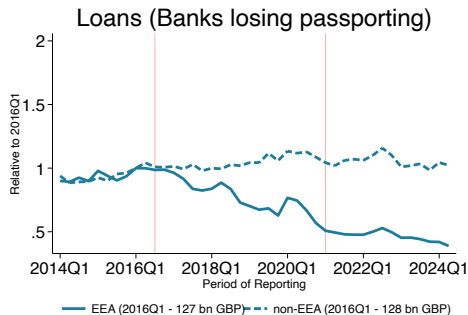
Net effect: Depends on parameters in loan demand and deposit supply, variable cost for loans and deposits

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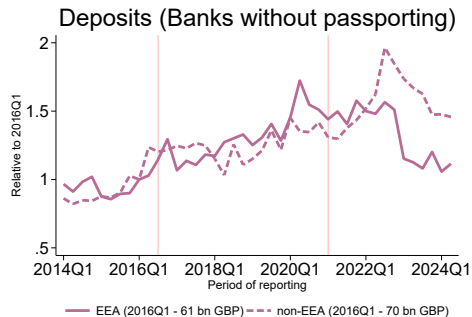
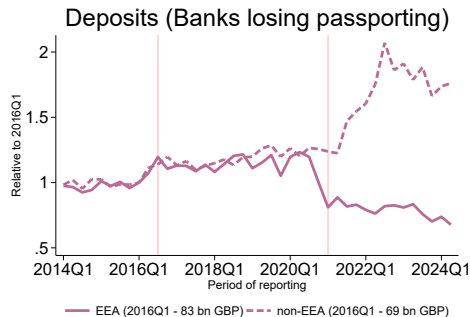
Service via Affiliate

$$\begin{aligned}
 & \max_{\{r_{bi}^L\}_i, \{\ell_{bi}\}_i, \{r_{bi}^D\}_i, \{s_{bi}\}_i} r_{bB}^L \ell_{bB} + r_{bR}^L \ell_{bR} - \frac{(\ell_{bB} + \tau_{BR}^L \ell_{bR})}{a_b} - \chi_{BR}^L \\
 & \quad - r_{bB}^D s_{bB} - r_{bR}^D s_{bR} - \frac{(s_{bB} + \tau_{BR}^D s_{bR})}{a_b} - \chi_{BR}^D \\
 & \quad + r_{bE}^L \ell_{bE} - \frac{\ell_{bE}}{a_b} - r_{bE}^D s_{bE} - \frac{s_{bE}}{a_b} - \chi_{BE}^A \\
 & \text{s.t. } \ell_{bB} + \ell_{bR} \leq s_{bB} + s_{bR}; \quad \ell_{bE} \leq s_{bE} \\
 & \ell_{bi} = \alpha_i^L \left(r_{bi}^L\right)^{-\sigma}, \quad s_{bi} = \alpha_i^D \left(r_{bi}^D\right)^{\theta} \quad \forall i \in \{B, E, R\}
 \end{aligned}$$

Loans, by Status



Deposits, by Status

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Consolidated by GUO

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

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Adjusted for Ring-fencing

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

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Banks operating before referendum

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

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Excluding Covid years

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

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Number of Countries in EEA and non-EEA

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

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Currency of Lending/Deposit-taking

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

Activities with other banks and financial institutions

- Increase in barriers \implies \downarrow in activities. Alternate channel \implies \uparrow in activities

	Non-group Banks		Financial Corps.	
	ln(Loans)	ln(Deposits)	ln(Loans)	ln(Deposits)
PostRefer \times PassAuth	-0.161 (0.145)	-0.174 (0.136)	-0.165 (0.195)	-0.187 (0.173)
PostRefer \times PassAuth \times EEA	-0.171 (0.157)	0.085 (0.198)	0.023 (0.273)	-0.119 (0.198)
Post21 \times PassAuth	-0.025 (0.124)	-0.121 (0.110)	-0.196 (0.158)	0.107 (0.170)
Post21 \times PassAuth \times EEA	-0.277 (0.184)	-0.518** (0.204)	-0.748*** (0.239)	-0.798*** (0.298)
Observations	142676	100801	57065	82276

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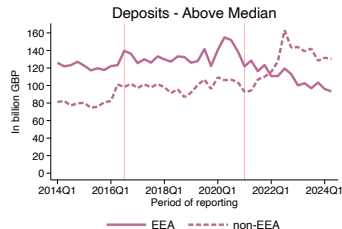
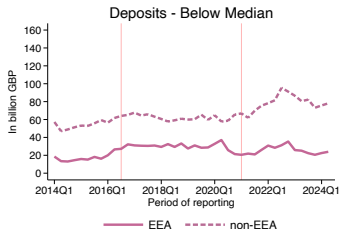
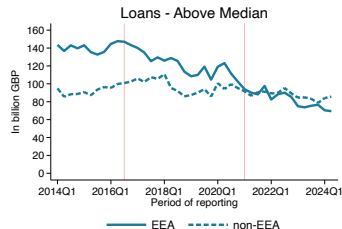
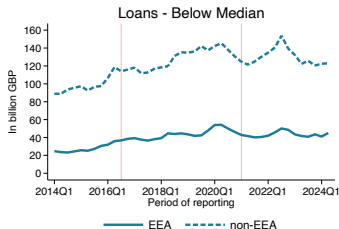
Other Robustness

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

Pre-referendum exports to EEA

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

Change in Stocks - by Pre-referendum exports to EEA



Change in Domestic Lending, by Pre-referendum exposure to EEA

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

Change in Domestic Deposits, by Pre-referendum exposure to EEA

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

Intragroup lending and deposit-taking

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

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Intragroup lending and deposit-taking

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

Assets and activities of affiliates in EEA - All EEA countries

	ln(Assets)	ln(Loans)	ln(Deposits)
PostRefer \times PassAuth \times EEA	-0.032 (0.183)	-0.049 (0.259)	0.105 (0.298)
Post21 \times PassAuth \times EEA	0.250 (0.175)	-0.377 (0.397)	0.091 (0.230)
Fixed Effects:			
Affiliate	Yes	Yes	Yes
GUO-Year	Yes	Yes	Yes
Country-Year	Yes	Yes	Yes
GUO-Country	Yes	Yes	Yes
Observations	12708	11102	9932

Assets or activities of affiliates in EEA - consolidated

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

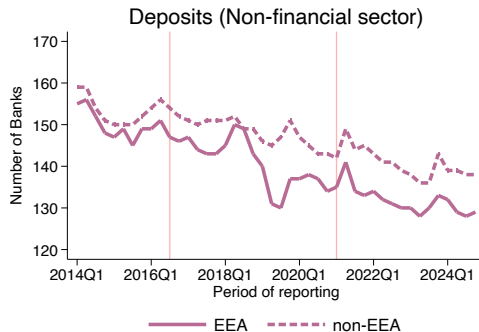
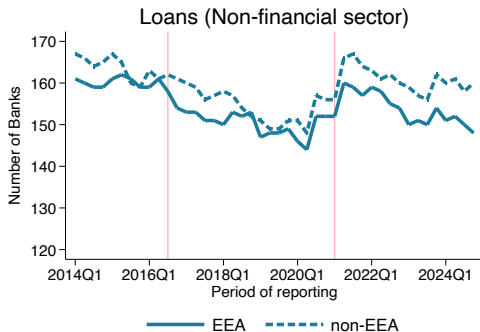
Assets or activities of affiliates in EEA - Diff-in-diff

	ln(Assets)	ln(Loans)	ln(Deposits)
PostRefer \times EEA	-0.083 (0.060)	0.055 (0.100)	-0.010 (0.093)
Post21 \times EEA	0.072 (0.079)	0.014 (0.116)	-0.111 (0.119)
Fixed Effects:			
Affiliate	Yes	Yes	Yes
GUO-Year	Yes	Yes	Yes
GUO-Country	Yes	Yes	Yes
Observations	13099	11494	10337

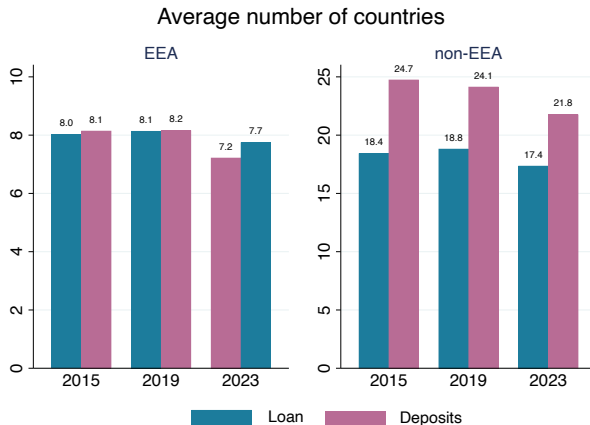
Assets or activities of affiliates in EEA - by GUO

	ln(Assets)	ln(Loans)	ln(Deposits)
PostRefer×PassAuth×EEA	0.048 (0.658)	1.137 (1.448)	0.491 (0.331)
Post21×PassAuth×EEA	-0.704* (0.383)	-1.028 (0.836)	-0.162 (0.329)
Fixed Effects:			
GUO-Country	Yes	Yes	Yes
GUO-Year	Yes	Yes	Yes
Country-Year	Yes	Yes	Yes
Observations	4088	2820	2571

Number of banks providing service to EEA and non-EEA



Number of countries banks provide service to non-financial sector



Summary statistics - Stocks

In thousands GBP		Mean	S.D	Median
Pre-referendum	Loans	983,727	2,527,719	195,293
	Deposits	756,918	250,8724	60,942
Post-referendum	Loans	1,153,567	3,012,339	249,265
	Deposits	1,044,774	3,424,718	81,152
New trade arrangment	Loans	1,107,183	2,813,686	249,512
	Deposits	1,095,182	3,509,887	75,107

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Summary statistics - Stocks

In thousands GBP		EEA			non-EEA		
		Mean	S.D	Median	Mean	S.D	Median
Pre-referendum	Loans	922,392	2,541,407	149,829	1,044,961	2,513,183	239,653
	Deposits	767,113	2,624,293	36,776	746,739	238,8452	87,301
Post-referendum	Loans	925,492	2,786,898	174,134	1,375,658	3,201,392	343,349
	Deposits	963,349	3,395,776	41,034	1,124,063	3,451,130	120,470
New trade arrangment	Loans	805,040	2,312,988	148,409	1,399,455	3,198,330	355,923
	Deposits	877,931	3,133,959	36,298	1,305,335	3,827,600	123,832

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Change in the number of countries (Exposure)

$$Num_ctries_{bt} = \beta_1 (PostRefer_t \times PreEEAExp_b) + \beta_2 (Post21 \times PreEEAExp_b) + \alpha_b + \alpha_t + \varepsilon_{bt}$$

Loans	EEA	EEA Balanced	non-EEA	non-EEA Balanced
PostRefer \times PreEEAExpL	-0.011* (0.007)	-0.006 (0.008)	0.005 (0.018)	0.003 (0.025)
Post21 \times PreEEAExpL	-0.015* (0.009)	-0.023** (0.010)	0.003 (0.019)	-0.002 (0.024)
Fixed Effects:				
Bank	Yes	Yes	Yes	Yes
Time	Yes	Yes	Yes	Yes
Observations	6177	4536	6159	4536

Change in the number of countries (Exposure)

$$Num_ctries_{bt} = \beta_1 (PostRefer_t \times PreEEAExp_b) + \beta_2 (Post21 \times PreEEAExp_b) \\ + \alpha_b + \alpha_t + \varepsilon_{bt}$$

Deposits	EEA	EEA Balanced	non-EEA	non-EEA Balanced
PostRefer×PreEEAExpD	-0.004 (0.006)	-0.003 (0.009)	0.005 (0.024)	-0.005 (0.033)
Post21×PreEEAExpD	-0.013 (0.010)	-0.014 (0.011)	0.001 (0.019)	0.005 (0.020)
Fixed Effects:				
Bank	Yes	Yes	Yes	Yes
Time	Yes	Yes	Yes	Yes
Observations	5999	4410	6093	4410

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