Assortative Matching, Interbank Markets, and Monetary Policy

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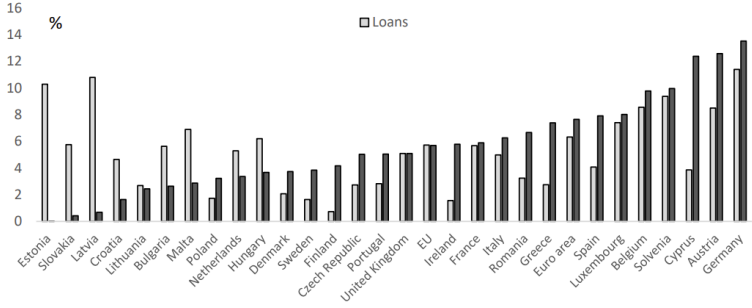
The views expressed here do not necessarily reflect the views of Deutsche Bundesbank

Motivation

The figure shows the interbank loans and deposits as % of total assets of all domestic banking groups and stand-alone banks in 2016. The data for United Kingdom is for the year 2015.



Source: ECB and Allen et al. (2020)

- European economies are generally bank-dependent
- Much dependence on interbank markets too. Particularly in Germany

This Paper

Data:

- Bank-to-bank linked credit registry from Germany
- Balance sheet and profit & loss statement data

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Model:

- Quantitative macroeconomic model with heterogeneous financial intermediaries
- Banks are ex-ante heterogeneous in cost efficiency
- Uninsured idiosyncratic deposit withdrawal risk
- Frictional over-the-counter bank-to-bank trading market
- Sequential market clearing in reverse order of efficiency types

Main Results

Data:

- Trends: IB volume and number of participants declining, concentration rising
- Size-based trading: big banks lend and borrow more
- Assortative matching: big banks are more exposed to other big banks
- Monetary tightening raises IB market volume and number of participants

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Model:

- Calibrated model matches unconditional and conditional data moments
- Assortative matching is inefficient
- Implications for secular trends, monetary and liquidity policy
- Imperfect deposit market competition extension

Literature

1. Heterogeneous financial intermediaries
   - Corbae and D'Erasmo (2021), Coimbra and Rey (2023), Jamilov and Monacelli (2024)

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3. Sequential market clearing
   - Atkeson and Burstein (2008)
4. Interbank markets in Europe
   - Giannone et al. (2012), Allen et al. (2020), Bittner et al. (2023)

What we do: we introduce (2) into (1), solve with (3), and calibrate following (4)

Empirics

Data

- Bank-to-bank linked credit registry data from Germany (BAKIS-M)
  - All banks domiciled in Germany
  - All exposures greater than €1 million must be reported
  - 2002-2019. Quarterly frequency
  - 1,800 unique banks per quarter, on average
  - 28,429 inter-bank connections per quarter, on average
  - Types: commercial, savings, state, cooperative, mortgage, building societies, development

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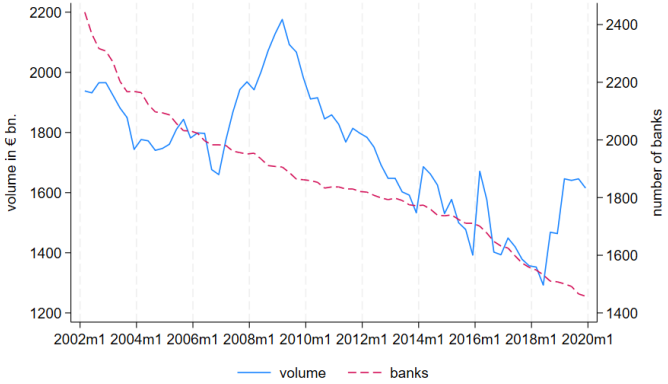
  - Types: commercial, savings, state, cooperative, mortgage, building societies, development
- Monthly balance sheet statistics (BISTA)
- Annual profit and loss accounts (GuV)

‣ Summary Statistics Table ‣ Lender-Borrower Exposures by Bank Type

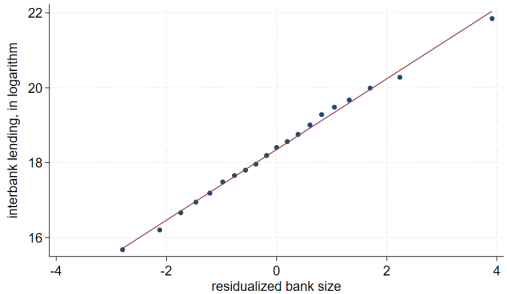
German Interbank Market over Time



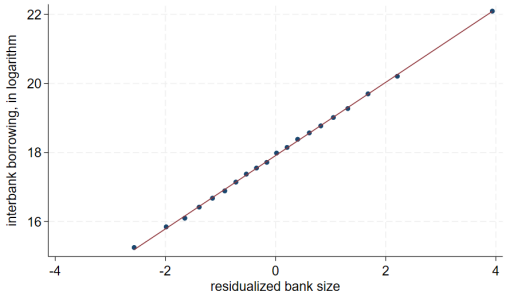
- Total volume and number of participants are declining

▸ Concentration is Rising

Size-Based Trading



(A) Bank Size and Interbank Lending

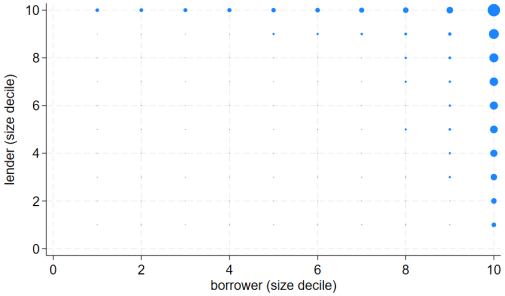


(B) Bank Size and Interbank Borrowing

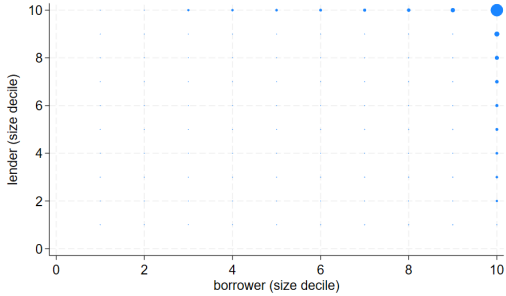
- Big banks lend and borrow more through the interbank market (control. for time FE)

▸ Shares vs Levels

Assortative Matching



(A) Weighted by Matches

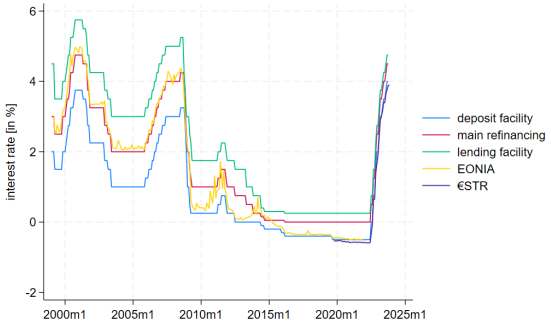


(B) Weighted by Volume

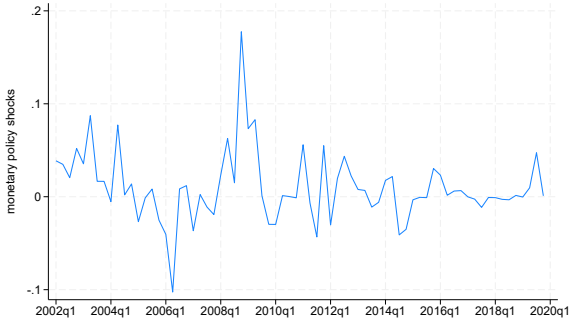
- Big banks trade more with other big banks

▸ Detailed Sorting Table ▸ Alternative Time Samples ▸ Excluding Development Banks and Building Societies

Interest Rates and Monetary Shocks



(A) Interest Rates



(B) ECB Monetary Surprises

- Source of the monetary surprise series: Jarocinski and Karadi (2020)

Local Projections

1. Average Effects

$$y_{i,j,t+h} = \alpha_i + \alpha_j + \boxed{\beta_h} \varepsilon_t + \gamma_h y_{i,j,t-1} + \omega_h^1 X_{i,t-1} + \omega_h^2 X_{j,t-1} + e_{i,j,t+h},$$

- $y_{i,j,t}$: bilateral quantity exposure, intensive (log volume) or extensive margin
- ε_t: monetary surprise
- α_i and α_j: lender and borrower fixed effects
- $X_{i,t}$ and $X_{j,t}$: lender and borrower controls (log total assets, the deposits to equity ratio, and the liquid assets to total assets ratio)
- Standard errors: three-way clustered at the time, lender, and borrower levels

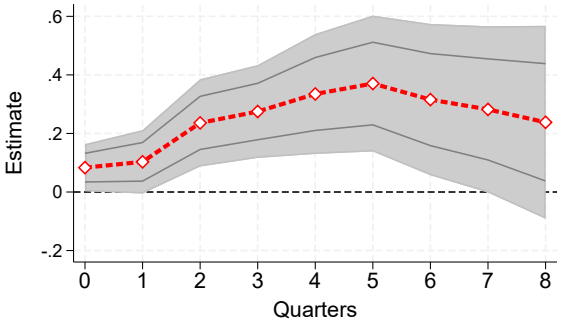
Local Projections

2. Heterogeneous Effects

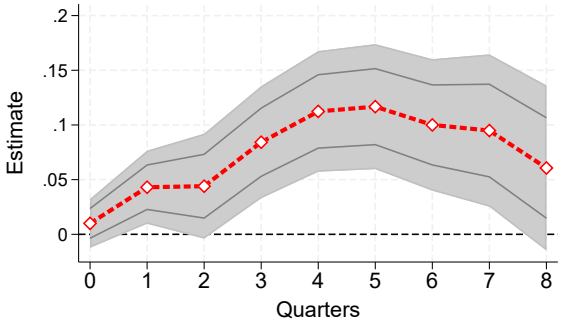
$$y_{i,j,t+h} = \alpha_{i,t} + \alpha_{j,t} + \boxed{\varphi_h} s_{i,t} \times s_{j,t} \times \varepsilon_t + \nu_h s_{i,t} \times s_{j,t} + \gamma_h y_{i,j,t-1} + e_{i,j,t+h},$$

- $s_{i,t}$: binary indicator for lender in top 10% of size density
- $s_{j,t}$: binary indicator for borrower in top 10% of size density
- $\alpha_{i,t}$ and $\alpha_{j,t}$: lender-time and borrower-time fixed effects
- Standard errors: three-way clustered at the time, lender, and borrower levels

Average Effects



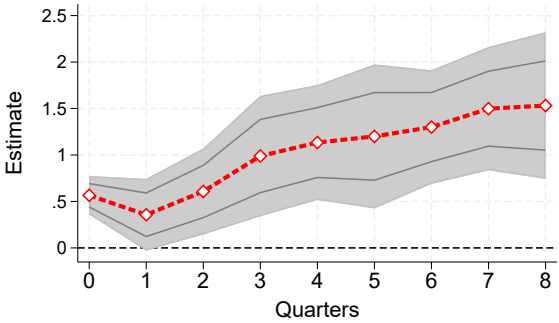
(A) Average Effect: Intensive Margin



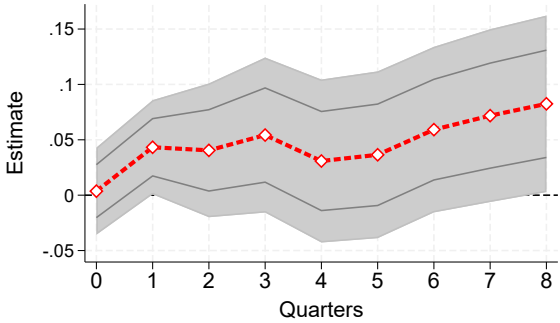
(B) Average Effect: Extensive Margin

▸ Robustness without bank controls ▸ Robustness with alternative sample

Heterogeneous Effects



(A) Heterogeneous Effect: Intensive Margin



(B) Heterogeneous Effect: Extensive Margin

▸ Robustness with alternative sample

Taking Stock

- German interbank market volume is large (€1.6 trillion)
- The volume and number of participants are declining over time
- Size-based trading: interbank lending and borrowing increase with bank size
- Assortative matching: big banks borrow from other big banks
- Monetary tightening raises intensive and extensive margins of IB exposure
- Response is higher if both lender and borrower are large

Model

Overview

- Discrete number $\mathcal{N}$ of risk-neutral banks, indexed by j
- Financial intermediaries are ex-ante heterogeneous in efficiency, $\kappa_j \sim N(1, \sigma_\kappa)$
- Incomplete markets and uninsured idiosyncratic deposit withdrawal risk, $\xi_{j,t} \sim N(0, \sigma_\xi)$
- Frictional intraday interbank market
- Interest rate corridor policy
- Representative firm
- Representative household
- Stationary equilibrium

Interest Rate Corridor Policy

$$R_t^L = R_t^N + S_t, \quad R_t^D = R_t^N - S_t$$

R_t^N: refinancing rate

R_t^L: lending facility rate

R_t^D: deposit facility rate

R_t^R: interest rate on reserves

S_t: symmetric spread policy

R_t^I: interbank interest rate

Interest rate corridor: $R_t^L \geq R_t^N \geq R_t^D \geq R_t^R$

Households

Preferences:

$$\max \mathbb{E}_t \sum_{k=0}^{\infty} \beta^k U(C_{t+k})$$

The period utility:

$$U(C_t) = \begin{cases} \frac{1}{1-\psi} C_t^{1-\psi} & , \psi \neq 1 \\ \ln C_t & , \psi = 1 \end{cases}$$

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Households supply labor inelastically and can save via bank deposits, $b_{j,t}$, which pay out a state non-contingent gross return R_t^B. The sequence of balance sheet constraints is:

$$C_t + \sum_{1}^{\mathcal{N}} b_{j,t} \leq \sum_{1}^{\mathcal{N}} R_t^B b_{j,t-1} + W_t + Div_t + T_t$$

Firms

Continuum of identical capital producing firms, indexed by i.

Firms intake stock of loans $L_t = \sum_1^{\mathcal{N}} l_t(j)$ and produce $\Phi\big(L_t(i)\big)$ units of capital:

$$\max_{L_t(i)} P_t \Phi\big(L_t(i)\big) - L_t(i), \quad \Phi' > 0, \Phi'' < 0$$

Symmetric solution and the price of capital: $L_t(i) = L_t, \quad P_t = \left[\Phi'\left(L_t\right)\right]^{-1}$

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Representative final goods producer:

$$Y_t = K_t^{\alpha}, \quad 0 < \alpha < 1$$

Return on capital, which depreciates every period, is:

$$R_{t+1}^K = \frac{\alpha K_{t+1}^{\alpha-1}}{P_t}$$

Financial Intermediaries

Balance sheet constraint:

$$b_{j,t} + n_{j,t} = l_{j,t} + s_{j,t}$$

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Law of motion of net worth with *beginning-of-period* variables is:

$$n_{j,t+1} = R^K_{t+1} l_{j,t} + R^R_{t+1} s_{j,t} - (1 + \kappa_j r^B_{t+1}) b_{j,t} - \nu_1 l^{\nu_2}_{j,t}, \quad \nu_1 > 0, \nu_2 > 1$$

Dynamic Bank Problem

$$V(n, \kappa; L) = \max_{\{l,b,n'\} \geq 0} \left\{ \beta \mathbb{E}\left[(1-\sigma) n' + \sigma V'(n, \kappa; L') \right] \right\}$$

subject to:

$$n' = R^{K'}(n, \kappa; L') l + R^{R} s - (1 + \kappa r^{B'}) b - \nu_1 l^{\nu_2}$$
$$b + n = l + s$$
$$l \leq \lambda V(n, \kappa; L)$$
$$s \geq \omega b$$

Intraday Interbank Market

Uninsured idiosyncratic deposit withdrawal risk: $\xi_{j,t}$

Following Bianchi and Bigio (2022), the surplus/deficit in reserves:

$$\Delta_{j,t} \equiv \omega b_{j,t} + \frac{\left(1 + \kappa_j r^B_{t+1}\right)}{R^R_{t+1}} \xi_{j,t} b_{j,t} - \omega b_{j,t} \left(1 + \xi_{j,t}\right)$$

Interbank interest rate restriction: $R^L_t \geq R^I_t \geq R^D_t$. Impose $R^N_t = R^I_t$.

Algorithm

Algorithm: sequential clearing similar to Atkeson and Burstein (2008)

Monotonic descending ordering of borrowers and lenders by efficiency κ_j

Match-specific, rank-based (x = rank integer) variable cost of volume q:

$$VC_{BL} = x^B \times x^L \times \varphi_1 q^{\varphi_2}, \quad \varphi_1 > 0, \varphi_2 > 1$$

Minimum volume cutoff $\underline{q}$

Advantages of this approach: flexibility, scalability

Algorithm

1. Round 1 starts. First-ranked borrower 1^{B} starts looking at the first-ranked lender 1^{L}. Choose quantity q by minimizing the total cost of borrowing subject to the outside option:

$$TC = q \times \left(R_t^I - R_t^L\right) + 1 \times 1 \times \varphi_1 q^{\varphi_2}$$

Feasibility constraint: $q^* = \min\left[\min\left(|\Delta_{1^L}|, |\Delta_{1^B}|\right), q^*\right]$. Minimum volume constraint: $q^* \geq \underline{q}$.

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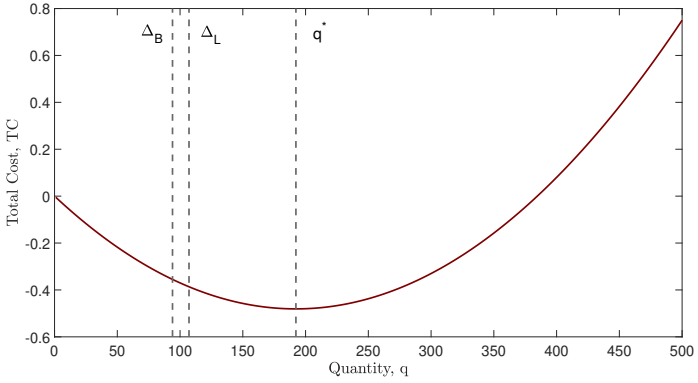
5. If a borrower x^B has any deficits to cover, it borrows the amount Δ_{x^B} from the central bank at the lending facility rate R_t^L.
6. Market closes.

Graphical Illustration of Round 1



- First-ranked borrower chooses. First-ranked lender is considered.
- Δ_L and Δ_B: excess reserves of the first-ranked lender and (absolute value of) deficit reserves of the choosing borrower

End-of-Period Net Worth

Denote by $A^B_{j,t}$ and $B^B_{j,t}$ bank j's borrowing from the interbank market and the deposit facility:

$$\hat{n}^B_{j,t+1} = n^B_{j,t+1} - \left(R^I_t - 1\right) A^B_{j,t} - \left(R^L_t - 1\right) B^B_{j,t}$$

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And similarly for the lenders:

$$\hat{n}^L_{j,t+1} = n^L_{j,t+1} + \left(R^I_t - 1\right) A^L_{j,t} + \left(R^D_t - 1\right) B^L_{j,t}$$

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Economy-wide aggregate net worth:

$$\hat{N}_t = \sum_{j \in L} \hat{n}^L_{j,t} + \sum_{j \in B} \hat{n}^B_{j,t}$$

Equilibrium

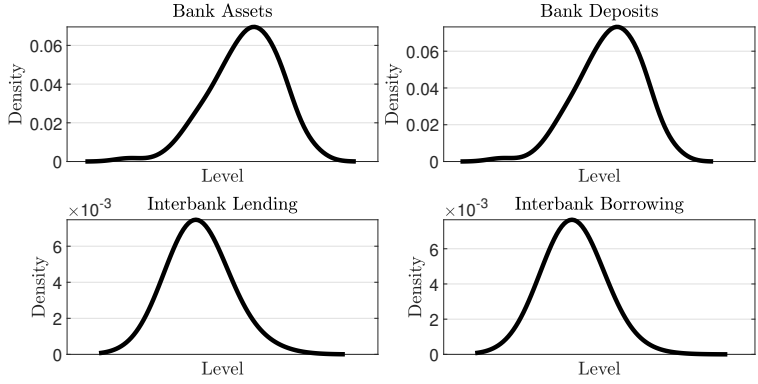
A *stationary competitive equilibrium* is characterized by a vector of exogenous aggregate prices $\{R^R, R^D, R^N, R^L, R^I\}$, endogenous aggregate prices $\{P, W, R^k\}$, endogenous aggregate quantities $\{L, K, N, B, Y, C, \hat{N}\}$, bank-level policies $\{l_j, b_j, n_j, s_j, \hat{n}_j\}$, and the bank-level value function V_j, such that:

1. bank policies and the value function solve the banks' optimization problem;
2. the household and non-financial firms optimize according to their problems;
3. aggregates are consistent with the respective stationary cross-sectional distributions;
4. markets for retail deposits, interbank transactions, and loans clear;
5. goods market clears: $Y_t = C_t$;

Calibration

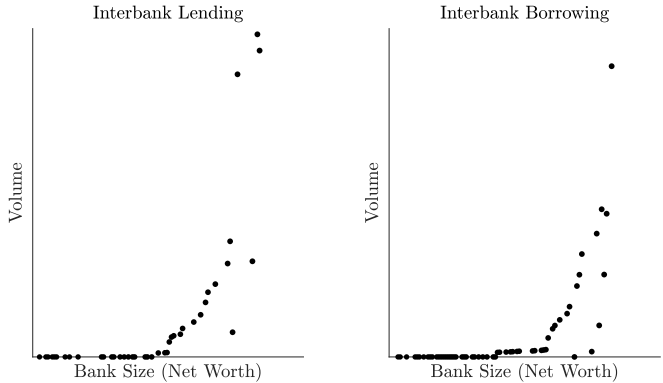
Parameter	Value	Description	Target/Source
		Macro and Firms	
α	0.36	Production function	Standard
β	0.994	Discount factor	Standard
ψ	1	Risk Aversion	Standard
a	3.81	Production technology	Target capital price = 1
b	0.75	Production techology	Target price elasticity of lending = 0.25
$\mathcal{N}$	100	Number of banks	Assumption
		Interbank Market	
$\underline{q}$	1.2	Minimum quantity cutoff	Target region of inaction = 5%
φ_1	1.3e-5	Match variable cost, linear	Target size-IB borrowing elasticity = 0.55
φ_2	2	Match variable cost, quadratic	Normalization
		Bank Balance Sheets	
σ_κ	0.042	Permanent heterogeneity volatility	Standard deviation of returns on assets = 4.2%
σ	0.973	Dividend payout frequency	Gertler and Kiyotaki (2010)
ν_1	4.00E-04	Non-interest expense, linear	Target non-interest expense to assets ratio = 1.9%
ν_2	2	Non-interest expense, quadratic	Normalization
σ_ξ	1.55	Stochastic deposit withdrawal volatility	Target interbank market loans to assets ratio = 13%
λ	0.1	Capital requirement ratio	Target assets to equity ratio = 11
		Policy	
ω	1.62%	Reserve Requirement Ratio	ECB, average across years
R^N	2.3%	Refinancing rate, percent p.a.	ECB, average across years
S	1.25%	Interest Corridor Spread, percent p.a.	ECB, average across years
R^S	0.64%	Interest Rate on Reserves, percent p.a.	ECB, average across years

Stationary Distributions in the Model



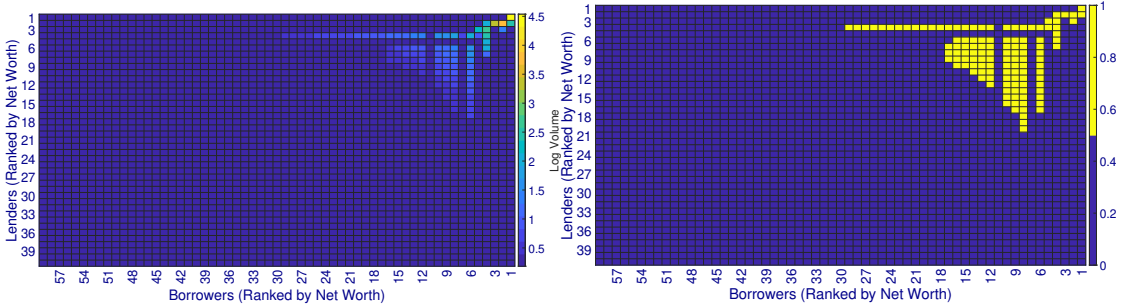
- The cross-section of bank size is driven by scale variance ($\nu_2 > 1$), ex-ante heterogeneity in efficiency κ_j, and idiosyncratic deposit withdrawal shocks ξ_j.

Size-Based Trading in the Model



- Large banks lend and borrow more in the interbank market.

Assortative Matching in the Model



(A) Intensive Margin (Continuous Volume)

(B) Extensive Margin (Binary Indicator)

- Large and efficient banks lend to and borrow from other large and efficient banks.

Steady States and Special Cases

	Baseline	No IB Match Cost
IB Volume	496.35	2577.21
IB Volume Largest Banks	342.74	545.35
IB Fraction of Matches Active	0.05	0.04
IB Fraction of Borrowers Active	0.47	0.88
Bank Assets	48.67	49.20
Bank Net Worth	4.68	4.90
Bank Deposits	46.60	46.95
Market Leverage Ratio	11.10	10.64
Price of Capital	1.04	1.04
Aggregate Output	4.05	4.07
Aggregate Consumption	4.98	5.02

- Assortative matching lowers IB volume by 80%, net worth by 5%, output by 40bps, and consumption by 76bps; raises leverage by 4.3%.

Steady States and Special Cases

	Baseline	No IB Match Cost	No IB Quantity Cutoff
IB Volume	496.35	2577.21	894.36
IB Volume Largest Banks	342.74	545.35	342.30
IB Fraction of Matches Active	0.05	0.04	0.56
IB Fraction of Borrowers Active	0.47	0.88	1.00
Bank Assets	48.67	49.20	48.76
Bank Net Worth	4.68	4.90	4.74
Bank Deposits	46.60	46.95	46.64
Market Leverage Ratio	11.10	10.64	10.96
Price of Capital	1.04	1.04	1.04
Aggregate Output	4.05	4.07	4.05
Aggregate Consumption	4.98	5.02	4.99

- Removing the minimum volume cutoff, $\underline{q}$, raises the extensive margin of the IB market and bank balance sheets with minor macroeconomic improvements.

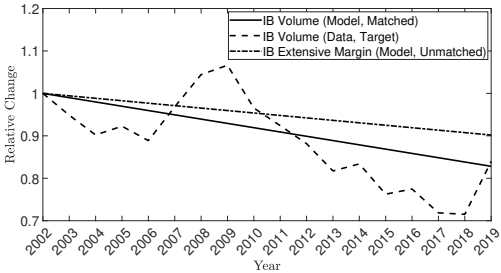
Steady States and Special Cases

	Baseline	No IB Match Cost	No IB Quantity Cutoff	Low Volatility
IB Volume	496.35	2577.21	894.36	0.00
IB Volume Largest Banks	342.74	545.35	342.30	0.00
IB Fraction of Matches Active	0.05	0.04	0.56	0.00
IB Fraction of Borrowers Active	0.47	0.88	1.00	0.00
Bank Assets	48.67	49.20	48.76	49.12
Bank Net Worth	4.68	4.90	4.74	4.31
Bank Deposits	46.60	46.95	46.64	47.43
Market Leverage Ratio	11.10	10.64	10.96	12.12
Price of Capital	1.04	1.04	1.04	1.04
Aggregate Output	4.05	4.07	4.05	4.06
Aggregate Consumption	4.98	5.02	4.99	5.00

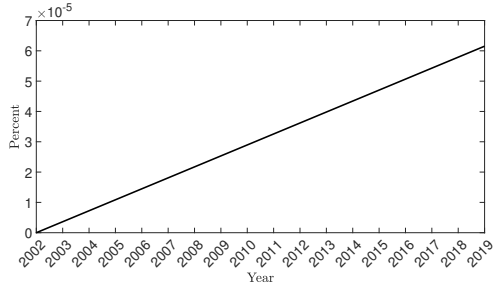
- Eliminating idiosyncratic shocks nullifies the liquidity management problem and shuts down IB trading.

Secular Decline in Interbank Trading

(A) Quantities (Output)

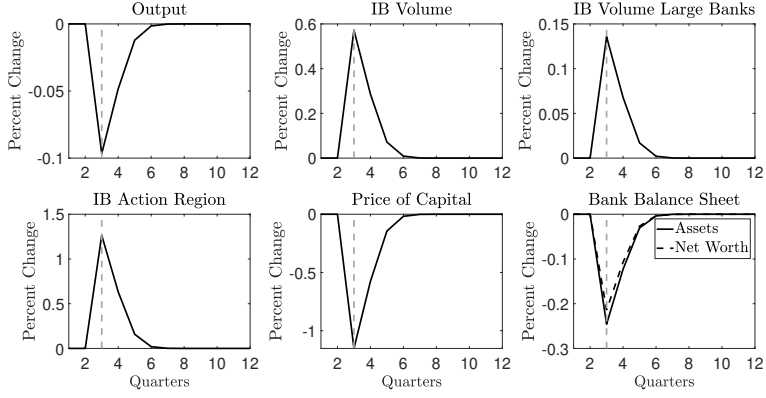


(B) Match Variable Cost (Input)



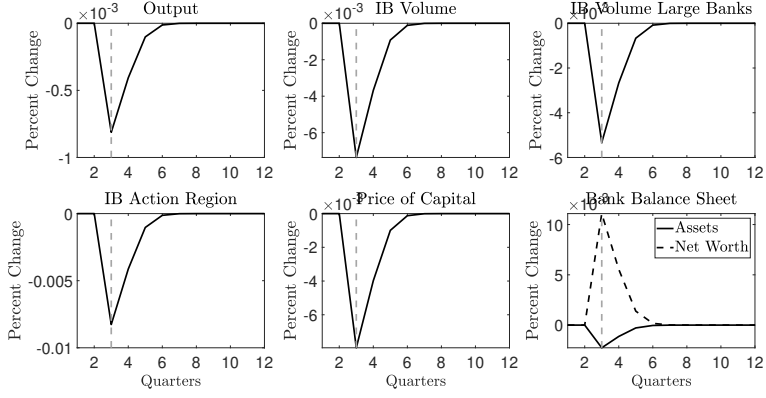
- Target the secular decline in aggregate interbank lending, $\sum A^{L}_{j,t}$
- Compute the path of IB variable cost, $\varphi_{1,t}$, to match the trend
- Decline in the IB market's extensive margin is untargeted

Impulse Response to a Monetary Shock



- Impulse: 2.4% p.a. increase in R^N and R^I, and a symmetric 1.5% p.a. increase in S_t
- IB market activity increases despite a financial and economic recession. As in the data

Impulse Response to Reserve Requirements



- Impulse: ω_t is increased from 0 to 1.62%
- IB activity falls; greater resiliency (higher net worth) at the cost of a recession.

Deposit Market Power

New preferences with $\chi > 0$:

$$U(C_t, B_t) = \begin{cases} \frac{1}{1-\psi} C_t^{1-\psi} + \chi B_t & , \psi \neq 1 \\ \ln C_t + \chi B_t & , \psi = 1 \end{cases}$$

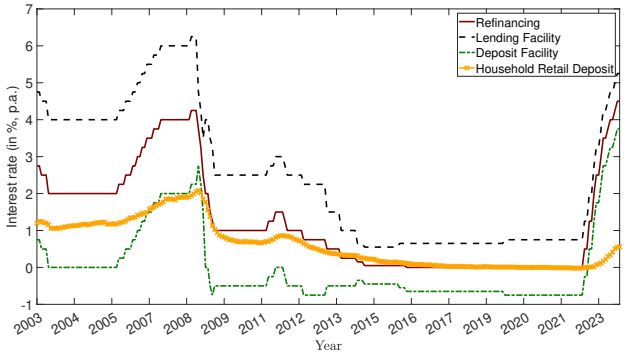
New balance sheet constraint:

$$C_t + \sum_1^{\mathcal{N}} b_{j,t} + M_t \leq R_t M_{t-1} + W_t + \sum_1^{\mathcal{N}} R_t^B b_{j,t-1} + \text{Div}_t + T_t$$

Deposit market Lerner condition:

$$R_{t+1}^B = \underbrace{\left(1 - \frac{U_B(C_t, B_t)}{U_C(C_t, B_t)}\right)}_{\text{Markdown}} R_{t+1}, \quad B_t = \sum_j^{\mathcal{N}} b_{j,t}$$

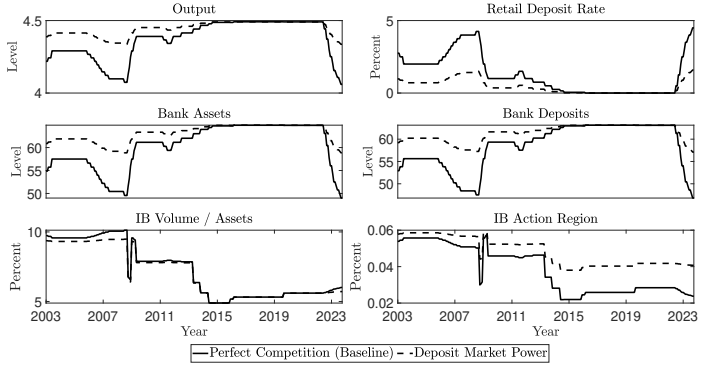
Retail Deposit Rates and the Policy Corridor



Notes: Time series of the average German retail household deposit interest rate along with the ECB refinancing, lending facility, and deposit facility rates. Source: Bundesbank and ECB.

- German retail deposit rates are sticky. The deposits channel (Drechsler et al., 2017, 2021).

The Role of Deposit Market Power



Notes: model simulations under perfect and imperfect deposit market competition assumptions. Inputs include exact time series of the ECB interest rate corridor involving the refinancing, lending facility, and deposit facility rates.

- Deposit market power expands the IB action region, increases quantities, decreases prices.

Conclusion

- Size-dependent over-the-counter trading and assortative matching.
- Theory and evidence from the German interbank market.

Conclusion

- Size-dependent over-the-counter trading and assortative matching.
- Theory and evidence from the German interbank market.

Future research:

- Bank-to-firm linkages and credit networks.

Appendix

Interbank Market Concentration

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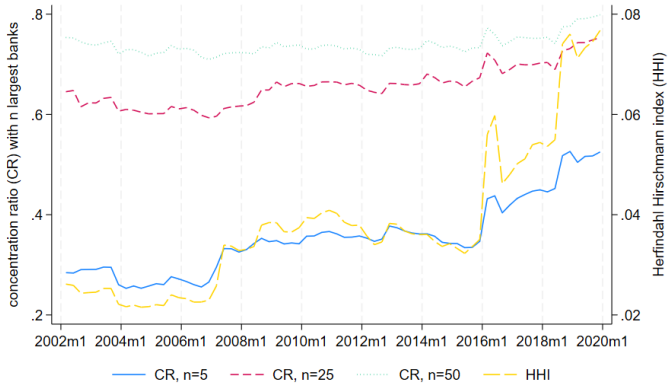

Summary Statistics

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Panel A: Interbank market level	Mean	SD	p25	p75	*N*
Number of borrowers	1,786	223	1,652	1,923	72
Number of lenders	1,861	228	1,718	1,990	72
Number of loans	28,429	5,632	24,190	32,436	72
New links	1,740	748	1,247	2,045	71
Terminated links	1,451	575	1,026	1,701	71
Panel B: Bank level (average)	**Mean**	**SD**	**p25**	**p75**	***N***
Assets [€ mn.]	3,309	21,289	142	1,213	2,585
Liquid assets / assets	0.238	0.118	0.160	0.301	2,585
Non-bank lending / assets	0.572	0.173	0.504	0.682	2,585
Bank lending / assets	0.140	0.143	0.063	0.154	2,585
Bank funding / assets	0.170	0.145	0.092	0.194	2,585
Non-bank funding / assets	0.675	0.180	0.651	0.778	2,585
Non-bank funding / capital	12.934	4.830	10.782	15.332	2,585
Capital / assets	0.062	0.038	0.047	0.065	2,585
Profits / assets	0.033	0.011	0.029	0.029	2,585
Market share [in %]	0.046	0.351	0.001	0.013	2,585

Notes: This table provides summary statistics for the main variables used in the empirical analysis. The top panel considers aggregated interbank-market statistics at the quarterly level, and the bottom panel shows summary statistics for the main bank balance-sheet characteristics averaged by bank. The sample is 2002:q1-2019:q4.

Lender-Borrower Exposures by Bank Type

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		borrower							
		commercial	state	savings	corporative	mortgage	building societies	development	=
lender	commercial banks	0.10	0.03	0.00	0.00	0.09	0.01	0.02	0.26
	state banks	0.06	0.05	0.08	0.00	0.03	0.00	0.02	0.25
	savings banks	0.01	0.10	0.00	0.00	0.03	0.00	0.01	0.14
	corporative banks	0.01	0.01	0.00	0.00	0.02	0.00	0.05	0.09
	mortgage banks	0.02	0.03	0.00	0.00	0.00	0.00	0.01	0.06
	building societies	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.03
	development banks	0.02	0.02	0.02	0.05	0.05	0.00	0.02	0.18
	=	0.23	0.24	0.11	0.05	0.22	0.02	0,13	

Notes: Interbank market lending and borrowing share by bank type (commercial, state savings, corporative, mortgage, and development banks as well as building societies). Lenders are shown in rows and borrowers in columns, i.e., lending from savings banks to state banks represent 10% of total interbank lending, whereas borrowing of savings banks from state banks represent 8% of total interbank borrowing. Aggregate values are based on the full sample between 2002:q1-2019:q4.

Size-Based Trading: Shares

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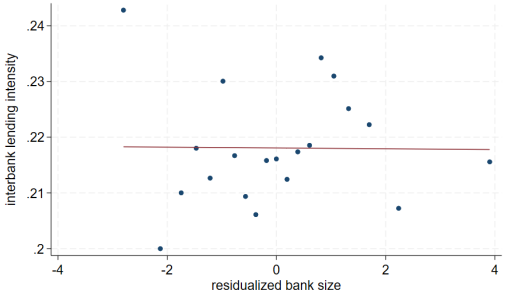
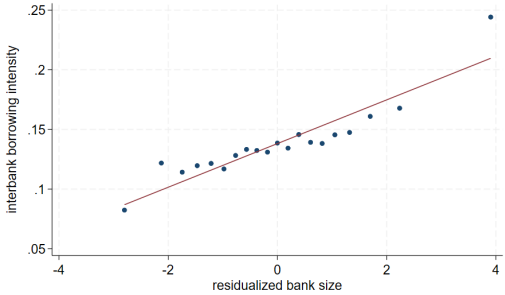


(A) Bank Size and Interbank Lending Share



(B) Bank Size and Interbank Borrowing Share

Lender-Borrower Matching

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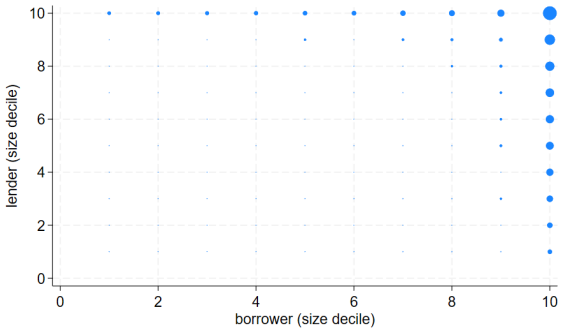
	$Match_{bct}$		$Match_{bct}^{weighted}$	
$Entity_{bt}$:	Top lender	Top borrower	Top lender	Top borrower
	(1)	(2)	(3)	(4)
$Entity_{bt} \times 2^{nd}$ decile $counterparty_{ct}$	0.001*	0.012***	0.014**	0.088***
	(0.001)	(0.002)	(0.007)	(0.017)
$Entity_{bt} \times 5^{th}$ decile $counterparty_{ct}$	0.006***	0.048***	0.061***	0.380***
	(0.002)	(0.007)	(0.017)	(0.058)
	(0.007)	(0.014)	(0.066)	(0.132)
$Entity_{bt} \times 10^{th}$ decile $counterparty_{ct}$	0.120***	0.156***	1.210***	1.508***
	(0.014)	(0.017)	(0.141)	(0.171)
N	58,767,439	58,767,439	58,767,439	58,767,439
R^2	0.326	0.333	0.323	0.330
Lender-Year FE	✓	✓	✓	✓
Borrower-Year FE	✓	✓	✓	✓
SE Cluster	Lender and Borrower			

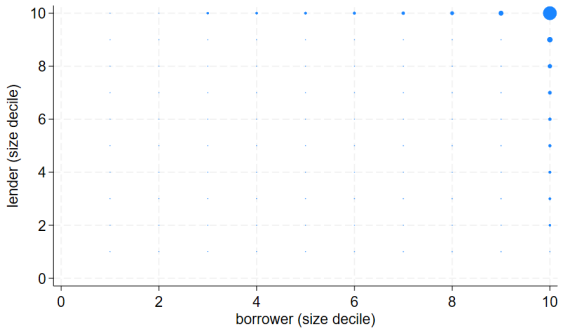
Notes: The sample is a filled panel for all possible combinations at the bank-counterparty-year level bct from 2002 to 2019. $Entity_{bt}$ is an indicator variable for a lender b in the top decile ("Top lender" in columns 1 and 3) or borrower b in the top decile ("Top borrower" in columns 2 and 4). $Counterparty_{ct}$ refers to borrowers in columns 1 and 3, and to lenders in columns 2 and 4. We generate separate indicator variables for counterparties according to their position in the size distribution in year t, with the bottom decile being the omitted category. The dependent variable in columns 1 and 2, $Match_{bct}$, equals 1 in case of a relationship between lender and borrower in a given year t, and 0 otherwise. The dependent variable in columns 3 and 4, $Match_{bct}^{weighted}$, is defined as $Match_{bct} \times \ln(Volume)_{bct}$, where $Volume_{bct}$ is the exposure between lender and borrower in a given year t. Standard errors (in parentheses) are double-clustered at the lender and borrower level.

Alternative Time Samples

Go Back



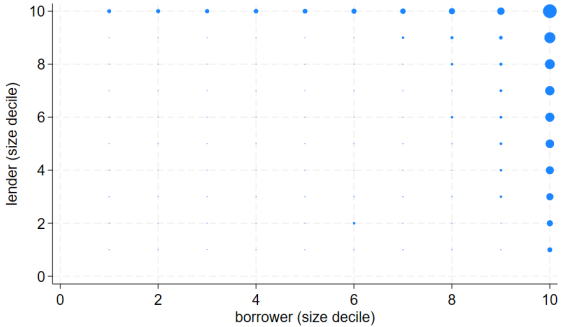
(A) Weighted by Matches, 2002-2006



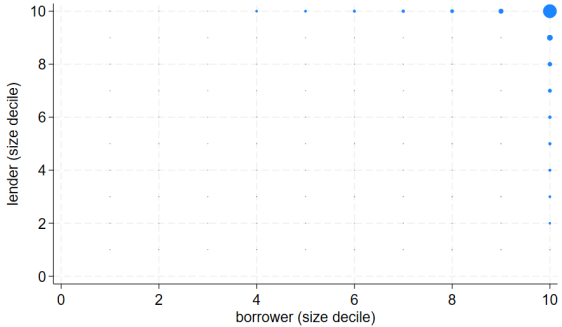
(B) Weighted by Volume, 2002-2006

Alternative Time Samples

Go Back



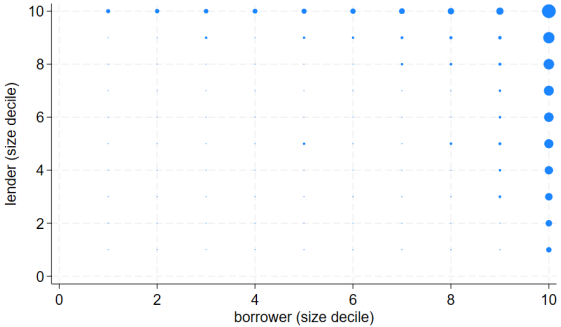
(c) Weighted by Matches, 2007-2009



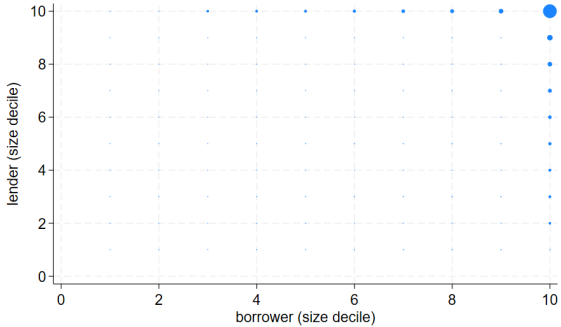
(d) Weighted by Volume, 2007-2009

Alternative Time Samples

Go Back



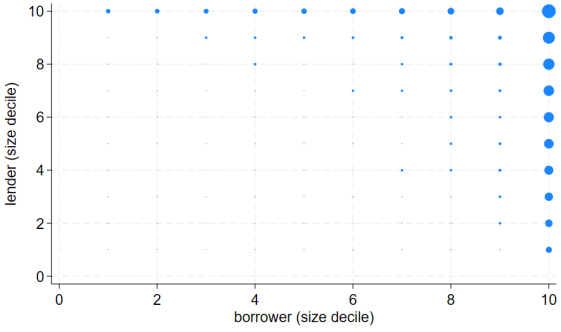
(E) Weighted by Matches, 2010-2014



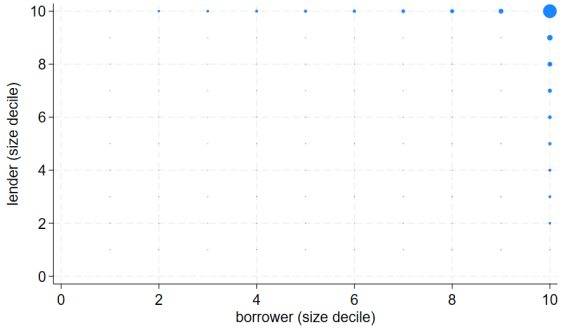
(F) Weighted by Volume, 2010-2014

Alternative Time Samples

Go Back



(G) Weighted by Matches, 2015-2019



(H) Weighted by Volume, 2015-2019

Alternative Bank Sample

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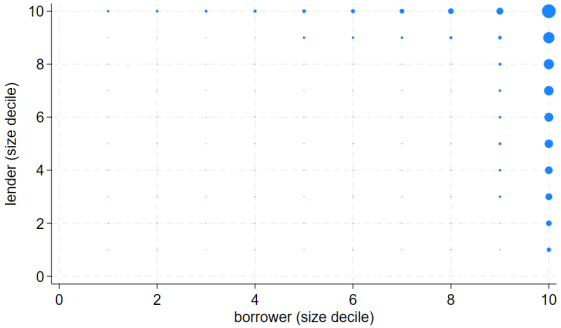
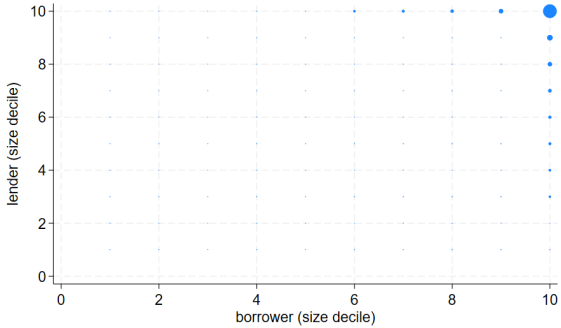


(I) Weighted by Matches, Altern. Sample



(J) Weighted by Volume, Altern. Sample

- Excluding building societies and development banks

Robustness without Controls

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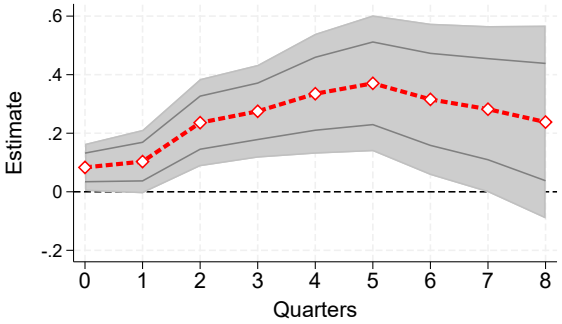
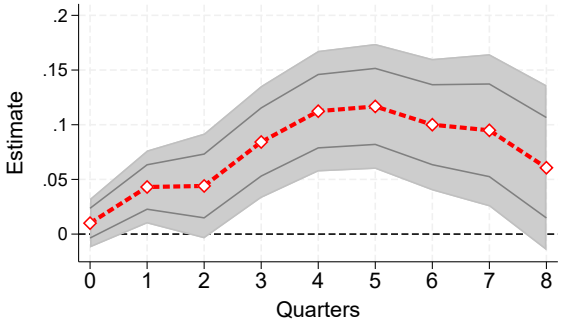


(A) Average Effect: Intensive Margin

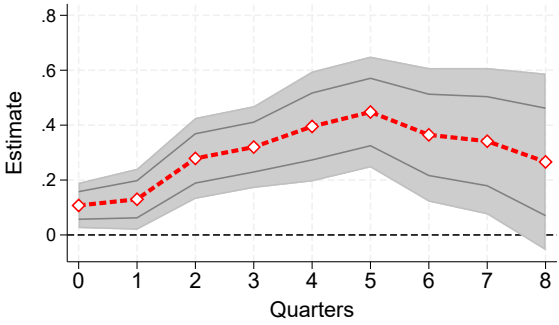


(B) Average Effect: Extensive Margin

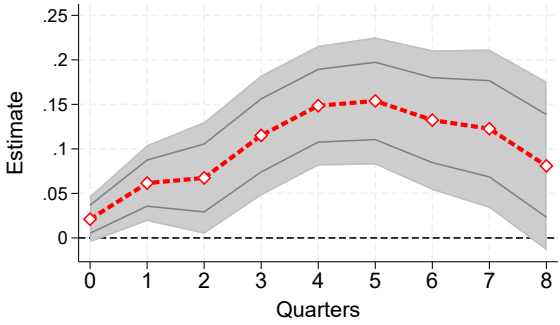
- Excluding lender and borrower controls, X_i and X_j

Alternative Bank Sample

Go Back



(A) Average Effect: Intensive Margin



(B) Average Effect: Extensive Margin

- Excluding building societies and development banks

Alternative Bank Sample

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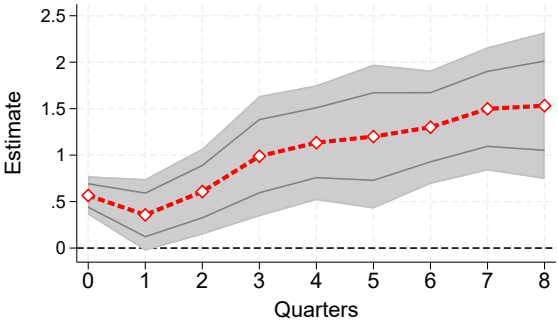
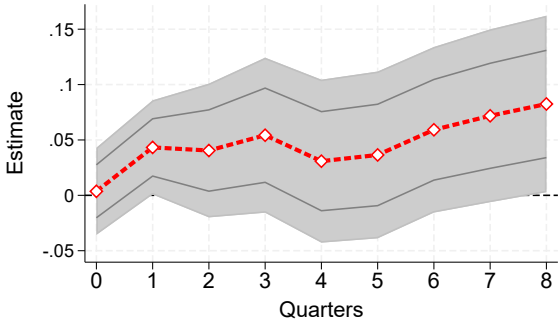
(c) Heterogeneous Effect: Intensive Margin



(d) Heterogeneous Effect: Extensive Margin



- Excluding building societies and development banks

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