The Disciplining Effect of Bank Supervision: Evidence from SupTech

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Note: The views expressed in this project are those of the authors and do not necessarily reflect those of the Banco Central do Brasil or the Bank for International Settlements.

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$\rightarrow$ We aim to address this research gap using unique SupTech data from the Central Bank of Brazil

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  2. banks' lending decisions
  3. firms' outcomes
- We employ difference-in-differences models to compare the outcomes of treated (versus non-treated) banks before (versus after) a SupTech event

Preview of findings

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- We provide evidence that these findings can be explained by a supervisory scrutiny channel

Contribution

1. The literature on the real effects of regulatory enforcement in the banking sector (Abbassi et al., 2023; Bonfim et al., 2022; Cortés et al., 2020; Danisewicz et al., 2018; Granja and Leuz, 2018; Haselmann et al., 2023; Hirtle et al., 2020; Kandrac and Schlusche, 2021; Kok et al., 2023; Passalacqua et al., 2022; Roman, 2016)

→ The effect of SupTech

2. The literature on supervisory frameworks in the banking sector (Agarwal et al., 2014; Carletti et al., 2021; Eisenbach et al., 2022; Ganduri, 2018; Haselmann et al., 2023; Lucca et al., 2014)

→ The effect of formal (punitive) versus informal (non-punitive) regulatory enforcement

Roadmap

Institutional setting

Data

The effect on banks' balance sheet

The effect on banks' lending behavior

The effect on firms' outcomes

Conclusion

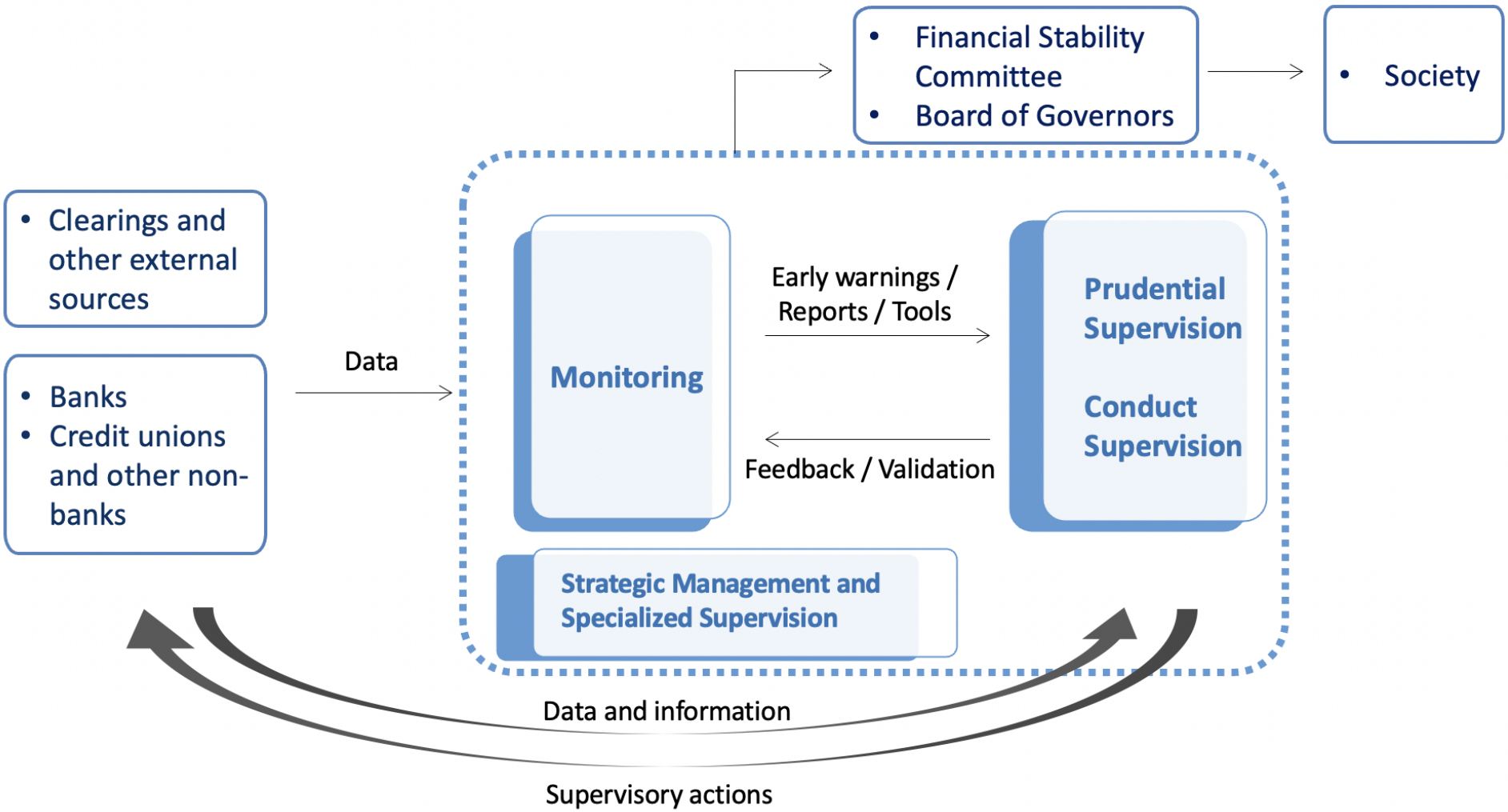
Supervisory framework

- Brazil has a robust bank supervision framework, based on macro- and micro-prudential policies (IMF, 2018)
- In terms of micro-prudential policies, the central bank relies on both on-site and off-site monitoring of individual financial institutions
  - → On-site bank inspections
  - → Off-site SupTech application

SupTech application

- The SupTech application analyzes banks' on- and off-balance sheet positions from 3 different perspectives (temporal, comparative, and intrinsic)
- The application can generate automatic alerts that suggest the need for further investigation to the supervisory departments
- This leads to "more focused supervision that allows the supervisor to act more preemptively" (BCB, 2022)
- This differs from other regulatory enforcement actions, such as bank sanctions and formal bank inspections

SupTech application



Data

- SupTech data Details
- Bank data Details
- Loan data Details
- Firm data Details

→ The ultimate dataset covers 1,325 banks (including 221 treated banks) and 870,000 firms over the period 2008-2021

Methodology

- First, we study how SupTech events affect banks' balance sheets:

$$y_{b,t} = \beta^{ATE} \textit{Post supervision}_{b,t} + \delta \boldsymbol{X}_{b,t-1} + \alpha_b + \alpha_t + \epsilon_{b,t} \quad (1)$$

where β^{ATE} captures the difference in the outcome variable of treated (versus non-treated) banks after (versus before) a SupTech event

Results

- Banks reclassify loans as problem loans and increase loan loss provisions

	(1) NPL/TA	(2) LLP/TA	(3) LLP_{risky}/TA
Post supervision	0.0060***	0.0014**	0.0044***
	(0.0020)	(0.0006)	(0.0014)
Observations	100,194	99,257	99,257
Adjusted R^2	0.6751	0.5398	0.6326
Controls	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes

Results

- There is not reduction in bank capital, profitability, or credit

	(4) Capital/TA	(5) ROA	(6) Loans/TA
Post supervision	-0.0055	-0.0036	0.0030
	(0.0066)	(0.0029)	(0.0069)
Observations	99,257	54,833	99,257
Adjusted R^2	0.8644	0.5657	0.8966
Controls	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes

Extensions

- A potential concern is that our results are due to the non-random assignment of the SupTech events

- To alleviate this concern, we use four methods to ensure that our estimates are well-identified:
  - → Parallel trends assumption Details
  - → Propensity score matching Details
  - → Falsification tests Details
  - → Alternative estimator Details (Baker et al., 2022)

Channel

- The literature has proposed 3 potential channels through which bank supervision can affect banks' balance sheets:
  1. Capital channel
  2. Market discipline channel
  3. Supervisory scrutiny channel

Supervisory scrutiny channel: The types of SupTech events

- First, we show that the effects are stronger for SupTech events related to regulatory non-compliance (similar to Kok et al., 2023)

Supervisory scrutiny channel: The types of SupTech events

	(1) NPL/TA	(2) LLP/TA	(3) LLP_{risky}/TA
$Post\ supervision_{regulatory}$	0.00810***	0.00178***	0.00544***
	(0.00225)	(0.00064)	(0.00159)
$Post\ supervision_{reporting}$	0.00267	0.00009	0.00059
	(0.00375)	(0.00109)	(0.00247)
Observations	101,194	99,257	99,257
Adjusted R-squared	0.63737	0.53892	0.63206
Bank FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes

The length of SupTech events

Supervisory scrutiny channel: Within-municipality spillovers

- Second, we show that the SupTech events have within-municipality spillovers, in line with a "deterrence effect" (see Colonnelli and Prem, 2022; Pomeranz, 2015; Rincke and Traxler, 2011)

Supervisory scrutiny channel: Within-municipality spillovers

	(1) NPL/TA	(2) LLP/TA	(3) LLP_{risky}/TA
Post × Treated	0.0033**	0.0013**	0.0015†
	(0.0015)	(0.0006)	(0.0009)
Observations	66,220	62,323	62,323
Adjusted R-squared	0.6505	0.5554	0.6361
Controls	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes

$$y_{b,c,t} = \gamma Post \times Treated_{c,t} + \delta \boldsymbol{X}_{b,t-1} + \alpha_b + \alpha_t + \epsilon_{b,c,t} \quad (2)$$

where $Post \times Treated_{c,t}$ is equal to one after a bank operating in municipality c was treated

In a nutshell

- We find that SupTech events induce banks to reveal unreported credit risks, in line with an informational disclosure effect
  - $\rightarrow$ The effects are similar to those of bank sanctions and on-site bank inspections (Delis et al., 2018; Passalacqua et al., 2022)
- These results can be rationalized by a supervisory scrutiny channel

Methodology

- Second, we study the effect of SupTech events on banks' lending behavior
- The literature has proposed 2 potential channels through which bank supervision can affect bank lending (Granja and Leuz, 2018):
  1. Capital shock channel
  2. Reallocation channel

Methodology

- We first test the capital shock channel:

$$\Delta Credit_{f,b,t} = \beta^{ATE} Post\ supervision_{b,t} + \delta \boldsymbol{X}_{f,b,t-1} + \alpha_{f,t} + \alpha_{b,f} + \epsilon_{f,b,t} \quad (3)$$

Results

- On average, we do not find a change in credit supply

	(1) Credit growth	(2) Credit growth	(3) Credit growth	(4) Credit growth
Post supervision	-0.0005	0.0004	0.0138	0.0144
	(0.0330)	(0.0305)	(0.0270)	(0.0362)
Observations	10,478,565	10,466,282	5,371,450	5,243,909
R-squared	0.0842	0.0845	0.4239	0.4976
Controls	No	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	No
Firm FE	Yes	Yes	No	No
Time FE	Yes	Yes	No	No
Firm $\times$ Time FE	No	No	Yes	Yes
Bank $\times$ Firm FE	No	No	No	Yes

Methodology

- We then extend the previous model to test the reallocation channel:

$$\Delta Credit_{f,b,t} = \beta^{ATE}(Post\ supervision_{b,t} \times Credit\ risk_{f,b,t-1}) + \delta \boldsymbol{X}_{f,b,t-1} + \alpha_{b,t} + \alpha_{f,t} + \alpha_{b,f} + \epsilon_{f,b,t} \quad (4)$$

where $Credit\ risk_{f,b,t}$ is a dummy variable equal to 1 if a borrower has a bad credit rating or has outstanding payments in arrears

Results

- We do find a reallocation in credit supply

	(1) Credit growth	(2) Credit growth	(3) Credit growth	(4) Credit growth
Panel A:				
Post supervision × Arrears	-0.0386***	-0.0604***	-0.0341**	-0.0542***
	(0.0136)	(0.0199)	(0.0163)	(0.0199)
R-squared	0.0868	0.4260	0.5023	0.4434
Panel B:				
Post supervision × Subprime	-0.0421	-0.0583**	-0.0499*	-0.0538*
	(0.0248)	(0.0296)	(0.0294)	(0.0315)
R-squared	0.0903	0.4245	0.5013	0.4420
Observations	10,219,038	5,196,395	5,069,598	5,189,108
Controls	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	No	No
Firm FE	Yes	No	No	No
Time FE	Yes	No	No	No
Bank × Time FE	No	No	No	Yes
Firm × Time FE	No	Yes	Yes	Yes
Bank × Firm FE	No	No	Yes	No

Extensions

- After a SupTech event, banks also increase interest rates and reduce the maturity of loans granted to less creditworthy borrowers Details

- The results are robust to a set of additional checks:
  - → Parallel trends assumption Details
  - → Falsification tests Details

In a nutshell

- SupTech events reduce bank lending to less creditworthy firms
  - $\rightarrow$ The effects are smaller than those of bank sanctions or on-site bank inspections (e.g., Delis et al., 2017; Bonfim et al., 2022)
- These results are consistent with the reallocation channel, indicating that SupTech events reduce banks' risk-taking and enhance banks' loan portfolio quality

Methodology

- Third, we study how firms' exposure to treated banks affects firm outcomes
- The key idea is that, by influencing banks' lending behavior, Sup-Tech events may have spillover effects to the real economy
- We test this using the following regression model:

$$\begin{aligned} y_{f,t} =& \beta_1 Post_{f,t} + \beta_2 Exposure_{f,t-1} + \beta^{ATE}(Post_{f,t} \times Exposure_{f,t-1}) \\ &+ \delta \boldsymbol{X}_{f,t-1} + \alpha_f + \alpha_{j,t} + \alpha_{m,t} + \epsilon_{f,t} \end{aligned} \tag{5}$$

Results

- On average, there are no spillover effects

	(1) Δ Credit	(2) Δ Employment	(3) Δ Revenue	(4) Δ Productivity
Post	0.1516***	0.0008	0.0110	0.0102
	(0.0274)	(0.0016)	(0.0160)	(0.0169)
Exposure	-0.0147*	0.0042***	-0.0071	-0.0125*
	(0.0083)	(0.0010)	(0.0068)	(0.0069)
Post × Exposure	-0.0912***	-0.0052***	.03900	0.0487
	(0.0194)	(0.0014)	(0.0291)	(0.0335)
Observations	2,604,159	2,487,823	2,687,711	2,515,362
R-squared	0.1325	0.1895	0.0840	0.0946
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Industry × Time FE	Yes	Yes	Yes	Yes
Municipality × Time FE	Yes	Yes	Yes	Yes

Results

- There are some spillover effects for less creditworthy firms

	(1) Δ Credit	(2) Δ Employment	(3) Δ Revenue	(4) Δ Productivity
Panel A:				
Post × Exposure × Arrears	-0.0349*	-0.0081*	-0.0093	-0.0025
	(0.0201)	(0.0041)	(0.0120)	(0.0121)
R-squared	0.1329	0.1903	0.1393	0.0950
Panel B:				
Post × Exposure × Subprime	0.0174	-0.0056	-0.0544**	-0.0529*
	(0.0150)	(0.0055)	(0.0259)	(0.0272)
R-squared	0.1340	0.1902	0.0844	0.0950
Observations	2,581,598	2,466,176	2,664,410	2,493,510
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Industry × Time FE	Yes	Yes	Yes	Yes
Municipality × Time FE	Yes	Yes	Yes	Yes

In a nutshell

- SupTech events generate small spillover effects to less creditworthy firms

- These firms cannot compensate the reduction in credit from treated banks, leading to a reduction in firm performance
  - $\rightarrow$ These effects differ from the negative spillovers of bank sanctions (Danisewicz et al., 2018) and the positive spillovers of on-site bank inspections (Passalacqua et al., 2022)

Conclusion

- Regulators increasingly rely on SupTech to identify banks where weaknesses are most likely to be found
- We provide novel insights that SupTech can help to improve banks' risk reporting and reduce risk-taking in bank lending
- Our findings warrant further research into SupTech, and its role in the optimal design of supervisory frameworks

Thank you!

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Appendix

Summary statistics

Summary statistics: Bank data

	N	Mean	SD	Min	Max
ln(TA)	131,928	18.824	2.469	13.604	25.213
Loans/TA	131,928	0.532	0.243	0.000	0.958
Deposits/TA	131,928	0.482	0.264	0.000	0.807
Liquidity/TA	131,928	0.334	0.213	0.020	0.957
Capital/TA	131,928	0.261	0.218	0.040	0.930
NPL/TA	131,928	0.036	0.036	0.000	0.198
LLP/TA	131,928	-0.011	0.012	-0.123	0.000
LLP_{risky}/TA	131,928	-0.023	0.024	-0.117	0.000
ROA	62,267	0.022	0.040	-0.114	0.184
Treated	131,928	0.211	0.410	0.000	1.000

Summary statistics

Summary statistics: Loan data

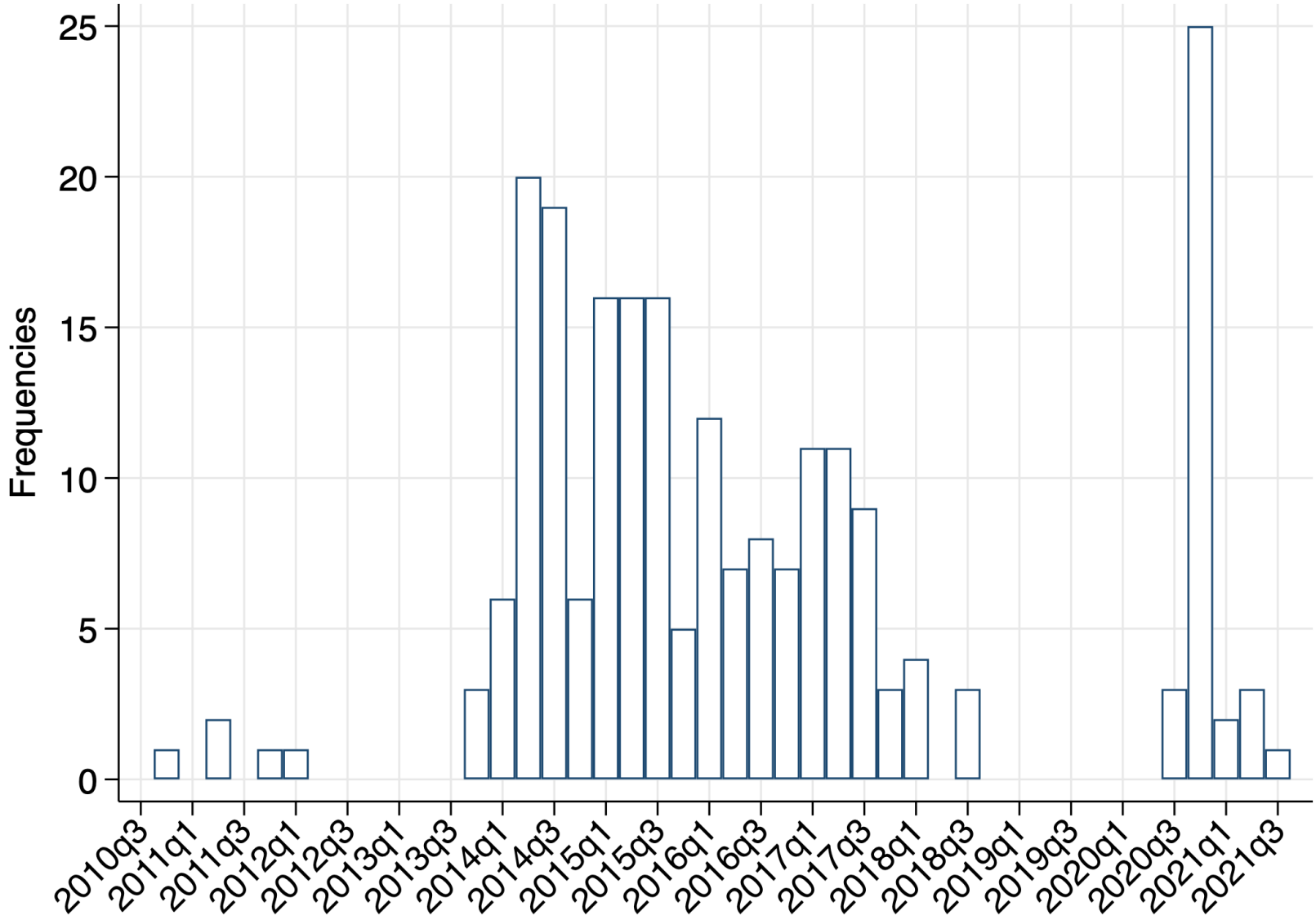
	N	Mean	SD	Min	Max
Credit growth	15,630,592	-0.028	0.473	-2.000	2.000
Collateral	15,630,592	0.607	0.489	0.000	1.000
ln(Amount)	15,630,592	10.363	1.969	0.010	26.047
ln(Rate)	15,630,592	2.506	2.924	-4.605	5.521
ln(Maturity)	15,630,592	2.811	1.271	0.000	7.375
N(Relationships)	15,630,592	2.235	1.715	1.000	31.000
Subprime	15,630,592	0.133	0.340	0.000	1.000
Arrears	15,630,592	0.206	0.404	0.000	1.000

Summary statistics

Summary statistics: Firm data

	N	Mean	SD	Min	Max
Δln(Credit)	8,603,946	0.008	0.664	-2.991	3.891
Δln(Employment)	3,685,596	0.000	0.207	-0.977	1.203
Δln(Wage/hour)	3,684,614	0.011	0.073	-0.409	0.655
Δln(Hours worked)	3,685,596	-0.001	0.270	-1.244	1.592
Δln(Revenue)	4,649,900	0.035	1.318	-13.106	13.700

Summary statistics



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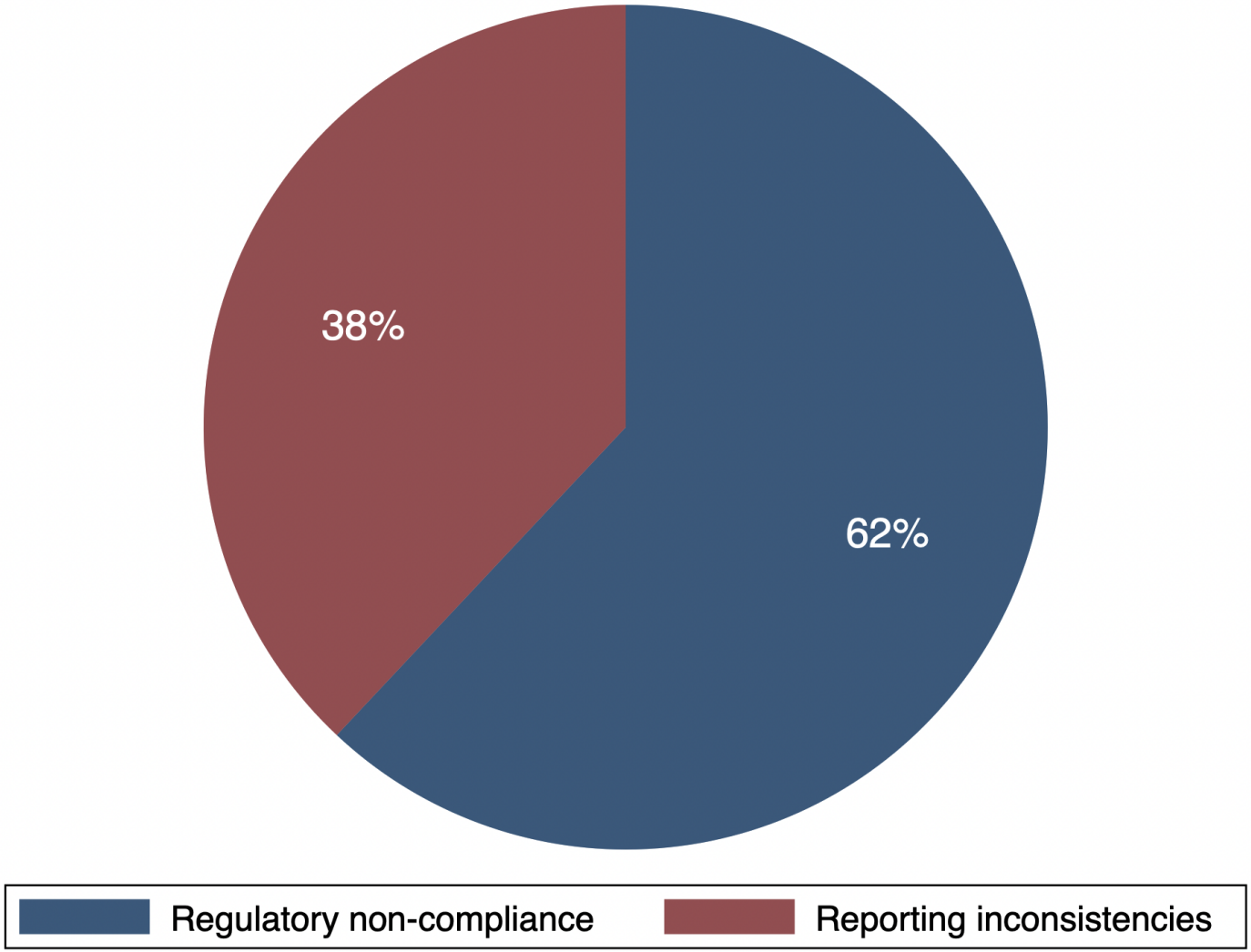

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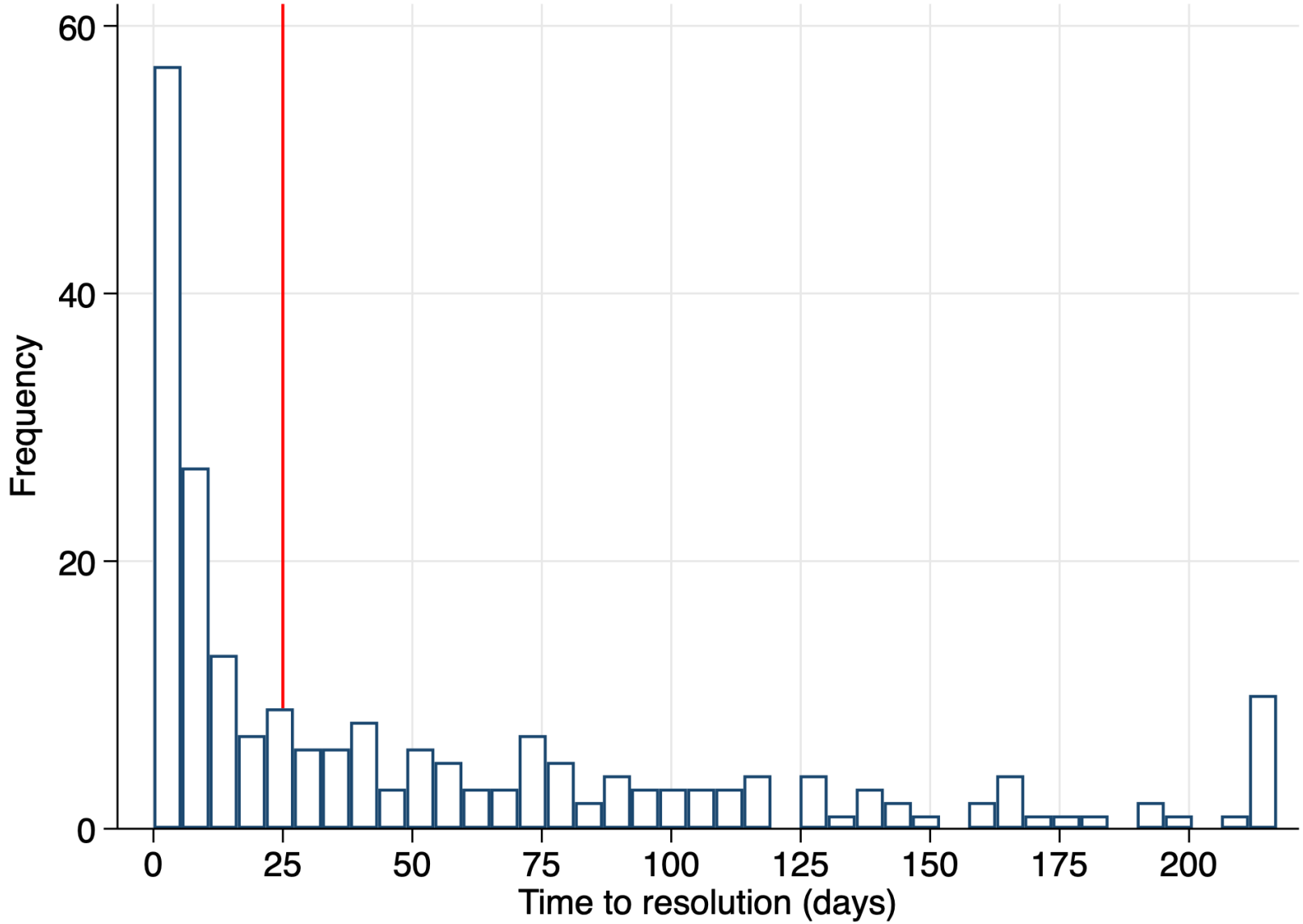
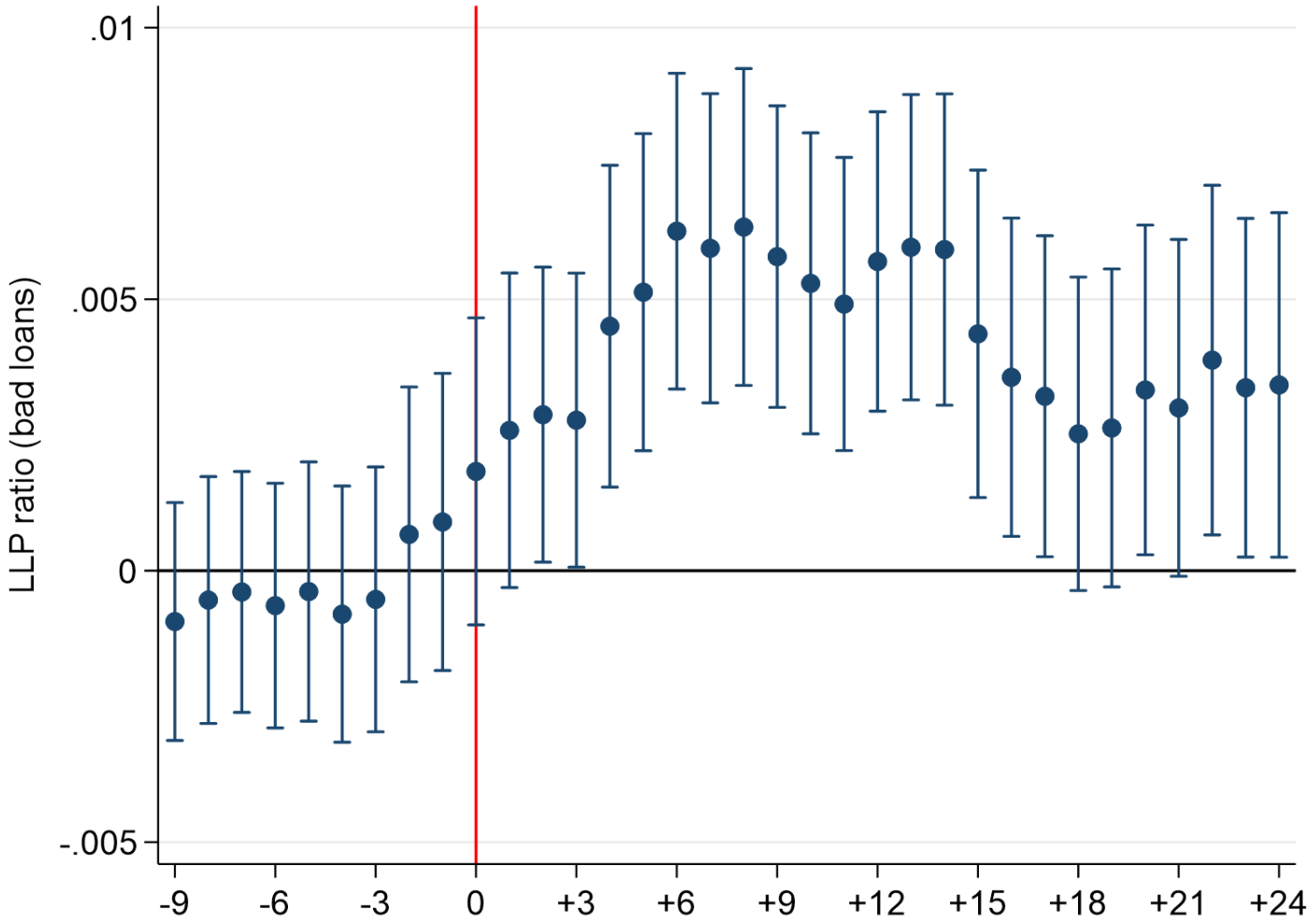


The effect on banks' balance sheet: Dynamic



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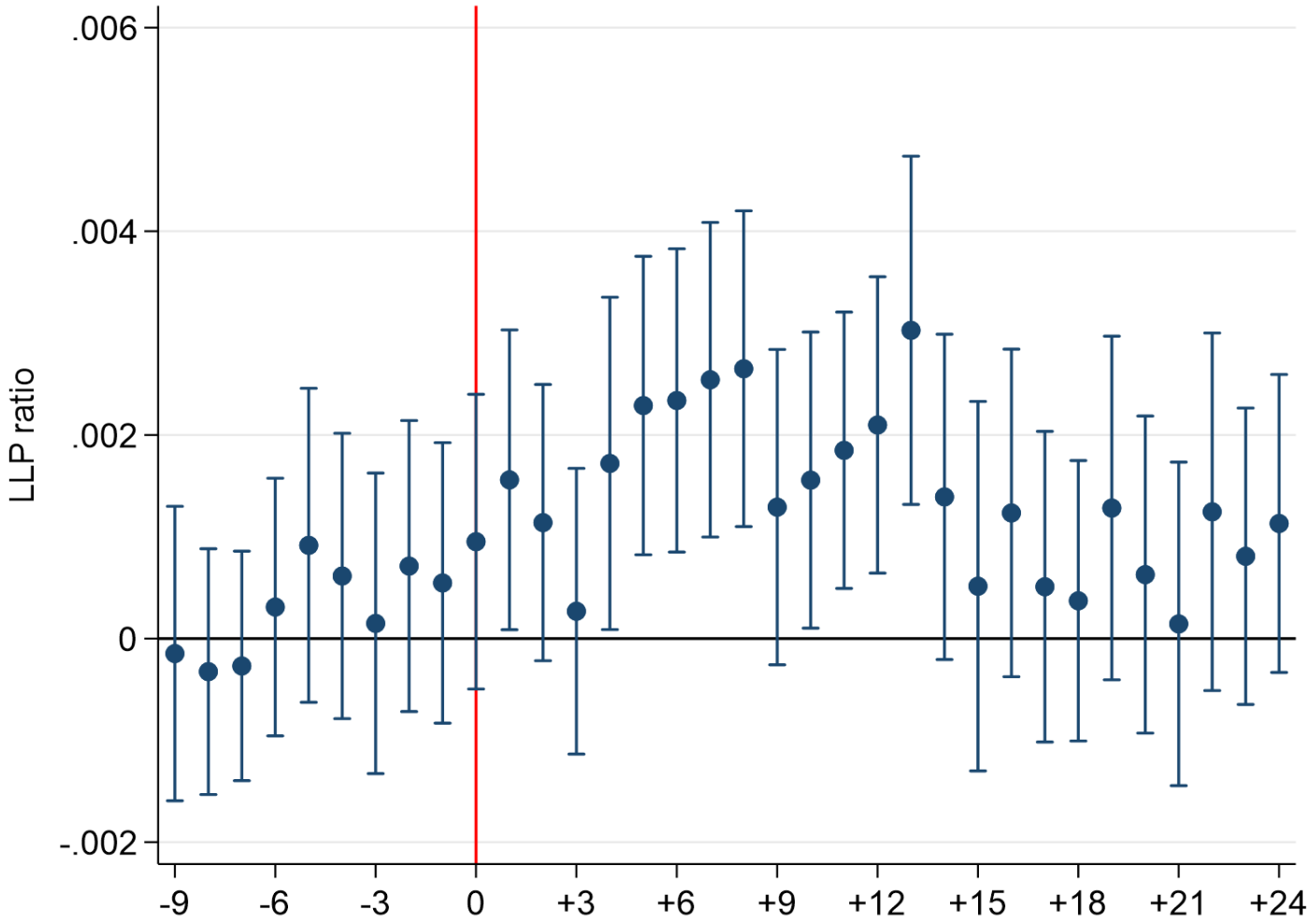

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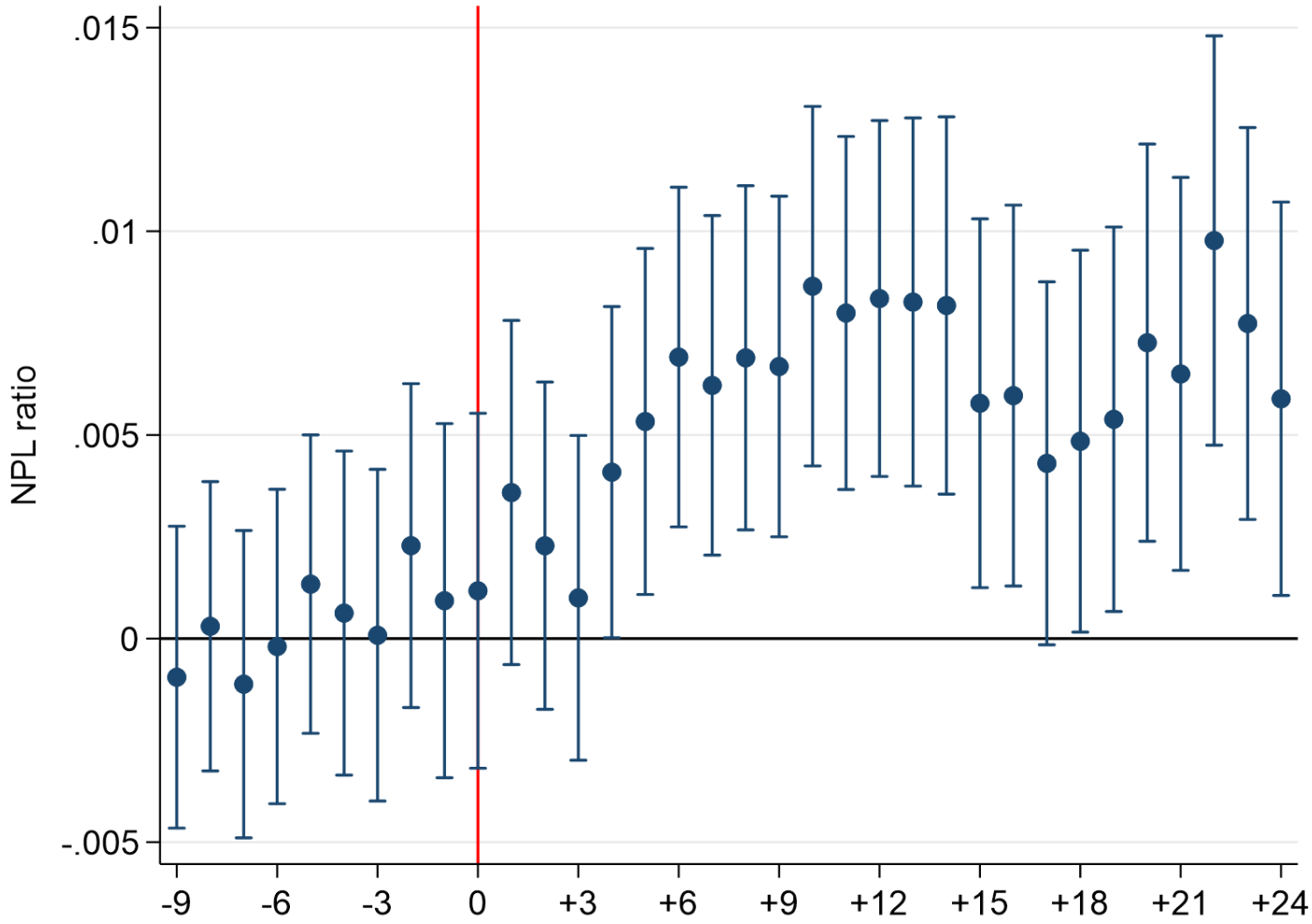

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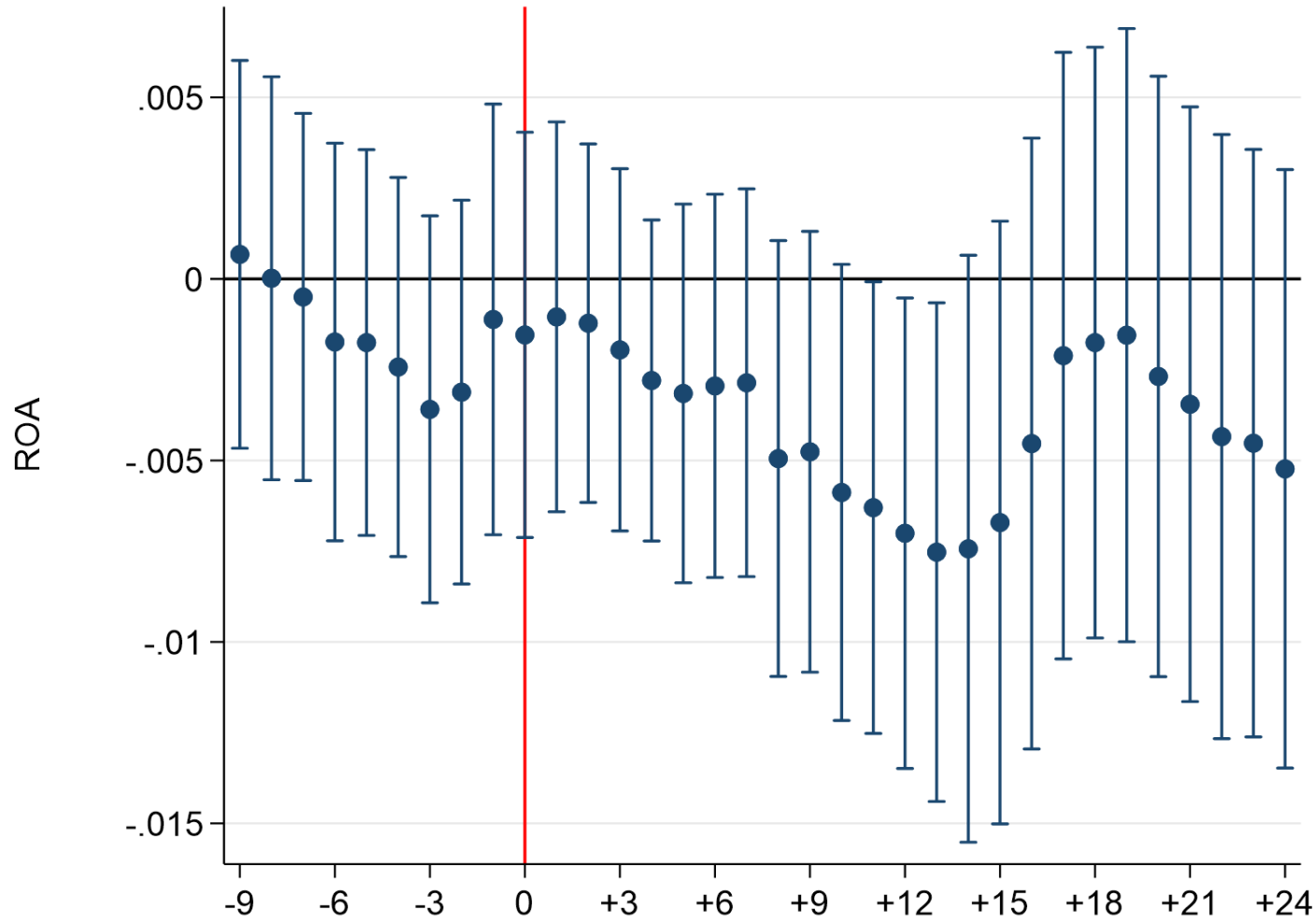

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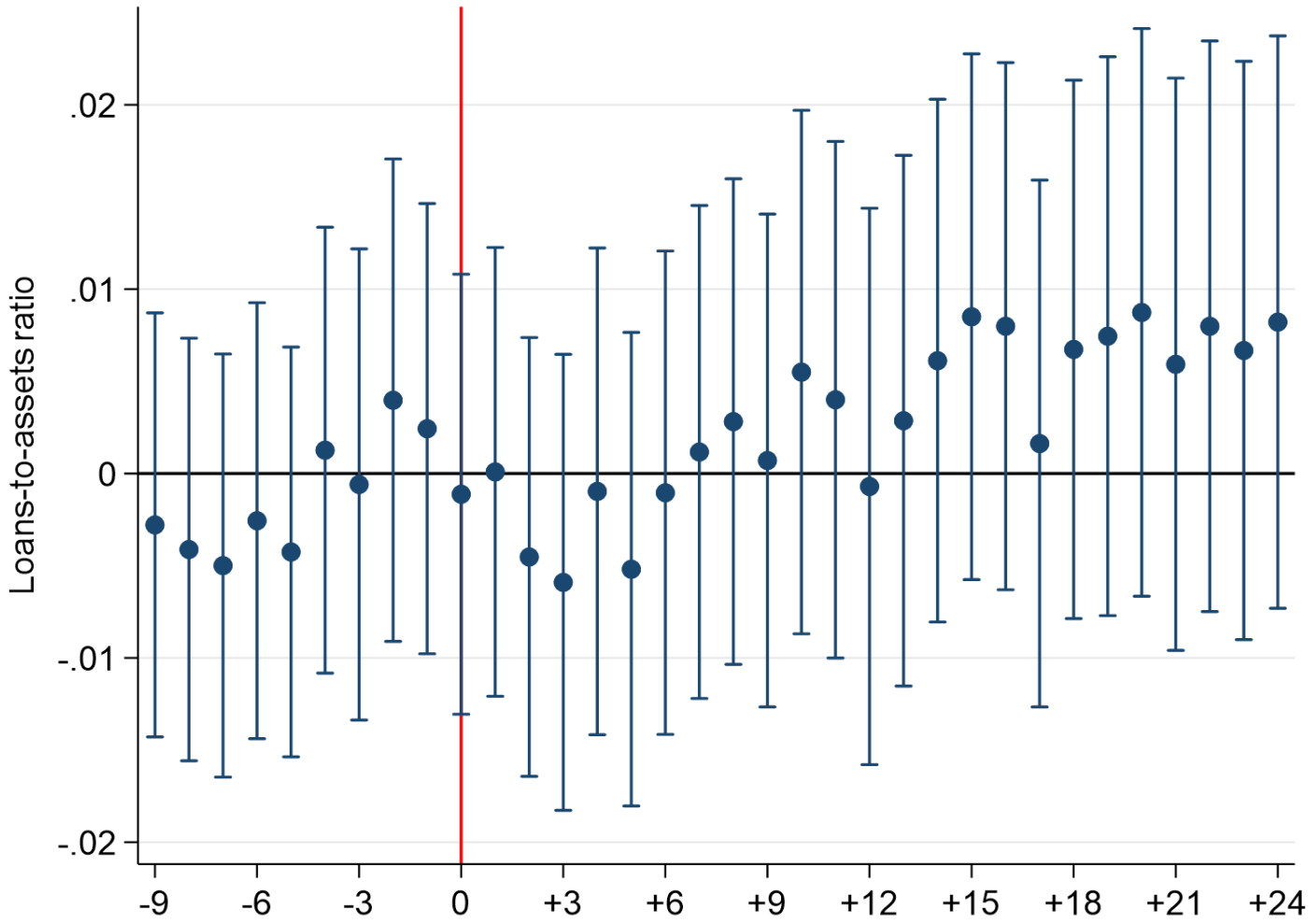
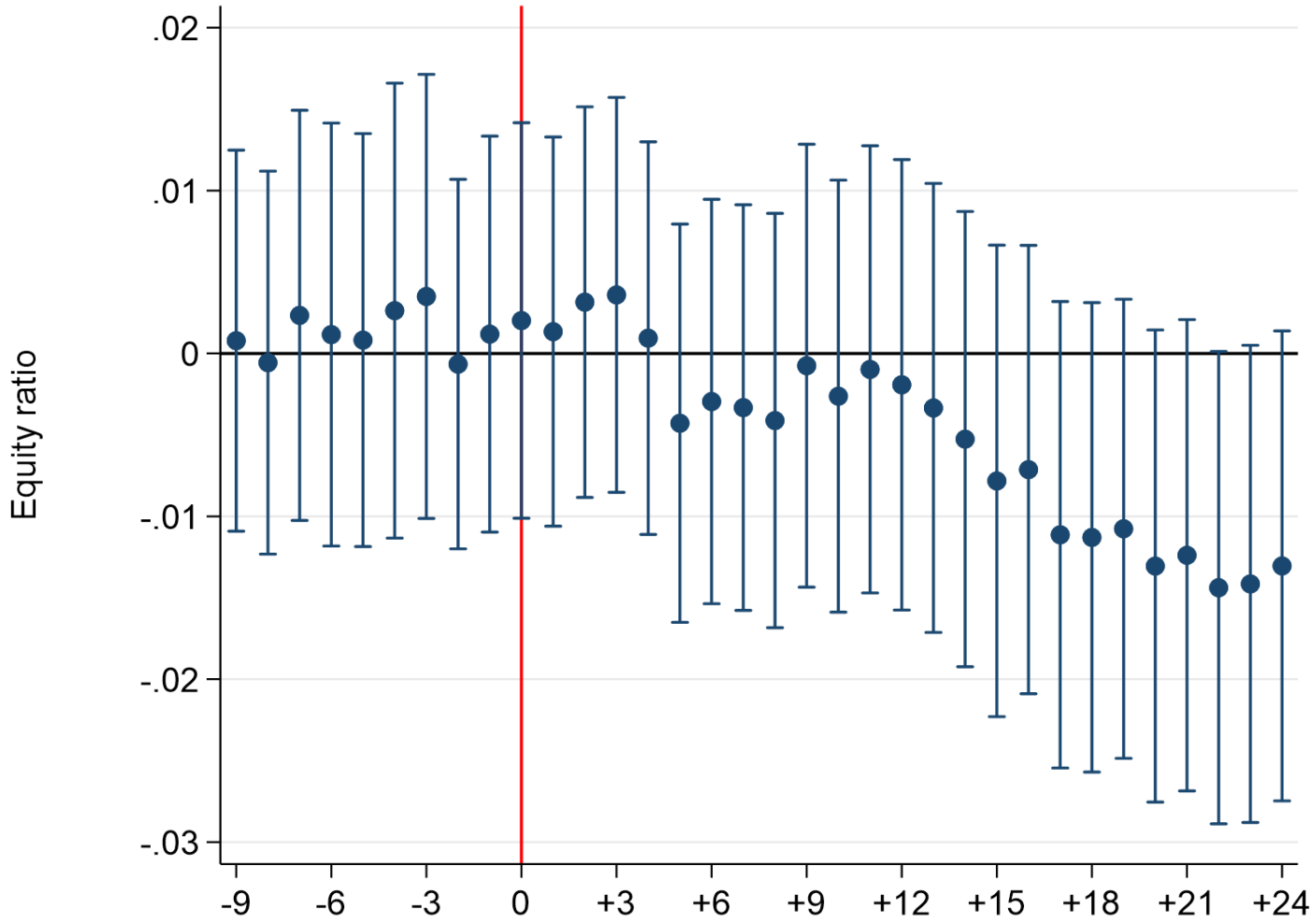


The effect on banks' balance sheet: Dynamic



The effect on banks' balance sheet: PSM

- To create a matched sample, we follow the standard approach in the literature: for a bank b inspected at period p, we compute the propensity score by running a logit model of the following form:

$$log(y_{b,p}) = \alpha_0 + \delta \boldsymbol{X}_{b,p} + \epsilon_{b,p} \tag{6}$$

- We then match (with replacement) an inspected bank with a non-inspected bank based on one-to-one nearest neighbor matching within a 0.25 standard deviations caliper of the estimated propensity score
- Based on the matched sample, we then re-estimate the regressions from Equation (1)

↑

The effect on banks' balance sheet: PSM

	(1) NPL/TA	(2) LLP/TA	(3) LLP_{risky}/TA	(4) Capital/TA	(5) ROA	(6) Loans/TA
Post supervision	0.0102***	0.0039*	0.0069**	0.0013	-0.0071	0.0003
	(0.0031)	(0.0024)	(0.0028)	(0.0081)	(0.0045)	(0.0090)
Observations	26,280	26,037	26,037	26,037	14,279	26,037
Adjusted R-squared	0.6393	0.3481	0.6050	0.8657	0.4547	0.8852
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes

The effect on banks' balance sheet: Falsification

- Although the staggered nature of SupTech events makes it unlikely that our results are driven by other events, we run falsification tests to ensure that our results are not driven by other, coinciding events
- Specifically, we assign a random date in the pre-enforcement period to the bank's supervisory intervention, and then estimate the effect of these placebo interventions on banks' balance sheet

↑

The effect on banks' balance sheet: Falsification

	(1) NPL/TA	(2) LLP/TA	(3) LLP_{risky}/TA	(4) Capital/TA	(5) ROA	(6) Loans/TA
Post supervision	0.0024	0.0002	0.0002	-0.0093	-0.0020	0.0095
	(0.0020)	(0.0006)	(0.0014)	(0.0086)	(0.0038)	(0.0083)
Observations	92,462	91,634	91,634	91,634	51,508	91,634
Adjusted R-squared	0.6834	0.5747	0.6379	0.8689	0.5919	0.8913
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes

The effect on banks' balance sheet: Stacked

- Recently, researchers have raised concerns about the use of standard two-way fixed effects estimators for difference-in-differences estimates with variation in treatment timing (e.g., Baker et al., 2022).
- To alleviate this concern, we provide an alternative estimation method, a stacked difference-in-differences model, that addresses this concern (see Deshpande and Li, 2019; Joaquim et al., 2019):

$$\begin{aligned} y_{b,p,t} = & \beta \, Treated_{b,p} + \gamma^{post}(Treated_{b,p} \times Post_{p,t}) + \\ & \alpha_{b,p} + \alpha_{p,t} + \epsilon_{b,p,t} \end{aligned} \tag{7}$$

↑

The effect on banks' balance sheet: Stacked

	(1) NPL/TA	(2) LLP/TA	(3) LLP_{risky}/TA	(4) Capital/TA	(5) ROA	(6) Loans/TA
Treated × Post	0.0077***	0.0014***	0.0043***	0.0036	-0.0007	-0.0015
	(0.0022)	(0.0005)	(0.0015)	(0.0045)	(0.0015)	(0.0050)
Observations	382,337	378,465	378,465	378,465	204,891	378,465
Adjusted R-squared	0.8373	0.6414	0.8392	0.9499	0.6852	0.9563
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank × Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Time × Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes

Channel: The length of SupTech events

	(1) NPL/TA	(2) LLP/TA	(3) LLP_{risky}/TA
$Post\ supervision_{short}$	0.0064**	0.0018***	0.0047***
	(0.0026)	(0.0007)	(0.0017)
$Post\ supervision_{long}$	0.0072***	0.0015***	0.0047
	(0.0026)	(0.0007)	(0.0037)
Observations	100,194	99,257	99,257
Adjusted R-squared	0.6751	0.5398	0.6326
Controls	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes

↑

The effect of SupTech events on banks' lending behavior

	(1) ln(Loan rate)	(2) ln(Loan rate)	(3) ln(Loan rate)	(4) ln(Loan rate)
Post supervision	0.2774	0.2390	0.1765	0.3541**
	(0.3771)	(0.2917)	(0.3254)	(0.1560)
Observations	14,870,060	12,452,655	6,219,594	6,100,998
R-squared	0.5313	0.5455	0.6281	0.8369
Controls	No	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	No
Firm FE	Yes	Yes	No	No
Time FE	Yes	Yes	No	No
Firm × Time FE	No	No	Yes	Yes
Bank × Firm FE	No	No	No	Yes

The effect of SupTech events on banks' lending behavior

	(1) ln(Loan rate)	(2) ln(Loan rate)	(3) ln(Loan rate)	(4) ln(Loan rate)
Panel A:				
Post supervision × Arrears	0.5166**	0.8615***	0.7554**	0.3485**
	(0.265)	(0.3209)	(0.3470)	(0.1672)
R-squared	0.5378	0.6176	0.6561	0.8364
Panel B:				
Post supervision × Subprime	0.4391***	0.8934***	0.7249*	0.4013**
	(0.1375)	(0.3363)	(0.3703)	(0.1830)
R-squared	0.5380	0.6177	0.6560	0.8362
Observations	10,219,038	5,196,395	5,189,108	5,069,598
Controls	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	No	No
Firm FE	Yes	No	No	No
Time FE	Yes	No	No	No
Bank × Time FE	No	No	Yes	No
Firm × Time FE	No	Yes	Yes	Yes
Bank × Firm FE	No	No	No	Yes

The effect of SupTech events on banks' lending behavior

	(1) ln(Maturity)	(2) ln(Maturity)	(3) ln(Maturity)	(4) ln(Maturity)
Post supervision	0.1921***	0.1644***	0.1007	0.0354
	(0.0422)	(0.0460)	(0.0665)	(0.0255)
Observations	14,870,060	12,452,655	6,219,594	6,100,998
R-squared	0.5218	0.5318	0.6226	0.8550
Controls	No	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	No
Firm FE	Yes	Yes	No	No
Time FE	Yes	Yes	No	No
Firm × Time FE	No	No	Yes	Yes
Bank × Firm FE	No	No	No	Yes

The effect of SupTech events on banks' lending behavior

	(1) ln(Maturity)	(2) ln(Maturity)	(3) ln(Maturity)	(4) ln(Maturity)
Panel A:				
Post supervision × Arrears	-0.2872**	-0.2475***	-0.2928***	-0.1506***
	(0.1097)	(0.0636)	(0.0675)	(0.0469)
R-squared	0.5386	0.6256	0.6386	0.8251
Panel B:				
Post supervision × Subprime	-0.2778*	-0.2996***	-0.3117***	-0.1810**
	(0.1680)	(0.0984)	(0.1004)	(0.0731)
R-squared	0.5382	0.6235	0.6364	0.8552
Observations	12,452,655	6,219,594	6,211,012	6,100,998
Controls	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	No	No
Firm FE	Yes	No	No	No
Time FE	Yes	No	No	No
Bank × Time FE	No	No	Yes	No
Firm × Time FE	No	Yes	Yes	Yes
Bank × Firm FE	No	No	No	Yes

The effect of SupTech events on banks' lending behavior

	(1) Pr(Collateral)	(2) Pr(Collateral)	(3) Pr(Collateral)	(4) Pr(Collateral)
Post supervision	0.0073	-0.0088	-0.0222	-0.0108
	(0.0477)	(0.0538)	(0.0422)	(0.0329)
Observations	14,870,060	12,452,655	6,219,594	6,100,998
R-squared	0.4738	0.4928	0.6035	0.8220
Controls	No	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	No
Firm FE	Yes	Yes	No	No
Time FE	Yes	Yes	No	No
Firm $\times$ Time FE	No	No	Yes	Yes
Bank $\times$ Firm FE	No	No	No	Yes

The effect of SupTech events on banks' lending behavior

	(1) Pr(Collateral)	(2) Pr(Collateral)	(3) Pr(Collateral)	(4) Pr(Collateral)
Panel A:				
Post supervision × Arrears	-0.0365	-0.0214	-0.0013	-0.0441*
	(0.0417)	(0.0231)	(0.0186)	(0.0238)
R-squared	0.4952	0.6049	0.6928	0.8223
Post supervision × Subprime	-0.0736	-0.0470	-0.0149	-0.1011**
	(0.0594)	(0.0295)	(0.0217)	(0.0462)
R-squared	0.4929	0.6035	0.6917	0.8221
Observations	10,219,038	5,196,395	5,189,108	5,069,598
Controls	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	No	No
Firm FE	Yes	No	No	No
Time FE	Yes	No	No	No
Bank × Time FE	No	No	Yes	No
Firm × Time FE	No	Yes	Yes	Yes
Bank × Firm FE	No	No	No	Yes

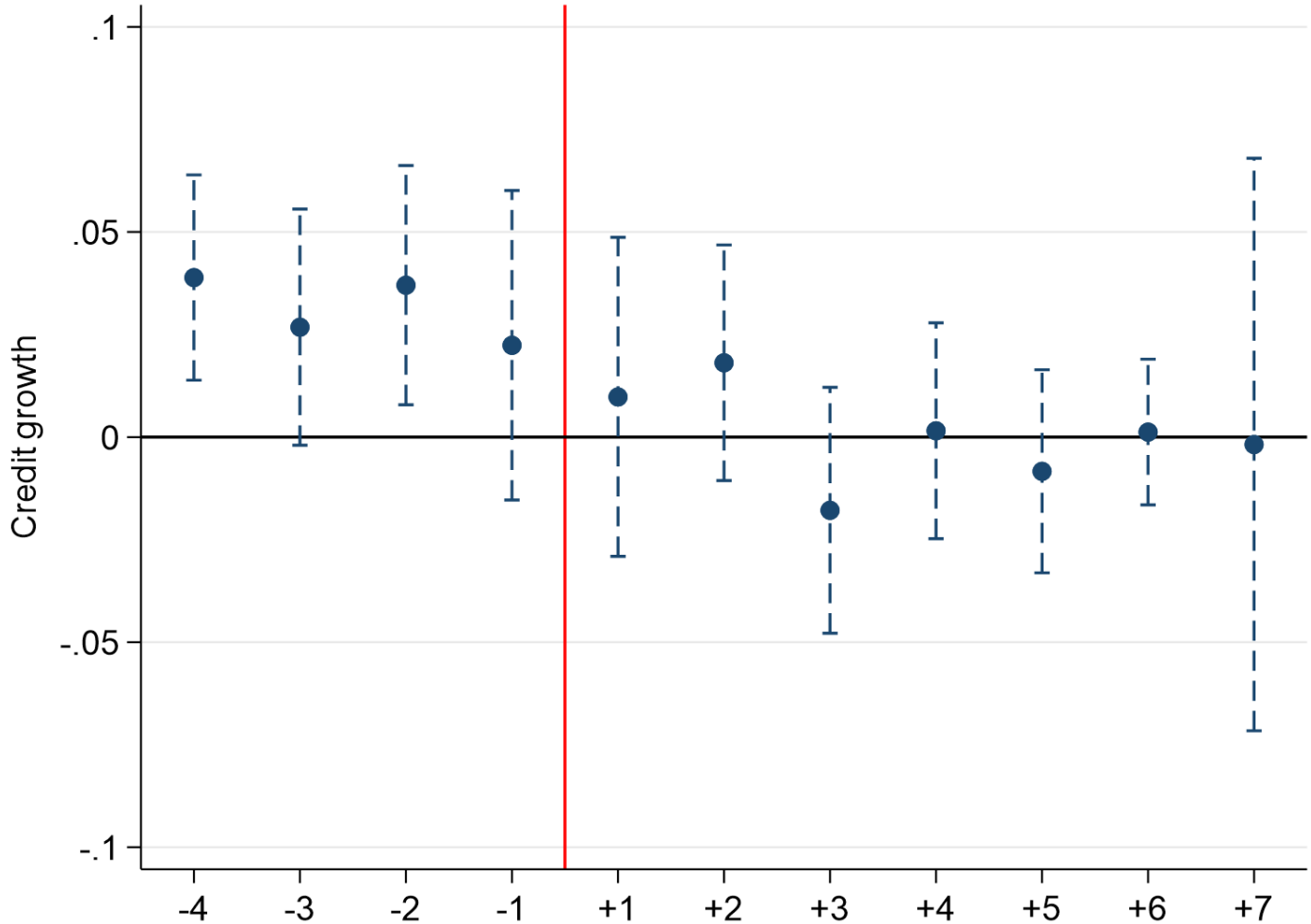
The effect of SupTech events on banks' lending behavior

	(1) Rating deviation	(2) Rating deviation	(3) Rating deviation	(4) Rating deviation
Post supervision	-0.02618	-0.02051	-0.03432	0.01538
	(0.02835)	(0.03102)	(0.05257)	(0.03192)
Observations	14,871,421	12,453,694	6,220,155	6,101,470
R-squared	0.0812	0.0877	0.1417	0.6109
Controls	No	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	No
Firm FE	Yes	Yes	No	No
Time FE	Yes	Yes	No	No
Firm × Time FE	No	No	Yes	Yes
Bank × Firm FE	No	No	No	Yes

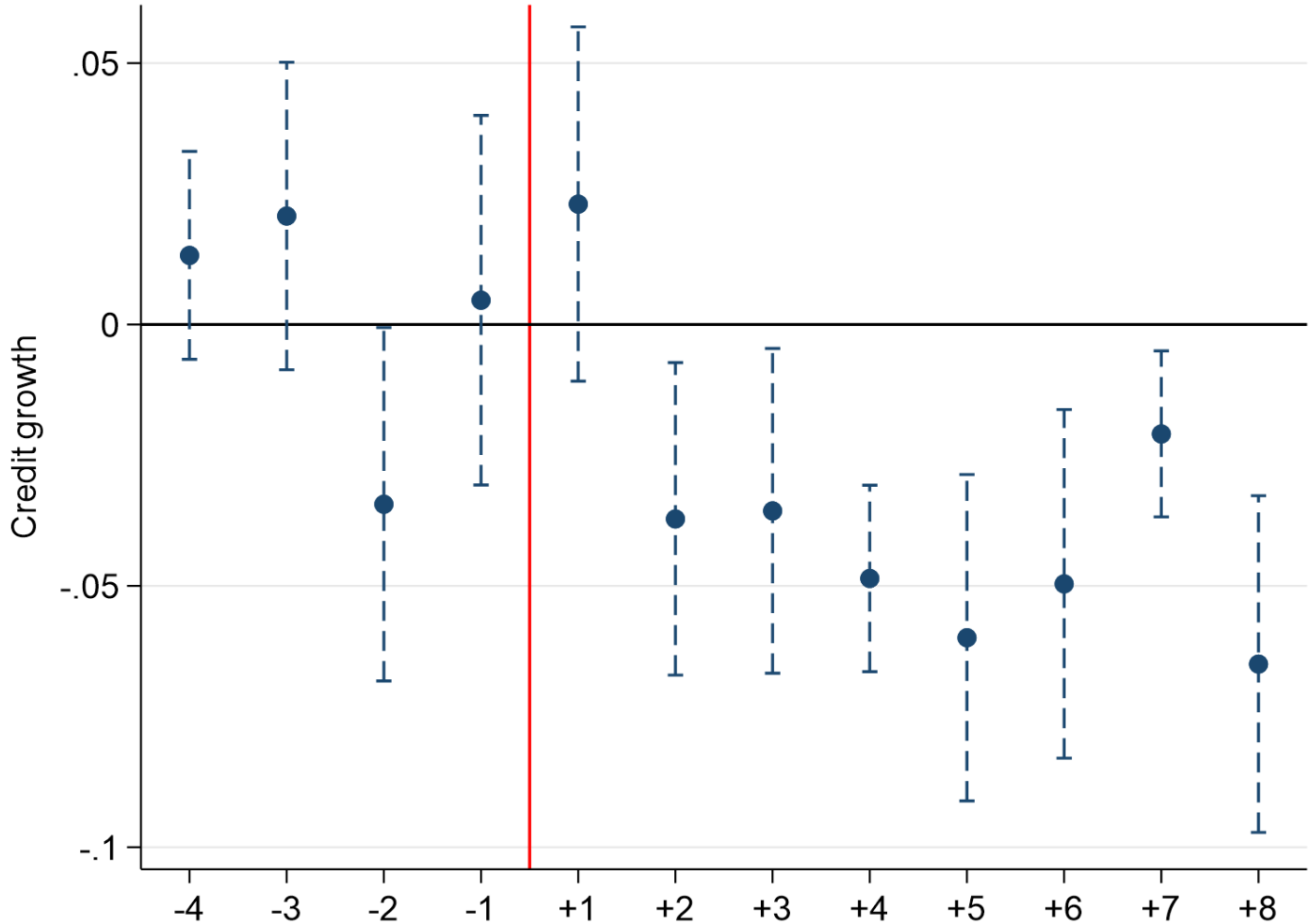
The effect of SupTech events on banks' lending behavior

	(1) Rating deviation	(2) Rating deviation	(3) Rating deviation	(4) Rating deviation
Panel A:				
Post supervision × Arrears	-0.1307**	-0.3567***	-0.3492***	-0.2470***
	(0.0574)	(0.1096)	(0.1122)	(0.0709)
R-squared	0.1048	0.1935	0.2321	0.6194
Panel B:				
Post supervision × Subprime	-0.0841	-0.1585	-0.1504	-0.0659
	(0.1379)	(0.1172)	(0.1188)	(0.1045)
R-squared	0.1741	0.5609	0.5914	0.7771
Observations	12,453,694	6,220,155	6,211,525	6,101,470
Controls	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	No	No
Firm FE	Yes	No	No	No
Time FE	Yes	No	No	No
Bank × Time FE	No	No	Yes	No
Firm × Time FE	No	Yes	Yes	Yes
Bank × Firm FE	No	No	No	Yes

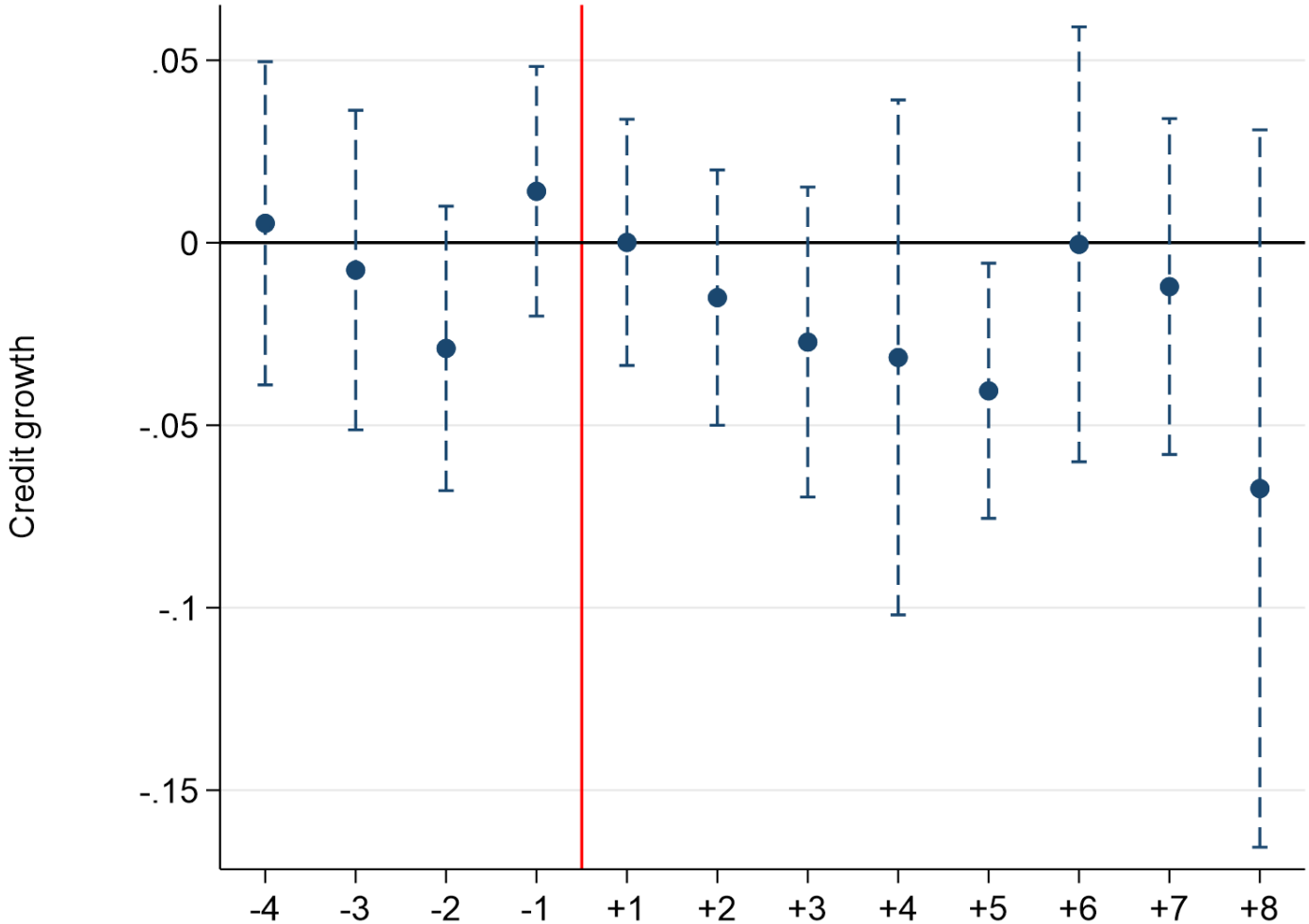
The effect of SupTech events on banks' lending behavior: Dynamic



The effect of SupTech events on banks' lending behavior: Dynamic



The effect of SupTech events on banks' lending behavior: Dynamic



The effect of SupTech events on banks' lending behavior: Falsification

	(1) Credit growth	(2) Credit growth	(3) Credit growth	(4) Credit growth
Post supervision	-0.0159	0.0081	-0.0017	0.0057
	(0.0249)	(0.0072)	(0.0050)	(0.0044)
Observations	10,478,565	10,466,282	5,371,450	5,243,909
R-squared	0.0059	0.0755	0.4418	0.5108
Controls	No	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	No
Firm FE	Yes	Yes	No	No
Time FE	Yes	Yes	No	No
Firm $\times$ Time FE	No	No	Yes	Yes
Bank $\times$ Firm FE	No	No	No	Yes

The effect of SupTech events on banks' lending behavior: Falsification

	(1) Credit growth	(2) Credit growth	(3) Credit growth	(4) Credit growth
Panel A:				
Post supervision×Arrears	0.0200	-0.0207	0.0124	-0.0313
	(0.0240)	(0.0081)	(0.0192)	(0.0199)
R-squared	0.0756	0.4441	0.5120	0.4589
Panel B:				
Post supervision×Subprime	0.0118	-0.0121	-0.0103	-0.0209
	(0.0295)	(0.0187)	(0.0137)	(0.0156)
R-squared	0.0799	0.4410	0.5092	0.4560
Observations	10,219,038	5,196,395	5,069,598	5,189,108
Controls	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	No	No
Firm FE	Yes	No	No	No
Time FE	Yes	No	No	No
Bank × Time FE	No	No	No	Yes
Firm × Time FE	No	Yes	Yes	Yes
Bank × Firm FE	No	No	Yes	No