

Micro Enterprise Exposure and Bank Profitability During the COVID Period

A Causal Assessment Using Difference in Differences, PSM and Fixed Effects Models

Martina Csikós

Márton Espán

Introduction

The COVID 19 pandemic caused severe economic disruptions that affected both firms and financial institutions. The impact however was uneven across the corporate sector. Micro enterprises defined as firms with at most nine employees were particularly vulnerable due to limited financial buffers restricted access to funding and high exposure to sudden demand shocks. These characteristics raise concerns about the stability of banks with strong exposure to such borrowers.

This study examines whether banks whose corporate loan portfolios are dominated by micro enterprises experienced a larger decline in financial performance during the pandemic than banks with only minimal exposure. If micro enterprises were disproportionately affected by the crisis banks lending primarily to these firms may have faced higher credit risk increased provisioning needs and reduced profitability.

By addressing this question the analysis sheds light on how borrower composition influences bank resilience during periods of systemic stress.

The Data

The analysis uses a panel of Brazilian banks with quarterly observations from 2014 quarter 1 to 2022 quarter 2 obtained from the Central Bank of Brazil. Bank performance is measured by return on assets.

Banks are classified into treated and untreated groups based on their exposure to micro enterprises measured in 2019 quarter 4. Treatment equals one for banks with at least fifty percent of corporate loans granted to micro enterprises and zero for banks with at most five percent exposure. Institutions with intermediate exposure are excluded.

The main variables are defined as follows. Return on assets equals 400 times quarterly net income divided by total assets. Bank size is measured the natural logarithm of total assets. Capitalisation is captured by equity over assets. Deposit funding equals deposits over assets. Lending intensity is measured by loans over assets. Operating costs are proxied by administrative expenses over assets. Categorical controls include state of headquarters business segment and aggregation type TD.

Preliminary Analysis

The first confirmed COVID 19 case in Brazil occurred in February 2020 therefore 2019 quarter 4 is treated as the last pre pandemic period. Figure 1 plots average return on assets for treated and untreated banks over time with the onset of the pandemic indicated.

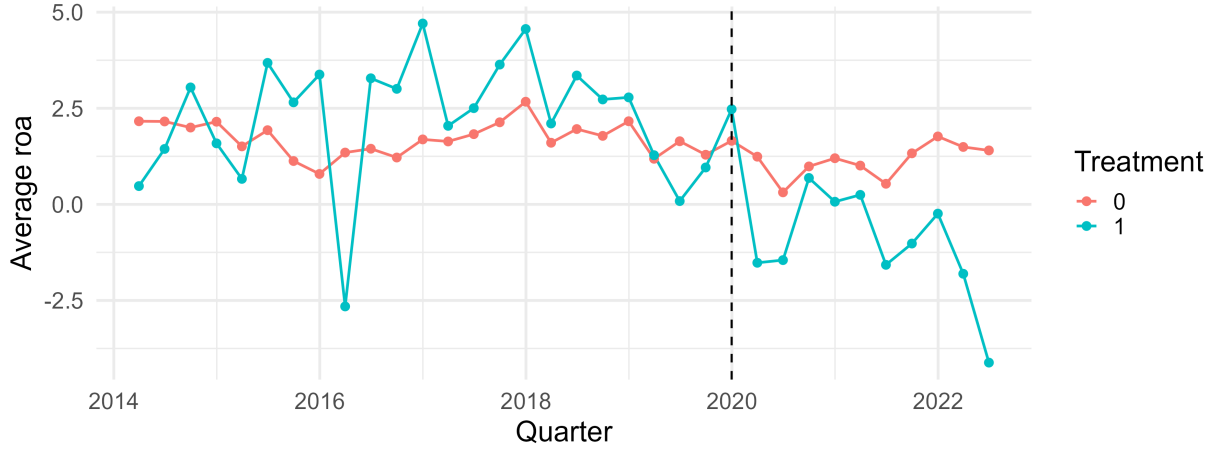


Figure 1: Average ROA over time for treated and untreated institutions

The figure suggests that banks with high exposure to micro enterprise clients experienced a more pronounced decline in profitability following the onset of the pandemic. While both groups exhibit time variation visual inspection does not indicate a strong divergence prior to 2020. After the onset of COVID treated institutions display a clear downward shift consistent with a stronger adverse impact of the shock.

Difference in Difference Approach

To estimate the effect of the COVID 19 shock we apply a two period difference in difference framework. The fourth quarter of 2019 is treated as the last pre COVID period and the third quarter of 2021 as the post period. This long difference is intended to capture the cumulative impact of the pandemic while smoothing short term volatility in quarterly profitability.

For each institution we construct the outcome difference

$$\Delta roa_i = roa_{i, 2021_{Q3}} - roa_{i, 2019_{Q4}},$$

and estimate the effect of treatment by regressing this difference first on the treatment indicator alone and then on a comprehensive set of control variables.

The baseline specification is

$$\Delta roa_i = \alpha + \tau treatment_i + \varepsilon_i,$$

and the extended specification is

$$\Delta roa_i = \alpha + \tau treatment_i + \beta_1 segment_i + \beta_2 log_assets_i + \beta_3 eq_assets_i + \beta_4 TD_i + \beta_5 loans_assets_i + \beta_6 dep_assets_i + \beta_7 state_i + u_i.$$

Table 2 in the Appendix reports the baseline estimates without control variables. The treatment coefficient suggests a sizeable effect. Banks whose corporate loan portfolios consisted of at least fifty percent micro enterprise clients experienced on average a decline in return on assets of approximately 3.28 percentage points more than banks with very low exposure.

While statistically significant this estimate is unlikely to reflect a causal effect. Banks with high micro enterprise exposure tend to be smaller hold fewer assets and operate business models that are inherently more vulnerable to adverse shocks. In contrast larger banks are less involved in micro lending and are structurally more resilient. As a result the estimated difference may partly reflect underlying structural heterogeneity rather than the effect of micro enterprise exposure itself.

Once control variables are included as shown in Table 3 in the Appendix the estimated treatment effect drops sharply and becomes economically and statistically negligible. The coefficient falls to roughly 0.05 percentage points indicating that observable bank characteristics explain most of the initial difference in performance.

Although this adjustment substantially reduces the estimated effect residual imbalances between treated and control institutions may still remain. For this reason the next stage of the analysis adopts a matching strategy to construct a more comparable control group.

Propensity Score Matching I

The construction of the matching design requires particular care due to the large number of categorical variables. The state variable comprises nine locations while segment and TD capture four and two categories respectively. Exact matching on all dimensions would result in a very small matched sample. Therefore in the first matching specification exact matching is applied only to segment and TD while state enters the propensity score model as a standard covariate.

Propensity score matching is implemented using a logit specification. A matching ratio of five is chosen to preserve the original treated control composition and the caliper is set to 0.2 to avoid excessive loss of observations.

The propensity score model is specified as

$$treatment_i \sim log_assets_i + eq_assets_i + dep_assets_i + loans_assets_i + adminexp_assets_i + state_i,$$

with exact matching imposed on TD_i and $segment_i$.

Before matching treated and control institutions differ substantially across key characteristics. As shown in Table 4 in the Appendix several covariates exhibit large standardized mean differences and severe variance imbalances indicating that untreated institutions do not form a credible counterfactual.

Matching substantially improves balance. Table 5 in the Appendix shows that standardized differences are reduced to near zero for most continuous variables while exact matching ensures

perfect balance in segment and TD. Residual imbalances remain primarily among a subset of state indicators and for log assets. These improvements are also illustrated in Figure 2 in the Appendix.

The resulting matched sample consists of 53 control and 26 treated institutions as reported in Table 6 in the Appendix. This reflects a deliberate trade off between covariate balance and sample size.

After balancing covariates using propensity score matching we re estimate the effect of micro enterprise exposure on the change in return on assets using weighted least squares. Since matching improves comparability between treated and control institutions the post matching analysis provides a cleaner assessment of the treatment effect.

Table 7 in the Appendix reports the weighted regression without control variables. The estimated treatment effect equals minus 2.86 percentage points and is statistically insignificant. This estimate is close to the corresponding coefficient obtained in the unmatched sample suggesting that matching alone does not materially alter the average treatment effect.

As a further step we apply regression adjustment after matching to address remaining covariate imbalances and improve estimation precision. The results are shown in Table 8 in the Appendix. Once controls are included the estimated treatment effect decreases to minus 0.64 percentage points and remains statistically insignificant. This mirrors the pattern observed in the unmatched data.

Overall the matched sample displays the same qualitative tendency observed earlier. Once observable differences are accounted for the effect of micro enterprise exposure on bank profitability becomes small and statistically indistinguishable from zero.

Propensity Score Matching II

The initial matching specification yields mixed balance outcomes particularly due to the large number of state categories. To assess robustness and improve balance we therefore estimate an alternative propensity score matching specification based exclusively on continuous covariates. Matching is implemented using nearest neighbour matching with a caliper of 0.05 and a ratio of five.

Balance diagnostics for this specification are reported in Tables 9 and 10 in the Appendix. Prior to matching treated and control institutions differ substantially across all continuous covariates. After matching standardized mean differences are reduced to near zero and variance ratios move close to one. These improvements are also illustrated in Figure 3.

The resulting matched sample sizes are reported in Table 11 in the Appendix. Relative to the baseline matching specification a larger number of observations is retained while maintaining excellent balance.

Regression results based on the matched sample are shown in Tables 12 and 13. The estimated treatment effect is small stable across specifications and statistically insignificant. Together with the strong balance properties this suggests that the alternative matching design yields more coherent and internally consistent results. Accordingly this matched sample is used as the primary sample in the subsequent analysis.

Fixed Effects Estimation

Since the COVID period represents a prolonged episode rather than a single shock and the data are observed at quarterly frequency we complement the previous analyses with a panel data approach that exploits within bank variation over time. To control for time invariant heterogeneity and common quarterly shocks we estimate a two way fixed effects model with bank and quarter effects. The treatment effect is identified by the interaction term `treatment:post` where `post` indicates quarters after the onset of COVID.

The model is estimated on both the full sample and the matched sample with and without additional control variables. Results without controls are reported in Tables 14 and 15 in the Appendix. In the full sample the estimated treatment effect is large negative and statistically significant while in the matched sample the coefficient is smaller and statistically insignificant.

Results for specifications with controls are reported in Tables 16 and 17 in the Appendix. In the full sample the treatment effect remains negative and statistically significant after controlling for time varying bank characteristics. In the matched sample the estimated effect is smaller and only marginally significant.

Across all specifications the estimated treatment effect is similar in sign and order of magnitude. Estimates based on the matched sample are approximately one to one and a half percentage points smaller than those obtained on the full sample but the qualitative conclusion is unchanged. Moreover the inclusion of state TD and segment indicators does not materially affect the estimated treatment effect in the matched specifications suggesting that these variables do not explain within bank variation in performance. Taken together the fixed effects results based on the matched sample provide the most credible evidence among the specifications considered.

Summary

Table 1: Summary of estimated treatment effects across methods

Method	Sample	Specification	Treatment Effect
OLS	Full sample	No controls	−3.30
OLS	Full sample	With controls	−0.05
OLS	Matched sample	No controls	−0.97
OLS	Matched sample	With controls	−0.61
FE	Full sample	No controls	−2.23
FE	Full sample	With controls	−2.56
FE	Matched sample	No controls	−0.87
FE	Matched sample	With controls	−1.07

The estimates obtained on the full sample are highly dispersed likely reflecting the volatility of ROA and the influence of outliers. By contrast the matched sample produces much more consistent results. Across all specifications the treatment effect is close to minus one percentage point. Although it remains uncertain whether all relevant confounders are fully controlled for the evidence suggests that on average the annual return on assets of banks with high micro enterprise exposure declined by roughly one percentage point following the onset of COVID.

Appendix

Table 2: Difference-in-Differences Regression Without Controls

	Estimate	Std. Error	p value
Intercept	−0.7000	0.8802	0.4271
treatment	−3.2815	1.4666	0.0261
Residual standard error: 11.37 on 259 df			
Multiple R^2 : 0.01896, Adjusted R^2 : 0.01517			
F statistic: 5.006 on 1 and 259 df, p value: 0.02611			

Table 3: Difference-in-Differences Regression With Controls

Variable	Estimate	Std. Error	p value
Intercept	−37.47401	12.22025	0.00241
treatment	−0.05798	2.04233	0.97737
segment198	−2.74427	3.72274	0.46174
segment199	−2.47514	3.21451	0.44206
segment9	0.15608	2.53113	0.95088
segmentOther	−2.17624	5.61723	0.69879
log_assets	1.58824	0.49382	0.00148
eq_assets	−0.25546	4.07725	0.95009
TDI	3.80736	2.68546	0.15755
loans_assets	1.58842	0.91269	0.08307
dep_assets	1.47139	3.06013	0.63108
stateGO	3.61820	5.29127	0.49476
stateMG	1.42475	3.95851	0.71922
stateOther	0.98063	3.92417	0.80288
statePR	−3.39270	4.58785	0.46032
stateRJ	0.84684	4.39888	0.84750
stateRO	2.81351	5.11473	0.58277
stateRS	1.83490	4.11446	0.65602
stateSC	4.43441	3.96130	0.26407
stateSP	1.25229	3.76090	0.73944
Residual standard error: 11.15 on 241 df			
Multiple R^2 : 0.1231, Adjusted R^2 : 0.05399			
F statistic: 1.781 on 19 and 241 df, p value: 0.02561			

Table 4: Balance Statistics Before Matching

Variable	Mean Treated	Mean Control	Std. Mean Diff.	Var. Ratio
distance	0.7483	0.1417	2.3579	1.4805
log_assets	17.2787	20.7193	-1.8060	0.5467
eq_assets	0.3418	0.2625	0.2779	1.5021
dep_assets	0.3719	0.3254	0.1679	0.8772
loans_assets	0.0796	0.3108	-1.7442	0.0177
adminexp_assets	0.0185	0.0140	0.1754	0.3090
stateBA	0.0638	0.0299	0.1386	.
stateGO	0.0106	0.0419	-0.3049	.
stateMG	0.1489	0.0958	0.1492	.
stateOther	0.1064	0.1377	-0.1017	.
statePR	0.0638	0.0479	0.0651	.
stateRJ	0.0532	0.0719	-0.0832	.
stateRO	0.0106	0.0479	-0.3632	.
stateRS	0.1489	0.0599	0.2501	.
stateSC	0.2766	0.0419	0.5246	.
stateSP	0.1170	0.4251	-0.9586	.
TDC	0.0426	0.2934	-1.2428	.
TDI	0.9574	0.7066	1.2428	.
segment197	0.1809	0.1257	0.1432	.
segment198	0.0106	0.0838	-0.7134	.
segment199	0.0213	0.3234	-2.0933	.
segment9	0.7766	0.4431	0.8006	.
segmentOther	0.0106	0.0240	-0.1298	.

Table 5: Balance Statistics After Matching

Variable	Mean Treated	Mean Control	Std. Mean Diff.	Var. Ratio
distance	0.4980	0.4644	0.1304	1.0960
log_assets	18.1380	18.5047	-0.1925	1.4089
eq_assets	0.3677	0.3312	0.1282	1.5023
dep_assets	0.3751	0.3312	0.1586	1.0483
loans_assets	0.0977	0.0861	0.0877	1.0788
adminexp_assets	0.0198	0.0162	0.1420	1.6769
stateBA	0.1154	0.0462	0.2832	.
stateGO	0.0000	0.0000	0.0000	.
stateMG	0.1538	0.2231	-0.1945	.
stateOther	0.0769	0.1923	-0.3742	.
statePR	0.1538	0.0897	0.2622	.
stateRJ	0.0769	0.0308	0.2057	.
stateRO	0.0385	0.0385	0.0000	.
stateRS	0.0769	0.0744	0.0072	.
stateSC	0.0385	0.1013	-0.1404	.
stateSP	0.2692	0.2038	0.2034	.
TDC	0.0769	0.0769	0.0000	.
TDI	0.9231	0.9231	0.0000	.
segment197	0.2692	0.2692	0.0000	.
segment198	0.0000	0.0000	0.0000	.
segment199	0.0769	0.0769	0.0000	.
segment9	0.6538	0.6538	0.0000	.
segmentOther	0.0000	0.0000	0.0000	.

Table 6: Matched Sample Sizes

	Control	Treated
All	167	94
Matched (ESS)	33.74	26
Matched	53	26
Unmatched	114	68
Discarded	0	0

Table 7: Weighted regression results without control variables (matched sample)

	Estimate	Std. Error	p value
Intercept	-2.859	1.918	0.140
treatment	-2.565	3.343	0.445
Residual standard error: 13.96 on 77 df			
Multiple R^2 : 0.007586, Adjusted R^2 : -0.005302			
F statistic: 0.5886 on 1 and 77 df, p value: 0.4453			

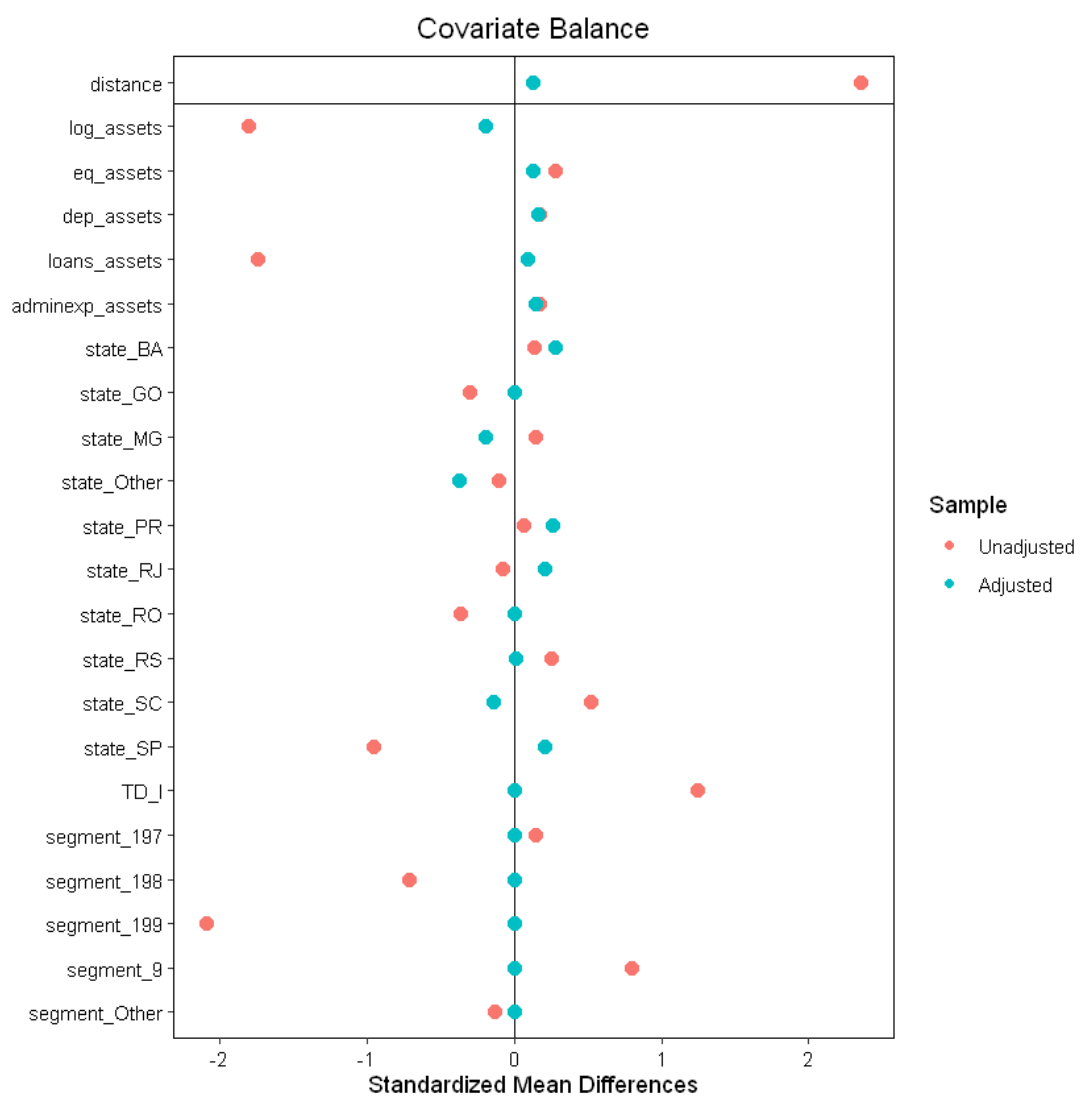


Figure 2: Standardized mean differences before and after matching

Table 8: Weighted regression results with control variables (matched sample)

Variable	Estimate	Std. Error	p value
Intercept	-161.1402	26.2030	< 0.0001
treatment	-0.6423	2.3873	0.7888
segment199	9.7445	5.5579	0.0845
segment9	8.5468	3.9792	0.0356
log_assets	6.1893	1.0844	< 0.0001
eq_assets	2.3589	8.1905	0.7743
TDI	31.9111	6.3828	< 0.0001
loans_assets	35.7535	8.1797	< 0.0001
dep_assets	3.2446	6.0362	0.5928
stateMG	0.7840	4.8376	0.8718
stateOther	7.7189	5.2143	0.1438
statePR	-4.5680	5.3221	0.3940
stateRJ	-3.4564	6.6683	0.6061
stateRO	2.2671	6.8999	0.7436
stateRS	-5.8608	6.0193	0.3340
stateSC	-4.2120	5.8725	0.4759
stateSP	13.0125	4.9793	0.0112
Residual standard error: 9.471 on 62 df			
Multiple R^2 : 0.6323, Adjusted R^2 : 0.5374			
F statistic: 6.664 on 16 and 62 df, p value: 1.97×10^{-8}			

Table 9: Balance Statistics Before Matching (Continuous Covariates Only)

Variable	Mean Treated	Mean Control	Std. Mean Diff.	Var. Ratio
distance	0.6972	0.1705	2.1639	1.0898
log_assets	17.2787	20.7193	-1.8060	0.5467
eq_assets	0.3418	0.2625	0.2779	1.5021
dep_assets	0.3719	0.3254	0.1679	0.8772
loans_assets	0.0796	0.3108	-1.7442	0.0177
adminexp_assets	0.0185	0.0140	0.1754	0.3090

Table 10: Balance Statistics After Matching (Continuous Covariates Only)

Variable	Mean Treated	Mean Control	Std. Mean Diff.	Var. Ratio
distance	0.5029	0.4979	0.0205	1.0331
log_assets	18.1463	18.2256	-0.0416	1.6681
eq_assets	0.3761	0.3590	0.0598	1.3922
dep_assets	0.2940	0.3179	-0.0863	0.8662
loans_assets	0.0991	0.0984	0.0047	1.1059
adminexp_assets	0.0163	0.0163	0.0028	1.3651

Table 11: Matched Sample Sizes

	Control	Treated
All	167	94
Matched (ESS)	46.46	38
Matched	66	38
Unmatched	101	56
Discarded	0	0

Table 12: Weighted regression results without control variables (matched sample)

	Estimate	Std. Error	p value
Intercept	-2.037	1.584	0.201
treatment	-0.970	2.620	0.712
Residual standard error: 12.86 on 102 df			
Multiple R^2 : 0.001342, Adjusted R^2 : -0.008448			
F statistic: 0.1371 on 1 and 102 df, p value: 0.7119			

Table 13: Weighted regression results with control variables (matched sample)

Variable	Estimate	Std. Error	p value
Intercept	-76.5227	19.2285	0.000132
treatment	-0.6139	2.3326	0.7930
log_assets	3.7068	0.9258	0.000121
eq_assets	6.0627	6.5558	0.3573
loans_assets	23.8734	7.7156	0.002572
dep_assets	7.5525	4.5936	0.1033
Residual standard error: 11.44 on 98 df			
Multiple R^2 : 0.241, Adjusted R^2 : 0.2023			
F statistic: 6.224 on 5 and 98 df, p value: 4.708×10^{-5}			

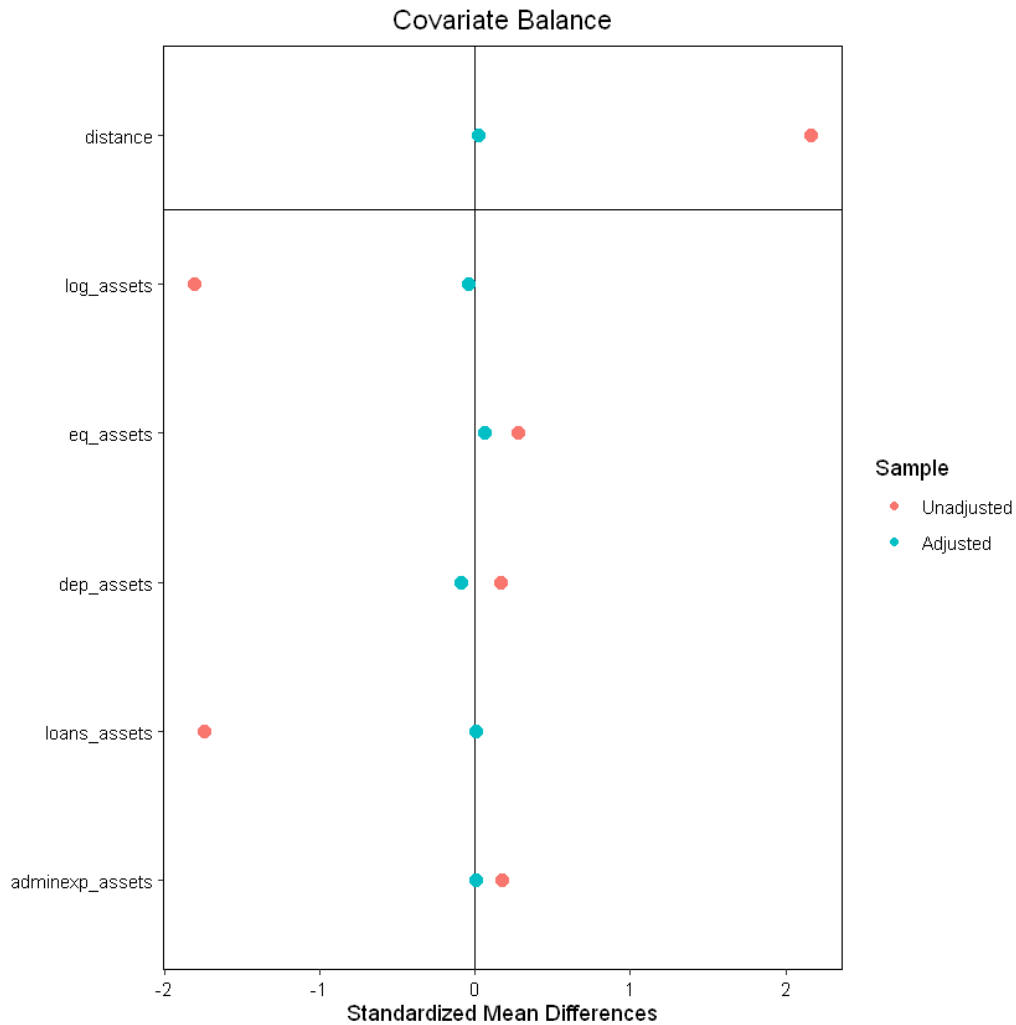


Figure 3: Standardized mean differences before and after matching (continuous covariates)

Table 14: Fixed effects model without controls (full sample)

	Estimate	Std. Error	p value
treatment:post	-2.22683	0.426907	1.8701e-07
Observations: 8,717	FinInst FE: 294	Quarter FE: 34	
RMSE: 7.75912	Within R^2 : 0.0006177	Adjusted R^2 : 0.276621	

Table 15: Fixed effects model without controls (matched sample)

	Estimate	Std. Error	p value
treatment:post	-0.87331	0.645671	0.1763
Observations: 3,098	FinInst FE: 104	Quarter FE: 34	
RMSE: 7.75912	Within R^2 : 0.0006177	Adjusted R^2 : 0.276621	

Table 16: Fixed effects model with controls (full sample)

Variable	Estimate	Std. Error	p value
log_assets	4.889480	0.298112	< 0.0001
eq_assets	17.624027	1.396976	< 0.0001
loans_assets	-0.079003	0.183406	0.6667
dep_assets	1.231668	1.144717	0.2819
stateCE	40.188755	3.235005	< 0.0001
stateMG	-4.183376	4.392313	0.3409
stateRS	9.030908	4.312259	0.0363
TDI	1.262167	0.703956	0.0730
segment196	10.191690	8.777445	0.2456
segment197	3.231386	1.620738	0.0462
segment198	3.475873	1.497635	0.0203
treatment:post	-2.561198	0.417317	< 0.0001
Observations: 8,717	FinInst FE: 294	Quarter FE: 34	
RMSE: 8.20626	Within R^2 : 0.063698	Adjusted R^2 : 0.282665	

Table 17: Fixed effects model with controls (matched sample)

Variable	Estimate	Std. Error	p value
log_assets	2.37167	0.484683	< 0.0001
eq_assets	6.90088	2.481436	0.00545
loans_assets	-8.22492	2.093186	< 0.0001
dep_assets	-1.86210	1.964405	0.34325
treatment:post	-1.06595	0.646299	0.09919
Observations: 3,098	FinInst FE: 104	Quarter FE: 34	
RMSE: 7.69448	Within R^2 : 0.0172	Adjusted R^2 : 0.287661	