Bank Access Costs: Impact on Entrepreneurship and Productivity

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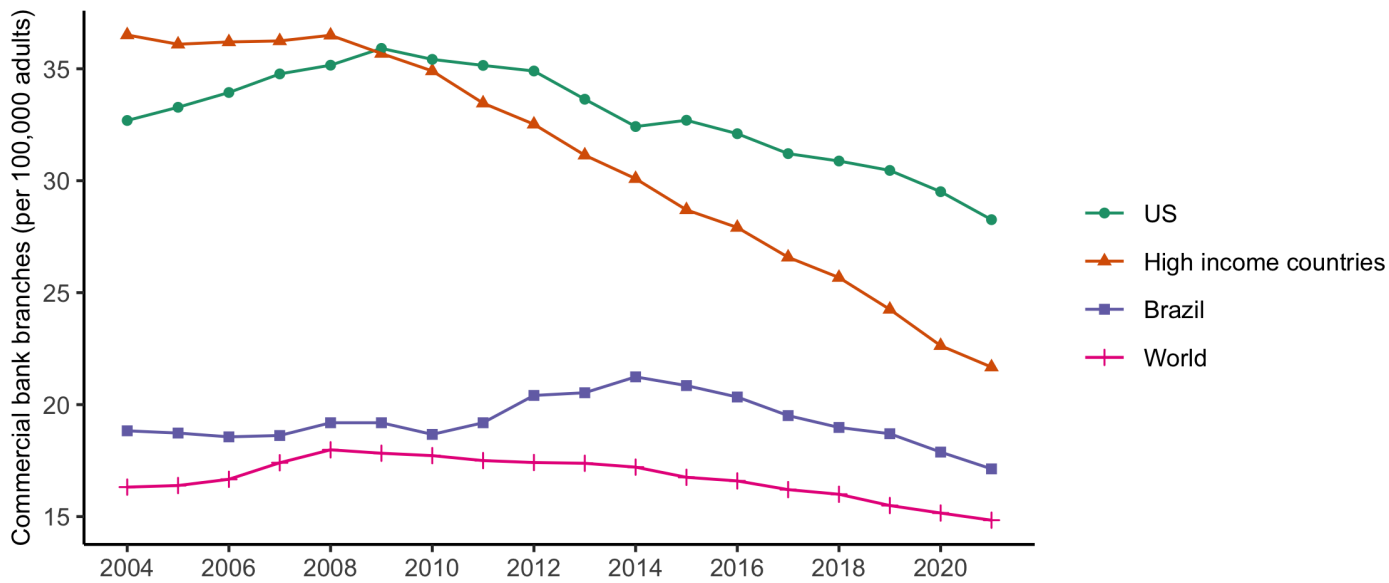
Motivation

- The distance between a firm and its nearest bank is an important factor in the cost and availability of credit (Ji, Teng and Townsend, 2021).

- Recently, the number of bank branches is decreasing in several countries.



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- In Brazil, Fonseca and Van Doornik (2022) study a 2004 financial inclusion policy that targets cities with low bank branch coverage.
  - Increase in credit availability and number of entrepreneurs in treated cities.
  - The size of the effect increases with the distance between treated cities and the nearest city with a bank branch before the reform.

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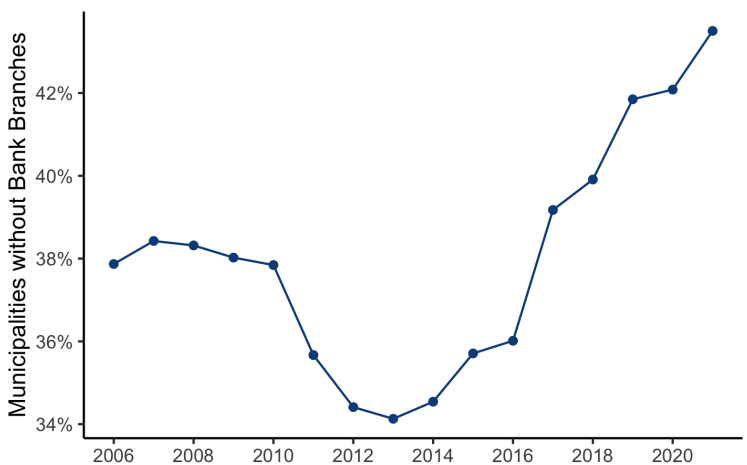
- However, in recent years:
  - The fraction of cities without bank branches in Brazil is increasing.



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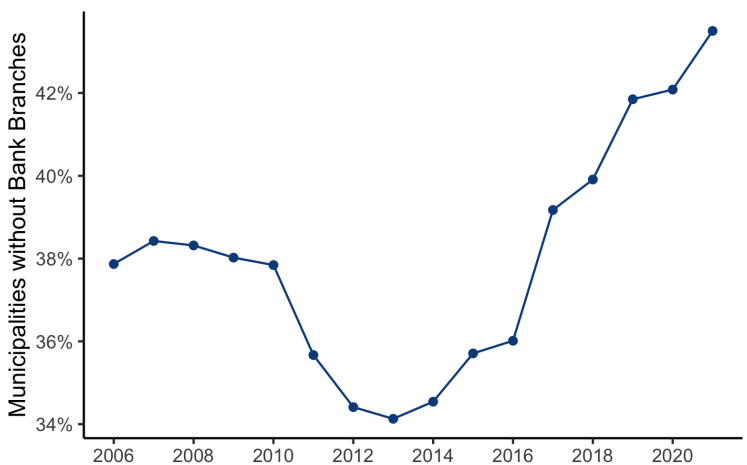
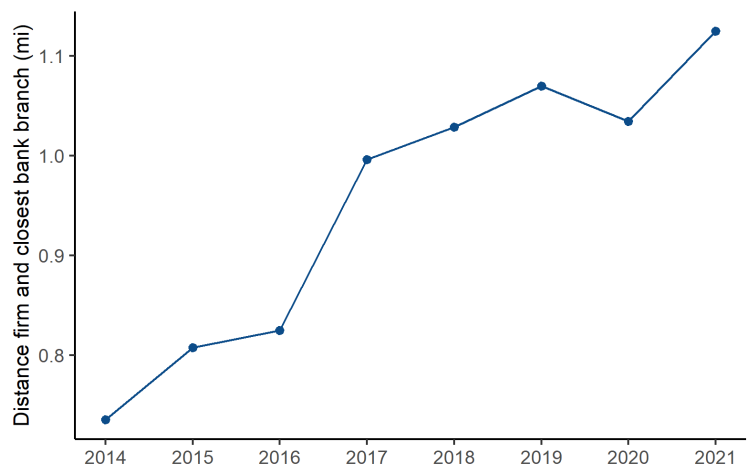
  - Increase in credit availability and number of entrepreneurs in treated cities.
  - The size of the effect increases with the distance between treated cities and the nearest city with a bank branch before the reform.

- However, in recent years:
  - The fraction of cities without bank branches in Brazil is increasing.
  - The distance between firms and its closest bank branch is increasing.

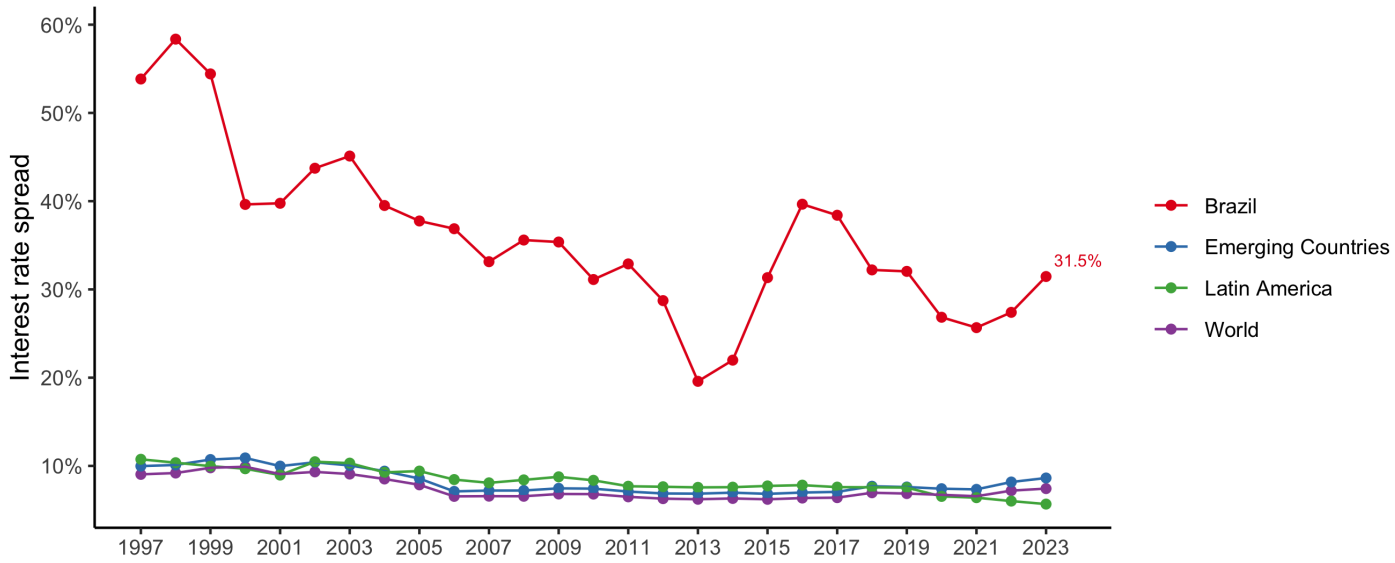




Motivation

- In 2023, Brazil had the third-highest interest rate spread in the world.
  - I.e., a $100, 1-year loan cost roughly $45 in interest.

- Despite that, banks play a crucial role in financing firms' investment.
  - One out of two Brazilian firms had a bank loan in 2012.



Spread Decomposition

Research Question

- What are the effects of the distance between firms and banks on the size distribution of firms, share of entrepreneurs, and access to finance?

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Main contributions:

- Separate out two different channels showing the effects of the distance on credit markets:
  - The direct effect of facing a higher transportation cost the further a firm is from a bank.
  - The market power it gives to banks. Part of the interest rate spread in the model is endogenous.

Contents

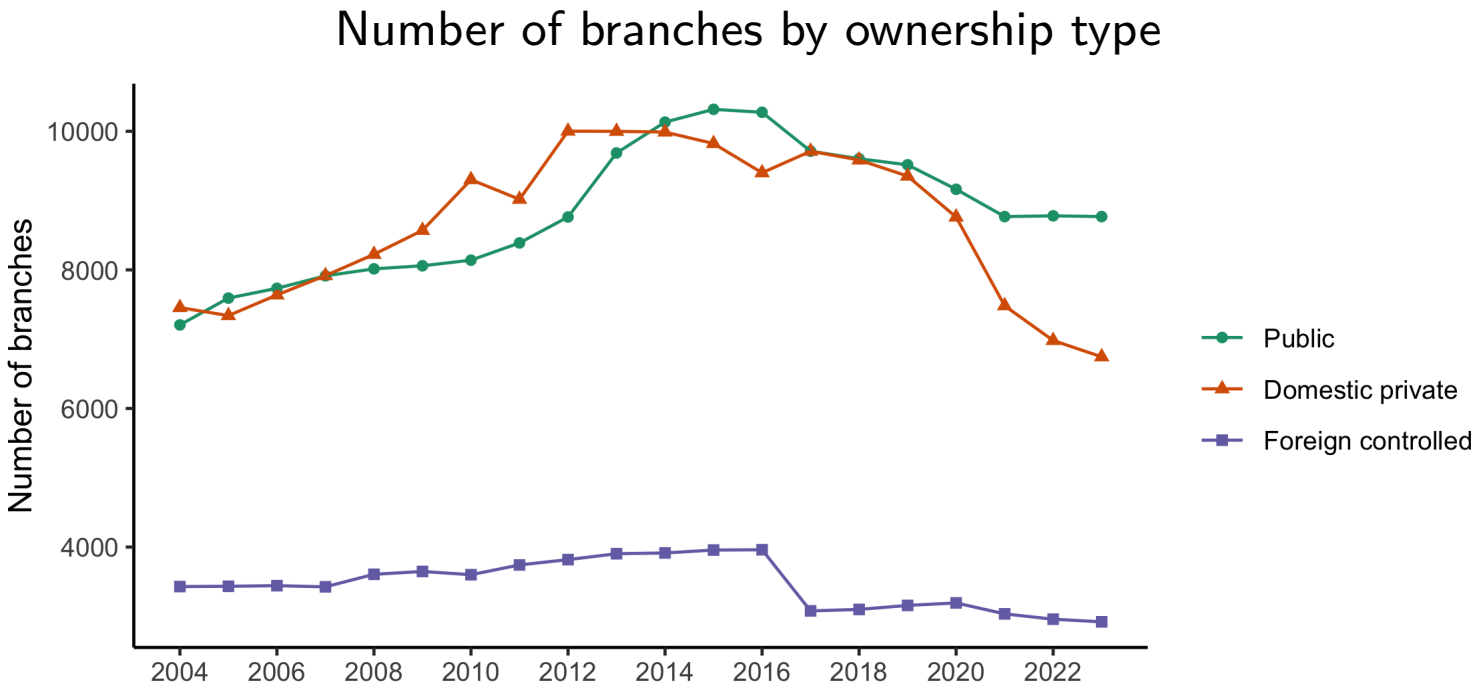
The decline of Brazilian bank branches

Characteristics of closed branches: 2017-2022

Variable	(1) Closed Branch Mean/(SE)	(2) Open Branch Mean/(SE)	(1)-(2) Pairwise t-test Mean difference
Population (Thousands)	2876.43 (60.57)	1951.53 (29.99)	924.90***
GDP per capita	11305.14 (93.17)	10209.80 (55.66)	1095.34***
Branch Age (Years)	14.28 (0.17)	27.53 (0.16)	-13.25***
Deposits (Thousands)	39.38 (30.50)	243.06 (92.02)	-203.68
Savings (Thousands)	3970.06 (79.54)	11166.82 (311.75)	-7196.77***
Distance to closest branch from same bank (mi)	8.03 (0.59)	12.78 (0.36)	-4.75***
Distance to closest branch from different bank (mi)	0.94 (0.06)	1.16 (0.04)	-0.23***
Number of observations	5197	15451	20648

*Statistical significance markers: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$*

The decline of Brazilian bank branches



Branches largest banks | Location closed branches

Literature

Relationship banking, soft information and role of distance in credit markets:

- Boot (2000), Drexler and Schoar (2014), Petersen and Rajan (2002), Agarwal (2010), Nguyen (2019), Degryse and Ongena (2005), Fonseca and Van Doornik (2022), Ji, Teng and Townsend (2021) and Oberfield et al. (2024)

Financial markets in Brazil:

- Joaquim, Doornik and Ornelas (2019), Tabak, Fazio and Cajueiro (2012), Sanches, Rocha and da Silva (2009), Nakane (2002), Cavalcanti et al. (2021), Madeira et al. (2018) and Ponticelli and Alencar (2016)

Model - Overview

- Closed economy, heterogeneous agent model in continuous time.

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  Agents:
  - Extract utility from consumption c only.
  - Uniformly distributed over a circumference with unit radius.
  - Are characterized by their: wealth a, productivity z, and position θ at the circumference.
  - Productivity: z is subject to idiosyncratic shocks.

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- Banks:
  - Finite set $\mathcal{J}$ of banks.
  - Each bank $j \in \mathcal{J}$ is located at a position β_j on the circumference, which is fixed at $t = 0$.

Firm's Problem

- Production function: $f(k, \ell) = z \cdot \left(k^{\alpha} \ell^{1-\alpha}\right)^{\phi}$

- Hire labor in a competitive market.

- Two ways of financing their capital needs:
  1. Through owner's wealth.
  2. If the owner's wealth is insufficient, they can borrow from of the banks.

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Using owner's wealth

$$\begin{aligned} \pi_S = \max_{\{k,\ell\}} \quad & z(k^{\alpha} \ell^{1-\alpha})^{\phi} - w\ell - (r+\delta)k \\ \text{subject to:} \quad & k \leq a \end{aligned}$$

Firm's Problem

Borrowing from bank $j \in \mathcal{J}$:

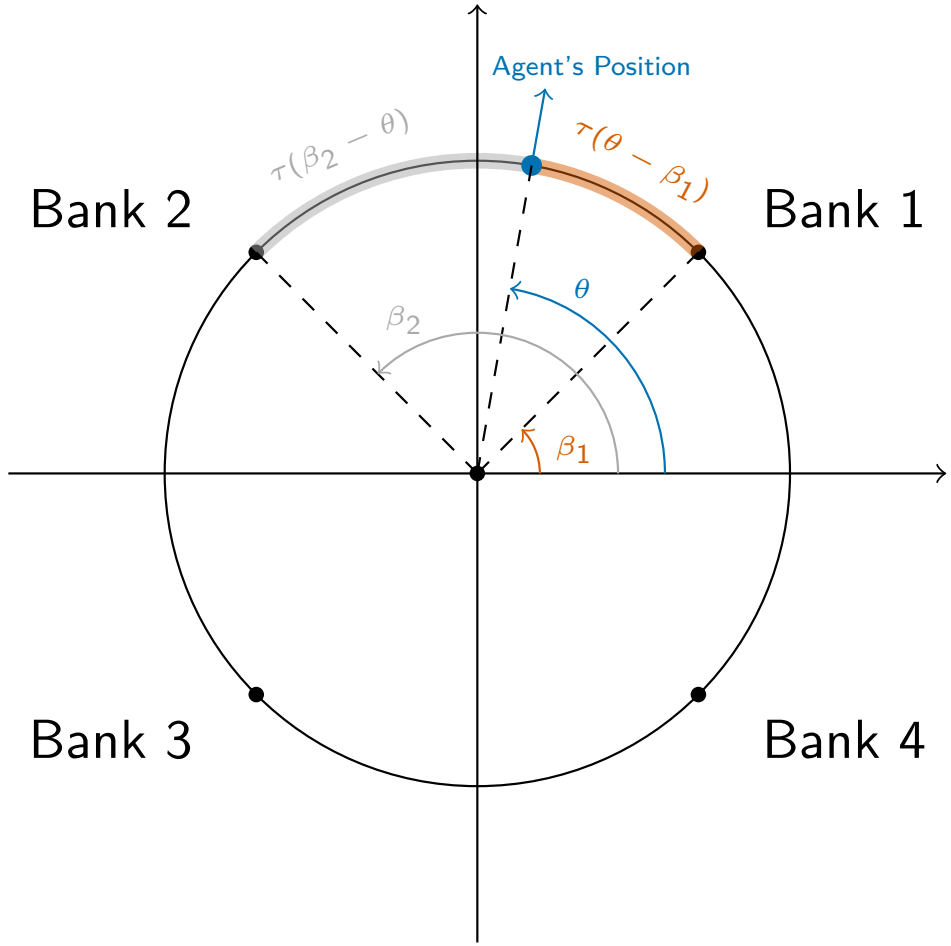
$$\pi_{L,j} = \max_{\{k,\ell\}} \quad z(k^{\alpha}\ell^{1-\alpha})^{\phi} - w\ell - r_{L,j}\underbrace{(k-a)}_{\text{loan}} - ra - \delta k - \mathrm{c}(\theta, \beta_j)$$

$$\text{subject to:} \quad a < k \leq \lambda(r_{L,j}) \cdot a$$

- $r_{L,j}$: interest rate charged by bank j.
- $\lambda(r_{L,j})$: borrowing constraint Details
- $\mathrm{c}(\theta, \beta_j)$: transportation cost when borrowing from bank j.

Transportation Cost

$$c(\theta, \beta_j) = \tau \cdot \min\{|\theta - \beta_j|, 2\pi - |\theta - \beta_j|\}$$



Agent's Problem

At each instant t the agent:

- Observes the realization of z_t and then
- Decides between being an entrepreneur or a worker:
  - Entrepreneur: receives profit π_t.
  - Worker: offers one unit of labor inelastically and receives wage w_t.
  - Income: $y_t = \max\{w_t, \pi_t\}$.

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Agent solves the usual intertemporal utility maximization problem:

$$\max_{\{c_t\}_{t\in[0,\infty)}} \mathbb{E}_0 \left[\int_0^\infty e^{-\rho t} \frac{c_t^{1-\gamma} - 1}{1-\gamma} \, \mathrm{d}t \right]$$

$$\text{subject to: } \begin{cases} \dot{a}_t = r_t a_t + y_t - c_t \\ \mathrm{d} \ln z_t = -\varphi \ln z_t \, \mathrm{d}t + \zeta \mathrm{d}W_t \\ a_t \geq 0 \end{cases}$$

HJB Household

Bank's Problem

Interest rate charged by bank j is given by:

$$r_{L,j} = r + \varepsilon + s_j$$

- r: Deposit rate.
- ε: Taxes, administrative and default costs.
- s_j: Strategy chosen by bank j.

Bank's Problem

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- r: Deposit rate.
- ε: Taxes, administrative and default costs.
- s_j: Strategy chosen by bank j.

Each bank $j \in \mathcal{J}$ chooses s_j to maximizes its profit, taking as given the strategies chosen by the other banks.

I will look for a joint strategy $\hat{\boldsymbol{s}} = (\hat{s}_j)_{j=1}^{|\mathcal{J}|}$ that is a Nash Equilibrium of the non-cooperative static game played by the banks.

Equilibrium

A stationary equilibrium for this economy is characterized by:

1. Deposit rate r and wage w.
2. A joint strategy vector $\hat{\boldsymbol{s}}$.
3. Firms allocations: $k(a, z, \theta, r, w, \hat{\boldsymbol{s}})$ and $\ell(a, z, \theta, r, w, \hat{\boldsymbol{s}})$.
4. A policy function $p(a, z, \theta)$.
5. A stationary distribution of wealth, productivity and position of the agents $g(a, z, \theta)$.

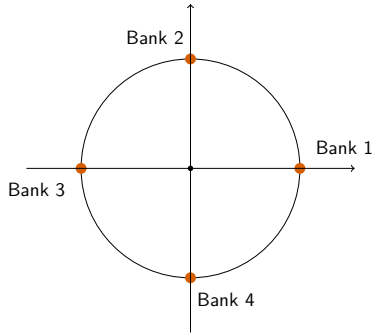
Such that:

- $\ell(a, z, \theta, r, w, \hat{\boldsymbol{s}})$ and $k(a, z, \theta, r, w, \hat{\boldsymbol{s}})$ solve the firm's problem.
- $p(a, z, \theta)$ and $g(a, z, \theta)$ solve the agent's problem.
- r and w clear the credit and labor markets.
- The joint strategy vector $\hat{\boldsymbol{s}}$ solves the bank's problem.

Market Clearing | Policy Function

Calibration

I calibrate the model with four banks:



I target the following moments in the calibration:

- Size distribution of firms (number of employees):
  - Micro: less than 9 employees.
  - Small: 10 to 49 employees.
  - Medium: 50 to 99 employees.
  - Large: 100 or more employees.
- Share of entrepreneurs.
- Share of firms without access to credit.
- Credit/GDP.
- Deposit rate.

Data

Preliminary Calibration Results

Parameters

Parameter		Value
Calibration		
ρ	Discount factor	0.12
φ	Diffusion process	0.06
ζ	Diffusion process	0.18
ϕ	Span of Control	0.74
η	Borrowing constraint	0.12
τ	Transportation cost	0.63
Assigned		
δ	Depreciation rate	0.04
γ	Coefficient of Relative Risk Aversion	1.50
α	Output elasticity of capital	0.40
Data		
ϵ	Costs and taxes contribution to the spread	7.42%
χ	Reserve requirement rate	23%

Model Fit

Moment	Model	Data
Targeted		
Share of entrepreneurs	13.8%	13.3%
Share of micro firms	81.4%	81.5%
Share of small firms	18.0%	15.4%
Share of medium firms	0.6%	1.6%
Share of large firms	$<$0.01%	1.5%
Share of firms without access to credit	51.0%	51.0%
Credit/GDP	44.2%	44.1%
Deposit rate	2.0%	2.0%
Others		
Bank's Nash Equilibrium Strategy	1.1%	-
Interest rate spread	8.5%	9.1%
Median Firm size	3.28	3
Average Firm size	6.22	13.5

Preliminary Results

	Variable	Base[1]	$\hat{s}_j = 0$	Transportation cost effect
		(1)	(2)	
Aggregates	Welfare	-	1.2%	
	Gini	0.387	0.389	
	GDP[2]	1.000	1.012	
	Credit[2]	1.000	1.161	
	Credit/GDP	44.2%	50.7%	
	Deposit rate	2.0%	2.4%	
	Wage[2]	1.000	1.009	
	Entrepreneurs	13.8%	13.5%	
	TFP	-	0.6%	
Firms	Micro	81.4%	80.7%	
	Small	18.0%	18.7%	
	Medium	0.6%	0.6%	
	Large	<0.01%	<0.01%	
	Without access to credit	51.0%	47.1%	
Banks	Bank strategy ($\hat{s}_j$)	1.1%	0.0%	
	Bank profit[2]	1.00	0.00	

[1] Column (1): Calibration parameters. Column (2): $\tau = 0.63$, but I impose $\hat{s}_j = 0, \forall j \in \mathcal{J}$. Column (3): $\tau = \frac{0.63}{2}$. Column (4): $\tau = \frac{0.63}{4}$. Column (5): $\tau = 0$.

[2] GDP, credit, wage and bank profit are normalized by their value in the base case.

Source of capital | Agents' characteristics by position

Preliminary Results

	Variable	Base[1]	$\hat{s}_j = 0$	Transportation cost effect
		(1)	(2)	(5)
Aggregates	Welfare	-	1.2%	3.9%
	Gini	0.387	0.389	0.384
	GDP[2]	1.000	1.012	1.018
	Credit[2]	1.000	1.161	1.211
	Credit/GDP	44.2%	50.7%	52.6%
	Deposit rate	2.0%	2.4%	2.8%
	Wage[2]	1.000	1.009	1.027
	Entrepreneurs	13.8%	13.5%	14.6%
	TFP	-	0.6%	2.2%
Firms	Micro	81.4%	80.7%	83.3%
	Small	18.0%	18.7%	16.3%
	Medium	0.6%	0.6%	0.4%
	Large	<0.01%	<0.01%	<0.01%
	Without access to credit	51.0%	47.1%	32.0%
Banks	Bank strategy ($\hat{s}_j$)	1.1%	0.0%	0.0%
	Bank profit[2]	1.00	0.00	0.00

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Source of capital Agents' characteristics by position

Preliminary Results

	Variable	Base[1]	$\hat{s}_j = 0$	Transportation cost effect		
		(1)	(2)	(3)	(4)	(5)
Aggregates	Welfare	-	1.2%	1.6%	2.8%	3.9%
	Gini	0.387	0.389	0.386	0.385	0.384
	GDP[2]	1.000	1.012	1.010	1.014	1.018
	Credit[2]	1.000	1.161	1.103	1.161	1.211
	Credit/GDP	44.2%	50.7%	48.3%	50.6%	52.6%
	Deposit rate	2.0%	2.4%	2.2%	2.5%	2.8%
	Wage[2]	1.000	1.009	1.011	1.020	1.027
	Entrepreneurs	13.8%	13.5%	14.0%	14.3%	14.6%
	TFP	-	0.6%	1.0%	1.7%	2.2%
Firms	Micro	81.4%	80.7%	82.0%	82.7%	83.3%
	Small	18.0%	18.7%	17.4%	16.8%	16.3%
	Medium	0.6%	0.6%	0.5%	0.5%	0.4%
	Large	<0.01%	<0.01%	<0.01%	<0.01%	<0.01%
	Without access to credit	51.0%	47.1%	43.2%	39.5%	32.0%
Banks	Bank strategy ($\hat{s}_j$)	1.1%	0.0%	0.7%	0.3%	0.0%
	Bank profit[2]	1.00	0.00	0.70	0.32	0.00

[1] Column (1): Calibration parameters. Column (2): $\tau = 0.63$, but I impose $\hat{s}_j = 0, \forall j \in \mathcal{J}$. Column (3): $\tau = \frac{0.63}{2}$. Column (4): $\tau = \frac{0.63}{4}$. Column (5): $\tau = 0$.

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Source of capital | Agents' characteristics by position

Conclusion

I propose a heterogeneous agent model to address the following questions:

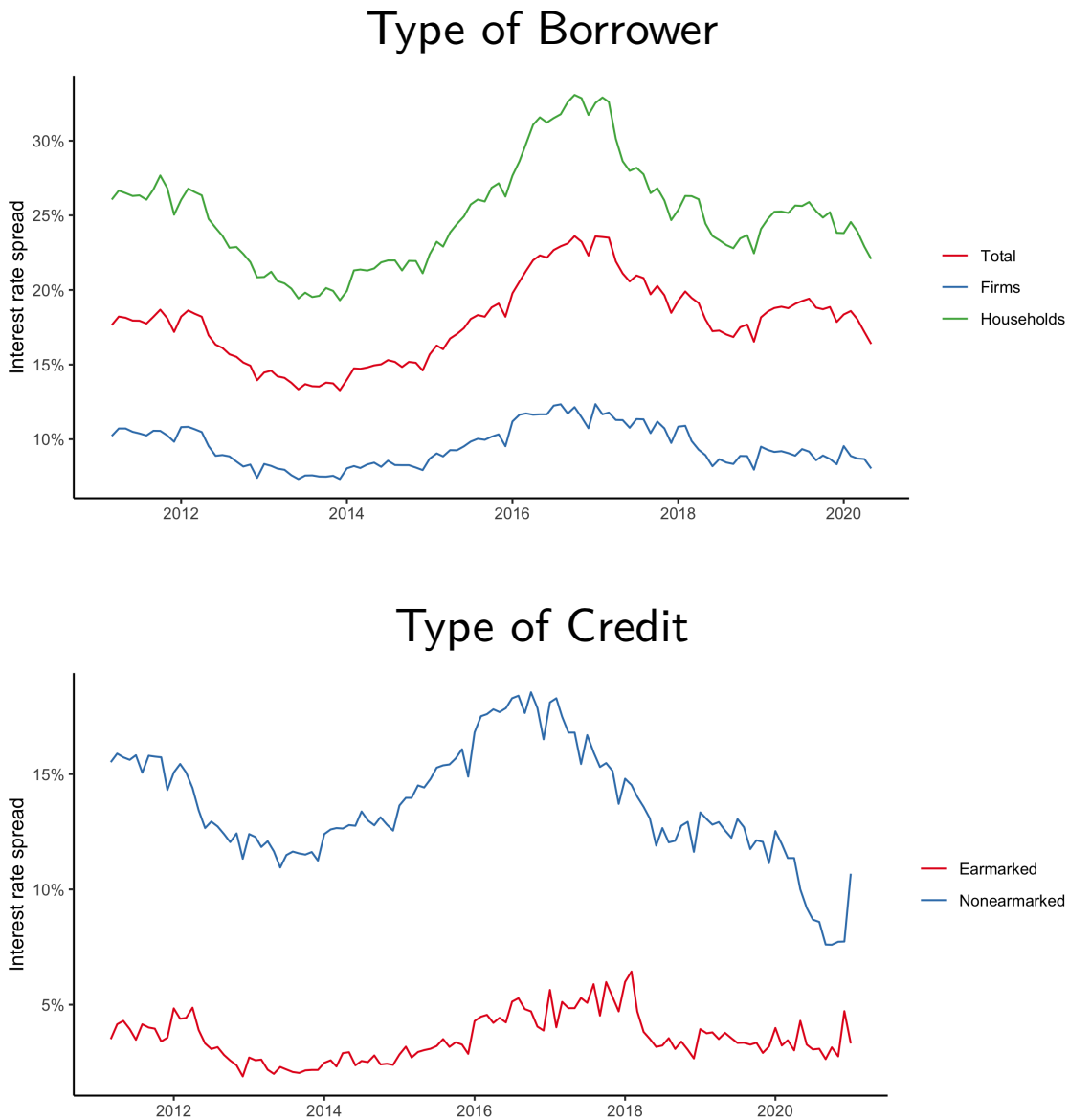
- How does the distance between firms and banks affect the interest rate spread?
- What are the effects of the distance on the size distribution of firms, share of entrepreneurs, GDP and access to finance?

My model is capable of identifying two different channels showing the effects of the distance in the credit market:

- Direct effect: Transportation cost.
- Indirect effect: Market power given to banks.

Thank you!

Interest rate spread decomposition



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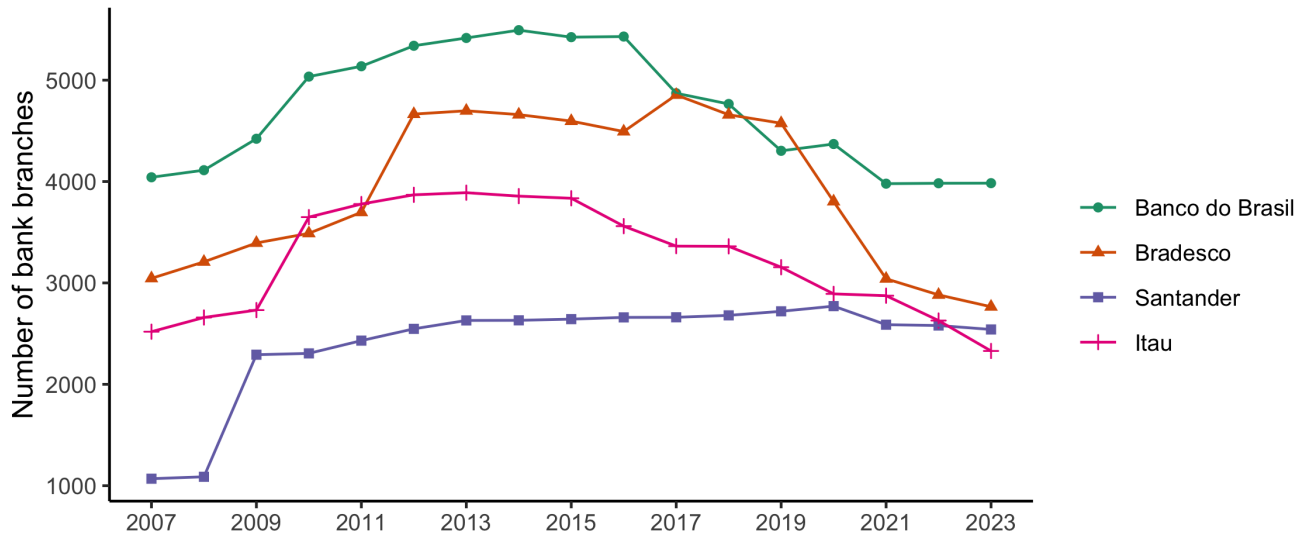
Top 4 Banks: Number of branches



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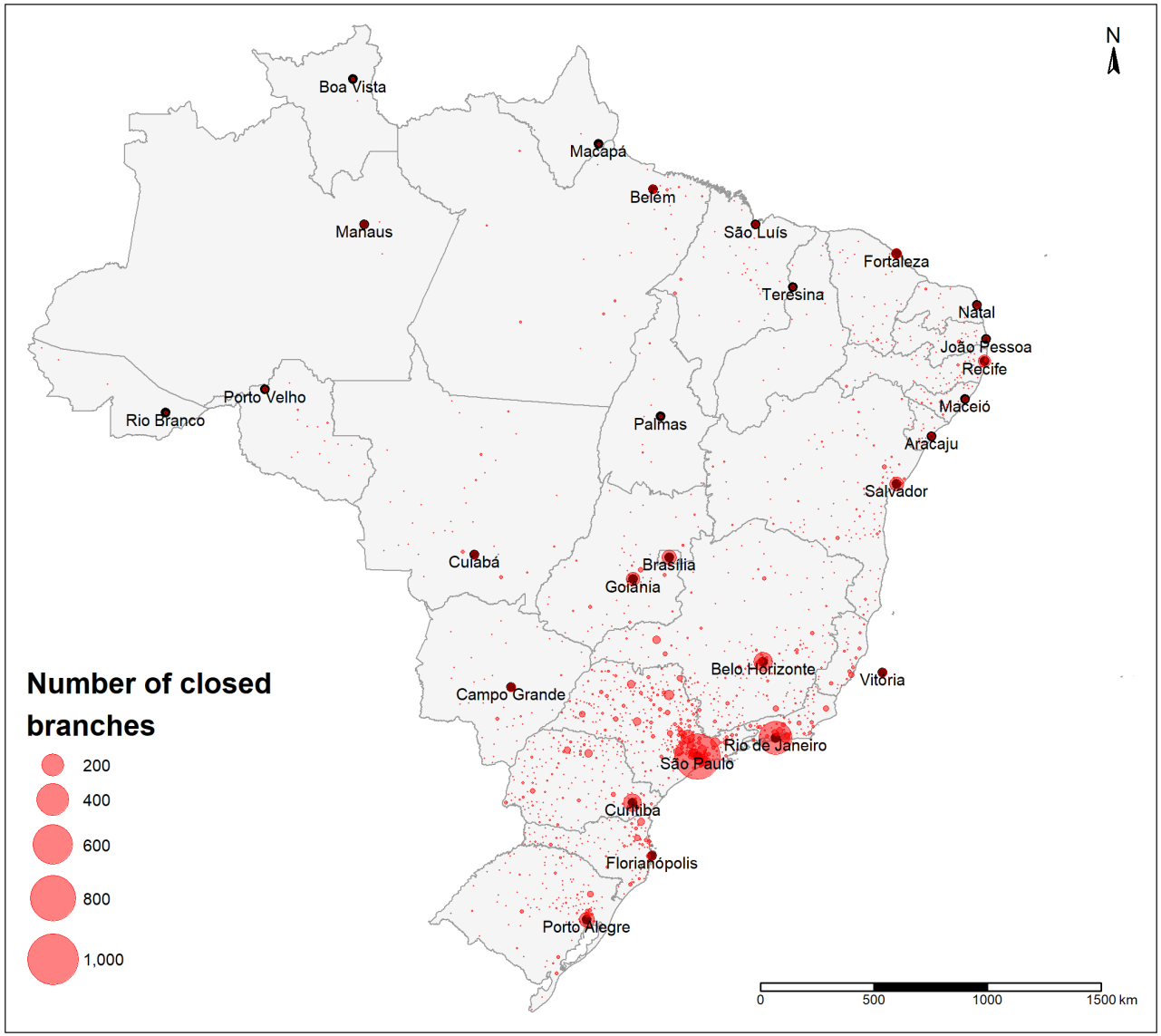
Location of closed branches



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Borrowing Constraint

- Borrowing constraint arises from the existence of limited liability in the loan agreement between the firm and the bank.
- If the firm does not pay for the loan, the bank can seize a fraction of the agent's wealth ηa.
- The maximum amount a bank is willing to lend must satisfy the following incentive compatibility constraint:

$$\overbrace{z(k^{\alpha}\ell^{1-\alpha})^{\phi} - w\ell - (r_{L,j}+\delta)(k-a) - a(r+\delta) - \mathrm{c}(\theta,\beta_j)}^{\text{Profit paying for the loan}} \geq \underbrace{z(k^{\alpha}\ell^{1-\alpha})^{\phi} - w\ell - \delta k - ra - \mathrm{c}(\theta,\beta_j) - \eta a}_{\text{Profit without paying for the loan}}$$

$$k \leq a\left(1 + \frac{\eta}{r_{L,j}}\right) = a\lambda(r_{L,j})$$

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Market Clearing

Labor market

$$\int_0^{2\pi}\int_{\underline{z}}^{\bar{z}}\int_{\underline{a}}^{\bar{a}} g(a,z,\theta)\mathbb{1}_{\{\pi^i \leq w\}}\,\mathrm{d}a\,\mathrm{d}z\,\mathrm{d}\theta = \int_0^{2\pi}\int_{\underline{z}}^{\bar{z}}\int_{\underline{a}}^{\bar{a}} \ell(\cdot)g(a,z,\theta)\mathbb{1}_{\{\pi^i > w\}}\,\mathrm{d}a\,\mathrm{d}z\,\mathrm{d}\theta$$

Credit market

$$\int_0^{2\pi}\int_{\underline{z}}^{\bar{z}}\int_{\underline{a}}^{\bar{a}} (k(\cdot)-a)g(a,z,\theta)\mathbb{1}_{\{\pi^i > w\}}\mathbb{1}_{\left\{\pi^i_{L,j_i'} > \pi^i_S\right\}}\,\mathrm{d}a\,\mathrm{d}z\,\mathrm{d}\theta =$$

$$(1-\chi)\left[\int_0^{2\pi}\int_{\underline{z}}^{\bar{z}}\int_{\underline{a}}^{\bar{a}} \underbrace{ag(a,z,\theta)\mathbb{1}_{\{\pi^i \leq w\}}}_{\text{Worker savings}}\,\mathrm{d}a\,\mathrm{d}z\,\mathrm{d}\theta\right.$$

$$\left.+\int_0^{2\pi}\int_{\underline{z}}^{\bar{z}}\int_{\underline{a}}^{\bar{a}} \underbrace{(a-k(\cdot))g(a,z,\theta)\mathbb{1}_{\{\pi^i > w\}}\mathbb{1}_{\left\{\pi^i_{L,j_i'} \leq \pi^i_S\right\}}}_{\text{Excess savings from those self-financing}}\,\mathrm{d}a\,\mathrm{d}z\,\mathrm{d}\theta\right]$$

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HJB and policy function for household problem

HJB equation for the household problem:

$$\rho v(a,z,\theta) = \max_c \{u(c) + \frac{\partial v(a,z,\theta)}{\partial a} \cdot [r \cdot a + y - c_t] + \frac{\partial v(a,z,\theta)}{\partial z} \cdot \mu(z) + \frac{1}{2}\frac{\partial^2 v(a,z,\theta)}{\partial z^2} \cdot \sigma^2(z)\}$$

where:

$$\mu(z) = \left(-\varphi \ln z + \frac{\zeta^2}{2}\right) z$$

$$\sigma(z) = \zeta z$$

Policy function:

$$p(a,z,\theta) = r \cdot a + y - (u')^{-1}\left(\frac{\partial v(a,z,\theta)}{\partial a}\right)$$

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Data

I obtain data to calibrate the model from the following sources:

Size distribution of firms:

- Annual Review of Social Information Database (RAIS).

Share of entrepreneurs:

- Brazil National Household Sample Survey (PNAD).

Credit/GDP:

- Central Bank of Brazil: Time Series Management System.

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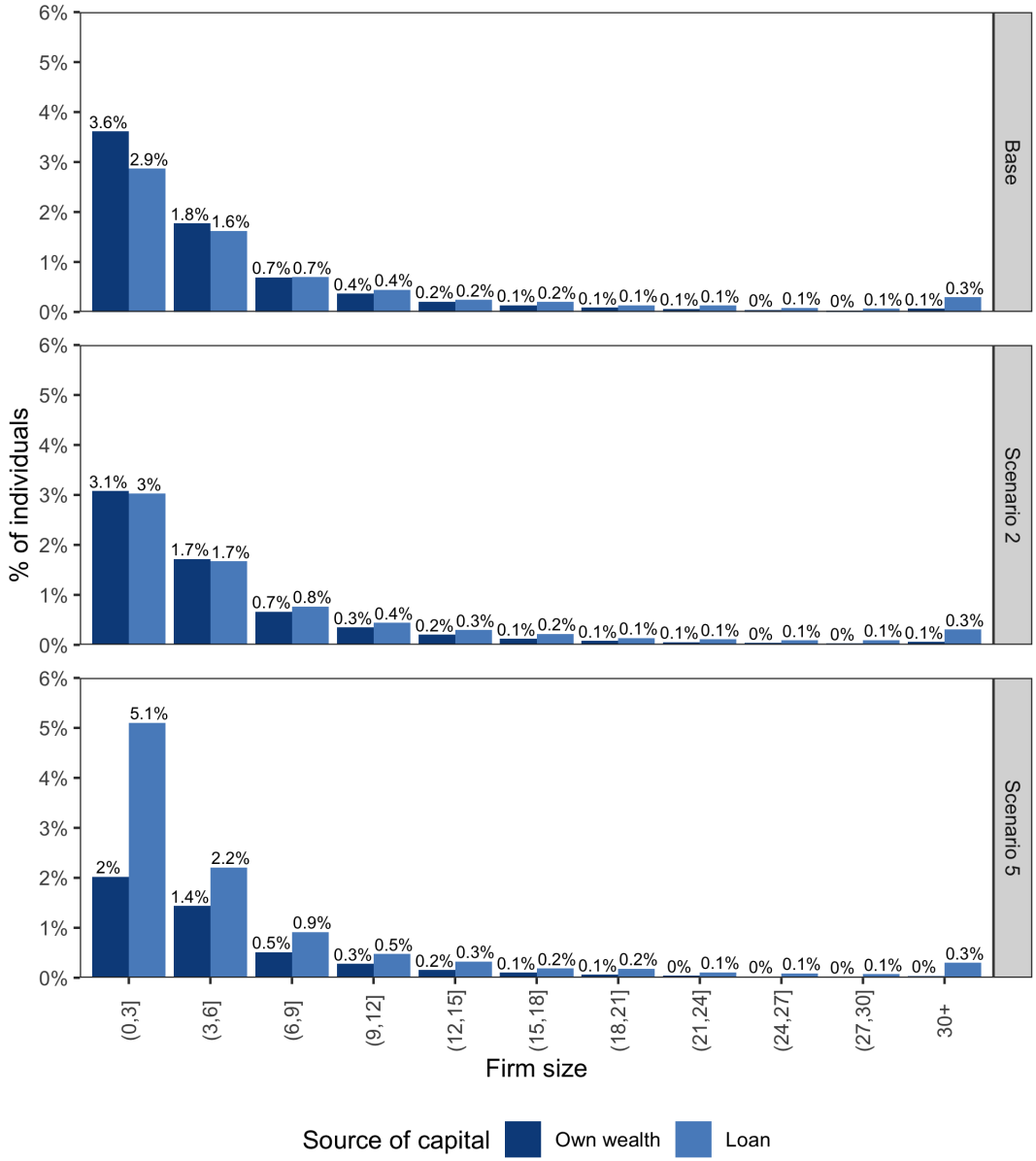
Results: source of capital



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Results: agents' characteristics by position

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