



XII Annual Seminar on
Risk, Financial Stability and Banking

Capital Allocation Across Regions, Sectors and Firms: evidence from a commodity boom in Brazil

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The views expressed in this presentation are those of the authors and do not necessarily reflect those of the Banco Central do Brasil.

Motivation

Does capital generated in agriculture flow to other sectors in the economy?
Does it relocate regionally? What is the role of the banking system?

- Event study: legalization of genetically engineered (GE) soy in Brasil (2003)
 - Classical problem of disentangling supply and demand

Bustos, P., B. Caprettini, and J. Ponticelli (2016). "Agricultural Productivity and Structural Transformation: Evidence from Brazil".

Motivation

Resources generated in agriculture might not fund other activities because...

... in an open small economy, comparative advantages might hold back other activities;

... the globalized banking system might export all these extra funds;

... financial frictions might deter resource reallocation;

→ Trace the effect of an exogenous increase in agricultural productivity on the supply of credit to industrial and service sectors.

- Land heterogeneity + legalization → local effects (adoption, profits, deposits)
- Bank branch networks → geographic relocation
- Individual firm loan data → impact across sectors and firm sizes
(intensive and extensive margin)

Data

- Global Agro-Ecological Zones, FAO
- Agricultural Census (IBGE) – 1996 and 2006
 - Planted areas with traditional and GE soy
 - Investment, profits and external financing (not separated by crop)
- Municipal Agricultural Production – PAM – (IBGE), yearly
 - Cultivated area, value of soy production
- RAIS (Ministry of Labor)
- Estban
- SCR

Soy potential yield under low and high agricultural technology

Local
impact

Powerful herbicide and no tillage

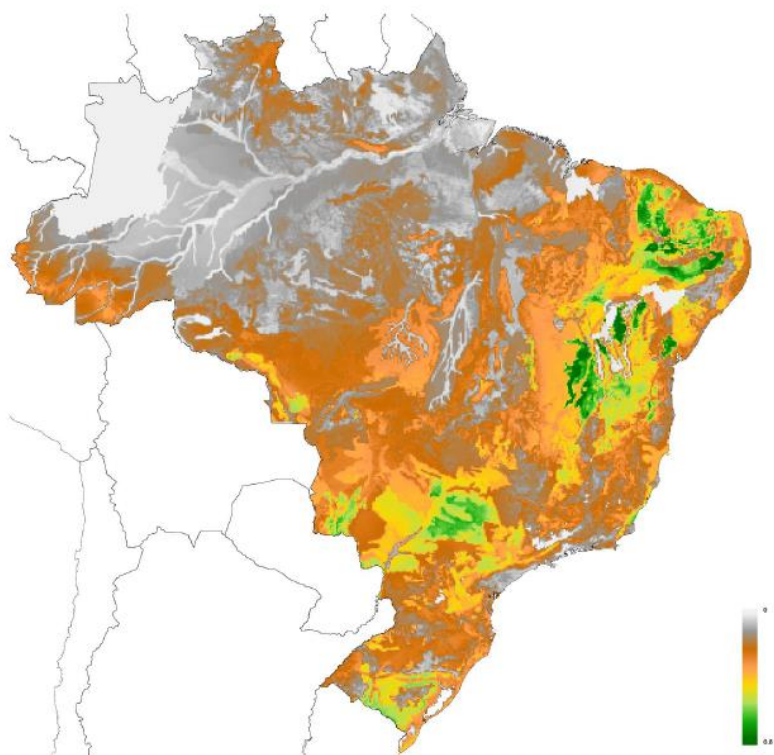


FIGURE V: Potential soy yield under low agricultural technology

Notes: Data from FAO-GAEZ.

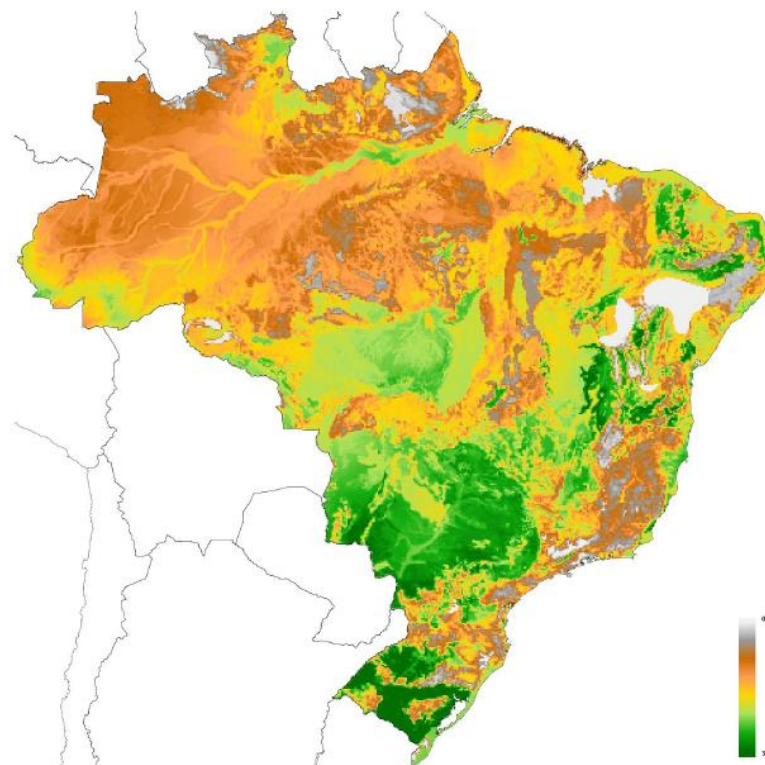


FIGURE VI: Potential soy yield under high agricultural technology

Notes: Data from FAO-GAEZ.

Identification strategy

Local
impact

Soy productivity (exogenous):

→ cross-section variation:

- land
- climate

→ time variation : 2003 legalization (intensity of treatment)

$$A_{jt}^{soy} = \begin{cases} A_j^{soy,LOW} & \text{for } t < 2003 \\ A_j^{soy,HIGH} & \text{for } t \geq 2003 \end{cases}$$

$$y_{jt} = \alpha_j + \alpha_t + \beta \log(A_{jt}^{soy}) + \varepsilon_{jt}$$

j: municipality ; t: year

Specification

Local
impact

$$\begin{aligned} y_{jt} &= \alpha_j + \alpha_t + \beta \log(A_{jt}^{soy}) \\ &+ \sum_t \gamma_t (\text{Municipality controls}_{j,1991} \times d_t) \\ &+ \sum_t \delta_t (\text{Bank controls}_{j,1996} \times d_t) + \varepsilon_{jt} \end{aligned}$$

- j: municipality; t: year

Controls:

- Municipality: income per capita (in logs), share of rural population, population density (in logs) and literacy rate;
- Banks: municipality averages, weighted by the participation in present agencies in 1996 (log value of assets, share of deposits over assets, and total number of bank branches)

$$\Delta y_j = \Delta \alpha + \beta \Delta \log(A_{jt}^{soy}) + \Delta \varepsilon_{jt}$$

Results – Agricultural Outcomes

Local
impact

TABLE II: SOY TECHNICAL CHANGE AND AGRICULTURAL OUTCOMES
SOY EXPANSION, GE SOY ADOPTION

Dependent variables:	Soy Area Agricultural Area		Δ $\frac{\text{GE Soy Area}}{\text{Agricultural Area}}$	Δ $\frac{\text{Non-GE Soy Area}}{\text{Agricultural Area}}$
	(1)	(2)	(3)	(4)
$\log(A_{jt}^{\text{soy}})$	0.014 [0.002]***	0.014 [0.002]***		
$\Delta \log(A_j^{\text{soy}})$			0.028 [0.002]***	-0.014 [0.002]***
fixed effects:				
municipality	yes	yes		
year	yes	yes		
municipality controls \times year	yes	yes		
bank controls \times year		yes		
municipality controls			yes	yes
Observations	44,524	44,524	3,749	3,749
R-squared	0.959	0.960	0.136	0.037
N clusters	3177	3177		
Data source dep.var. :	PAM 1996-2010	PAM 1996-2010	Agricultural Census 1996 and 2006	

Notes: Standard errors clustered at municipality level are reported in brackets in columns 1 and 2. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Municipality controls include: share of rural adult population, income per capita (in logs), population density (in logs), literacy rate, all observed in 1991 (source: Population Census). Bank controls capture average characteristics of banks operating in a given municipality, including: bank size in terms of assets (in logs) and number of branches (in logs), and importance of deposits as a share of bank financing (deposits/assets). Bank characteristics are weighted by share of branches of each bank in each municipality, all observed in 1996 (source: ESTBAN).

Results - Agricultural Outcomes

Local
impact

TABLE III: SOY TECHNICAL CHANGE AND AGRICULTURAL OUTCOMES
REVENUES FROM SOY PRODUCTION, AGRICULTURAL PROFITS, INVESTMENT AND USE OF EXTERNAL FINANCE

Dependent variables:	log (1+ revenues from soy production)		Δ Profits (pct)	Δ log Inv	Δ log Ext Fin
	(1)	(2)	(3)	(4)	(5)
$\log(A_{jt}^{soy})$	0.183 [0.087]**	0.167 [0.086]*			
$\Delta \log(A_j^{soy})$			0.470 [0.234]**	0.154 [0.036]***	-0.082 [0.058]
fixed effects:					
municipality	yes	yes			
year	yes	yes			
municipality controls \times year	yes	yes			
bank controls \times year		yes			
municipality controls			yes	yes	yes
Observations	44,524	44,524	3,794	3,794	3,794
R-squared	0.959	0.960	0.001	0.018	0.042
N clusters	3177	3177			
Data source dep.var. :	PAM 1996-2010	PAM 1996-2010	Agricultural Census 1996 and 2006		

Notes: Standard errors clustered at municipality level are reported in brackets in columns 1 and 2. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Municipality controls include: share of rural adult population, income per capita (in logs), population density (in logs), literacy rate, all observed in 1991 (source: Population Census). Bank controls capture average characteristics of banks operating in a given municipality, including: bank size in terms of assets (in logs) and number of branches (in logs), and importance of deposits as a share of bank financing (deposits/assets). Bank characteristics are weighted by share of branches of each bank in each municipality, all observed in 1996 (source: ESTBAN).

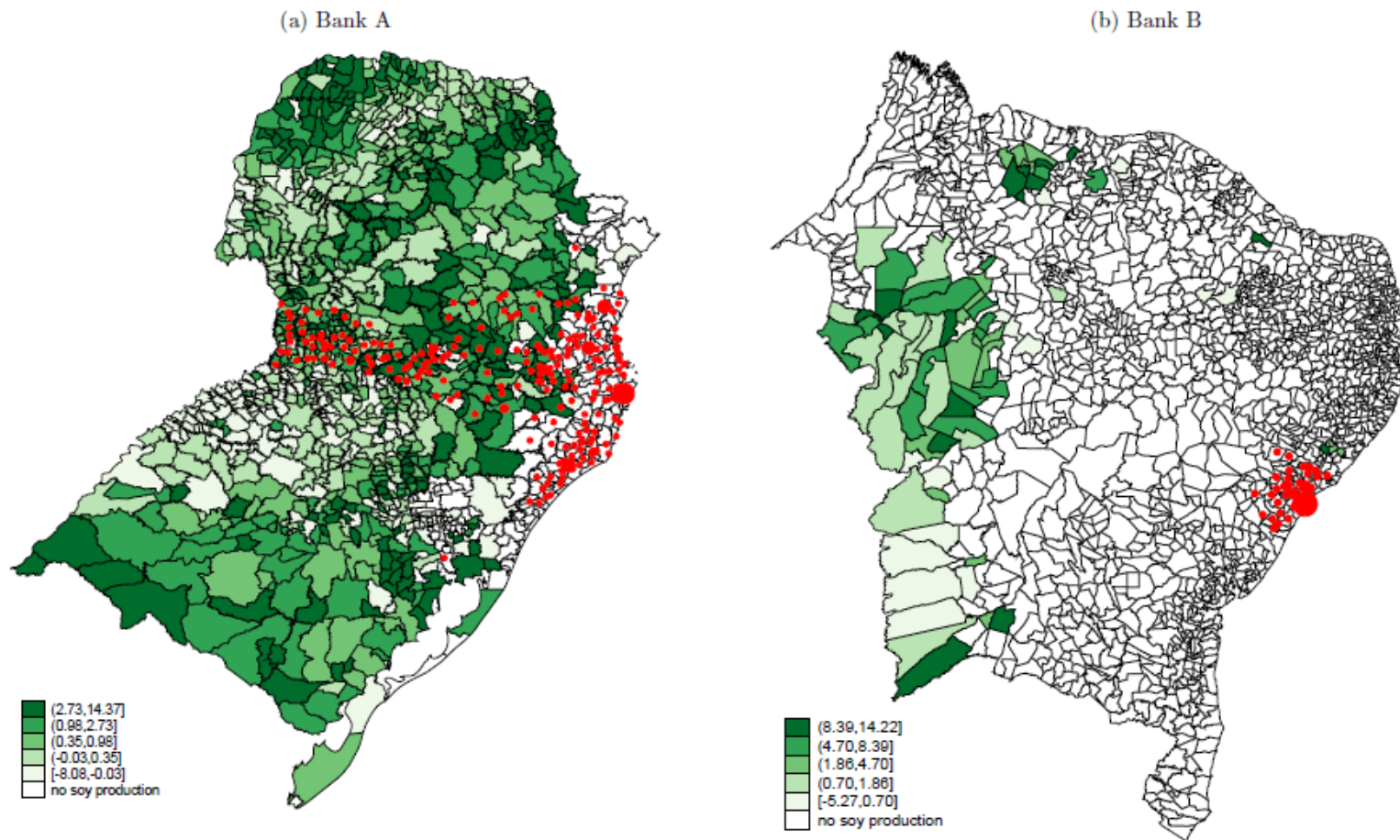
Results – Local Bank Outcomes

Local
impact

TABLE IV: SOY TECHNICAL CHANGE AND LOCAL BANKING
SECTOR OUTCOMES
TOTAL DEPOSITS AND TOTAL LENDING

Outcomes:	log(total deposits)		log(total loans)	
	(1)	(2)	(3)	(4)
$\log A_{soy}$	0.053 [0.015]***	0.037 [0.014]***	-0.057 [0.028]**	-0.041 [0.026]
fixed effects:				
municipality	yes	yes	yes	yes
year	yes	yes	yes	yes
municipality controls \times year		yes		yes
bank controls \times year		yes		yes
Observations	44,524	44,524	44,524	44,524
R-squared	0.975	0.977	0.951	0.953
N clusters	3177	3177	3177	3177

Notes: Outcomes are total monetary value (in 2000 BRL) at municipality/year level, in logs, winsorized at 1% in each tail. Standard errors clustered at municipality level are reported in brackets. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Municipality controls include: share of rural adult population, income per capita (in logs), population density (in logs), literacy rate, all observed in 1991 (source: Population Census). Bank controls capture average characteristics of banks operating in a given municipality, including: bank size in terms of assets (in logs) and number of branches (in logs), and importance of deposits as a share of bank financing (deposits/assets). Bank characteristics are weighted by share of branches of each bank in each municipality, all observed in 1996 (source: ESTBAN).



Notes: Data from Central Bank of Brazil and PAM (IBGE).

→ Firm level credit supply shock:

$$loans_{ibt} = I_{ib,t=0} r_{bt}^{\lambda} u_{bit}$$

$$\log(loans_{ibt}) = \delta_i + \delta_t + \delta_b + \lambda \log r_{bt} + \varepsilon_{bit}$$



$$\log r_{bt} = \rho_t + \rho_b + \mu \log Deposits_{bt} + v_{bt}$$

$$\log(loans_{ibt}) = \delta_i + \delta_t + \delta_b + \beta \log \widehat{Deposits}_{bt} + e_{bit} \quad (8)$$

- Exclude soy producing areas
 - Exclude sector linked to soy by IO matrix
 - Include: industry dummies
 - municipality dummies
 - size dummies
- } X time dummies

$$\log(\widehat{loans_{idsbt}}) = \delta_i + \delta_b + \delta_{dt} + \delta_{st} + \delta_{size,t} + \beta \log \widehat{Deposits_{bt}} + \varepsilon_{bit} \quad (9)$$

$$\log(y_{idsbt}) = \delta_i + \delta_b + \delta_{dt} + \delta_{st} + \delta_{size,t} + \beta \log \widehat{Deposits_{bt}} + \varepsilon_{bit} \quad (10)$$

↑
Main lender

TABLE VI: THE EFFECT OF BANK EXPOSURE ON FIRM-LEVEL OUTCOMES
LOANS, EMPLOYMENT, WAGE BILL

	log loan main lender		log loan all lenders		log employment		log wage bill	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log $\widehat{deposit}$	2.567 [0.758]***	2.623 [0.739]***	1.417 [0.612]**	1.449 [0.515]***	0.036 [0.051]	0.086 [0.046]*	0.114 [0.109]	0.179 [0.061]***
fixed effects:								
firm	yes	yes	yes	yes	yes	yes	yes	yes
year	yes	yes	yes	yes	yes	yes	yes	yes
size quartile × year	yes	yes	yes	yes	yes	yes	yes	yes
municipality × year		yes		yes		yes		yes
sector × year		yes		yes		yes		yes
Observations	1,551,393	1,547,783	1,551,393	1,547,783	1,551,393	1,547,783	1,551,393	1,547,783
R-squared	0.670	0.676	0.752	0.757	0.950	0.951	0.954	0.955
N clusters	115	115	115	115	115	115	115	115

Notes: Outcomes winsorized at 1% in each tail. Standard errors clustered at bank level are reported in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Size quartiles are computed using firm employment. Sectors are 2-digit sectors according to the Brazilian CNAE classification.

Independent variable in all panels is: $\log \widehat{\text{deposit}}$
Firm-level outcomes reported in bold in each row

	agriculture		manufacturing		services		other	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A								
log loan - main lender	3.378 [1.079]***	2.718 [1.495]*	2.487 [0.779]***	2.458 [0.780]***	2.505 [0.771]***	2.572 [0.754]***	3.556 [1.081]***	3.441 [0.990]***
Panel B								
log loan - all lenders	2.972 [1.174]**	2.637 [1.044]**	1.591 [0.536]***	1.611 [0.508]***	1.293 [0.614]**	1.336 [0.526]**	2.157 [1.018]**	1.834 [0.845]**
Panel C								
log employment	0.141 [0.140]	0.259 [0.234]	0.163 [0.062]***	0.227 [0.063]***	0.003 [0.055]	0.060 [0.049]	0.144 [0.194]	0.191 [0.191]
Panel D								
log wage bill	0.187 [0.221]	0.311 [0.412]	0.336 [0.116]***	0.396 [0.090]***	0.067 [0.116]	0.129 [0.064]**	0.152 [0.239]	0.224 [0.182]
fixed effects:								
firm	yes	yes	yes	yes	yes	yes	yes	yes
year	yes	yes	yes	yes	yes	yes	yes	yes
size quartile × year	yes	yes	yes	yes	yes	yes	yes	yes
municipality × year		yes		yes		yes		yes
sector × year		yes		yes		yes		yes
Observations	8,226	5,406	271,678	268,762	1,185,531	1,181,795	77,235	74,182
R-squared	0.959	0.976	0.961	0.963	0.947	0.949	0.973	0.975
N clusters	58	53	102	101	111	111	76	76

Notes: Outcomes winsorized at 1% in each tail. Standard errors clustered at bank level are reported in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Size quartiles are computed using firm employment. Sectors are 2-digit sectors according to the Brazilian CNAE classification.

TABLE VIII: THE EFFECT OF BANK EXPOSURE ON FIRM-LEVEL
OUTCOMES - BY FIRM SIZE QUANTILES
LOANS, EMPLOYMENT, WAGE BILL

	log loan main lender (1)	log loan all lenders (2)	log employment (3)	log wage bill (4)
$\log \widehat{\text{deposit}} \times Q1$	2.610 [0.737]***	1.462 [0.514]***	0.111 [0.047]**	0.201 [0.061]***
$\log \widehat{\text{deposit}} \times Q2$	2.614 [0.738]***	1.458 [0.514]***	0.100 [0.045]**	0.190 [0.061]***
$\log \widehat{\text{deposit}} \times Q3$	2.620 [0.739]***	1.453 [0.514]***	0.094 [0.045]**	0.184 [0.060]***
$\log \widehat{\text{deposit}} \times Q4$	2.627 [0.739]***	1.445 [0.515]***	0.081 [0.044]*	0.175 [0.060]***
fixed effects:				
firm	yes	yes	yes	yes
year	yes	yes	yes	yes
size quartile \times year	yes	yes	yes	yes
municipality \times year	yes	yes	yes	yes
sector \times year	yes	yes	yes	yes
Observations	1,547,783	1,547,783	1,547,783	1,547,783
R-squared	0.676	0.757	0.951	0.955
N clusters (lenders)	115	115	115	115

Notes: Outcomes winsorized at 1% in each tail. Standard errors clustered at bank level are reported in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Size quartiles are computed using firm employment. Sectors are 2-digit sectors according to the Brazilian CNAE classification.

→ Municipality credit supply shock:

$$\text{Municipality Exposure}_{dt} = \log \underbrace{\sum_b \frac{n_{bd}}{N_b}}_{\text{destination}} \underbrace{\sum_{o \in O_b} \frac{n_{bo,t=0}}{N_{o,t=0}} T_{o,t=0} A_{ot}^{\text{soy}}}_{\text{origin}} \quad (11)$$

$$I_{dt} = \alpha_d + \alpha_t + \beta \text{Municipality exposure}_{dt} + \varepsilon_{dt} \quad (13)$$

TABLE X: PROPAGATION TO NON-SOY PRODUCING REGIONS: ACCESS TO BANK CREDIT
OVERALL, BY SECTOR AND FIRM SIZE CATEGORY

	sector					firm size category			
	all firms (1)	agriculture (2)	manufacturing (3)	services (4)	other (5)	micro (6)	small (7)	medium (8)	large (9)
destination municipality exposure	0.015 [0.005]***	0.011 [0.018]	0.020 [0.011]*	0.011 [0.004]**	0.003 [0.009]	0.017 [0.005]***	0.029 [0.014]**	0.041 [0.033]	-0.008 [0.020]
fixed effects:									
municipality	yes	yes	yes	yes	yes	yes	yes	yes	yes
year	yes	yes	yes	yes	yes	yes	yes	yes	yes
municipality controls x year	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	23,660	14,559	18,803	23,447	23,440	23,550	20,470	12,543	22,040
R-squared	0.501	0.446	0.513	0.482	0.278	0.394	0.433	0.487	0.573
N clusters	1696	1458	1574	1695	1696	1696	1664	1404	1694

Notes: Outcomes winsorized at 1% in each tail. Standard errors clustered at municipality level are reported in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

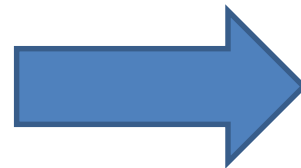
Thank you!

$$\log(deposits)_{bot} = \alpha_b + \alpha_o + \alpha_t + \beta \log(A_{ot}^{soy}) + \varepsilon_{bot} \quad (4)$$

TABLE V: SOY TECHNICAL CHANGE AND DEPOSITS IN BANK BRANCHES
TOTAL DEPOSITS

outcomes	log(total deposits)		
	(1)	(2)	(3)
$\log A_{soy}$	0.159 [0.025]***	0.110 [0.025]***	0.118 [0.025]***
fixed effects:			
municipality	yes	yes	yes
bank	yes	yes	yes
year	yes	yes	yes
municipality controls × year		yes	yes
bank controls × year			yes
Observations	118,548	118,548	118,548
R-squared	0.886	0.889	0.892
N clusters	3176	3176	3176

Notes: Outcomes are total monetary value (in 2000 BRL) at municipality/bank/year level, in logs, winsorized at 1% in each tail. Standard errors clustered at municipality level are reported in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Municipality controls include: share of rural adult population, income per capita (in logs), population density (in logs), literacy rate, all observed in 1991 (source: Population Census). Bank controls include: bank size in terms of assets (in logs) and number of branches (in logs), and importance of deposits as a share of bank financing (deposits/assets), all observed in 1996 (source: ESTBAN).



$\log \widehat{Deposits}_{bt}$