# Geographic discontinuity of a macroprudential policy: Evidence from Brazilian municipalities

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The views expressed in this work are those of the author and do not necessarily reflect those of the Banco Central or its members.

# Summary

- Macroprudential policy: changing upper-bound limit of eligible house for a conforming housing loan - SFH
- Since 2013: distinct limit across Brazilian States
- Outcome: value of real estate's collateral as housing price
- Strategy: Geographic-sharp RDD, Dif-in Dif
- Results: Temporally difference until 15% in the value of collaterals between neighbors with distinct limits; permanent difference of Metropolitan Areas and States' capitals (20% and 40%, respectively)
- Bunching: Changing in distribution of collaterals' values

# Outline

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# Motivation

## Regional Credit

- Loans and Brazilian municipalities: Credit and local housing (Madeira (2016)), Bankruptcy Reform and local credit (Ponticelli and Alencar (2016))
- Conforming loans (another specific fund - FNE) and local impact in Northeast (Da Mata and Resende (2015))
- Changing limit of conforming housing loans in US: (Adelino, Schoar, and Severino, 2012)
- Credit and local housing prices: Mian, Rao, and Sufi ( (2013))

# Motivation

## Macroprudential policies

- Plenty of financial instruments for financial regulation have been used after Great Recession
- Some of these tools affected housing market: loan-to-value (LTV), loan-to-income (LTI) ratios, or thresholds for conforming loans
- Macroprudential-housing policies had been implemented in various countries
  - Ireland (Hallissey, Kelly, O'Malley, et al., 2014)
  - Canada (Allen et al., 2017)
  - India (Campbell, Ramadorai, and Ranish, 2015)
  - Brazil (Araujo, Barroso, Gonzalez, et al., 2016)

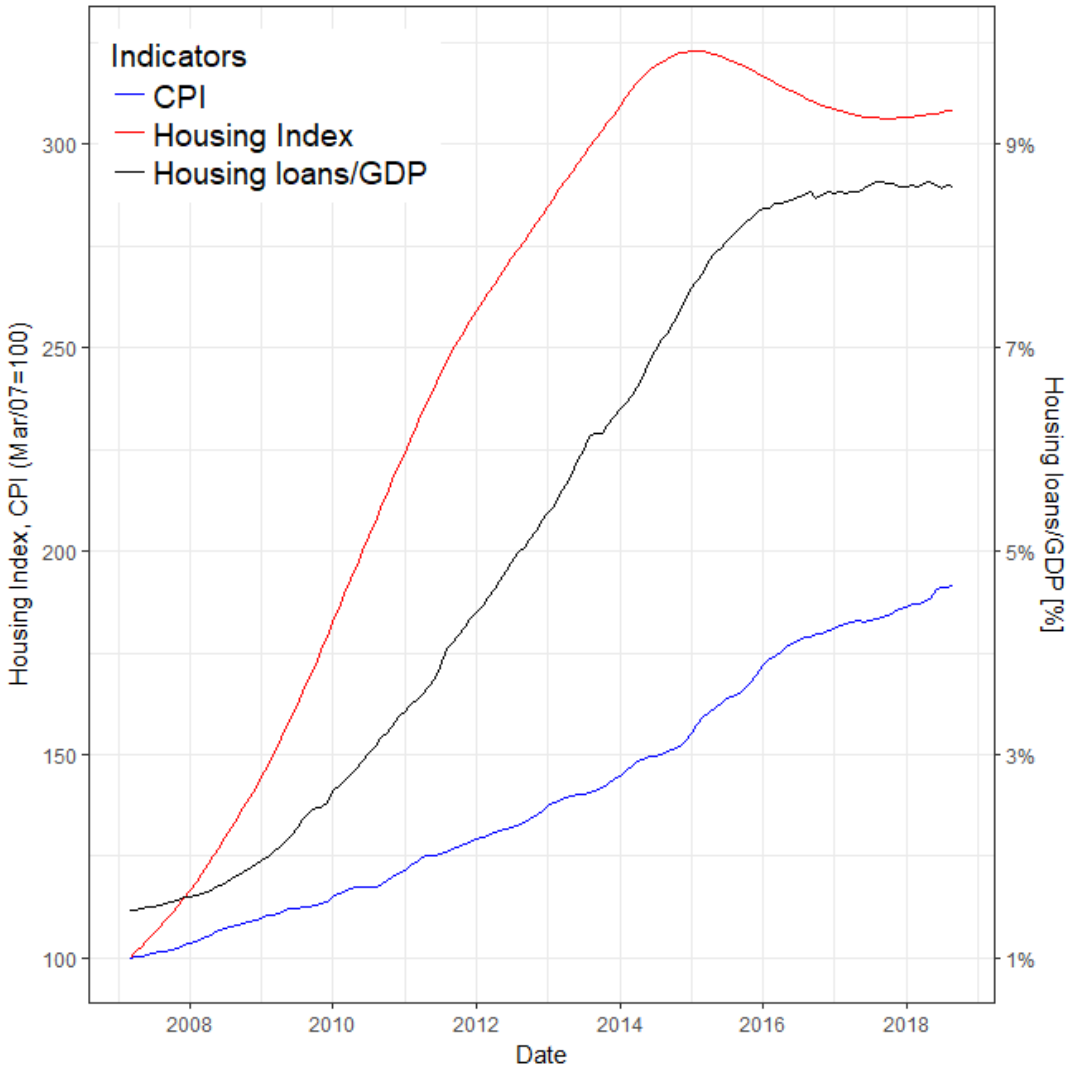
Contribution to literature: regional impact of changing the limit of a conforming loan (Housing Finance System - SFH)

# Outline

# Brazilian housing financial market

- History: scarce long term lending due to high inflation (Haddad and Meyer (2011))
- Brazilian Housing Finance System created in 1964 (Law 4,380) imposing monetary correction for inflation in contracted loans
- Currently: SFH is a conforming loan with lower/subsidized rates;
- Low inflation since Real Plan (1994)
- Law 9,514 (1997) created Real Estate Financing System, that made easier the recovery of the property
- Fiduciary property law (2004): bank is owner of real estate until the end of payment

# Brazilian housing financial market - Indicators



# SFH, currently

- Two funds of SFH:
  - a compulsory one (FGTS), derivative from a 8 % tax on private sector wages, building/financing real estate for lowest income class
  - a voluntary one, SBPE (Savings Deposit) with free income-tax, financing real estate for middle class
- 65% of total SPBE invested in financial institutions fund must finance Brazilian housing credit
- At least 80% of this credit should go to SFH
- SFH loans are available to prospective borrowers of their first house and that are not already homeowners in that city.
- Upper-bound limit for housing price to be eligible for SFH loan

# Eligible limit for SFH over time (1000 BRL)

# Eligible limit for SFH over time (1000 BRL)

# Eligible limit for SFH changing over time

# Outline

# Database

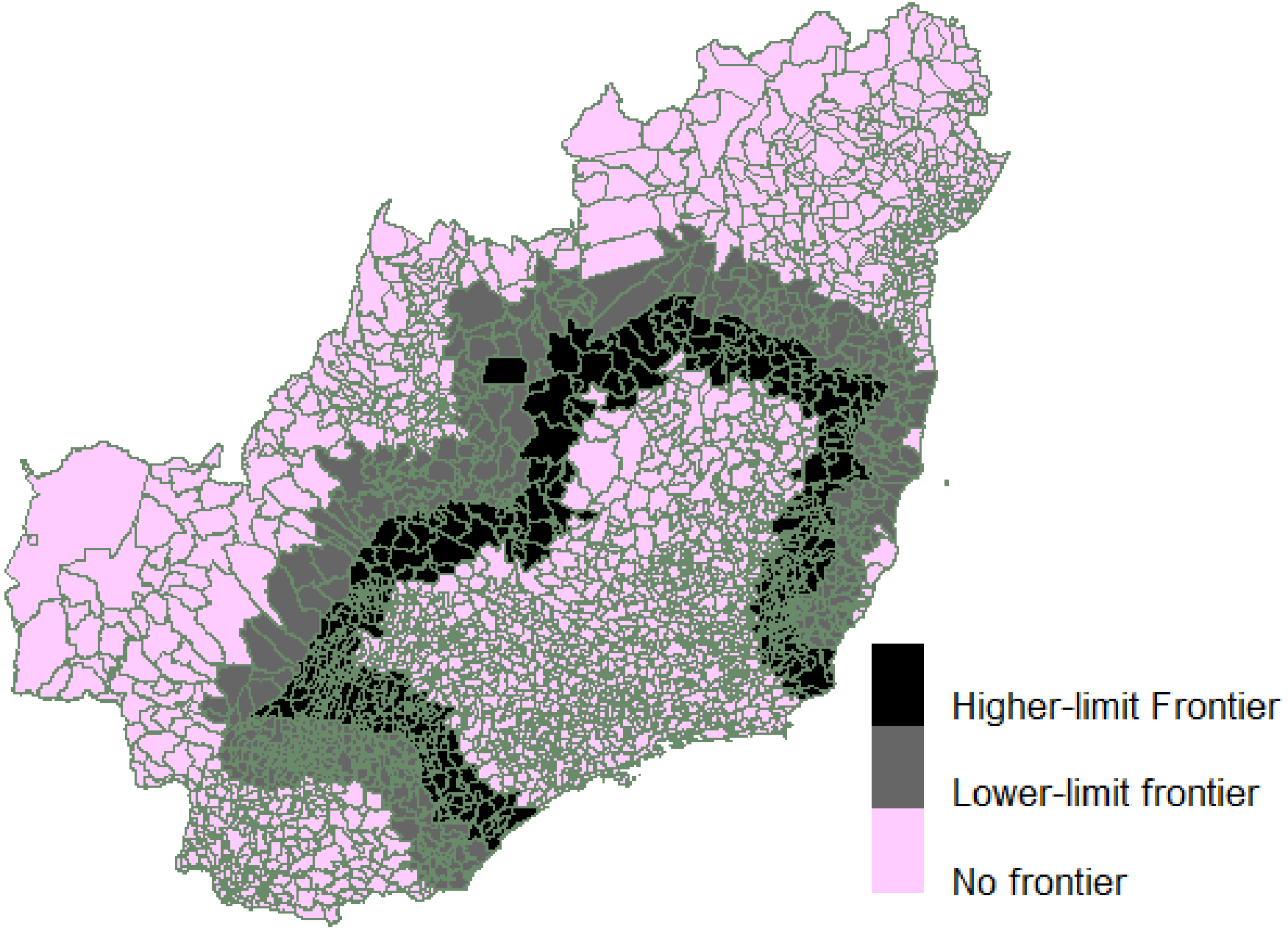
## Registry credit data

- Credit Registry System (SCR) from all financial system.
- Banks send monthly credit data to Central Bank of Brazil
- Unit of observation: loan contract
- Type of borrower/credit line
- Local Observation: borrower's zip code and municipality (from Receita Federal - Brazilian Internal Revenue Service)

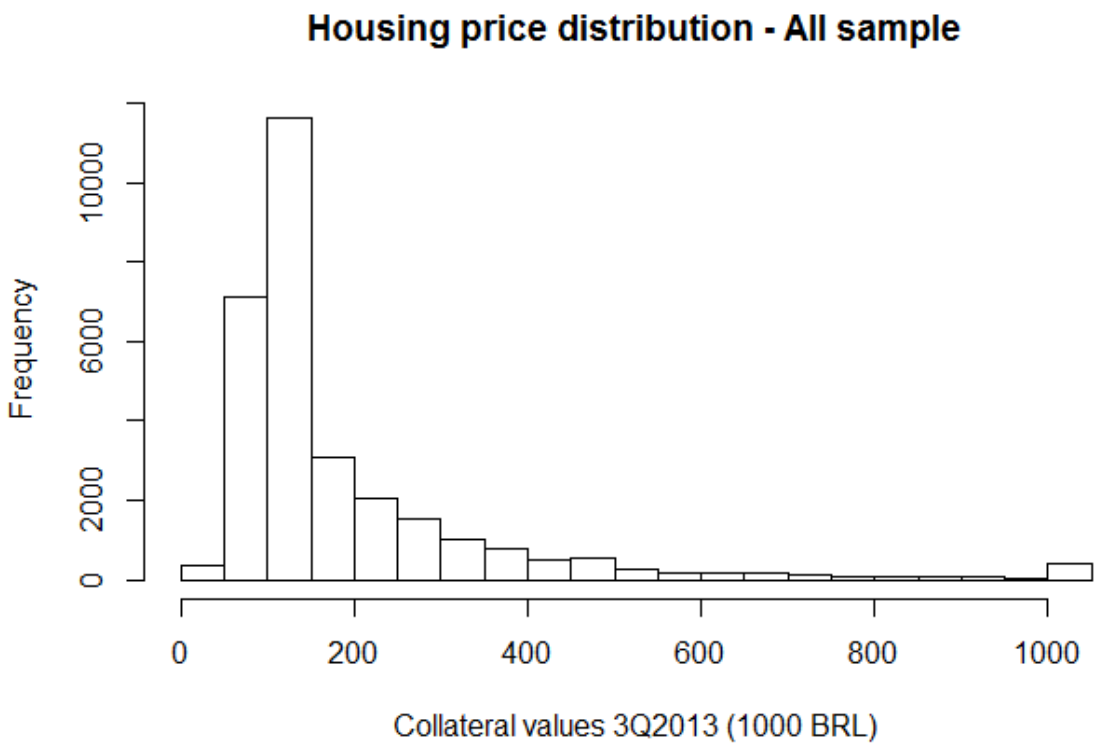
# Empirical Strategy

## Regions of study

- Compare the effect of the boundary with distinct loan-elegible limits
- Only loans for Households
- Housing financial contracts and 1st-degree mortgage
- Housing price as a collateral of those lines
- Bank's evaluation of collateral
- New contracts for each quarter
- Municipality level
- 925 municipalities: border municipalities + municipalities less than 75km away (Euclidian distance) from border municipalities


Higher-limit Frontier
Lower-limit frontier
No frontier

# Housing prices are really lower than the limit




So we use some measures of prices for a municipality level: average, quartiles and 90th percentile housing prices

# Geographic RDD

- Sharp Regression Discontinuity Design
- Geographic RDD (Keele and Titiunik, 2014): two dimensions (latitude and longitude)
- location of a municipality $m$ that contains a house financed by a SFH loan is given by $S_m = (S_{m1}, S_{m2})$
- Treatment (location of real estate's municipality): $T_i = T(S_i)$
- $\mathcal{F}$ is a set of possibilities of points in the frontier with 75km-radius
- Average causal effect of the treatment

$$\tau_{SRD} = \mathbb{E}[(Y_m(T=1) - Y_m(T=0))|m \in \mathcal{F}]$$

# Assumptions for Geographical RDD

## Assumption 1: Continuity of Conditional Distribution Functions

For all $s \in \mathcal{F}$, the marginal density of $S_i$, $f(S)$, is positive in a neighborhood of $\mathcal{F}$ and $F(S)$ is continuous at this region. (Continental region: both latitude and longitude are continuous)

## Assumption 2: Continuity of the Conditional Regression Function

Conditional regression function $E[(Y_m(D=1) - Y_m(D=0)]$ is continuous in for all $s \in \mathcal{F}$, i.e., variables in the neighborhood of the SFH boundary have comparable potential outcomes.

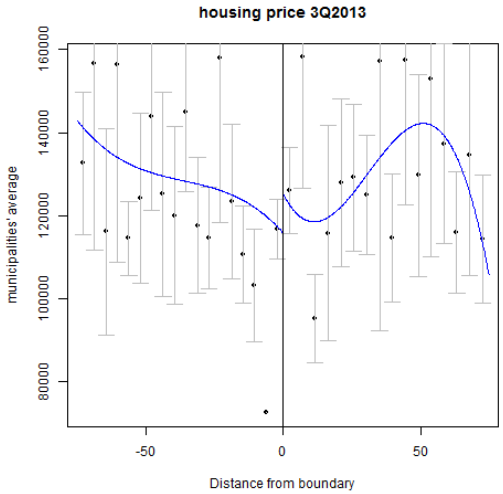
| Variable | GDP (BRL million) | Population | Area ($km^2$) | IMR (1,000 births) | Total Credit (BRL million) | Bank branches | Bank branches-like |
|---|---|---|---|---|---|---|---|
| Lower limit region | 818.5 | 30759.2 | 979.0 | 12.67 | 40.54 | 4.940 | 1.373 |
| Higher limit region | 882.9 | 24973.5 | 750.4 | 12.76 | 42.18 | 4.799 | 1.386 |
| T-test | -0.147 | 0.742 | 2.897 | -0.103 | -0.043 | 0.079 | -0.023 |
| P-value | 0.884 | 0.459 | 0.004 | 0.918 | 0.965 | 0.937 | 0.982 |

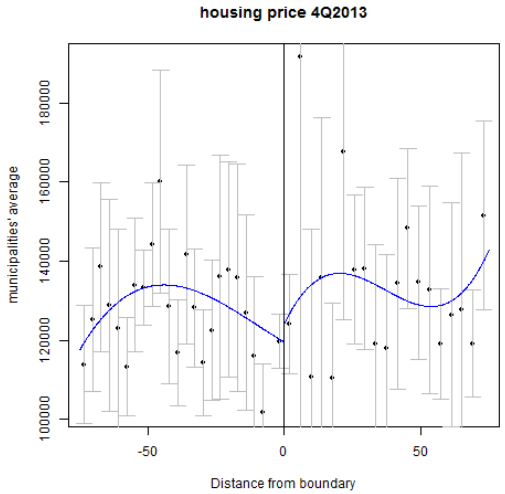
Source: IBGE, DataSUS, Estban.

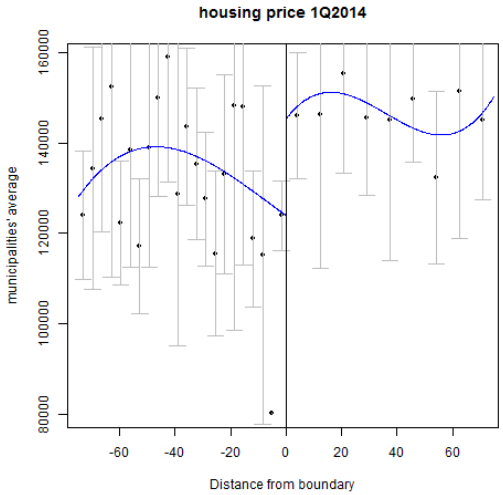
# Descritive Statistics - Housing loans

| Region | All | Lower-limit region | | Higher-limit region | | All Contracts |
|---|---|---|---|---|---|---|
| Period | SFI | SFH | FGTS | SFH | FGTS | |
| 3Q2013 | 38 | 9,072 | 12,519 | 9,182 | 8,270 | 39,081 |
| 4Q2013 | 44 | 8,998 | 8,894 | 8,851 | 5,962 | 32,749 |
| 1Q2014 | 83 | 9,767 | 7,464 | 11,567 | 5,116 | 33,997 |
| 2Q2014 | 96 | 10,568 | 9,730 | 10,435 | 5,716 | 36,545 |
| 3Q2014 | 964 | 8,220 | 13,073 | 7,648 | 9,031 | 38,936 |
| 4Q2014 | 487 | 8,509 | 12,209 | 8,172 | 9,267 | 38,644 |
| 1Q2015 | 270 | 6,723 | 10,506 | 6,531 | 7,415 | 31,445 |
| 2Q2015 | 233 | 5,217 | 11,403 | 5,000 | 8,947 | 30,800 |
| 3Q2015 | 374 | 3,295 | 13,021 | 2,881 | 9,661 | 29,232 |
| 4Q2015 | 105 | 3,590 | 13,947 | 3,355 | 10,840 | 31,837 |
| 1Q2016 | 101 | 3,565 | 12,071 | 4,330 | 12,198 | 32,265 |
| 2Q2016 | 225 | 2,405 | 12,257 | 2,204 | 13,052 | 30,143 |
| 3Q2016 | 201 | 2,437 | 10,853 | 2,443 | 9,575 | 25,509 |
| 4Q2016 | 169 | 2,976 | 14,820 | 2,418 | 9,565 | 29,948 |
| 1Q2017 | 115 | 1,954 | 9,314 | 1,901 | 8,432 | 21,716 |
| 2Q2017 | 109 | 2,147 | 11,221 | 1,877 | 9,633 | 24,987 |
| 3Q2017 | 116 | 2,324 | 10,733 | 2,170 | 8,911 | 24,254 |
| All | 3,730 | 91,767 | 194,035 | 90,965 | 151,591 | 532,088 |

# Outline



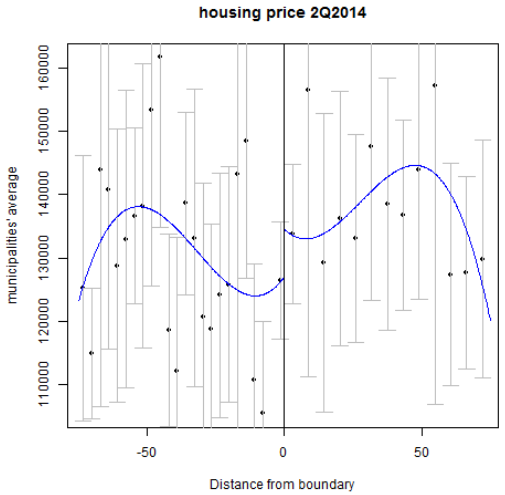
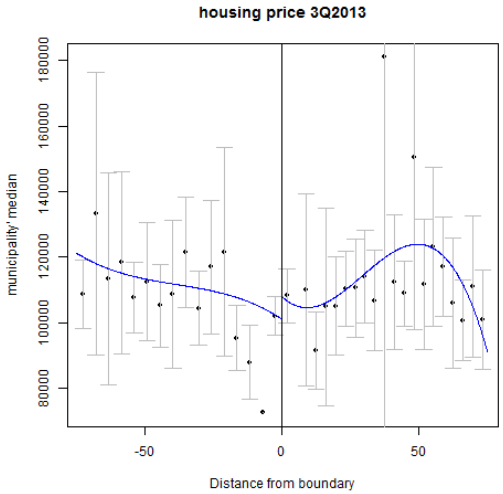
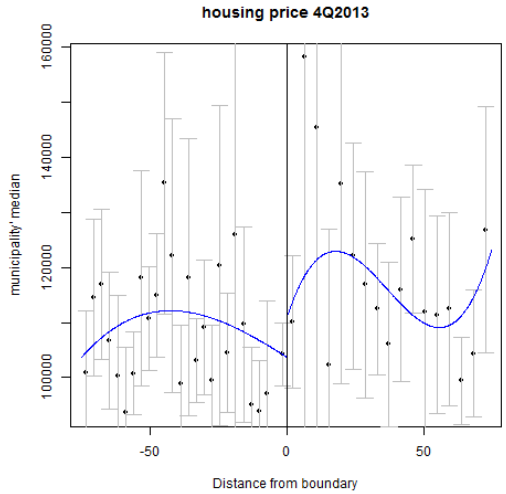
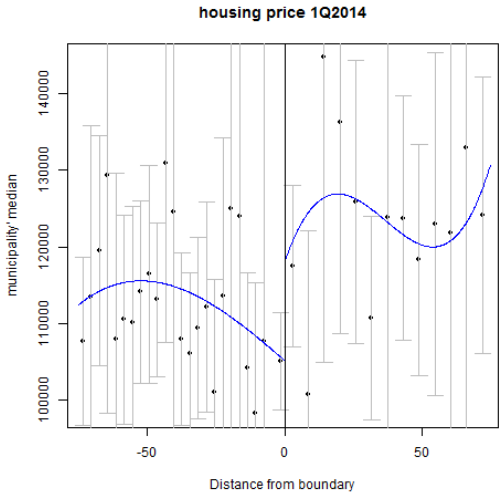




Figure: Municipalities' average housing price - 1st change



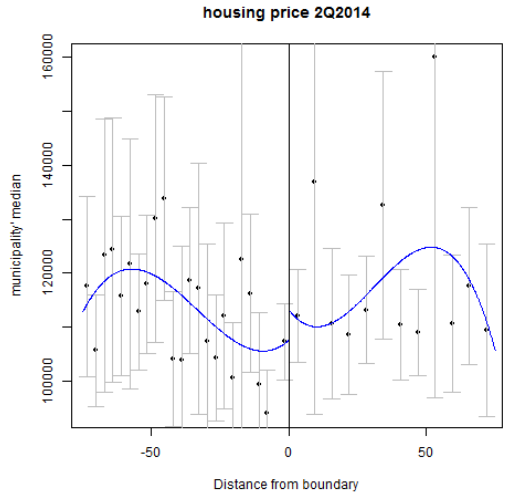
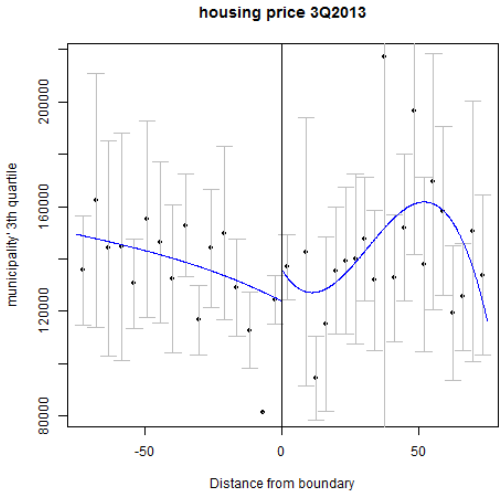
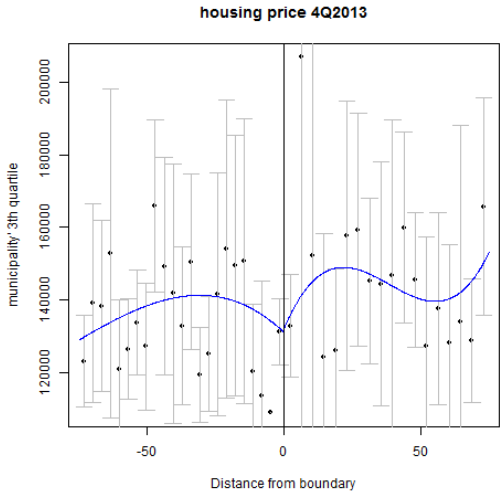
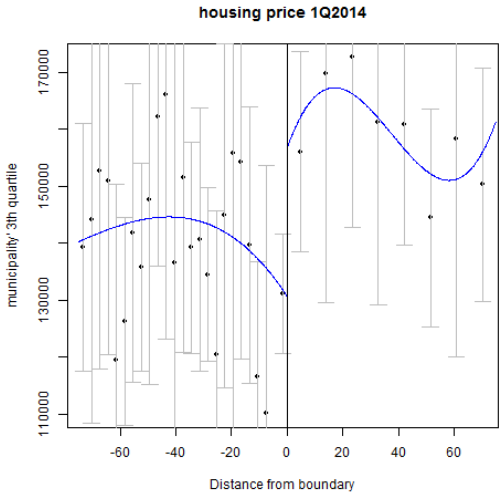




Figure: Municipalities' median housing price - 1st change



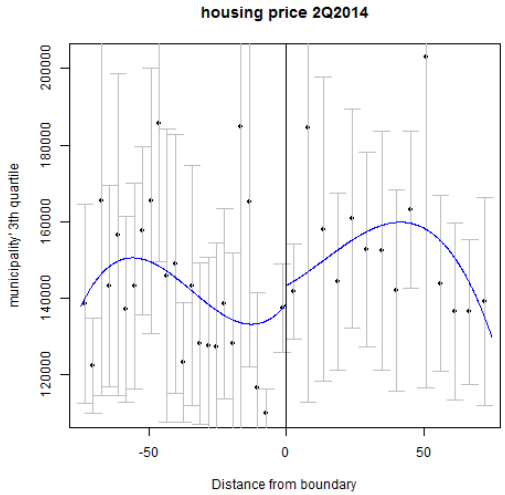
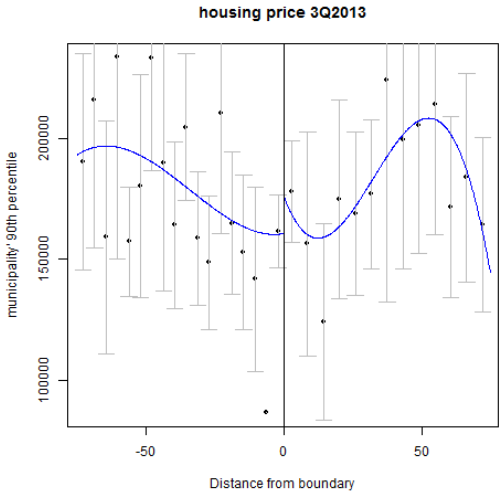
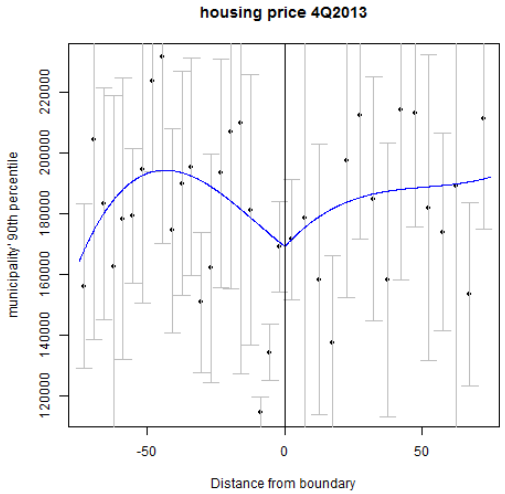
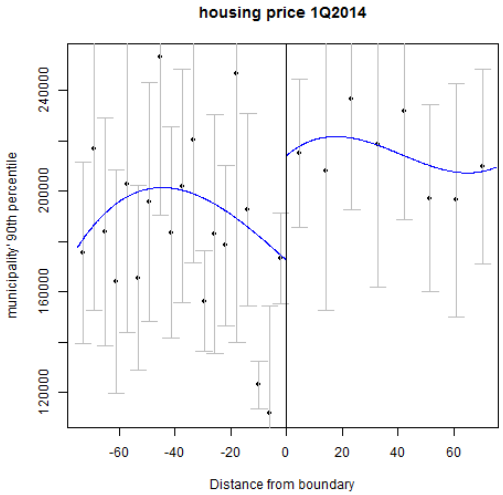




Figure: Municipalities' 3th quantile housing price - 1st change



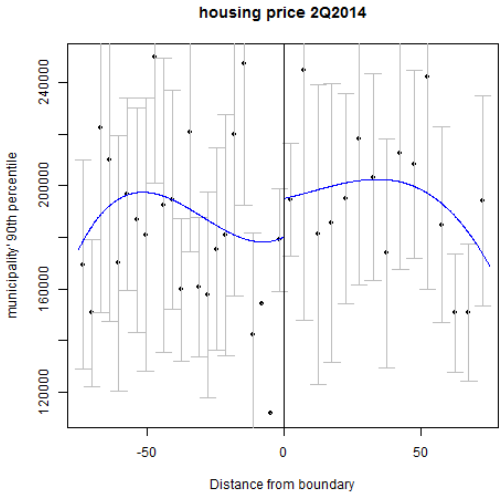
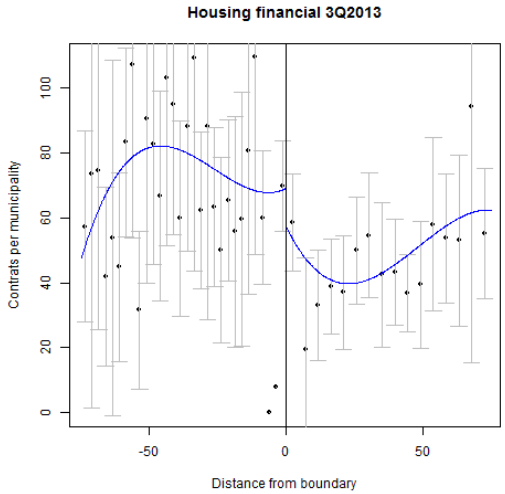
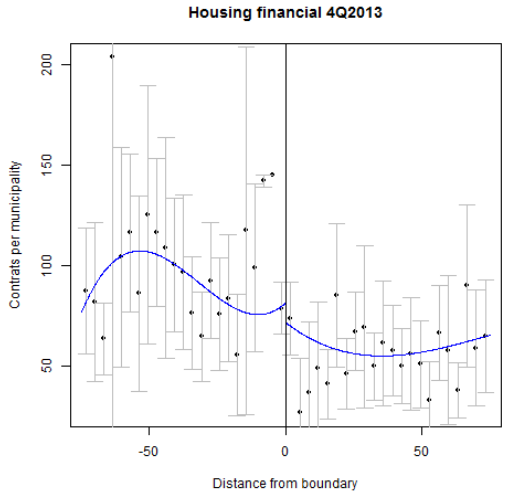
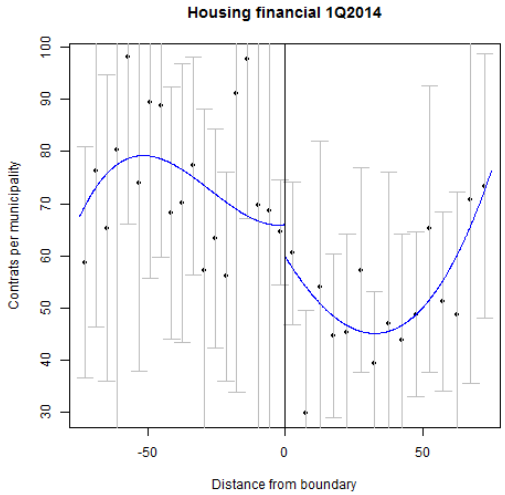




Figure: Municipalities' 90th percentile housing price - 1st change



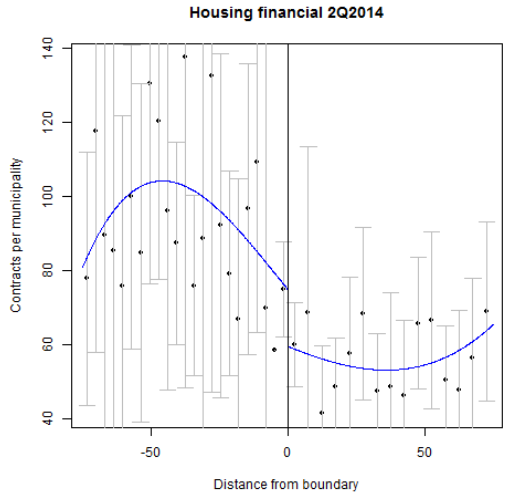




Figure: Municipalities' number of contracts - 1st change

$$\mathbb{E}(Y_i|Z_m, T = 1) - \mathbb{E}(Y_i|Z_m, T = 0)$$

| | *Dependent variable: municipalities' housing prices* | | | | | | |
|---|---|---|---|---|---|---|---|
| | All sample | | | | SFH and SFI, regular | | FGTS |
| Period | Average | 2nd quartile | 3rd quartile | 90th quantile | Average | 3rd quartile | Average |
| 2Q2013 | -1,763.1 | 331.0 | 142.4 | -6,975.9 | 15,925.3 | 17,637.9 | -1,158.6 |
| | (8,362.2) | (7,843.9) | (9,116.3) | (11,936.9) | (12,324.4) | (12,723.3) | (2,772.8) |
| 3Q2013 | 6,667.5 | 5,680.4 | 9,541.2 | 9,208.9 | 15,945.9 | 16,092.5 | 5,089.4 |
| | (5,825.5) | (5,048.7) | (7,384.8) | (11,103.0) | (11,587.9) | (14,251.5) | (3,002.5) |
| 4Q2013 | 2,847.1 | 5,879.4 | -302.7 | -2,856.9 | 4,265.5 | 8,639.7 | -1,597.1 |
| | (6,831.9) | (6,636.4) | (7,967.4) | (10,789.9) | (9,944.1) | (12,205.2) | (2,640.2) |
| 1Q2014 | 17,965.1** | 11,281.7* | 20,646.** | 33,277.7** | 23,661.2* | 29,705.7* | -692.4 |
| | (7,381.7) | (5,999.5) | (9,064.2) | (15,168.8) | (14,092.9) | (17,783.7) | (2,762.4) |
| 2Q2014 | 6,571.6 | 4,889.8 | 3,650.2 | 12,296.2 | 24,899.3** | 21,556.1* | 927.0 |
| | (6,890.7) | (5,570.7) | (8,109.4) | (13,764.3) | (10,911.2) | (13,714.4) | (2,782.7) |
| 3Q2014 | 3,203.9 | 2,985.5 | 2,009.9 | 7,020.1 | 16,650.8 | 22,444.6 | -1,009.5 |
| | (7,209.2) | (6,985.8) | (7,940.9) | (11,088.3) | (12,266.3) | (14,124.0) | (2,610.6) |
| 4Q2014 | -6,474.3 | -2,942.4 | -3,604.2 | -14,465.0 | -7,039.6 | 3,238.1 | 277.5 |
| | (6,847.7) | (6,083.5) | (7,680.6) | (12,993.4) | (18,098.1) | (19,408.3) | (2,599.2) |
| N | 925 | 925 | 925 | 925 | 925 | 925 | 925 |

*Note:* *p<0.1; **p<0.05; ***p<0.01

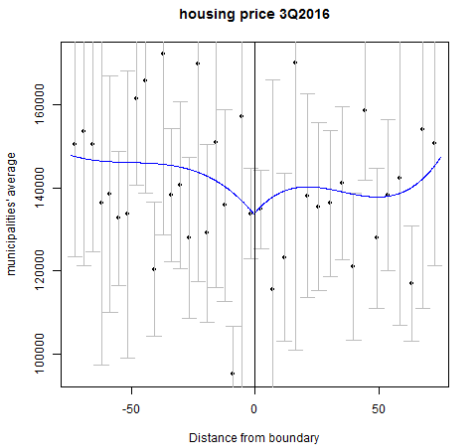
$Z_m$: GDP per capita, number of bank branches, Infant Mortality Rate

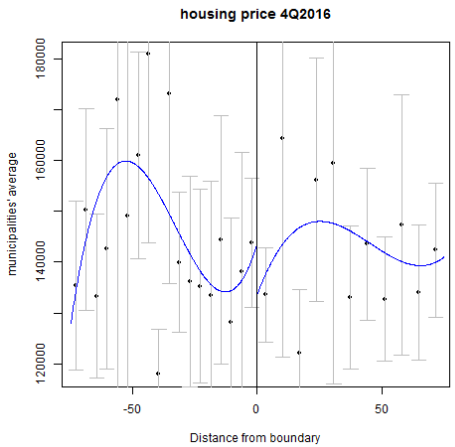
| | *Dependent variable* | | | | | |
|---|---|---|---|---|---|---|
| | Loan-to-Value (0 to 1) | | | Maturity (months) | | |
| Period | All sample | SFH and SFI | FGTS | All sample | SFH and SFI | FGTS |
| 2Q2013 | | | | 10.472* | 13.303* | 8.381 |
| | | | | (6.117) | (7.890) | (6.544) |
| 3Q2013 | -0.004 | -0.013 | 0.007 | 4.968 | 21.352*** | -4.438 |
| | (0.015) | (0.017) | (0.017) | (6.330) | (7.679) | (6.200) |
| 4Q2013 | -0.012 | -0.019 | 0.015 | -8.300 | -13.621* | 3.213 |
| | (0.013) | (0.017) | (0.014) | (6.525) | (7.810) | (7.224) |
| 1Q2014 | -0.007 | -0.017 | 0.002 | 4.556 | 14.047* | 1.660 |
| | (0.014) | (0.020) | (0.015) | (6.464) | (7.610) | (7.418) |
| 2Q2014 | -0.007 | 0.018 | 0.001 | 11.796* | 18.690*** | 2.182 |
| | (0.013) | (0.017) | (0.016) | (6.388) | (7.155) | (7.878) |
| 3Q2014 | 0.003 | 0.003 | 0.002 | 4.635 | 26.210*** | -1.890 |
| | (0.013) | (0.023) | (0.012) | (6.231) | (9.004) | (6.319) |
| 4Q2014 | -0.014 | -0.036* | -0.018 | -4.541 | -9.471 | -4.562 |
| | (0.014) | (0.020) | (0.012) | (5.718) | (9.639) | (6.041) |
| 1Q2015 | -0.004 | -0.075*** | 0.023 | 6.414 | 14.665 | 1.627 |
| | (0.028) | (0.019) | (0.029) | (6.178) | (9.932) | (6.216) |
| 2Q2015 | 0.005 | -0.027 | 0.019 | 3.185 | 9.539 | 2.977 |
| | (0.011) | (0.021) | (0.012) | (6.137) | (11.069) | (4.422) |
| N | 925 | 925 | 925 | 925 | 925 | 925 |

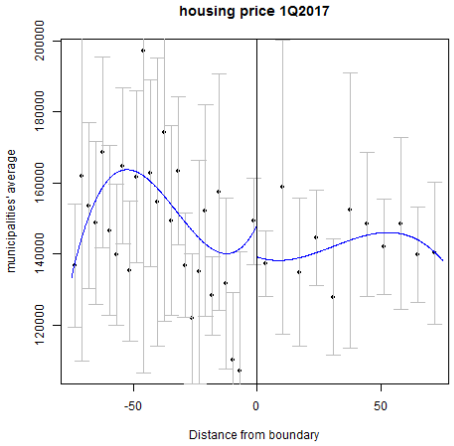
*Note:* *p<0.1; **p<0.05; ***p<0.01

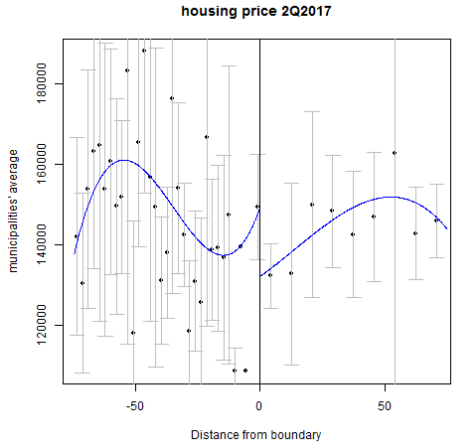
$Z_m$: GDP per capita, number of bank branches, Infant Mortality Rate.

# No impact in second period of change (2016)



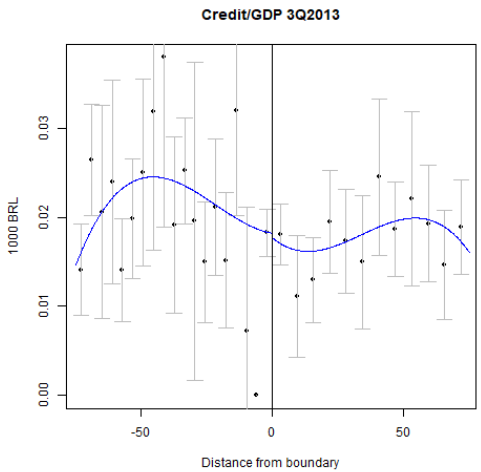



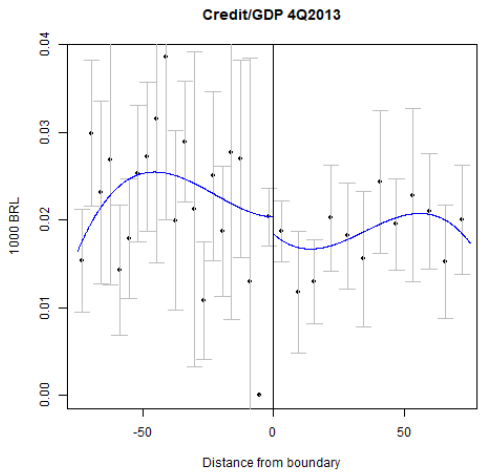



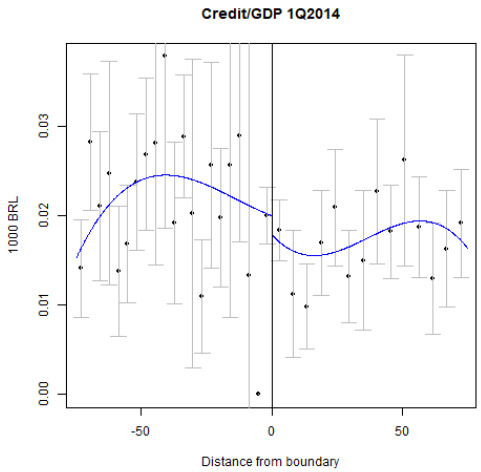



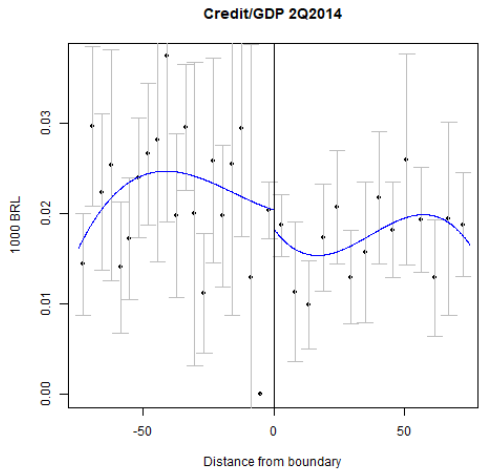
# Outline

# Evaluating covariates - Credit/GDP per municipality

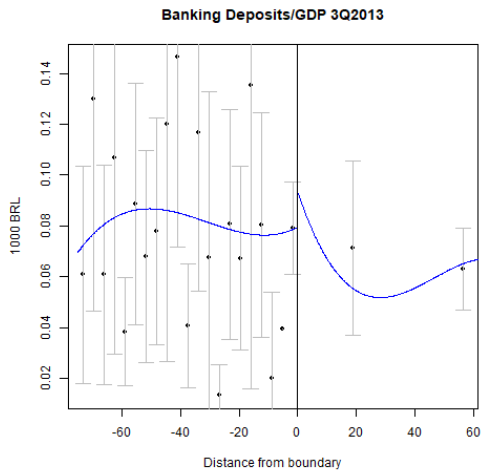


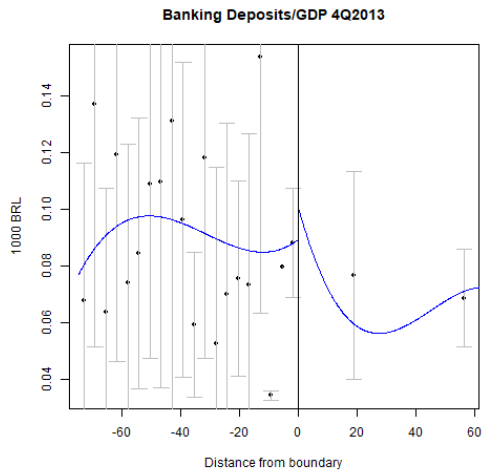



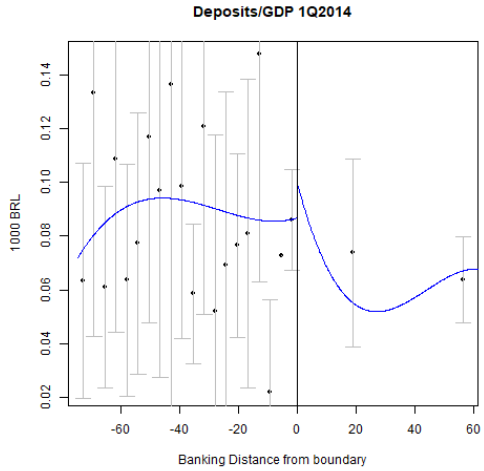



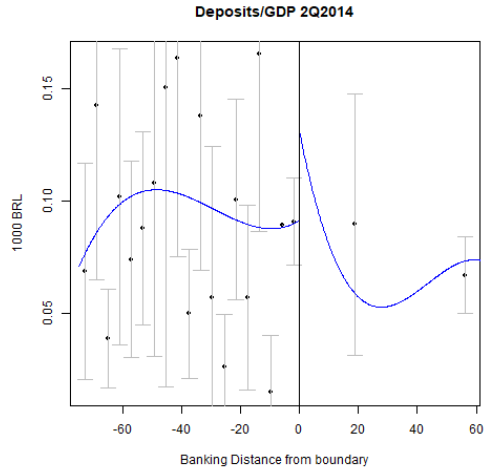



# Evaluating covariates - Deposits/GDP per municipality



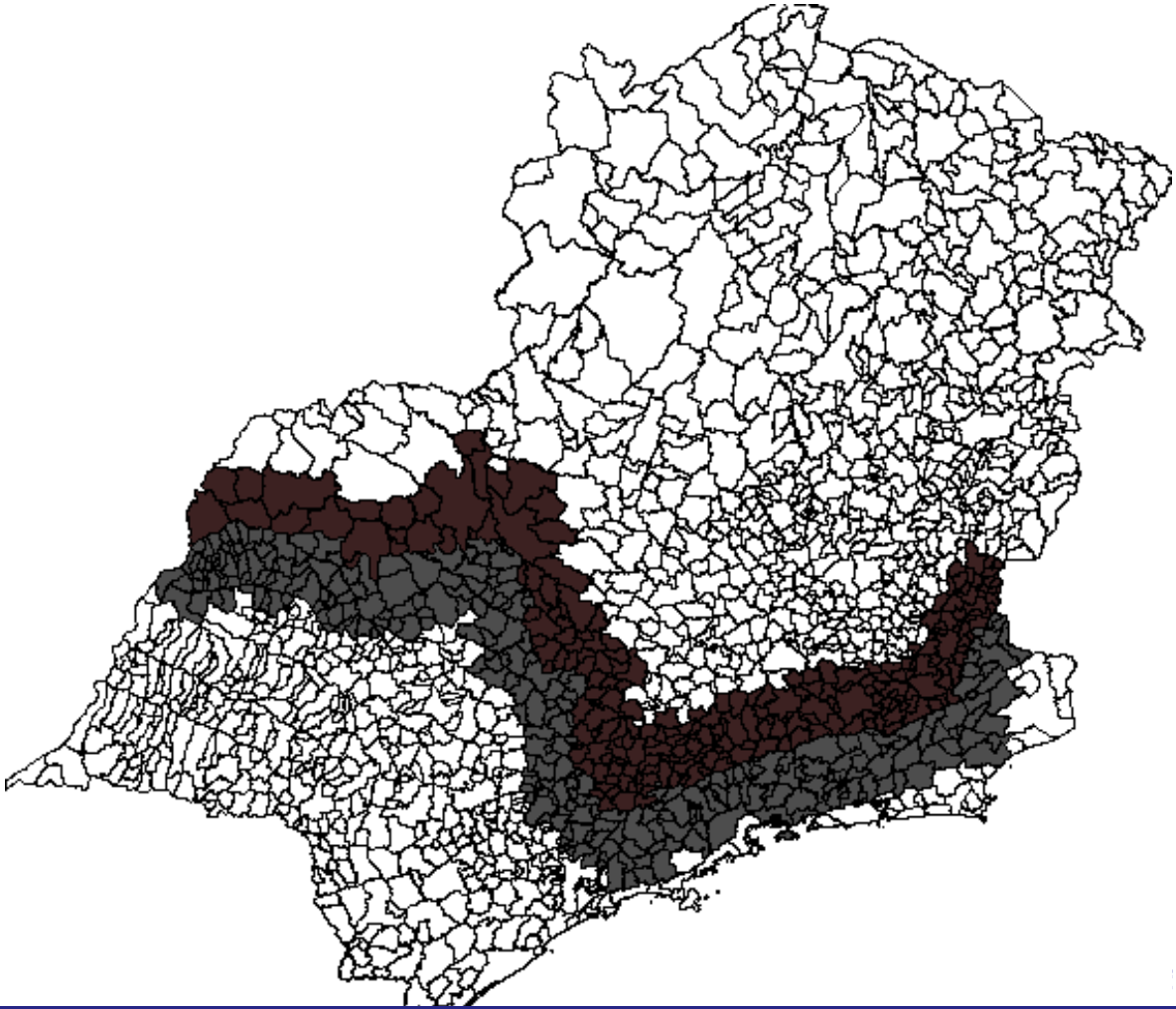



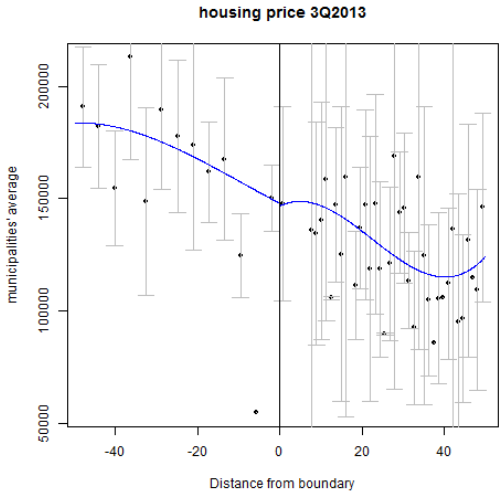



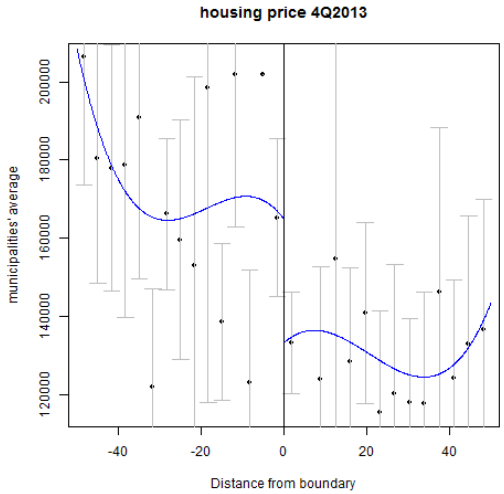



# Geographical Counterfactual

## Evaluate boundary of States with the same limit of SFH





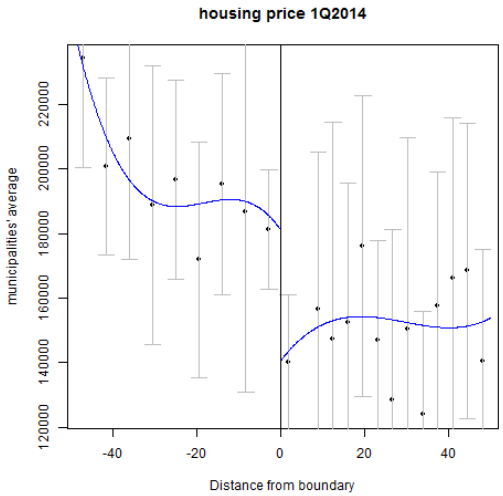





Figure: Municipalities' average housing price over groups/time - 1st

# How about other regions in country?

- Most of housing loans occur in big cities
- 2 new databases (Loan-level):
  - States' Capitals: 4 municipalities with Higher limit and 23 with lower limit
  - Metropolitan Areas: 138 municipalities with Higher limit and 266 with lower limit
- Differences-in-Differences analysis:

$$P_{h \in m} = \phi t + \gamma r + \beta t * r + \eta z_m + \psi z_h + \theta c_m \qquad (1)$$

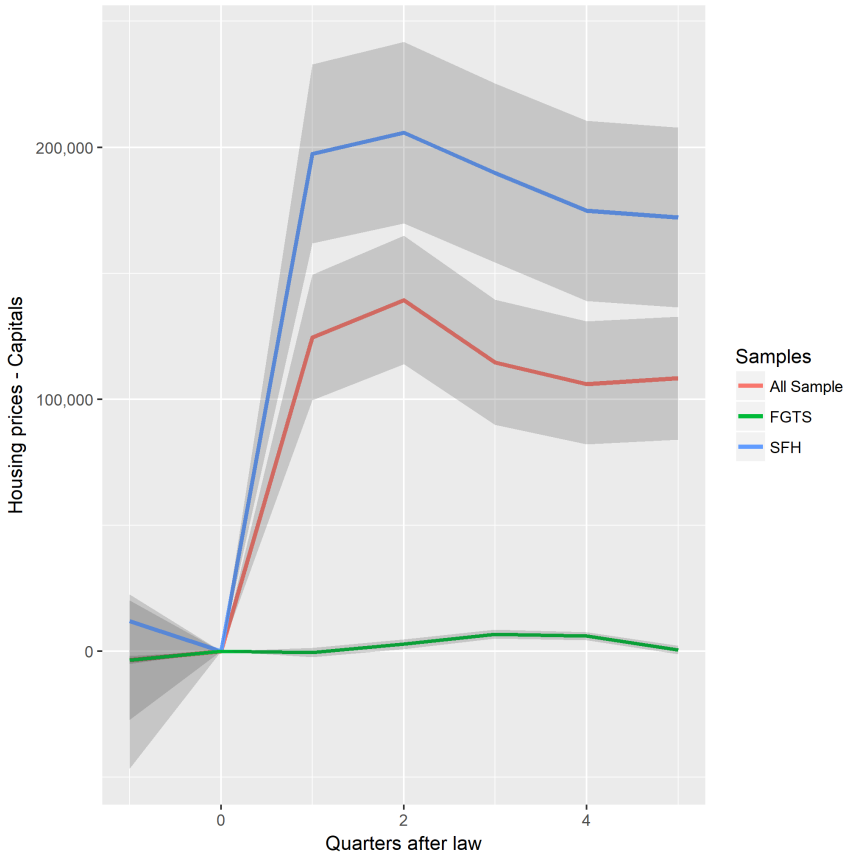
- $P$: price of a real estate $h$ in a municipality $m$
- $t$: 0/1 if before/after 3Q2013
- $r$: 0/1 if $m$ belongs to lower/higher SFH limit
- covariates $z$, $c$

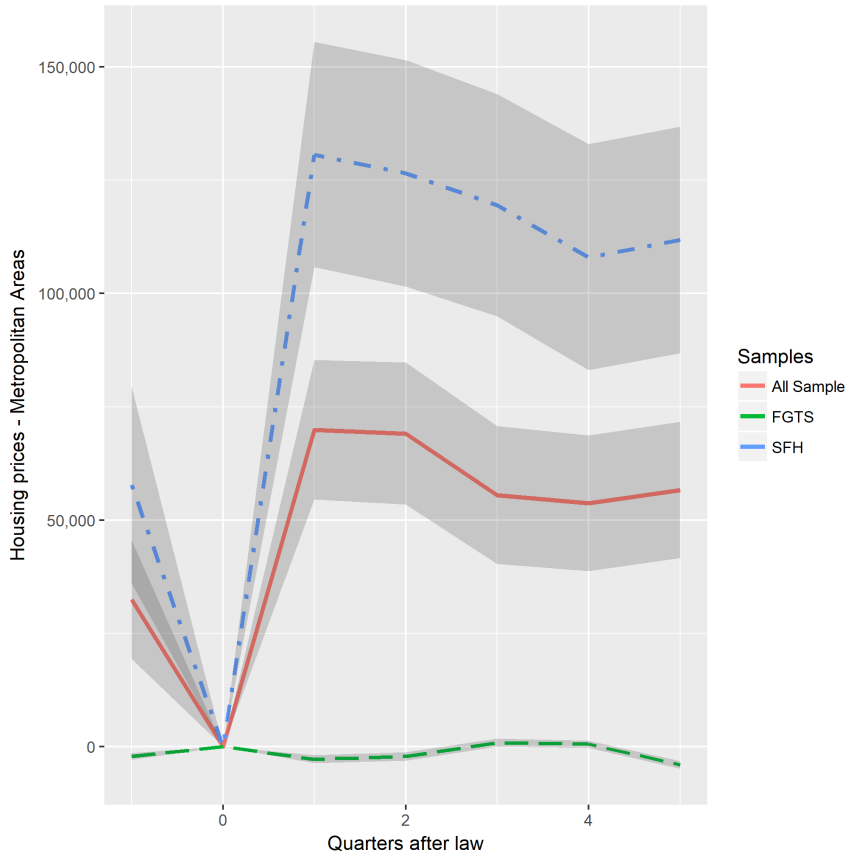
| | *Dependent variable:* housing price | | | | | |
|---|---|---|---|---|---|---|
| | Capitals (27 municipalities) | | | Metropolitan Areas (404 municipalities) | | |
| | All loans | SFH, SFI | FGTS | All loans | SFH, SFI | FGTS |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *Panel A: 6 months after policy* | | | | | | |
| reg750 | 1,484.8 | -16,563.8 | 1,551.4** | -4,105.3 | -49,013.6*** | 17,127.7*** |
| | (15,831.3) | (22,159.8) | (742.3) | (6,444.5) | (10,448.8) | (272.7) |
| 1Q2014 | -71,503.4*** | -167,971.4*** | 2,901.5*** | -52,125.4*** | -129,729.0*** | 416.1* |
| | (10,580.9) | (15,667.0) | (441.6) | (6,162.2) | (10,209.4) | (251.1) |
| **t*r** | 150,349.8*** | 218,639.5*** | 3,324.8*** | 71,035.6*** | 127,151.6*** | -2,051.1*** |
| | (15,081.6) | (21,030.7) | (755.0) | (8,369.0) | (13,040.7) | (393.1) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 142,326 | 101,711 | 40,615 | 264,609 | 171,725 | 92,884 |
| $R^2$ | 0.005 | 0.005 | 0.176 | 0.007 | 0.006 | 0.204 |
| Adjusted $R^2$ | 0.005 | 0.005 | 0.175 | 0.007 | 0.005 | 0.204 |
| F Statistic | 72.981*** | 58.537*** | 960.823*** | 186.882*** | 95.477*** | 2,376.145*** |
| *Panel B: 3 months after policy* | | | | | | |
| Higher-limit | 261.0 | -20,712.7 | 2,839.3*** | -5,626.0 | -51,690.7*** | 17,369.6*** |
| region | (15,502.6) | (21,977.2) | (593.2) | (6,352.5) | (10,456.8) | (241.5) |
| 4Q2013 | -96,555.7*** | -184,689.3*** | 1,408.5*** | -58,603.6*** | -131,277.2*** | 986.5*** |
| | (10,134.7) | (15,304.1) | (337.2) | (5,979.6) | (10,187.1) | (214.0) |
| **t*r** | 126,848.5*** | 198,955.6*** | -436.0 | 70,789.9*** | 130,528.8*** | -2,798.0*** |
| | (14,344.0) | (20,407.9) | (571.5) | (8,083.4) | (12,965.6) | (328.3) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 146,008 | 102,638 | 43,370 | 273,454 | 173,100 | 100,354 |
| $R^2$ | 0.005 | 0.005 | 0.238 | 0.007 | 0.006 | 0.240 |
| Adjusted $R^2$ | 0.005 | 0.005 | 0.238 | 0.007 | 0.006 | 0.240 |
| F Statistic | 75.424*** | 56.642*** | 1,505.371*** | 203.135*** | 96.753*** | 3,163.320*** |

| | *Dependent variable:* housing price | | | | | |
|---|---|---|---|---|---|---|
| | Capitals (27 municipalities) | | | Metropolitan Areas (404 municipalities) | | |
| | All loans | SFH, SFI | FGTS | All loans | SFH, SFI | FGTS |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *Panel C: 9 months after policy* | | | | | | |
| Higher-limit | -6,942.5 | -29,732.7 | -813.2 | -2,765.1 | -50,189.6*** | 15,996.4*** |
| region | (15,123.8) | (21,594.4) | (739.0) | (6,210.1) | (10,240.9) | (287.9) |
| 2Q2014 | -95,713.2*** | -189,915.8*** | 4,106.1*** | -68,265.1*** | -149,815.4*** | 1,009.6*** |
| | (9,986.1) | (15,196.1) | (427.7) | (5,758.9) | (9,819.9) | (251.9) |
| **t*r** | 123,680.2*** | 200,422.8*** | 6,755.1*** | 57,135.4*** | 119,460.4*** | 854.0** |
| | (14,281.4) | (20,447.5) | (720.4) | (7,882.5) | (12,639.9) | (390.4) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 147,731 | 102,828 | 44,903 | 277,953 | 175,412 | 102,541 |
| $R^2$ | 0.005 | 0.006 | 0.197 | 0.007 | 0.006 | 0.202 |
| Adjusted $R^2$ | 0.005 | 0.006 | 0.197 | 0.007 | 0.006 | 0.202 |
| F Statistic | 82.706*** | 68.438*** | 1,225.733*** | 193.968*** | 104.237*** | 2,591.656*** |
| *Panel D: 12 months after policy* | | | | | | |
| Higher-limit | 3,616.7 | -10,206.1 | 556.5 | -15.7 | -41,127.0*** | 16,051.5*** |
| region | (14,932.3) | (21,963.7) | (1,027.6) | (6,153.2) | (10,458.5) | (378.5) |
| 3Q2014 | -78,262.9*** | -151,680.5*** | 5,516.4*** | -54,954.9*** | -106,992.9*** | 3,160.9*** |
| | (9,759.8) | (15,578.7) | (571.4) | (5,648.0) | (10,220.9) | (316.4) |
| **t*r** | 111,505.8*** | 179,615.9*** | 6,449.6*** | 54,789.8*** | 109,331.4*** | 462.9 |
| | (13,828.9) | (20,752.1) | (947.3) | (7,702.0) | (13,066.9) | (483.7) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 151,843 | 101,281 | 50,562 | 285,163 | 170,842 | 114,321 |
| $R^2$ | 0.005 | 0.005 | 0.112 | 0.007 | 0.005 | 0.128 |
| Adjusted $R^2$ | 0.005 | 0.005 | 0.112 | 0.007 | 0.005 | 0.128 |
| F Statistic | 80.655*** | 51.939*** | 708.333*** | 200.428*** | 85.253*** | 1,673.794*** |

# Event-Study estimation

$$P_{h\in m} = \sum_{t=-1}^{t} \phi D_t + \gamma r + \sum_{t=-1}^{t} \beta(D_t * r) + \eta z_m + \psi z_h + \theta c_m \quad (2)$$



# Main Results

| | Geographic Neighbors | Metropolitan Areas | States' Capitals |
|---|---|---|---|
| Level | Municipality | Loan contract | |
| Method | RDD | Dif-in-Dif | |
| Higher-limit Coefficient (Max) | 23,661.2 | 88,138.0 | 202,075.7 |
| Average Housing Price | 179,402 | 408,347 | 476,957 |
| % Increase | 14.8% | 17,0% -19.1% | 35.7% - 42.3% |
| Impact | Temporally | Permanent | Permanent |

# Impact on local taxes - Panel Data

$$Tax_{mt} = \alpha + \beta Contr_{mt} + \delta SFH_{mt} + \phi Cov_{mt} + \gamma_t + \epsilon_{mt} \quad (3)$$

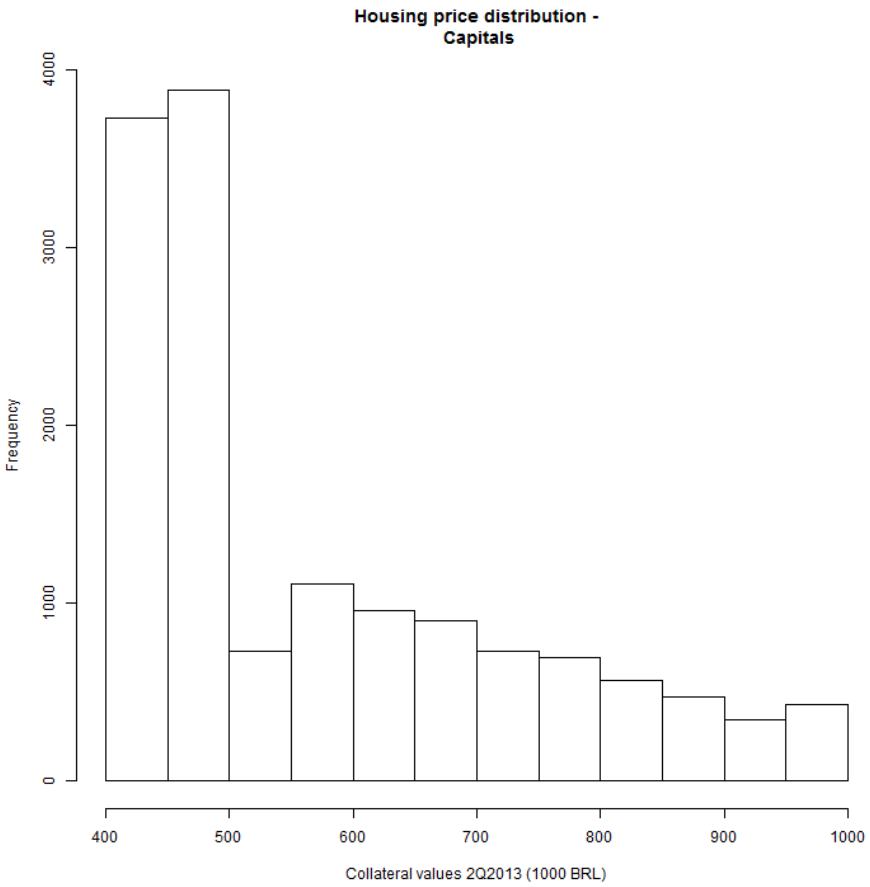
- Local taxes: property tax (IPTU), transfer tax (ITBI)
- Panel: municipality $m$, quarter $t$
- Variables of Interest:
  - Number contracts/100,000 inhabitants
  - Dummy SFH: 0 for lower-limit region; 0 for higher-limit region until 2012; 1 for higher-limit region after 2012.
- Covariates: population, GDP per capita, Infant Mortality Rate, Educational index (5th grade IDEB) only for odd years
- Fixed effects $\gamma_t$

| | *Dependent variable:* | | | | | |
|---|---|---|---|---|---|---|
| | Transfer Tax | Property Tax | Transfer Tax | Property Tax | Transfer Tax | Property Tax |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Housing contracts | 3,558.4*** | -4.062,8*** | 6.022,73*** | -4.966,68*** | | |
| | (562.86) | (732.85) | (991.99) | (984.02) | | |
| Higher limit | 89,572.7 | 521,535.7*** | | | 332,745.7*** | 808,754.0*** |
| | (95,324.5) | (124,113.0) | | | (118,775.0) | (195,418.1) |
| Educational Index | No | No | Yes | Yes | Yes | Yes |
| Other Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Years | 2012-2015 | | 2013, 2015 | | 2011, 2013, 2015 | |
| Observations | 20,961 | 20,961 | 10,272 | 10,272 | 15,381 | 15,381 |
| $R^2$ | 0.004 | 0.009 | 0.008 | 0.009 | 0.003 | 0.009 |
| $R^2$ Overall | 0.057 | 0.036 | 0.062 | 0.036 | 0.054 | 0.039 |
| F Statistic | 10.876*** | 27.204*** | 8.142*** | 8.797*** | 5.989*** | 17.033*** |
| *Note:* | | | | | | *p<0.1; **p<0.05; ***p<0.01 |

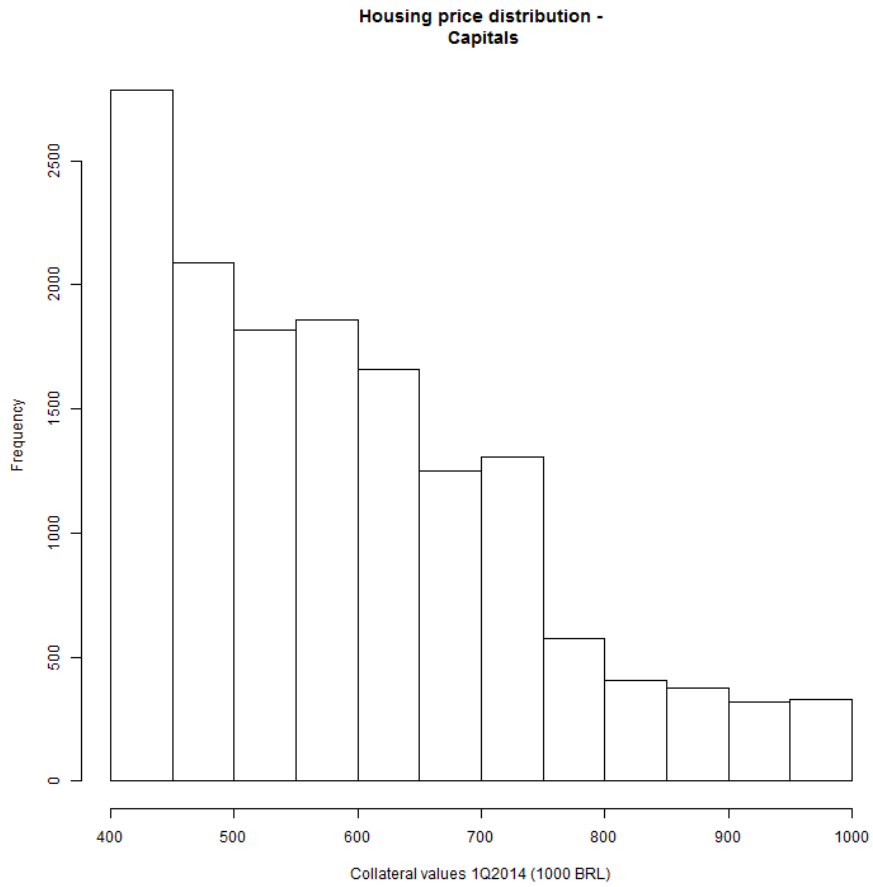
# Outline

# Distortion of distribution - States' Capitals

## Before

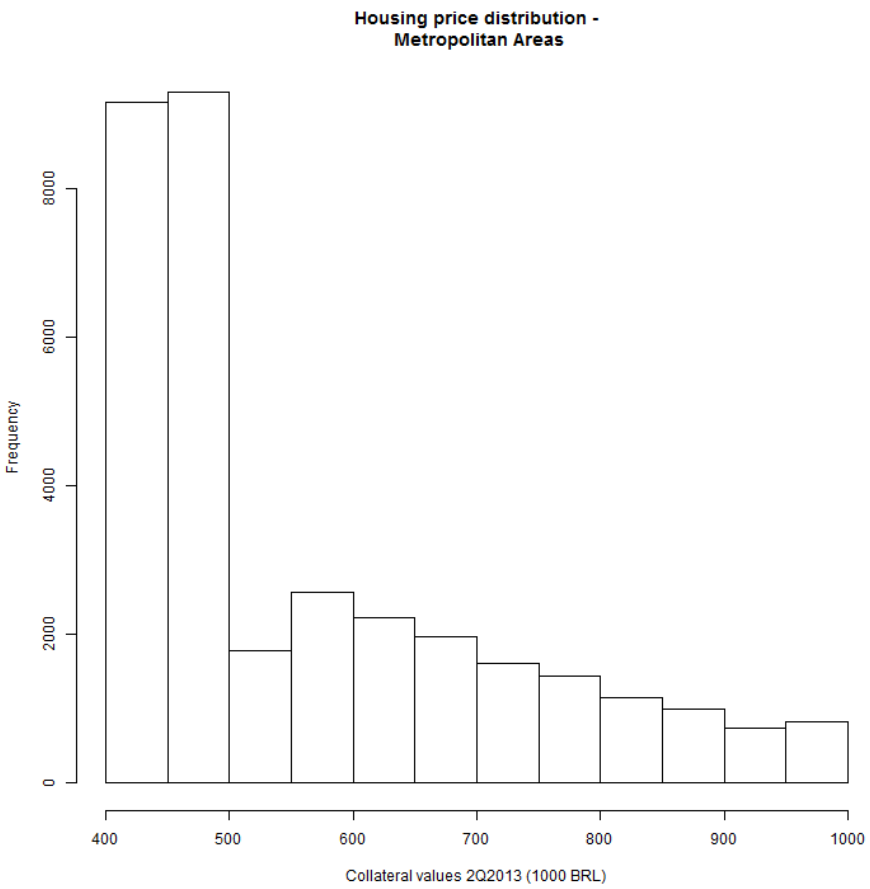



## After

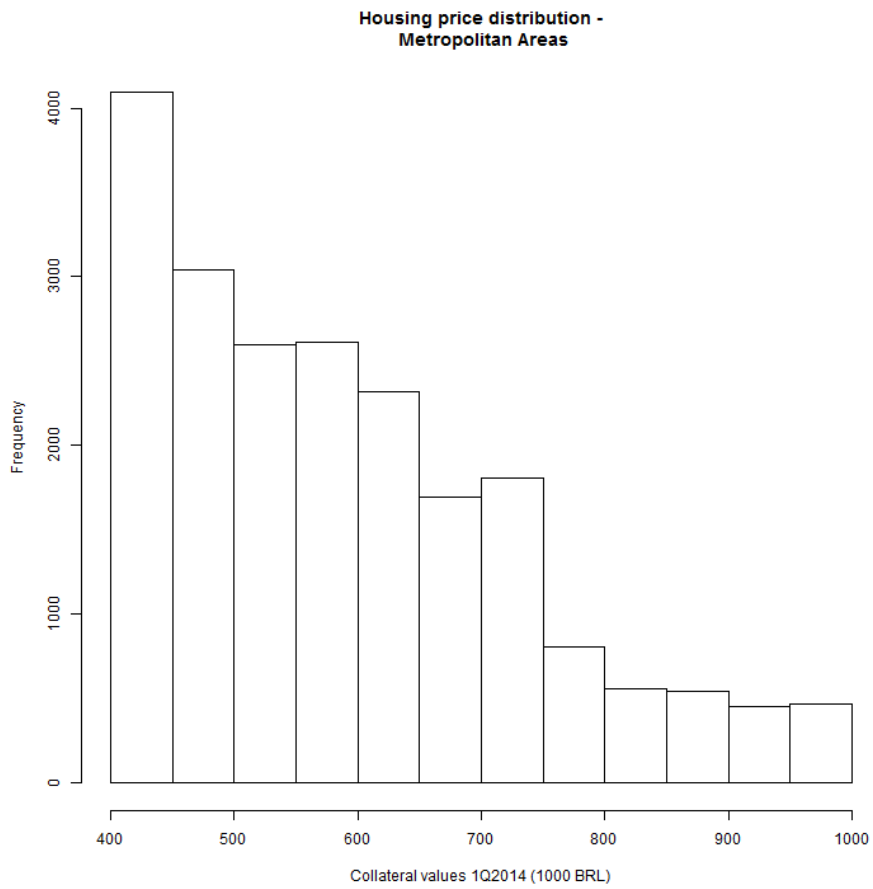


# Distortion of distribution - Metropolitan Areas

## Before




## After



# Method

- Strategy: Foremmy at al (JPE 2017): compare density before and after the density
- Range selected (400,000-600,000)
- Compare areas of histogram over time weighted to the distance from the threshold $c$ (500,000 BRL)
- Deviation from Empirical distribution function:

$$\hat{F}(k) - F(k) = \sum_{i=1}^{n} m_i(k_i - k_{i-1})(\frac{k_i - k_{i-1}}{2} - c) \qquad (4)$$

- where $k_i$ and $k_{i-1}$ are, respectively, the upper and the lower bound of each bin $i$, $m$ is the frequency of contracts in that bin
- $k_i - k_{i-1} = 10$

# Impact of law-begin at 3Q2013

| **After...** | **6 months** | **1 year** | **1.5 years** | **2 years** |
|---|---|---|---|---|
| | | Nominal Values | | |
| Capitals | 3,110.8 | 1,592.3 | 1,606.3 | 2,239.0 |
| MAs | 2,727.1 | 1,401.4 | 1,472.8 | 1,783.0 |
| | | Real Values | | |
| Capitals | 3,108.6 | 1,940.2 | 1,714.0 | 1,798.5 |
| MAs | 2,719.8 | 1,723.7 | 1,490.0 | 1,651.7 |

# Impact of law-begin at Nov-2016

| **After...** | **4 months** | **7 months** | **10 months** |
|---|---|---|---|
| Lower Limit Region | | | |
| Capitals | 551.2 | 615.8 | 628.6 |
| MAs | 442.4 | 580.8 | 601.5 |
| Higher Limit Region | | | |
| Capitals | 648.1 | 790.2 | 679.8 |
| MAs | 599.1 | 669.6 | 768.9 |

# Conclusions

- Heterogeneous impact across regions: 40% in States' capitals, 20% in Metropolitan Areas and 15% difference in housing collaterals beyond regions with distinct limit.
- No evidences that those laws changed outcomes from housing market for lower-class families (FGTS)
- Limit in 2013 is clearly more biding than in 2016
- Restraint can alter average housing price between 1,500 and 3,000 BRL