

# Lending Standards over the Credit Cycle

Giacomo Rodano<sup>1</sup>    Nicolas Serrano-Velarde<sup>2</sup>  
Emanuele Tarantino<sup>3</sup>

<sup>1</sup> Bank of Italy

<sup>2</sup> Bocconi University

<sup>3</sup> University of Mannheim

ACPR

@Paris, 04 October 2017

# Research Question

What is the impact of rating segmentation in capital markets?

- ▶ Large effects in corporate bond markets for publicly traded US firms.
- ▶ Contrast with lack of evidence on bank relations with SMEs.

Conceptual issues:

1. Neoclassical vs rationing mechanism.

Use loan-level data on  $p$  &  $q$  at from Credit Register.

2. Isolate banks lending standards from demand changes.

Use institutional setting that randomizes firms into rating classes.

# Ideal Experiment

Bank interacts with two economically identical firms ( $A, B$ ).

- ▶ Firm  $A$  randomly allocated into investment grade category.
- ▶ Firm  $B$  randomly allocated into speculative category.
- ▶ True type observed by bank but not by the market.
- ▶ Market only observes allocation into investment v. speculative.

Ingredients of experiment:

1. Randomization: all demand side characteristics kept constant.
2. Segmentation: bank has more information than market.

# Institutional Setting

Reproduce experiment using institutional features of Italian credit market:

- ▶ Banks share common rating system for SMEs.
- ▶ Rating is unsolicited and based on past balance sheet information.
- ▶ Altman methodology: continuous variable and categorical ratings.

Sharp allocation mechanism:

$$S = \begin{cases} \textit{Performing} & \text{if } 0 \leq s_i < 1.35, \\ \textit{Substandard} & \text{if } -0.75 \leq s_i < 0. \end{cases}$$

# Randomization

Compare banks' credit conditions to firms at the threshold:

- ▶ At the threshold: firms on the same demand for credit.
- ▶ At the threshold: joint analysis of price and quantity of credit.

Empirical test:

1. Test: regression discontinuity specification.
2. Data: quarterly loan-level data from Italian Credit Registry.
3. H0: segmentation should not matter for banks' lending.
4. Verify that identification assumptions satisfied (balancing, relevance, manipulation).

# Main Results (1)

| THRESHOLD ESTIMATES | 2004–2007   | 2008–2009   | 2010–2011 |
|---------------------|-------------|-------------|-----------|
| TOTAL LENDING       | $\approx 0$ | +31%        | +20%      |
| INTEREST RATE       | -2%         | $\approx 0$ | -6%       |
| PRODUCTION          |             |             |           |

$\approx 0$  not significant, + higher for performing, - lower for performing.

# Main Results (1)

| THRESHOLD ESTIMATES | 2004–2007   | 2008–2009   | 2010–2011 |
|---------------------|-------------|-------------|-----------|
| TOTAL LENDING       | $\approx 0$ | +31%        | +20%      |
| INTEREST RATE       | -2%         | $\approx 0$ | -6%       |
| PRODUCTION          | 20%         | 40%         | 20%       |

$\approx 0$  not significant, + higher for performing, - lower for performing.

# Contribution

1. Market segmentation extends to bank lending for SMEs.

Market exposure limits use of private information by banks.

2. Lending standards adjusted via distinct margins across the cycle:

In boom, narrowing spreads as in corporate bond literature.

In bust, widening of quantity differences.

3. How lending standards affect real activity across the cycle.



# Institutional and Theoretical Setting

# Market Segmentation (1)

Why distinction between performing and substandard matter?

- ▶ Bank of Italy classifies substandard loans as non-performing loans.
- ▶ Ratio between performing and non-performing loans:

Major indicator for portfolio assessment by rating agencies

Empirical test: cost of bank financing from external markets.

1. Value of continuous score not correlated with banks' cost of financing.
2. Implications for banks' funding is time dependent.

## Market Segmentation (2)

|                             | (1)              | (2)            | Pre 2008<br>(3) | Post 2008<br>(4) |
|-----------------------------|------------------|----------------|-----------------|------------------|
| Substandard to Total Credit | 1.26***<br>(.46) | 1.24*<br>(.66) | -.37<br>(.29)   | 1.34**<br>(.68)  |
| Continuous Variable 1       |                  | -.2<br>(.15)   |                 |                  |
| Continuous Variable 2       |                  | .09<br>(.31)   |                 |                  |
| Bank Characteristics        | Yes              | Yes            | Yes             | Yes              |
| Bank Fixed Effects          | No               | No             | Yes             | Yes              |
| Time Fixed Effects          | Yes              | Yes            | Yes             | Yes              |
| R-squared                   | .76              | .76            | .85             | 0.54             |
| N                           | 4,788            | 4,728          | 2,233           | 2,212            |

- ▶ 25% higher share of substandard lending in bank portfolio implies an increase in the banks' interest rate of about 26%.
- ▶ Controls: bank (total assets, tier 1, liquidity) and issuance characteristics (amounts, maturity, investor composition).

# Bank Lending with Market Segmentation

Competitive financial markets, risk neutral agents.

- ▶ Firms: 2 firms allocated into performing and substandard classes.
- ▶ Bank: observes firms “as if” identical, raises funding.

2 scenarios:

1. Investors understands firms are observationally identical.

Then same contracts at equilibrium.

2. Investors observe only discrete rating, then market segmentation.

Cost to fund performing firm is  $1 + r$ ,  $1 + r + \Delta$  for substandard firm.

# Bank Lending with Market Segmentation

Hölmstrom-Tirole moral hazard setting:

- ▶ Firms have identical project of size  $I$ , and own assets  $A$ .

Success probability is  $p$  only with success, benefits  $B$  otherwise.

The project returns  $R$  if successful.

- ▶ Contract: sharing rule (interest rate) and fraction of project funded  $x$ .

Intuition: values of  $r$  and  $\Delta$  shift the threshold of  $A$  (net worth channel).

# Bank Lending with Market Segmentation

Testable predictions:

1. In boom, small values of  $r$  and  $\Delta$ :

Full funding for both firms, only charge interest rate spread.

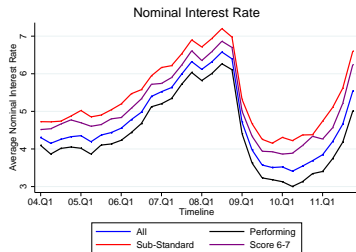
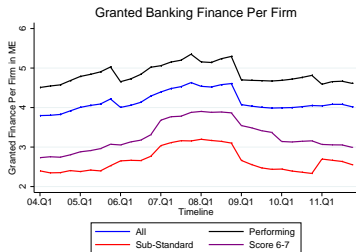
2. In bust, higher values of  $r$  and  $\Delta$ . The bank has two options:

- ▶ Monitoring: costly but allows for full funding.
- ▶ No Monitoring: fund a smaller fraction of the project ( $x < 1$ ).

Possible equilibrium: performing receive monitored finance, substandard are rationed.

# Economic and Banking Environment

# Firm Financing Environment

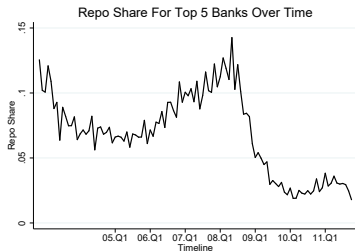
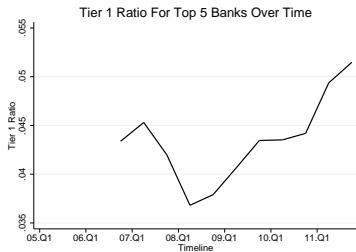


- ▶ 2004–2007: credit to substandard grew by 29%, to performing by 13%.
- ▶ Credit expansion accompanied by credit quality deterioration.

▶ More

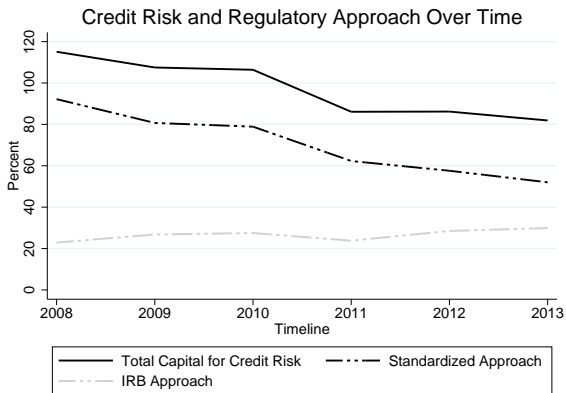


# Banking Environment (1)



► More on banking environment

# Banking Environment (2)



# Empirical Framework and Results

# Regression Discontinuity Design

Estimate the jump in outcomes directly at the threshold:

$$\begin{aligned} y_{i,t} = & \beta_0 + \beta_1 \text{Performing}_{i,t} + \beta_2 (\text{Performing}_{i,t} \times \text{Crisis}_t) \\ & + \beta_3 (\text{Performing}_{i,t} \times \text{Recovery}_t) + f(s_{i,t} - \bar{s}) \\ & + \text{Performing}_{i,t} \times g(s_{i,t} - \bar{s}) + \pi_t + u_{i,t}. \end{aligned} \quad (1)$$

- ▶  $\text{Performing}_i = 1$  if firm  $i$  is *Performing*, 0 if *Substandard*.
- ▶  $\text{Crisis}_t = 1$  from 2008 onwards,  $\text{Recovery}_t = 1$  from 2010 onwards.
- ▶  $f(\cdot)$  and  $g(\cdot)$ : polynomials below and above the threshold.
- ▶ Identifying assumption: local continuity of  $E(u_{i,\cdot} | s_{i,\cdot})$ .

Null: segmentation should not matter for banks' lending,  $\beta_t = 0$  for all  $t$ .

# Outcome Variables

First, we consider financing outcomes of firm  $i$ :

- ▶ Log total value of bank financing to firm  $i$ .
- ▶ Log value of interest rate applied to a new loan to firm  $i$ .

Then, real implications of lending standards for firm  $i$ :

- ▶ Expenditures in production inputs.
- ▶ Value of production.

# Credit Allocations

| Dependent Variable                         | <i>Quantity</i> |                  | <i>Price</i>     |                 |
|--|-----------------|------------------|------------------|-----------------|
|  | (1)             | (2)              | (1)              | (2)             |
| <i>Boom</i> × <i>Performing</i>            | .08<br>(.07)    | .07<br>(.07)     | -.02<br>(.01)    | -.02*<br>(.01)  |
| <i>Crisis</i> × <i>Performing</i>          | .19***<br>(.03) | .18***<br>(.03)  | .00<br>(.01)     | .00<br>(.01)    |
| <i>Recovery</i> × <i>Performing</i>        | -.09**<br>(.04) | -.08**<br>(.04)  | -.04***<br>(.01) | -.04**<br>(.01) |
| <i>Lagged Rating</i>                       |                 | -.01***<br>(.00) |                  | .00***<br>(.00) |
| <i>Polynomial</i>                          | Yes             | Yes              | Yes              | Yes             |
| <i>Quarter</i> × <i>Year Fixed Effects</i> | Yes             | Yes              | Yes              | Yes             |
| R-squared                                  | 0.05            | 0.05             | 0.37             | 0.37            |
| N  | 166,993         | 157,775          | 109,586          | 105,865         |

- Internal validity:    ► Manipulation    ► Balancing    ► Relevance of the threshold

# Real Effects

| Dependent Variable                         | <i>Production</i> |                  | <i>Investment</i> |                 | <i>Intermediates</i> |                 | <i>Employment</i> |                  |
|--|-------------------|------------------|-------------------|-----------------|----------------------|-----------------|-------------------|------------------|
|  | (1)               | (2)              | (1)               | (2)             | (1)                  | (2)             | (1)               | (2)              |
| <i>Boom</i> × <i>Performing</i>            | .18**<br>(.07)    | .21***<br>(.07)  | .07<br>(.11)      | .13<br>(.11)    | .11*<br>(.07)        | .14**<br>(.07)  | .18**<br>(.06)    | .18**<br>(.06)   |
| <i>Crisis</i> × <i>Performing</i>          | .17***<br>(.03)   | .17***<br>(.03)  | .32***<br>(.05)   | .31***<br>(.06) | .19***<br>(.03)      | .18***<br>(.03) | .16***<br>(.03)   | .15***<br>(.03)  |
| <i>Recovery</i> × <i>Performing</i>        | -.16**<br>(.04)   | -.15**<br>(.04)  | -.29***<br>(.06)  | -.29**<br>(.06) | -.12***<br>(.04)     | -.11**<br>(.04) | -.16***<br>(.03)  | -.13***<br>(.03) |
| <i>Lagged Rating</i>                       |                   | -.01***<br>(.00) |                   | -.00*<br>(.00)  |                      | -.00*<br>(.00)  |                   | -.01***<br>(.00) |
| <i>Polynomial</i>                          | Yes               | Yes              | Yes               | Yes             | Yes                  | Yes             | Yes               | Yes              |
| <i>Quarter</i> × <i>Year Fixed Effects</i> | Yes               | Yes              | Yes               | Yes             | Yes                  | Yes             | Yes               | Yes              |
| R-squared                                  | 0.08              | 0.08             | 0.07              | 0.07            | 0.09                 | 0.09            | 0.02              | 0.02             |
| N  | 43,758            | 41,157           | 36,072            | 33,889          | 43,095               | 40,585          | 41,441            | 39,041           |

# Market Segmentation — Mechanism

Exploit bank heterogeneity:

1. Alternative mechanisms: capitalization v. investor composition.
2. Analyze impact of differences in organizational structure.

Study dynamics of market segmentation over the cycle:

1. Studying how banks treat marginally downgraded firms over the cycle.
2. Providing within-phases evidence.



# Mechanism: Specification (1)

Explore the mechanism: capitalization and investor composition.

$$\begin{aligned} y_{i,b,t} = & \beta_0 + \beta_1 \text{Performing}_{i,t} + \beta_2 (\text{Performing}_{i,t} \times \text{Crisis}_t) \\ & + \beta_3 (\text{Performing}_{i,t} \times \text{Recovery}_t) \\ & + \gamma_1 (\text{Performing}_{i,t} \times \text{Tier1}_b) + \gamma_2 (\text{Performing}_{i,t} \times \text{Tier1}_b \times \text{Crisis}_t) \\ & + \gamma_3 (\text{Performing}_{i,t} \times \text{Tier1}_b * \text{Recovery}_t) \\ & + \delta_1 (\text{Performing}_{i,t} \times \text{Repo}_b) + \delta_2 (\text{Performing}_{i,t} \times \text{Repo}_b \times \text{Crisis}_t) \\ & + \delta_3 (\text{Performing}_{i,t} \times \text{Repo}_b \times \text{Recovery}_t) \\ & + f(s_{i,t} - \bar{s}) + \text{Performing}_{i,t} \times g(s_{i,t} - \bar{s}) + X_{i,b,t} \Psi + \pi_t + u_{i,t}. \quad (2) \end{aligned}$$

# Bank Heterogeneity

| Dependent Variable  | Quantity         |                 |                 | Price           |                 |        |
|---|------------------|-----------------|-----------------|-----------------|-----------------|--------|
|   | (1)              | (2)             | (3)             | (1)             | (2)             | (3)    |
| <i>Boom</i> × <i>Performing</i> × <i>Tier1</i>            | .21<br>(.31)     | -.07<br>(.23)   |                 | .04<br>(.16)    | .23<br>(.11)    |        |
| <i>Crisis</i> × <i>Performing</i> × <i>Tier1</i>          | -.90**<br>(.03)  | -.75**<br>(.36) |                 | .01<br>(.27)    | .17<br>(.25)    |        |
| <i>Recovery</i> × <i>Performing</i> × <i>Tier1</i>        | .01<br>(.53)     | -.14<br>(.45)   |                 | .24<br>(.40)    | .04<br>(.38)    |        |
| <i>Boom</i> × <i>Performing</i> × <i>Repo</i>             | -.01<br>(.15)    | -.02<br>(.11)   |                 | -.21**<br>(.08) | .11<br>(.11)    |        |
| <i>Crisis</i> × <i>Performing</i> × <i>Repo</i>           | .43*<br>(.26)    | .33*<br>(.2)    |                 | .49**<br>(.15)  | .10<br>(.14)    |        |
| <i>Recovery</i> × <i>Performing</i> × <i>Repo</i>         | .16<br>(.38)     | -.05<br>(.30)   |                 | -.33<br>(.27)   | -.11<br>(.27)   |        |
| <i>Boom</i> × <i>Performing</i> × <i>Organization</i>     |                  |                 | -.01<br>(.01)   |                 | -.02**<br>(.01) |        |
| <i>Crisis</i> × <i>Performing</i> × <i>Organization</i>   |                  |                 | -.04**<br>(.02) |                 | -.00<br>(.01)   |        |
| <i>Recovery</i> × <i>Performing</i> × <i>Organization</i> |                  |                 | .01<br>(.02)    |                 | .02<br>(.02)    |        |
| <i>Lagged Rating</i>                                      | -.00***<br>(.00) |                 |                 | .00***<br>(.00) |                 |        |
| <i>Polynomial</i>   | Yes              | Yes             | Yes             | No              | Yes             | Yes    |
| <i>Quarter</i> × <i>Year Fixed Effects</i>                | Yes              | Yes             | Yes             | Yes             | Yes             | No     |
| <i>Firm</i> × <i>Year Fixed Effects</i>                   | No               | No              | No              | Yes             | No              | Yes    |
| R-squared   | 0.02             | 0.55            | 0.61            | 0.36            | 0.77            | 0.76   |
| N   | 787,634          | 787,634         | 814,864         | 89,140          | 89,140          | 99,471 |

## Mechanism: Specification (2)

Study dynamics of market segmentation over the cycle: downgrades.

$$y_{i,b,t} = \beta_0 + \beta_1 \text{Down}_{i,t} + \beta_2 (\text{Down}_{i,t} \times \text{Crisis}_t) + \beta_3 (\text{Down}_{i,t} \times \text{Recovery}_t) \\ + f(s_{i,t} - s_{i,t-1}) + \text{Down}_{i,t} \times g(s_{i,t} - s_{i,t-1}) + \pi_t + u_{i,t}. \quad (3)$$

- ▶  $\text{Down}_{i,t} = 1$  if downgrade from category 6 to 7, and is 0 otherwise.
- ▶  $f(\cdot)$  and  $g(\cdot)$ , change in the continuous variable between  $t - 1$  and  $t$ .

Idea: close to 0, we consider only “marginal” downgrades.

# Downgraded Firms

| Dependent Variable                         | <i>Quantity</i>  |                 | <i>Price</i>    |                 | <i>Production</i> |                 |
|--|------------------|-----------------|-----------------|-----------------|-------------------|-----------------|
|  | (1)              | (2)             | (1)             | (2)             | (1)               | (2)             |
| <i>Boom</i> × <i>Down</i>                  | .10***<br>(.03)  | .25**<br>(.11)  | .03***<br>(.00) | .01<br>(.02)    | .08***<br>(.03)   | .21*<br>(.11)   |
| <i>Crisis</i> × <i>Down</i>                | -.08*<br>(.05)   | -.09**<br>(.05) | -.02**<br>(.01) | -.01**<br>(.01) | -.08*<br>(.05)    | -.11**<br>(.05) |
| <i>Recovery</i> × <i>Down</i>              | -.15***<br>(.05) | -.13**<br>(.05) | .02*<br>(.01)   | .02*<br>(.01)   | -.01<br>(.05)     | .01<br>(.05)    |
| <i>Polynomial</i>                          | No               | Yes             | No              | Yes             | No                | Yes             |
| <i>Quarter</i> × <i>Year Fixed Effects</i> | Yes              | Yes             | Yes             | Yes             | Yes               | Yes             |
| R-squared                                  | 0.01             | 0.02            | 0.39            | 0.39            | 0.02              | 0.04            |
| N  | 88,830           | 88,830          | 70,848          | 70,848          | 22,978            | 22,978          |

## Mechanism: Specification (3)

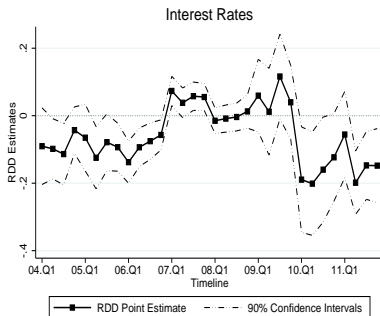
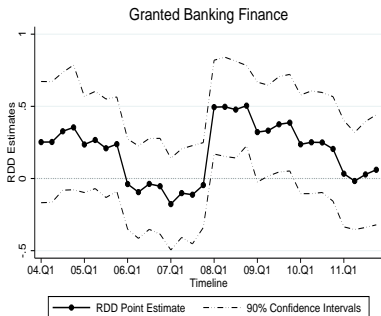
Study dynamics of market segmentation over the cycle: within cycle.

$$y_i = \alpha + \beta \text{Performing}_i + f(s_i - \bar{s}) + \text{Performing}_i \cdot g(s_i - \bar{s}) + u_i \quad (4)$$

Specification:

- ▶ Estimation on each quarter's cross-section of firms.
- ▶ Outcomes considered: financial and real allocations.

# Credit Allocations over Time



Results:

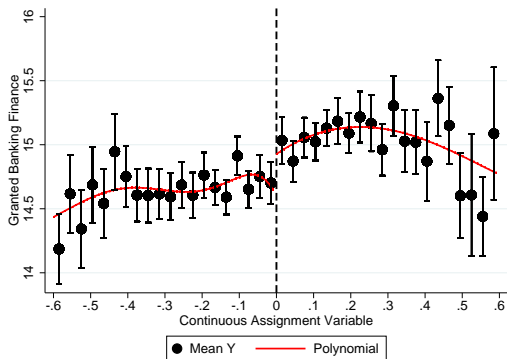
▶ Table

▶ Robustness

▶ Simple averages comparison

▶ Local linear regression

# Construction of Time Series: Quantity in Q2.2009



- Plot: conditional regression function (bin of 0.03) and polynomial fit.

# Robustness Checks

Internal validity of the RD design:

1. Manipulation of the rating: ▶ Manipulation
2. Balancing of firm and bank characteristics: ▶ Balancing
3. Relevance of the threshold: ▶ Relevance of the threshold



# Conclusions

Thank you very much for your attention!

# Appendix

# Firm Financing Environment (1)

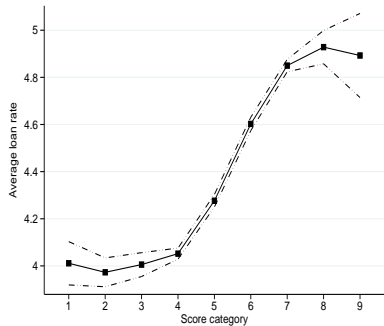
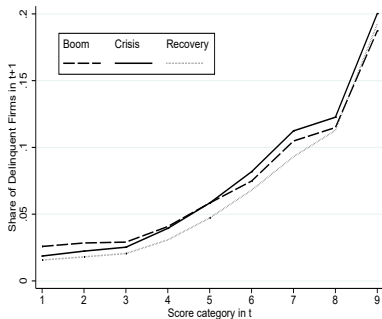
|                            | All               | Performing        | Substandard       |
|----------------------------|-------------------|-------------------|-------------------|
| Term Loans: Interest Rate  | 4.57<br>(1.62)    | 4.32<br>(1.56)    | 5.3<br>(1.6)      |
| Maturity                   | .66<br>(.47)      | .66<br>(.47)      | .65<br>(.48)      |
| N                          | 253,502           | 188,026           | 65,475            |
| All Bank Financing Granted | 8,503<br>(37,200) | 9,237<br>(40,600) | 6,167<br>(23,100) |
| N                          | 543,855           | 414,041           | 129,754           |

## Firm Financing Environment (2)

|                      | All          | Performing   | Substandard  |
|----------------------|--------------|--------------|--------------|
| Employment           | 92<br>(294)  | 95<br>(295)  | 76<br>(290)  |
| Investment to Assets | .05<br>(.06) | .05<br>(.06) | .04<br>(.06) |
| Return to Assets     | .05<br>(.10) | .07<br>(.08) | .00<br>(.13) |
| Leverage             | .67<br>(.19) | .61<br>(.18) | .86<br>(.10) |
| N                    | 143,953      | 108,353      | 35,600       |

- ▶ Heterogeneity suggests that simple comparison of credit allocations to firms in different classes merely reflects differences in firms' economic characteristics.

# Score Variable and Lending Decisions



# Institutional Setting

- ▶ Rating's categorical value provides accurate estimate for likelihood of firm default.
- ▶ Continuous variable not linked to default probability (Altman, 03). Moreover, difficult to interpret — industry specific value.
- ▶ Banks disclose corporate credit exposure to external investors by reporting only the categorical value. This introduces rating segmentation.

▶ Back

# Unicredit Annual Report

## A.2.2 Balance-sheet and off-balance sheet exposure by internal rating class (book values)

| EXPOSURES                                     | INTERNAL RATING CLASSES |                  |                  |                  |                  |                   |
|---|-------------------------|------------------|------------------|------------------|------------------|-------------------|
|   | 1                       | 2                | 3                | 4                | 5                | 6                 |
| <b>A. On-balance-sheet exposures</b>          | 126,021,087             | 4,633,994        | 2,817,825        | 658,281          | 221,906          | 15,531,788        |
| <b>B. Derivative contracts</b>                | 2,823,785               | 286,258          | 42,845           | 1,876            | -                | 3,388             |
| B.1 Financial derivative contracts            | 2,823,737               | 286,258          | 42,845           | 1,876            | -                | 3,388             |
| B.2 Credit derivatives                        | 48                      | -                | -                | -                | -                | -                 |
| <b>C. Guarantees given</b>                    | 38,789,792              | 1,404,816        | 102,484          | 554,109          | 802,610          | 2,633,261         |
| <b>D. Other commitments to disburse funds</b> | 3,226,127               | 28,345           | 115,695          | 26,102           | 18,195           | 425,750           |
| <b>Total</b>                                  | <b>170,860,791</b>      | <b>6,353,413</b> | <b>3,078,849</b> | <b>1,240,368</b> | <b>1,042,711</b> | <b>18,594,187</b> |

A.2.2 Balance-sheet and off-balance sheet exposure by internal rating class (book values) continued

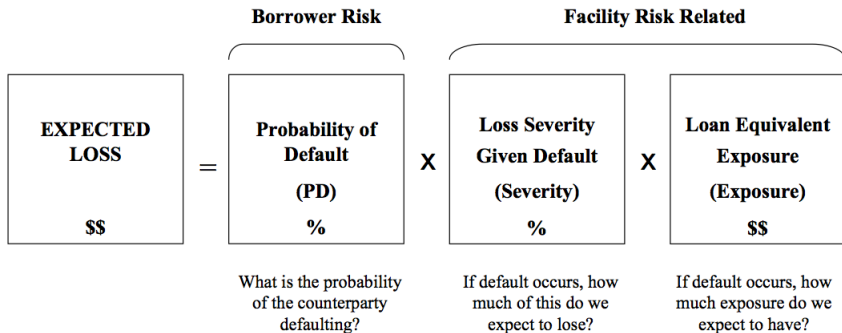
| EXPOSURES                                     | INTERNAL RATING CLASSES |                |                |               | IMPAIRED ASSETS  | NO RATING         | TOTAL              |
|---|-------------------------|----------------|----------------|---------------|------------------|-------------------|--------------------|
|   | 7                       | 8              | 9              | 10            |                  |                   |                    |
| <b>A. On-balance-sheet exposures</b>          | 129,694                 | 29,120         | 270,597        | 15,006        | 1,338,373        | 44,204,140        | 195,871,811        |
| <b>B. Derivative contracts</b>                | -                       | -              | -              | -             | -                | 1,458,205         | 4,616,357          |
| B.1 Financial derivative contracts            | -                       | -              | -              | -             | -                | 1,246,407         | 4,404,511          |
| B.2 Credit derivatives                        | -                       | -              | -              | -             | -                | 211,798           | 211,846            |
| <b>C. Guarantees given</b>                    | 916,725                 | 127,966        | 429,707        | 7,907         | 133,191          | 4,960,386         | 50,862,954         |
| <b>D. Other commitments to disburse funds</b> | 110,749                 | 8,707          | -              | -             | -                | 4,185,278         | 8,144,948          |
| <b>Total</b>                                  | <b>1,157,168</b>        | <b>165,793</b> | <b>700,304</b> | <b>22,913</b> | <b>1,471,564</b> | <b>54,808,009</b> | <b>259,496,070</b> |

# Score and S&P's

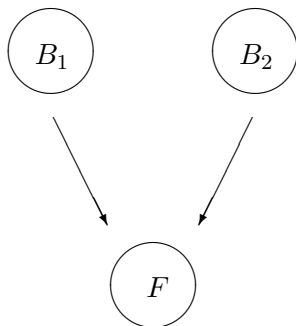
|                    | <b>CREDIT GRADES</b> | <b>RISK LEVEL</b>    | <b>PD (bp)</b>    | <b>S&amp;P</b> |
|--------------------|----------------------|----------------------|-------------------|----------------|
| <b>Performing</b>  | 1                    | Minimal              | 0-1               | AAA            |
|                    | 2                    | Modest               | 2-4               | AA             |
|                    | 3                    | Average              | 5-10              | A              |
|                    | 4                    | Acceptable           | 11-50             | BBB            |
|                    | 5                    | Acceptable with care | 51-200            | BB             |
|                    | 6                    | Management Attention | 201-1000          | B              |
| <b>Substandard</b> | 7                    | Special Mention      | 1000+             | CCC            |
|                    | 8                    | Substandard          | Interest Suspense | CCC / CC       |
|                    | 9                    | Doubtful             | Provision         | CC / C         |
|                    | 10                   | Loss                 | Default / Loss    | D              |



# Expected Loss Components

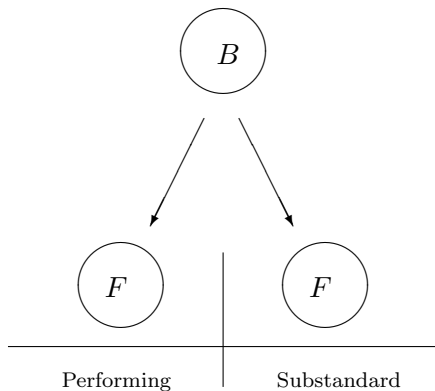


# Empirical Strategy: Jiménez et al.



$B_1$  and  $B_2$ : banks with different capital or liquidity position.

# Empirical Strategy: Our Paper



$B$ : banks. Firms observationally identical, only differ for the risk class they belong to.

# Appendix — Results

# Quarterly Estimates Table

| Period    | 04.Q1         | 04.Q2           | 04.Q3           | 04.Q4         | 05.Q1         | 05.Q2            | 05.Q3          | 05.Q4           | 06.Q1            | 06.Q2            | 06.Q3            | 06.Q4           | 07.Q1          | 07.Q2         | 07.Q3          | 07.Q4          |
|-----------|---------------|-----------------|-----------------|---------------|---------------|------------------|----------------|-----------------|------------------|------------------|------------------|-----------------|----------------|---------------|----------------|----------------|
| Quantity  | .25<br>(.24)  | .25<br>(.25)    | .33<br>(.25)    | .35<br>(.26)  | .24<br>(.20)  | .27<br>(.21)     | .21<br>(.19)   | .24<br>(.19)    | -.04<br>(.20)    | -.09<br>(.18)    | -.04<br>(.21)    | -.05<br>(.20)   | -.18<br>(.20)  | -.10<br>(.18) | -.11<br>(.19)  | -.04<br>(.19)  |
| R-squared | .02           | .02             | .02             | .02           | .02           | .02              | .02            | .02             | .02              | .02              | .03              | .03             | .02            | .02           | .02            | .02            |
| N         | 5614          | 5621            | 5621            | 5599          | 5601          | 5608             | 5604           | 5605            | 5822             | 5822             | 5815             | 5829            | 6224           | 6230          | 6237           | 6234           |
| Price     | -.09<br>(.07) | -.10**<br>(.05) | -.11**<br>(.06) | -.04<br>(.05) | -.07<br>(.06) | -.13***<br>(.05) | -.08*<br>(.05) | -.09**<br>(.04) | -.14***<br>(.04) | -.09***<br>(.04) | -.07***<br>(.03) | -.06**<br>(.03) | .07**<br>(.03) | .04<br>(.03)  | .06**<br>(.03) | .05**<br>(.02) |
| R-squared | .17           | .18             | .18             | .16           | .15           | .17              | .17            | .19             | .17              | .15              | .14              | .15             | .14            | .14           | .13            | .12            |
| N         | 1758          | 1922            | 2229            | 3522          | 3048          | 3177             | 3459           | 4002            | 3318             | 3922             | 4204             | 5123            | 4808           | 4680          | 4921           | 5853           |

| Period    | 08.Q1          | 08.Q2           | 08.Q3           | 08.Q4           | 09.Q1        | 09.Q2         | 09.Q3         | 09.Q4          | 10.Q1          | 10.Q2           | 10.Q3          | 10.Q4         | 11.Q1         | 11.Q2            | 11.Q3            | 11.Q4           |
|-----------|----------------|-----------------|-----------------|-----------------|--------------|---------------|---------------|----------------|----------------|-----------------|----------------|---------------|---------------|------------------|------------------|-----------------|
| Quantity  | .49**<br>(.19) | .50***<br>(.18) | .48***<br>(.18) | .51***<br>(.19) | .32<br>(.21) | .33*<br>(.20) | .37*<br>(.20) | .39**<br>(.20) | .23<br>(.21)   | .25<br>(.22)    | .25<br>(.22)   | .21<br>(.20)  | .03<br>(.25)  | -.02<br>(.22)    | .03<br>(.23)     | .06<br>(.23)    |
| R-squared | .02            | .02             | .02             | .02             | .02          | .03           | .03           | .03            | .02            | .02             | .02            | .02           | .01           | .01              | .01              | .01             |
| N         | 5328           | 5323            | 5330            | 5316            | 5108         | 5106          | 5102          | 5093           | 4105           | 4104            | 4102           | 4098          | 3955          | 3952             | 3942             | 3943            |
| Price     | -.02<br>(.02)  | -.01<br>(.02)   | -.00<br>(.02)   | .01<br>(.03)    | .06<br>(.06) | .01<br>(.07)  | .11<br>(.08)  | .04<br>(.07)   | -.19*<br>(.10) | -.20**<br>(.10) | -.16*<br>(.09) | -.12<br>(.08) | -.06<br>(.08) | -.20***<br>(.06) | -.15***<br>(.06) | -.15**<br>(.08) |
| R-squared | .13            | .10             | .13             | .12             | .09          | .07           | .08           | .09            | .08            | .11             | .10            | .13           | .14           | .15              | .13              | .10             |
| N         | 3845           | 3633            | 3431            | 3466            | 2918         | 2884          | 2783          | 3407           | 2542           | 2762            | 2911           | 3299          | 3019          | 2957             | 3120             | 2699            |

▶ Back

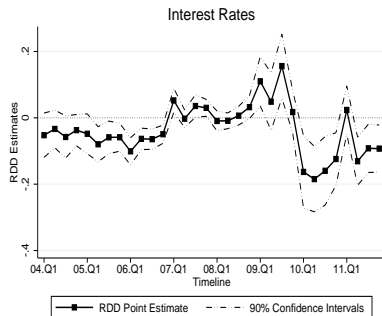
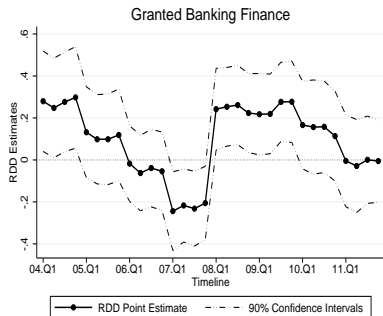
# Robustness Checks

Results robust to:

- ▶ Estimation through local linear regression and multiple bandwidth selection methods.
- ▶ Scaling total lending by assets, expressing interest rates in terms of basis point differences.
- ▶ Inclusion of firm and contract characteristics.
- ▶ Inclusion of lagged rating values (categorical and continuous).

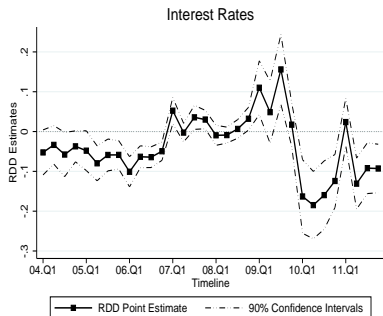
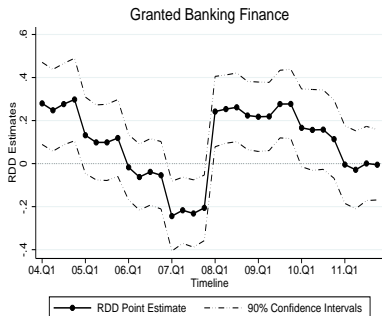
▶ Back

# LLR Robust



- ▶ Linear estimator with local-quadratic bias correction and triangular kernel. Bandwidth chosen following Imbens and Kalyanaraman (2012).

# LLR Conventional





# Appendix - Internal Validity

# Manipulation (1)

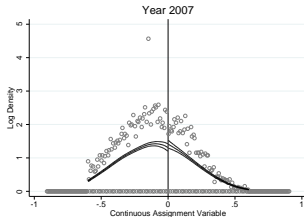
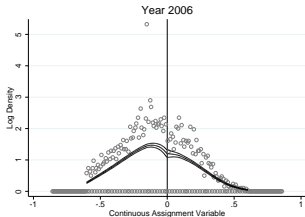
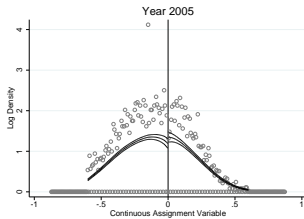
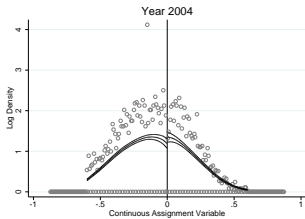
Can firms select into better categories?

1. A priori difficult: rating unsolicited, secret algorithm, constructed based on lagged balance sheets.
2. Testable: *systematic* discontinuity of firms' distribution at the threshold.

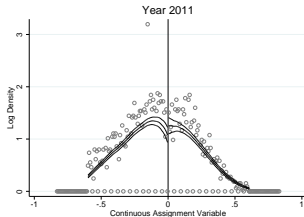
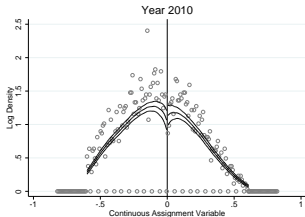
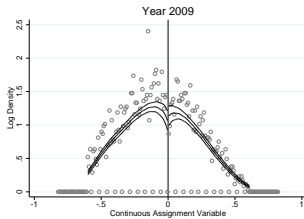
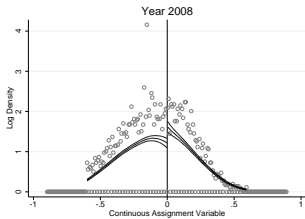
Kernel local linear regression of log density  $f(\cdot)$  on both sides of threshold. Estimate through:

$$\hat{\theta} = \ln \hat{f}^+ - \ln \hat{f}^-$$

# McCrary Self-Selection Test



# McCrary Self-Selection Test



## Manipulation (2)

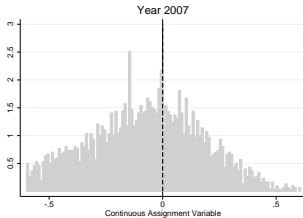
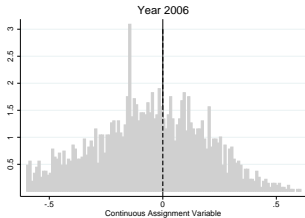
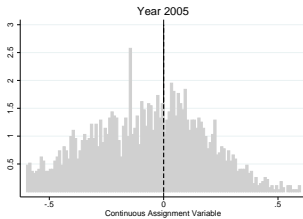
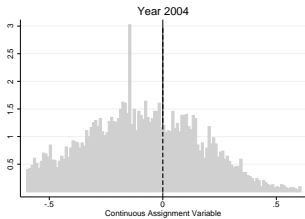
Exploit important feature of the rating: resampling.

- ▶ Rating computed on the basis of the yearly balance sheets.
- ▶ Share of new firms in the sample ranges between 46% and 51% of the same year's sample.

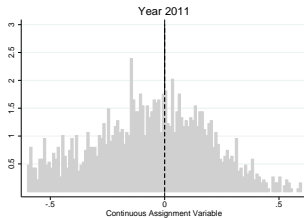
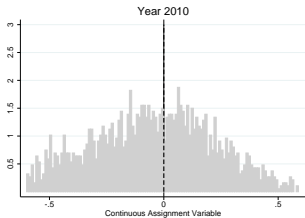
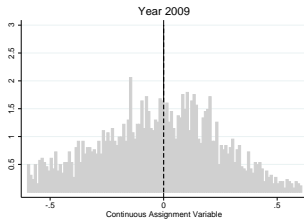
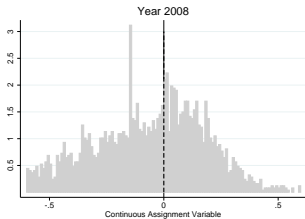
Why is this important?

- ▶ If manipulation: no firm enters the sample just below the threshold.
- Manipulation rejected by the data.

# Resampling



# Resampling



# Balancing Tests

Assumption: close to the threshold firms are as if randomly sampled.

- ▶ If not true: firm characteristics differ systematically across the threshold.
- ▶ Test: variables logically unaffected by threshold but plausibly related to outcome.
- ▶ Estimate:

$$\bar{X}_i = \alpha + \kappa S_i + f(s_i - \bar{s}) + S_i \cdot g(s_i - \bar{s}) + u_i \quad (5)$$

$$H_0: \hat{\kappa} \neq 0$$



# Balancing Characteristics Test

| Period   | 2004          | 2005          | 2006          | 2007           | 2008          | 2009          | 2010          | 2011          |
|--|---------------|---------------|---------------|----------------|---------------|---------------|---------------|---------------|
| <i>Panel A: Pre-Sample Characteristics</i>     |               |               |               |                |               |               |               |               |
| Leverage                                       | 0<br>(.03)    | .01<br>(.04)  | -.04<br>(.03) | -.03<br>(.03)  | .05<br>(.04)  | -.01<br>(.04) | -.04<br>(.05) | .01<br>(.06)  |
| N  | 3967          | 3636          | 3595          | 3678           | 2888          | 2705          | 2168          | 2024          |
| Return to Assets                               | 0<br>(.01)    | 0<br>(.01)    | 0<br>(.01)    | -.01<br>(.01)  | -.02<br>(.01) | 0<br>(.01)    | 0<br>(.02)    | 0<br>(.02)    |
| N  | 5306          | 4844          | 4750          | 4836           | 3776          | 3504          | 2721          | 2508          |
| Investment to Assets                           | .02<br>(.01)  | .02<br>(.02)  | .01<br>(.01)  | .02<br>(.02)   | .02<br>(.02)  | -.02<br>(.02) | -.03<br>(.03) | -.02<br>(.02) |
| N  | 4501          | 4136          | 4083          | 4174           | 3353          | 3100          | 2414          | 2237          |
| <i>Panel B: Bank Balancing Characteristics</i> |               |               |               |                |               |               |               |               |
| Non Performing                                 |               | .01<br>(.01)  | 0<br>(.01)    | .01<br>(.01)   | 0<br>(.01)    | -.01<br>(.01) | 0<br>(.01)    | -.03<br>(.03) |
| N  |               | 5736          | 5944          | 6358           | 5411          | 5276          | 4235          | 4045          |
| Asked  | .02<br>(.04)  | 0<br>(.05)    | -.02<br>(.04) | -.07<br>(.05)  | -.03<br>(.04) | .04<br>(.04)  | .03<br>(.05)  | -.07<br>(.05) |
| N  | 5687          | 5677          | 5889          | 6306           | 5370          | 5264          | 4217          | 4030          |
| Bank Size                                      | -.12<br>(.14) | -.05<br>(.14) | -.02<br>(.11) | .23**<br>(.12) | .1<br>(.14)   | .09<br>(.17)  | .04<br>(.19)  | .23<br>(.18)  |
| N  | 5652          | 5641          | 5855          | 6287           | 5356          | 5108          | 4105          | 3937          |
| <i>Panel C: Time Invariant Characteristics</i> |               |               |               |                |               |               |               |               |
| Activity: Food Industry                        | .03<br>(.04)  | -.04<br>(.05) | .03<br>(.04)  | -.01<br>(.04)  | .05<br>(.04)  | .04<br>(.04)  | .06<br>(.06)  | -.06<br>(.06) |
| N  | 5951          | 5876          | 6098          | 6514           | 5551          | 5360          | 4307          | 4110          |
| Location: Top 5 Cities                         | .06<br>(.06)  | .03<br>(.06)  | .05<br>(.06)  | -.06<br>(.06)  | .02<br>(.06)  | -.01<br>(.06) | .07<br>(.08)  | .05<br>(.07)  |
| N  | 5951          | 5876          | 6098          | 6514           | 5551          | 5360          | 4307          | 4110          |

# Balancing Tests

- ▶ Pre-sample characteristics: firm financing, investment, and profitability measures taken in 2003. Firms at the threshold comparable in pre-sample period.
- ▶ Bank characteristics: no difference in banks' probability of reporting nonperforming loans. Moreover, firms do not display a different propensity to apply for loans to new banks. Last row: tests for assortative matching between banks and firms.
- ▶ Time-invariant characteristics: no statistically or economically significant evidence of firms clustering into sectors such as food industries. No differences in firms' geographic locations.

# Relevance of the Threshold

RDD estimates caused by *casual* variation in contracts?

1. RDD captures variation close to the threshold: ✓
2. RDD inconsistent with placebo thresholds: ✓
3. RDD reproduced on other rating thresholds.

This test confirms that it is distinction between substandard and performing that matters for bank risk management.

# Placebo Threshold Estimates

We draw 100 randomly distributed “fake” thresholds along support of the raging categories, and re-run the baseline specification.

| Period                                   | 04.Q1 | 04.Q2  | 04.Q3  | 04.Q4 | 05.Q1 | 05.Q2   | 05.Q3 | 05.Q4  | 06.Q1   | 06.Q2   | 06.Q3   | 06.Q4  | 07.Q1 | 07.Q2 | 07.Q3 | 07.Q4 |
|--|-------|--------|--------|-------|-------|---------|-------|--------|---------|---------|---------|--------|-------|-------|-------|-------|
| True Threshold: Quantity Estimates       | .25   | .25    | .33    | .35   | .24   | .27     | .21   | .24    | -.04    | -.09    | -.04    | -.05   | -.18  | -.10  | -.11  | -.04  |
| Mean of Placebo Estimates                | .08   | .11    | .10    | .11   | -.09  | -.09    | -.09  | -.03   | .011    | .03     | .01     | .03    | -.09  | -.09  | -.09  | -.08  |
| Median of Placebo Estimates              | .07   | .09    | .09    | .06   | -.06  | -.02    | -.06  | -.03   | .00     | .03     | .04     | .08    | -.03  | -.02  | -.01  | .00   |
| Fraction Significant Placebo Estimates   | .10   | .10    | .12    | .11   | .12   | .15     | .14   | .11    | .04     | .08     | .06     | .08    | .04   | .06   | .07   | .07   |
| Fraction Opposite Sign Placebo Estimates | .04   | .03    | .03    | .03   | .08   | .08     | .08   | .06    | .01     | .02     | .01     | .02    | .01   | .02   | .03   | .03   |
| Number of Placebos                       | 97    | 97     | 97     | 97    | 97    | 97      | 97    | 97     | 97      | 97      | 97      | 97     | 97    | 97    | 97    | 97    |
| True Threshold: Price Estimates          | -.09  | -.10** | -.11** | -.04  | -.07  | -.13*** | -.08* | -.09** | -.14*** | -.09*** | -.07*** | -.06** | .07** | .04   | .06** | .05** |
| Mean of Placebo Estimates                | -.03  | .00    | -.01   | -.01  | -.01  | .02     | -.20  | .07    | -.01    | -.13    | 1.03    | -.01   | -.00  | .02   | -.00  | .02   |
| Median of Placebo Estimates              | -.00  | .02    | -.01   | -.00  | .00   | .01     | .00   | .01    | .00     | .00     | .00     | .00    | -.00  | .01   | .00   | .00   |
| Fraction Significant Placebo Estimates   | .13   | .14    | .11    | .16   | .25   | .15     | .20   | .15    | .24     | .21     | .26     | .22    | .23   | .23   | .15   | .20   |
| Fraction Opposite Sign Placebo Estimates | .05   | .00    | .00    | .08   | .15   | .00     | .11   | .00    | .00     | .00     | .00     | .12    | .10   | .07   | .10   | .10   |
| Number of Placebos                       | 133   | 133    | 133    | 133   | 133   | 133     | 133   | 133    | 133     | 133     | 133     | 133    | 133   | 133   | 133   | 133   |

| Period                                   | 08.Q1 | 08.Q2  | 08.Q3  | 08.Q4  | 09.Q1 | 09.Q2 | 09.Q3 | 09.Q4 | 10.Q1 | 10.Q2  | 10.Q3 | 10.Q4 | 11.Q1 | 11.Q2   | 11.Q3   | 11.Q4  |
|--|-------|--------|--------|--------|-------|-------|-------|-------|-------|--------|-------|-------|-------|---------|---------|--------|
| True Threshold: Quantity Estimates       | .49** | .50*** | .48*** | .51*** | .32   | .33*  | .37*  | .39** | .23   | .25    | .25   | .21   | .03   | -.02    | .03     | .06    |
| Mean of Placebo Estimates                | .06   | .07    | .07    | .10    | -.00  | -.00  | .00   | .01   | .05   | .04    | .02   | .03   | -.04  | -.04    | -.07    | -.07   |
| Median of Placebo Estimates              | .04   | .03    | .03    | .03    | -.02  | -.02  | .00   | -.01  | .03   | .03    | .03   | .01   | -.04  | -.03    | -.02    | -.02   |
| Fraction Significant Placebo Estimates   | .11   | .12    | .10    | .08    | .06   | .07   | .06   | .10   | .09   | .08    | .06   | .08   | .12   | .08     | .06     | .09    |
| Fraction Opposite Sign Placebo Estimates | .02   | .02    | .01    | .00    | .04   | .05   | .04   | .05   | .04   | .03    | .02   | .03   | .05   | .04     | .03     | .04    |
| Number of Placebos                       | 97    | 97     | 97     | 97     | 97    | 97    | 97    | 97    | 97    | 97     | 97    | 97    | 97    | 97      | 97      | 97     |
| True Threshold: Price Estimates          | -.02  | -.01   | -.00   | .01    | .06   | .01   | .11   | .04   | -.19* | -.20** | -.16* | -.12  | -.06  | -.20*** | -.15*** | -.15** |
| Mean of Placebo Estimates                | .05   | .01    | -.02   | .07    | -.02  | -.01  | .00   | -.02  | -.02  | -.13   | -.05  | .01   | -.00  | .02     | -.05    | -.04   |
| Median of Placebo Estimates              | .00   | .00    | .00    | .00    | -.01  | -.01  | -.01  | -.01  | -.02  | -.02   | -.01  | .01   | -.00  | .01     | .00     | -.00   |
| Fraction Significant Placebo Estimates   | .20   | .17    | .20    | .21    | .21   | .20   | .23   | .16   | .23   | .26    | .23   | .20   | .24   | .17     | .11     | .21    |
| Fraction Opposite Sign Placebo Estimates | .09   | .04    | .11    | .09    | .14   | .10   | .11   | .09   | .00   | .00    | .00   | .11   | .11   | .00     | .00     | .00    |
| Number of Placebos                       | 133   | 133    | 133    | 133    | 133   | 133   | 133   | 133   | 133   | 133    | 133   | 133   | 133   | 133     | 133     | 133    |

Result: mean and median of the threshold estimates for bank credit and interest rates systematically close to zero.

# Other Thresholds (1)

| Period                                      | 2004          | 2005          | 2006          | 2007          | 2008          | 2009          | 2010          | 2011           |
|---|---------------|---------------|---------------|---------------|---------------|---------------|---------------|----------------|
| <i>Threshold Between Categories 1 and 2</i> |               |               |               |               |               |               |               |                |
| Quantity                                    | -.3<br>(.24)  | -.15<br>(.26) | .07<br>(.26)  | .17<br>(.31)  | -.28<br>(.27) | -.19<br>(.25) | -.3<br>(.23)  | -.32<br>(.21)  |
| N   | 2555          | 2693          | 2648          | 2684          | 2886          | 2975          | 2677          | 2773           |
| Price                                       | .04<br>(.11)  | .13<br>(.12)  | .08<br>(.11)  | .03<br>(.08)  | -.12<br>(.08) | -.23<br>(.2)  | -.04<br>(.18) | -.22<br>(.22)  |
| N   | 583           | 716           | 782           | 815           | 715           | 712           | 832           | 775            |
| <i>Threshold Between Categories 2 and 3</i> |               |               |               |               |               |               |               |                |
| Quantity                                    | -.12<br>(.39) | -.19<br>(.4)  | -.45<br>(.39) | -.3<br>(.35)  | -.25<br>(.41) | -.2<br>(.34)  | -.45<br>(.36) | -.51<br>(.35)  |
| N   | 2311          | 2508          | 2480          | 2383          | 2265          | 2243          | 2243          | 2375           |
| Price                                       | 0<br>(.13)    | .16<br>(.12)  | -.1<br>(.11)  | .01<br>(.08)  | -.02<br>(.14) | -.1<br>(.27)  | -.23<br>(.22) | .7***<br>(.22) |
| N   | 1099          | 1427          | 1595          | 1702          | 1475          | 1260          | 1406          | 1825           |
| <i>Threshold Between Categories 3 and 4</i> |               |               |               |               |               |               |               |                |
| Quantity                                    | -.24<br>(.31) | -.03<br>(.3)  | -.14<br>(.35) | .29<br>(.29)  | .11<br>(.33)  | -.29<br>(.32) | -.15<br>(.29) | .29<br>(.3)    |
| N   | 6087          | 6361          | 6371          | 6526          | 6040          | 5968          | 5840          | 6128           |
| Price                                       | -.03<br>(.08) | .03<br>(.09)  | .09<br>(.08)  | -.03<br>(.04) | -.08<br>(.06) | -.01<br>(.13) | -.12<br>(.15) | -.03<br>(.12)  |
| N   | 7197          | 9359          | 10255         | 10547         | 9033          | 8625          | 11153         | 13158          |

# Other Thresholds (2)

| Period                                      | 2004             | 2005          | 2006           | 2007            | 2008            | 2009           | 2010             | 2011           |
|---|------------------|---------------|----------------|-----------------|-----------------|----------------|------------------|----------------|
| <i>Threshold Between Categories 4 and 5</i> |                  |               |                |                 |                 |                |                  |                |
| Quantity                                    | -.33<br>(.24)    | .22<br>(.24)  | -.44*<br>(.24) | -.18<br>(.21)   | -.2<br>(.24)    | -.06<br>(.24)  | -.26<br>(.24)    | -.41*<br>(.23) |
| N   | 7019             | 7359          | 7437           | 7616            | 6960            | 6878           | 6711             | 7058           |
| Price                                       | 0<br>(.05)       | -.05<br>(.06) | .03<br>(.04)   | -.01<br>(.03)   | 0<br>(.03)      | -.02<br>(.1)   | -.23***<br>(.08) | .07<br>(.07)   |
| N   | 11072            | 14972         | 16561          | 17056           | 14662           | 13505          | 17687            | 19743          |
| <i>Threshold Between Categories 7 and 8</i> |                  |               |                |                 |                 |                |                  |                |
| Quantity                                    | -.25<br>(.48)    | -.28<br>(.51) | -.29<br>(.55)  | -.06<br>(.55)   | -.36<br>(.63)   | -.63<br>(.66)  | 1.44*<br>(.73)   | 1.01<br>(.88)  |
| N   | 4160             | 4136          | 4256           | 4602            | 3752            | 3472           | 2875             | 2688           |
| Price                                       | 0<br>(.19)       | -.2<br>(.17)  | .1<br>(.11)    | -.22**<br>(.09) | -.08<br>(.1)    | .35*<br>(.2)   | -.56<br>(.56)    | -.12<br>(.27)  |
| N   | 6058             | 8394          | 10412          | 13192           | 8280            | 6047           | 5883             | 5791           |
| <i>Threshold Between Categories 8 and 9</i> |                  |               |                |                 |                 |                |                  |                |
| Quantity                                    | -.9<br>(1.4)     | .18<br>(1.16) | .51<br>(1.12)  | -1.31<br>(1.36) | -1.26<br>(1.09) | -.42<br>(1.24) | -.97<br>(.95)    | -1.68<br>(1.2) |
| N   | 596              | 649           | 598            | 646             | 595             | 668            | 517              | 616            |
| Price                                       | -1.29<br>(54.98) | -.01<br>(.53) | .21<br>(.26)   | .09<br>(.27)    | -.02<br>(.13)   | .07<br>(.5)    | .4<br>(.47)      | -.31<br>(.4)   |
| N   | 380              | 494           | 655            | 761             | 518             | 701            | 471              | 489            |

# Simple Averages Comparison

What is the advantage of threshold identification?

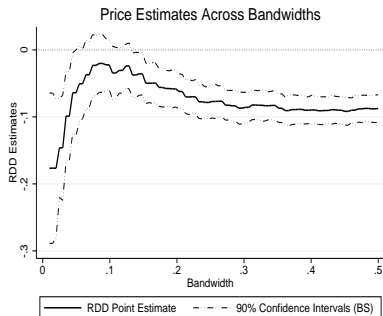
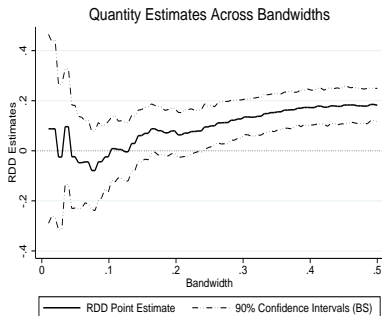
- ▶ Estimate simple means difference specification for increasingly larger bins around the threshold:

$$y_i = \delta + \gamma S_i + u_i \quad \text{for} \quad \bar{s} - h \leq s_i \leq \bar{s} + h$$

- ▶ Study how the value of  $\hat{\gamma}$  changes as we increase the bin size  $h$ .

Results: estimates are biased for larger values of  $h$  around the threshold. Direction of this bias varies with time.

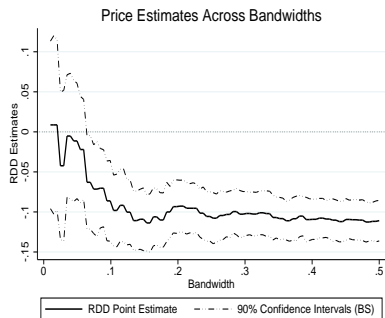
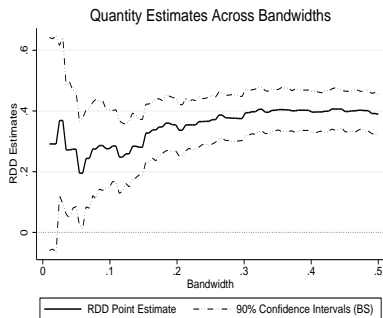
# Quantities and Interest Rates in Q2.2011



- ▶ Simple averages imply significant difference in the quantity of total bank financing and in the value of interest rates.
- ▶ Threshold estimates yield non-significant difference in amount of lending and significantly different rates.



# Quantities and Interest Rates in Q2.2009



- ▶ Simple averages comparison implies statistically significant interest rate spread of approximately 11%.
- ▶ We find no interest rate difference at the threshold.