Real Effects of Negative Interest Rates: Micro-Evidence in Japan

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Negative Interest Rate Policy (NIRP)

- Zero Policy Rates After the Financial Crisis of 2008
  - Unconventional Monetary Policies: QQE and FG

- Negative Policy Rates
  - Germany, Denmark, Japan, Sweden, Switzerland and Euro Area

  ✓ There is few research.
  ✓ There is no consensus on its overall effect.

- Causal Effects of the BOJ’s Introduction of the NIRP

  ➢ Two Different Theoretical Hypotheses
Main Messages

• Employing the **DID** to examine causal effects of the BOJ’s NIRP
  
  ➢ Loan-level data of Japanese banks and borrowing firms

• The NIRP **decreased** Japanese banks’ credit supply.
  
  ➢ The NIRP also had an **unpleasant** credit allocation effect.

• The NIRP had a **contractionary** real effect on firm investment.
  
  ➢ In the **long-lasting** low interest rate environment, the **reversal interest rate** may had emerged until the adoption of the NIRP.
1. Motivation
   - Theoretical/Empirical Hypotheses, The BOJ’s NIRP, and What we do

2. Identification
   - The DID Regression to Evaluate the Treatment Effects of the NIRP

3. Results
   - Credit Supply and Real Effects of the NIRP

4. Conclusion
   - Our Findings and Future Research
The Limited Pass-through View

- The Limited Pass-Through View of Eggertsson et al. (2019)

- Once deposit rates become bounded by zero in the NIRP, lending rates do not decrease, but rather increase; vice versa.

  - It matters how much banks depend on deposit financing.

- They empirically examined the NIRP in Sweden.

  - Deposit Rates ↓ Zero → Lending Rates ↑ → Economy ↓
  
  - Deposit Financing ↑ → Lending ↓
The Reversal Interest Rate View

• The Reversal Interest Rate View of Brunnermeier and Koby (2018)

➢ The *reversal interest rate* below which an accommodating policy rate cut results in contractionary effects

✓ Analyzing a *long-lasting* low/negative interest rate regime

➢ Two Effects of a Policy Rate Cut on Bank’s BS

✓ Positive Effect: Capital Gains on Long-term Bonds
✓ Negative Effect: Decreases in Future Cash Flows (e.g., due to *lower lending rates*)

➢ Neg > Pos → Policy Rate Cut → Reverses Intended Effects
Two Empirical Hypotheses for Introduction of NIRP

• The Reversal Interest Rate View
  ➢ If the policy rate already had reached the reversal interest rate in a “low-for-long” low interest rate regime before the NIRP,

  ✓ The introduction itself would damage the macroeconomy.

• The Limited Pass-through View
  ➢ If deposit rates had not been bounded by zero before the NIRP,

  ➢ As long as the reversal interest rate does not exist, or if any, the policy rate had not reached the reversal interest rate,

  ✓ The introduction itself would have favorable effects.
In both countries, before the NIRP, deposit spreads were positive, while after the NIRP, deposit spreads became negative.

Note that the interest rates in Japan are missing one digit!!

- In Japan, even before the NIRP, deposit rates were bounded close to zero in the long-lasting low interest rate regime.
• In Sweden, after the NIRP, lending rates do not decrease, unlike before the NIRP → The Limited Pass-through View

• In Japan, after the NIRP, lending rates continue to decrease, like before the NIRP → The Reversal Interest Rate View
Lending Rates after the BOJ’s NIRP
Two Facts for the NIRP in Japan

Fact 1. Deposit rates had been bounded by zero even before the NIRP.

Fact 2. Lending rates have continued to decrease since the introduction.

➢ The limited pass-through view ×

➢ The reversal interest rate view ○

✓ Emphasizes banks’ lower interest margins and lending rates

✓ Analyzes a long-lasting low interest rate regime, like in Japan
Introduction of the BOJ’s NIRP as a Policy Shock

• The BOJ announced the introduction of the NIRP on 29th Jan. 2016.

  The BOJ has implemented it since 16th Feb. 2016 without changing the negative policy rate.

• Until just before this announcement, BOJ Governor Kuroda had denied the introduction of the NIRP.

  The introduction was unexpected by the financial market/banks.

  ✔ Interpreted as a policy shock, or a quasi natural experiment

  ➢ We exploit this situation to identify causal effects of the NIRP.
Three-tier System of the BOJ’s NIRP

1. Basic Balance:
The *average* outstanding balance of each bank’s current account in **2015**, to which the positive interest rate of 0.1% is applied.

2. Macro Add-on Balance:
A certain proportion of the basic balance to accommodate change in demand for banks’ current account.

3. Policy-rate Balance:
The negative interest rate of **-0.1%** is charged on *excess reserves above the sum* of the basic and the macro add-on balance.

- When the NIRP was adopted, the macro balance was set to **zero**.
- The NPR was applied to excess reserves *above the basic balance*. 
What We Do

- The BOJ’s introduction of the NIRP can be interpreted as a policy shock, or a quasi natural experiment.

- We examine causal effects of the introduction of the NIRP using the DID estimation method with the treatment variable:

\[
\begin{align*}
\text{TREAT}_i = 1 & \quad \text{if } R_i = \frac{\text{Reserve}_{i, \text{March 2016}} - \text{Mean (Reserve}_{i, \text{2015}})}{\text{Mean (Reserve}_{i, \text{2015}})} > 0, \\
\text{TREAT}_i = 0 & \quad \text{otherwise.}
\end{align*}
\]

- Causal effects on banks’ lending behavior using loan-level data

- Real effects on borrowing firms’ funding and investment behavior
Time Line and Identification

Basic Account: 2015 Average of Current Account

Policy-Rate Account: Current Account minus Basic Account

Announce

Causal Effect: Before and After Mar 2016

Jan    Dec    Jan    Mar

2015    2016    2017
Identification: Causal Effects on Bank Lending

- Loan-level Dataset from $t = \text{March 2016}$ to $t = \text{March 2017}$
  - More than 12,000 observations in the annual dataset
  - 90 Japanese banks and 1,300 listed borrowing firms
  - Approximately 50% of all loans in the banking sector

- Three Types of Bank Loan Equations Specified at the Loan level
  - Can utilize more cross-sectional variation than bank-level spec
  - Can control for time-varying unobservable supply and demand factors using year*bank FEs and year*firm FEs
Identification: Causal Effects on Bank Lending (1)

- Model for Credit Supply

$$\Delta \text{LOAN}_{it}^j = \alpha + \beta \text{TREAT}_i \ast D2017_t + \gamma X_{it-1} + v_i + u_t^j + \varepsilon_{it}^j$$

- $\text{TREAT}_i$ is the treatment variable indicating whether bank $i$’s current account is exposed to the negative policy rate.

- $D2017_t$ is the year dummy of 2017 to capture the time effect of 2017 whose reference period is 2016.

- Controlling for demand factors using year*firm FEs: $u_t^j$
• Model for Credit Allocation

\[ \Delta \text{LOAN}_{it}^j = \alpha + \beta_1 \text{TREAT}_i * D2017_t + \beta_2 \text{TREAT}_i * \text{FIRM}_{t-1}^j \]

\[ + \beta_3 \text{TREAT}_i * \text{FIRM}_{t-1}^j * D2017_t + \gamma X_{it-1} + \nu_i + u_t^j + \varepsilon_{it}^j \]

Credit Allocation Effects
Demand Factor

➢ Using the low distance-to-default indicator as the indicator of firms with high default risk: \( \text{FIRM}_{it}^j = \text{FLDD4}_{it}^j \)

✓ \( \text{FLDD4}_{it}^j = 1 \) if firm \( j \)'s DD is in the lowest quartile of DD, and \( \text{FLDD4}_{it}^j = 0 \) otherwise.
Causal Effects on Bank Lending (3)

- Model for Interaction Effects of Bank and Firm Risks

\[
\Delta \text{LOAN}^j_{it} = \alpha + \beta_1 \text{BANK}^j_{it} \times \text{FIRM}^j_{t-1} + \beta_2 \text{BANK}^j_{it} \times \text{FIRM}^j_{t-1} \times D2017_t \\
+ \beta_3 \text{TREAT}^j_i \times \text{FIRM}^j_{t-1} + \beta_4 \text{TREAT}^j_i \times \text{FIRM}^j_{t-1} \times D2017_t \\
+ \beta_5 \text{TREAT}^j_i \times \text{BANK}^j_{it} \times \text{FIRM}^j_{t-1} \\
+ \beta_6 \text{TREAT}^j_i \times \text{BANK}^j_{it} \times \text{FIRM}^j_{t-1} \times D2017_t + \gamma X_{it-1} + \nu_{it} + \mu^j_t + \varepsilon^j_{it}
\]

- Using the market capital ratio to capture bank’s BS risk as \( \text{BANK}^j_{it} = \text{BMCAP}^j_{it} \) (Sarin and Summers (2016))

- Controlling for supply factors using year*bank FEs: \( \nu_{it} \)
# Causal Effects on Bank Lending

<table>
<thead>
<tr>
<th>Model</th>
<th>Supply</th>
<th>Allocation</th>
<th>Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>$TREAT_i \times D2017_t$</td>
<td>-4.462**</td>
<td>-13.24***</td>
<td></td>
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<tr>
<td></td>
<td>(1.681)</td>
<td>(5.215)</td>
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<tr>
<td>$TREAT_i \times FLDD4_{t-1}^j \times D2017_t$</td>
<td>6.266*</td>
<td>3.758</td>
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<tr>
<td></td>
<td>(3.471)</td>
<td>(6.873)</td>
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<tr>
<td>$TREAT_i \times BMCAP_{it-1} \times FLDD4_{t-1}^j \times D2017_t$</td>
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<td></td>
<td>-4.172**</td>
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<td>(2.094)</td>
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<th>8660</th>
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<tbody>
<tr>
<td>Bank fixed effects</td>
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<td>Yes</td>
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<tr>
<td>Bank*Year fixed effects</td>
<td>No</td>
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<td>Yes</td>
</tr>
<tr>
<td>Firm*Year fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*Notes:* Robust standard errors are in parentheses. *, **, and *** denote significance at levels of 0.10, 0.05, and 0.01, respectively. The dependent variable is $\Delta LOAN$, which indicates the growth rate of the total amount of loans outstanding.
Identification: Real Effects on Borrowing Firms

- Model for Effects on Firm’s Outcomes: Funding and Investment

\[ \Delta \text{FIRMOUT}_t^j = \alpha + \beta_1 \text{WTREAT}_t^j \* D2017_t \]  
Real Effects on Firm Outcome

\[ + \beta_2 \text{WTREAT}_t^j \* \text{FIRM}_{t-1}^j \* D2017_t + \gamma Z_{t-1}^j + u^j + \varepsilon_{it}^j, \]  
Real Effects Ascribed to Firm Default Risk

- Treatment variable, \( \text{WTREAT}_t^j \), captures how much lending bank’s current account is exposed to the negative policy rate:

\[ \text{WTREAT}_t^j = \sum_{i \in F_j, \text{March 2016}} R_i \times \frac{\text{LOAN}_{i, \text{March 2016}}^j}{\text{LOAN}_{\text{March 2016}}^j}, \]  
Firm’s Borrowing Exposure

\[ R_i = \frac{\text{Reserve}_{i, \text{March 2016}} - \text{Mean (Reserve}_{i, \text{2015})}}{\text{Mean (Reserve}_{i, \text{2015})}}. \]
### Causal Effects on Firm Funding and Leverage

All of the real effects on borrowing firms’ funding behavior are not significant!

<table>
<thead>
<tr>
<th>Firm Outcome Variable:</th>
<th>ΔCASH</th>
<th>ΔCASH</th>
<th>ΔCP</th>
<th>ΔCP</th>
<th>Δ SB</th>
<th>Δ SB</th>
<th>LEV</th>
<th>LEV</th>
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<tr>
<td>WTREATD&lt;sub&gt;j&lt;/sub&gt;×D2017&lt;sub&gt;t&lt;/sub&gt;</td>
<td>-2.306</td>
<td>-3.074</td>
<td>-0.036</td>
<td>-0.049</td>
<td>0.300</td>
<td>0.338</td>
<td>0.507</td>
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<td>(2.318)</td>
<td>(2.536)</td>
<td>(0.100)</td>
<td>(0.125)</td>
<td>(0.454)</td>
<td>(0.513)</td>
<td>(2.554)</td>
<td>(2.437)</td>
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<td>WTREATD&lt;sub&gt;j&lt;/sub&gt;×FLDD4&lt;sub&gt;4j−1&lt;/sub&gt; × D2017&lt;sub&gt;t&lt;/sub&gt;</td>
<td>3.952</td>
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<td>(3.842)</td>
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<td>(0.774)</td>
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*Notes:* Robust standard errors are in parentheses. *, **, and *** denote significance at levels of 0.10, 0.05, and 0.01, respectively.
### Real Effects on Firm Fixed Investment

<table>
<thead>
<tr>
<th>Firm Outcome Variable:</th>
<th>INVEST</th>
<th>INVEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>$WTREATD^j \times D2017_t$</td>
<td>-10.11**</td>
<td>-9.914**</td>
</tr>
<tr>
<td></td>
<td>(4.638)</td>
<td>(4.838)</td>
</tr>
<tr>
<td>$WTREATD^j \times FLDD4^j_{t-1} \times D2017_t$</td>
<td>-0.930</td>
<td>(8.250)</td>
</tr>
</tbody>
</table>

| Industry fixed effects | Yes | Yes |
| Firm fixed effects     | Yes | Yes |
| Firm control variables | Yes | Yes |
| N                      | 1529 | 1528 |

**Notes:** Robust standard errors are in parentheses. *, **, and *** denote significance at levels of 0.10, 0.05, and 0.01, respectively.
Conclusions

• The BOJ’s NIRP decreased Japanese banks’ credit supply.

• The NIRP also had an unpleasant credit allocation effect.
  ➢ More financially unsound banks allocated more to risky firms.

• The NIRP had a contractionary real effect on firm investment.
  ➢ It more decreased investment by firms whose lending banks were more affected by the negative policy rate.

• In the long-lasting low interest rate regime, the reversal interest rate had been at/above 0% until the introduction of the NIRP.
Additional Issues to be Addressed

• Causal effects of banks’ net interest margins and charter values (Altavilla et al. (2017), Ampudia and Heuvel (2018), Claessens et al. (2018))

• Causal effects of firm’s borrowing rates in debt financing (Eggertsson et al. (2019))

• Robustness Check

➢ Using changes in banks’ equity just before and after the announcement as IV for our treatment variables

➢ Comparison among six countries adopting the NIRP