Who Borrows from the Lender of Last Resort?¹

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¹The views expressed herein are those of the authors and do not necessarily represent the position of the European Central Bank or the Eurosystem.
Lender of Last Resort (LOLR)

Theory of the LOLR (Bagehot, 1873)

- Financial crises are characterized by lack of funding for banks
- Lack of funding is due to market failure (information asymmetry, bank runs)
- Inherently ‘good’ banks cannot finance assets and need to sell them at fire sale discounts. This depletes bank capital and leads to a credit crunch
- LOLR should prevents a credit crunch by lending to illiquid (but solvent) banks, which produces large welfare gains

LOLR plays important role in economic policy

- Central banks were set up to act as LOLR (e.g., Federal Reserve)
- Large LOLR interventions during recent financial crisis
  - European Central Bank’s (ECB) main policy for addressing the financial crisis
  - ECB currently has €1 trillion in loans outstanding
Introduction

This paper

Why do banks take up LOLR funding from the ECB during the financial crisis?

– Is borrowing driven by the need to avoid fire-sales as Bagehot had hoped?
– Or do other motivations explain bank borrowing?
Introduction

Literature

● Theory

● Empirics
  – Miron (1986), Bordo (1990)

● Contribution
  – First paper using LOLR micro-data to analyze motivation for banks’ borrowing
  – Important because welfare implications of LOLR intervention depend on banks’ motivation
Outline

1. Data and Institutional Background
2. LOLR Theories
3. Identification Strategy and Results
4. Aggregate Asset Reallocation
Novel LOLR micro-data

- ECB data (proprietary)
  1. ECB lending for each bank and week from August 2007 to December 2011
  2. Collateral pledged against borrowing (at ISIN-level)

- Bank and securities data (public)
  1. Securities characteristics (Bloomberg)
  2. Bank characteristics (Bankscope, SNL Europe)
  3. Euro bank stress test data

- Sample represents the universe of European banks
ECB is the LOLR in Europe

- ECB provides loans via repos (i.e., loans against collateral)
  - Accepts a wide range of collateral from many banks
  - Each type of collateral has a haircut (just as in private repos)
    - E.g., if haircut is 10%, then bank can borrow $45 against $50 market value bond
    - do not depend on which bank is borrowing
    - *Note:* These are full recourse loans

- Since late 2008, ECB allows unlimited borrowing against eligible collateral
  - Only constraint on bank borrowing is having collateral

- For risky assets, ECB haircuts are less than in private markets ("haircut subsidy")
  - but the interest rate is *higher* than in private repo markets
  - consistent with Bagehot’s advice to “lend freely at a penalty rate”
Private repo markets stopped accepting Greek bonds as collateral in March 2010
ECB continues lending against Greek collateral at less than 8% haircut

⇒ Provides large haircut subsidy on Greek bonds
In early 2008, most Greek sovereign debt used in private repo markets

By mid 2010, Greek sovereign debt migrates to ECB
Haircut Subsidies

- Not only for Greek Debt but other risky collateral
  - haircut subsidies also on other risky collateral, e.g., mortgage-backed securities, covered bonds, etc.

- **Haircut subsidies are largest for the riskiest collateral**
  - e.g., distressed-country sovereign bonds (Ireland, Italy, Portugal, Spain)
  - but not safe sovereign bonds (e.g., German bunds)

- Total ECB subsidy received by a bank:
  \[ \text{Total ECB subsidy} = \text{Total Borrowing} \times \text{Average Haircut subsidy} \]

*Are there differences in banks’ take-up of ECB subsidies?*

⇒ *Look at whether high-borrowing banks also use riskier collateral*
Sort banks into quintiles by borrowing as of July 2010

Proxy for collateral risk by credit rating
Collateral risk of high-borrowing banks increases starting early 2010

⇒ There is a *divergence* in the take-up of ECB subsidies across banks!
Sort banks into quintiles by borrowing as of July 2010

Proxy for collateral risk by share of distressed-country sovereign debt
⇒ Divergence in take-up of ECB subsidies across banks starting early 2010!
Why do banks take up subsidies from the ECB?

1. Banking panics
2. Risk-shifting
3. Political Economy
Banking panics

- Banks cannot roll over short-term financing of assets because of a market failure (e.g., bank runs)

⇒ Need financing for their *pre-existing* holdings of risky assets, otherwise fire sale

- LOLR financing allows them to finance assets while they slowly de-lever, avoiding fire sales

⇒ Use LOLR funding to finance existing (not new) holdings of risky assets

- Some banks suffer more illiquidity than others (to explain cross-sectional pattern)

- *Explains divergence if some banks suffered a series of worse financing shocks over time and in response pledged increasingly risky collateral*
Empirical Analysis

Risk-shifting

- Decline in bank asset values → increased likelihood of default → risk-shifting
  - Weakly-capitalized banks want to buy risky assets whose downside correlates with their own default

- Haircut subsidies allow banks to risk-shift onto LOLR
  - Lending is under-collateralized → LOLR takes some loss if bank defaults
  - Attractive to weakly-capitalized banks

→ Haircut subsidy is bank-specific: bigger for weakly-capitalized banks

- Cost of taking subsidy: LOLR interest rate > private-market interest rate

⇒ Net benefit is positive for weakly-capitalized banks
  - They borrow from LOLR to buy risky assets, pledging them as collateral

- Explains divergence if weakly-capitalized banks used LOLR loans to purchase risky assets by pledging them as collateral
Identification Strategy

1. Analyze if **weakly-capitalized** banks risk shift onto the LOLR
   - Do they borrow more and pledge riskier collateral over time

2. Identification Problem: During a crisis banks’ financial strength is endogenous
   - Measures of bank’s strength during the crisis may reflect concerns about the likelihood of runs

3. Solution: Use bank capital **before** the start of the crisis to proxy for banks’ strength/risk-shifting incentives **during** the crisis
   - Banks with less pre-crisis capital are more likely to have risk-shifting incentives during the crisis
   - Proxy for pre-crisis capital using bank credit rating as of August 2007

4. Main concern: Pre-crisis bank capital may correlate in the cross-section with future bank runs (e.g., country of domicile)
Empirical Analysis

Estimation

- Main OLS Regression:

\[ y_{it} = \alpha_i + \delta_t + \beta BankRating_{i,07} \times Post_t + \varepsilon_{it} \]

- Outcome Variable \( y_{it} \):
  1. Borrowing Indicator Variable
  2. Log(Borrowing)
  3. Average Collateral Rating (measure of collateral risk)
  4. Distressed-country Sovereign Debt/Asset\(_{i,07}\) (second measure of collateral risk)

- \( BankRating_{it} \) is median credit rating as of August 2007
  - Assign numerical values (AAA=1, AA+=2, etc.)

- \( \beta > 0 \): Weaker banks take up ECB subsidies

- \( Post_t \) is a vector of year-quarter indicator variables
  - look at cross-section evolution over time
⇒ One-standard-deviation decrease in 2007 bank rating raises likelihood of borrowing by 12 percentage points
⇒ One-standard-deviation decrease in 2007 bank rating raises natural logarithm of borrowing by 15%
⇒ One-standard-deviation worsening of bank rating 2007 reduces collateral rating by 22% of a one-standard deviation
⇒ One-standard-deviation decrease in bank rating 2007 increases pledging of distressed-country sovereign debt by 25% of a one-standard deviation
Empirical Analysis

Results: Summary [Table 2]

\[ y_{it} = \alpha_i + \delta_t + \beta BankRating_{i,07} \times Post_t + \varepsilon_{it} \]

<table>
<thead>
<tr>
<th></th>
<th>Borrowing Indicator(_{it})</th>
<th>Log(Borrowing)(_{it})</th>
<th>Collateral Rating(_{it})</th>
<th>Distressed-Sovereign Debt/Assets(_{i,07})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank Rating(_{i,07}) * Post-Greek Bailout(_t)</td>
<td>0.053***</td>
<td>0.068***</td>
<td>0.144***</td>
<td>0.180***</td>
</tr>
<tr>
<td></td>
<td>(0.011)</td>
<td>(0.017)</td>
<td>(0.039)</td>
<td>(0.063)</td>
</tr>
<tr>
<td>Bank Rating(_{i,07}) * Post-Lehman(_t)</td>
<td>0.011</td>
<td>0.023*</td>
<td>0.001</td>
<td>0.070</td>
</tr>
<tr>
<td></td>
<td>(0.011)</td>
<td>(0.013)</td>
<td>(0.023)</td>
<td>(0.044)</td>
</tr>
<tr>
<td>Time Fixed Effects</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Bank Fixed Effects</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Banks</td>
<td>292</td>
<td>292</td>
<td>287</td>
<td>276</td>
</tr>
<tr>
<td>Observations</td>
<td>51,684</td>
<td>51,684</td>
<td>45,997</td>
<td>48,852</td>
</tr>
<tr>
<td>R2</td>
<td>0.476</td>
<td>0.789</td>
<td>0.672</td>
<td>0.645</td>
</tr>
</tbody>
</table>

- \( Post - Lehman_t = \text{Oct 08-Jun 10}; \)  \( Post - GreekBailout_t = \text{Jul 10-Dec 11} \)
- Standard errors clustered at bank level
- A bank’s 2007 rating strongly predicts its collateral risk and borrowing following the first Greek debt crisis
Main Predictions

- Banking panic: an increase in a bank’s risky collateral does NOT reflect increased holdings
- Risk-shifting: increase in risky collateral DOES reflect increased holdings

Problem: Banks don’t reveal what they hold

- Solution: Bank stress tests forced them to reveal their sovereign debt holdings!

Estimate OLS regression:

\[
\Delta Holdings_{it} = \alpha + \delta_t + \beta \Delta Pledged_{it} + \varepsilon_{it}
\]

- \( \beta = 0 \): Banking panics (increase in collateral does NOT reflect increase in holdings)
- \( \beta = 1 \): Risk-shifting (increase in collateral DOES reflect increase in holdings)
Empirical Analysis

Test #1 Results [Table 3]

\[ \Delta Holdings_{it} = \alpha + \delta_t + \beta \Delta Pledged_{it} + \varepsilon_{it} \]

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>( \Delta t+1,i ) Distressed Sovereign Debt Pledged/Assets( i,07 )</th>
<th>Bank Rating( i,07 )</th>
<th>Bank Rating( i,07 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample</td>
<td>All</td>
<td>Bank Rating( i,07 ) &lt;AA-</td>
<td>Bank Rating( i,07 ) ( \geq AA- )</td>
</tr>
<tr>
<td></td>
<td>(2)</td>
<td>(4)</td>
<td>(6)</td>
</tr>
<tr>
<td>( \Delta t+1,i ) Distressed Sovereign Debt Pledged/Assets( i,07 )</td>
<td>0.444**</td>
<td>0.542**</td>
<td>0.047</td>
</tr>
<tr>
<td></td>
<td>(0.185)</td>
<td>(0.196)</td>
<td>(0.182)</td>
</tr>
<tr>
<td>Time Fixed Effects</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Obs</td>
<td>106</td>
<td>50</td>
<td>56</td>
</tr>
<tr>
<td>Banks</td>
<td>53</td>
<td>25</td>
<td>28</td>
</tr>
<tr>
<td>R2</td>
<td>0.198</td>
<td>0.274</td>
<td>0.025</td>
</tr>
</tbody>
</table>

- For each $1 increase in collateral, holdings increase by $0.44
- The relationship is strong for lower-rated banks, consistent with risk-shifting
  - Banking panics can explain at most 56% of ECB borrowing
Country-level factors are the most plausible drivers of differences in liquidity, e.g., bad news about distressed countries can lead to country-wide deposit flight.

Regression:

\[ y_{it} = \alpha + \gamma_{ct} + \beta BankRating_{i,07} \times Post_t + \varepsilon_{it} \]

- \( \gamma_{ct} \) = full set of country-time dummies
- \( \beta > 0 \): Bank Rating predicts ECB borrowing and collateral risk within countries
Empirical Analysis

Test #2 Results [Table 4]

$$y_{it} = \alpha + \gamma_{ct} + \beta \text{BankRating}_{i,07} \times \text{Post}_t + \varepsilon_{it}$$

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Borrowing Indicator (_{it})</th>
<th>Log(Borrowing) (_{it})</th>
<th>Collateral Rating (_{it})</th>
<th>Distressed Sovereign Debt (<em>{it}/\text{Assets}</em>{i,07})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank Rating(_{i,07}) * Post-Greek Bailout(_t)</td>
<td>0.047***</td>
<td>0.035**</td>
<td>0.062**</td>
<td>0.054*</td>
</tr>
<tr>
<td>(0.012)</td>
<td>(0.016)</td>
<td>(0.030)</td>
<td>(0.030)</td>
<td></td>
</tr>
<tr>
<td>Bank Rating(_{i,07}) * Post-Lehman(_t)</td>
<td>0.013</td>
<td>0.009</td>
<td>-0.005</td>
<td>-0.015</td>
</tr>
<tr>
<td>(0.011)</td>
<td>(0.014)</td>
<td>(0.024)</td>
<td>(0.035)</td>
<td></td>
</tr>
<tr>
<td>Country-Time Fixed Effects</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Bank Fixed Effects</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Banks</td>
<td>292</td>
<td>292</td>
<td>287</td>
<td>276</td>
</tr>
<tr>
<td>Observations</td>
<td>51,684</td>
<td>51,684</td>
<td>45,997</td>
<td>48,852</td>
</tr>
<tr>
<td>R2</td>
<td>0.518</td>
<td>0.818</td>
<td>0.766</td>
<td>0.733</td>
</tr>
</tbody>
</table>

- \(\beta\) statistically significant, but 22-58% smaller after controlling for country-time FE
- Banking panics explains at most 58%; consistent with Test #1 results
Banking Panics: Test #3

1. Look only at non-distressed country banks (German, French, Dutch banks . . .)
   - e.g., not subject to deposit flight

2. Regression:

   \[ y_{it} = \alpha_i + \delta_t + \beta \text{BankRating}_{i,t-07} \times \text{Post}_t + \varepsilon_{it} \]

   - Run the test using only non-distressed country banks
   - \( \beta > 0 \): Bank rating predicts ECB borrowing and collateral risk outside the distressed countries
Empirical Analysis

Test #3 Results [Table 5]

\[ y_{it} = \alpha_i + \delta_t + \beta \text{BankRating}_{i,07} \times \text{Post}_t + \varepsilon_{it} \]

<table>
<thead>
<tr>
<th>Sample</th>
<th>Bank Rating(_{i,07}\times) Post-Greek Bailout(_t)</th>
<th>Bank Rating(_{i,07}\times) Post-Lehman(_t)</th>
<th>Time Fixed Effects</th>
<th>Bank Fixed Effects</th>
<th>Banks</th>
<th>Observations</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.043*** (0.012)</td>
<td>0.012 (0.013)</td>
<td>Y</td>
<td>Y</td>
<td>234</td>
<td>41,418</td>
<td>0.486</td>
</tr>
<tr>
<td></td>
<td>(2)</td>
<td>(3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-distressed Sovereigns</td>
<td>Log(Borrowing)(_{it})</td>
<td>Collateral Rating(_{it})</td>
<td>Distressed Sovereign Debt(<em>{it}/)Assets(</em>{i,07})</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Borrowing Indicator(_{it})</td>
<td>0.047*** (0.015)</td>
<td>0.011 (0.014)</td>
<td>0.049* (0.026)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- \( \beta \) statistically significant, but up to 60% smaller for non-distressed country banks
- Consistent with tests #1 and #2 results
Banks invest in risky assets because they are pressured by regulators
- ECB may want to act as a LOLR to sovereigns but is restricted
- Instead, lends to banks to support sovereigns
- Regulatory pressure amplifies banks’ risk-shifting incentives
- Both risk-shifting and political economy involve active risk-taking

Regression:

\[
\text{DistressedCountrySovereignShare}_{it} = \alpha_i + \delta_t + \beta \text{BankRating}_{i,07} \times \text{Post}_t + \epsilon_{it}
\]

- Run our test using only non-distressed country banks
- \( \beta > 0 \): Bank rating predicts distressed-country sovereign debt pledging by non-distressed country banks

\( \Rightarrow \) not due to regulatory pressure
Empirical Analysis

Testing Political Economy [Tables 5 and 7]

\[ DistressedCountrySovereignShare_{it} = \alpha_i + \delta_t + \beta BankRating_{i,07} Post_t + \varepsilon_{it} \]

<table>
<thead>
<tr>
<th>Bank Headquarters Sample</th>
<th>Non-distressed Sovereigns</th>
<th>Distressed Sovereign</th>
<th>Distressed Sovereign</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Debt_{it}/Assets_{i,07}</td>
<td>Debt_{it}/Assets_{i,07}</td>
</tr>
<tr>
<td>Dependent Variable</td>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Bank Rating_{i,07} Post-Greek Bailout_{t}</td>
<td>0.036*</td>
<td>0.300**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.019)</td>
<td>(0.137)</td>
<td></td>
</tr>
<tr>
<td>Bank Rating_{i,07} Post-Lehman_{t}</td>
<td>0.003</td>
<td>0.118</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.085)</td>
<td></td>
</tr>
<tr>
<td>Week Fixed Effects</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Bank Fixed Effects</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Banks</td>
<td>221</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>41,418</td>
<td>5,131</td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>0.486</td>
<td>0.779</td>
<td></td>
</tr>
</tbody>
</table>

- Bank rating remains predictive for non-distressed country banks
- Relationship is particularly strong for large (i.e, publicly-listed) banks
Banks invest in risky assets because of differences in private valuation
- Due to differences in their business models, expertise, or ‘optimism’
- All explanations emphasize *active* risk-taking

Does *not* predict the result that weaker banks pledge riskier collateral
- that is the main prediction of risk-shifting

*Unlikely* to apply to distressed-country sovereign debt

Regression:

\[ y_{it} = \alpha_i + \delta t + \beta BankRating_{i,07} \times Post_t + \gamma X_{it} \times Post_t + \varepsilon_{it} \]

- \( X_{it} \) controls for bank size, business type, and funding structure
- \( \beta > 0 \): Bank rating continues to predict ECB borrowing and collateral *after* controls
Testing Differences in Private Valuation [Table 6]

\[ y_{it} = \alpha_i + \delta_t + \beta BankRating_{i,07} \times Post_t + \gamma X_{it} \times Post_t + \varepsilon_{it} \]

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Borrowing Indicator (_{it})</th>
<th>Log(Borrowing)(_{it})</th>
<th>Collateral Rating(_{it})</th>
<th>Distressed Sovereign Debt(<em>{it}/\text{Assets}</em>{i,07})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank Rating(_{i,07}) * Post-Greek Bailout(_t)</td>
<td>0.039***</td>
<td>0.055***</td>
<td>0.171***</td>
<td>0.207**</td>
</tr>
<tr>
<td>(0.011)</td>
<td>(0.019)</td>
<td>(0.047)</td>
<td>(0.067)</td>
<td></td>
</tr>
<tr>
<td>Bank Rating(_{i,07}) * Post-Lehman(_t)</td>
<td>-0.013</td>
<td>0.042***</td>
<td>-0.004</td>
<td>0.098*</td>
</tr>
<tr>
<td>(0.010)</td>
<td>(0.015)</td>
<td>(0.027)</td>
<td>(0.048)</td>
<td></td>
</tr>
<tr>
<td>Time Fixed Effects</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Bank Fixed Effects</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Banks</td>
<td>292</td>
<td>292</td>
<td>272</td>
<td>276</td>
</tr>
<tr>
<td>Observations</td>
<td>48,852</td>
<td>48,852</td>
<td>43,720</td>
<td>48,852</td>
</tr>
<tr>
<td>R2</td>
<td>0.492</td>
<td>0.811</td>
<td>0.684</td>
<td>0.656</td>
</tr>
</tbody>
</table>

- \( \beta \) almost unchanged after controlling for: log(Assets), Deposit Share, Loan Share, and pre-crisis Distressed-Country Sovereign Debt

⇒ No evidence supporting differences in private valuations
Additional results and robustness

1. Results stronger for publicly listed banks
   - Table 7

2. Results robust to using alternative bank quality measure (CDS)
   - Table 8

3. Results similar to using alternative borrowing measures (borrowing/collateral, borrowing/assets)
   - Table 9

4. Results qualitatively similar to using changes in bank ratings over time
   - Table 10
Empirical Analysis

Summing up: Total periphery sovereign debt collateral almost constant

- Sovereign debt pledged with ECB is roughly constant
Empirical Analysis

... but large redistribution across banks

- 1/3 of Periphery sovereign debt moved from high-capital to low-capital banks
  ⇒ **Risky assets** transition to **risky banks**
...but large redistribution across banks

Similar result for all periphery-originated debt
Conclusion

First paper to empirically analyze why banks' take up LOLR funding

1. Weakly-capitalized banks actively invest in risky assets using LOLR funding
2. Rejects pure Bagehot view of the crisis; indicates risk-shifting and possibly political economy

What do we learn from the results?

– We show that LOLR funding leads to a transitioning of risky assets to risky banks!
– One would hope for the opposite! ⇒ LOLR funding could exacerbate the crisis
– Results must be considered in the context of European financial crisis:
  • Net benefit of LOLR intervention depends on this cost versus beneficial externalities

⇒ LOLR intervention should directly address risk-shifting incentives of risky banks (restructuring, recapitalization)
⇒ Suggests that regulation and LOLR should be in a single entity (banking union)