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 Europystem.

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

- **1** 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?

Literature

• Theory

 Thornton (1802), Bagehot (1873), Diamond and Dybvig (1983), Goodhart (1987), Goodfriend and King (1988), Goodhart (1995), Freixas, Giannini, Hoggarth, and Rochet (1999), Repullo (2000), Rochet and Vives (2004), Diamond and Rajan (2005), Freixas and Rochet (2008), Tucker (2009), Stein (2012)

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

Data and Institutional Background

2 LOLR Theories

- Identification Strategy and Results
- Aggregate Asset Reallocation

Novel LOLR micro-data

- ECB data (proprietary)
 - ECB lending for each bank and week from August 2007 to December 2011
 - Collateral pledged against borrowing (at ISIN-level)
- Bank and securities data (public)
 - Securities characteristics (Bloomberg)
 - 2 Bank characteristics (Bankscope, SNL Europe)
 - 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"

Example: Greek Sovereign Bonds (Figure 1)



Figure plots CDS on Greek Government Debt

Private repo markets stopped accepting Greek bonds as collateral in March 2010

Example 1: Greek Sovereign Bonds (Figure 1)



- ECB continues lending against Greek collateral at less than 8% haircut
- ⇒ Provides large haircut subsidy on Greek bonds

Example 1: Greek Sovereign Debt Migrates to ECB



- In early 2008, most Greek sovereign debt used in private repo markets
- By mid 2010, Greek sovereign debt migrates to ECB

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:
 - = Total Borrowing × Average Haircut subsidy

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

 \Rightarrow Look at whether high-borrowing banks also use riskier collateral

The Take-up of ECB Subsidies



- Sort banks into quintiles by borrowing as of July 2010
- Proxy for collateral risk by credit rating

The Take-up of ECB Subsidies



- Collateral risk of high-borrowing banks increases starting early 2010
- ⇒ There is a *divergence* in the take-up of ECB subsidies across banks!

The Take-up of ECB Subsidies: Measure #2



- Sort banks into quintiles by borrowing as of July 2010
- Proxy for collateral risk by share of distressed-country sovereign debt

The Take-up of ECB Subsidies: Measure #2



⇒ Divergence in take-up of ECB subsidies across banks starting early 2010!

Theories

Why do banks take up subsidies from the ECB?

Banking panics

2 Risk-shifting

Olitical 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

Risk-shifting

- Decline in bank asset values \rightarrow increased likelihood of default \rightarrow risk-shifting
 - Weakly-capitalized banks want to buy risky assets whose downside correlates with their own default
- Haircut subsidies allows banks to risk-shift onto LOLR
 - $\bullet~$ Lending is under-collateralized \rightarrow LOLR takes some loss if bank defaults
 - Attractive to weakly-capitalized banks
- \rightarrow Haircut subsidy is bank-specific: bigger for weakly-capitalized banks
 - Cost of taking subsidy: LOLR interest rate > private-market interest rate
- \Rightarrow 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

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

Estimation

- Main OLS Regression:

 $y_{it} = \alpha_i + \delta_t + \beta BankRating_{i,07} * Post_t + \varepsilon_{it}$

- Outcome Variable yit:

- Borrowing Indicator Variable
- 2 Log(Borrowing)
- 3 Average Collateral Rating (measure of collateral risk)
- O 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

Bank Credit Rating and Borrowing



⇒ One-standard-deviation decrease in 2007 bank rating raises likelihood of borrowing by 12 percentage points

Bank Credit Rating and Log(Borrowing)



⇒ One-standard-deviation decrease in 2007 bank rating raises natural logarithm of borrowing by 15%

Results: Bank Rating and Collateral Rating Over Time



 \Rightarrow One-standard-deviation worsening of bank rating 2007 reduces collateral rating by 22% of a one-standard deviation

Results: Bank Rating and Periphery Sovereign Debt Over Time



⇒ One-standard-deviation decrease in bank rating 2007 increases pledging of distressed-country sovereign debt by 25% of a one-standard deviation

Results: Summary [Table 2]

	Borrowing Indicator _{it}	Log(Borrowing) _{it}	Collateral Rating _{it}	Distressed- Sovereign Debt _{it} /Assets _{i,07}
	(1)	(2)	(3)	(4)
Bank Rating _{i,07} * Post-Greek Bailout,	0.053***	0.068***	0.144***	0.180***
	(0.011)	(0.017)	(0.039)	(0.063)
Bank Rating 1,07* Post-Lehmant	0.011	0.023*	0.001	0.070
	(0.011)	(0.013)	(0.023)	(0.044)
Time Fixed Effects	Y	Y	Y	Y
Bank Fixed Effects	Y	Y	Y	Y
Banks	292	292	287	276
Observations	51,684	51,684	45,997	48,852
R2	0.476	0.789	0.672	0.645

 $y_{it} = \alpha_i + \delta_t + \beta BankRating_{i,07} * Post_t + \varepsilon_{it}$

- Post Lehman_t = Oct 08-Jun 10; Post GreekBailout_t = 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

Testing Banking Panics [Test #1]

- 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
- 2 Problem: Banks don't reveal what they hold
 - Solution: Bank stress tests forced them to reveal their sovereign debt holdings!
- Stimate OLS regression:

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

- $-\beta = 0$: Banking panics (increase in collateral does <u>NOT</u> reflect increase in holdings)
- $-\beta = 1$: Risk-shifting (increase in collateral <u>DOES</u> reflect increase in holdings)

Test #1 Results [Table 3]

Dependent Variable	$\Delta_{t+1,i}$ Distressed Sovereign Debt Holdings _t /Assets _{i,07}			
Sample	All	Bank Rating _{i,07} <aa-< th=""><th>Bank Rating_{i,07} >=AA-</th></aa-<>	Bank Rating _{i,07} >=AA-	
	(2)	(4)	(0)	
$\Delta_{t+1,i} \text{ Distressed Sovereign} \\ \text{Debt } Pledged_t/Assets_{i,07}$	0.444** (0.185)	0.542** (0.196)	0.047 (0.182)	
Time Fixed Effects	Y	Y	Y	
Obs	106	50	56	
Banks	53	25	28	
R2	0.198	0.274	0.025	

 $\Delta \textit{Holdings}_{it} = \alpha + \delta_t + \beta \Delta \textit{Pledged}_{it} + \varepsilon_{it}$

- For each \$1 increase in collateral, holdings increase by \$0.44
- The relationship is strong for lower-rated banks, consistent with risk-shifting
- \Rightarrow Banking panics can explain at most 56% of ECB borrowing

Banking panics: Test #2

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

2 Regression:

$$y_{it} = \alpha + \gamma_{ct} + \beta BankRating_{i,07} * Post_t + \varepsilon_{it}$$

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

Test #2 Results [Table 4]

Dependent Variable	Borrowing Indicator _{it}	Log(Borrowing) _{it}	Collateral Rating _{it}	Distressed Sovereign Debt _{it} /Assets _{i,07}
	(1)	(2)	(3)	(4)
Bank Rating _{i,07} * Post-Greek Bailout _t	0.047***	0.035**	0.062**	0.054*
	(0.012)	(0.016)	(0.030)	(0.030)
Bank Rating 1,07* Post-Lehmant	0.013	0.009	-0.005	-0.015
	(0.011)	(0.014)	(0.024)	(0.035)
Country-Time Fixed Effects	Y	Y	Y	Y
Bank Fixed Effects	Y	Y	Y	Y
Banks	292	292	287	276
Observations	51,684	51,684	45,997	48,852
R2	0.518	0.818	0.766	0.733

 $y_{it} = \alpha + \gamma_{ct} + \beta BankRating_{i,07} * Post_t + \varepsilon_{it}$

• β 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

Look only at non-distressed country banks (German, French, Dutch banks ...)

- e.g., not subject to deposit flight
- 2 Regression:

$$y_{it} = \alpha_i + \delta_t + \beta BankRating_{i,07} * Post_t + \varepsilon_{it}$$

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

Test #3 Results [Table 5]

Sample	Non-distressed Sovereigns			
Dependent Variable	Borrowing Indicator _{it}	Log(Borrowing) _{it}	Collateral Rating _{it}	Distressed Sovereign Debt _{it} /Assets _{i.07}
	(1)	(2)	(3)	(4)
Bank Rating _{i,07} * Post-Greek Bailout _t	0.043***	0.047***	0.068**	0.049*
	(0.012)	(0.015)	(0.033)	(0.026)
Bank Rating 1,07* Post-Lehmant	0.012	0.011	0.012	0.003
	(0.013)	(0.014)	(0.023)	(0.023)
Time Fixed Effects	Y	Y	Y	Y
Bank Fixed Effects	Y	Y	Y	Y
Banks	234	234	229	221
Observations	41,418	41,418	36,912	39,117
R2	0.486	0.799	0.769	0.673

 $y_{it} = \alpha_i + \delta_t + \beta BankRating_{i,07} * Post_t + \varepsilon_{it}$

• β statistically significant, but up to 60% smaller for non-distressed country banks

Consistent with tests #1 and #2 results

Testing Political Economy

- 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
- 2 Regression:

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

- Run our test using only non-distressed country banks
- β > 0: Bank rating predicts distressed-country sovereign debt pledging by *non*-distressed country banks
 - \Rightarrow **not** due to regulatory pressure

Testing Political Economy [Tables 5 and 7]

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

Bank Headquarters	Non-distressed Sovereigns		
Sample	All	Publicly Listed	
Dependent Variable	Distressed Sovereign Debt _{it} /Assets _{i,07} (1)	Distressed Sovereign Debt _{it} /Assets _{i,07} (2)	
Bank Rating _{i.07} * Post-Greek Bailout,	0.036*	0.300**	
	(0.019)	(0.137)	
Bank Rating 1,07* Post-Lehmant	0.003	0.118	
	(0.017)	(0.085)	
Week Fixed Effects	Y	Y	
Bank Fixed Effects	Y	Y	
Banks	221	29	
Observations	41,418	5,131	
R2	0.486	0.779	

• Bank rating remains predictive for non-distressed country banks

• Relationship is particularly strong for large (i.e, publicly-listed) banks

Other Differences in Private Valuation

- 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
- Obes 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

Generation:

$$y_{it} = \alpha_i + \delta_t + \beta BankRating_{i,07} * Post_t + \gamma X_{it} * Post_t + \varepsilon_{it}$$

 $- \chi_{it}$ 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]

 $y_{it} = \alpha_i + \delta_t + \beta BankRating_{i,07} * Post_t + \gamma X_{it} * Post_t + \varepsilon_{it}$

Dependent Variable	Borrowing Log(Borrowing) _{it}		Collateral Rating _{it}	Distressed Sovereign Debt _{it} /Assets _{i,07}
	(1)	(2)	(3)	(4)
Bank Rating _{i,07} * Post-Greek Bailout _t	0.039***	0.055***	0.171***	0.207**
	(0.011)	(0.019)	(0.047)	(0.067)
Bank Rating 1,07* Post-Lehmant	-0.013	0.042***	-0.004	0.098*
	(0.010)	(0.015)	(0.027)	(0.048)
Time Fixed Effects	Y	Y	Y	Y
Bank Fixed Effects	Y	Y	Y	Y
Banks	292	292	272	276
Observations	48,852	48,852	43,720	48,852
R2	0.492	0.811	0.684	0.656

- β almost unchanged after controlling for: log(Assets), Deposit Share, Loan Share, and pre-crisis Distressed-Country Sovereign Debt
- \Rightarrow No evidence supporting differences in private valuations

Additional results and robustness

Results stronger for publicly listed banks

- Presults robust to using alternative bank quality measure (CDS) (CDS)
- Results similar to using alternative borrowing measures (borrowing/collateral, borrowing/assets)
- Results qualitatively similar to using changes in bank ratings over time Table 10

Summing up: Total periphery sovereign debt collateral almost constant



Sovereign debt pledged with ECB is roughly constant

... 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

Conclusion

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

- Weakly-capitalized banks actively invest in risky assets using LOLR funding
- Pejects 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! \Rightarrow 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)