

The Anatomy of the Transmission of Macroprudential Policies

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Macroprudential Regulation

- ▶ Post-crisis rush to implement “macroprudential” policies
 - Rationale based on two observations
 - Banks take excessive risk because of guarantees
 - Build-up of household leverage leads to lower GDP growth and higher unemployment (Mian et al. (2017))

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 - Borrower-based leverage limits most used tool
 - Little work on transmission: recent policies, data limitations

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- ⇒ Regulate residential mortgages market
 - Borrower-based leverage limits most used tool
 - Little work on transmission: recent policies, data limitations
- ▶ **This paper:** Analysis of the transmission of limits on household leverage in the residential mortgage market:
 - 1) How is mortgage credit reallocated?
 - 2) Are limits effective in slowing down house price growth?
 - 3) How do banks adjust their risk exposure?

Setting

- ▶ Borrower Leverage Limits
 - LTI and LTV limits on new residential mortgages
 - Adopted in Ireland in February 2015
- ▶ Ireland as a laboratory
 - Credit-fueled boom-bust cycle during the recent crisis
 - 2002-07: household debt/GDP from 55% to 101%
 - 2007-10: GDP growth -10%, unemployment 4.6% to 13.3%
- ▶ Data
 - Mortgage-level data for residential mortgages
 - House price data by county
 - Loan-level data (credit to firms), security-level holdings
- ▶ Lending Limits are Binding
 - 43% of the typical issuance affected by the regulation
 - ... but mortgage credit risk exposure basically unaffected

This Paper

- ▶ **Banks reallocate mortgage credit across counties and incomes**
 - From counties where borrowers are closer to the limits to counties where borrowers are further away from the limits
 - Reallocation primarily driven by credit expansion towards rich borrowers in counties distant from the limits
 - These households get larger loans and increase leverage
- ▶ **Reallocation slows down house prices in “hot” counties**
 - House prices in counties that receive less credit slow down
 - House prices for large apartments in counties that receive more credit accelerate
- ▶ **Banks maintain a stable risk exposure**
 - New issuance is riskier based on previous boom-bust cycle
 - Exposed banks increase (relative to less exposed banks)
 - (risky) corporate lending (higher volumes, lower rates)
 - holdings of risky securities

Intro
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Setting
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Facts
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House Prices
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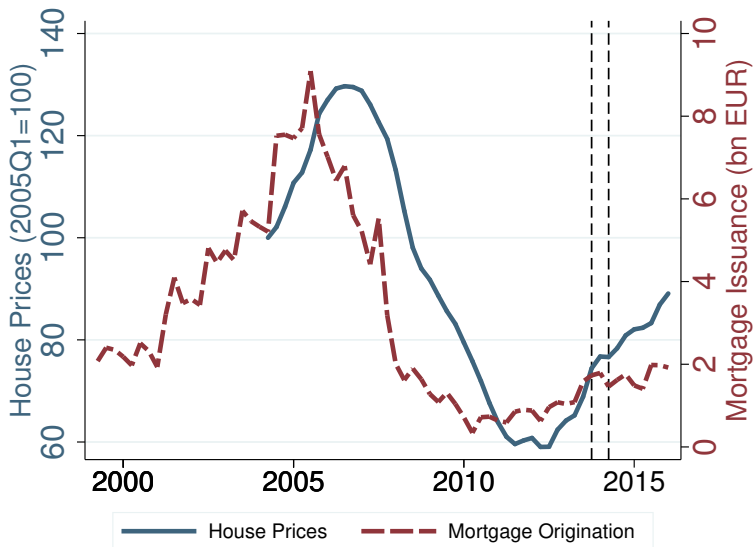
Bank Credit Reallocation
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Bank Risk Exposure
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Conclusion
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Setting and Data

Boom and Bust



Limits on Residential Mortgage Issuance

▶ Rationale:

- Governor Patrick Honahan (Jan 2015):

*“What we are trying to **prevent** is another psychological **loop between credit and prices and credit**. If we avoid that, we can keep banks safe, we can keep borrowers safe.”*

▶ Timeline:

- Oct 7, 2014: Central bank starts consultations
- Feb 9, 2015: Limits are disclosed and implemented

▶ Loan-to-Income (LTI) limits:

- 3.5

▶ Loan-to-Value (LTV) limits:

- 90 for First-Time-Buyers (FTB)
- 80 for Second- and Subsequent-Buyers (SSB)
- 70 for Buy-To-Let (BTL)

Intro
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Setting
○○

Facts
○○○

House Prices
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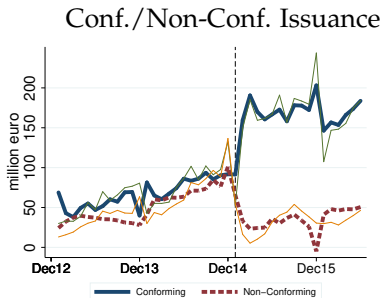
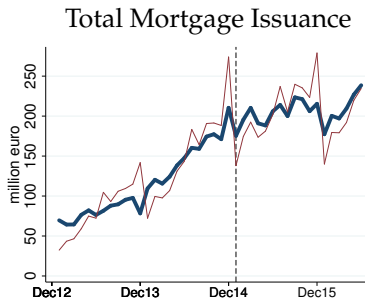
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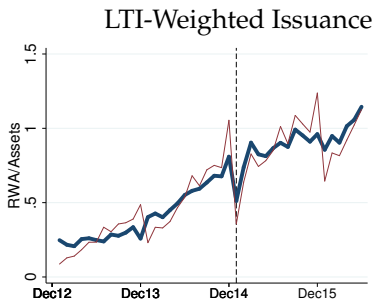
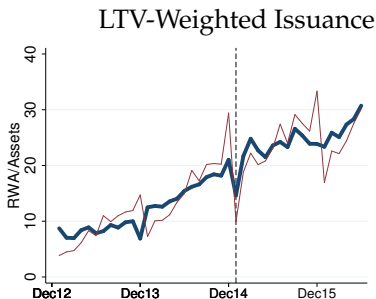
Some Facts

Market Becomes Conforming



- No stark decrease in mortgage issuance
- The market “moves” from non-conforming to conforming

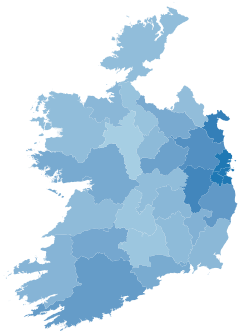
Buildup of Risk Exposure Unaffected



- LTV-weighted issuance as a fraction of assets keeps increasing
- LTI-weighted issuance as a fraction of assets keeps increasing

County-Level Distance from the Limits

- 1) Measure loan-level distance from its LTV and LTI limit
- 2) Standardize the two distances to have $\mu = 0, \sigma = 1$
- 3) Average at county level in pre-regulation period

[▶ Other Maps](#)[▶ SumStats](#)

- Urban counties are closer to the lending limits (especially low-income households)
- Rural counties have larger distance to the lending limits (especially high-income households)

Intro
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Setting
○○

Facts
○○○

House Prices
○○○○○

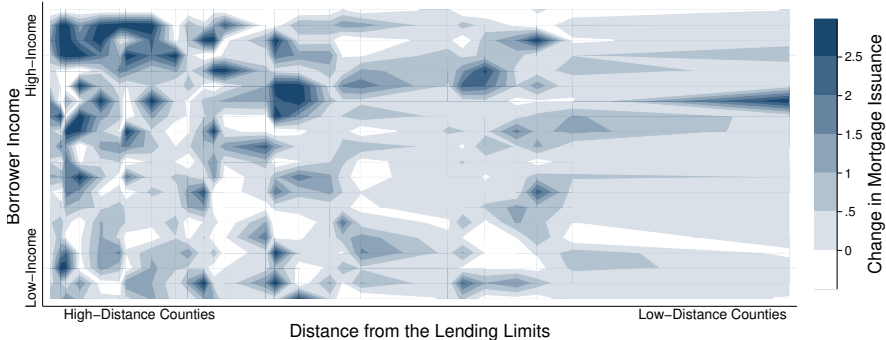
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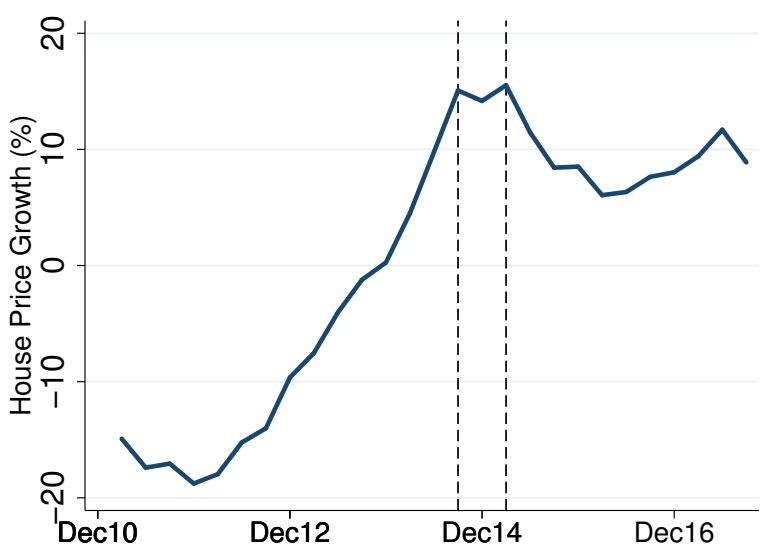
Conclusion
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House Prices

Reallocation Across Counties

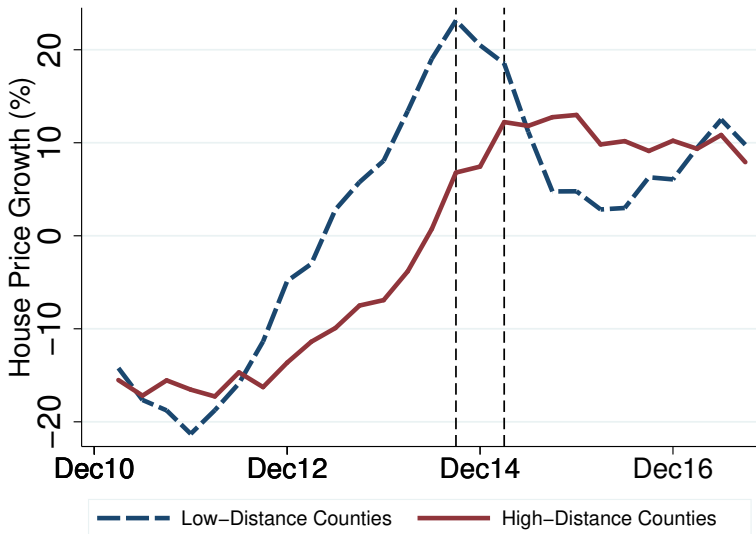


House Price Growth



Prices Slow Down in Low-Distance Counties

▸ Survey of Expectations



Change in House Prices

$$\Delta HP_{cp}^{14Q3-16Q4} = \alpha + \beta_1 Distance_c \times Size_p + \beta_2 Distance_c + \beta_3 Size_p + \epsilon_{cp}$$

- Observations at (c, p) county-property type level
- Size based on no. of bedrooms

Change in House Prices

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- Observations at (c, p) county-property type level
- Size based on no. of bedrooms

	Δ House Price			
	(1)	(2)	(3)	(4)
<i>Distance</i>	0.324*** (0.080)	0.253*** (0.064)	0.249*** (0.071)	0.275*** (0.072)
<i>Distance</i> × 1BR	-0.147*** (0.026)			
<i>Distance</i> × 2BR		0.068*** (0.024)		
<i>Distance</i> × 3BR+			0.078*** (0.011)	
1BR	-0.114*** (0.006)			
2BR		0.080*** (0.006)		
3BR+			0.034*** (0.001)	
Observations	162	162	162	54
R-squared	0.485	0.339	0.244	0.319

► Similar pattern for Price/Rent ratio

Borrower Leverage

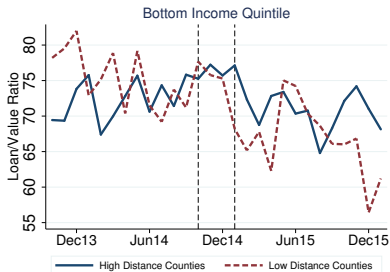
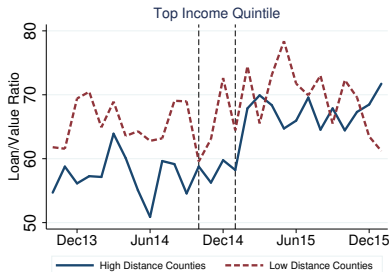
Several channels might explain this credit reallocation

- Borrowers unable to conform postpone transaction
- Borrowers increase downpayment/buy cheaper property
- Lenders reallocate credit to make-up for lost business

Borrower Leverage

Several channels might explain this credit reallocation

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- ▶ Leverage \uparrow for high-income borrowers, especially in high-distance counties

Intro
○○○

Setting
○○

Facts
○○○

House Prices
○○○○○

Bank Credit Reallocation
○○○○○○○○○

Bank Risk Exposure
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Bank Credit Reallocation

Bank-Level Heterogeneity

- Banks are differentially affected by the lending limits
Variation in share of issuance that is non-conforming

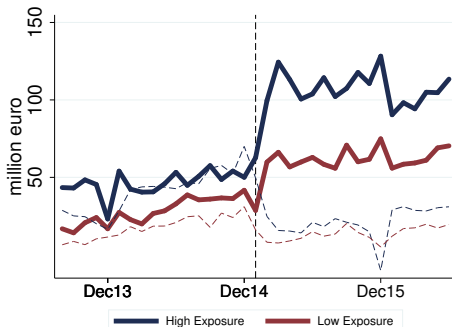
$$Exposure_b = \frac{\sum_{t=Oct13}^{Sep14} \text{Non-Conforming Issuance}_{bt}}{\sum_{t=Oct13}^{Sep14} \text{Total Issuance}_{bt}}$$

Bank-Level Heterogeneity

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- Variation in share of issuance that is non-conforming

$$Exposure_b = \frac{\sum_{t=Oct13}^{Sep14} \text{Non-Conforming Issuance}_{bt}}{\sum_{t=Oct13}^{Sep14} \text{Total Issuance}_{bt}}$$

Conforming Mortgage Issuance



Bank Mortgage Credit Reallocation

$$Issuance_{bcht} = \alpha + \beta Post_t \times Exposure_b + \gamma X_{bt-1} + \theta_{ht} + \eta_{ct} + \nu_b + \epsilon_{bcht}$$

- Bank b , county c , income bucket h , time t
- County-time FE, income-time FE, bank FE
- Time-varying bank controls: Log(Assets), Leverage, Loans/Assets

Bank Mortgage Credit Reallocation

$$Issuance_{bcht} = \alpha + \beta Post_t \times Exposure_b + \gamma X_{bt-1} + \theta_{ht} + \eta_{ct} + \nu_b + \epsilon_{bcht}$$

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	Q1	Q2	Q3	Q4	Q5
Post × Exposure	-1.311** (0.553)	-0.570 (0.552)	-0.307 (0.642)	-0.773 (0.615)	2.085** (0.928)
Bank Controls	✓	✓	✓	✓	✓
Bank FE	✓	✓	✓	✓	✓
Income-Time FE	✓	✓	✓	✓	✓
County-Time FE	✓	✓	✓	✓	✓
Observations	2,404	2,786	2,947	2,512	1,929
R-squared	0.496	0.505	0.582	0.590	0.655

Double Clustering at the bank-county and month level

- ▶ One st.dev higher exposure: ↓ 10% mortgage issuance (Q1), ↑ 15% mortgage issuance (Q5)

Bank Mortgage Credit Reallocation

$$LoanSize_{bcht} = \alpha + \beta Post_t \times Exposure_b + \gamma X_{bt-1} + \theta_{ht} + \eta_{ct} + \nu_b + \epsilon_{bcht}$$

- Bank b , county c , income bucket h , time t
- County-time FE, income-time FE, bank FE
- Time-varying bank controls: Log(Assets), Leverage, Loans/Assets

	Q1	Q2	Q3	Q4	Q5
Post×Exposure	-0.546 (0.386)	-0.773*** (0.273)	-1.050** (0.469)	-1.856*** (0.476)	4.591*** (1.250)
Bank Controls	✓	✓	✓	✓	✓
Bank FE	✓	✓	✓	✓	✓
Income-Time FE	✓	✓	✓	✓	✓
County-Time FE	✓	✓	✓	✓	✓
Observations	2,404	2,786	2,947	2,512	1,929
R-squared	0.446	0.359	0.360	0.369	0.476

Double Clustering at the bank-county and month level

- ▶ Q5 borrowers increase loan size from exposed banks

Bank Mortgage Credit Reallocation

$$LTV_{bcht} = \alpha + \beta Post_t \times Exposure_b + \gamma X_{bt-1} + \theta_{ht} + \eta_{ct} + \nu_b + \epsilon_{bcht}$$

- Bank b , county c , income bucket h , time t
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- Time-varying bank controls: Log(Assets), Leverage, Loans/Assets

	Q1	Q2	Q3	Q4	Q5
Post×Exposure	-91.148***	-30.657**	-0.421	-6.747	67.309**
	(14.915)	(14.100)	(16.285)	(12.749)	(26.549)
Bank Controls	✓	✓	✓	✓	✓
Bank FE	✓	✓	✓	✓	✓
Income-Time FE	✓	✓	✓	✓	✓
County-Time FE	✓	✓	✓	✓	✓
Observations	2,363	2,755	2,896	2,466	1,866
R-squared	0.389	0.264	0.242	0.265	0.372

Double Clustering at the bank-county and month level

- One st.dev higher exposure: ↓ 6.6pp LTV (Q1), ↑ 4.9pp LTV (Q5)

Bank Mortgage Credit Reallocation

$$LTI_{bcht} = \alpha + \beta Post_t \times Exposure_b + \gamma X_{bt-1} + \theta_{ht} + \eta_{ct} + \nu_b + \epsilon_{bcht}$$

- Bank b , county c , income bucket h , time t
- County-time FE, income-time FE, bank FE
- Time-varying bank controls: Log(Assets), Leverage, Loans/Assets

	Q1	Q2	Q3	Q4	Q5
Post × Exposure	-4.855 (6.830)	3.548 (4.521)	5.461 (4.001)	2.357 (4.193)	4.453*** (1.579)
Bank Controls	✓	✓	✓	✓	✓
Bank FE	✓	✓	✓	✓	✓
Income-Time FE	✓	✓	✓	✓	✓
County-Time FE	✓	✓	✓	✓	✓
Observations	1,396	1,775	1,929	1,743	1,267
R-squared	0.426	0.419	0.484	0.492	0.538

Double Clustering at the bank-county and month level

- One st.dev higher exposure: ↑ 0.3pp LTI (Q5)

Mortgage Rates

Mortgage rates are decreasing during our sample period **especially** for high-income borrowers

Income Quintiles	<i>Rate (%)</i>		
	Pre	Post	Difference
Q1	4.12	3.84	-0.29
Q2	4.24	3.85	-0.39
Q3	4.21	3.81	-0.40
Q4	4.21	3.80	-0.40
Q5	4.24	3.78	-0.46

- 1) Explains why high-income borrowers take larger loans
- 2) Suggest a credit supply channel (Mian and Sufi, AER)

Mortgage Rates and Bank Heterogeneity

Rates down more for mortgages issued by exposed banks to high income borrowers

$$Rate_{hbt} = \alpha + \beta Post_t \times Exposure_b + \eta_b + \mu_t + \epsilon_{hbt}$$

	Income Quintiles				
	Q1	Q2	Q3	Q4	Q5
Post × Exposure	0.805* (0.482)	0.127 (0.376)	0.002 (0.467)	-0.592 (0.536)	-1.829*** (0.525)
Observations	383	383	383	383	371
R-squared	0.620	0.727	0.782	0.622	0.581
Bank FE	✓	✓	✓	✓	✓
Time FE	✓	✓	✓	✓	✓

Standard errors double clustered at the bank-time level

Reallocation Across Counties

$$Issuance_{bcht} = \alpha + \beta Post_t \times Exposure_b + \gamma X_{bt-1} + \theta_{ht} + \nu_b + \eta_{ct} + \epsilon_{bcht}$$

- Bank b , county c , income bucket h , time t
- County-time FE, bank FE, time-varying bank controls
- Time-varying bank controls: Log(Assets), Leverage, Loans/Assets

Low-Distance Counties	Q1	Q2	Q3	Q4	Q5
Post × Exposure	-1.763*	-1.231	-0.101	-0.306	1.327*
	(0.954)	(0.991)	(0.529)	(0.811)	(0.661)
Observations	664	850	981	933	795
R-squared	0.531	0.564	0.660	0.623	0.715

High-Distance Counties	Q1	Q2	Q3	Q4	Q5
Post × Exposure	-0.840	-0.204	-0.372	-0.439	2.664*
	(0.575)	(0.646)	(0.823)	(0.689)	(1.519)
Observations	1,739	1,936	1,965	1,579	1,134
R-squared	0.432	0.372	0.397	0.421	0.425

Standard errors double clustered at the bank-county and month level

- One st.dev higher exposure: ↓ 13% mortgage issuance (Q1) in low-distance counties, ↑ 19% mortgage (Q5) in high-distance

Reallocation Across Counties

$$LTV_{bcht} = \alpha + \beta Post_t \times Exposure_b + \gamma X_{bt-1} + \theta_{ht} + \nu_b + \eta_{ct} + \epsilon_{bcht}$$

- Bank b , county c , income bucket h , time t
- County-time FE, bank FE, time-varying bank controls
- Time-varying bank controls: Log(Assets), Leverage, Loans/Assets

Low-Distance Counties	Q1	Q2	Q3	Q4	Q5
Post X Exposure	-95.156*** (32.174)	-34.655 (28.343)	12.483 (14.928)	-12.752 (23.987)	26.131 (21.635)
Observations	655	849	976	924	785
R-squared	0.453	0.312	0.241	0.239	0.311
High-Distance Counties	Q1	Q2	Q3	Q4	Q5
Post×Exposure	-83.793*** (17.870)	-30.936 (19.919)	-7.822 (23.212)	3.152 (11.624)	99.522*** (34.871)
Observations	1,707	1,906	1,919	1,542	1,080
R-squared	0.412	0.287	0.277	0.295	0.434

Standard errors double clustered at the bank-county and month level

- One st.dev higher exposure: ↓ 6.9pp LTV (Q1) in low-distance counties, ↑ 7.2pp LTV (Q5) in high-distance

Intro
○○○

Setting
○○

Facts
○○○

House Prices
○○○○○

Bank Credit Reallocation
○○○○○○○○○

Bank Risk Exposure
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Conclusion
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Bank Risk Exposure

Risk in Residential Mortgages

- ▶ We **do not observe defaults** on recent mortgages
 - ⇒ “Random forest” model to obtain default probability

Risk in Residential Mortgages

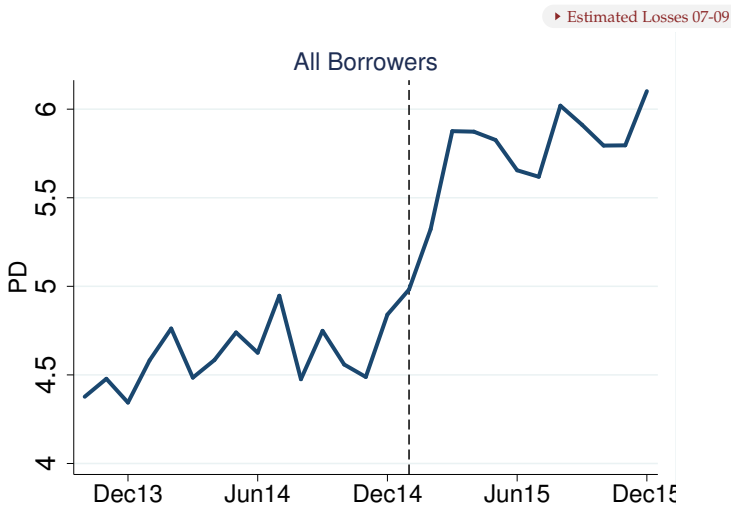
- ▶ We **do not observe defaults** on recent mortgages
⇒ “Random forest” model to obtain default probability

Idea: Use data from previous boom-bust cycle to predict loan-level probabilities

(Mullainathan and Spiess (2017), Liberman et al. (2017))

Mortgage Portfolio Becomes Riskier...

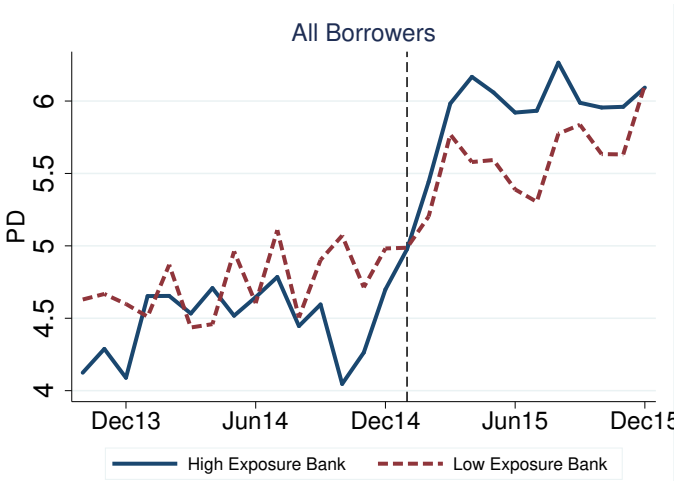
- Caveat: conditional on a bust with 2007-09 characteristics



... Mainly Driven by Exposed Banks

▶ Q1

▶ Q5



Credit to Firms

$$\Delta VOL_{bclqt} = \alpha + \beta Post_t \times Exposure_b + \gamma X_{bt-1} + \delta_{bc} + \eta_{clqt} + \epsilon_{bclqt}$$

- Bank b , industry l , county c , quality q , time t
- Semi-annual data from 2013H1 to 2016H1, $Post = 1$ from 2015H1
- Risky, bank rating 5. NonRisky, bank rating 1-4

	Total	Risky	NonRisky	Total
Exposure \times Post	1.382*** (0.401)	2.761*** (0.659)	0.740* (0.435)	0.697 (0.449)
Exposure \times Post \times Risky				2.253*** (0.547)
Exposure \times Risky				-0.182 (0.307)
Time-Varying Bank Controls	✓	✓	✓	✓
Industry-County-Quality-Time FE	✓	✓	✓	✓
Bank-County FE	✓	✓	✓	✓
Observations	10,092	3,227	6,865	10,092
R-squared	0.525	0.569	0.493	0.527

Credit to Firms

$$\Delta RATE_{bclqt} = \alpha + \beta Post_t \times Exposure_b + \gamma X_{bt-1} + \delta_{bc} + \eta_{clqt} + \epsilon_{bclqt}$$

- Bank b , industry l , county c , quality q , time t
- Semi-annual data from 2013H1 to 2016H1, $Post = 1$ from 2015H1
- Risky, bank rating 5. NonRisky, bank rating 1-4

	Total	Risky	NonRisky	
Exposure \times Post	-0.719*** (0.195)	-1.677*** (0.557)	-0.234 (0.268)	-0.187 (0.262)
Exposure \times Post \times Risky				-1.753** (0.674)
Exposure \times Risky				0.058 (0.367)
Time-Varying Bank Controls	✓	✓	✓	✓
Industry-County-Quality-Time FE	✓	✓	✓	✓
Bank-County FE	✓	✓	✓	✓
Observations	10,007	3,183	6,823	10,007
R-squared	0.478	0.508	0.463	0.479

Holdings of Securities

$$NetBuys_{sbt} = \alpha + \beta Exposure_b \times Post_t \times Yield_s + \gamma_{bt} + \eta_{st} + \epsilon_{sbt}$$

$$NetBuys_{sbt} = \frac{Holdings_{sbt} - Holdings_{sbt-1}}{0.5 * (Holdings_{sbt} + Holdings_{sbt-1})}$$

- Net Buys $\in [-2, 2]$ of security s by bank b between t and $t - 1$
- Quarterly data: 2013Q1 to 2016Q2, $Post = 1$ from 2015Q2

	Net Buys	Buys	Sells
Exposure \times Post \times Yield	0.067***	0.292***	-0.251**
	(0.022)	(0.098)	(0.102)
Bank-Time FE	✓	✓	✓
Security-Time FE	✓	✓	✓
Observations	7,707	7,707	7,707
R-squared	0.949	0.919	0.915

Intro
○○○

Setting
○○

Facts
○○○

House Prices
○○○○○

Bank Credit Reallocation
○○○○○○○○○

Bank Risk Exposure
○○○○○

Conclusion
○

Concluding Remarks

Conclusion

- We analyze the transmission of macroprudential policies aimed at limiting household leverage and bank risk-taking
- In response to the policy, banks reallocate mortgage credit both geographically and across the incomes
 - Targeting high income households and areas where the new limits are less binding
 - Conversely, low income households in areas where the limits are more binding borrow less
- These changes in mortgage credit are effective in slowing down the ongoing house price appreciation
- The newly issued mortgages are on average riskier
- Banks increase their risk-taking in asset classes unaffected by the regulation