Life Below Zero:
Bank Lending Under Negative Policy Rates

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October 27, 2016

Monetary policy in unchartered territory

- To stimulate post-crisis economy, monetary policy has become non-standard
- Some central banks have lowered policy rates to negative
  - Are zero/negative interest rates special?
- **This paper:** transmission of negative policy rates to the economy
  - Is the transmission via bank lending different than for positive rates?
  - Benefits and costs/risks?

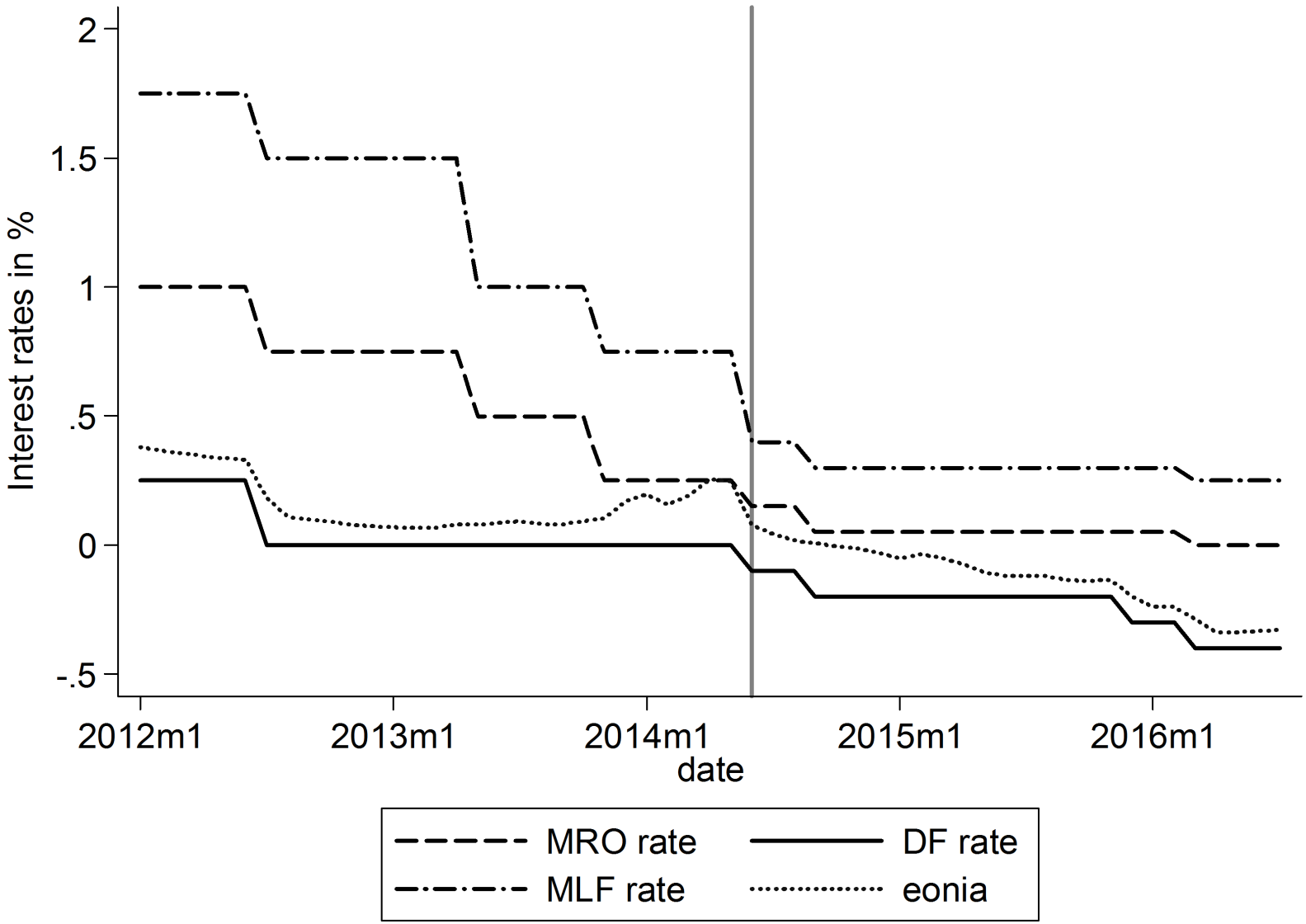
Our findings and contribution

1. Transmission of negative rates depends on banks' funding structure – different from other "non-standard" measures
   - More deposits $\rightarrow$ risk taking $\Uparrow$
   - No such effect for lower but non-negative rates

Our findings and contribution

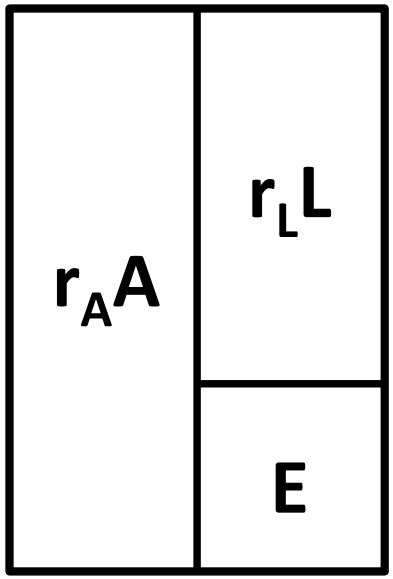
1. Transmission of negative rates depends on banks' funding structure – different from other "non-standard" measures
   - More deposits $\rightarrow$ risk taking $\Uparrow$
   - No such effect for lower but non-negative rates
2. Distributional consequences of monetary policy – bank lending and bank risk-taking channels
   - Relatively less lending by high-deposit banks, focus on **new** risky borrowers
   - Safe borrowers switch to low-deposit banks
   - Relaxation of financial constraints for risky borrowers $\rightarrow$ investment $\Uparrow$

Background on negative policy rates in the Eurozone



Effect of Negative Policy Rates on Bank Risk Taking

Two effects at work in banks when interest rates decrease



- Bank finances opaque assets (A) with liabilities (L)
- Net worth (equity E) determines risk taking (skin in the game)

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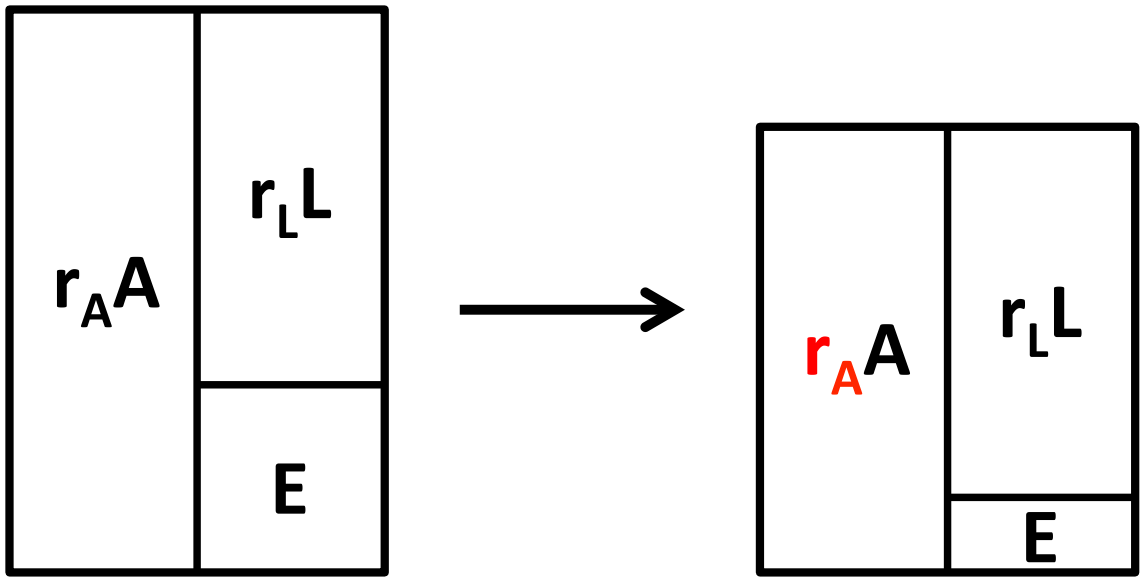
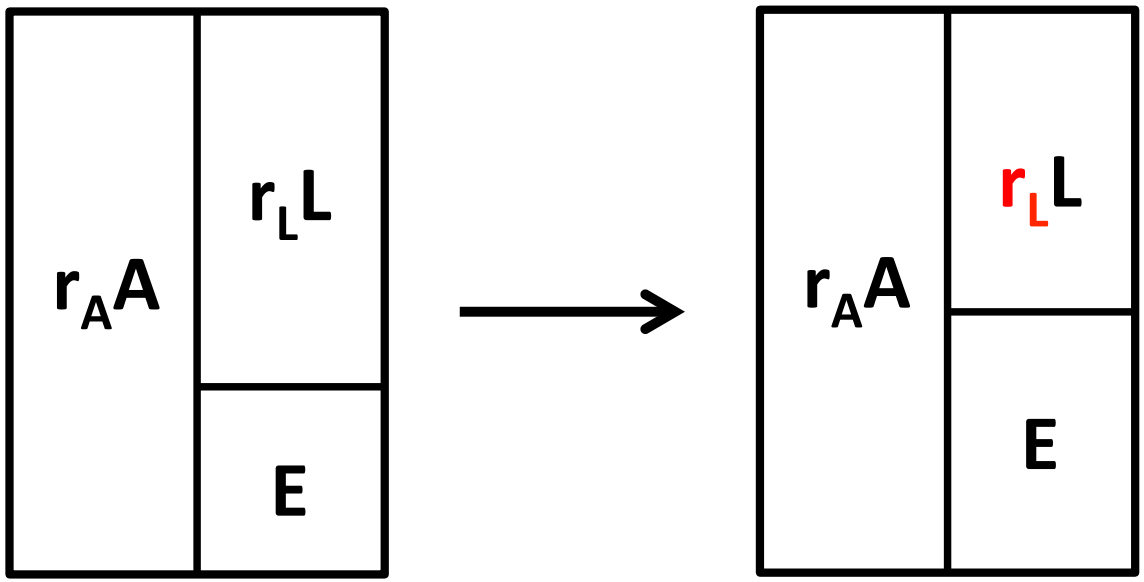


- Pass-through of lower policy rate to rates on assets/loans (r_A)
- Net worth $\Downarrow$ (ceteris paribus) $\rightarrow$ risk taking $\Uparrow$

Two effects at work in banks when interest rates decrease

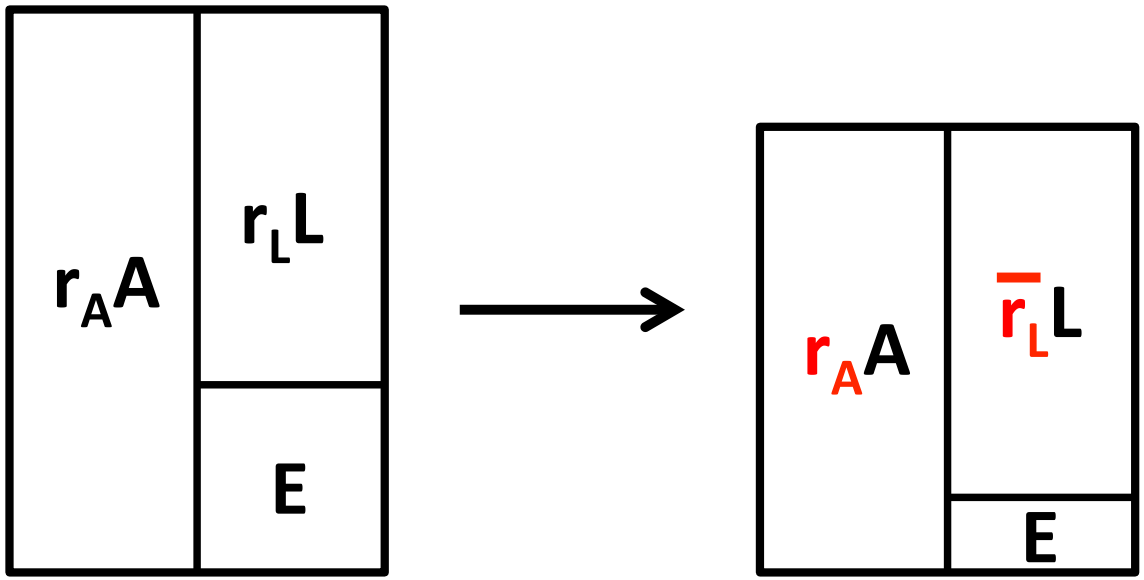


- Pass-through of lower policy rate to rates on liabilities (r_L)
- Net worth $\Uparrow$ (ceteris paribus) $\rightarrow$ risk taking $\Downarrow$

How to separate asset and liability effect?

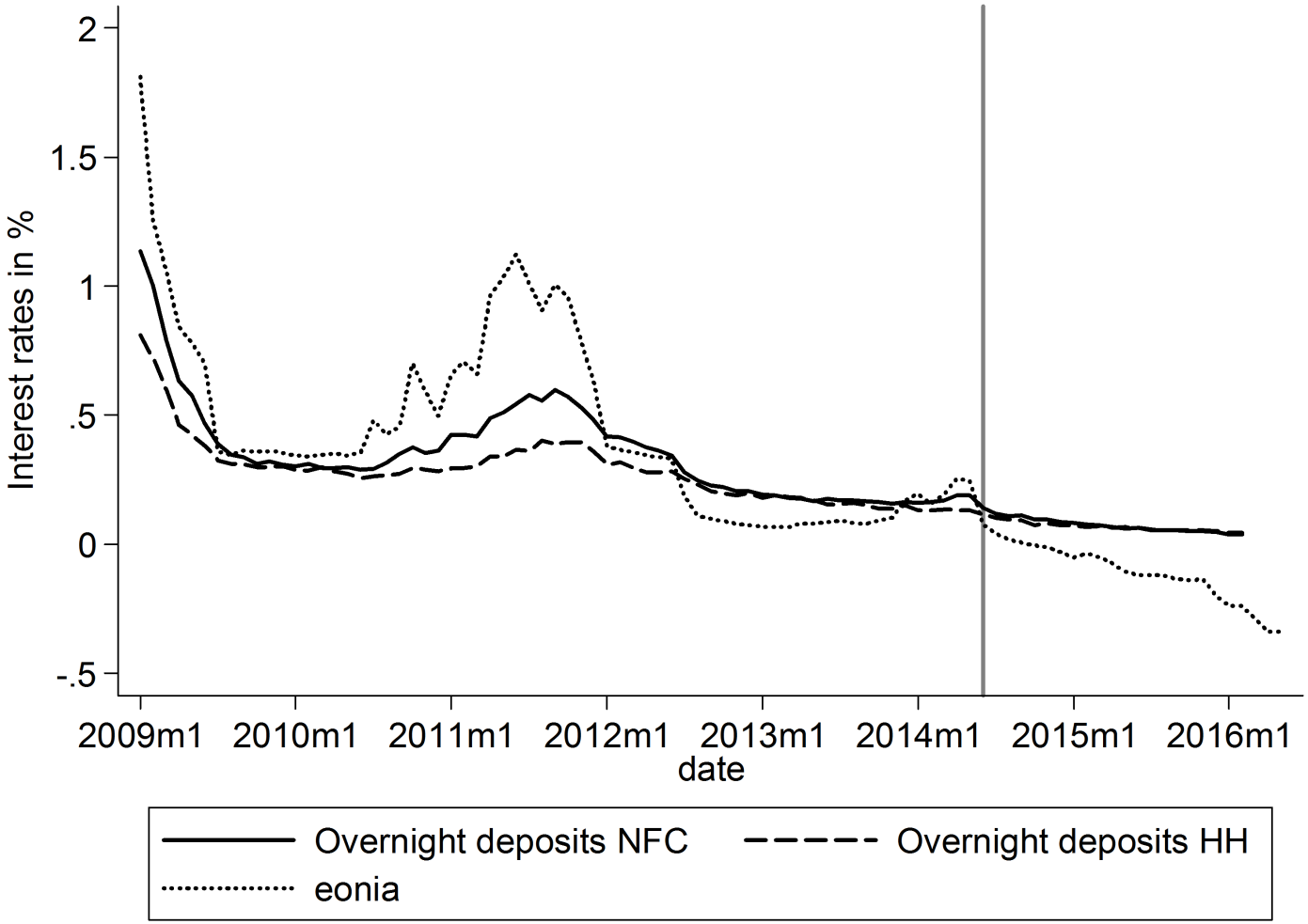
- Literature uses bank capital to vary strength of liability effect
- Mixed evidence (Jiménez et al. 2014 vs. Dell'Ariccia, Laeven, and Suarez 2016)
- Problem: bank capital depends on what happens to assets and liabilities

Identification through negative policy rates

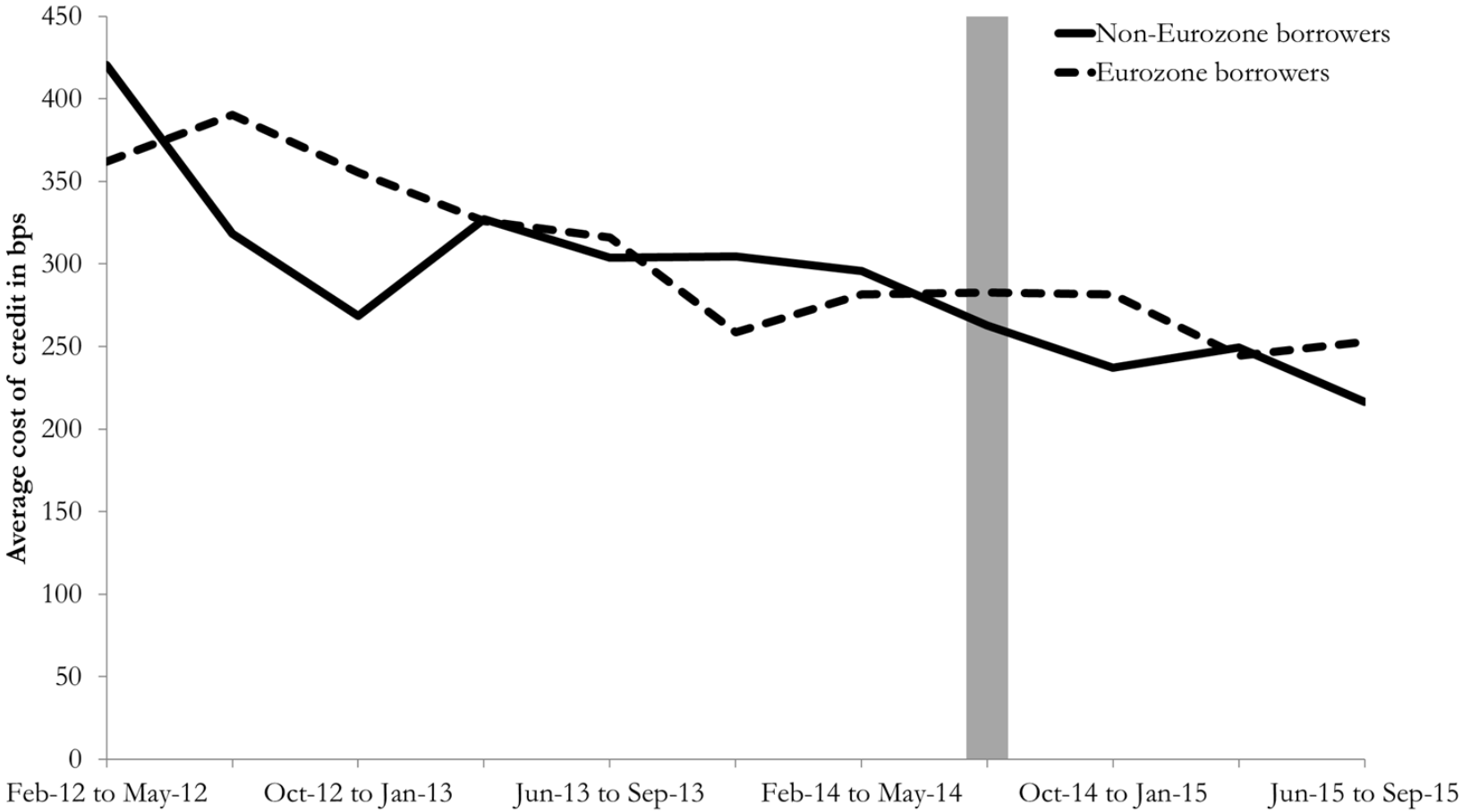


- No pass-through of negative policy rate to rates on deposits ($\bar{r}_L$)
- Liability effect shut down for banks with a lot of deposit funding
- Overall net worth $\Downarrow \rightarrow$ risk taking $\Uparrow$

No pass-through of negative rates to deposit rates



Pass-through of lower rates to loan rates



Long-term (> 5y) loans

Differential impact of negative policy rates

- Compare risk taking by banks with different extent of deposit funding before and after policy rates become negative
- Liability effect weaker for banks with more deposit funding (net worth $\Downarrow \rightarrow$ risk taking $\Uparrow$)

Data description

1. **Data**
   - Syndicated loans: DealScan
   - Both public and private firms in Europe: Amadeus
   - Loans granted by any Eurozone lead arranger(s) (at the bank-group level): SNL
   - January 2013 (2011) to December 2015
2. **Measure of bank risk taking**
   - Ex-ante volatility of firms with new loans from Eurozone banks
3. **Exposure to treatment (negative rate in 06/2014)**
   - Deposit-to-asset ratios in 2013 (range from 0.5 to 78%)

Summary statistics | Deposit ratios | Equity ratios | Fees

Difference-in-differences specification

$$y_{ijt} = \beta_1 \textit{Deposit ratio}_j \times \textit{After}(06/2014)_t + \beta_2 X_{it} + \delta_t + \eta_j + \epsilon_{ijt},$$

where i = firms, j = banks (lead arrangers), and t = transaction date

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Two identification challenges

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Two identification challenges

1. Monetary policy also affects firms' demand for loans

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where i = firms, j = banks (lead arrangers), and t = transaction date

Two identification challenges

1. Monetary policy also affects firms' demand for loans
2. Monetary policy reacts to economic conditions

Difference-in-differences specification

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Two identification challenges

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2. Monetary policy reacts to economic conditions

Control group provides the counterfactual

Difference-in-differences specification

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where i = firms, j = banks (lead arrangers), and t = transaction date

Two identification challenges

1. Monetary policy also affects firms' demand for loans
2. Monetary policy reacts to economic conditions

Control group provides the counterfactual

- Add industry-year & country-year FE (X_{it})
- Examine non-Eurozone borrowers
- Placebo around July 2012: lower but still non-negative rate

ROA volatility of bank-financed firms

Sample	$\ln(\sigma(ROA_i)^{5y})$					
	2013 – 2015				2011 – 2015	2011 – 2015, non-Euro
Deposit ratio × After(06/2014)	0.017***	0.016***	0.018***	0.020***	0.020***	0.033**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.014)
Deposit ratio × After(07/2012)					-0.007	-0.012
					(0.004)	(0.010)
Bank FE	Y	Y	Y	Y	Y	Y
Month-year FE	Y	Y	Y	Y	Y	Y
Country FE	N	Y	N	N	N	N
Industry FE	N	Y	Y	N	N	N
Country-year FE	N	N	Y	Y	Y	Y
Industry-year FE	N	N	N	Y	Y	Y
N	1,576	1,576	1,576	1,576	2,490	542

Graph

ROA volatility of bank-financed firms – robustness

Robustness	$\ln(\sigma(ROA_i)^{5y})$					
						Alt. definition deposit ratio
Deposit ratio × After(06/2014)	0.020***	0.023***	0.019***	0.022***	0.019***	0.019***
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)
$\ln(\text{Assets})_{t-1}$	0.081			0.029		
	(0.059)			(0.063)		
Securities ratio$_{t-1}$		0.009**		0.014**		
		(0.004)		(0.006)		
Equity ratio$_{t-1}$			0.035	0.105**		
			(0.054)	(0.049)		
Equity ratio × After(06/2014)					0.025	
					(0.051)	
Bank FE	Y	Y	Y	Y	Y	Y
Month-year FE	Y	Y	Y	Y	Y	Y
Country-year FE	Y	Y	Y	Y	Y	Y
Industry-year FE	Y	Y	Y	Y	Y	Y
N	1,576	1,576	1,576	1,576	1,576	1,576

More robustness

- Former loan spreads as alternative risk measure Table
- Public firms' stock-return volatility Table
- Shorter sample ending before March 2015 (ECB's PSPP) Table
- Inclusion of non-Eurozone lenders facing negative rates Table

Bank Lending Channel and Risk Taking

Implications for bank lending channel

- Imperfect pass-through of negative policy rate to rates on deposits:

  Net worth $\Downarrow \rightarrow$ lending volume $\Downarrow$

- But also risk taking $\Uparrow$, hence **concentrated lending to riskier firms**

Impact of negative policy rates on bank lending channel

- Regressions run at the bank-month-year level

	ln(Total loan volume)		
Sample	2013 – 2015	2013 – 2015	2011 – 2015
Deposit ratio × After(06/2014)	-0.010**	-0.009*	-0.009**
	(0.004)	(0.005)	(0.004)
Deposit ratio × After(07/2012)			0.008
			(0.006)
Deposit ratio	-0.003		
	(0.009)		
Bank FE	N	Y	Y
Month-year FE	Y	Y	Y
N	759	759	1,371

Implications for borrower composition

- High-deposit banks add high-risk borrowers: new **and** switching Table
- Safe borrowers disproportionately switch to low-deposit banks Figure
- No average effect on loan size
  - But larger loans for riskier firms granted by high-deposit banks Table

Illustration

Mechanism and Real Effects

Mechanism

- Loan spread and other terms are not adjusted to reflect higher risk of borrowers Table
- Treatment effect stronger for poorly-capitalized banks (in line with Jiménez et al. 2014) Table

Impact of negative policy rates on banks' loan portfolio

- Lowering rates to negative overcomes rationing

Sample	$\ln(\sigma(ROA_i)^{5y})$ Private firms	$\ln(\sigma(ROA_i)^{5y})$ Public firms	$ROA_{i,t-1}$ Private and public firms	$Leverage_{i,t-1}$ Private and public firms
Deposit ratio × After(06/2014)	0.027***	0.011	-0.036	-0.238**
	(0.009)	(0.007)	(0.083)	(0.110)
Bank FE	Y	Y	Y	Y
Month-year FE	Y	Y	Y	Y
Country-year FE	Y	Y	Y	Y
Industry-year FE	Y	Y	Y	Y
N	904	672	1,576	1,569

Real effects: investment growth of risky firms

Sample	$\Delta_{t+1,t}\ln(Investment_i)$			
	$2013-2014$		$2011-2014$	
	Bottom tercile	Top tercile	Bottom tercile	Top tercile
Deposit ratio × After(06/2014)	-0.057	0.514**	-0.050	0.171
	(0.118)	(0.243)	(0.081)	(0.139)
Deposit ratio × After(07/2012)			0.053	-0.061
			(0.060)	(0.076)
Bank FE	Y	Y	Y	Y
Month-year FE	Y	Y	Y	Y
Country-year FE	Y	Y	Y	Y
Industry-year FE	Y	Y	Y	Y
N	146	149	305	308

Conclusion

On the one hand...

- More lending to constrained borrowers that invest
  - Justification as a tool to stimulate post-crisis economy
  - Transmission to real economy operates differently: effective lower bound < 0 (Brunnermeier and Koby 2016)

Conclusion

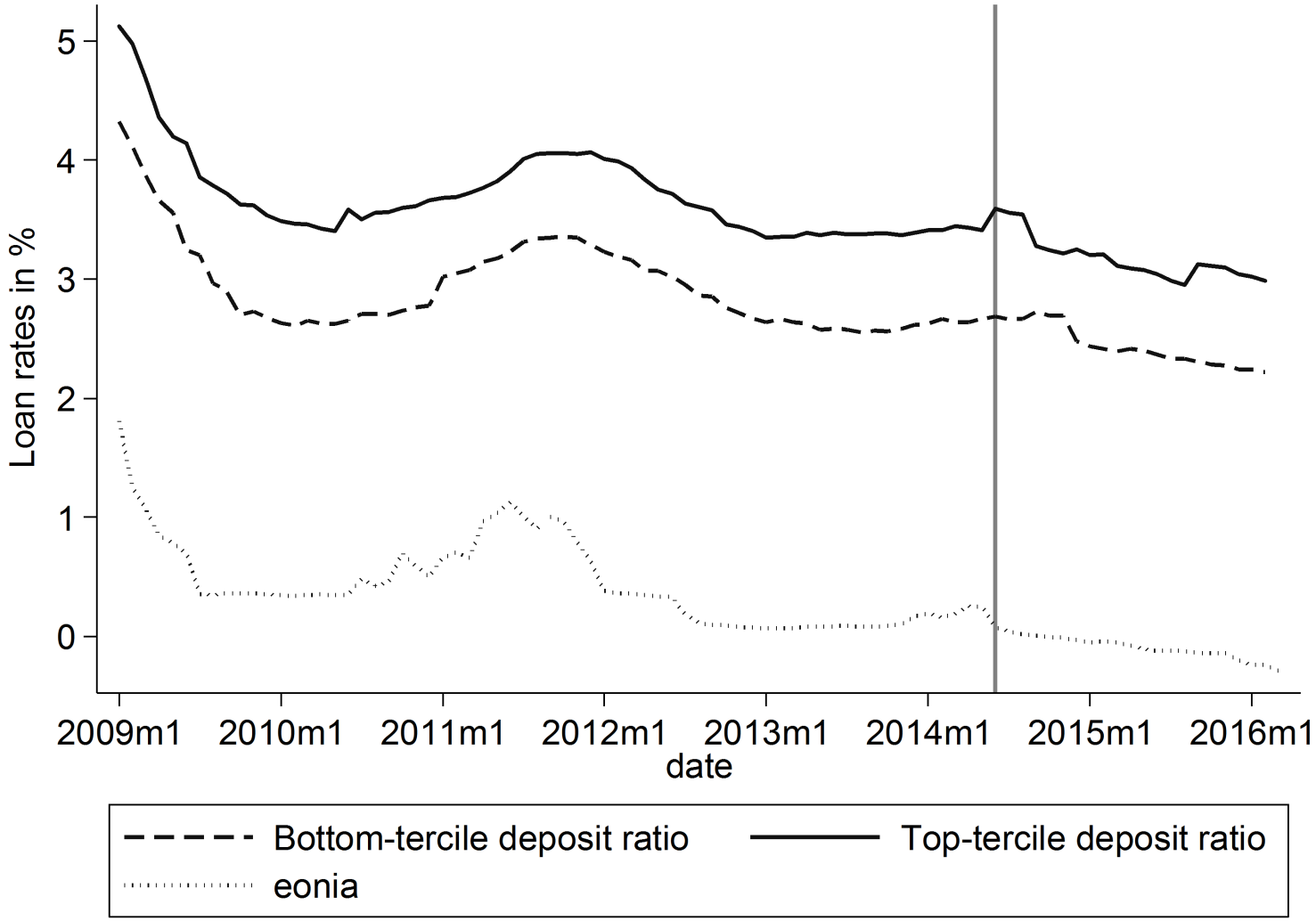
On the one hand...

- More lending to constrained borrowers that invest
  - Justification as a tool to stimulate post-crisis economy
  - Transmission to real economy operates differently: effective lower bound < 0 (Brunnermeier and Koby 2016)

On the other hand...

- Long-term consequences
  - Distributional effects: efficient matching of high-risk borrowers with high-deposit banks?
  - Financial stability?

Pass-through of lower rates to loan rates



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Summary statistics

Loans sample	Mean	Std. dev.	Min	Max	N
$\sigma(ROA_i)^{5y}$	0.041	0.046	0.001	0.488	1,576
$\sigma(return_i)^{36m}$	0.086	0.037	0.001	0.329	825
Deposit ratio in %	40.793	9.452	0.486	64.527	2,450
Equity ratio in %	5.369	1.088	3.398	13.608	2,450
Eurozone firm $\in \{0, 1\}$	0.781	0.414	0	1	2,450
All-in-drawn spread in bps	264.329	157.035	10	850	791
Loan size in 2016 €bn	0.741	1.932	0.001	68.482	2,426
Secured $\in [0, 1]$	0.690	0.460	0	1	986
Avg. loan share of lead arrangers $\in [0, 1]$	0.233	0.186	0	1	591
Financial covenants $\in \{0, 1\}$	0.034	0.181	0	1	2,450
Maturity of loan in months	58.782	27.331	1	345	2,386
No. of lead arrangers	3.644	2.862	1	20	2,450
Bank-level sample	Mean	Std. dev.	Min	Max	N
Deposit ratio in %	43.053	18.688	0.486	78.392	70
Equity ratio in %	6.158	2.878	1.463	22.643	70
ln(Total assets)	11.872	1.361	7.064	14.409	70
Loans-to-assets ratio in %	57.207	17.602	2.025	87.402	66
Return on assets in %	0.064	0.834	-3.288	4.067	70
Net interest margin in %	1.252	0.672	-0.042	3.423	68

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Further bank-level summary statistics

	Tercile	N	Mean	Std. dev	t-stat
Deposit ratio in %	Bottom	24	21.58	12.60	13.82
	Top	23	61.13	6.04	
Equity ratio in %	Bottom	24	4.98	2.26	1.94
	Top	23	6.19	2.04	
ln(Total assets)	Bottom	24	12.22	1.61	2.00
	Top	23	11.46	0.94	
Loans-to-assets ratio in %	Bottom	22	39.92	17.97	6.75
	Top	23	68.44	8.56	
Return on assets in %	Bottom	24	0.04	0.44	0.54
	Top	23	0.17	1.05	
Net interest margin in %	Bottom	23	0.78	0.44	4.98
	Top	23	1.53	0.57	

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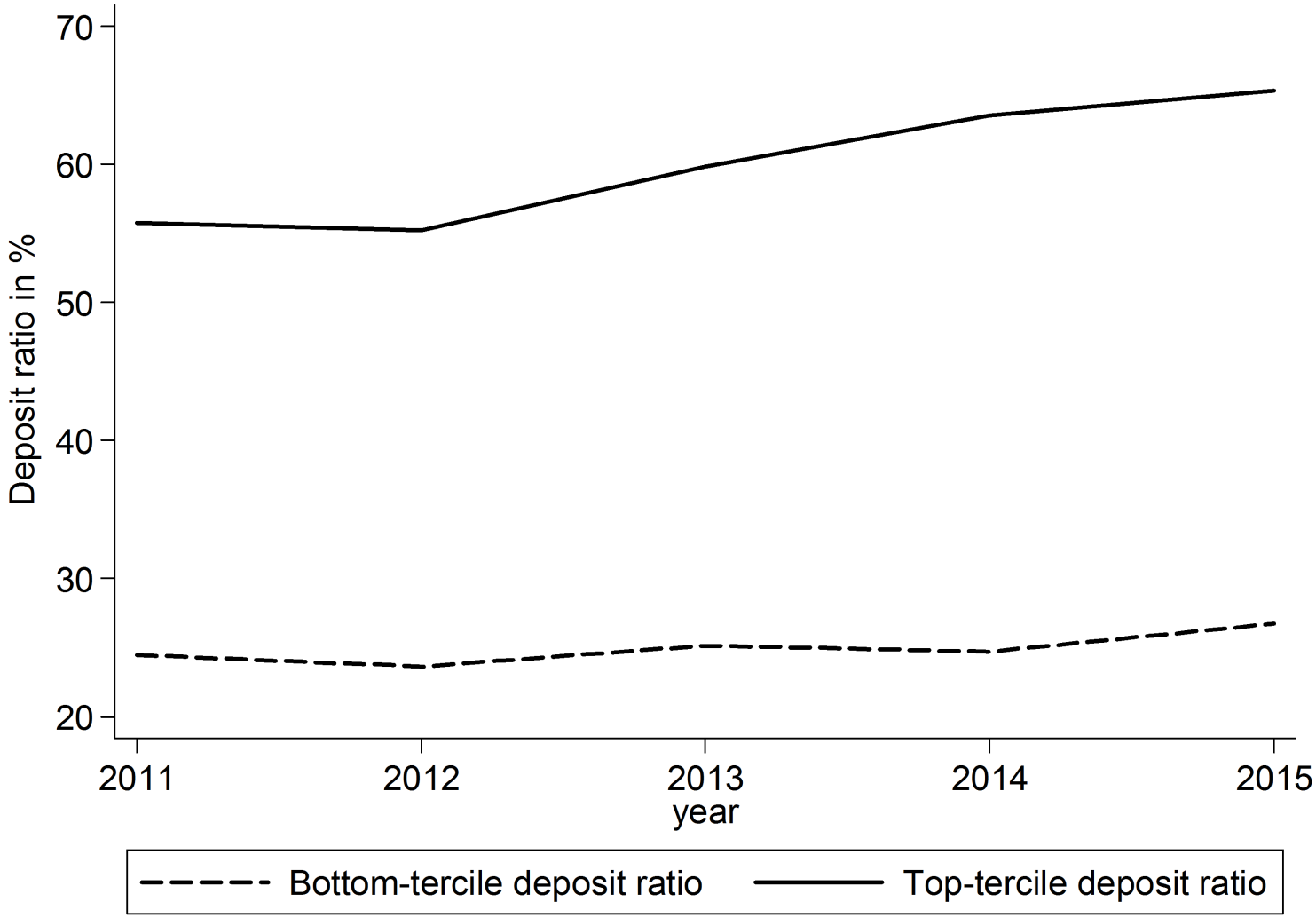
Deposit ratios of high-deposit vs. low-deposit banks



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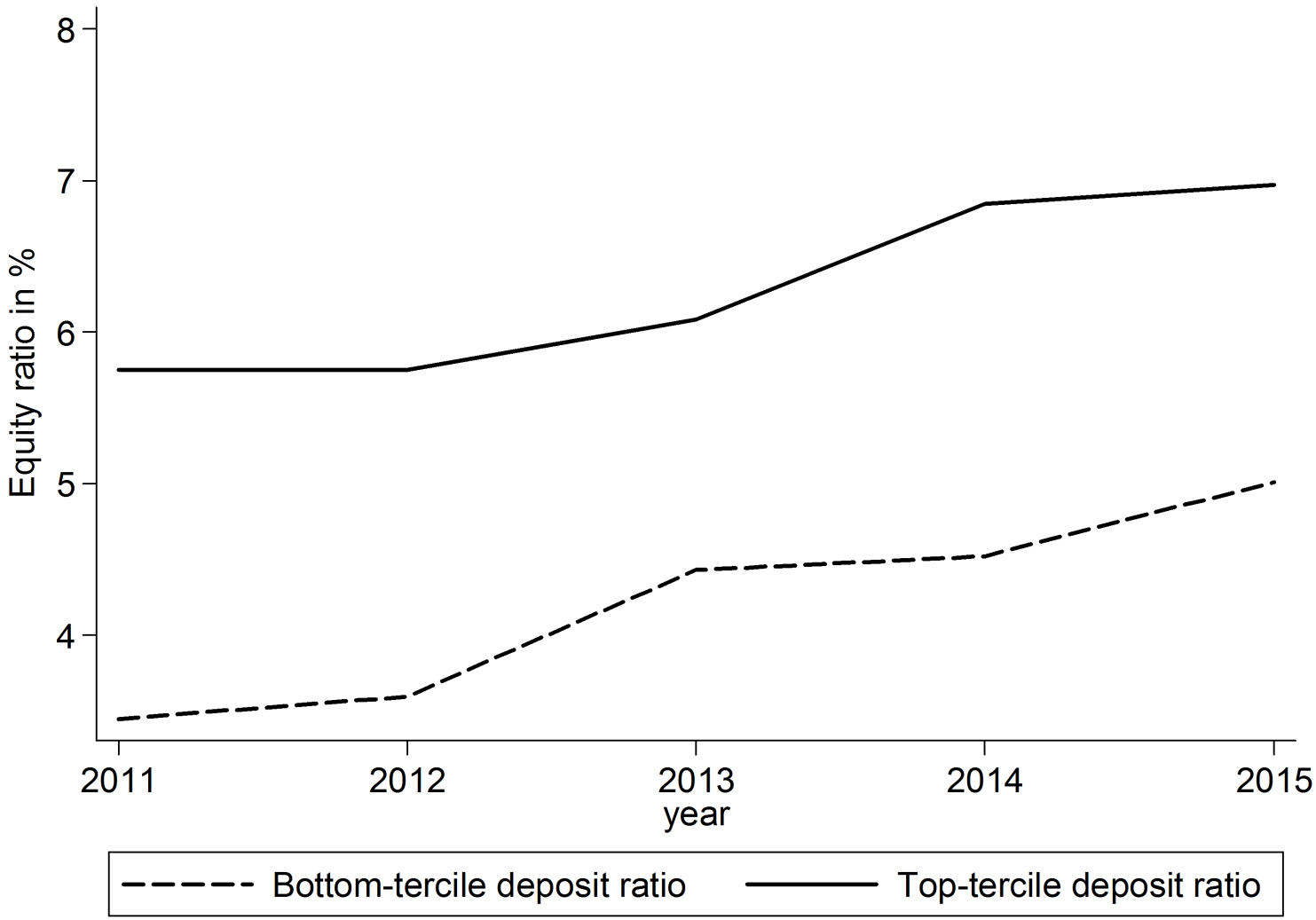
Equity ratios of high-deposit vs. low-deposit banks



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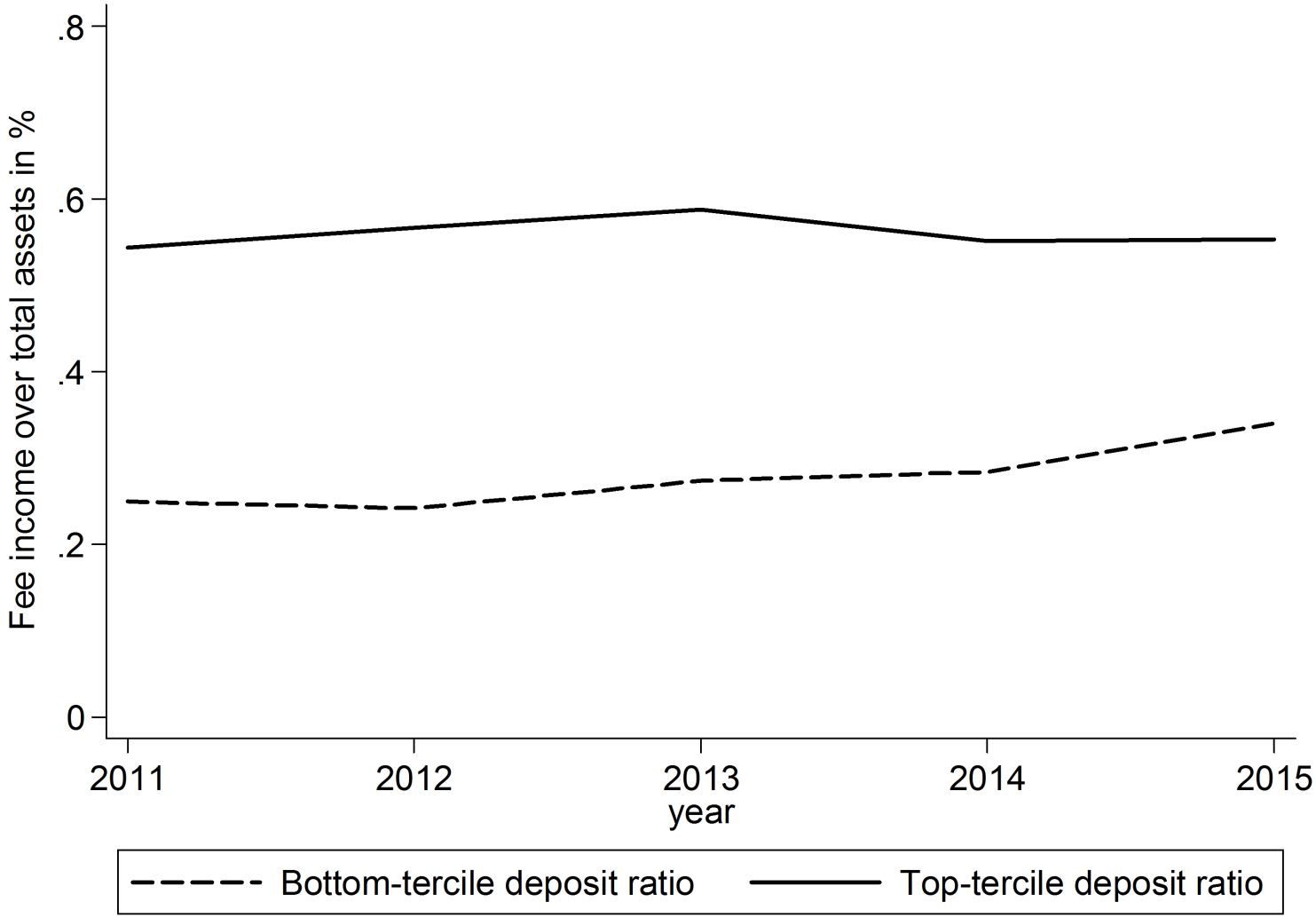
Fee income of high-deposit vs. low-deposit banks



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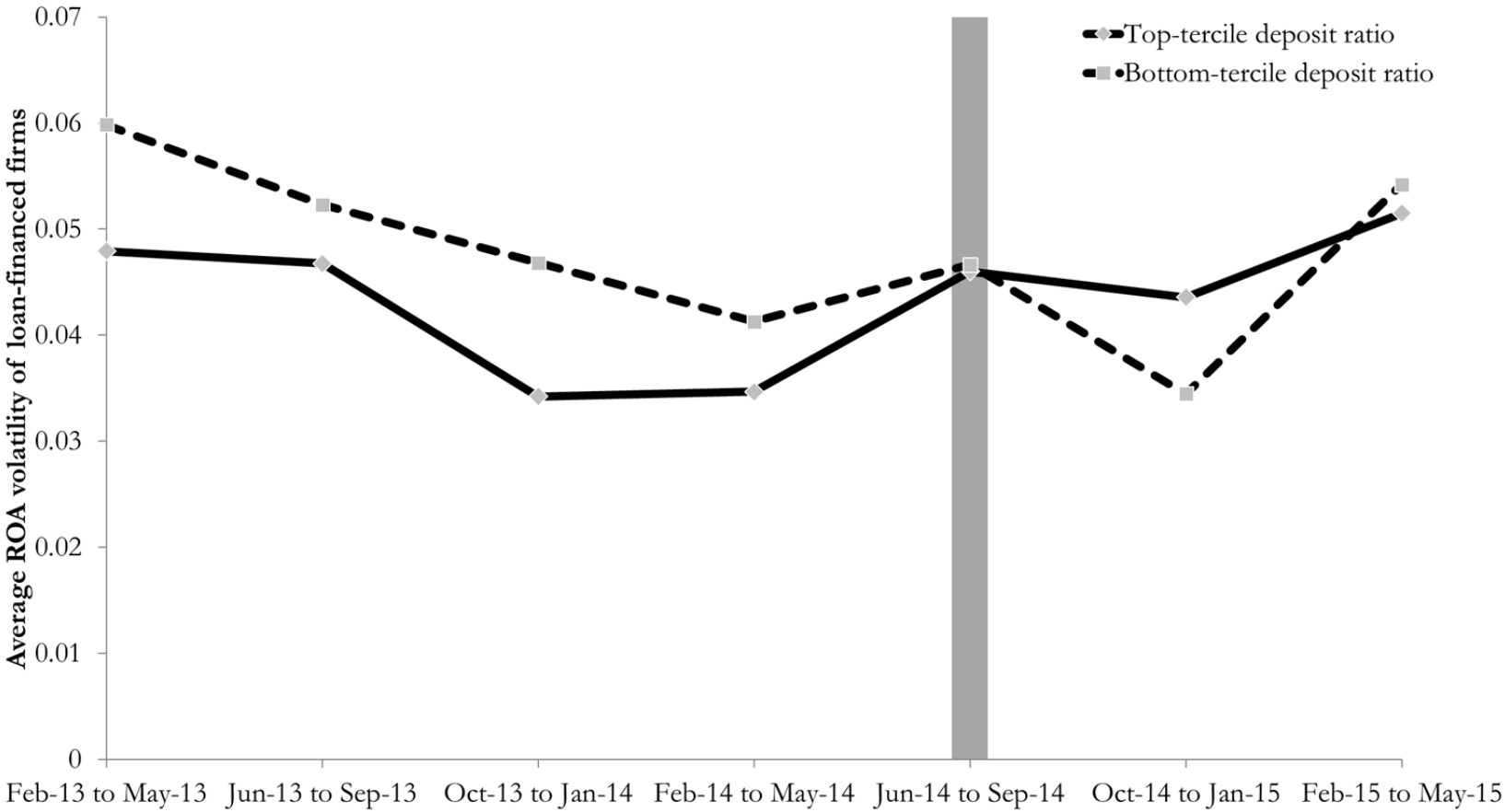
Treatment effect on risk taking by high-deposit vs. low-deposit banks



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ROA volatility of bank-financed firms – robustness

Robustness	$\ln(\sigma(ROA_i)^{5y})$					Alt. definition deposit ratio
Deposit ratio × After(06/2014)	0.020***	0.023***	0.019***	0.022***	0.019***	0.019***
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)
$\ln(\text{Assets})_{t-1}$	0.081			0.029		
	(0.059)			(0.063)		
Securities ratio$_{t-1}$		0.009**		0.014**		
		(0.004)		(0.006)		
Equity ratio$_{t-1}$			0.035	0.105**		
			(0.054)	(0.049)		
Equity ratio × After(06/2014)					0.025	
					(0.051)	
Bank FE	Y	Y	Y	Y	Y	Y
Month-year FE	Y	Y	Y	Y	Y	Y
Country-year FE	Y	Y	Y	Y	Y	Y
Industry-year FE	Y	Y	Y	Y	Y	Y
N	1,576	1,576	1,576	1,576	1,576	1,576

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Former loan spreads of bank-financed firms

Sample	ln(All-in-drawn spread before sample period)					
	2013 – 2015				2011 – 2015	2011 – 2015, non-Euro
Deposit ratio × After(06/2014)	0.012**	0.011**	0.012**	0.010*	0.007	0.041*
	(0.006)	(0.005)	(0.006)	(0.006)	(0.008)	(0.023)
Deposit ratio × After(07/2012)					-0.003	-0.020
					(0.007)	(0.017)
Bank FE	Y	Y	Y	Y	Y	Y
Month-year FE	Y	Y	Y	Y	Y	Y
Country FE	N	Y	N	N	N	N
Industry FE	N	Y	Y	N	N	N
Country-year FE	N	N	Y	Y	Y	Y
Industry-year FE	N	N	N	Y	Y	Y
N	1,218	1,218	1,218	1,218	1,746	445

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Stock-return volatility of bank-financed firms

Sample	$\ln(\sigma(return_i)^{36m})$					
	$2013-2015$				$2011-2015$	$2011-2015$, non-Euro
Deposit ratio × After(06/2014)	0.005*	0.005*	0.007***	0.007***	0.007*	0.002
	(0.003)	(0.003)	(0.002)	(0.003)	(0.004)	(0.014)
Deposit ratio × After(07/2012)					-0.000	0.006
					(0.003)	(0.013)
Bank FE	Y	Y	Y	Y	Y	Y
Month-year FE	Y	Y	Y	Y	Y	Y
Country FE	N	Y	N	N	N	N
Industry FE	N	Y	Y	N	N	N
Country-year FE	N	N	Y	Y	Y	Y
Industry-year FE	N	N	N	Y	Y	Y
N	825	825	825	825	1,348	363

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ROA volatility of bank-financed firms – sample ends in February 2015

	$\ln(\sigma(ROA_i)^{5y})$			
Deposit ratio × After(06/2014)	0.014**	0.012*	0.013$^{(*)}$	0.016*
	(0.007)	(0.007)	(0.008)	(0.008)
Bank FE	Y	Y	Y	Y
Month-year FE	Y	Y	Y	Y
Country FE	N	Y	N	N
Industry FE	N	Y	Y	N
Country-year FE	N	N	Y	Y
Industry-year FE	N	N	N	Y
N	864	864	864	864

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Negative rates outside the Eurozone

Extend sample to include non-Eurozone lenders facing negative rates:

1. Denmark (Nationalbanken): -0.20% in July 2012 (raised in late April 2014, negative again starting September 2014)
2. Sweden (Riksbanken): -0.10% in February 2015
3. Switzerland (SNB): -0.25% on sight deposits exceeding exemption threshold, starting January 2015

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ROA volatility of bank-financed firms – inclusion of Danish, Swedish, and Swiss banks

	$\ln(\sigma(ROA_i)^{5y})$			
Deposit ratio × After	0.011***	0.010**	0.011**	0.012***
	(0.004)	(0.004)	(0.005)	(0.005)
Bank FE	Y	Y	Y	Y
Month-year FE	Y	Y	Y	Y
Country FE	N	Y	N	N
Industry FE	N	Y	Y	N
Country-year FE	N	N	Y	Y
Industry-year FE	N	N	N	Y
N	1,342	1,342	1,342	1,342

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ROA volatility of bank-financed firms: new borrowers

	$\ln(\sigma(ROA_i)^{5y})$			
Deposit ratio × After(06/2014)	0.017***	0.016***	0.017***	0.018***
	(0.005)	(0.005)	(0.006)	(0.006)
Bank FE	Y	Y	Y	Y
Month-year FE	Y	Y	Y	Y
Country FE	N	Y	N	N
Industry FE	N	Y	Y	N
Country-year FE	N	N	Y	Y
Industry-year FE	N	N	N	Y
N	1,468	1,468	1,468	1,468

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ROA volatility of bank-financed firms: potential switchers

	$\ln(\sigma(ROA_i)^{5y})$			
Deposit ratio × After(06/2014)	0.015**	0.013*	0.012	0.020**
	(0.007)	(0.007)	(0.008)	(0.009)
Bank FE	Y	Y	Y	Y
Month-year FE	Y	Y	Y	Y
Country FE	N	Y	N	N
Industry FE	N	Y	Y	N
Country-year FE	N	N	Y	Y
Industry-year FE	N	N	N	Y
N	1,061	1,061	1,061	1,061

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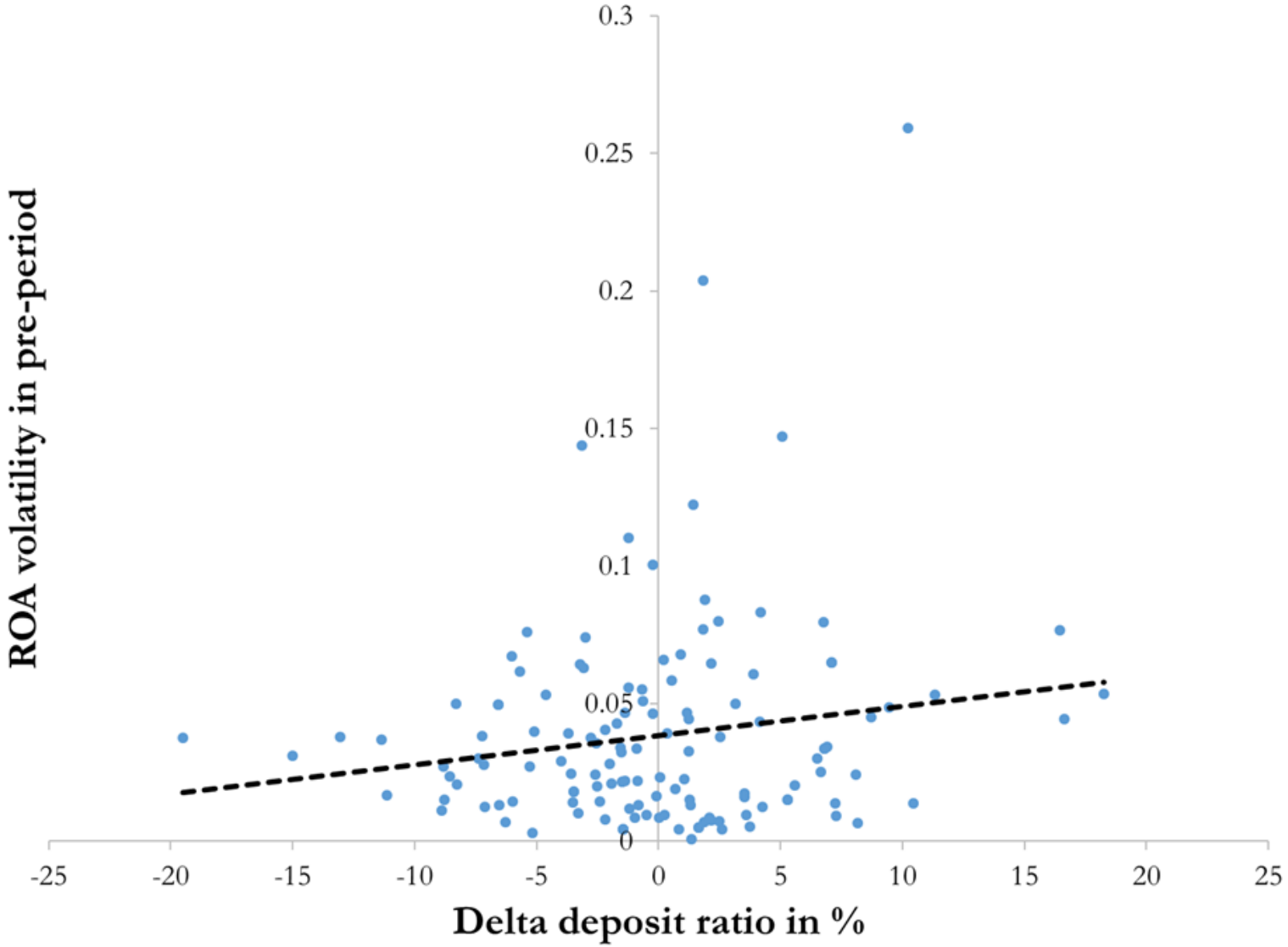
ROA volatility of firms switching banks



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Impact on loan size: new borrowers

	ln(Loan size)				
Deposit ratio × After(06/2014)	-0.000	-0.005	-0.006	-0.006	-0.011
	(0.006)	(0.006)	(0.005)	(0.006)	(0.007)
Deposit ratio × After(06/2014) × $\sigma(ROA_i)^{5y}$					0.284**
					(0.126)
Deposit ratio × $\sigma(ROA_i)^{5y}$					-0.252***
					(0.091)
$\sigma(ROA_i)^{5y}$ × After(06/2014)					-8.584
					(5.413)
$\sigma(ROA_i)^{5y}$					6.886*
					(3.739)
Bank FE	Y	Y	Y	Y	Y
Month-year FE	Y	Y	Y	Y	Y
Country FE	N	Y	N	N	N
Industry FE	N	Y	Y	N	N
Country-year FE	N	N	Y	Y	Y
Industry-year FE	N	N	N	Y	Y
N	1,468	1,468	1,468	1,468	1,468

Back

Impact on loan size: potential switchers

	ln(Loan size)				
Deposit ratio × After(06/2014)	-0.006	-0.002	-0.001	-0.000	0.004
	(0.008)	(0.007)	(0.008)	(0.009)	(0.011)
Deposit ratio × After(06/2014) × $\sigma(ROA_i)^{5y}$					0.021
					(0.177)
Deposit ratio × $\sigma(ROA_i)^{5y}$					-0.207**
					(0.083)
$\sigma(ROA_i)^{5y}$ × After(06/2014)					1.608
					(7.855)
$\sigma(ROA_i)^{5y}$					5.214
					(3.446)
Bank FE	Y	Y	Y	Y	Y
Month-year FE	Y	Y	Y	Y	Y
Country FE	N	Y	N	N	N
Industry FE	N	Y	Y	N	N
Country-year FE	N	N	Y	Y	Y
Industry-year FE	N	N	N	Y	Y
N	1,061	1,061	1,061	1,061	1,061

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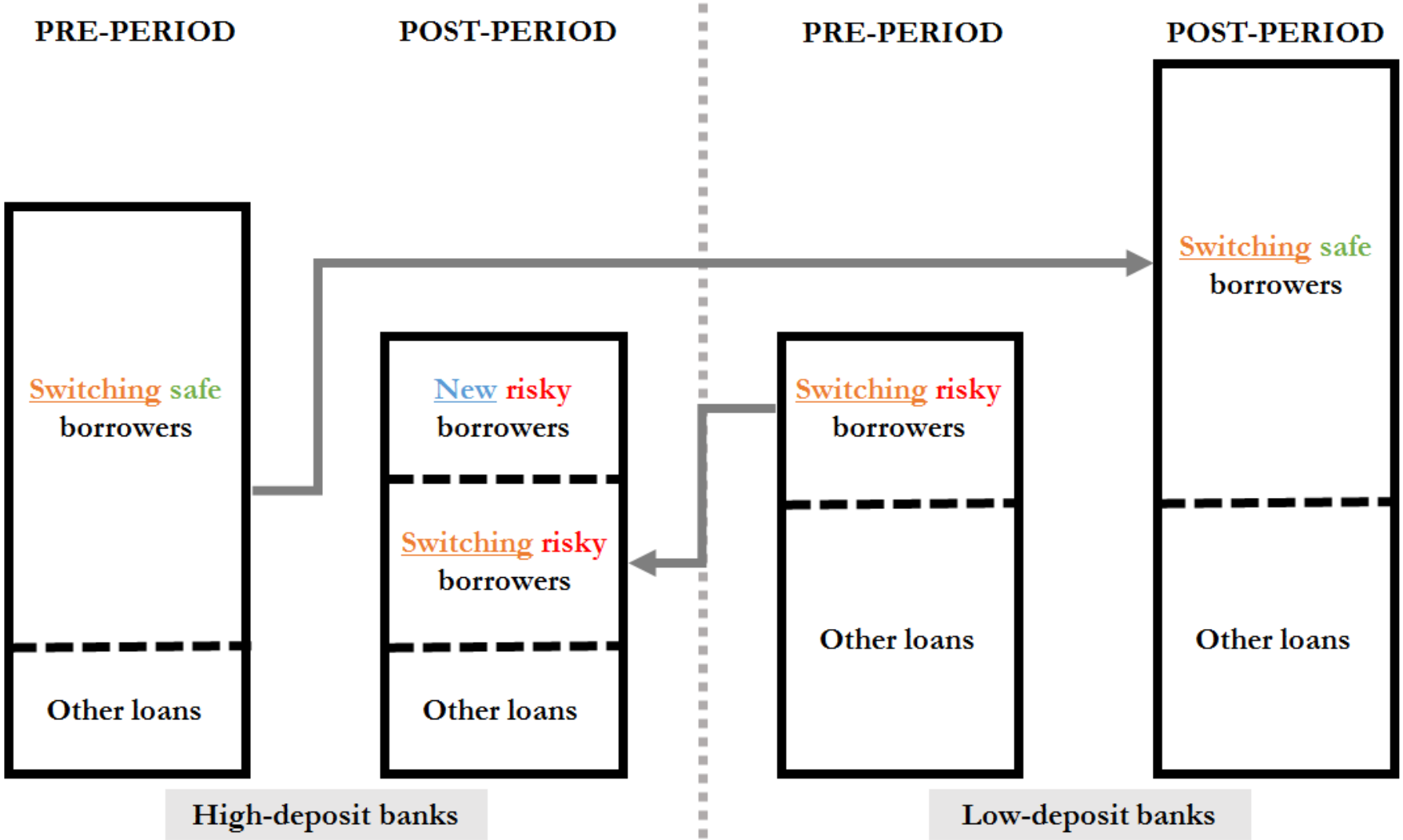
Summary of distributional effects



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Impact on loan spreads

Sample	ln(All-in-drawn spread)					
	2013 – 2015				2011 – 2015	2011 – 2015, non-Euro
Deposit ratio × After(06/2014)	-0.009	-0.006	-0.003	-0.002	-0.001	0.015
	(0.006)	(0.005)	(0.006)	(0.007)	(0.006)	(0.012)
Deposit ratio × After(07/2012)					-0.002	0.002
					(0.004)	(0.015)
Bank FE	Y	Y	Y	Y	Y	Y
Month-year FE	Y	Y	Y	Y	Y	Y
Country FE	N	Y	N	N	N	N
Industry FE	N	Y	Y	N	N	N
Country-year FE	N	N	Y	Y	Y	Y
Industry-year FE	N	N	N	Y	Y	Y
N	791	791	791	791	1,332	367

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Impact on other loan terms

	Secured $\in [0,1]$	Lead share $\in [0,1]$	Covenants $\in \{0,1\}$	ln(Maturity)
Deposit ratio $\times$ After(06/2014)	-0.000	0.003	0.001	-0.001
	(0.003)	(0.002)	(0.001)	(0.002)
Bank FE	Y	Y	Y	Y
Month-year FE	Y	Y	Y	Y
Country-year FE	Y	Y	Y	Y
Industry-year FE	Y	Y	Y	Y
N	986	591	2,450	2,386

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Interaction of treatment with bank capitalization

- Ambiguous evidence using rate decreases in the positive
  - Jiménez et al. (2014) vs. Dell'Ariccia, Laeven, and Suarez (2016)
- Role of bank capitalization for strength of the asset-side channel under negative rates

	$\ln(\sigma(ROA_i)^{5y})$			
Sample	$2013-2015$		$2011-2015$	
	Bottom tercile	Top tercile	Bottom tercile	Top tercile
Deposit ratio × After(06/2014)	0.033***	-0.010	0.031***	-0.010
	(0.010)	(0.014)	(0.010)	(0.015)
Deposit ratio × After(07/2012)			-0.007	-0.006
			(0.008)	(0.016)
Bank FE	Y	Y	Y	Y
Month-year FE	Y	Y	Y	Y
Country-year FE	Y	Y	Y	Y
Industry-year FE	Y	Y	Y	Y
N	527	534	819	832

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