

Credit Supply Shocks and the Real Economy: A Granular View from Bank-Firm Loan Data

[Preliminary Finding]

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What this paper does

Main research question:

- Does finance matter for real economic activity?
- Specifically, do bank-loan supply shocks affect firms' real activity?

Problem in past literature:

- Cannot isolate bank-loan supply shocks from firm-demand shocks

New methodology:

- Pioneered by Amiti and Weinstein (2013)
- Exploit micro-level, matched bank-firm loan data
- Decompose bank-level and firm-level loan growth into 4 components:
 - (1) Bank shock (2) Firm shock (3) Industry shock (4) Common shock

Outline

❑ Data and stylized facts

- LAR, CPFS (and bank balance sheet)

❑ Loan growth decomposition

- Methodology
- Evolution of the granular bank and firm shocks

❑ Validation of the shock estimates

- Bank shock validity
- Firm shock validity

❑ Regression analysis [*prelim results*]

- Bank supply shocks and firm-level investment
- Bank supply shocks and aggregate investment

Data Overview

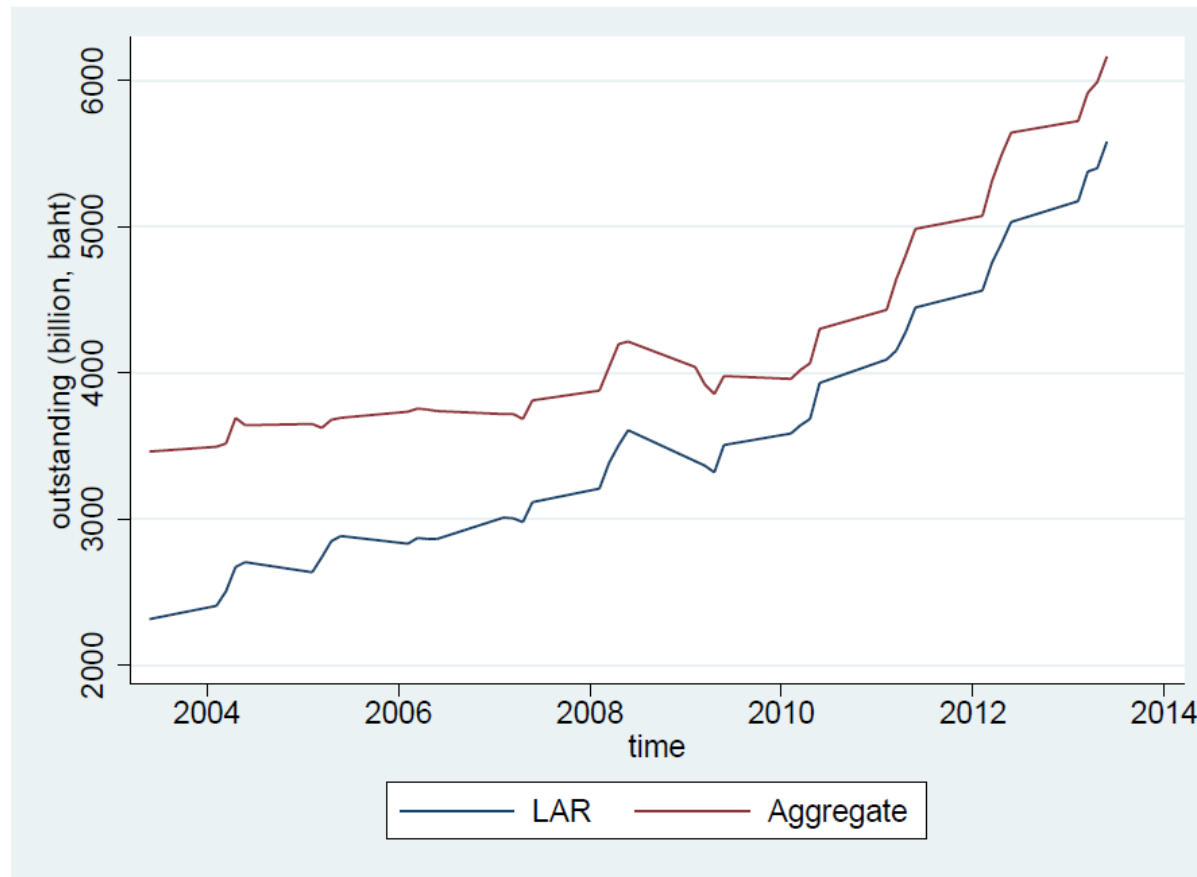
Number of firms (Matched LAR-CPFS)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Small	9,840	11,016	10,978	11,006	12,464	11,408	11,727	12,812	13,558	14,661
Medium	3,447	4,059	4,222	4,346	4,967	4,839	4,910	5,054	5,220	5,733
Large	2,099	2,346	2,425	2,595	2,921	2,852	2,941	2,976	3,255	3,596
Total in LAR	15,386	17,421	17,625	17,947	20,352	19,099	19,578	20,842	22,033	23,990
NCB				131,501	135,262	144,922	151,033	157,880	175,614	188,985
CPFS	131,386	176,015	180,704	193,946	214,448	221,020	225,847	234,534	243,681	227,866

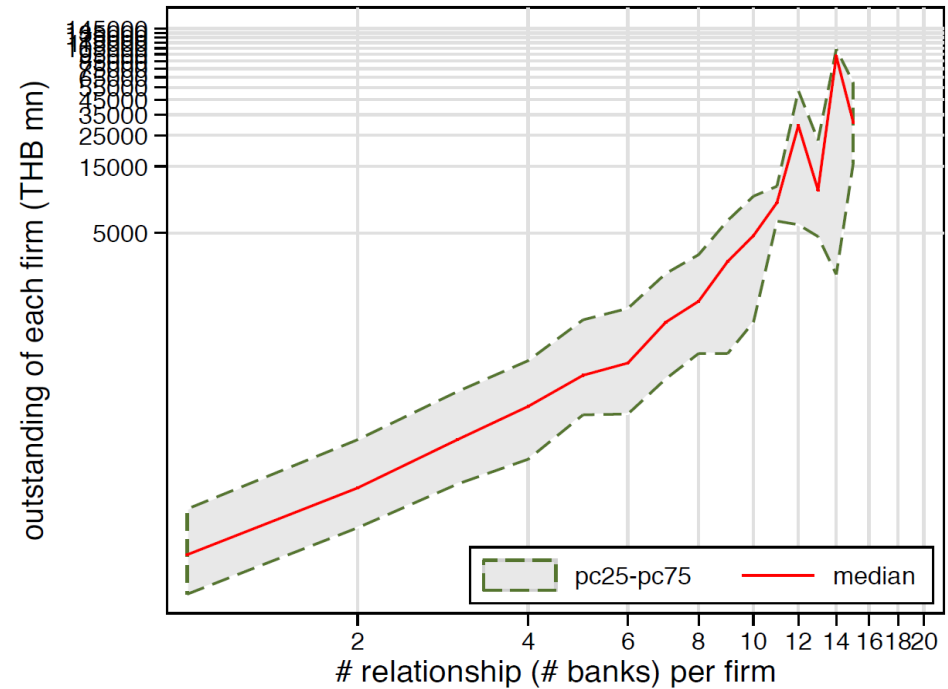
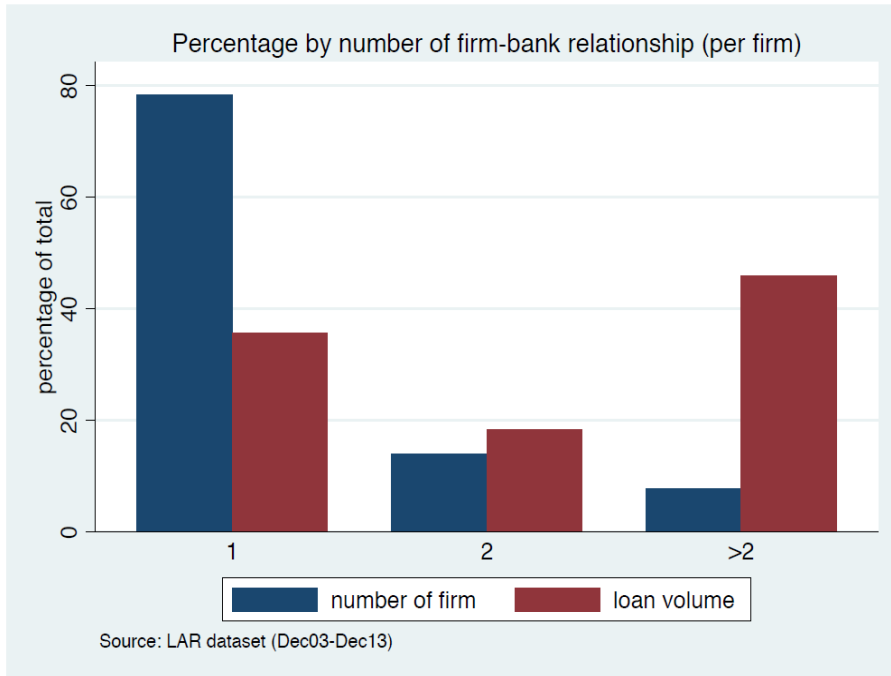
Number of banks (LAR)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
All financial institutions	37	35	32	32	34	33	31	31	29	29
Banks only	31	29	28	28	30	29	28	27	26	26

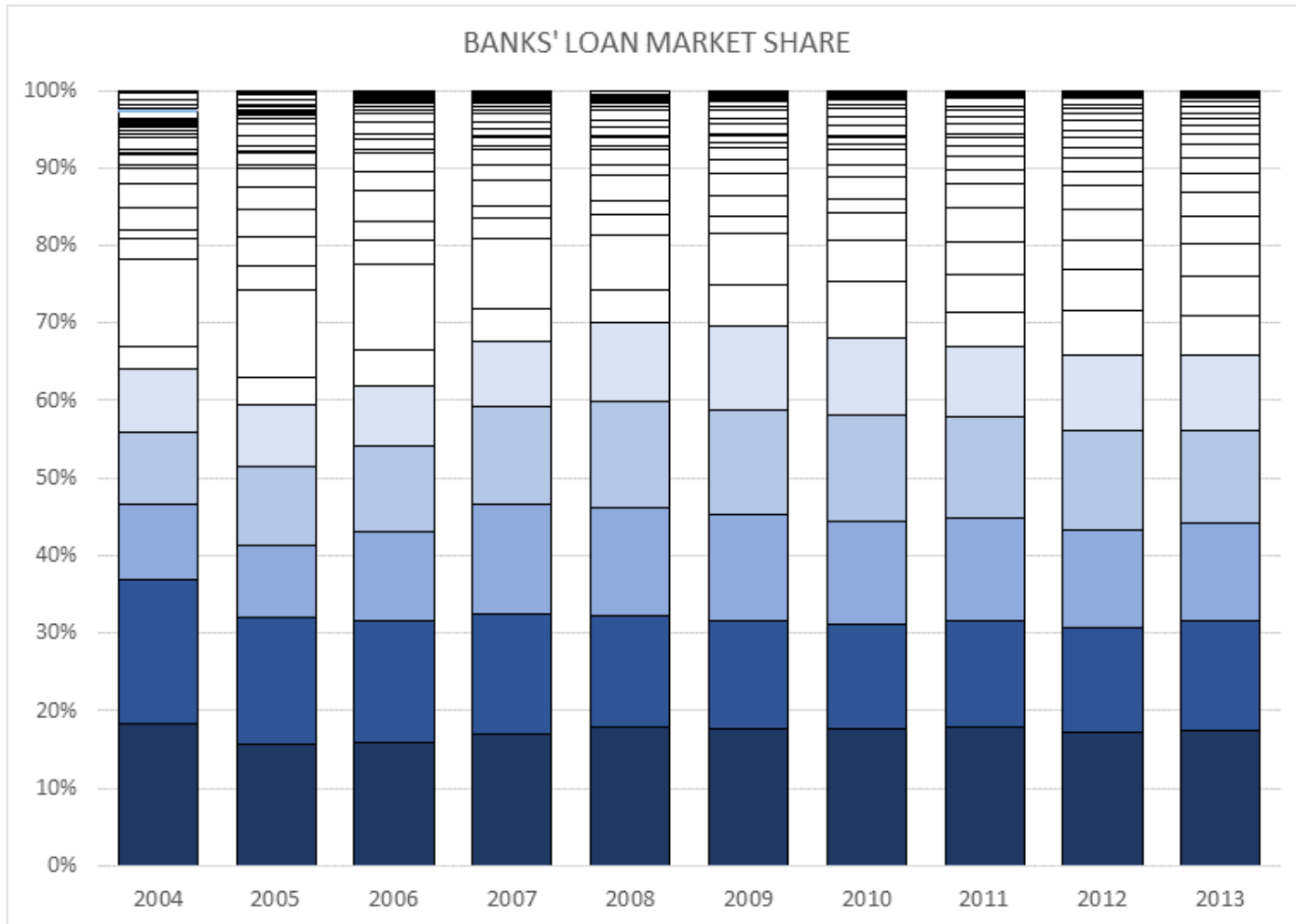
Aggregate loans vs. LAR data



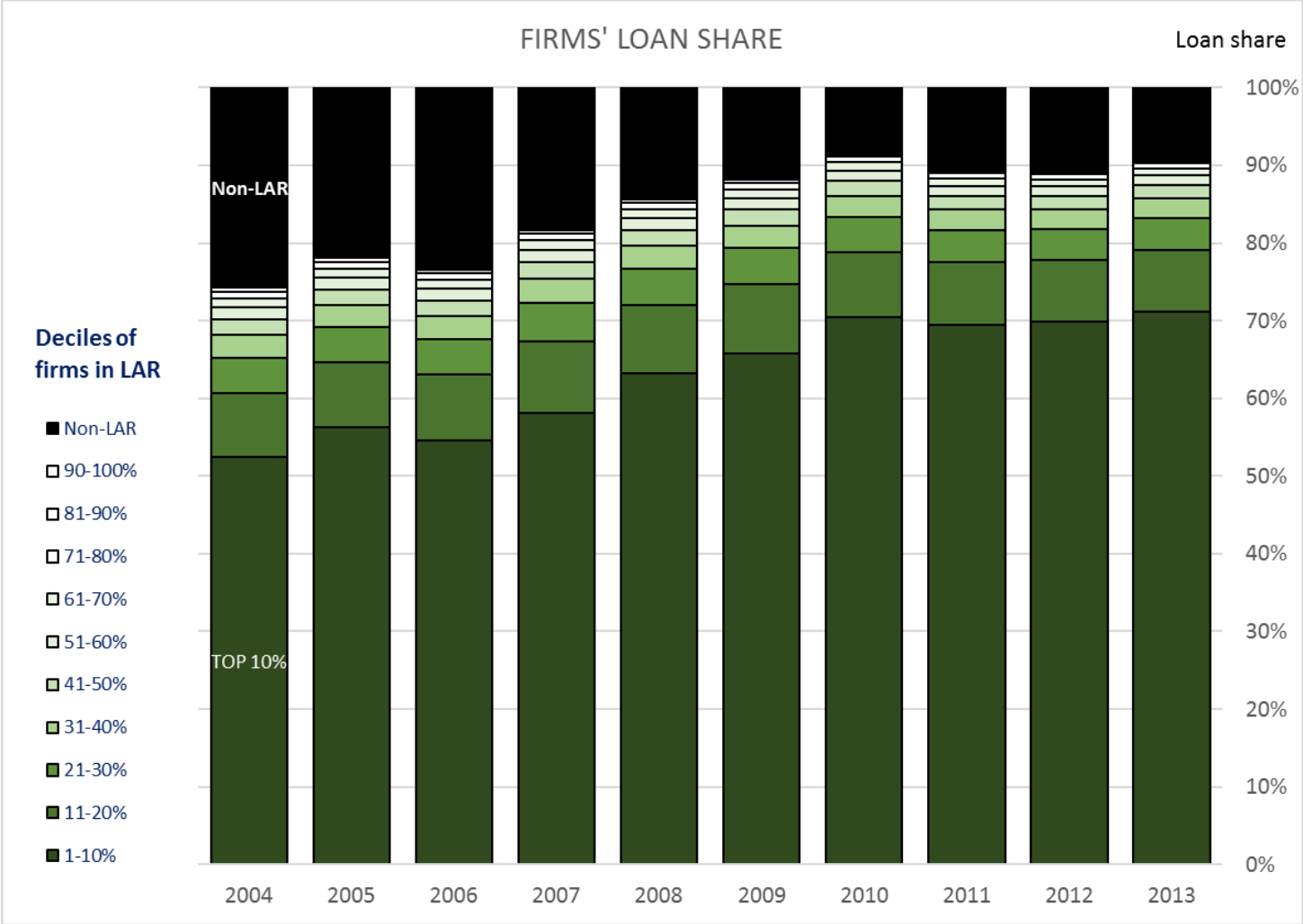
Firm-Bank Relationships



Credit Market Concentration: Bank Side

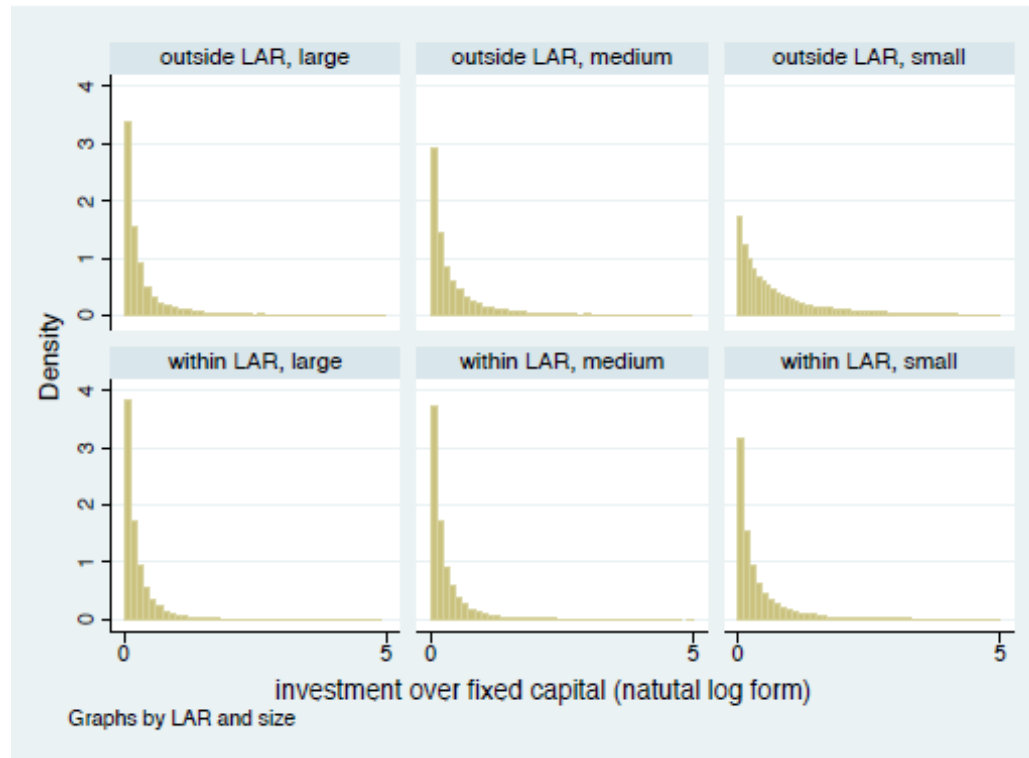


Credit Market Concentration: Borrower Side



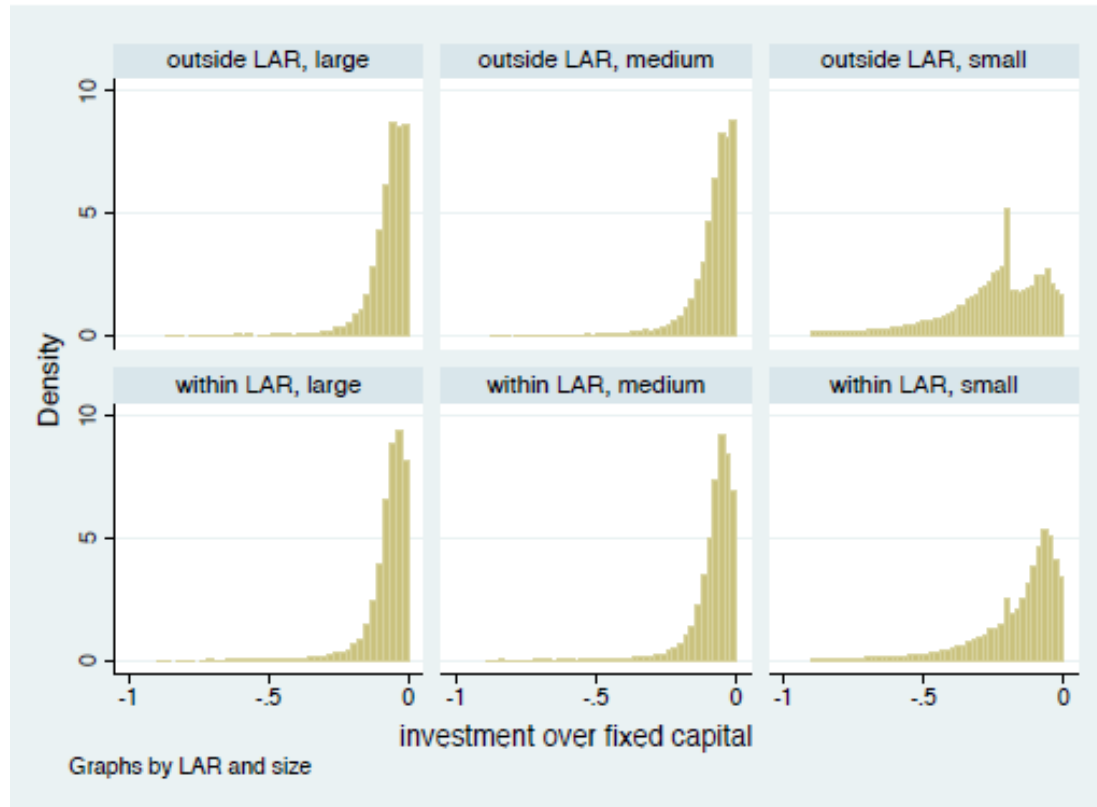
Firm Characteristics: LAR vs. Non-LAR

Positive Investment



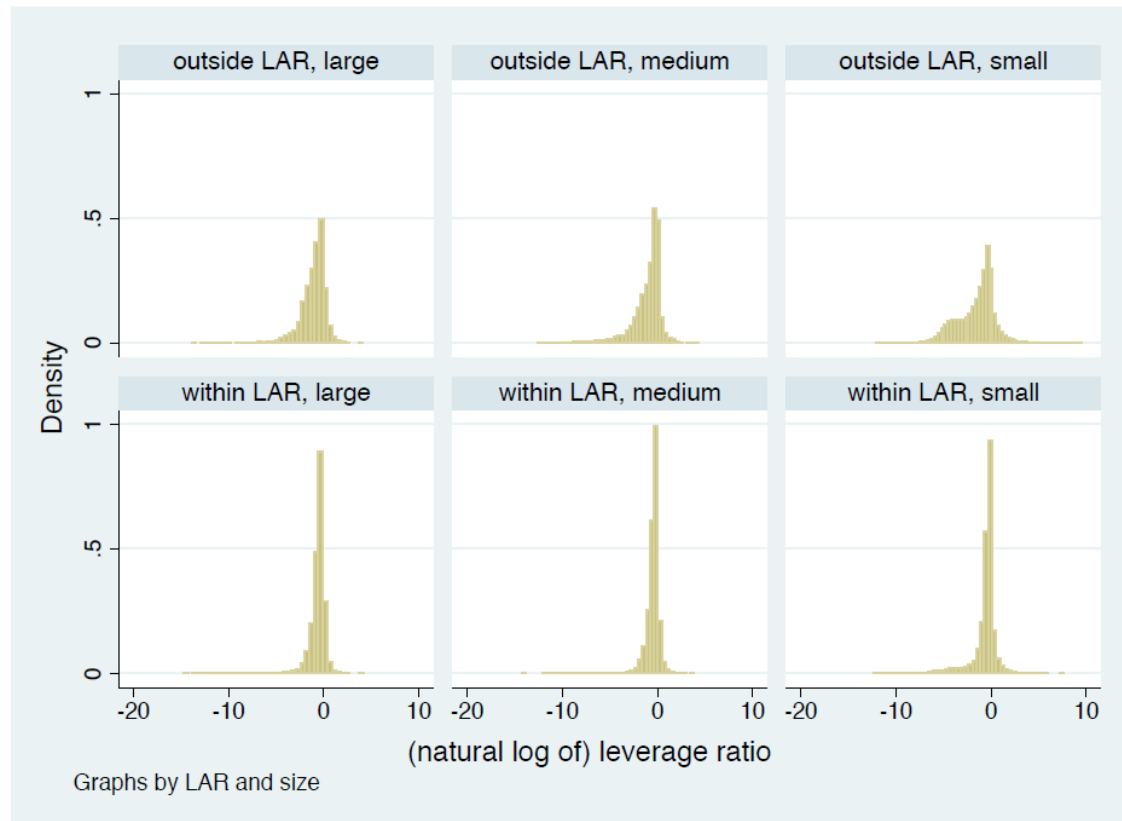
Firm Characteristics: LAR vs. Non-LAR (2)

Negative Investment



Firm Characteristics: LAR vs. Non-LAR (3)

Leverage



Methodology

Bank-level and firm-level loan growth can be written as:

$$\begin{aligned} D_{f,t} &= \text{firmshock}_{f,t} + \sum_b \theta_{fb,t-1} \text{bankshock}_{b,t} \\ D_{b,t} &= \text{bankshock}_{b,t} + \sum_f \phi_{fb,t-1} \text{firmshock}_{f,t} \end{aligned}$$

where $D_{f,t}$ = firm-level loan growth ($f = 1, 2, \dots, F$)

$D_{b,t}$ = bank-level loan growth ($b = 1, 2, \dots, B$)

$\theta_{fb,t-1}$ = loan share of each bank in each firm' loan portfolio

$\phi_{fb,t-1}$ = loan share of each firm in each bank' loan portfolio

$$\sum_b \theta_{fb,t-1} = 1 \text{ and } \sum_f \phi_{fb,t-1} = 1$$

With $F+B$ equations and $F+B$ unknowns, we can solve for a unique set of firm and bank shocks (up to a numeraire) in each time period.

Shock Decomposition: A Matrix Form:

Input:

Each firm's total loan growth

$$\hat{D}_{Ft} \equiv \begin{pmatrix} D_{2t}^F - D_{1t}^F \\ \vdots \\ D_{Ft}^F - D_{1t}^F \end{pmatrix}$$

Each bank's total loan growth

$$\hat{D}_{Bt} \equiv \begin{pmatrix} D_{2t}^B - D_{1t}^B \\ \vdots \\ D_{Bt}^B - D_{1t}^B \end{pmatrix}$$

Each bank's share in a firm's total loan

$$\hat{\Theta}_t \equiv \begin{pmatrix} \hat{\theta}_{22t} & \dots & \hat{\theta}_{2Bt} \\ \vdots & \ddots & \vdots \\ \hat{\theta}_{F2t} & \dots & \hat{\theta}_{FBt} \end{pmatrix}$$

Each firm's share in a bank's total loan

$$\hat{\Phi}_t \equiv \begin{pmatrix} \hat{\phi}_{22t} & \dots & \hat{\phi}_{F2t} \\ \vdots & \ddots & \vdots \\ \hat{\phi}_{2Bt} & \dots & \hat{\phi}_{FBt} \end{pmatrix}$$

Output:

Firm shocks

$$\hat{A}_t \equiv \begin{pmatrix} \alpha_{2t} \\ \vdots \\ \alpha_{Ft} \end{pmatrix}$$

Bank shocks

$$\hat{B}_t \equiv \begin{pmatrix} \hat{\beta}_{2t} \\ \vdots \\ \hat{\beta}_{Bt} \end{pmatrix}$$

$$\hat{A}_t = \hat{D}_{Ft} - \hat{\Theta}_{t-1} \hat{B}_t$$

$$\hat{B}_t = \hat{D}_{Bt} - \hat{\Phi}_{t-1} \hat{A}_t.$$

Shock Decomposition

After obtaining firm and bank shocks, we extract common and industry shock as follows:

$$\text{commonshock}_t = \text{median}(\text{firmshock}_{f,t}) + \text{median}(\text{bankshock}_{b,t})$$

$$\text{industryshock}_{n,t} = \text{median}(\widetilde{\text{firmshock}}_{f,t})_{f \in N}$$

and the residual firm and bank shocks:

$$\text{firm-specific shock}_{f,t} = \text{firmshock}_{f,t} - \text{median}(\text{firmshock}_{f,t}) - \text{industry}_{n,t}$$

$$\text{bank-specific shock}_{b,t} = \text{bankshock}_{b,t} - \text{median}(\text{bankshock}_{b,t})$$

That is, each bank's aggregate lending can be exactly decomposed into four terms:

$$\begin{aligned} D_{b,t} = & \text{commonshock}_t + \text{bank-specific shock}_{b,t} \\ & + \sum \phi_{fb,t-1} \text{industry}_{n,t} + \sum \phi_{fb,t-1} \text{firm-specific shock}_{f,t} \end{aligned}$$

Interpretation of shock components

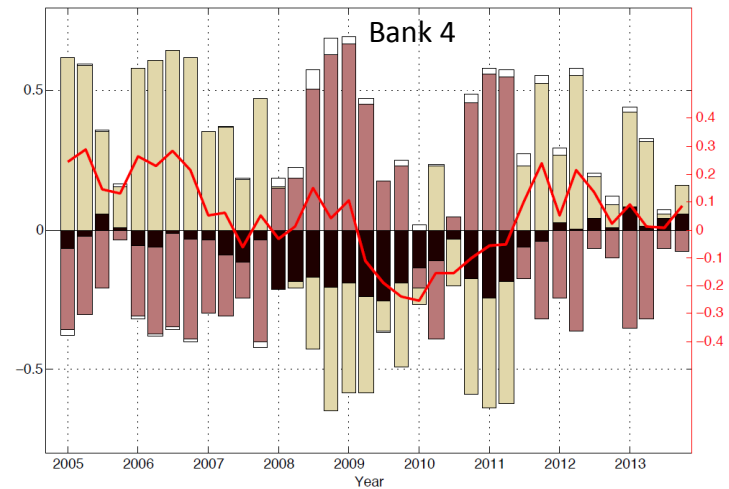
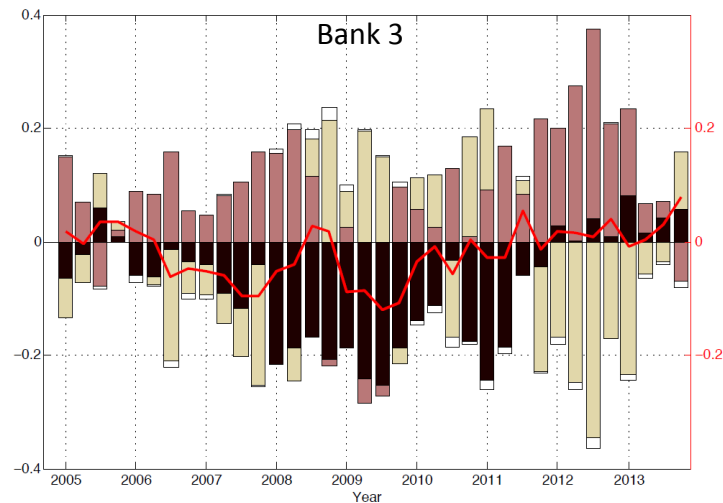
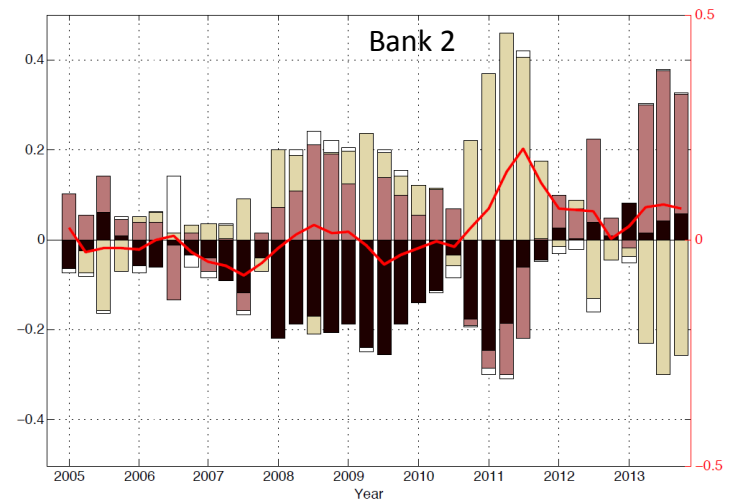
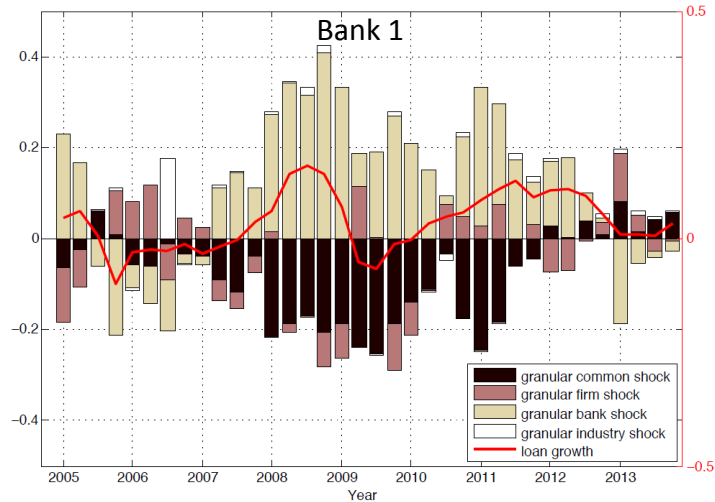
Common shock: changes in loan growth that are common across all bank-firm lending pairs, e.g. monetary policy shock, global shock

Industry shock: changes in loan growth that may arise due to bank's loan portfolio that is skewed towards certain industries experiencing shocks

Firm-borrowing shock: changes in loan growth that arise due to idiosyncratic changes in firms' borrowing demand, firm-level productivity shocks, firm-level credit constrained, etc.

Bank supply shock: changes in loan growth due to idiosyncratic changes in bank's loan supply (relative to the median bank shock) that could be driven by changes in the cost of capital, liquidity, balance sheet health, etc.

Bank Supply Shock: Selected Banks



Aggregate-Level Granular Shocks

We now can obtain a decomposition of *aggregate* loan growth into “granular shocks” using the previous bank-level shocks:

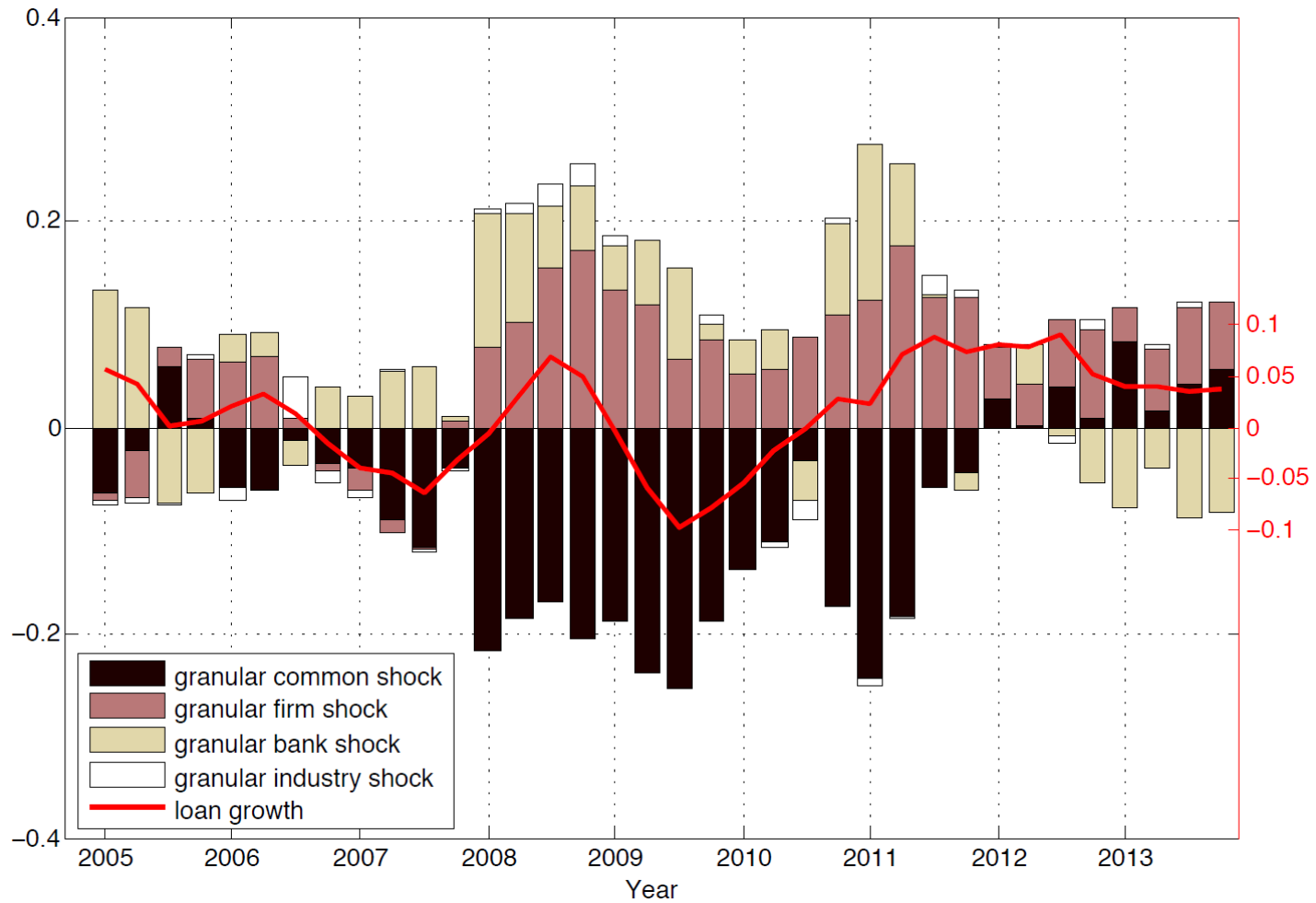
$$\begin{aligned} D_t &= \sum_b W_{b,t-1} D_{b,t} \\ &= common_t + \sum_b W_{b,t-1} industryshock_{b,t} + \sum_b W_{b,t-1} bankshock_{b,t} + \sum_b W_{b,t-1} firmshock_{b,t} \\ &= common_t + granular.indus.shock_t + granular.firm.shock_t + granular.bank.shock_t \end{aligned}$$

where D_t = country-level aggregate loan growth,

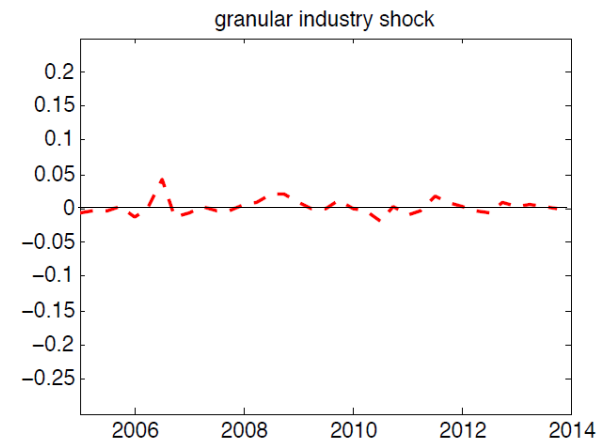
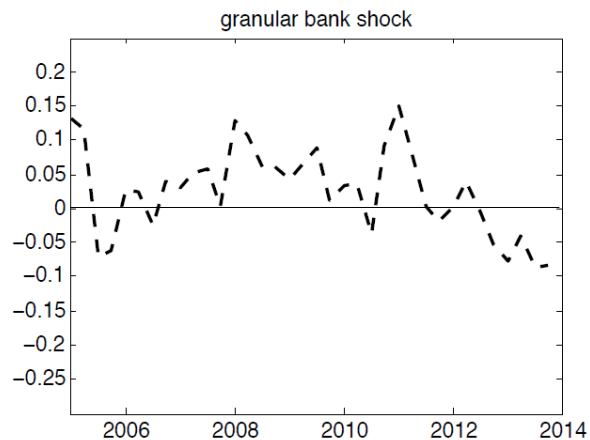
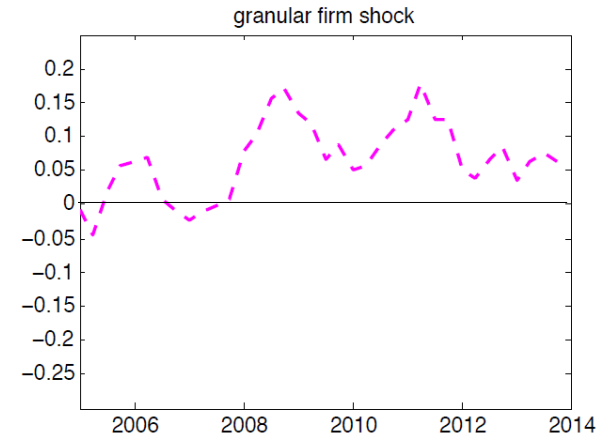
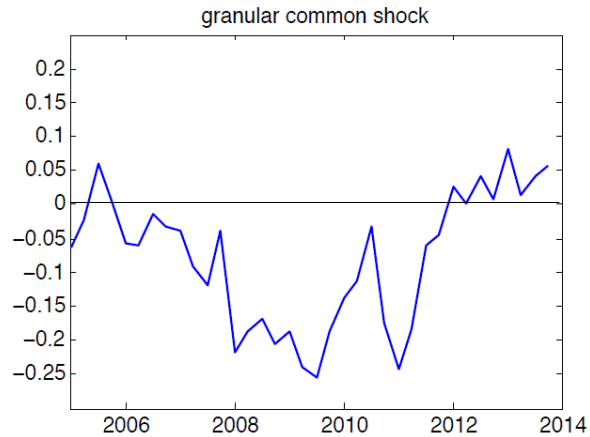
$W_{b,t}$ = the average share of each bank b in aggregate lending in year t

These time-varying granular shocks can be used to study how different shocks affect the real variables at the aggregate level

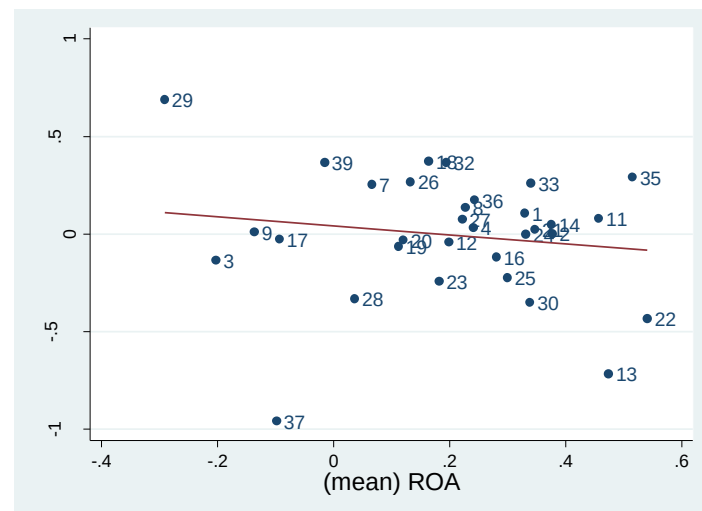
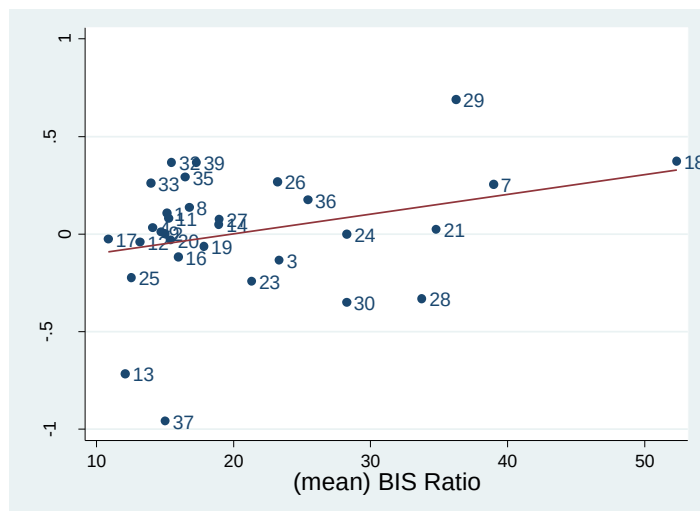
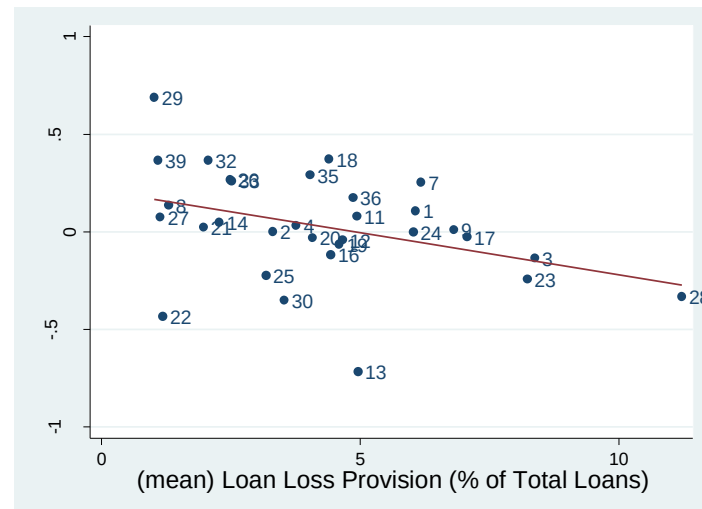
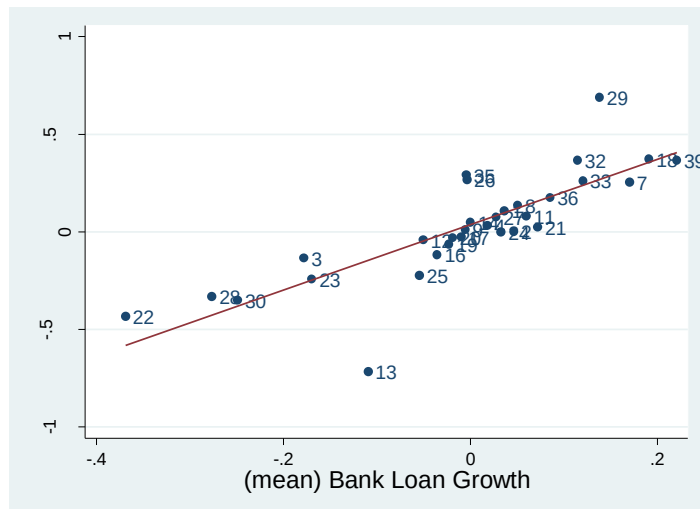
Granular Shock Decomposition of Aggregate Loan Growth



Granular Shock Decomposition of Aggregate Loan Growth (2)



Validation of Bank Supply Shocks (2005-2013)



Validation of Bank Supply Shocks (2)

Dependent Variable: Bank Shock	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
BIS ratio	0.007** (2.574)							0.008*** (2.815)	0.011*** (3.572)
NPL growth		-0.000* (-1.908)						-0.000*** (-2.697)	-0.000* (-1.937)
Loan loss provision			-0.020*** (-3.701)					-0.016*** (-2.965)	-0.017*** (-3.024)
Short-term investment/Total assets				-0.008*** (-3.314)				-0.007*** (-2.934)	-0.003 (-1.425)
Debt/Total liabilities					0.003** (2.176)			0.003** (2.445)	0.004*** (2.730)
ROA						0.021 (0.593)		-0.041 (-1.046)	-0.046 (-1.163)
Foreign bank dummy							-0.110*** (-3.166)		-0.182*** (-5.003)
Constant	-0.148* (-1.727)	-0.031 (-0.437)	0.093 (1.260)	0.158 (1.216)	-0.022 (-0.303)	0.086 (0.674)	0.051 (0.645)	-0.049 (-0.534)	-0.024 (-0.266)
Observations	928	911	928	928	928	928	928	911	911
R-squared	0.044	0.020	0.036	0.038	0.025	0.020	0.030	0.083	0.105
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES

Robust t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

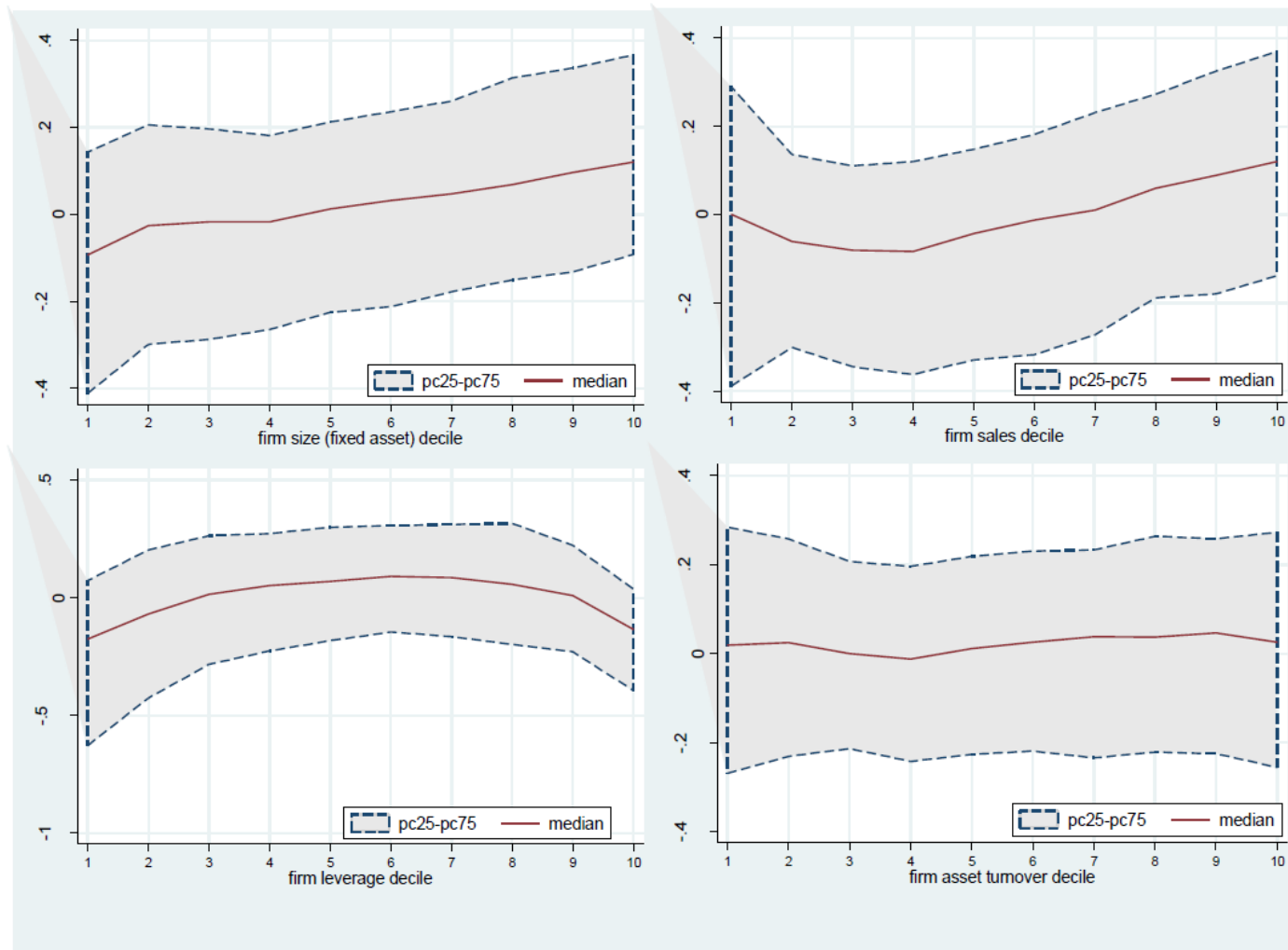
Validation of Bank Supply Shocks (3)

Two-sample t test of the equality of bank shock means: **Local banks VS. Foreign banks**

Group	Obs	Mean	Std. Dev.	Diff(Mean)	H ₀ : diff = 0			
					Equal variances		Unequal variances	
					t value	Prob	t value	Prob
<i>Full period (2005-2013)</i>								
Local	13	0.029	0.338	0.054	0.455	0.652	0.451	0.656
Foreign	19	-0.025	0.322					
<i>Pre-GFC (2005-2007)</i>								
Local	12	0.007	0.130	-0.072	-0.775	0.445	-0.894	0.380
Foreign	18	0.078	0.301					
<i>GFC (2008-2009)</i>								
Local	13	0.326	0.537	0.478	2.745	0.010	2.653	0.014
Foreign	17	-0.152	0.418					
<i>Post-GFC (2010-2013)</i>								
Local	13	-0.028	0.683	-0.001	-0.007	0.995	-0.006	0.995
Foreign	15	-0.027	0.330					

Bank shocks generated by banks with foreign origins are statistically significantly more negative than Thai local banks during the GFC

Validation of Firm Shocks



Validation of Firm Shocks

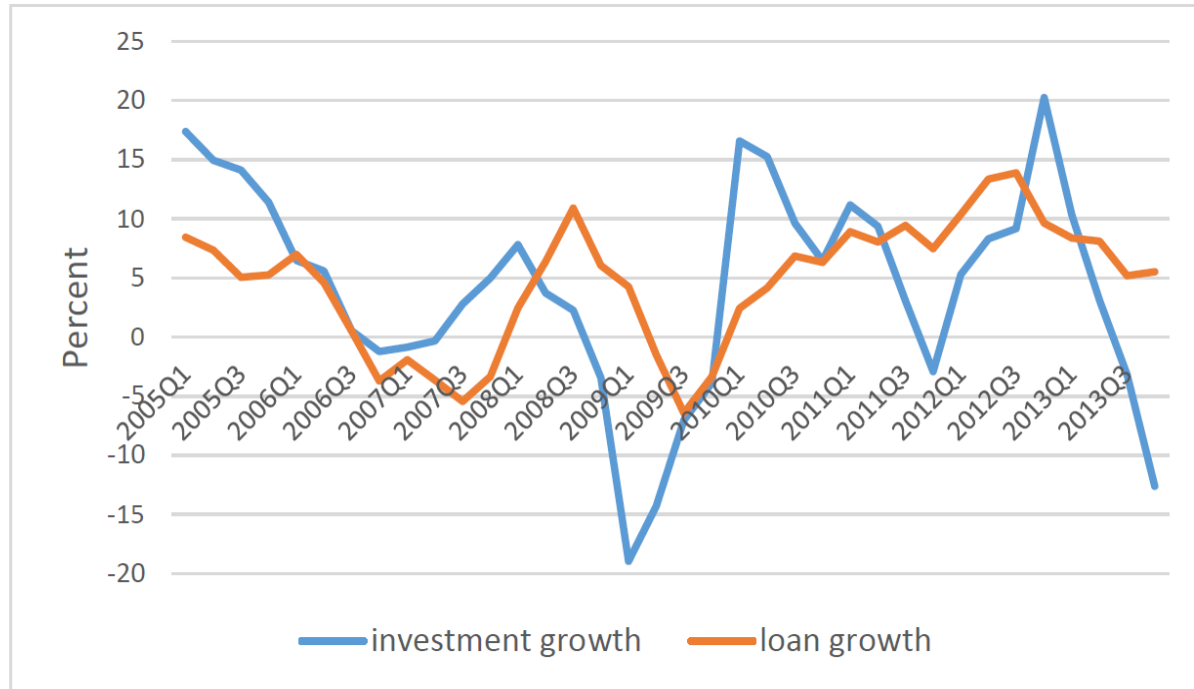
Firm Shocks VS. Firm Characteristics

VARIABLES	Firm Shock	Firm Shock	Firm Shock	Firm Shock
	(1)	(2)	(3)	(4)
Mean log of k_t	0.039*** (27.465)			
Mean log of $sales_t$		0.033*** (21.859)		
Mean of leverage ratio			-0.000*** (-78.312)	
Mean of asset turnover ratio				0.001 (0.152)
Constant	-0.612*** (-25.698)	-0.597*** (-22.692)	-0.014*** (-5.554)	0.030*** (8.193)
Observations	33,223	31,404	38,526	33,312
R-squared	0.024	0.016	0.000	0.000

Regression Analysis

Question: Do bank loan supply shocks affect firm's investment?

Aggregate investment growth VS. Corporate loan growth (LAR)



Results: Firm-Level Investment

VARIABLES	Full Sample			
	(1) Investment	(2) Investment	(3) Investment	(4) Investment
Debt Growth	0.249***			
Bank Shock		0.086***	0.084***	0.086***
Firm Shock		0.081***	0.079***	0.086***
Industry Shock		0.127***	0.128***	0.138***
Bank Shock*Lev				0.001
Firm Shock*Lev				-0.001***
Leverage	-0.017***	0.007***		0.003***
Constant	0.059***	0.026***	0.066***	0.066***
Observations	99,231	97,243	100,947	98,912
Number of firms	26,536	26,294	27,028	26,607
R-squared	0.122	0.084	0.032	0.035
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Firm characteristics ^{1/}	YES	YES	NO	NO

1/ Including ROA, current asset/capital (log), net profit/capital (log)

Results: Firm-Level Investment (2)

Dep Var: Investment	Small				Medium				Large			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Debt Growth	0.191***				0.344***				0.337***			
Bank Shock		0.068***	0.058***	0.058***		0.094***	0.099***	0.093***		0.083***	0.086***	0.098***
Firm Shock		0.060***	0.054***	0.057***		0.087***	0.092***	0.103***		0.086***	0.089***	0.100***
Industry Shock		0.180**	0.166**	0.174**		0.055*	0.072*	0.083**		0.048	0.060	0.061*
Bank Shock*Lev				0.002				0.008				-0.004
Firm Shock*Lev				-0.000				-0.001***				-0.001**
Leverage	-0.012***	0.007***		0.002***	-0.023***	0.017***		0.009***	-0.022***	0.013**		0.013**
Constant	-0.145***	-0.162***	0.002	0.004	0.294***	0.240***	0.158***	0.143***	0.294***	0.235***	0.152***	0.128***
Observations	57,286	56,145	59,623	57,743	26,152	25,733	25,897	25,782	15,793	15,365	15,427	15,387
Number of firms	17,990	17,777	18,486	18,081	7,946	7,879	7,925	7,894	4,166	4,133	4,147	4,137
R-squared	0.109	0.081	0.013	0.015	0.363	0.260	0.139	0.146	0.355	0.242	0.152	0.158
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm characteristics^{1/}	YES	YES	NO	NO	YES	YES	NO	NO	YES	YES	NO	NO

1/ Including ROA, current asset/capital (log), net profit/capital (log)

Results: Aggregate Investment

Variable	loan growth		investment growth	
	(1)	(2)	(3)	(4)
common shock _t	1.148**	1.670**	0.775**	0.856**
industry shock _t	0.878**	1.147**	-0.897	-0.113
firm shock _t	1.431**	1.168**	0.226	0.140
bank shock _t	1.079**	1.024**	0.954**	0.688**
Intercept	0.026**	-0.00**	0.066	0.000
Standardised Var	No	Yes	No	Yes
Observation	36	36	36	36
R^2	0.88	0.88	0.23	0.23
<i>Shapley R-square</i>				
common shock _t	0.346	0.346	0.453	0.453
industry shock _t	0.027	0.026	0.136	0.136
firm shock _t	0.494	0.494	0.130	0.130
bank shock _t	0.133	0.133	0.281	0.281

What's Next

- ❑ How much do bank supply shocks matter:
 - Regress LAR bank shocks on non-LAR firms' investment (using NCB loan outstanding to calculate loan shares)
 - Explore firms with different number of relationships
- ❑ Further bank shock validation:
 - Compare bank shocks to bank-by-bank Loan Officer Survey data
- ❑ Test the importance of bank shocks for other variables:
 - Firms' revenue, profitability, exports, etc.