Ownership Network and Firm Growth: What Do Five Million Companies Tell About Chinese Economy

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Motivation

- Huge success of Chinese economic growth in the last four decades; while a lagging developed financial system
  - Allen, Qian, and Gu (2017); Song and Xiong (2018)
  - Allen, Qian, Qian (2005)
  - A state-dominant financial system contributes to the growth of the state-owned sector, under state capitalism

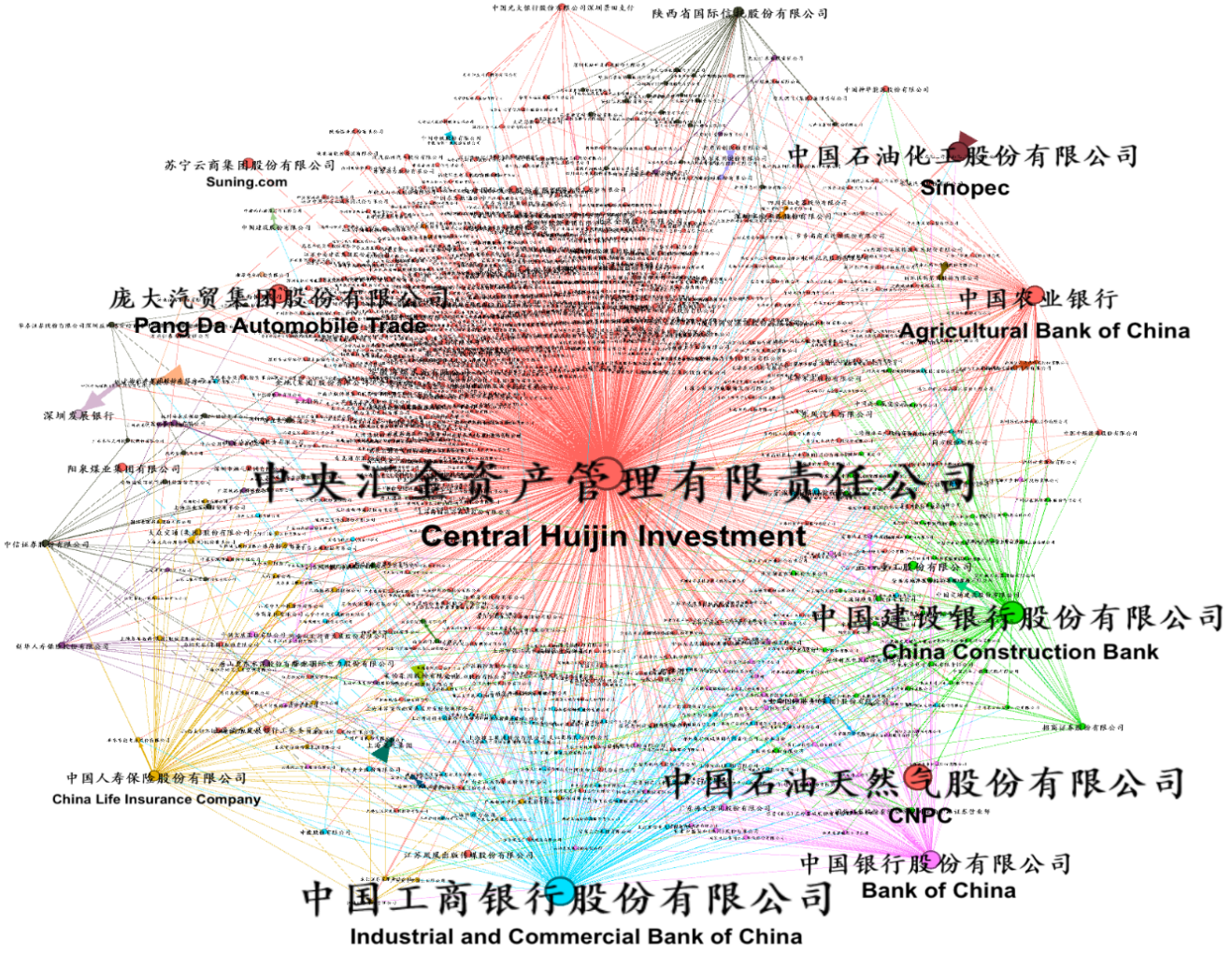
- China's growth model
  - "Grasp the large, let go of the small" (Hsieh and Song, 2015)
  - Privatization plays an important role in promoting growth (Chen, Igami, Sawada, and Xiao, 2018; Huang, Li, Ma and Xu, 2017)
  - Song, Storesletten and Zilibotti (2011)

- Better understanding of Chinese economy
  - How the private sector emerged and grew in a credit constrained environment without sufficient access to formal financing
  - Map out the network of the whole economy using bilateral equity ownership
  - How the equity ownership network contributes to the real growth of the economy over time

Research Questions

- Unique data
  - Firm-to-firm equity investments for all registered firms in China (over *40 mm after dropping self-employed businesses*)
- The allocation of equity capital
  - Structure of equity ownership networks (Cai et al., 2020)
  - How do firms' bilateral equity investments evolve over time
    - Industry distribution: does capital mainly flow to risky industries (e.g. real estate)?
    - geographic distribution (Cai et al., 2020)
- How a firm's position in ownership networks contributes to its growth?
  - Network positions (centrality) and firm growth
  - Does equity capital *complement* or *substitute* bank loans in terms of promoting real growth?
  - Does equity capital favor more SOEs or nonSOEs?

Network visualization: a significant SOE



Literature

- Finance-growth nexus for Chinese economy
  - Leading role of the banking system in supporting growth has been widely documented
    - An overview of China's financial system and growth model
      - *Allen, Gu and Qian (2017); Song and Xiong (2018)*
    - Deteriorating efficiency of credit allocation via standard banking sector
      - *Bai, Hsieh and Song (2016); Chen and Wen (2017); Cong el al. (2019)*
    - Recent growth of shadow banking satisfied the financing needs of the credit constrained industries
      - *Allen, Qian, Tu, Yu (2019); Allen, Gu, Qian, Qian (2019b); Chen, He and Liu (2019); Acharya, Qian, Yang (2018)*
  - Very scarce evidence on the allocation of equity capital
- Social/economic networks and economic outcomes
  - Decision making *(Laumann et al., 1977; Larcker, So and Wang, 2013, Gao, 2015)*
  - Information diffusion *(Ahern, 2017)*
  - Industrial organization *(Ahern and Harford, 2014; Herskovic et al., 2019)*

Preview of Results

- Using the complete equity ownership networks for all the registered firms in China, we provide a first piece of evidence showing how capital is allocated in the network, and how it contributes to growth under state capitalism.
- *How does the network look like?* - The equity ownership network has been expanding dramatically since 2000s
  - The number of in-network firms tripled
  - Large firms are more likely to connect to other firms, as investors/investees; New entrants, fewer connections
  - *Cross share holding* is rare in China (below 0.5%)
- *Network and growth* - A firm's network position affects firm's future growth.
  - A large proportion (roughly 43%) of financing comes from equity capital.
  - Entering ownership networks is associate with significantly higher real growth
  - In-network firms with higher network centrality tend to have improved real growth
    - Of the five network measures, *eigenvector* has the largest economic impact, closely followed by *degree* centrality
    - One-std-dev increase in eigenvector centrality can improve growth by 23.7 percent
  - Given the in-network reality, the average effect of network centrality on growth decrease over years, and has been *diminishing* since 2009.

Preview of Results

- Heterogeneity
  - The effect of network on real growth tends to be more pronounced for high-productivity firms (esp for firms with financial constraints) and less pronounced for firms with state connections
  - *Global vs. Local effect*
    - Controlling for local centrality, the effect of global centrality is still positive and significant
  - *Time effect:* being longer in the network, the effect on growth is stronger
- Identification
  - Quasi-experiment: creating pseudo networks by dropping 100 firms with the highest eigenvector centrality in the network of 2017
  - The *centrality-growth nexus* remains statistically significant and economically meaningful after network structure changes

Preview of Results

- The Stimulus Plan announced in Nov 2008
  - Provides a shock to bank credit to SOEs *(Cong et al. 2019)*
  - Overall, the effect of network centrality tends to be less pronounced after the Stimulus Plan ("Four-trillion" Plan) than before, suggesting a *crowding-out* effect on equity capital.
  - Equity vs. bank credit
    - For bank-affiliated nonSOEs (within *3* steps of network connections), the effect of network centrality is more pronounced after the Stimulus Plan, whereas such effect is mitigated for bank-affiliated SOEs.
  - The ownership network may *substitute* bank loans in promoting growth for SOEs, whereas *complement* bank loans in promoting growth for nonSOEs.

Outline of the rest of the talk

- Motivation
- Network visualization: an example of *Central Huijin*
- Data
- Network Analysis
  - Centrality
  - Aggregated-level evidence
- Effects of Network position (centrality)
  - Network centrality and firm growth
  - Identification
  - Heterogenous effects
  - Equity capital vs bank credit: *Stimulus Plan in 2008*

What is “registered capital” in China?

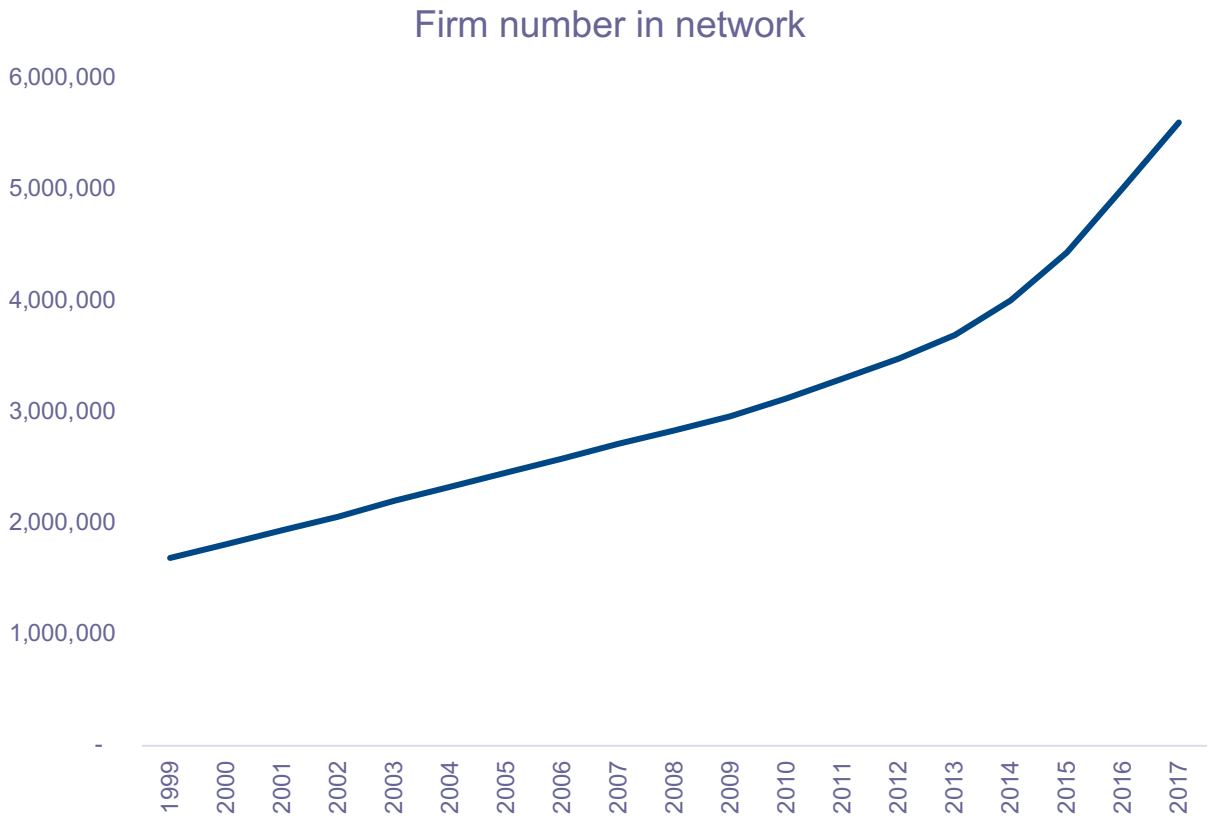
- In the past (before 2014), firm registration in China was based on a paid-in system
  - All registered capital has to be fully paid within the first two years after the firm is registered at the SAIC.
  - “*Firm registration Rule*” in China (1994, 2006, 2014 versions); “*Company Law*” (2005, 2014 versions)
    - For LLCs, all the shareholders are required to be recorded at the SAIC as well as the share change.
    - For incorporated companies, all the original shareholders are required to be recorded at the SAIC while there is no mandatory requirement that the change later has to be recorded. Shareholders have incentives to register at the SAIC to get the government endorsement.
    - Ownership indicated by registered capital means both the cash flow rights and voting rights.
- The “*Company Law*” (2014) changed the old paid-in system to a subscription system
  - The registered capital can be different from the actual paid-in capital.

Data

- Firm registration and ownership: 1950- 2017
  - Source*:* iFind, originally from China's State Administration for Industry and Commerce (SAIC)
  - Covering all the registered firms in China (over 40mm)
  - We focus on 5.6 mm that "in network" (***80%*** of total capital)
  - Variables
    - Firm registration date, registered capital, industry, ownership type (e.g. SOE or others), status (existing or bankrupt), location, etc.
    - Dynamic updates on shareholder identity, shareholders' ownership
- Annual Industry Survey: 1998-2013
  - *Source: China's National Bureau of Statistics*
  - Firm financial and production information
    - Industrial firms above certain threshold

Dynamic ownership network: size change

- By 2017, there are 5.60 mm firms/institutions in network, remaining over 35mm out of network.



Network Centrality

- Degree
  - In-degree, out-degree, degree
  - Unweighted: the number of investors/investees for firm i;
- Betweenness
  - How well situated a node is in terms of the shortest paths that it lies on (Bonacich, 1972)
  - Weighted by investment share percentage (or investment amount)
- Eigenvector
  - The importance of firm i depends on the importance of firms held by itself (Bonacich, 1987, Bonacich and Lloyd, 2001; Bonacich, 2007)
  - Weighted by investment share percentage (or investment amount)

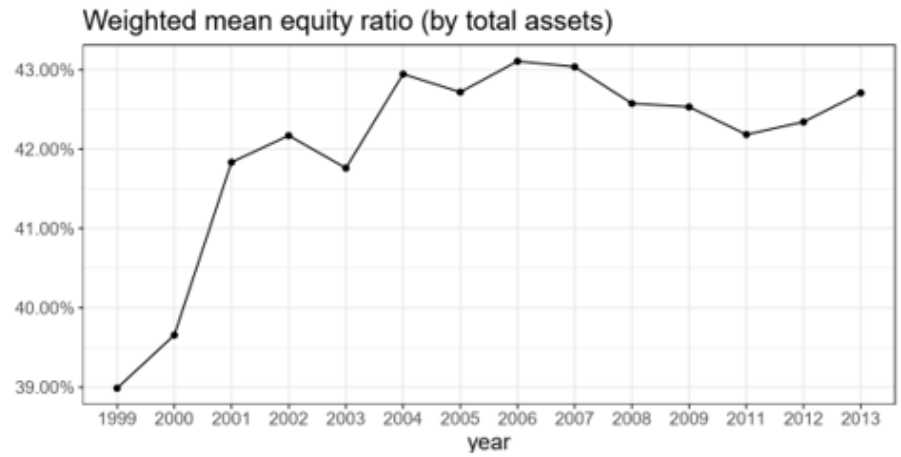
Capital flows by industry

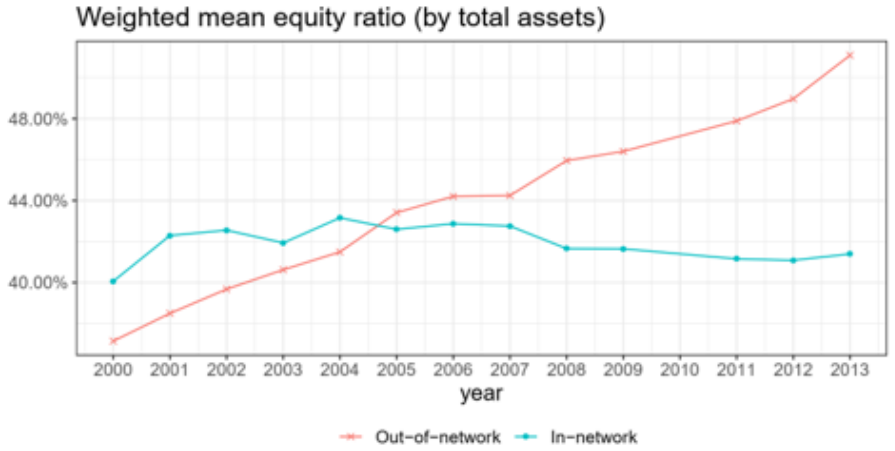
- Aggregated from the industry-level network

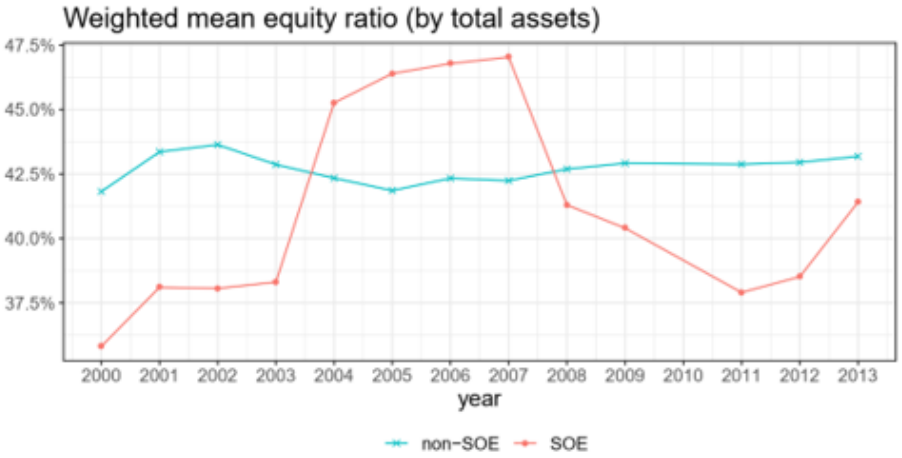
	Invested amount/Firm num, in RMB (across industry)	Total investment amount/Firm num, in RMB (across & within industry)	Firm num
Financial industry	7,369	10,825	136,020
Construction/Real estate	4,342	6,557	482,433
Mining	4,280	5,147	31,256
Utilities	3,659	7,075	67,576
Water, Environmental Services and Infrastructure Services	3,316	3,628	34,440
Transportation, Warehousing and Postal Services	2,628	8,966	121,430
Rental and Business Services	2,235	4,236	878,427
Education	1,612	1,660	12,914
Health Care and Social Assistance	1,469	1,639	16,357
Professional, Scientific and Technical Services	1,153	1,461	396,993
Public Services, Social Welfare and Social Organization	1,013	1,307	3,711
Information, Software and Technology Services	914	1,654	194,360
Household Services, Reparing & Other Services	883	936	105,194
Arts, Entertainment and Recreation	776	968	88,378
Manufacturing	684	1,271	845,650
Wholesale and Retail Trade	560	768	1,120,982
Agriculture, Forestry, Fishing and Hunting	531	649	845,650
Accommodation and Food Services	429	468	95,004
International Organizations	384	393	4,303

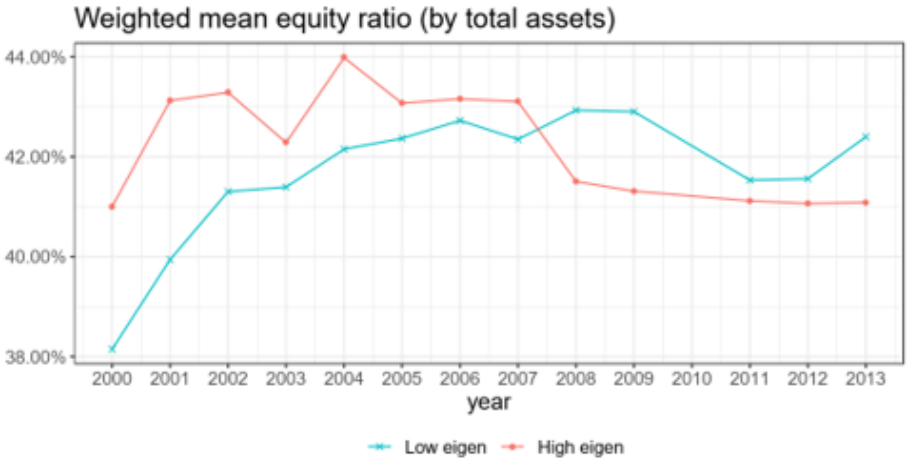
Equity ratio, state ownership and network position

- AIS firms

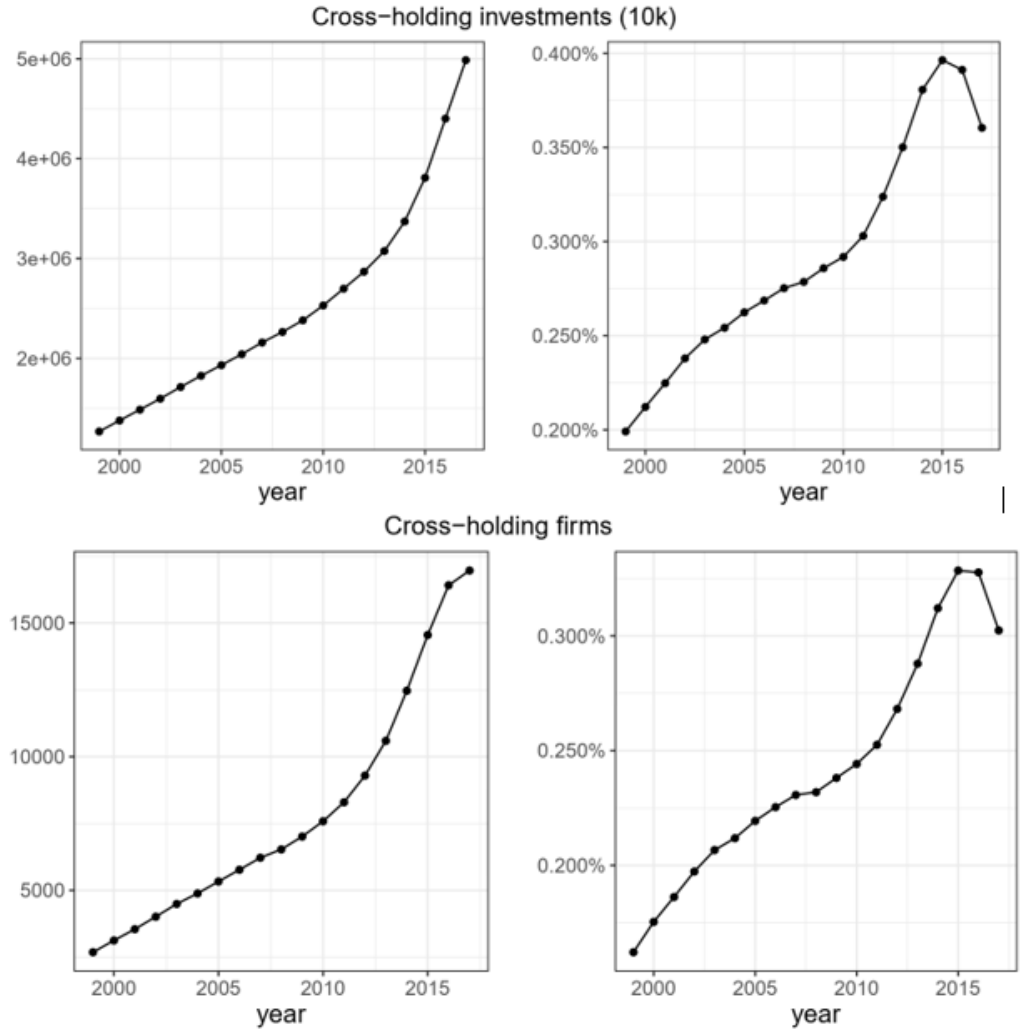








Equity cross holding in China



Summary Stats

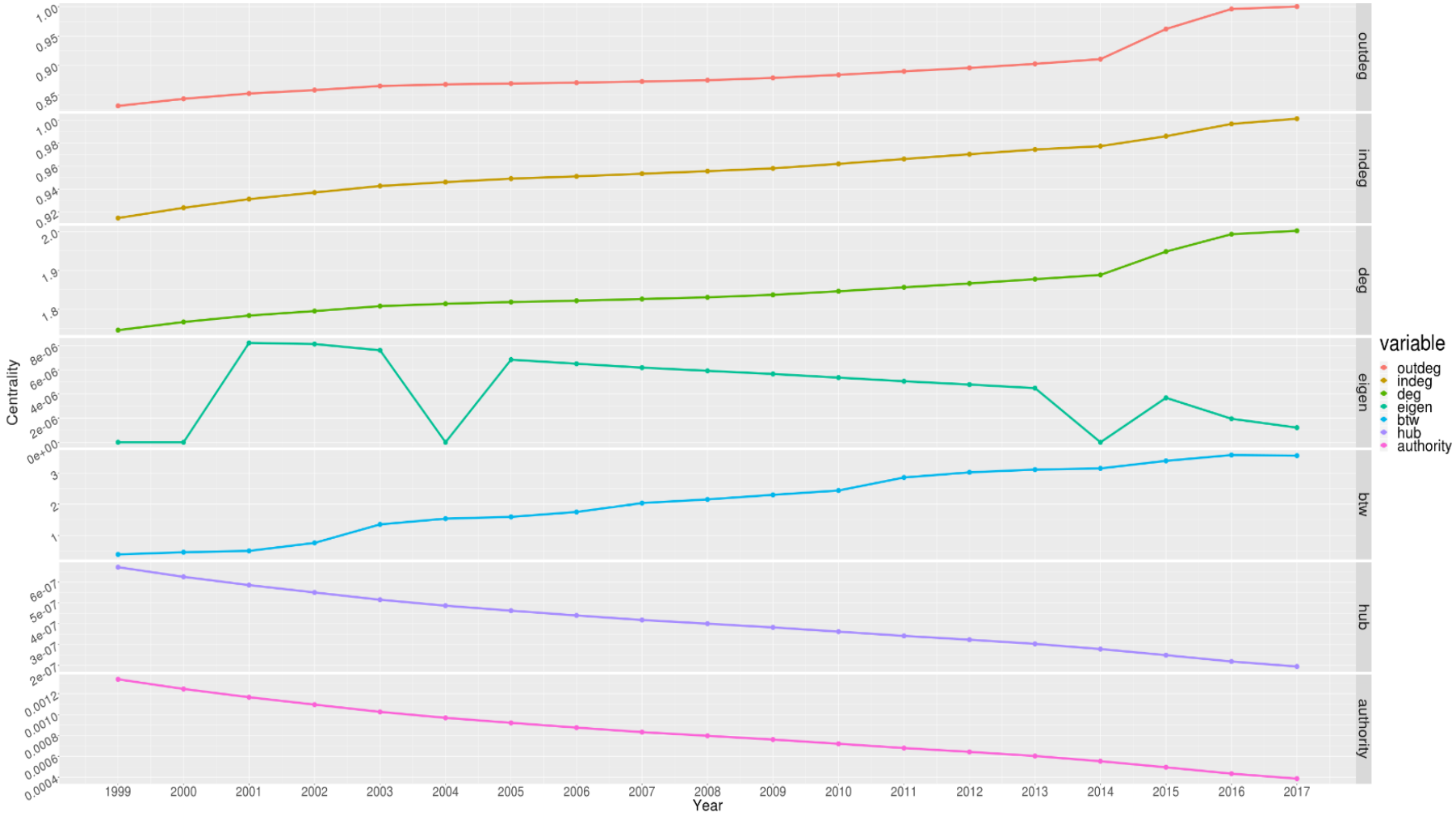
- Entire equity ownership network in 2017

Centrality measures	Obs.	Mean	Std. Dev.	Min	25%	50%	75%	Max
In-degree	5,604,486	0.90	1.17	0.00	0.00	1.00	1.00	350
Out-degree	5,604,486	0.90	21.90	0.00	0.00	0.00	1.00	32,415
Degree	5,604,486	1.81	21.92	1.00	1.00	1.00	2.00	32,416
Betweenness	5,604,486	1.75	573.63	0.00	0.00	0.00	0.00	1,000,000
Betweenness cash	5,604,486	0.16	32.44	0.00	0.00	0.00	0.00	63,299
Eigenvector	5,604,486	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Eigenvector cash	5,604,486	0.00	0.00	0.00	0.00	0.00	0.00	1.00

Variable	Obs.	Mean	Median	Std. Dev.	Min	Max
Investors						
Reg cap (mn)	877,663	45.95	5.00	2,949.31	0.00	900,000.00
Firm age (years)	891,722	10.05	8.00	8.56	0.00	67.00
Investees						
Reg cap (mn)	2,982,000	36.29	2.00	2,332.02	0.00	1,000,000.00
Firm age (years)	3,010,000	10.35	8.00	9.42	0.00	67.00
Investors & Investees						
Reg cap (mn)	836,526	115.46	5.70	2,281.41	0.00	836,000.00
Firm age (years)	855,125	13.54	13.00	10.13	0.00	67.00

Centrality for the entire ownership network

- Change over time: 1999-2017



Summary Stats (matched sample with AIS: 2000-2013)

- Centralities are calculated weighted either by share percentage of investees or the investment RMB amount

Variables	Obs	Mean	Median	Std. Dev.	Min	Max
Firm growth	2,336,536	0.137	0.076	0.445	-1.970	2.343
Firm age	2,336,536	2.024	2.079	0.865	0.000	4.143
Total assets	2,336,536	123,732	16,917	1,927,914	1	900,000,000
Firm size	2,336,536	9.901	9.736	1.482	0.000	20.618
ROA	2,336,536	0.102	0.035	0.197	-0.359	1.700
Leverage	2,336,536	0.569	0.583	0.295	0.000	2.187
SOE	2,336,536	0.078	0.000	0.269	0.000	1.000
In net	2,336,536	0.286	0.000	0.452	0.000	1.000
Log indeg	2,336,536	-0.164	-0.524	0.866	-0.525	4.489
Log outdeg	2,336,536	0.066	-0.391	1.075	-0.391	5.702
Log deg	2,336,536	-0.071	-0.619	0.998	-0.619	4.509
Log btw	2,336,536	0.009	-0.186	1.038	-0.187	19.841
Log eigen	2,336,536	-0.028	-0.448	1.052	-0.449	9.868
Log btw cash	2,336,536	-0.009	-0.038	0.871	-0.038	26.176
Log eigen cash	2,336,536	0.016	-0.044	1.169	-0.044	28.170

Ownership network and firm growth: baseline results

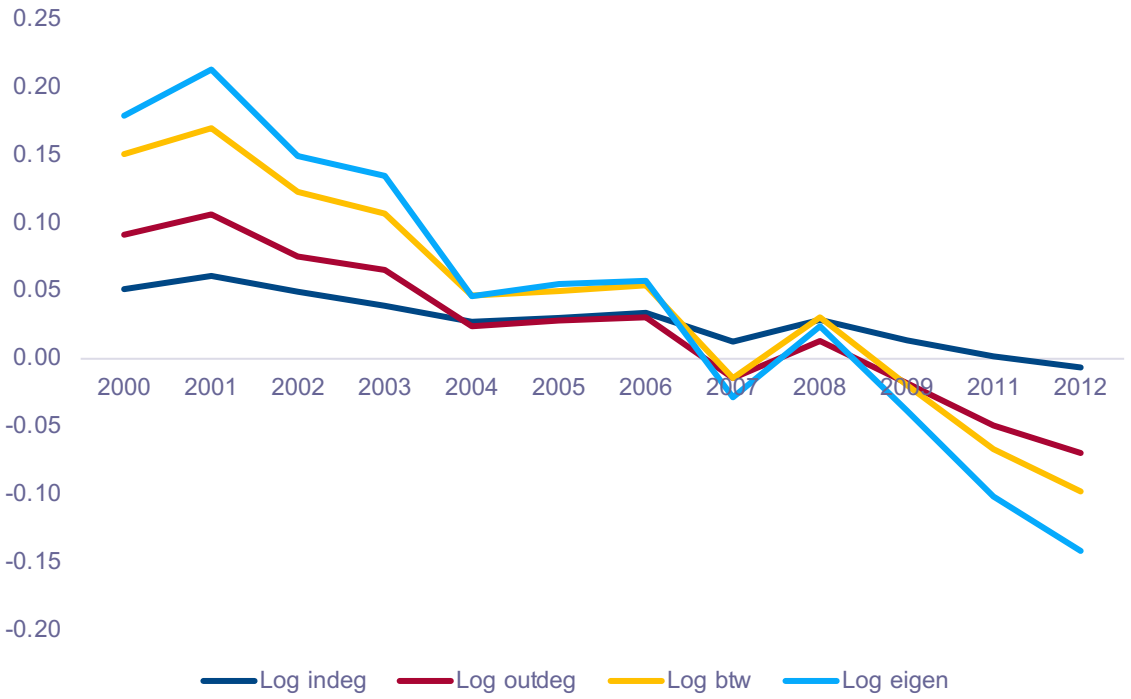
- Among the five measures of centrality, *eigenvector* has the largest economic effect, closely followed by *out-degree* and *degree* centrality.
- *Ceteris paribus*, one-std-dev increase in *Log eigen* can improve firm growth by 23.7 percent, all else being equal.

Dep. Var	*Firm growth*				
	(1)	(2)	(3)	(4)	(5)
In net	0.0505***	0.0120***	0.0145***	0.0431***	0.00463**
	(0.00205)	(0.00227)	(0.00278)	(0.00189)	(0.00230)
Log indeg	-0.00821***				
	(0.00108)				
Log outdeg		0.0239***			
		(0.000974)			
Log deg			0.0188***		
			(0.00137)		
Log btw				0.00489***	
				(0.000646)	
Log eigen					0.0308***
					(0.00113)
Other controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
# of obs.	2,336,536	2,336,536	2,336,536	2,336,536	2,336,536
R-squared	0.443	0.443	0.443	0.443	0.443

ATE of network centrality: 2000-2013

- Rerun regressions with the interactions of *ln net* and *year dummies* as well as those of *centrality* and *year dummies*.

- The value plotted shows the mean values of
  *centralities*coefficients of Log centralities +coefficients of ln-net*



Conditional on in-degree centrality

- *Possible selection issue:*
  - Firms with low in-degree could be expected by investors to be less profitable and grow at a slower rate
  - Use variations in in-degree and examine whether the remaining network centralities affect firm growth.

Dep. Var	*Firm growth*		
	(1)	(2)	(3)
In net	-0.00746*	0.00367	0.0226***
	(0.00409)	(0.00365)	(0.00285)
Low indeg	-0.0161***	0.0160***	0.0538***
	(0.00417)	(0.00411)	(0.00346)
Log outdeg	0.0151***		
	(0.00149)		
Log outdeg*Low indeg	0.0126***		
	(0.00227)		
Log deg		0.0160***	
		(0.00173)	
Log deg *Low indeg		0.0187***	
		(0.00239)	
Log eigen			0.0371***
			(0.00137)
Log eigen* Low indeg			-0.00474**
			(0.00186)
Other controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	1,850,213	1,850,213	1,850,213
R-squared	0.443	0.443	0.444

Identification: creating pseudo networks

- Our baseline model:

$$Growth_{it} = \beta \log\_eigen_{it} + \gamma X_{it} + \epsilon_{it} \quad (1)$$

- Our endogeneity comes from: $cov(log\_eigen_{it}, \epsilon_{it})$
- Eigenvector centrality from actual network: $\log\_eigen_{it}$; Eigenvector centrality from the pseudo network: $\log\_eigen\_drop_{it}$
  - 1st: Then the variation created by the entry of these 100 firms in the networks

$$log\_eigen_{it} = \beta_0 log\_eigen\_drop_{it} + \gamma X_{it} + z_{it} \quad (2)$$

  - 2nd: If we replace $z_{it} = \log\_eigen_{it} - log\_eigen\_drop_{it}$
- Our baseline model can be written as

$$Growth_{it} = \beta z_{it} + \gamma X_{it} + u_{it} \quad (3)$$

where $u_{it} = \epsilon_{it} + \beta_0 log\_eigen\_drop_{it}$ for the residual z_{it} from Model (2) or $u_{it} = \epsilon_{it} + \log\_eigen\_drop_{it}$ if z_{it} is the variation in the eigen-vector centrality created by adding the top100s.

- If u_{it} is uncorrelated with z_{it} conditional on X_{it}, our estimate β would be unbiased.
  - $Cov(z_{it}, log\_eigen\_drop_{it} | X_{it}) = 0$
  - $Cov(z_{it}, \epsilon_{it} | X_{it}) = 0$.

Identification: creating pseudo networks

- We create pseudo networks by dropping the top 100 firms with the highest eigenvector centrality in the actual ownership network of 2017.

Dep. Var		*Firm growth*		$z_{it} = \Delta log\ eigen$	*Firm growth*
	(1)	(2)	(3)	(4)	(5)
Log eigen	0.0271***		0.0217***		
	(0.000971)		(0.00138)		
Log eigen drop		0.0306***	0.00891***	-0.00135	
		(0.00133)	(0.00183)	(0.00555)	
$\Delta Log\ eigen$					0.0217***
					(0.00141)
ROA	0.363***	0.367***	0.367***	0.00447	0.365***
	(0.00593)	(0.00615)	(0.00615)	(0.00405)	(0.00615)
Leverage	-0.0114***	-0.0124***	-0.0118***	-0.0257***	-0.0115***
	(0.00346)	(0.00361)	(0.00361)	(0.00300)	(0.00361)
Firm age	-0.0109***	-0.00957***	-0.00981***	0.0110***	-0.0104***
	(0.00140)	(0.00148)	(0.00148)	(0.00189)	(0.00148)
Firm size	-0.377***	-0.374***	-0.375***	0.0428***	-0.372***
	(0.00172)	(0.00179)	(0.00179)	(0.00144)	(0.00178)
SOE	-0.0166***	-0.0164***	-0.0163***	-0.00741	-0.0172***
	(0.00443)	(0.00458)	(0.00458)	(0.00688)	(0.00458)
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	857,566	801,593	801,593	801,593	801,593
R-squared	0.410	0.405	0.406	0.817	0.405

Identification: creating pseudo networks (cont.)

- We further exclude firms directly connected to these top 100 firms with the highest eigenvector centrality in the ownership network of 2017.

Dep. Var	*Firm growth*			
	(1)	(2)	(3)	(4)
Log eigen	0.0272***		0.0250***	
	(0.000993)		(0.00140)	
Log eigen drop		0.0290***	0.00359*	
		(0.00137)	(0.00186)	
Δ *Log eigen*				0.0256***
				(0.00143)
ROA	0.363***	0.367***	0.367***	0.365***
	(0.00594)	(0.00617)	(0.00617)	(0.00616)
Leverage	-0.00875**	-0.00976***	-0.00918**	-0.00882**
	(0.00348)	(0.00363)	(0.00362)	(0.00362)
Firm age	-0.0108***	-0.00955***	-0.00981***	-0.0103***
	(0.00141)	(0.00150)	(0.00150)	(0.00150)
Firm size	-0.381***	-0.377***	-0.378***	-0.375***
	(0.00174)	(0.00181)	(0.00181)	(0.00180)
SOE	-0.0174***	-0.0172***	-0.0170***	-0.0176***
	(0.00449)	(0.00463)	(0.00464)	(0.00463)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	848,927	794,311	794,311	794,311
R-squared	0.410	0.406	0.406	0.406

Heterogeneity: Global vs local effect over time

- Longer being in the network, the stronger the network effect
- Local effect diminishes; while global effect increases over time
  - Eigenvector centrality has stronger effect, compared to betweenness

Dep. Var	*Firm growth*			
	(1)	(2)	(3)	(4)
	Investees		Investors	
Investee	-0.0501***	-0.0359***		
	(0.00741)	(0.00764)		
Investors			-0.118***	-0.0912***
			(0.00548)	(0.00590)
Year – Entry year	0.00866***	0.00770***	0.0131***	0.0135***
	(0.000780)	(0.000765)	(0.000618)	(0.000621)
Log indeg	0.0323***	0.0202***	0.0114***	0.0187***
	(0.00357)	(0.00387)	(0.00187)	(0.00274)
(Year – Entry year)* Log indeg	-0.00576***	-0.00577***	-0.00430***	-0.00770***
	(0.000441)	(0.000442)	(0.000371)	(0.000513)
Log outdeg	0.0230***	0.0200***	0.0612***	0.0491***
	(0.00151)	(0.00227)	(0.00261)	(0.00367)
(Year – Entry year)* Log outdeg	-0.00270***	-0.00450***	-0.00963***	-0.0137***
	(0.000288)	(0.000441)	(0.000404)	(0.000558)
Log btw	-0.00452***		0.000444	
	(0.00160)		(0.00144)	
(Year – Entry year)* Log btw	0.00229***		0.00101***	
	(0.000354)		(0.000326)	
Log eigen		0.00638***		-0.00724*
		(0.00243)		(0.00393)
(Year – Entry year)* Log eigen		0.00342***		0.00817***
		(0.000474)		(0.000760)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
# of Obs.	437,157	437,157	553,698	553,698
R-squared	0.402	0.403	0.392	0.393

Heterogeneity: SOE vs. nonSOEs

- State connections tend to *mitigate* the effect of network centrality on growth.
- One std-dev increase in Log deg would improve firm growth by 14.7 percent for nonSOEs, while such effect is 8.7 percent less for SOEs.

Dep. Var	*Firm Growth*				
	(1)	(2)	(3)	(4)	(5)
In net	0.0505***	0.0117***	0.0139***	0.0432***	0.00441*
	(0.00205)	(0.00227)	(0.00278)	(0.00189)	(0.00230)
Log indeg	-0.00757***				
	(0.00110)				
SOE*Log indeg	-0.00674***				
	(0.00243)				
Log outdeg		0.0249***			
		(0.000998)			
SOE*Log outdeg		-0.00847***			
		(0.00181)			
Log deg			0.0202***		
			(0.00140)		
SOE*Log deg			-0.0119***		
			(0.00214)		
Log btw				0.00578***	
				(0.000672)	
SOE*Log btw				-0.00703***	
				(0.00149)	
Log eigen					0.0313***
					(0.00116)
SOE* Log eigen					-0.00333*
					(0.00192)
Other controls	Yes	Yes	Yes	Yes	Yes
Firm, Year FE	Yes	Yes	Yes	Yes	Yes
# of obs.	2,336,536	2,336,536	2,336,536	2,336,536	2,336,536
R-squared	0.429	0.430	0.429	0.429	0.430

Heterogenous effects: high vs low productivity firms

- HTFP=1 if the TFP value is above median, and 0 otherwise.
- The effect of network centrality tends to be more pronounced for HTFP firms.

Dep. Var	*Firm Growth*				
	(1)	(2)	(3)	(4)	(5)
ln net	0.0510***	0.0128***	0.0160***	0.0432***	0.00586**
	(0.00206)	(0.00228)	(0.00278)	(0.00190)	(0.00231)
HTFP	0.0355***	0.0355***	0.0352***	0.0358***	0.0354***
	(0.000818)	(0.000818)	(0.000820)	(0.000817)	(0.000818)
Log indeg	-0.0134***				
	(0.00116)				
HTFP * Log indeg	0.00830***				
	(0.000723)				
Log outdeg		0.0180***			
		(0.00106)			
HTFP * Log outdeg		0.00922***			
		(0.000710)			
Log deg			0.0108***		
			(0.00144)		
HTFP * Log deg			0.0124***		
			(0.000732)		
Log btw				-0.000324	
				(0.000800)	
HTFP * Log btw				0.00773***	
				(0.000746)	
Log eigen					0.0252***
					(0.00124)
HTFP * Log eigen					0.00804***
					(0.000744)
Other controls	Yes	Yes	Yes	Yes	Yes
Firm, year FE	Yes	Yes	Yes	Yes	Yes
# of obs.	2,281,558	2,281,558	2,281,558	2,281,558	2,281,558
R-squared	0.429	0.430	0.430	0.429	0.430

Heterogenous effects: the impact of financial constraints

Dep. Var	*Firm growth*			
	(1)	(2)	(3)	(4)
Log indeg	-0.00507**			
	(0.00209)			
HTFP * Log indeg	-0.0151**			
	(0.00188)			
Fin constraint * Log indeg	-0.00401			
	(0.00266)			
HTFP* Fin constraint * Log indeg	0.0213***			
	(0.00266)			
Log outdeg		-0.0230***		
		(0.00145)		
HTFP * Log outdeg		-0.00364***		
		(0.00133)		
Fin constraint * Log outdeg		-0.00122		
		(0.00180)		
HTFP*Fin constraint * Log outdeg		-0.000937		
		(0.00207)		
Log btw			-0.00620***	
			(0.00140)	
HTFP * Log btw			-0.00454***	
			(0.00141)	
Fin constraint * Log btw			-0.000268	
			(0.00175)	
HTFP* Fin constraint * Log btw			0.00393**	
			(0.00177)	
Log eigen				-0.0174***
				(0.00171)
HTFP * log eigen				-0.00878***
				(0.00149)
Fin constraint * Log eigen				-0.000837
				(0.00207)
HTFP* Fin constraint * Log eigen				0.00794***
				(0.00204)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
# of Obs.	1,106,001	1,106,001	1,106,001	1,106,001
R-squared	0.197	0.198	0.197	0.197

The impact of the Fiscal Stimulus Plan (2009)

- A **shock** to bank lending to SOEs, especially those with close relationship with banks
- *Fiscal Stimulus Plan (2009)*- a combination of fiscal and credit program, featured spending RMB 4 trillion (US$586 billion) on a wide range of national infrastructure and social welfare projects, as well as encouraging increase in credit supply (Chen, He, Liu, 2019; Cong et al., 2019; Acharya, Qian and Yang, 2019).
- Bank subs =1 if the firm is affiliated with banks within 3 layers of the ownership network

Dep. Var	*Firm Growth*				
	(1)	(2)	(3)	(4)	(5)
In net	0.0444***	0.0124***	0.00472*	0.0431***	-0.00630***
	(0.00206)	(0.00229)	(0.00284)	(0.00189)	(0.00237)
Bank subs	0.00348	0.0177**	0.0148	-0.00540	0.0322***
	(0.0168)	(0.00770)	(0.0132)	(0.00800)	(0.0106)
Post FS* Bank subs	-0.0975***	-0.0371***	-0.0994***	-0.0487***	-0.0834***
	(0.0163)	(0.00664)	(0.0123)	(0.00706)	(0.00950)
Log Centrality	0.00399***	0.0249***	0.0321***	0.00904***	0.0456***
(in-deg, out-deg, deg, btw, eigen)	(0.00116)	(0.00105)	(0.00146)	(0.000861)	(0.00130)
Post FS * Log Centrality	-0.0356***	-0.00399***	-0.0250***	-0.00509***	-0.0254***
(in-deg, out-deg, deg, btw, eigen)	(0.000799)	(0.000699)	(0.000764)	(0.000799)	(0.000802)
Bank subs* Log Centrality	0.00395	0.00687**	-0.00776	0.00168	-0.0206***
(in-deg, out-deg, deg, btw, eigen)	(0.00687)	(0.00323)	(0.00548)	(0.00139)	(0.00399)
Post FS*Bank subs* Log Centrality	0.0727***	0.0208***	0.0648***	0.0137***	0.0557***
(in-deg, out-deg, deg, btw, eigen)	(0.00692)	(0.00300)	(0.00544)	(0.00138)	(0.00389)
Other Controls	Yes	Yes	Yes	Yes	Yes
Firm, year FE	Yes	Yes	Yes	Yes	Yes
# of obs.	2,336,536	2,336,536	2,336,536	2,336,536	2,336,536
R-squared	0.430	0.430	0.430	0.429	0.430

Subsample of bank-affiliated firms

- The positive effect of network centrality on growth is more significant for bank-affiliated nonSOEs, less so for bank-affiliated SOEs (offset by state-connections, in col 3).
- After the Stimulus Plan in 2009, it is easier for bank-affiliated SOEs to obtain loans; the network effect is less pronounced for them.

- Taken together, ownership network may *substitute* loans in promoting growth for SOEs, whereas *complement* loans in promoting growth for nonSOEs.

Dep. Var	*Firm Growth*				
	(1)	(2)	(3)	(4)	(5)
Post FS * SOE	-0.00235	-0.0320	0.0337	-0.0177	0.00623
	(0.0458)	(0.0238)	(0.0405)	(0.0252)	(0.0318)
Log Centrality	-0.0183*	0.0390***	0.0106	0.00955***	0.00531
(in-deg, out-deg, deg, btw, eigen)	(0.0108)	(0.00492)	(0.00827)	(0.00243)	(0.00646)
Post FS * Log Centrality	0.0290***	0.0145***	0.0329***	0.00643***	0.0254***
(in-deg, out-deg, deg, btw, eigen)	(0.00657)	(0.00287)	(0.00524)	(0.00176)	(0.00371)
SOE * Log Centrality	-0.00861	-0.0135*	-0.00177	-0.00166	-0.00553
(in-deg, out-deg, deg, btw, eigen)	(0.0198)	(0.00762)	(0.0132)	(0.00470)	(0.00948)
Post FS*SOE* Log Centrality	-0.0199	-0.0163*	-0.0415**	-0.0110**	-0.0269**
(in-deg, out-deg, deg, btw, eigen)	(0.0221)	(0.00965)	(0.0172)	(0.00529)	(0.0122)
Other controls	Yes	Yes	Yes	Yes	Yes
Firm,Year FE	Yes	Yes	Yes	Yes	Yes
Observations	32,023	32,023	32,023	32,023	32,023
R-squared	0.459	0.463	0.460	0.461	0.461

Conclusion

- Using a complete equity ownership network for all the registered firms in China, we provide the first evidence showing how capital is allocated in the network, and how it contributes to growth under state capitalism.
- The network has been expanding rapidly since 2000s, though new entrant firms tend to attract and make less investment so obtain less global importance.
- Entering the network is associated with higher future growth; in-network firms with higher centrality tend to have higher growth.
  - Such effect of network position on growth tends to be more pronounced for high-productivity firms and nonSOEs.
  - Over time, the average effect of network centrality on growth decreases, and has been diminishing since the Stimulus Plan in 2009, suggesting a *crowding-out* effect of the sudden increase in bank credit.
  - Equity ownership network serves as a substitute to bank credit for SOEs, while as a complement to bank credit for nonSOEs in promoting real growth.

Ownership Network and Firm Growth: What Do Five Million Companies Tell About Chinese Economy

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