

“Capital Supply Channel through Venture Capitals: Evidence from Matched Data”




Prepared for CIGS Workshop

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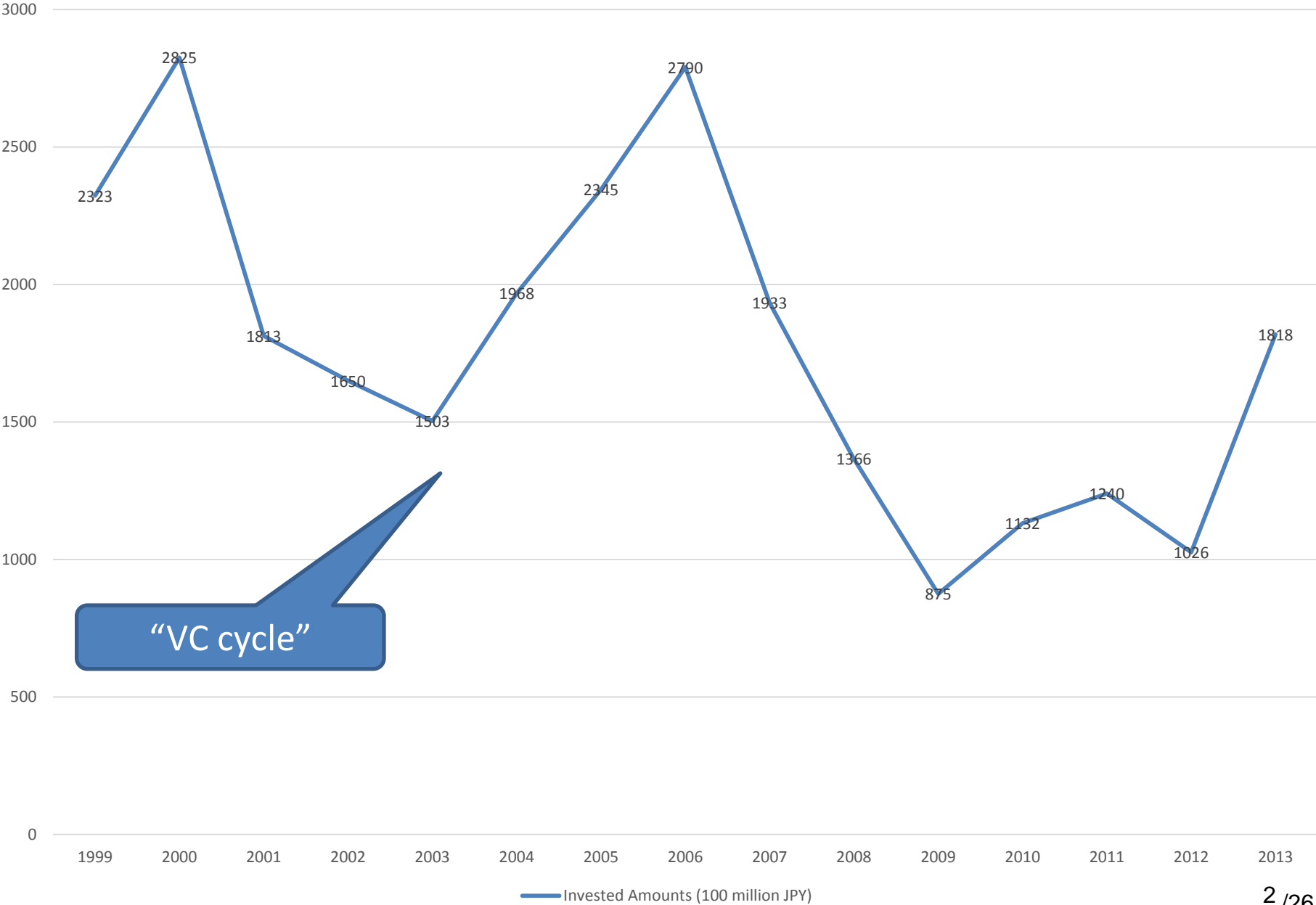
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1. Introduction & Motivation

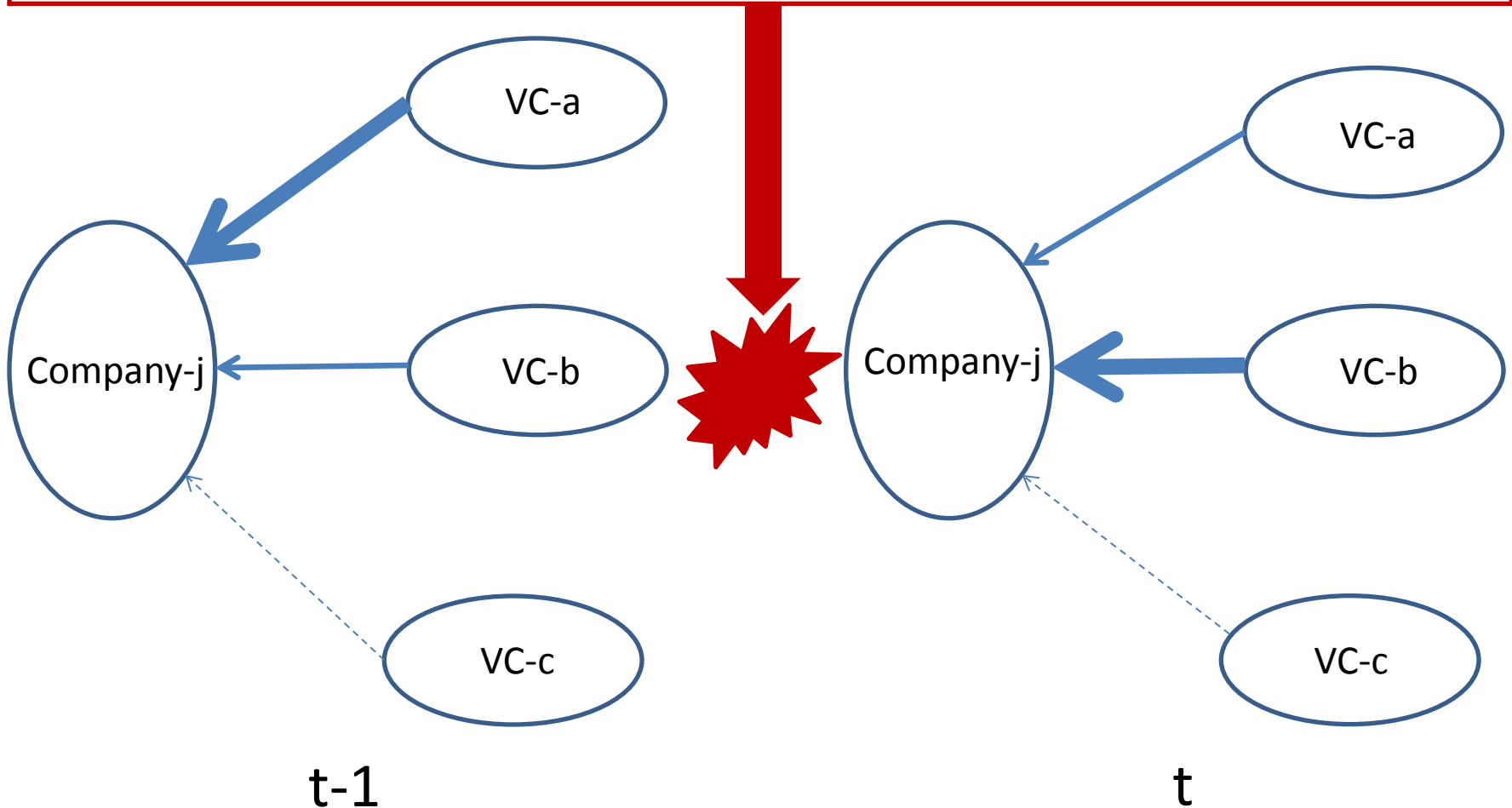
- Capital (i.e., fund) provision of Venture capital firms' (VCs')
 - What kinds of VCs provide larger capitals? 
 - How this pattern interacted with exogenous shocks?
- Gompers et al. (JFE 2008) 
 - Experienced VCs provide “more” funds under market upturn
 - No control for fund demand 
- This paper
 - Take advantage of multiple relations b/w companies & VCs
 - Apply the within-“venture company” estimator to the data
 - Khawaja & Mian (AER 2008), Jimenez et al. (AER 2012), Hosono & Miyakawa (RIETI 2014) in banking study

VC Investment Flows in Japan



Shock

(e.g., aggregate variables $\uparrow \downarrow$, inst' change, natural disaster etc.)



Panel data could be used as far as the “shock” is cleanly identified

2. Key Findings

■ Controlling for...

=“Time Variant”

□ Company-level: TV unobservable factors

⇔ E.g., fund demand (★)

=“Time Invariant”

□ VC-level: Observable characteristics/TIV unobserved factors

□ Company-VC match-level: TV unobservable factors

⇔ E.g., assortative matching

■ We find...

⚡ Gompers et al. (2008)

□ More experienced VCs tend to provide more funds

□ This is magnified (mitigated) under market downturn (upturn)

⇔ Experienced VCs provide “less” funds under market turn

□ Missing the control for venture company-level TIV factors leads to substantial overestimation of these effects (≠ Gompers et al. 2008)

3. Literature (1): VC's Characteristics

- In the context of VC characteristics potentially affecting their capital provision,
 - Sorensen (2008) discussed the mechanism that VCs can
 - Learning-by-investment

 - Kannianen & Keuschnigg (2004), Fulghieri & Sevilir (2009)
 - Size of VCs' portfolio and the fundamental conditions
 - Under economic downturn where the risk associated with startups become higher, VCs with larger portfolio could provide more funds since they can more easily diversify

- **Our paper: Incorporate these ideas into the study of investment**

3. Literature (2): VC's Investment

■ Gompers et al. (2008)

- Investment records of U.S. venture capitals between 1975-98
- Regressing the VC investment measured in each VC-level on...
 - Tobin's Q measured for nine industry categories, Each VC's investment experience, Industry-level fixed effect, and year-fixed effect

- Found...
 - Under market upturn (downturn), more experience VCs increase (decrease) more than less experienced VCs.
 - Not identifying the demand and supply factor

■ **Our paper: Using within-firm estimator to control for demand**

Gompers et al. (2008)

Dependent variable	(1) Firm Industry Investment (>0)	(2) Firm Industry Investment (>0)
PM Measure	<i>Q</i>	<i>Q</i>
PM Measure	0.1432 [10.94]***	0.1473 [11.57]***
EXPERIENCE	0.0151 [0.92]	
INDEXP		-0.0018 [0.10]
NONINDEXP		
SPECIALIZATION		
EXPERIENCE * PM Measure	0.0248 [3.13]***	
INDEXP * PM Measure		0.0409 [4.92]***
NONINDEXP * PM Measure		
SPECIALIZATION * PM Measure		
Lagged Firm Ind. Invest	0.2727 [26.82]***	0.2403 [23.21]***
Lagged Firm Nonindustry Invest.		
Fixed Effects:	Industry Year	Industry Year
Adj. R-squared	33.28%	33.82%
N	14,795	14,795

Market matters (industry Q)


Experience magnifies the impact of Q

3. Data (1): Match & VCs

■ **JVR data**: Company-VC match-level unbalanced panel data in Japan from 1991FY to 2012FY including...

□ Company-VC match-specific fund provision in year t

□ VC's characteristics

- Age (VC_AGE), location, type (e.g., bank-dependent), name of executives, capital (TIV), #Employees (TIV)
- Cumulative investment amounts prior to the current round (VC_PRE_INV)

- Cumulative number of VCs with which the VC collaborate in past (VC_PRE_COLL)

3. Data (2): Aggregate Variables

■ Stock index growth rates (*STOCK*)

□ JASDAQ Index

□ TOPIX

Large fluctuation

FY	Growth Rate of JASDAQ Index (%)	Growth Rate of TOPIX (%)
1991	n.a.	-3.6
1992	n.a.	-26.4
1993	n.a.	2.9
1994	22.7	13.2
1995	-16.2	0.7
1996	-10.6	-2.6
1997	-45.8	-21.2
1998	0.5	-9.3
1999	213.1	36.8
2000	-45.3	-27.2
2001	-8.4	-23.5
2002	-12.9	-18.6
2003	42.9	24.5
2004	22.6	7.6
2005	54.9	40.2
2006	-21.0	6.9
2007	-18.6	-11.1
2008	-36.9	-42.1
2009	7.8	19.0
2010	6.6	-3.0
2011	-6.0	-17.3
2012	19.8	22.9
2013	45.3	56.7
2014	15.1	6.6

Variable	Definition	Obs.	Mean	Std. Dev.	Min.	Max.	
INV	Amount of funds invested by VC-i to Company-j in yeat t (log value)	6,135	9.90	1.64	0.00	17.40	
VC_AGE	(i) Computed over all company-VC matches and years	Each year minus VC-i's established year	5,560	15.41	11.88	-12	83
VC_PRE_INV	Accumulated amount of funds invested by VC-i prior to year t (log value)	6,160	14.13	2.01	4.61	17.84	
VC_PRE_COLL	Accumulated number of collaborated VCs for VC-i prior to year t (log value)	6,161	3.88	1.77	0.00	6.86	
VC_AGE ×STOCK(t)	(ii) Computed over the matches with JASDAQ Index data available	VC_AGE times the growth rate of JASDAQ index	5,553	246.99	1214.75	-2,344.00	7,672.00
VC_PRE_INV ×STOCK(t)	JASDAQ Index data available	VC_PRE_INV times the growth rate of JASDAQ index	6,153	191.69	882.16	-745.00	3,521.00
VC_PRE_COLL ×STOCK(t)	JASDAQ index	VC_PRE_COLL times the growth rate of JASDAQ index	6,154	49.38	244.82	-263.00	1,104.00
VC_AGE ×STOCK(t)	(iii) Computed over the matches with MOTHERS Index data available	VC_AGE times the growth rate of TOPIX	5,560	30.25	508.60	-1,896.00	1,690.00
VC_PRE_INV ×STOCK(t)	MOTHERS Index data available	VC_PRE_INV times the growth rate of TOPIX	6,160	0.93	371.50	-748.00	708.00
VC_PRE_COLL ×STOCK(t)	TOPIX	VC_PRE_COLL times the growth rate of TOPIX	6,161	1.31	111.14	-286.00	266.00

4. Empirical Strategy

■ Match-level estimation

Accounting for various firm-level factors including loan demand

$$\text{INV}(i, j, t) = \eta(j, t) + \beta_1 \text{VC_AGE}(i, t) + \beta_2 \text{VC_PRE_INV}(i, t) + \beta_3 \text{VC_PRE_COLL}(i, t - 1)$$

Main interest-1

$$+ \gamma_1 \text{VC_AGE}(i, t) \text{STOCK}(t) + \gamma_2 \text{VC_PRE_INV}(i, t) \text{STOCK}(t) + \gamma_3 \text{VC_PRE_COLL}(i, t - 1) \text{STOCK}(t)$$

Main interest-2

$$+ \text{YEAR}(t) + \varepsilon(i, j, t)$$

Able to account for, e.g., assortative matching up to some extent

5. Empirical Analyses (1)

■ Two hypotheses

□ Hypothesis 1:

VCs with a higher VC_PRE_INV provide larger amounts of capitals

□ Hypothesis 2:

(i) The positive marginal impact of VC_PRE_INV becomes larger (smaller) when STOCK is lower (higher) if less experienced VCs' finance is adversely affected by macroeconomic condition.

(ii) The positive marginal impact of VC_PRE_INV becomes smaller (larger) when STOCK is lower (higher) if more experienced VCs crowd out less experienced VCs.

5. Empirical Analyses (2-1): Baseline

All Sample with respect to Growth Rate of JASDAQ Index

Dependent Variable: INV(t)	STOCK = Growth Rate of JASDAQ Index					
	(i)		(ii)		(iii)	
	Coef.	SD	Coef.	SD	Coef.	SD
VC_AGE(t)	-0.0002	0.0018	-0.0018	0.0025	-0.0038	0.0028
VC_PRE_INV(t)	0.5425	0.0267 ***	0.5337	0.0335 ***	0.5824	0.0396 ***
VC_PRE_COLL(t)	-0.5836	0.0310 ***	-0.5789	0.0407 ***	-0.6506	0.0482 ***
VC_AGE × STOCK(t)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
VC_PRE_INV × STOCK(t)	-0.0007	0.0004 *	-0.0009	0.0004 **	-0.0012	0.0005 **
VC_PRE_COLL × STOCK(t)	0.0007	0.0005	0.0011	0.0006 *	0.0014	0.0006 **
CONSTANT	0.2510	0.1565	2.0759	5.0220	3.0257	11.8345
Number of Obs.			5,158			
F-Value	76.51		2.07		0.87	
Prob > F	0.0000		0.0000		0.9985	
R-Squared	0.0818		0.1413		0.1943	
Year Effect	Yes		Yes		Yes	
Company Time-Variant FE	Yes		Yes		Yes	
VC-Level Time-Invariant FE	No		Yes		Yes	
Match-Level Time-Invariant FE	No		No		Yes	

First part of H2 supported

H1 supported

5. Empirical Analysis (2-2): Economic Impacts

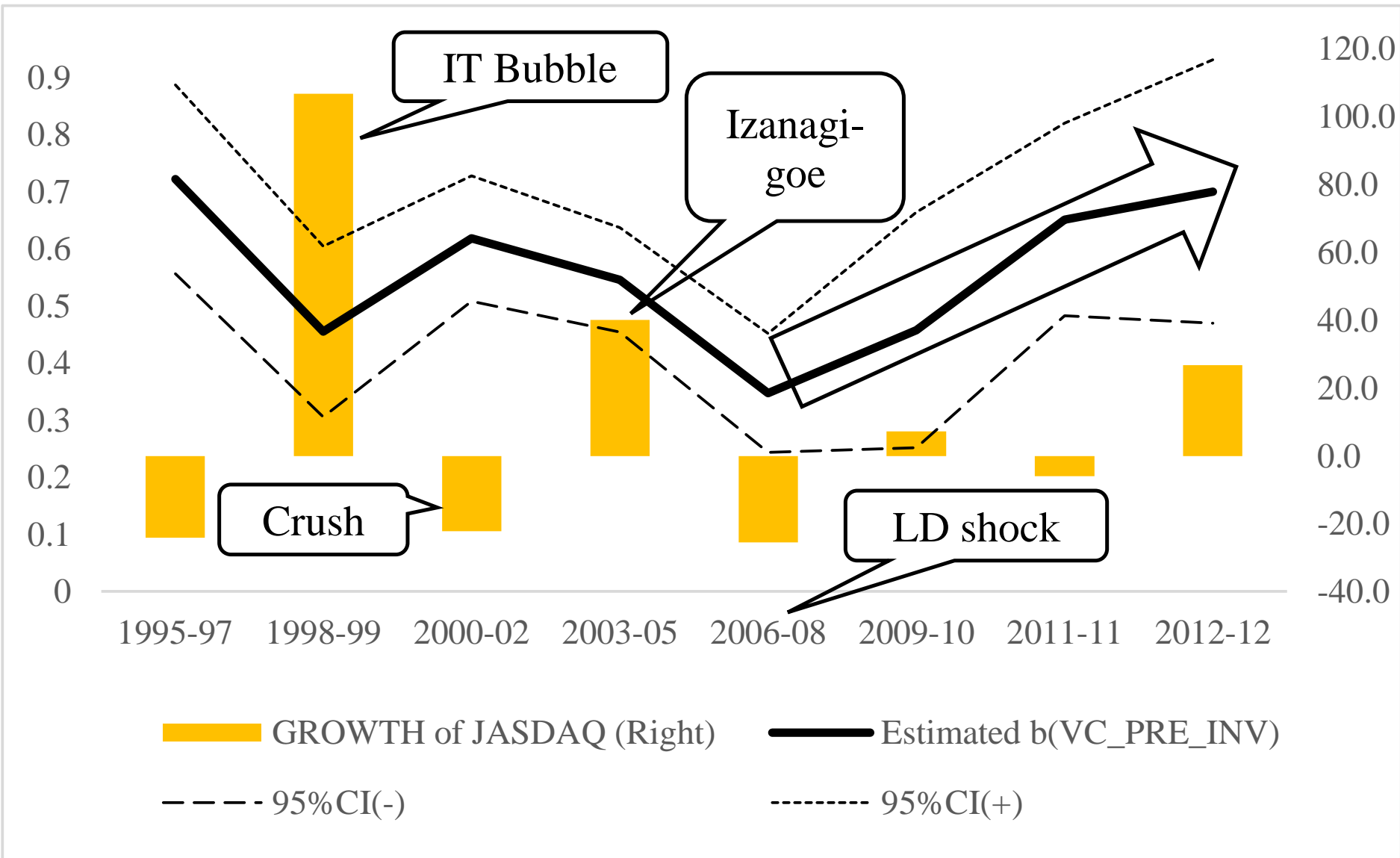
- $\beta(VC_PRE_INV) = 0.5824$ & $\beta(VC_PRE_INV \times STOCK) = -0.0012$.
- Hypothetical past investment experience of VC i for venture company j increases by one standard deviation (i.e., 2.01) in year t
- Stock market is in zero growth in year t
 - $INV(i, j, t)$ will increase by $0.5824 \times (2.01) = 1.17$ than in the case that VC experience stays in a same level as before
 - Standard deviation of $INV(i, j, t)$ is 1.64,
- Suppose that the stock market is in boom (i.e., $STOCK = 213.1$ as in 1999)
 - $INV(i, j, t)$ will increase by $0.5824 \times (2.01) + (-0.0012) \times (2.01) \times (213.1) = 0.66$
 - Around half when stock market is in boom

5. Empirical Analyses (3): Robustness to TOPIX

All Sample with respect to Growth Rate of TOPIX

Dependent Variable: INV(t)	STOCK = Growth Rate of TOPIX					
	(i)		(ii)		(iii)	
	Coef.	SD	Coef.	SD	Coef.	SD
VC_AGE(t)	0.0003	0.0017	-0.0014	0.0025	-0.0034	0.0028
VC_PRE_INV(t)	0.5332	0.0260 ***	0.5207	0.0327 ***	0.5641	0.0386 ***
VC_PRE_COLL(t)	-0.5760	0.0302 ***	-0.5664	0.0401 ***	-0.6316	0.0472 ***
VC_AGE × STOCK(t)	0.0000	0.0001	0.0000	0.0001	0.0000	0.0001
VC_PRE_INV × STOCK(t)	-0.0023	0.0010 **	-0.0021	0.0011 *	-0.0032	0.0013 **
VC_PRE_COLL × STOCK(t)	0.0022	0.0012 *	0.0024	0.0013 *	0.0034	0.0015 **
CONSTANT	0.2589	0.1563 *	2.0444	5.0208	3.0257	11.8279
Number of Obs.	5,167					
F-Value	76.1		2.06		0.86	
Prob > F	0.0000		0.0000		0.9987	
R-Squared	0.0813		0.1404		0.1936	
Year Effect	Yes		Yes		Yes	
Company Time-Variant FE	Yes		Yes		Yes	
VC-Level Time-Invariant FE	No		Yes		Yes	
Match-Level Time-Invariant FE	No		No		Yes	

5. Empirical Analyses (4): Time-Split Estimation



5. Empirical Analyses (5): Industry Features

Panel A: All Sample with respect to Growth Rate of JASDAQ Index

Dependent Variable: INV(t)	STOCK = Growth Rate of JASDAQ Index							
	(i) Internet		(ii) Financial		(iii) Electronics		(iv) pharmaceutical	
	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD
VC_AGE(t)	-0.0002	0.0032	-0.0178	0.0146	-0.0076	0.0055	-0.0119	0.0070 *
VC_PRE_INV(t)	0.6381	0.0519 ***	0.4927	0.1727 ***	0.4772	0.0914 ***	0.5288	0.0912 ***
VC_PRE_COLL(t)	-0.6826	0.0599 ***	-0.4729	0.2104 **	-0.5104	0.0968 ***	-0.5013	0.1016 ***
VC_AGE × STOCK(t)	0.0000	0.0000	0.0007	0.0004	0.0001	0.0001 *	0.0001	0.0001
VC_PRE_INV × STOCK(t)	-0.0013	0.0006 **	-0.0075	0.0046	-0.0017	0.0018	-0.0025	0.0013 *
VC_PRE_COLL × STOCK(t)	0.0014	0.0008 *	0.0086	0.0057	0.0025	0.0022	0.0015	0.0019
CONSTANT	0.0727	0.2959	0.7779	0.8610	0.5130	0.4980	0.0607	0.6013
Number of Obs.	1,761		182		264		491	
F-Value	27.81		2.88		7.22		8.21	
Prob > F	0.0000		0.0107		0.0000		0.0000	
R-Squared	0.0869		0.0898		0.1443		0.0924	

Panel B: All Sample with respect to Growth Rate of TOPIX

Dependent Variable: INV(t)	STOCK = Growth Rate of TOPIX							
	(i) Internet		(ii) Financial		(iii) Electronics		(iv) pharmaceutical	
	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD
VC_AGE(t)	0.0003	0.0034	-0.0093	0.0128	-0.0048	0.0054	-0.0119	0.0069 *
VC_PRE_INV(t)	0.6109	0.0511 ***	0.4743	0.1730 ***	0.4900	0.0917 ***	0.5139	0.0933 ***
VC_PRE_COLL(t)	-0.6531	0.0603	-0.4842	0.2112	-0.5291	0.0983	-0.4948	0.0989
VC_AGE × STOCK(t)	0.0000	0.0001	0.0007	0.0006	-0.0001	0.0002	0.0002	0.0003
VC_PRE_INV × STOCK(t)	-0.0014	0.0019	-0.0136	0.0073 *	0.0010	0.0043	-0.0049	0.0032
VC_PRE_COLL × STOCK(t)	0.0018	0.0022	0.0151	0.0090 *	0.0003	0.0043	0.0037	0.0033
CONSTANT	0.0880	0.2955	0.8083	0.8629	0.5727	0.5017	0.0623	0.6022
Number of Obs.	1,767		182		264		491	
F-Value	26.79		2.72		6.42		7.97	
Prob > F	0.0000		0.015		0.0000		0.0000	
R-Squared	0.0837		0.0853		0.1303		0.090	
Year Effect	Yes		Yes		Yes		Yes	
Company Time-Variant FE	Yes		Yes		Yes		Yes	
VC-Level Time-Invariant FE	No		No		No		No	
Match-Level Time-Invariant FE	No		No		No		No	

5. Empirical Analyses (6-1): Round Features

Panel A: All Sample with respect to
Growth Rate of JASDAQ Index

Dependent Variable: INV(t)	STOCK = Growth Rate of JASDAQ Index			
	(i) Invest Round ≤ 3		(ii) Invest Round > 3	
	Coef.	SD	Coef.	SD
VC_AGE(t)	-0.0009	0.0019	0.0003	0.0033
VC_PRE_INV(t)	0.5446	0.0321 ***	0.5444	0.0437 ***
VC_PRE_COLL(t)	-0.6353	0.0369 ***	-0.5390	0.0518 ***
VC_AGE \times STOCK(t)	0.0000	0.0000	0.0001	0.0001 *
VC_PRE_INV \times STOCK(t)	-0.0013	0.0004 ***	0.0009	0.0008
VC_PRE_COLL \times STOCK(t)	0.0015	0.0005 ***	-0.0009	0.0010
CONSTANT	0.6563	0.1777 ***	-0.1957	0.2718
Number of Obs.	2,854		2,304	
F-Value	58.04		29.77	
Prob > F	0.0000		0.0000	
R-Squared	0.1090		0.0721	

5. Empirical Analyses (6-2): Round Features

Dependent Variable: INV(t)	STOCK = Growth Rate of TOPIX			
	(i) Invest Round ≤ 3		(ii) Invest Round > 3	
	Coef.	SD	Coef.	SD
VC_AGE(t)	-0.0005	0.0018	0.0011	0.0033
VC_PRE_INV(t)	0.5225	0.0308 ***	0.5529	0.0430 ***
VC_PRE_COLL(t)	-0.6110	0.0357 ***	-0.5513	0.0508 ***
VC_AGE \times STOCK(t)	-0.0001	0.0001	0.0001	0.0001
VC_PRE_INV \times STOCK(t)	-0.0044	0.0012 ***	0.0008	0.0017
VC_PRE_COLL \times STOCK(t)	0.0043	0.0014 ***	-0.0007	0.0019
CONSTANT	0.6615	0.1772 ***	-0.1897	0.2718
Number of Obs.	2,862		2,305	
F-Value	58.29		29.16	
Prob > F	0.0000		0.0000	
R-Squared	0.1091		0.0708	
Year Effect	Yes		Yes	
Company Time-Variant FE	Yes		Yes	
VC-Level Time-Invariant FE	No		No	
Match-Level Time-Invariant FE	No		No	

5. Empirical Analyses (7-1): Endogeneity Bias

All Sample with respect to Growth Rate of JASDAQ Index

Dependent Variable: INV(t)	STOCK = Growth Rate of JASDAQ Index Without controlling form time-variant firm individual effect							
	(i)		(ii)		(iii)		(iv)	
	Coef.	SD	Coef.	SD	Coef.	SD	Coef.	SD
VC_AGE(t)	0.0020	0.0022	0.0000	0.0021	-0.0021	0.0196	-0.0044	0.0242
VC_PRE_INV(t)	0.6838	0.0280 ***	0.5656	0.0294 ***	1.0048	0.0808 ***	1.0284	0.0956 ***
VC_PRE_COLL(t)	-0.7292	0.0346 ***	-0.5741	0.0351 ***	-1.2021	0.1103 ***	-1.1906	0.1325 ***
VC_AGE × STOCK(t)	0.0001	0.0000 *	0.0001	0.0000 *	0.0001	0.0000 *	0.0001	0.0000
VC_PRE_INV × STOCK(t)	0.0005	0.0004	0.0000	0.0004	0.0008	0.0005	0.0008	0.0005
VC_PRE_COLL × STOCK(t)	-0.0005	0.0006	0.0000	0.0005	-0.0006	0.0006	-0.0006	0.0007
CONSTANT	1.3995	0.8902	4.1342	0.8786 ***	-0.6094	1.0607	-2.4314	1.6123
Number of Obs.	5,523							
F-Value	46.26		6.47		4.93		1.62	
Prob > F	0.0000		0.0000		0.0000		0.0000	
R-Squared	0.1619		0.5177		0.2074		0.2711	
Year Effect	Yes		Yes		Yes		Yes	
Company Time-Invariant FE	No		Yes		No		Yes	
VC-Level Time-Invariant FE	No		No		Yes		Yes	
Match-Level Time-Invariant FE	No		No		No		Yes	

5. Empirical Analysis (7-2): Endogeneity Bias

- $\beta(VC_PRE_INV)$ becomes around double to the baseline case
 - Such overestimation could be the case if...
 - $\beta(\text{"omitted" fund demand}) > 0$
 - $\text{Corr}(\text{fund demand}, VC_PRE_INV) > 0$
 - ↔ More experienced VCs can more easily access to deal flows than VCs with smaller experience due to, for example, their broader network (Hochberg et al. 2007)

5. Empirical Analysis (7-3): Endogeneity Bias

- $\beta(VC_PRE_INV \times STOCK)$ is not significant (baseline < 0)

□ Such overestimation could be the case if...

- $\beta(\text{"omitted" fund demand}) > 0$
- $\text{Corr}(\text{fund demand}, VC_PRE_INV \times STOCK) > 0$
 - ↔ The tendency of more experienced VCs easily accessing to venture companies with larger fund demand becomes higher during the boom in stock market (Gompers et al. 2008)

5. Empirical Analysis (7-4): Endogeneity Bias

- Although venture companies with higher fund demand are likely to be funded by more experienced VCs when stock market is in boom, VCs with less investment experience in fact increase their fund supply more than VCs with more experience
- Presumably, higher funding availability faced by low experienced VCs generates the latter result
- These results provide a complementary view to that in Gompers et al. (2008): Under the boom in stock market...
 - Not only the experienced VCs increase their fund provision due to the larger deal flows
 - But also the less experienced VCs increase fund provision due to less financial constraint
 - Both of which lead to the observed high volatility in the aggregated venture capital investments

6. Policy Implication

- Fostering more experienced VCs could lead to more stable VC investments.
 - Decline of investment by more experienced VCs under market downturn is not the consequence of financial friction but natural reaction to smaller fund demand
 - It is less experienced VCs which magnify the investment fluctuation under market upturn and downturn
 - Also, inducing more experienced VCs to provide larger amount of funds under market downturn could generate substantial resource misallocation

- It could be effective from policy perspective to provide some sort of supports to less experienced VCs under market downturn

7. Summary

- VCs' characteristics matter in systematic way
- Experience matters not only in statistical but economic sense
- Sizable endogeneity bias (could flip the implication)

- Future studies
 - Interaction with firms' characteristics
 - Firm level studies on firm dynamics (IPO etc.)

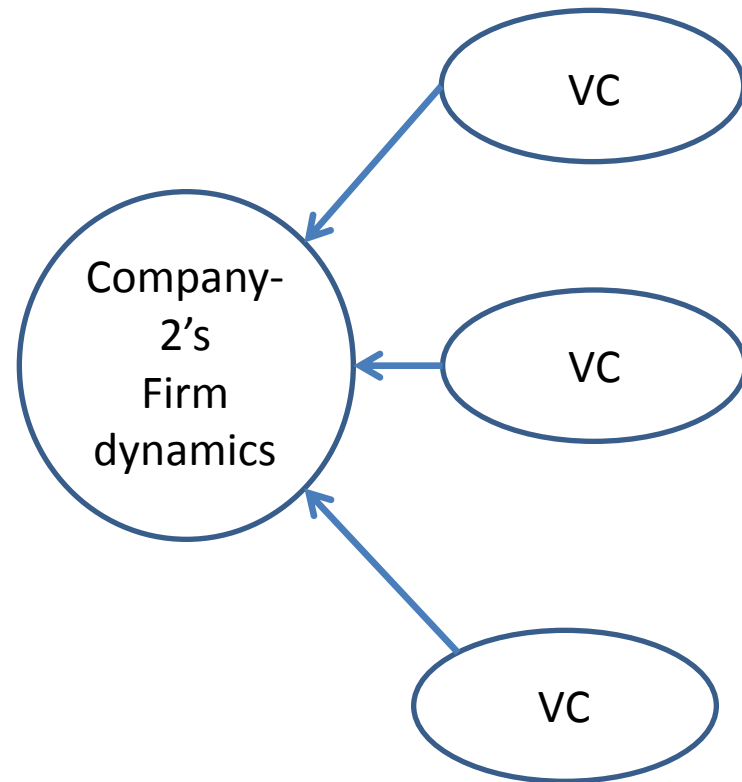
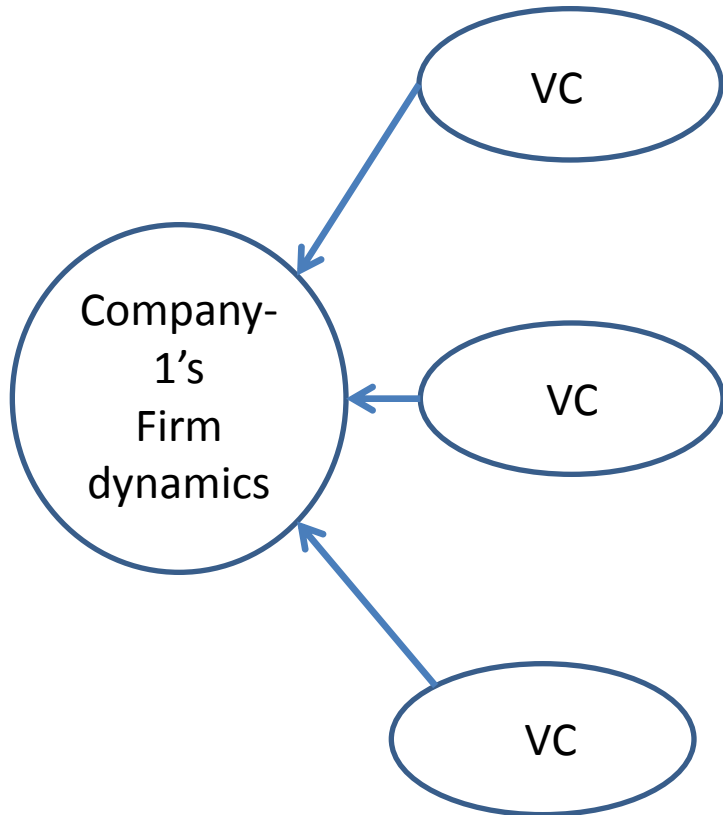
 - Descriptive explanation for the evolution of VC industry

 - Sorting pattern b/w company & VC
 - Dynamics of VC composition over rounds

W/ VCs having more experiences

VS.

W/ VCs having less experiences



Thank you and comments are welcome!

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