

Angels and Venture Capitalists: Complements or Substitutes?

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Broad objectives

- Examine interaction between angels and VCs
- Examine angel heterogeneity
- Explore implications for start-up performance




Central research question

- Are Angels and VCs complements or substitutes?
 - Choice of investors over time
 - How do prior investor type choices affect subsequent investor type choices?
 - Performance implications of investor choices



Angel – VC Relationships

- “[VCs are] stupid, insufferable, arrogant, (... they) don't know how to build communities or good products, and they don't back start-ups early enough.”
 - Dave McClure (Super-angel)



“When angels invest that brings
credibility to the company, making it
easier for venture capitalists to invest”

- From a BC angel



Theoretical Considerations (1): Dynamic financing pattern

- **Complements:**
 - Examples: Google and Facebook
 - “Integrated financial eco-system”
 - Stepping stone logic
- **Substitutes:**
 - Examples: Smartcells, Club Penguin
 - “Separate financial eco-systems”
 - Lock-in effect



Theoretical Considerations (2): Reasons for substitute / complements

- Investor-led
 - Investors create integration/separation
 - Treatment effect logic
- Company-led
 - Companies self-select into investor types
 - Selection effect logic
- Both important
 - Slightly different implications



Theoretical considerations (3): Performance implications

- Complements hypothesis
 - Supermodular production function
 - Benefits of diversity
- Substitutes hypothesis
 - Submodular production function
 - Benefits of investor homogeneity
- Super/Submodularity could come from company selection or investor treatment effects
 - Identification challenges: see Athey & Stern (1998), Cassiman & Veuglers (2006)

Our Main Findings

- Angels and VCs are dynamic substitutes
 - Substitutes stronger for VC=>Angel than Angel=>VC
 - VC => Angel driven by a selection effect
 - Angel =>VC driven by a treatment effect
 - Substitutes stronger for one-company angels
 - Strong within-type persistence
 - Driven by selection effects
- VCs associated with better performance
 - Simple angels have lowest exit rate
 - Tentative: negative interaction effects angel and VC funding (“performance substitutes”)
 - Performance effects largely driven by selection

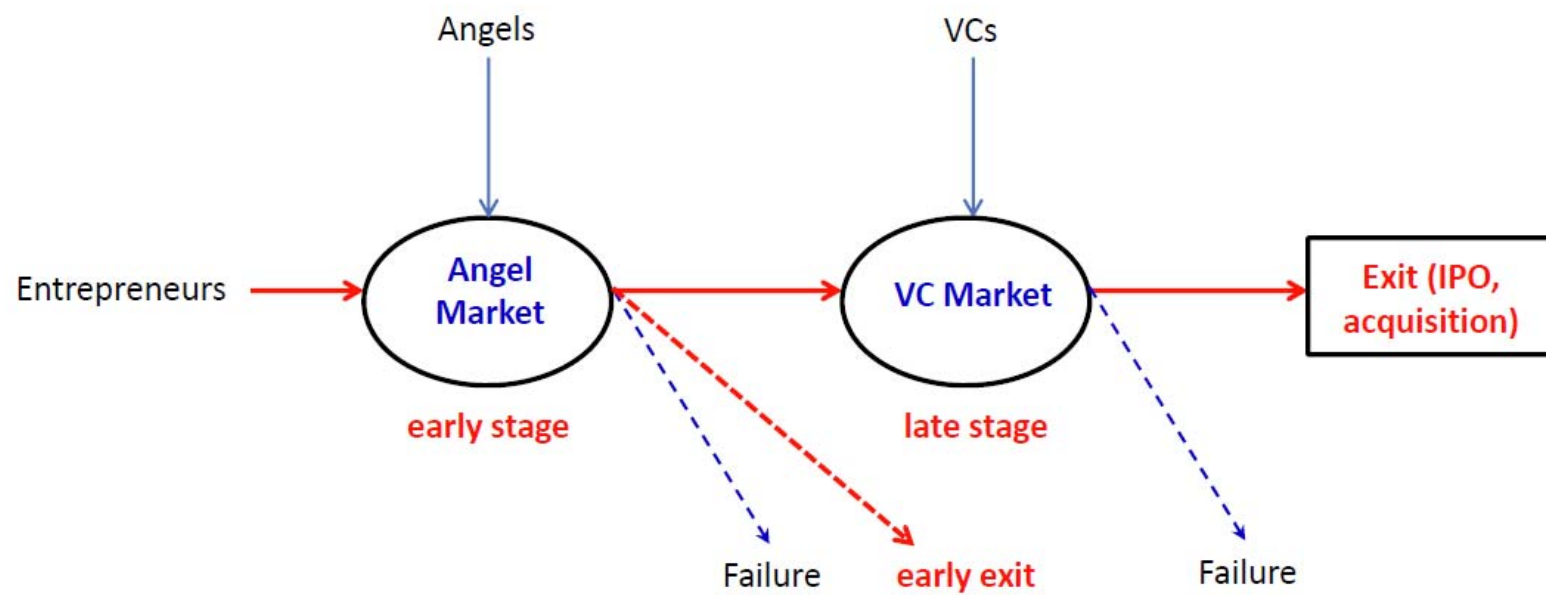
Literature

- Goldfarb, Hoberg, Kirsch, and Triantis (2012)
 - “Brobeck” data of VC & angel syndicates
 - VCs have more aggressive control rights
 - Mixing angels & VCs bad for performance
 - Driven by split decision rights
- Kerr, Lerner and Schoar (2013)
 - Data on 2 angel groups
 - Regression discontinuity approach
 - Getting angel financing good for companies
- Nascent angel literature
 - Theory: Chemmanur and Chen (2006), Schure (2006), Schwienbacher (2009)
 - Empirical: Mason and Harrison (2002), Shane (2008)

Friends or Foes?

The Interrelationship between Angel and Venture Capital Markets by Hellmann and Thiele(2013)





Angel market “feeds” VC market

Coexistence of angel and VC markets

- Search model with free entry
- Endogenous determination
 - Size & Competition
 - Efficiency & Valuation
- Key insights
 - Hold-up affects angel and VC market equilibria
 - Entry into VC reduces (not eliminates) hold-up
 - Angels can chose strategies to avoid VC market
 - Substitutes vs. Complements relationship depends on hold-up at VC stage



The Data

Special thanks to the Investment Capital Branch of the
Government of the Province of British Columbia



Data sources

- BC Venture Capital Program
 - Regulator's database
 - Tax credits
 - Company regulatory filings data
 - Financial statements
 - Share registries
- Augment with other sources:
 - Thomson One: (VX, SDC GNI, SDC M&A)
 - CapitalIQ
 - Bureau van Dijk (Dunn Bradstreet)
 - SEDAR
 - BC company registry
 - Internet searches



Data quality

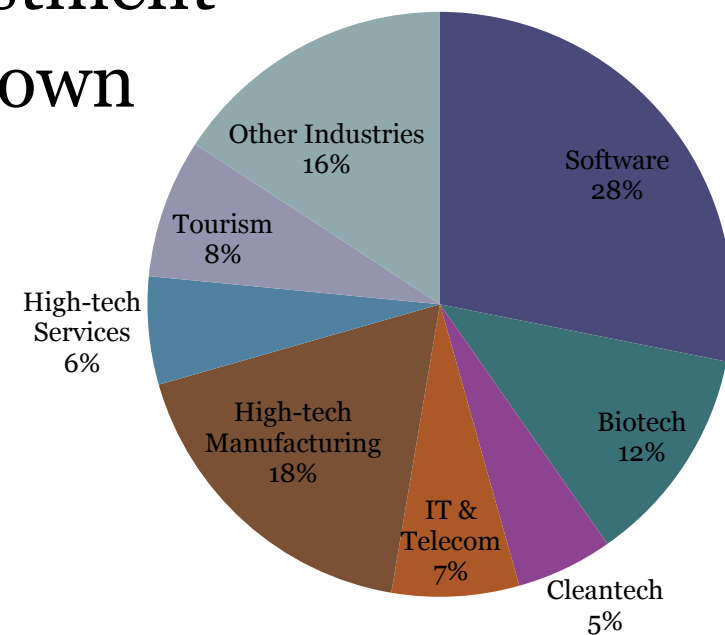
- Strengths:
 - Rare data
 - Rich data
 - Precise data
 - Near comprehensive data
- Weaknesses:
 - Huge data processing
 - Still want more data
 - Imperfect instrument
 - External validity

Company sample

- Must have received funding under tax credit program
- Sample period:
 - Funding: 1995 Q1 – 2009 Q1
 - Exits up to 2012Q4
- Number of observations
 - 469 companies
 - 6815 company – quarter observations with financing
- Average company age:
 - ...at first financing: 2.4 years
 - ...at last financing: 6.2 years
 - ... at exit / end of sample: 10.2 years

Some descriptive statistics

- 73% of companies in Greater Vancouver Area
- 13% exited
- 23% ceased operation
- 10% obtained US VC investment
- Standard industry breakdown



Definitions: Angels and VCs

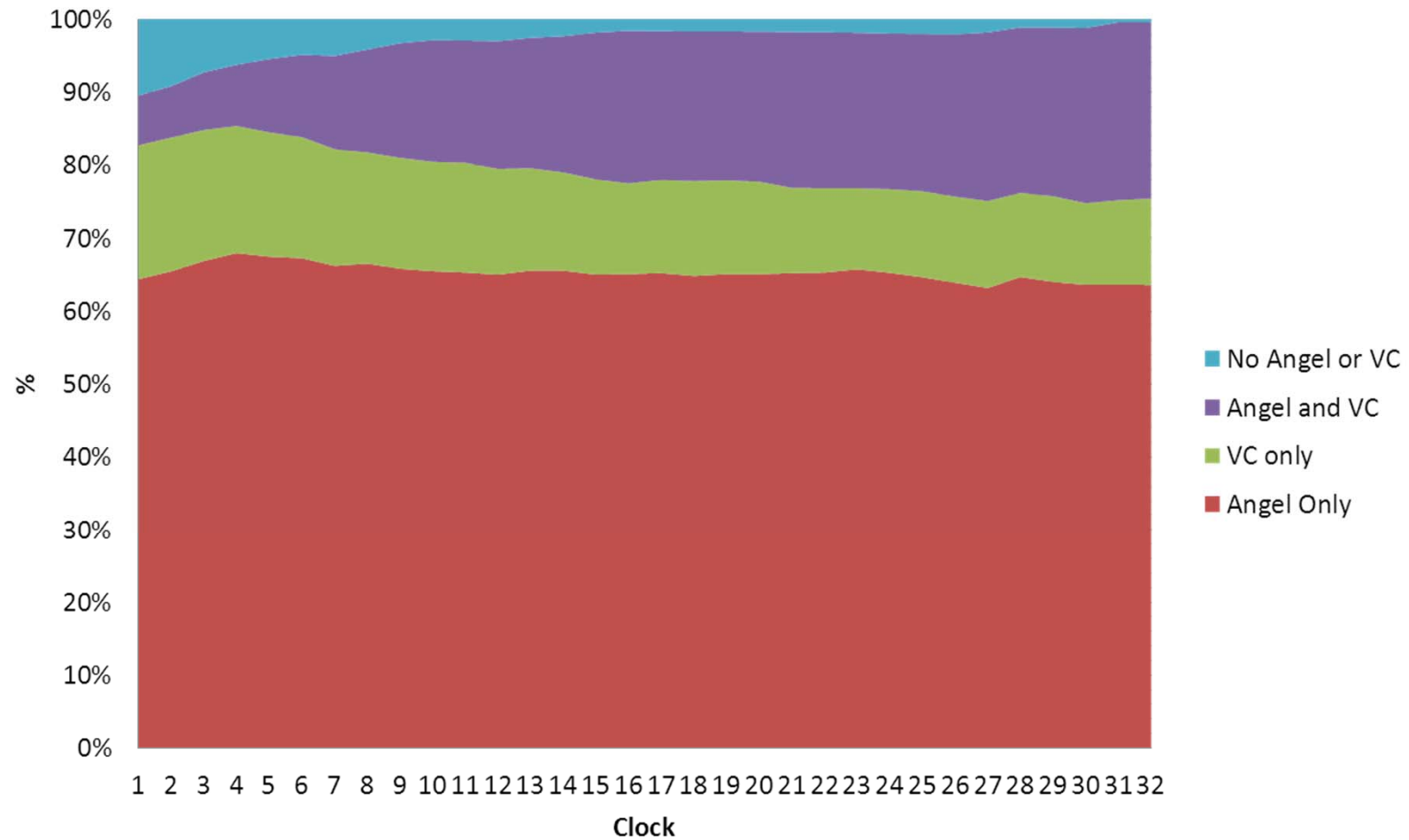
- Many informal characterizations untenable
 - Small vs. large, active vs. passive, nice vs. nasty, ...
- Key distinction: intermediated or not?
 - VC invest other's money: GP-LP structure
 - Angels invest own money
- Grey zone: angel funds
 - Individuals, but some intermediation
- Angels vs. “family & friends”
 - Family: objective definition, partially observable
 - Friends: subjective definition, unobservable



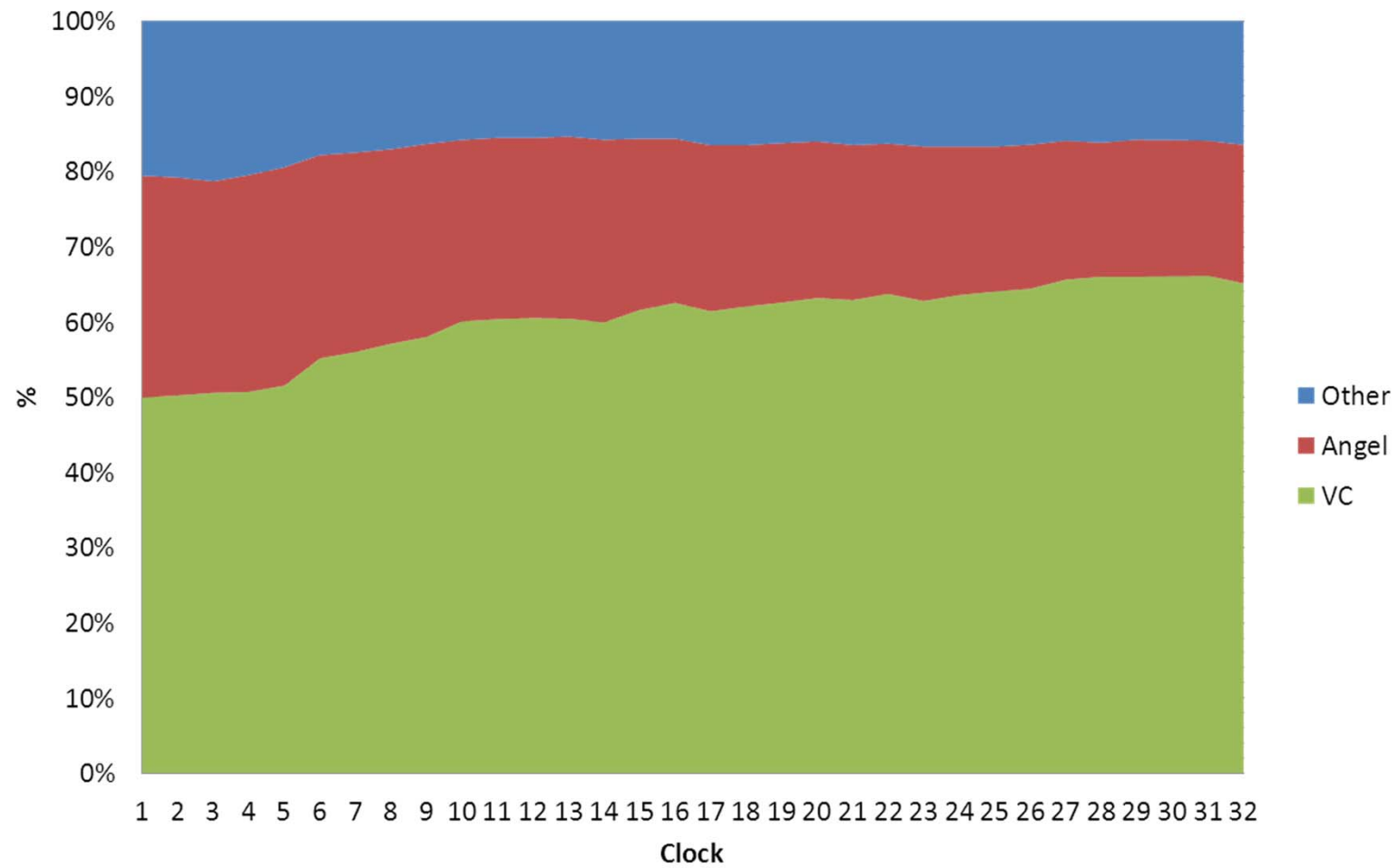
Investor data sources

- Share registries
 - Detailed and accurate
 - Available for
 - 49% of companies
 - 38% of all financing quarters
- Tax credit database
 - Accurate for all tax credit investments
 - Misses all non-tax-credit investments
- Venture Expert
 - Decent coverage, but not perfect
 - Mostly contains venture capital investments

Angel vs. VC - Number of Companies (Cumulative Investments)



Cumulative Investment Amount by Investor Types

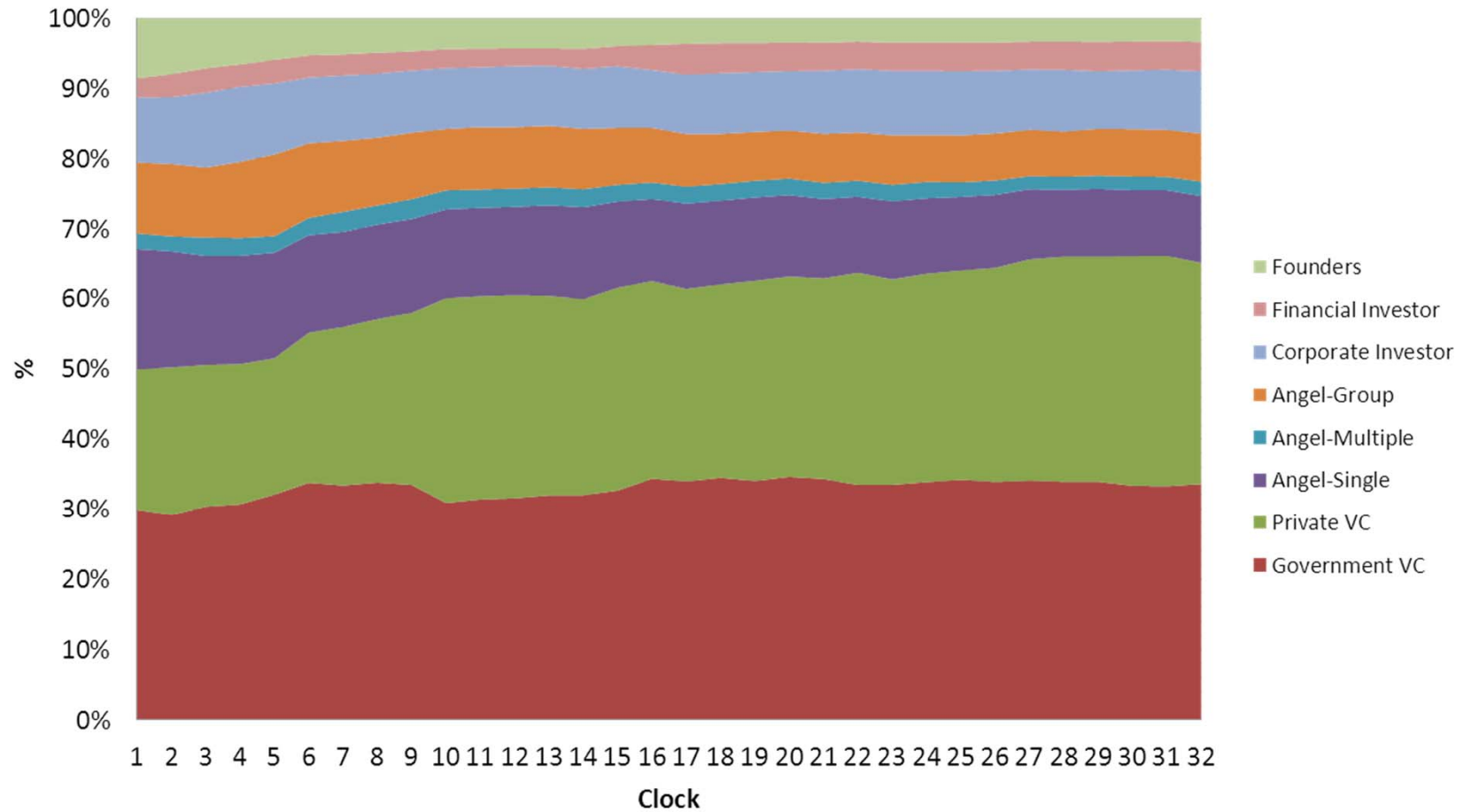




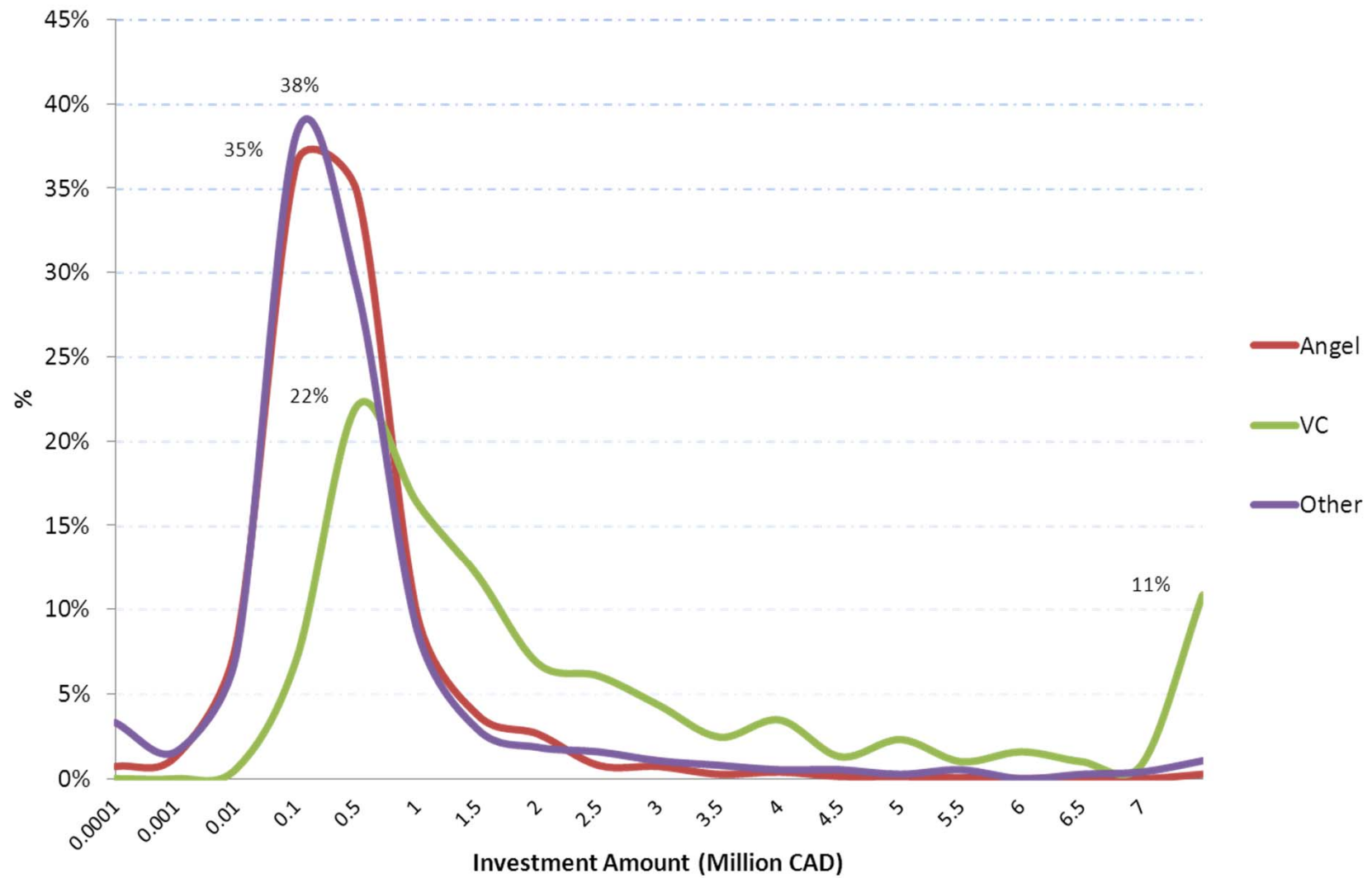
Are all angels alike?

- Simple angels
 - Single company investors
 - Friends and acquaintances
- Sophisticated angels
 - Repeat investors
 - Professional angels (“Super angels”)
 - Family offices & Individual’s funds
- Angel funds
 - Syndication with stable set of private investors
 - Spectrum of informal to formal

Cumulative Investment Amount by Investor Types - Decomposed



Distribution of Investment Amount by Investor Types.





The Dynamics of Financing Arrangements

Basic Regression Framework

- Linear panel regressions
 - Time measured in quarters
 - Cross section of companies
- Dependent Variable
 - Log amount of current investment by investor type
 - At time “t”
- Key Independent Variables
 - Log amount of prior investment by investor type
 - Cumulative amount by time “t-1”
- Controls



Controls

- Geography fixed effects
- Industry fixed effects
- Calendar time fixed effects
- Age at first investment
- Time since first investment
- Time since last round

Table 3: The Effect of Prior Investor Choices on Current Investor Choices.

	Angel	VC	Other	All
Prior Cumulative				
Angel	0.106*** (0.0119)	-0.0366*** (0.0119)	-0.0107 (0.0103)	0.0185 (0.0164)
VC	-0.0808*** (0.0106)	0.159*** (0.00931)	-0.0203** (0.00895)	0.0308** (0.0135)
Other	0.00958 (0.00993)	0.000417 (0.00876)	0.1000*** (0.00785)	0.0160 (0.0118)
Age at First Round	-0.0151 (0.0188)	0.0160 (0.0134)	-0.0128 (0.0139)	0.00668 (0.0233)
Controls	YES	YES	YES	YES
Observations	6,815	6,815	6,815	6,815
Number of companies	469	469	469	469

Variations of main model

- Inspired by basic decomposition

Expected Investment Amount

= Probability (Investment > 0)

* (Investment Amount | Investment > 0)

- Var 1: Probability of funding by type
- Var 2: Investment Amount | Investment > 0
 - “round-to-round analysis”
- Results sketch same substitutes picture

Table 4A: Probability (Investment > 0)

	Angel	VC	Other	Any Investment
Prior Cumulative				
Angel	0.00694*** (0.000848)	-0.00221*** (0.000719)	-0.000985 (0.000732)	0.00110 (0.00105)
VC	-0.00644*** (0.000771)	0.00981*** (0.000569)	-0.00201*** (0.000639)	5.99e-05 (0.000893)
Other	0.000449 (0.000724)	-5.63e-05 (0.000540)	0.00716*** (0.000561)	0.000702 (0.000802)
Controls	YES	YES	YES	YES
Observations	6,815	6,815	6,815	6,815
Number of companies	469	469	469	469

Table 4B: Investor Amount | (Investment >0)

	Angel	VC	Other	Total
Prior Cumulative				
Angel	0.392*** (0.0346)	-0.194*** (0.0307)	-0.0891** (0.0352)	0.00753 (0.0148)
VC	-0.294*** (0.0304)	0.574*** (0.0308)	-0.101*** (0.0297)	0.103*** (0.0118)
Other	0.0129 (0.0229)	-0.0422** (0.0212)	0.339*** (0.0285)	0.00615 (0.00919)
Controls	YES	YES	YES	YES
Observations	1,719	1,719	1,719	1,719
Number of companies	469	469	469	469

Endogeneity

- Treatment:
 - Prior investor actions cause current investor choices
- Selection / Unobserved heterogeneity
 - Unobserved company characteristics (“company needs”) are driving correlation current and prior investor choices
- Both effects interesting
- Approach 1: Company fixed effects
 - Takes out all time-invariant unobserved heterogeneity

Table 6: Company Fixed Effect Regressions

	Angel	VC	Other	Total
Prior Cumulative				
Angel	-0.0372 (0.0457)	-0.0409* (0.0209)	-0.0552* (0.0306)	-0.0673 (0.0523)
VC	-0.110*** (0.0276)	0.0163 (0.0235)	-0.0400* (0.0225)	-0.0660* (0.0347)
Other	-0.00655 (0.0304)	-0.000309 (0.0239)	-0.0890*** (0.0254)	-0.00561 (0.0400)
Controls	YES	YES	YES	YES
Observations	6,815	6,815	6,815	6,815
Number of companies	469	469	469	469
R-squared	0.101	0.074	0.048	0.113

Approach 2: IV using tax credits shocks

- Work in Progress
- Exploit variation in availability of funding due to government tax credit program changes
 - Three programs: EBC, AFD, RVC
- Differentiate by industry
 - Programs target different segments over time
- Rank condition:
 - Variation by program over time
- Exclusion Restriction
 - Shocks unrelated to future funding and performance
- Limitation
 - Strictly speaking *uptake* rather than *availability*

IV construction

- Total tax credits for program “p” & year “t”
 - $TC(p,t)$
- Weighted average for {p,t} for company “j”
 - $Z(p,t,j) = \sum_{\tau=t_0}^{\tau=t} w(j, \tau) TC(p,t)$
- Weights
 - $w(j, \tau) = \frac{I(\tau)}{\sum_{\tau'=t_0}^{\tau'=t} I(\tau')}$
- Many refinements possible

IV construction – numerical example

Year	Current Inv't in ABC	Cumulative Inv't in ABC	EBC Tax Credits	IV EBC Tax Credits	RVC Tax Credits	IV RVC Tax Credits
2002	\$1	\$1	\$20	\$20	\$100	\$100
2003	\$0	\$1	\$30	\$20	\$90	\$100
2004	\$4	\$5	\$40	\$36	\$80	\$84
2005	\$0	\$5	\$50	\$36	\$70	\$84
2006	\$5	\$10	\$60	\$48	\$60	\$72

First Stage Regressions

	Prior Cumulative		
	Angel	VC	Other
TC(EBC)	0.0437*** (0.0078)	-0.0002 (0.0096)	0.0068 (0.0082)
TC(RVC)	-0.0383*** (0.0093)	0.0873*** (0.0113)	-0.0066 (0.0102)
TC(AFD)	0.1657*** (0.0148)	-0.0166 (0.0180)	-0.0091 (0.0162)
CONTROLS	Yes	Yes	Yes

Second Stage IV Regressions

	Angel	VC	Other	Total
Prior Cumulative				
IV – Angel	0.104 (0.117)	-0.158* (0.0941)	-0.165 (0.137)	-0.0873 (0.157)
IV – VC	0.231 (0.180)	0.0934 (0.144)	0.00216 (0.219)	0.220 (0.224)
IV – Other	-0.596 (1.282)	-0.448 (0.810)	-1.253 (1.010)	0.618 (2.494)
Controls	YES	YES	YES	YES
Observations	6,815	6,815	6,815	6,815
Number of companies	469	469	469	469



Decomposing Angel Investors

- Single Company Angel
 - Angel invests in only one company
 - May invest in several rounds
 - No indication of commitment to angel investing
- Multiple Company Angel
 - Angel invests in more than one company
 - Some indication of commitment to angel investing
- Angel Fund
 - Investment vehicle owned by multiple angels

Table 8: Decomposing Angel Investors.

	Angel - Single	Angel - Multiple	Angel - Fund	VC	Other
Prior Cumulative					
Angel - Single	0.116*** (0.0121)	0.0179** (0.00761)	-0.0193** (0.00864)	-0.0334*** (0.00890)	0.00991 (0.00970)
Angel - Multiple	-0.0203 (0.0148)	0.0411*** (0.0106)	-0.0131 (0.00991)	0.00131 (0.00917)	0.00773 (0.0122)
Angel - Fund	-0.0504*** (0.00838)	-0.00894 (0.00600)	0.125*** (0.00869)	-0.0122 (0.00755)	-0.0171** (0.00731)
VC	-0.0623*** (0.00878)	-0.0173*** (0.00576)	-0.0337*** (0.00719)	0.163*** (0.00842)	-0.0133* (0.00783)
Other	0.0170* (0.00909)	0.00256 (0.00634)	-0.000909 (0.00722)	0.00733 (0.00909)	0.0942*** (0.00868)
Controls	YES	YES	YES	YES	YES
Angel (Single vs. Multiple)	0.136*** (36.47)	-0.023 (2.17)	-0.006 (0.17)	-0.035*** (6.67)	0.002 (0.01)
Angel (Single vs. Fund)	0.166*** (158.51)	0.027*** (9.73)	-0.144*** (128.33)	-0.021** (5.85)	0.027*** (7.78)
Angel (Multiple vs. Fund)	0.030 (2.34)	0.050*** (14.41)	-0.138*** (89.60)	0.013 (1.24)	0.025 (2.46)



Further Decomposing Non-Angel Investors

- VCs
 - Government VCs
 - Retail VCCs
 - Government-owned banks
 - Private VCs
- Other investors
 - Corporate Investors
 - Financial Investors
 - Founders and Families

Table 9: Decomposing all Investor Categories

	Angel - Single	Angel - Multiple	Angel - Fund	Private VC	Gov. VC	Corporate Investor	Financial Investor	Founders
Prior Cumulative								
Angel - Single	0.111*** (0.0123)	0.0165** (0.00782)	-0.0201** (0.00897)	-0.0237*** (0.00810)	-0.0253*** (0.00914)	-0.00337 (0.00758)	0.00112 (0.00404)	-0.00661 (0.00745)
Angel - Multiple	-0.0218 (0.0145)	0.0415*** (0.0106)	-0.0161 (0.0101)	0.00703 (0.00707)	-0.000518 (0.00841)	-0.00769 (0.00975)	0.00397 (0.00552)	-0.000807 (0.00933)
Angel - Fund	-0.0491*** (0.00846)	-0.00683 (0.00611)	0.124*** (0.00885)	-0.00616 (0.00606)	-0.00905 (0.00744)	-0.00757 (0.00596)	-0.00657* (0.00351)	-0.0124** (0.00483)
Private VC	-0.0128 (0.00936)	-0.0145** (0.00682)	-0.0180** (0.00835)	0.0814*** (0.0109)	0.0354*** (0.0134)	0.00921 (0.00792)	-0.00404 (0.00485)	-0.00368 (0.00543)
Gov. VC	-0.0556*** (0.00829)	-0.00687 (0.00625)	-0.0278*** (0.00736)	0.00636 (0.00870)	0.137*** (0.0114)	-0.0120* (0.00694)	0.000853 (0.00421)	-0.0182*** (0.00485)
Corporate Investor	0.00916 (0.0104)	-0.00485 (0.00738)	0.00952 (0.00708)	0.0102 (0.00772)	0.000358 (0.00887)	0.0731*** (0.00816)	0.00498 (0.00417)	0.0116 (0.00739)
Financial Investor	-0.0132 (0.0140)	-0.00818 (0.00984)	0.00276 (0.0107)	-0.00104 (0.00885)	-0.000590 (0.0114)	0.00747 (0.0111)	0.0179*** (0.00635)	-0.00417 (0.00936)
Founders	0.0317*** (0.0118)	0.0168** (0.00824)	-0.00865 (0.00855)	0.00812 (0.00606)	-0.00497 (0.00821)	0.0288*** (0.00894)	0.0120*** (0.00449)	0.0847*** (0.00838)



The Relationship between Financing Arrangements and Performance



Performance measures used

- Exit (IPO or Acquisition)
- “Death”
- US Venture Capitalist
 - Measure of distinction
- Revenues
 - $\text{Log}(\$1 + \text{Revenues})$
 - Obtained from financial statements and BvD
- Employees
 - $\text{Log}(1 + \# \text{ of employees})$
 - Obtained from variety of sources

Table 10: Relationship Investor Choices and Company Performance

Investment Amount	Exit	Death	USVC	Revenue	Employees
Prior Cumulative					
Angel	-0.246 (0.187)	-0.00499 (0.137)	-0.311* (0.185)	-0.0369 (0.0277)	0.0211* (0.0114)
VC	0.509*** (0.121)	-0.0484 (0.106)	0.393*** (0.133)	0.0544** (0.0241)	0.0176** (0.00736)
Other	0.0292 (0.123)	-0.221** (0.102)	0.291* (0.150)	0.00138 (0.0275)	-0.00585 (0.0118)
DV -one year lagged				0.0567 (0.0433)	0.214*** (0.0558)
Controls	YES	YES	YES	YES	YES
Angel vs. VC	-0.755*** (16.45)	0.043 (0.09)	-0.704*** (8.32)	-0.091** (6.53)	0.003 (0.09)
Observations	14,719	14,719	13,930	4,083	2,339
Number of companies	469	469	463	302	202

Table 11: IV Regressions: Investor Choices and Company Outcomes.

Investment Amount	Exit	Death	USVC	Revenue	Employees
Prior Cumulative					
Angel	-2.827*	1.112	0.511	-0.0269	-1.174
	(1.641)	(1.605)	(4.394)	(0.233)	(1.592)
VC	0.0102	0.837	-0.821	0.293	-0.146
	(5.275)	(5.160)	(2.685)	(0.324)	(0.239)
Other	26.98	-1.379	-1.654	1.211	1.545
	(17.89)	(17.50)	(41.29)	(1.038)	(1.908)
DV -one year lagged				-0.0390**	0.255*
				(0.0189)	(0.145)
Controls	YES	YES	YES	YES	YES
Observations	14,719	14,719	13,930	4,083	2,339
Number of companies	469	469	463	302	202

Table 12: Interaction Effects between Angels and VC

Investment Amount	Exit	Death	USVC	Revenue	Employee
Prior Cumulative					
Angel * VC	-0.0384** (0.0150)	0.00535 (0.0155)	-0.0535*** (0.0187)	-0.00410 (0.00321)	-0.00198 (0.00132)
Angel	-0.400* (0.235)	0.0121 (0.147)	-0.658** (0.290)	-0.0587* (0.0330)	0.00669 (0.0139)
VC	0.394*** (0.134)	-0.0317 (0.116)	0.244* (0.133)	0.0476* (0.0256)	0.0157** (0.00774)
Other	0.0633 (0.126)	-0.226** (0.104)	0.348** (0.156)	0.00352 (0.0273)	-0.00218 (0.0124)
DV - one year lagged				0.0572 (0.0435)	0.211*** (0.0558)
Controls	YES	YES	YES	YES	YES
Observations	14,719	14,719	13,930	4,083	2,339
Number of companies	469	469	463	302	202

Table 12: Company Outcomes: Decomposing Angel Investors.

	Exit	Death	USVC	Revenue	Employee
Prior Cumulative					
Angel - Single	-0.329** (0.140)	-0.0509 (0.141)	-0.204 (0.132)	-0.0245 (0.0314)	0.0126 (0.0106)
Angel - Multiple	0.0501 (0.0996)	-0.120 (0.119)	-0.190** (0.0956)	-0.00682 (0.0251)	-0.00501 (0.00729)
Angel - Fund	-0.0931 (0.105)	0.217** (0.102)	-0.0623 (0.108)	0.0378* (0.0217)	0.0268** (0.0130)
VC	0.496*** (0.113)	-0.0632 (0.112)	0.439*** (0.148)	0.0509** (0.0243)	0.0119 (0.00794)
Other	0.102 (0.129)	-0.189* (0.107)	0.361** (0.162)	0.00139 (0.0276)	-0.00854 (0.0125)
Revenues - one year lagged				0.0585 (0.0431)	
Employees - one year lagged					0.212*** (0.0560)
Controls	YES	YES	YES	YES	YES
Observations	14,719	14,719	13,930	4,083	2,339
Number of companies	469	469	463	302	202

Table 12: Interaction Effects: Decomposing Angel Investors.

	Exit	Death	USVC	Revenue	Employee
Prior Cumulative					
Angel - Single * VC	-0.0478*** (0.0173)	0.00615 (0.0179)	-0.0131 (0.0215)	0.000465 (0.00256)	-0.000461 (0.00109)
Angel - Multiple * VC	0.0152 (0.0177)	-0.00228 (0.0172)	-0.0238 (0.0254)	-0.000256 (0.00261)	0.000296 (0.000972)
Angel - Fund * VC	-0.000343 (0.0159)	-0.0105 (0.0129)	-0.0117 (0.0154)	-0.00429 (0.00294)	-0.000266 (0.000916)
Angel - Single	-0.813*** (0.271)	0.0538 (0.253)	-0.256 (0.347)	-0.00529 (0.0363)	0.00748 (0.0177)
Angel - Multiple	0.285 (0.284)	-0.151 (0.245)	-0.472 (0.399)	-0.0101 (0.0364)	-0.000739 (0.0143)
Angel - Fund	0.0248 (0.256)	0.0968 (0.170)	-0.114 (0.234)	-0.0103 (0.0400)	0.0235** (0.0113)
VC	0.290 (0.193)	-0.128 (0.174)	0.0271 (0.199)	0.0226 (0.0346)	0.0109 (0.0127)
Other	0.121 (0.129)	-0.191* (0.108)	0.392** (0.165)	-0.000151 (0.0274)	-0.00784 (0.0131)

Table 13: IV Regressions: Interaction Effects between Angels and VC

Investment Amount	Exit	Death	USVC	Revenue	Employee
Prior Cumulative					
IV - Angel * VC	0.242 (0.409)	0.349 (0.516)	-0.0357 (0.264)	-0.0409 (0.0321)	-0.0940 (0.0844)
IV - Angel	1.229 (6.431)	6.965 (8.113)	-0.663 (5.105)	-0.234 (0.294)	-1.098 (0.820)
IV - VC	2.516 (3.633)	4.453 (4.586)	-0.978 (2.428)	-0.213 (0.388)	-0.0979 (0.0896)
IV - Other	15.38 (11.46)	-18.12 (14.47)	4.305 (14.59)	-0.0765 (0.586)	-0.431 (1.302)
DV - one year lagged				-0.00168 (0.0166)	0.225** (0.109)
Controls	YES	YES	YES	YES	YES
Observations	14,719	14,719	13,930	4,083	2,339
Number of companies	469	469	463	302	202



Conclusion

- Examine interactions of angels and VC
 - Consider heterogeneity among angels
- Main findings
 - Substitutes co-financing patterns
 - Stronger patterns for less committed angels
 - Weaker performance results
- Results have implications for
 - Investors
 - Entrepreneurs
 - Policy Makers

Conclusion

- Agenda: Examine interaction angels and VCs
- Question: Substitutes or complements?
- British Columbia dataset:
 - Share registries with time dimension
 - BC Government that has tweaked the program
- Main findings
 - Substitutes in dynamic financing patterns
 - Pattern stronger for less committed angels
 - Both selection and treatment at work
 - Performance results
 - ... are more tentative, but...
 - VC backed companies appear to do better
 - Mixing investor type appears to harm performance