

Life Cycle Cash Flows of Ventures

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Summary: A New Measure

Normalized NPV, aka. the net present value of aggregate life cycle cash flows per dollar invested in the first funding round

- ▶ Discounted at zero discount rate: 2.15
- ▶ Discounted using Kaplan and Schoar PME: 0.88
- ▶ Discounted using Nagel and Korteweg GPME: 0.95

Summary: A Policy Change

National Securities Markets Improvement Act (NSMIA) of 1996

- ▶ Increases supply of capital to ventures (Ewens and Farre-Mensa, 2019)
- ▶ We expect a structural break soon after 1996
 - ▶ NPV of ventures should come down (to all investors)
 - ▶ Ownership given up by entrepreneurs should come down
- ▶ We find empirical support

Summary: Time-Varying Break-Even Time

Time to break-even for a value-weighted portfolio of all ventures started the first round in a given quarter

(a) Discounting: GPME

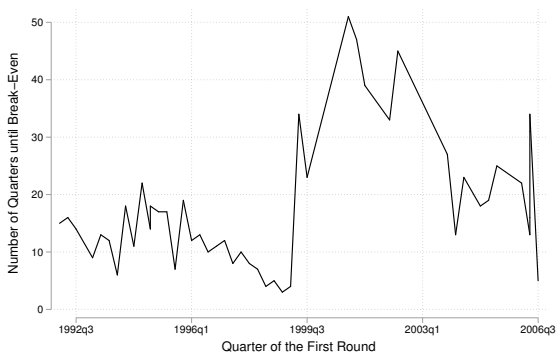


Figure: Break-even Time by the First-Round Time

Summary: The Structural Break

Normalized NPV, before and after a structural break in Q2 of 1999

	Pre-Break	Post-Break
Zero Discount Rate	5.29	1.02
PME	2.51	0.30
GPME	2.27	0.48

Summary: Effect of the Increasing Capital Supply

Participation by more experienced VCs predicts successful exit.

Before the structural break, but not after.

Summary: Effect of the Increasing Capital Supply

Participation by more experienced VCs predicts # of patents filed.

Both before and after the structural break.

Data Limitations: Missing Valuation Data

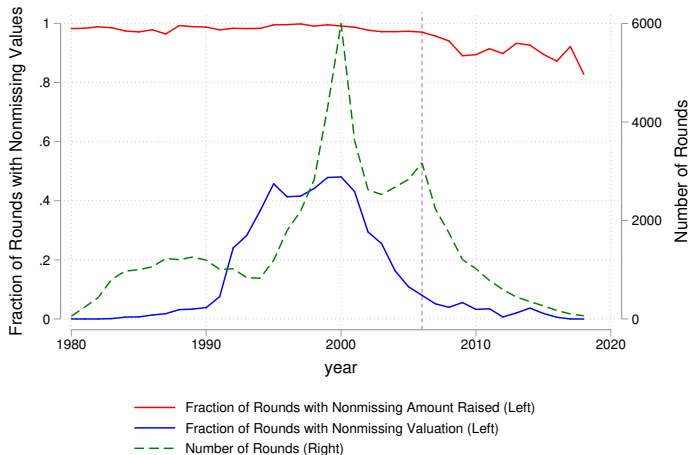


Figure: Fraction of Rounds with Nonmissing Data in Each Year

Data Limitations: Solution

How we handle data limitations

- ▶ Examine first round to exit return to a hypothetical investor participating in all funding rounds
- ▶ Statistical model for missing values
- ▶ Assume that ventures existing for 12 or more years from the first funding round without exiting are dead

An Illustration of the Methodology

Year	0	1	2	3	4
Stage	Round 1	Round 2	Round 3	Round 4	Bankrupt
Amount Raised	2	5	8	20	n.a.
Post-Money Valuation	10	20	40	80	8
Market Return	10%	10%	10%	10%	10%
Pre-Money Valuation	8	15	32	60	n.a.
Ownership Given Up	20%	25%	20%	25%	n.a.
Round-to-Round Return	50%	60%	50%	-90%	n.a.
Round-to-Exit Return	-64%	-76%	-85%	-90%	n.a.
Normalized NPV (PME)	-3.07				

- ▶ **Normalized NPV** captures the net return to all equity holders

$$-3.07 = \frac{1}{10} * \left(-10 - \frac{5}{1.1} - \frac{8}{1.1^2} - \frac{20}{1.1^3} + \frac{8}{1.1^4} \right)$$

- ▶ We use the first-round pre-money valuation as a **proxy** for the amount of money invested by the entrepreneurs

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Risk Adjustment of Cash Flows

Generalized Public Market Equivalent (GPME)

- ▶ Korteweg and Nagel (2016) Stochastic Discount Factor

$$M_{t+1} = \exp(a - br_{m,t+1}) \quad (1)$$

where $r_{m,t+1}$ is the log cumulative return on the market portfolio since the first round

- ▶ PME (Kaplan and Schoar (2005)) is a special case

We use three specifications for discounting:

- ▶ "NoDisc": $a = 0$ and $b = 0$
- ▶ "PME": $a = 0$ and $b = 1$
- ▶ "GPME": $a = 0.033$ and $b = 1.444$

The Rest of the Presentation

- ▶ Related Literature
- ▶ Data
- ▶ Facts about Venture Fundings over Time
- ▶ Aggregate Discounted Life-Cycle Cash Flows
- ▶ The Structural Break in 1999
- ▶ VC Experience and Performance

Related Literature

See paper for full list of references.

- ▶ How to measure risk-adjusted returns to investing in ventures
 - ▶ Kaplan and Schoar (2005), Korteweg and Nagel (2016), Cochrane (2005), Korteweg and Sorensen (2010)
- ▶ Whether VC investments outperform the market
 - ▶ Harris, Jenkinson, and Kaplan (2014a), Harris, Jenkinson, and Kaplan (2015), Nanda and Rhodes-Kropf (2013)
- ▶ Whether experience of VCs matter
 - ▶ Sorensen (2007), Du and Hellmann (2019), Bottazzi, Da Rin, and Hellmann (2008), Ewens and Farre-Mensa (2019), Harris, Jenkinson, Kaplan, and Stucke (2014b)

Data

- ▶ Financing round data: VentureXpert
- ▶ Exit information
 - ▶ SDC Merger and Acquisition, SDC Global New Issues
- ▶ Sample selection
 - ▶ 16,396 US-based ventures
 - ▶ 57,884 funding rounds from 1980 to 2018
 - ▶ First round no later than 2006
- ▶ Cross-check ventures with missing exit events or exit values
 - ▶ PitchBook, Bloomberg, NASDAQ, Crunchbase, Internet

Data: Cross-Check

SDC \ Other Data	Alive	BR	IPO	MA	Total	Source
	48	440	8	389	885	PitchBook
	202	97	0	37	336	Bloomberg
Alive	0	0	4	0	4	Nasdaq
	30	16	1	6	53	Crunchbase
	673	51	1	23	748	Others
Total	953	604	14	455	2026	

Data: Why First Round in 2006 or Earlier

Outcome of Venture	Frequency	Fraction
Exit (IPO/MA/BR) in 12 Years	8,050	49.1%
Exit (IPO/MA/BR) after 12 Years	934	5.7%
Active with All Rounds in 12 Years	7,194	43.9%
Active with Rounds after 12 Years	218	1.3%

Actual Data vs. Data Filled with Imputation Models

Amount Raised						
Group	Actual or Filled	# Rounds	% Rounds	Total Raised (\$ B)	% Raised	
A	Actual	14,029	98.1%	142.2	99.4%	
	Filled	275	1.9%	0.9	0.6%	
B	Actual	42,372	97.2%	300.9	98.8%	
	Filled	1,208	2.8%	3.8	1.2%	

First-Round Ownership Given Up					
Group	Actual or Filled	# Ventures	% Ventures	Avg. 1st-Round OGU	
A	Actual	3,871	99.6%	37.1%	
	Filled	14	0.4%	30.2%	
B	Actual	112	0.9%	37.4%	
	Filled	12,399	99.1%	32.3%	

We separate all the ventures to two groups.

- ▶ **Group A** : with first-round post-money valuation data
- ▶ **Group B**: without first-round post-money valuation data

Actual Data vs. Data Filled with Imputation Models

M&A Value					
Group	Actual or Filled	# Ventures	% Ventures	Total Value(\$ B)	% Value
A	Actual	909	52.4%	142.8	77.9%
	Filled	826	47.6%	40.5	22.1%
B	Actual	2,244	50.2%	369.2	78.0%
	Filled	2,224	49.8%	104.4	22.0%

We use OLS models to impute missing values of key variables.

Trend: Increasing First-Round Amount Raised

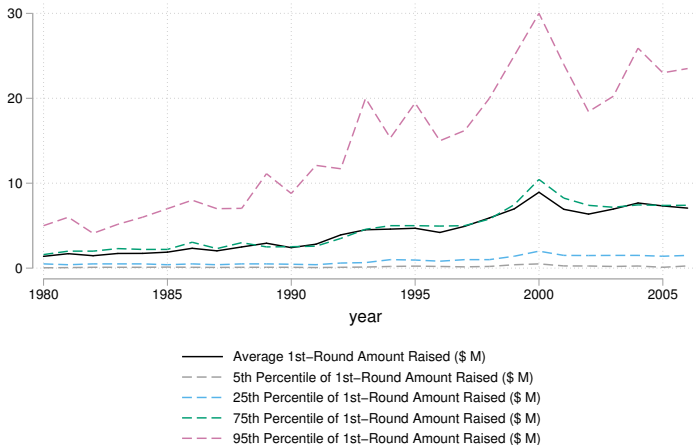


Figure: First-round Amount Raised by the Year of the Rounds

Trend: Changing Venture Outcome Distribution

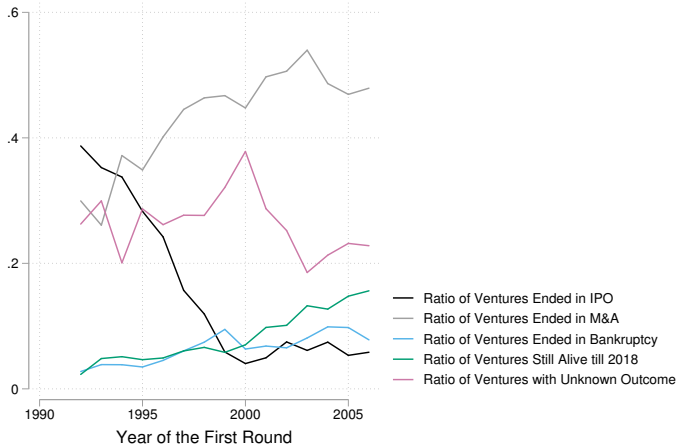


Figure: Fraction of Venture Outcomes by Year of the First Round

Aggregate Discounted Cash Flows over Life Cycle

(a) GPME, Group AB

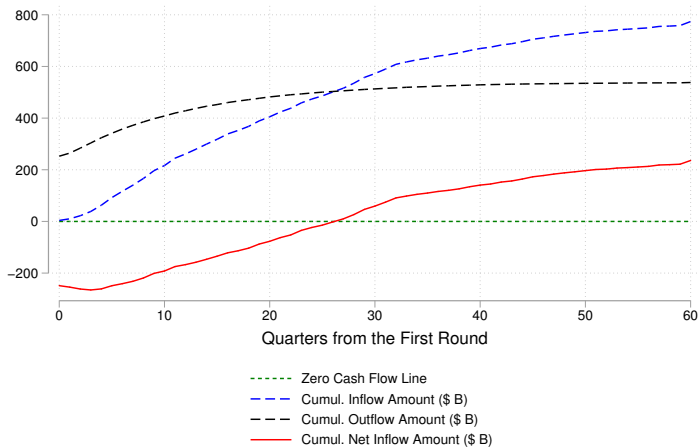


Figure: Cumulative Cash Flows by Quarters from the First Round

NPV Normalized by First-round Cash Flow

(a) GPME, Group AB

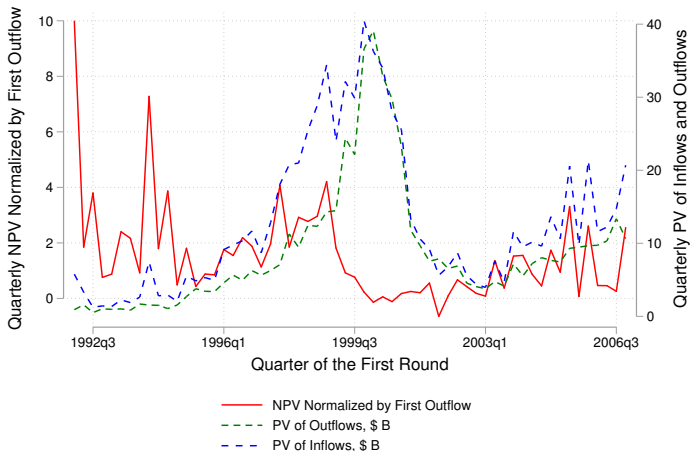


Figure: Normalized Inflow, Normalized Outflow, and Normalized NPV

Structural Break Test: Constant and AR(1) Models

Normalized NPV _t	(1)	(2)	(3)	(4)	(5)	(6)
Constant	2.029*** (0.295)	1.864*** (0.276)	1.875*** (0.228)	0.901** (0.346)	0.897*** (0.330)	1.483*** (0.261)
Normalized NPV _{t-1}				0.533*** (0.113)	0.499*** (0.116)	0.135 (0.102)
Observations	60	60	60	59	59	59
R-squared	0.000	0.000	0.000	0.282	0.246	0.030
Sample	GroupA	GroupA	GroupAB	GroupA	GroupA	GroupAB
Discounting	PME	GPME	GPME	PME	GPME	GPME
Break Date	1999Q2	1999Q2	1999Q2	1999Q2	1999Q2	1999Q2
Chi-squared	35.04	22.08	15.49	13.21	9.12	15.53
DF	1	1	1	2	2	2
P Value	0.000	0.000	0.002	0.025	0.134	0.009

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

We apply a Supremum Wald test (Andrews (1993)) for a structural break in the parameters of the model, at an unknown break date.

Regression Analysis

- ▶ Change in Normalized NPV after the break.

$$\text{Normalized NPV}_i = \alpha \lg(\text{1-st Round Amount Raised}_i) + \beta \text{Post-1999}_i + \gamma \text{industry}_i + \epsilon_i$$

- ▶ Change in first round ownership given up after the break.

$$\text{Ownership Given Up}_i = \alpha \lg(\text{1-st Round Amount Raised}_i) + \beta \text{Post-1999}_i + \gamma \text{industry}_i + \epsilon_i$$

- ▶ Predictability of experienced VC participation on NPV

$$\text{Normalized NPV}_i = \alpha \lg(\text{1-st Round Amount Raised}_i) + \beta_1 \text{Top 30 VC}_i + \beta_2 \text{Top 30 VC}_i \times \text{Post-1999}_i + \gamma X_i + \epsilon_i$$

- ▶ Predictability of experienced VC participation on innovation

$$\text{Innovation}_i = \alpha \lg(\text{1-st Round Amount Raised}_i) + \beta_1 \text{Top 30 VC}_i + \beta_2 \text{Top 30 VC}_i \times \text{Post-1999}_i + \gamma X_i + \epsilon_i$$

Change in Normalized NPV and Ownership Given Up

	(1)	(2)	(3)	(4)
	NPV Normalized by	First Outflow	1st-Round Ownership	Given Up
lg(1st-Round Amount Raised)	-2.909*	-1.282	0.0557***	0.0572***
	(1.536)	(0.812)	(0.00467)	(0.00280)
Post-1999	-5.847***	-3.655***	-0.0278**	-0.0115
	(2.093)	(1.250)	(0.0136)	(0.00902)
<i>N</i>	1018	2590	1018	2590
<i>R</i> ²	0.074	0.035	0.147	0.155
Sample	Group A	Group A	Group A	Group A
Discounting	GPME	GPME	-	-
Industry FE	Yes	Yes	Yes	Yes
Top 30 VC Participation	Yes	No	Yes	No

Standard errors in parentheses

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

- ▶ **Top 30 VC Participation:** we separately conduct the regression on subsamples with and without Top 30 VC participation, to control for venture quality.

VC Experience and Realized Normalized NPV

VARIABLES	NPV Normalized by First Outflow					
lg(1st-Round Amount Raised)	-1.684*** (0.461)	-1.617*** (0.469)	-1.779*** (0.488)	-1.042*** (0.215)	-1.029*** (0.214)	-1.139*** (0.226)
Top 30 VC	3.455*** (0.993)	5.677*** (1.746)	4.497*** (1.569)	2.307*** (0.573)	3.672*** (1.179)	2.940** (1.148)
Top 30 VC × Post-1999		-3.943** (1.919)	-4.174** (1.908)		-2.100* (1.254)	-2.349* (1.237)
WAVG VC Ratio of Exit			5.830** (2.381)			4.860*** (0.916)
WAVG VC Ratio of Next Round			-0.838 (1.091)			-0.426 (0.582)
WAVG VC Ratio of Bankruptcy			-0.615 (4.247)			2.481 (2.588)
lg(WAVG VC # Rounds)			0.688 (0.568)			0.279 (0.296)
<i>N</i>	3608	3608	3608	11899	11899	11899
<i>R</i> ²	0.080	0.083	0.087	0.034	0.035	0.038
Sample	Group A	Group A	Group A	Group AB	Group AB	Group AB
Discounting	GPME	GPME	GPME	GPME	GPME	GPME
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year × Industry FE	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

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

VC Experience and Innovation

VARIABLES	Has Patent		lg(1 + # Patents)		lg(1 + # Citations)	
lg(1st-Round Amount Raised)	0.000178 (0.00878)	-0.00484 (0.00610)	0.0723 (0.0456)	0.0974*** (0.0254)	0.105 (0.0854)	0.194*** (0.0465)
Top 30 VC	0.0902*** (0.0280)	0.0531*** (0.0175)	0.209* (0.123)	0.196** (0.0945)	0.684** (0.284)	0.446** (0.196)
Top 30 VC × Post-1999	-0.0425 (0.0337)	-0.00141 (0.0152)	-0.0127 (0.148)	0.0406 (0.0878)	-0.219 (0.320)	-0.0122 (0.170)
WAVG VC Ratio of Exit	0.0869 (0.0688)	0.0335 (0.0358)	0.0294 (0.239)	0.210 (0.207)	-0.654 (0.812)	0.139 (0.277)
WAVG VC Ratio of Next Round	0.0853** (0.0406)	0.00120 (0.0227)	-0.241 (0.214)	0.0123 (0.135)	-0.0733 (0.446)	0.173 (0.304)
WAVG VC Ratio of Bankruptcy	0.294 (0.220)	-0.0446 (0.118)	0.204 (0.686)	0.167 (0.455)	-2.028 (2.702)	0.384 (1.312)
lg(WAVG VC # Rounds)	0.0325* (0.0188)	0.0419*** (0.00996)	0.183*** (0.0599)	0.0698*** (0.0246)	0.261 (0.207)	0.131 (0.0819)
<i>N</i>	3608	11899	2039	6450	2039	6450
<i>R</i> ²	0.112	0.090	0.126	0.096	0.144	0.114
Sample	Group A	Group AB	Group A	Group AB	Group A	Group AB
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year × Industry FE	Yes	Yes	Yes	Yes	Yes	Yes

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

Conclusion

- ▶ Return to ventures in the aggregate
 - ▶ Focus on the collective return to all equity holders
 - ▶ GPME/PME for risk adjustment
- ▶ Break-even time for a portfolio of all ventures
 - ▶ Across all periods: Around 5 years
- ▶ A structural break in the Q2 of 1999
 - ▶ Profitability declines
 - ▶ Ownership given up by entrepreneurs decreases
- ▶ Experienced VCs' participation in first round
 - ▶ Higher NPV
 - ▶ Higher probability of successful exit
 - ▶ More patent grants
- ▶ After the break, relationship between VC's experience and investment performance becomes weaker

Thanks!