

Do Investors Overvalue Startups? Evidence from the Junior Stakes of Mutual Funds

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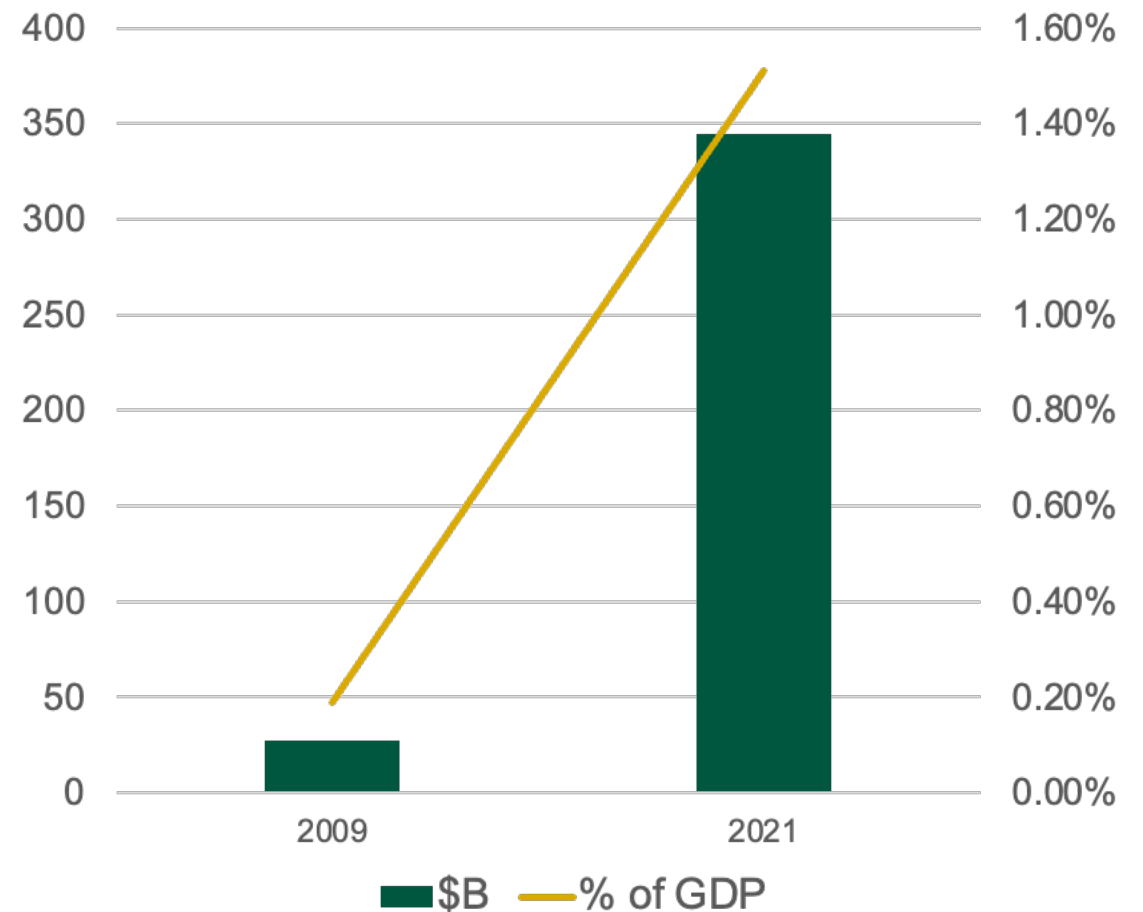
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Rise of Non-Traditional Investors in Private Startups

- Investments in U.S. startups rose sharply 2009-2021
- 2021: MF/HF/pension/SWFs half of all \$ (PitchBook)
- VC-backed startups have multi-tier capital structures with complex payment priorities among investors and founders upon exits
- Do mutual funds value their preferred stock holdings fairly?
 - MFs set values of their private startup holdings daily, affecting Net Asset Value and fund returns
 - MFs are subject to runs like banks



Research Questions

1. How much do senior and junior securities of startups with MF investments differ in model fair valuations?
 - Option-pricing based model of contingent claims
2. How do mutual funds report their junior stakes in startups relative to model fair values?
3. Do fund family characteristics affect their valuations?
4. Do changes in startup-specific or market-wide conditions affect their valuations?

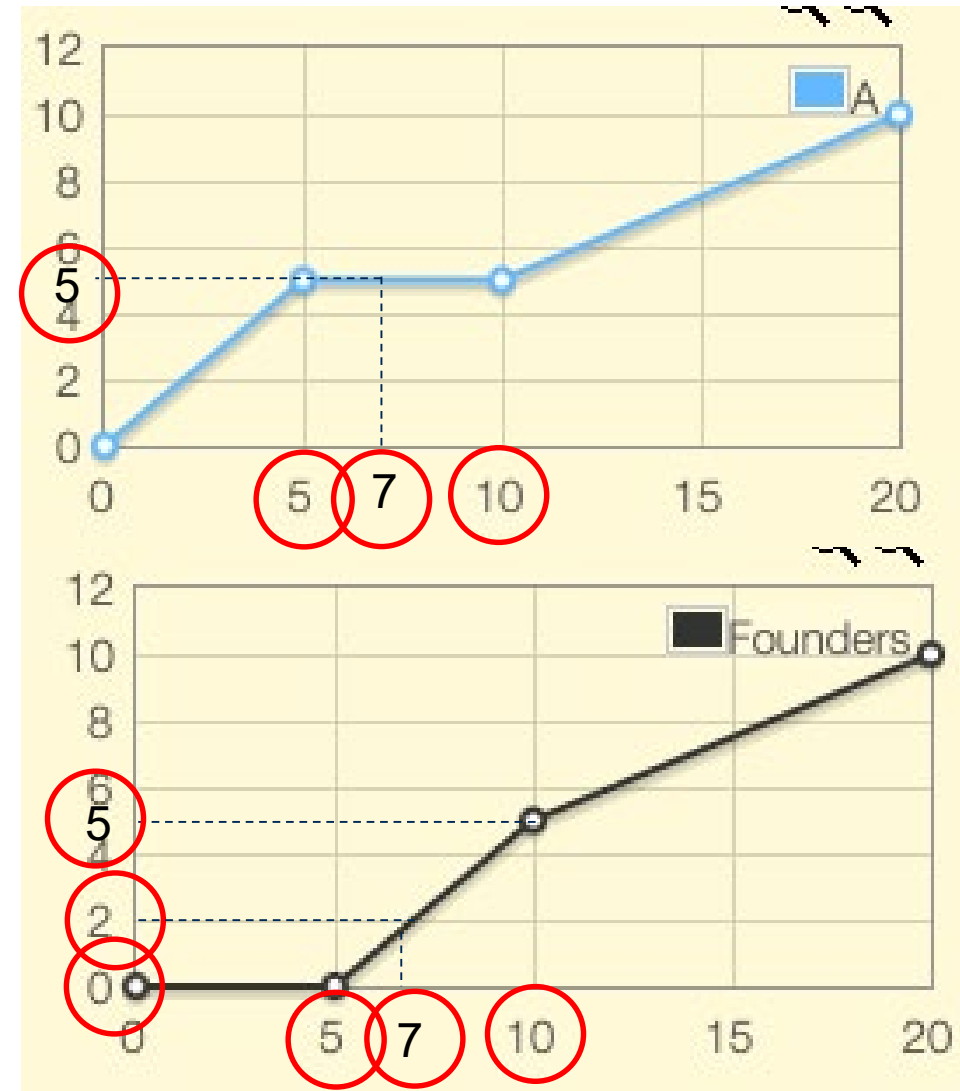
Preview of Results

1. The latest-issued and most senior security is worth 48% more per share than junior securities held by mutual funds in model fair values
2. Mutual funds report their junior stakes in startups at 43% higher valuation than model fair values, i.e., close to par with the senior securities
3. Overvaluation is lower for more experienced fund families & higher for secondary transactions.
4. Overvaluation of junior stakes decreases after down rounds.

Overall, mutual funds appear to overweight the probability of successful exits (e.g., IPOs) where all securities convert to common equity and are valued equally and underweight the probability of negative outcomes.

Exit Payoff Difference Between Investors

- **Exit diagram** plots the exit payoff of a security (y-axis) against the value of the whole firm (x-axis) at the time of the exit
- Suppose a VC invests \$5M in Series A structured as 5M shares of convertible preferred.
 - Founders have 5M shares of common.
- If the firm is sold for \$5M a year later:
 - Series A receives \$5M, and founders receive \$0M.
- At \$7M, Series A receives \$5M (redemption) and founders \$2M.
- At \$10M and higher, each receives 50% of firm value and are treated equally.
 - Series A chooses to convert if firm value \geq \$10M
- PV of common < PV of Series A as of the Series A investment date, as functions of the probabilities of high vs. low-value exits



Exit Equation

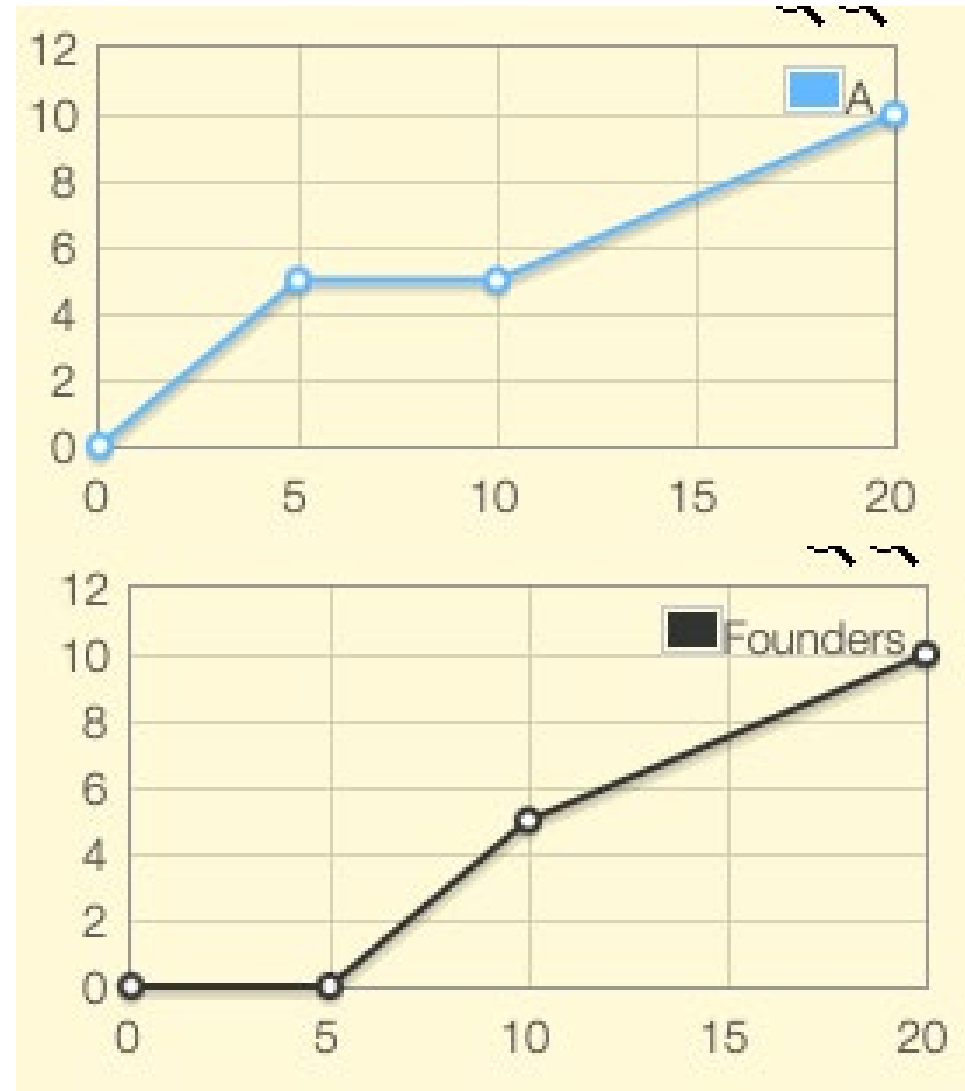
- Express a stake in a firm as linear combinations of call options on the firm's enterprise value at exit
- $C(x)$ = call option with strike price x

- Series A's stake:

$$C(0) - C(5) + \frac{1}{2} C(10)$$

- Founders' stake:

$$C(5) - \frac{1}{2} C(10)$$



VCV Model (Metrick and Yasuda 2010, 2021)

Value each C^* using Black-Scholes:

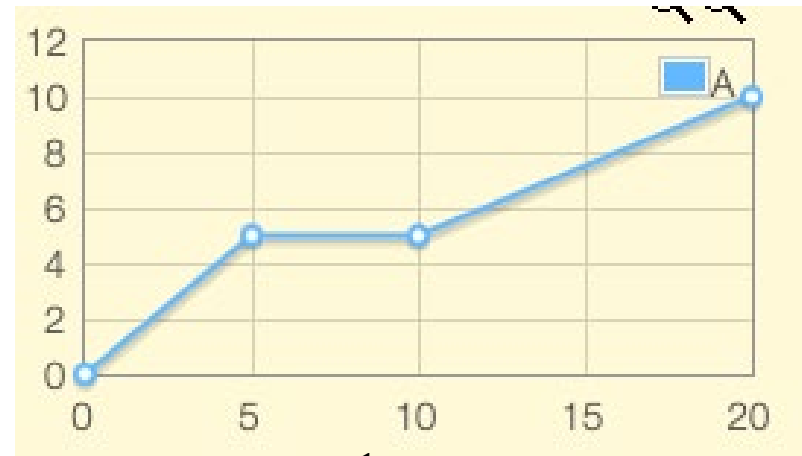
$$C_0 = N(d_1)S_0 - N(d_2)Xe^{-rT}$$

where:

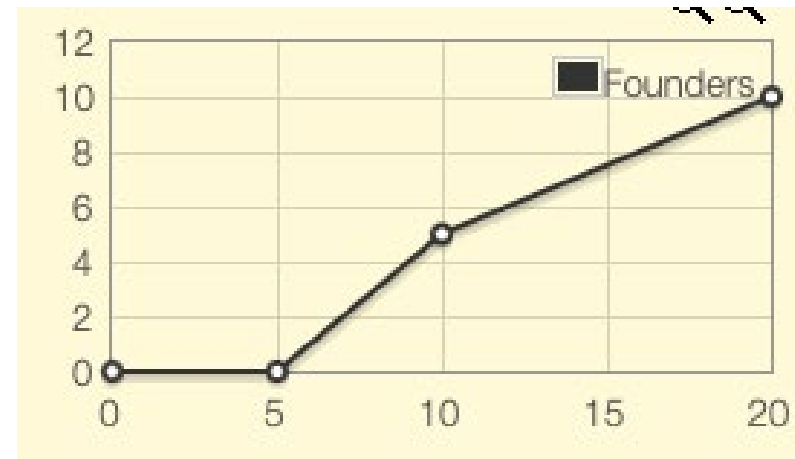
- S_0 : current enterprise value
- X : strike price
- T : time to expiration
- r : risk-free rate
- σ : volatility

Also:

1. Assume no cash dividends
2. Exit occurs randomly with continuous-time probability q and expected holding period $H = \frac{1}{q}$
 - Exponential distribution



$$C(0) - C(5) + \frac{1}{2} C(10)$$



$$C(5) - \frac{1}{2} C(10)$$

Random-Expiration Option

- An exit forces the embedded option value of VC security to get expired – exercise or let expire
- If an exit date is known – i.e., the firm exits with 100% probability on a single date T – then the prob. distribution of *firm value at exit* can be modeled using standard BS formula
- Exit date not known on deal date
- Our modeling choice:
 - Think of VC security as a prob. weighted combination of multiple options with different exit dates
 - Expected value of option = an integral of the probability of expiration on a given date x BS option value with that expiration date
 - For any given T , BS formula puts reasonable probability distribution on potential exit value of firm on that date. **Exit value distribution is a function of exit time.**
 - We assume exponential distribution for exit time with instantaneous probability q ($H = 1/q$)

$$\text{Value of RE call option (random-expiration)} = \int_0^{\infty} \underbrace{[SN(d_1) - Xe^{-rT}]}_{\text{Call option value with expiration at } T} \underbrace{N(d_2)]}_{\text{Probability of expiration at } T} qe^{-qT} dT$$

Inferring Fair Value of Junior Stakes

- Known: Most recent transaction price (e.g., Series A Price)
- Using the **most recent transaction price**, find the value of the whole firm such that the Series A investment is fair, i.e., \$0 NPV (What You Pay is What You Get)
- Purchase price = \$5M = $C(0) - C(5) + \frac{1}{2} C(10)$
 - S_0 that satisfies this condition = \$8.75M
 - By definition, if the whole firm is worth \$8.75M, A's stake is worth \$5M, or what VC paid for it.
- Using \$8.75M as the implied fair value of the whole firm on Series A's investment date, calculate founders' stake's fair value
- $C(5) - \frac{1}{2} C(10)$ (with $S_0 = \$8.75M$) = \$3.75M
- On per share basis, founders' common stock is worth $\frac{\$3.75M}{5M \text{ shares}} = \text{\$0.75}$, compared to Series A's **\\$1** per share.
- Series A's preferred stock is worth **33%** more than common stock $(\frac{\$1}{\$0.75} - 1)$
- Key: Using the **most recent transaction price** paid by investors, we can back out the **fair value** of other illiquid securities in the startup's capital structure.
- We generalize the model for startups with multiple funding rounds (Series B, C, D, etc.)

Hypotheses

H_01 : Junior stakes held by MFs are worth less than the latest issued securities on a per-share basis (*Senior-Junior fair value gap*)

H_02 : MFs value junior securities higher than their implied fair values on average. (*Excess valuation*)

H_03 : Longer investment experience in VC-backed startups by MFs is associated with smaller excess valuation (*Learning*)

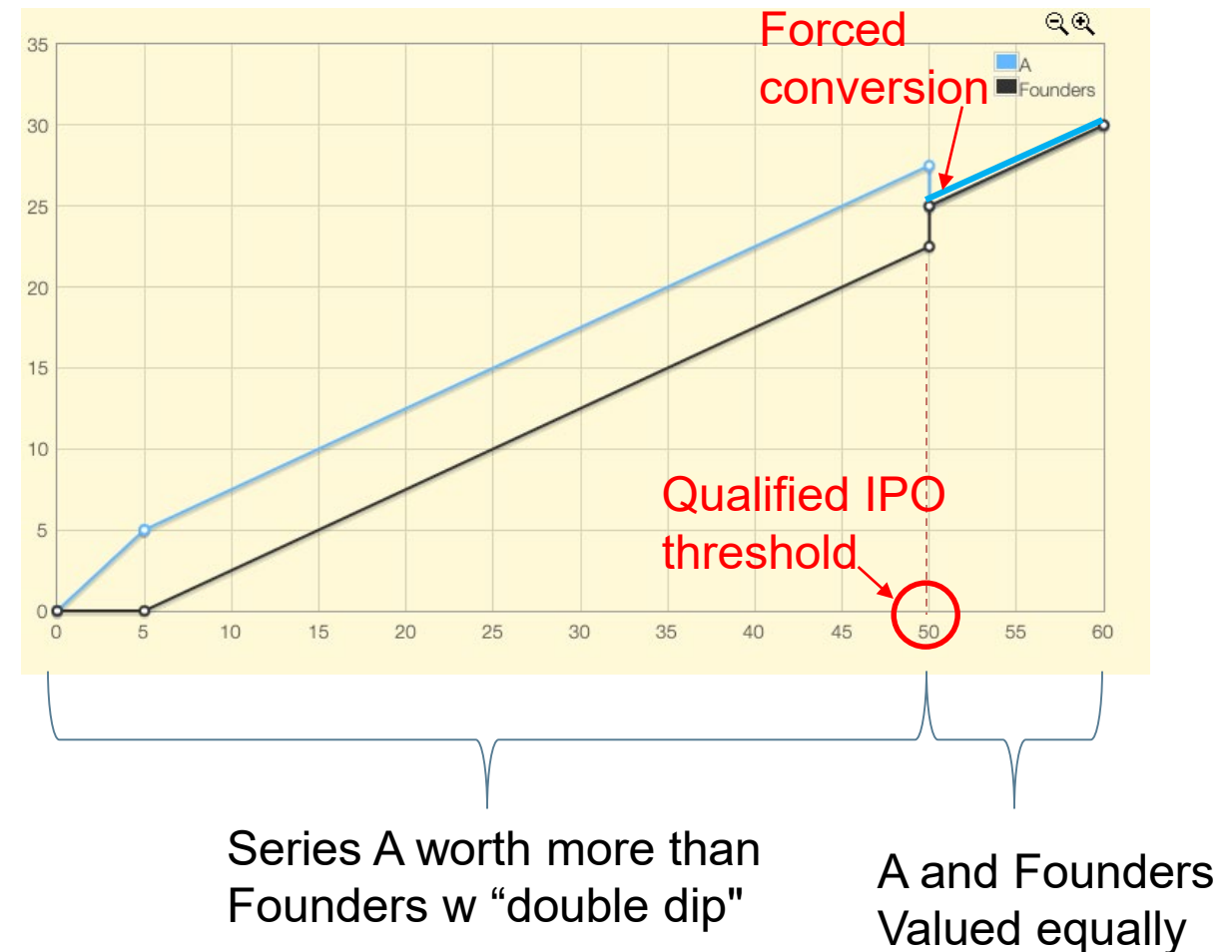
H_04 : MFs pay more than fair values when they buy junior securities in secondary transactions; the secondary buyers also value them more excessively than primary buyers (*Naïve or optimism*)

H_05 : MFs' excess valuation of junior stakes declines after a down round; further if down rounds trigger conversion rate adjustment (*Learning*)

H_06 : MFs' excess valuation of junior stakes correctly anticipates future positive outcomes, e.g., IPOs (*Anticipatory valuation*)

Forced Conversion to Common at IPO

- VC preferred stock often has additional privilege to participate or “double dip”
- Their payoff is always higher than that of common, unless IPO occurs
- Upon a qualified IPO (which VC investor approves), VC’s stake in preferred is forced to convert to common
- After IPO exits, VC and founders’ securities are valued equally on per-share basis
- So if excess valuation of junior stakes is concentrated in periods right before IPOs, then it is ex post justified to a point.



Data

- Private companies have multiple funding rounds and series (distinct securities).
- Security names not standardized and no reliable identifier provided
- CRSP Survivor-Bias Free Mutual Fund Database
- SEC Mutual Fund N-CSR and N-Q Filings
- Certificate of Incorporation, S-1 Filings from Genesis; Pitchbook, TechCrunch, web search
- Sample: U.S. active equity mutual funds, 2010 to 2018
 - Currently extending to 2022.

Each time there is a new round, the startup files a restated Certificate of Incorporation (COI) with the state.

State of Delaware
Secretary of State
Division of Corporations
Delivered 06:14 PM 01/29/2014
FILED 06:09 PM 01/29/2014
SRV 140108856 - 4348296 FILE

RESTATED CERTIFICATE OF INCORPORATION

OF

DROPBOX, INC.

ARTICLE IV: AUTHORIZED SHARES

The Corporation is authorized to issue a total of 1,526,661,381 shares of its capital stock, which shall be divided into three (3) classes, designated "Class A Common Stock," "Class B Common Stock" and "Preferred Stock." The total number of shares of Class A Common Stock authorized to be issued is 700,000,000 shares, \$0.00001 par value per share. The total number of shares of Class B Common Stock authorized to be issued is 600,000,000 shares, \$0.00001 par value per share. The total number of shares of Preferred Stock authorized to be issued is 226,661,381 shares, \$0.00001 par value per share, of which 95,810,910 are designated as "Series A Preferred Stock", 78,023,640 are designated as "Series A-1 Preferred Stock", 29,268,103 are designated as "Series B Preferred Stock" and 23,558,728 are designated as "Series C Preferred Stock."

1.9 "Original Issue Price" shall mean \$0.06263 per share for the Series A Preferred Stock, \$0.01605 per share for the Series A-1 Preferred Stock, \$9.0491 per share for the Series B Preferred Stock and \$19.1012 per share for the Series C Preferred Stock. The Original Issue Price shall be as adjusted for any additional stock splits or combinations of such Preferred Stock, stock dividends on such Preferred Stock, recapitalizations or reclassifications of such Preferred Stock or the like with respect to such Preferred Stock.

Hypothesis #1: *Senior-Junior Fair Value Gap*

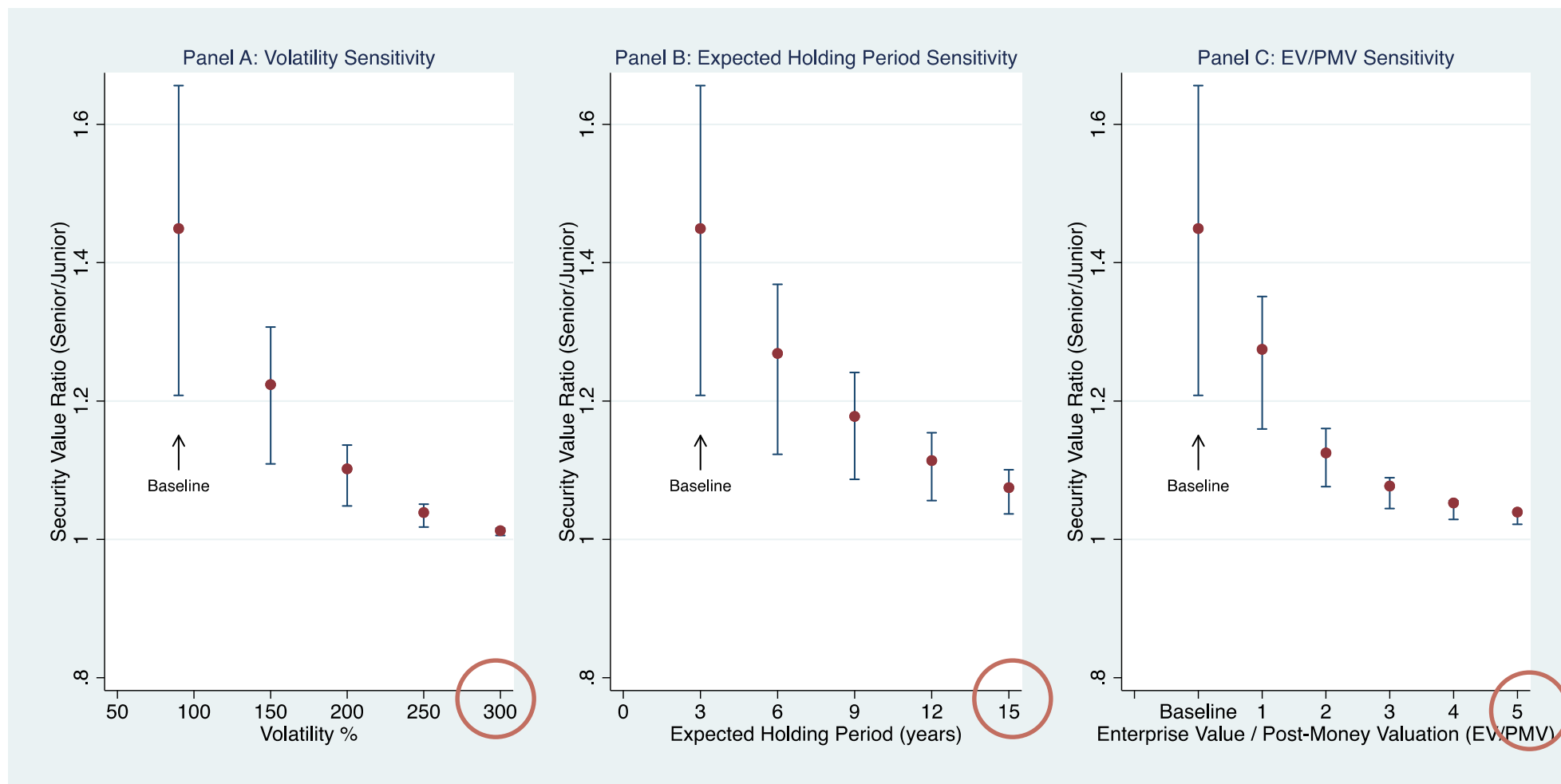
$DevDeal_{i,j} = \frac{New\ Round\ Price_j}{Fair\ Value_{i,t_j}} - 1$ and measures how much more valuable the latest security_j is relative to the junior security_i that mutual funds hold, at the time of the latest security_j round.

Sample	No. Firms	No. Security Pairs	Mean	Median	Std. Dev.	Median Round Gap
Total	65	214	62.9%	47.3%	83.3%	2
Primary	61	167	48.5%	35.7%	79.6%	1
Secondary	19	59	103.0%	84.4%	75.9%	4

- Consistent with H1, the latest-issued and most senior security is worth 48.5% more than junior securities held by MFs
- The fair value differences rise to 62.9% if we include securities bought in secondary transactions.
- MFs buy much earlier-round securities in secondaries, which tend to be worth less in model fair values both because they are junior and their liquidation preference amount is smaller.

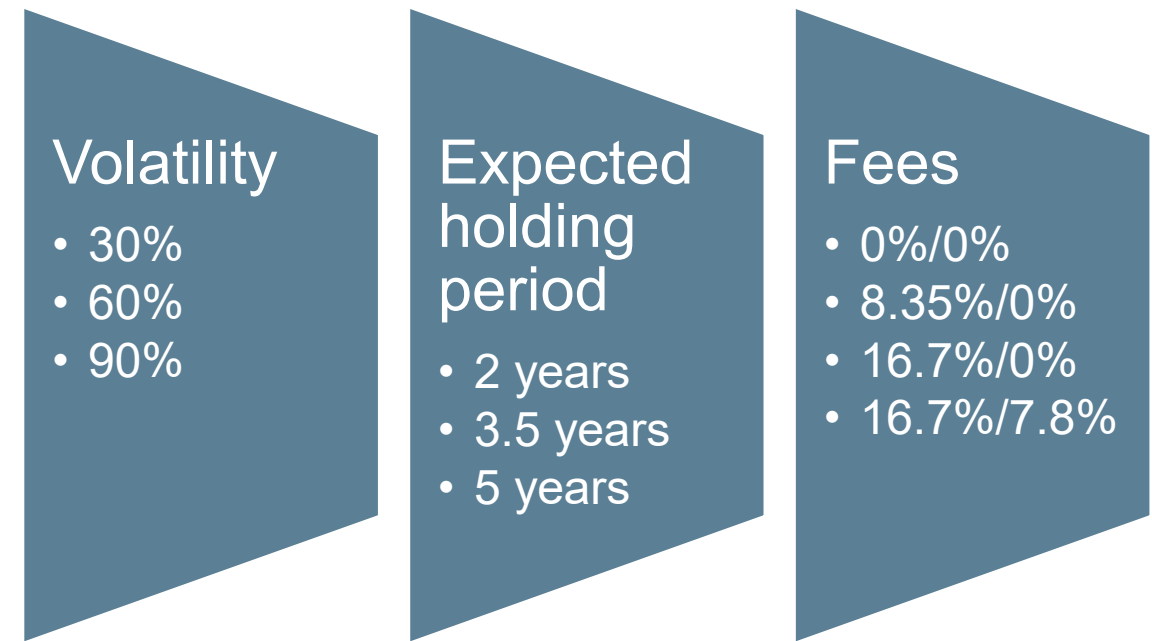
Sensitivity Analysis (1) Single Inputs

- Closing the fair value gap bet. senior and junior security requires unrealistic values for model assumptions.
- Volatility: $\geq 300\%$
- Expected holding period: > 15 years
- Enterprise value: $\geq 5x$ Post-money valuation



Sensitivity Analysis (2): Input Combinations

- We now vary (i) volatility, (ii) expected holding period, and (iii) fees simultaneously (36 combinations).
 - VC 2% fees and 20% carry
 - To achieve \$0 NPV net of fees, gross investment value need to exceed purchase price.
 - For mutual funds, assume VC syndicate co-investors
- Under *all* 36 combinations, senior fair value > junior fair value
 - 23%-85% senior *premium* for “All”
 - 8%-69% for “Primary” purchases
 - 39%-176% for “Secondary” purchases
- MFs’ holdings of junior securities consistently worth significantly less than senior securities



$$[Volatility] \times [Expected Holding Period] \times [Fees]$$

$$3 \times 3 \times 4 = 36 \text{ combinations}$$

Hypothesis #2: MF Excess Valuation

$DevPrc_{i,j} = \frac{MF\ Valuation_{i,t_j}}{Fair\ Value_{i,t_j}} - 1$ and measures how mutual funds value the junior security_i relative to its implied fair value at the time of the latest security_j round.

Sample	No. Firms	No. Security Pairs	No. Family	No. Family-Security Pairs	Mean	Median	Std. Dev.
Total	65	214	40	520	67.8%	42.4%	113.1%
Primary	61	167	39	387	43.3%	28.2%	107.7%
Secondary	19	59	19	133	138.9%	119.0%	97.3%

- Consistent with H2, mutual funds report their junior stakes in startups at 43% higher valuation than fair values
- Given the fair value difference of 48%, this implies MFs **mark junior securities close to par with the senior securities.**
- Overvaluation (relative to fair value) is also higher for secondary purchases than for primary ones

Learning, Naïve/Optimism, or Strategic Inflation?

Evidence in support of naïve/optimism and learning, rather than intentional inflation

1. MFs with longer experience in startup investments have smaller excess valuation (Learning) (**H_03**)
2. MF purchasers in secondary markets overpay relative to fair values (\neq Strategic inflation) (**H_04**)
3. After down rounds, excess valuation diminishes; disappears if conversion rate adjusted (Learning) (**H_05**)
4. Our paper #1 also examines and finds no evidence of strategic inflation (*Review of Finance* 2023, v27, p,693–738)
5. Learning appears limited and localized during sample period

Examples of Secondary Purchases

- If only strategically inflating the values of junior stakes, MFs would pay fair values when acquiring junior stakes in secondary markets, then report excess value in later periods
- If they naively believe junior stakes worth more than fair values, they would pay higher price to acquire them

Fund	Issuer	Series Acquired	Acquisition Cost	Latest Series	Latest Issue Price	Acquired Series Fair Value	Excess Price Paid
T ROWE PRICE GROWTH STOCK FUND, INC	TWITTER	Series A	16.13	Series G	16.09	8.62	87%
T ROWE PRICE GROWTH STOCK FUND, INC	TWITTER	Series B	16.09	Series G	16.09	8.62	87%
T ROWE PRICE GROWTH STOCK FUND, INC	TWITTER	Series C	16.13	Series G	16.09	8.62	87%
T ROWE PRICE GROWTH STOCK FUND, INC	TWITTER	Series D	16.09	Series G	16.09	8.63	86%
FIDELITY MAGELLAN FUND	DOCUSIGN	Series B	13.18	Series E	13.13	3.08	328%
FIDELITY MAGELLAN FUND	DOCUSIGN	Series B-1	13.34	Series E	13.13	3.08	333%
JOHN HANCOCK FUNDS II: MID CAP STOCK FUND	DOCUSIGN	Series B	13.13	Series E	13.13	3.08	327%
JOHN HANCOCK FUNDS II: MID CAP STOCK FUND	DOCUSIGN	Series B-1	13.13	Series E	13.13	3.08	326%
JOHN HANCOCK FUNDS II: MID CAP STOCK FUND	DOCUSIGN	Series D	13.13	Series E	13.13	5.69	131%
NEUBERGER BERMAN FOCUS FUND	SWEETGREEN	Series D	12.00	Series H	13.04	8.11	48%

These funds paid excess price to acquire junior securities in secondary markets

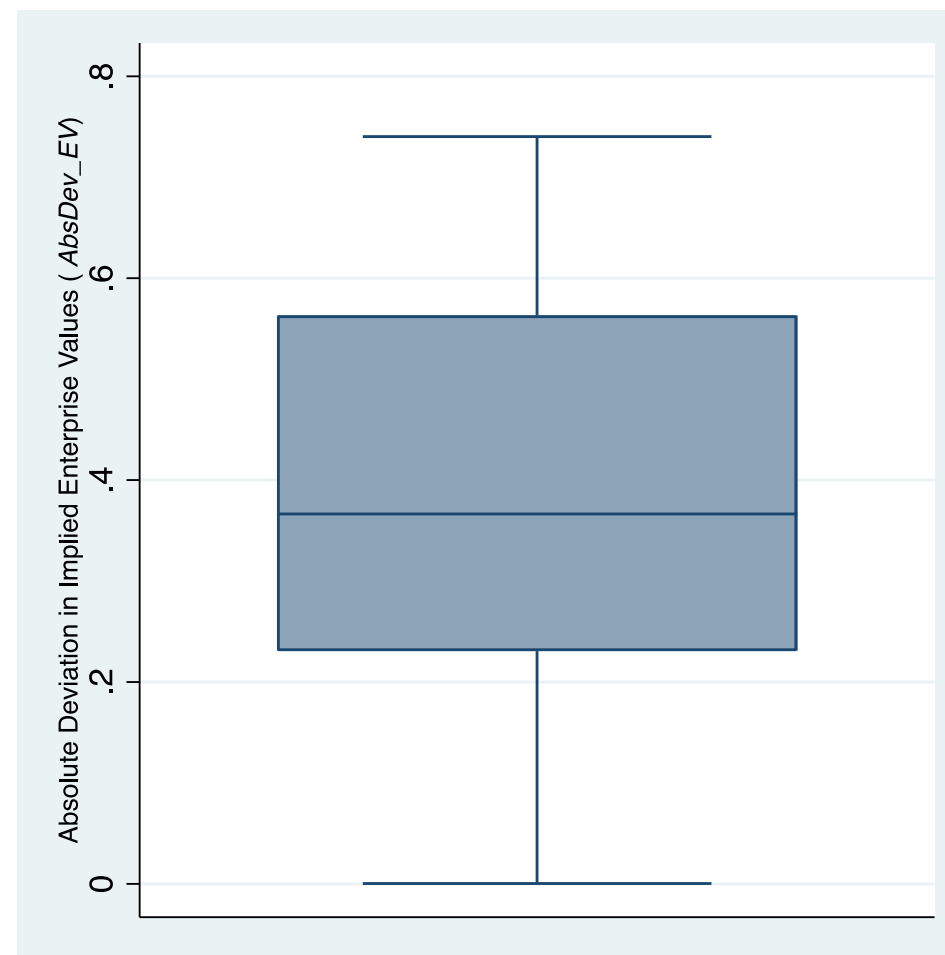
Overpayment consistent with naïve/optimism not strategic

Counterfactuals

- 108 observations where a fund family simultaneously reports a junior and a senior stake at the time of senior security issuance *at the same price*.
- They cannot *both be fairly valued*.
- We calculate the two implied enterprise values (senior_EV and junior_EV) and measure the absolute value differences as:

$$AbsDev_EV = \left| \frac{senior_EV}{junior_EV} - 1 \right|$$

- Its median is **37%**, with I.Q. range of 23-56%
- Consistent with mutual funds making a valuation error when they report two different securities at the same price.



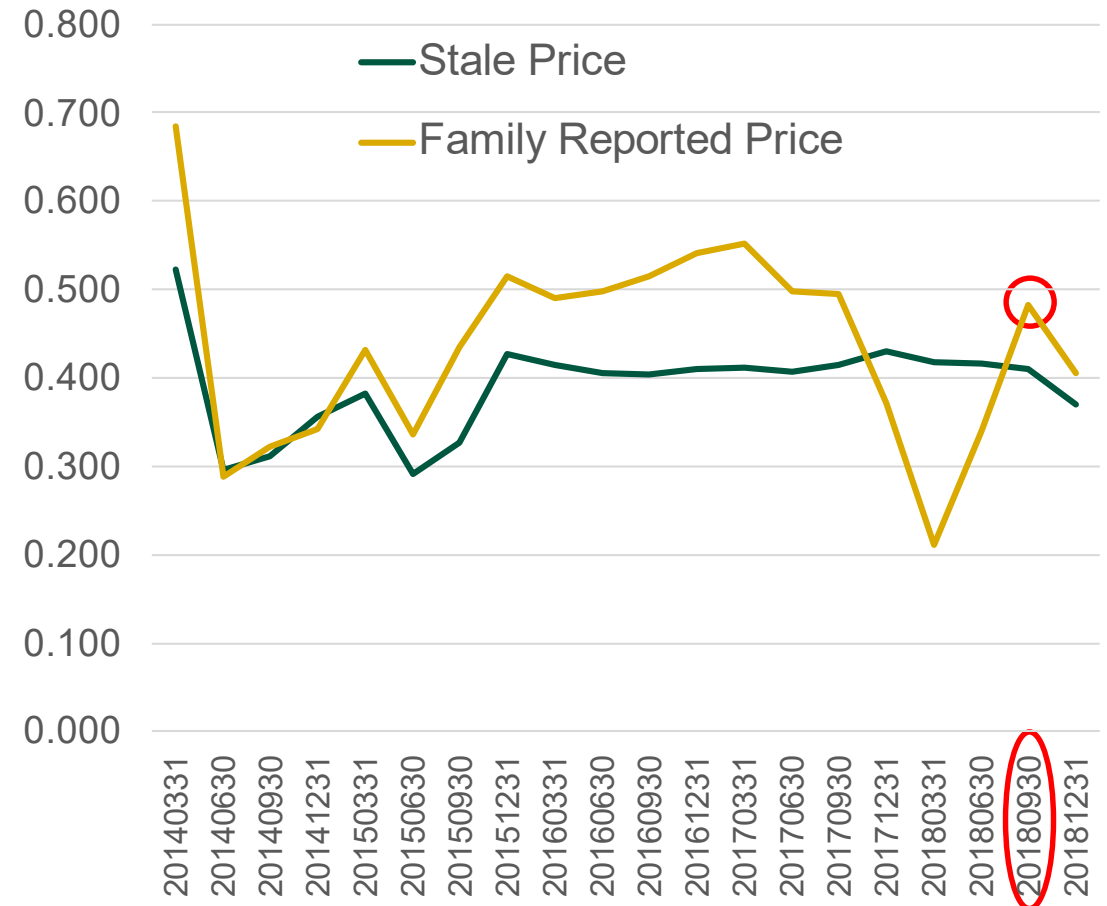
Aggregate Misvaluation by MF Funds

Each quarter we report the aggregate misvaluation as:

$$AggDevPrc_t = \frac{\sum_F \sum_i q_{Fit} \times Price_{Fit}}{\sum_F \sum_i q_{Fit} \times Fair Value_{i t}} - 1$$

q_{Fit} equals the number of preferred security i held by fund family F at quarter.

- 2 alternative methods
- Junior securities are held at 44% above fair values on average
- 3Q 2018, mutual funds reported \$7.1B in holdings, compared to fair values of \$4.8B, or 48% higher.
- “Back of the envelope”: “true” portfolio weight = 5% or \$5M but reported \$7M (40% overvaluation). Once corrected, it represents 40%*5% = 2% loss on the fund portfolio value.
- SVB loss on bond was \$2B on \$209B portfolio



Conclusion

1. Senior preferred is worth 48% more than junior preferred.
2. Yet mutual funds report their junior stakes at 43% higher than fair values, i.e., close to par with senior preferred
3. Overvaluation is lower for more experienced fund families & higher for secondary transactions.
4. Overvaluation erodes after down rounds.

Mutual funds appear to (naively) overweight the probability of successful exits where all converts to common and downplay the probability of negative outcomes.

Recommendation to policymakers: Require mutual funds to differentiate the reported values between senior and junior securities.

Next steps: Extending sample to 2022, examine learning/spillover in down markets