Stock Market Overvaluation Moon Shots, and Corporate Innovation
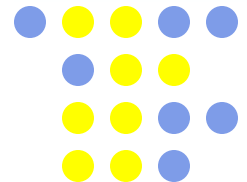
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NetApp (NTAP), April 2000

- NetApp: an S&P 500, Nasdaq 100 firm in our sample
  - Software, systems, services to manage/store data

- 4/2000 valuation, near peak of tech boom
  - In top-quintile valuation by valuation ratio (VP), equity issuance, subsequent 3-year return

- In fiscal 2000 (starting 5/2000), in top innovation quintile
  - Innovative input (R&D), output (patent count, citations), inventiveness (patent novelty, originality, scope)

- Causality?

Tesla and SpaceX

- Current examples (outside our sample period)

- Founded by celebrity entrepreneur Elon Musk

- Does investor enthusiasm for such businesses encourage moon-shot innovation?

- Tesla (IPO date: June 2010)
  - Aims to disrupt the car industry with electric vehicles affordable to average consumer

- Approx. 7-fold run-up in Tesla in under a year (3/2013 - 2/2014) hard to explain as rational response to news
  - Cornell & Damodoran (2014), Cornell (2016)

- Musk's SpaceX: almost literally a `moon shot' business
  - Monetizing space travel, colonization of Mars
- Private firm valued at $21 billion as of 10/16/17 (*New York Times*)
- Valuations of many unicorns such as SpaceX grossly inflated
  - Valuations based upon recently-issued shares with special cash flow rights
  - Gornall & Strebulaev (2017)

- Such valuations not based on market prices
  - Not automatically investor misperception
- However, almost surely induces investor misperception
  - Managers/employees in innovative start-ups attracted with option compensation
  - Other potential stakeholders
  - Such investors lack financial sophistication, information needed to adjust reported valuations for subtle biases
- "These financial structures and their valuation implications can be confusing and are grossly misunderstood not just by outsiders, but even by sophisticated insiders…SpaceX's value actually fell in 2008" during a period when its reported valuation increased.
  - Ilya Strebulaev, quoted in *New York Times,* 10/16/17

Outline

1. Misvaluation hypothesis of innovation
2. Tests of misvaluation effects on innovation input, output, and inventiveness measures

   Moonshots—very high inventiveness

3. Channel for misvaluation effects on innovation
   - External financing channel (equity issuance)
   - Non-financing channel
4. Nonlinearity of misvaluation effects, and relation to growth, catering incentives

The Misvaluation Hypothesis of Corporate Innovation

- Overvalued firms invest more in innovation
  - Finance with overvalued equity
  - Cater to investor optimism to maintain high reputation, stock price
    - Agency problems of overvalued equity
      - Jensen (2005)
- R&D investment ➔ innovative output
  - (patents, citations)
- Ambitious projects—novel, original, wide scope
  - At the extreme, moon shots

Past research on market valuations and investment

- ## Q theory
  - Positive relation between prices (proxy for growth prospects) and investment

- ## Association of stock prices with investment, controlling for cash flow or profitability
  - Barro (1990), Blanchard, Rhee & Summers (1993), Morck, Shleifer & Vishny (1990)

- ## Association of stock prices with investment for equity-dependent firms
  - Baker, Stein & Wurgler (2003)

Misvaluation and capital expenditures

Misvaluation measures

- ## Accruals
  - Polk & Sapienza (2009)

- ## Analyst forecast dispersion
  - Gilchrist, Himmelberg & Huberman (2005), Bakke & Whited (2010)

- ## Component of firm Q not explained by fundamentals
  - Chirinko & Schaller (2001, 2012), Campello & Graham (2013), Warusawitharana & Whited (2015)

- ## Mutual fund fire sales or fund flows
  - Hau & Lai (2013), Camanho (2015)

Determinants of R&D, innovative output

- Large literature on drivers of innovation
  - E.g., access to public markets
    - Acharya & Xu (2015)

- Very little on how misvaluation affects R&D
  - Parise (2013 w.p.): relation of undervaluation (mutual fund fire sales) to R&D

- No work we know of on how misvaluation affects innovative outcomes

Research Questions

- Does **R&D** (vs. CAPX) increase with overvaluation?

- Does innovative **output** increase with overvaluation?

- Does **inventiveness** (patent novelty, originality, scope) increase with overvaluation?

- Do the most overvalued firms **take moon shots**?

- Are effects via **equity issuance**?

- Do these effects depend on **growth prospects, catering incentives**?

Measuring overvaluation

- Use misvaluation measures that filter growth prospects from stock price
  - Entirely; or
  - Variations unrelated to misvaluation

Misvaluation Proxies

- Residual income valuation ratio *VP*
  - (Residual Income Value)/Price
  - *V* combines book value, analyst forecasts of future earnings to form discounted value
  - Overall measure of misvaluation
- Mutual fund outflows *MFFLOW*
  - Price pressure, temporary underpricing
    - Arguably exogenous to firm fundamentals

Motivation for *VP*

- Misvaluation measure in several past studies
  - Lee, Myers & Swaminathan (1999), Frankel & Lee (1998), D'Mello & Shroff (2000), Dong, Hirshleifer, Richardson & Teoh (2006), Dong, Hirshleifer & Teoh (2012)

- VP predicts one-month-ahead returns on the Dow 30 stocks
  - Not subsumed by B/M
  - Lee, Myers, & Swaminathan (1999)

- …cont. …

- *VP* predicts cross-section of one-year-ahead returns
  - Frankel & Lee (1998)
- *VP* effect concentrated at subsequent earnings announcement dates
  - Ali, Hwang & Trombley (2003)
- Standard risk measures/controls do not subsume ability of *VP* to predict returns
  - Ali, Hwang & Trombley (2003)

Calculation of *VP*

- Fundamental Value **V**

  = Invested Capital **B**

  + Discounted Stream of Excess Earnings

- For each stock in month t, calculate $V(t)$

- Use same procedure as past researchers

- Use earnings forecast (FEPS) for year $t + 1$, $t + 2$; assume forecast in $t + 3$ is perpetuity

$$V_t = B_t + \frac{(FROE_{t+1} - r_e)B_t}{1 + r_e} + \frac{(FROE_{t+2} - r_e)B_{t+1}}{(1 + r_e)^2} + \underbrace{\frac{(FROE_{t+3} - r_e)B_{t+2}}{(1 + r_e)^2 r_{e,t}}}_{\text{perpetuity}}$$

Motivation for *MFFLOW*

- Mutual fund outflows (inflows) create pressure for the fund to sell (buy) stocks
  - Coval & Stafford (2007)
  - Stocks with large fund outflows experience negative returns that are reversed in 2 years
    - Suggests outflows associated with undervaluation
- **Hypothetical** orders projected from disclosed portfolio weights
  - Edmans, Goldstein & Jiang (2012)
  - So *MFFLOW* unlikely to reflect private information, firm fundamentals

Outflows only
Edmans, Goldstein & Jiang (2012)

- Possible concern MFFLOW
  - Investors buy fund based on industry/sector fundamental innovation prospects?
  - Exclude sector, specialized funds
- Buying actively always viewpoint based
- Selling often not viewpoint based
  - Sell what you happen to own to raise cash
  - Insider trading literature
  - Barber & Odean (2008) on investor attention
- To minimize concern, focus on fund outflows

Motivation for *MFFLOW* … cont.

Use of mutual fund flow measure to study misvaluation and **capital investment**

- Dessaint, Foucault, Fresard & Matray (2015)

- Gao & Luo (2013), Camanho (2015)
  - Actual instead of hypothetical fund flow

- Hau & Lai (2013), Parise (2013)
  - Similar price pressure measure based on mutual fund fire sales

Calculation of *MFFLOW*

- Mutual fund **%** outflow for fund j for quarter t

$$\%Outflow_{j,t} = \frac{TA_{j,t-1}\left(1 + R_{j,t}\right) - TA_{j,t}}{TA_{j,t-1}}$$

$TA_{j,t}$ = total assets, $R_{j,t}$ = return of fund j for quarter t

- Sum over funds j for which $Outflow_{j,t} \geq 0.05$ to get quarterly *QMfflow* for stock i in quarter t:

- $QMfflow_{i,t} = \sum_{j=1}^{m} \frac{Outflow_{j,t} \times Share_{i,j,t} \times P_{i,t}}{VOL_{i,t}}$

- *MFFLOW* = sum of *QMfflow* over preceding 4 quarters

Price Effect of *MFFLOW*

- We set zero *MFFlow* observations to missing
  - When mutual funds have zero or close to zero holdings of a stock, *MFFlow* would equal zero; such a value does not indicate stock overvaluation

- Consequently, our *MFFlow* measure has a stronger price pressure effect than that documented in Edmans, Goldstein, and Jiang (2012)
  - Highest-*MFFlow* decile experiences a market-adjusted return of −12% two quarters after the *MFFlow* measurement
  - Edmans, Goldstein, and Jiang (2012): highest-outflow decile has a peak price pressure of −6.5% market-adjusted return

Sample

- Intersection of CRSP/COMPUSTAT/IBES U.S. stocks, 1976-2012

- Patents/citations data: Kogan, Papanikolaou, Seru & Stoffman (2016), last data in 2010
  - End patent/citations-related variables in 2008 to reduce truncation bias

- Require both *BP*, *VP*
  - Non-financial firms traded on NYSE, AMEX or NASDAQ (no ADR, REITS)

- MFFLOW data from CDA/Spectrum & CRSP (1981-2012)

Measures of innovative input, output, and inventiveness

- Innovative input:
  - R&D (for comparison, CAPX) scaled by lagged assets

- Innovative output:
  - PAT (applied for and ultimately granted)
  - CITES (ultimately received)

Measures of innovative input, output, and inventiveness

- Three inventiveness measures:
  - **NOVELTY** = CITES/PAT

  Average technology- and year-adjusted citations per patent (Seru 2014)

  - **ORIGINALITY**: Degree to which a patent cites previous patents spanning wide range of technologies.
  1 – Herfindahl index of citations of previous patents across different industries
    - Trajtenberg, Henderson & Jaffe (1997)
  - **SCOPE**: Degree to which a patent is cited by future patents spanning a wide range of technologies.

$$Scope_i = 1 - \sum_{j}^{n_i} s_{ij}^2$$

Innovative Activity, Inventiveness Increase with Overvaluation

- Independent variables standardized, $\mu = 0$, $\sigma = 1$

- Control for year/industry fixed effects, BTM, sales growth, cash flows, leverage…

- Standard errors clustered by firm and year

Basic finding:

- R&D , CAPX, innovative output (NPAT, CITES), and inventiveness (ORIGINALITY, SCOPE, NOVELTY)

  all increase with overvaluation

Sensitivity of Innovative Investment to Overvaluation

- Sensitivity of R&D to VP much stronger than to growth (BP, or sales growth GS) or cash flow (CF)
  - One-σ reduction in VP $\rightarrow$ 2.57% increase in RD, or 31.1% of sample mean RD
- Sensitivity of R&D to misvaluation much greater than sensitivity of CAPX
  - 4-8 times higher depending on controls
  - Results consistent using *VP* or *MFFLOW* as mispricing proxy

Table 3. Regressions of R&D and CAPX on Misvaluation

	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	RD				*CAPX*			
VP	-2.57	-2.46			-0.31	-0.42		
	(-14.86)	(-12.74)			(-3.76)	(-3.66)		
MFFLOW			-1.35	-1.27			-0.25	-0.29
			(-6.75)	(-6.51)			(-3.26)	(-3.37)
BP	-0.42		-0.72		-1.09		-0.97	
	(-2.75)		(-3.73)		(-8.36)		(-7.23)	
GS		0.88		1.04		0.58		0.54
		(5.49)		(5.49)		(4.35)		(4.13)
CF	1.35	1.92	1.28	1.87	1.57	2.04	1.50	1.87
	(5.50)	(8.62)	(4.86)	(6.90)	(10.34)	(11.64)	(9.85)	(11.55)
LEV	-1.49	-1.18	-1.60	-1.37	0.70	0.62	0.55	0.51
	(-13.18)	(-10.78)	(-11.85)	(-10.27)	(7.82)	(6.32)	(6.02)	(5.56)
Log(AGE)	-0.86	-0.84	-1.44	-1.25	-1.09	-0.75	-0.93	-0.57
	(-7.03)	(-5.17)	(-9.23)	(-6.61)	(-10.34)	(-5.11)	(-7.34)	(-3.62)
SIZE	-2.86	-2.36	-3.33	-2.89	0.11	0.13	0.01	-0.01
	(-11.33)	(-10.38)	(-12.14)	(-11.24)	(0.99)	(1.12)	(0.09)	(-0.13)
Intercept	7.19	6.96	7.54	7.32	7.60	7.32	7.26	7.21
	(38.81)	(51.92)	(47.78)	(49.69)	(35.97)	(36.99)	(36.86)	(33.60)
N	40,206	34,658	31,084	27,982	62,954	54,445	47,839	43,253
R^2	0.3271	0.3233	0.3135	0.3099	0.1301	0.1275	0.1229	0.1182

Table 3. Regressions of Innovative Output Measures on Misvaluation

	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	Log(1+PAT)				Log(1+CITES)			
VP	-0.09	-0.10			-0.04	-0.05		
	(-5.53)	(-4.95)			(-7.10)	(-5.95)		
MFFLOW			-0.07	-0.07			-0.03	-0.03
			(-5.59)	(-5.48)			(-6.21)	(-6.12)
BP	-0.05		-0.05		-0.02		-0.02	
	(-4.02)		(-3.40)		(-3.55)		(-3.30)	
GS		0.03		0.03		0.02		0.02
		(4.39)		(3.40)		(5.24)		(4.44)
CF	0.12	0.17	0.13	0.18	0.05	0.07	0.06	0.08
	(9.49)	(11.67)	(7.76)	(9.91)	(9.60)	(11.72)	(7.84)	(9.89)
LEV	-0.18	-0.18	-0.22	-0.21	-0.08	-0.08	-0.09	-0.08
	(-11.58)	(-11.41)	(-11.35)	(-10.85)	(-12.60)	(-12.02)	(-11.87)	(-11.28)
Log(AGE)	0.09	0.19	0.10	0.15	0.04	0.08	0.04	0.06
	(5.94)	(6.94)	(4.39)	(4.97)	(5.43)	(6.83)	(3.81)	(4.70)
SIZE	0.66	0.69	0.70	0.72	0.24	0.25	0.24	0.25
	(19.10)	(19.61)	(17.39)	(17.54)	(20.07)	(20.65)	(18.20)	(18.42)
Intercept	-0.13	-0.21	-0.16	-0.19	-0.09	-0.11	-0.08	-0.10
	(-6.88)	(-9.73)	(-6.98)	(-7.48)	(-12.35)	(-14.18)	(-9.47)	(-9.08)
N	55,048	47,295	40,692	36,598	53,935	46,296	39,714	35,701
R^2	0.3909	0.4103	0.3977	0.4109	0.3590	0.3797	0.3648	0.3799

Table 4. Regressions of Inventiveness Measures on Misvaluation

	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	Novelty				*Originality*				*Scope*			
VP	-6.13	-5.98			-2.06	-2.12			-1.88	-1.77		
	(-9.54)	(-7.64)			(-7.27)	(-6.21)			(-8.96)	(-6.93)		
MFFLOW			-3.53	-3.22			-1.10	-1.08			-1.26	-1.18
			(-5.88)	(-5.87)			(-4.14)	(-4.25)			(-5.83)	(-5.77)
BP	-1.79		-2.83		-0.60		-1.04		-0.34		-0.55	
	(-2.64)		(-3.56)		(-2.11)		(-2.88)		(-1.41)		(-1.69)	
GS		3.18		3.72		0.56		0.77		0.63		0.77
		(5.73)		(5.82)		(3.25)		(3.92)		(3.92)		(4.21)
CF	5.74	7.37	6.10	7.62	1.73	2.31	1.61	2.26	1.87	2.36	1.87	2.34
	(7.87)	(10.41)	(6.87)	(8.81)	(7.51)	(10.44)	(5.35)	(8.29)	(6.89)	(8.06)	(5.44)	(6.66)
LEV	-7.38	-6.68	-7.84	-7.20	-2.60	-2.47	-3.01	-2.78	-2.72	-2.61	-2.88	-2.67
	(-11.80)	(-10.95)	(-10.96)	(-10.07)	(-11.22)	(-10.55)	(-10.60)	(-9.90)	(-11.91)	(-11.13)	(-10.34)	(-10.12)
Log(AGE)	1.24	3.52	-0.01	1.50	1.63	2.66	1.57	2.21	1.41	2.51	1.38	1.92
	(1.50)	(3.33)	(-0.01)	(1.31)	(5.98)	(6.55)	(3.84)	(4.55)	(4.91)	(6.34)	(3.49)	(4.46)
SIZE	12.76	12.85	12.32	12.70	5.28	5.26	5.23	5.28	4.87	4.79	4.46	4.49
	(14.67)	(14.04)	(12.50)	(12.70)	(17.26)	(16.20)	(14.31)	(14.33)	(12.14)	(11.40)	(9.60)	(9.35)
Intercept	-2.73	-2.83	0.05	0.59	2.57	2.28	3.08	3.05	-5.33	-6.18	-4.62	-5.04
	(-4.11)	(-3.49)	(0.06)	(0.57)	(8.72)	(7.42)	(10.75)	(8.97)	(-13.29)	(-12.94)	(-8.51)	(-8.24)
N	53,935	46,296	39,714	35,701	54,968	47,228	40,633	36,544	53,935	46,296	39,714	35,701
R^2	0.1328	0.1432	0.1352	0.1426	0.1904	0.1963	0.1896	0.1950	0.2220	0.2368	0.2321	0.2455

Path Analysis

Overvaluation can promote R&D and CAPX investment:

- Indirectly via equity financing channel
  - Stein (1996), Baker, Stein & Wurgler (2003)

- Directly, through catering
  - Polk & Sapienza (2009), Jensen (2005)

- Shared misperceptions of investors, managers

- Effects on debt issuance, governance…,

Direct Catering and the Equity Channel

- Use R&D as an example:

$$RD = a_1 + b_1\, MFFLOW + c_1 EI + controls + u_1$$

$$EI = a_2 + b_2\, MFFLOW + controls + u_2$$

- MFFLOW effect on RD through non-issuance channels (e.g., catering): b_1

- MFFLOW effect on RD through equity issuance (EI): $b_2 \times c_1$

Table 5. Path Analysis of Misvaluation Effects on Investment

- Effect of misvaluation on R&D or CAPX via non-equity than equity channels

(1) Direct Effect of *MFFLOW* on Investment

MFFLOW → *RD*	Coefficient	*t*-stat	*MFFLOW* → *CAPX*	Coefficient	*t*-stat
	-19.8209	(-5.66)		-4.1831	(-2.47)

(2) Indirect Effect of *MFFLOW* on Investment via Equity Channel

MFFlow → *EI*	-42.8982	(-8.55)	*MFFlow* → *EI*	-42.8982	(-8.55)
EI → *RD*	0.1399	(11.88)	*EI* → *CAPX*	0.0370	(8.79)
Equity Path Effect	-6.0015		Equity Path Effect	-1.5872	

(3) Total *MFFlow*

Effect on RD	-25.8224		Total *MFFlow* Effect on *CAPX*	-5.7703	
% Direct Path	76.76%		% Direct Path	72.49%	
% Equity Path	23.24%		% Equity Path	27.51%	

Nonlinearity in the effect of overvaluation

- Extreme overvaluation (lowest VP or MFFLOW) firms have stronger incentives to increase R&D investment and take 'moonshots'

- Fixed cost effects of investment, issuance

- Within-firm knowledge spill-overs

- Increasing returns/network externality effects stronger among overvalued firms

- **Moonshots**

Interaction with Overvaluation

- Overvalued firms have much higher innovation sensitivity to *VP* (or *MFFLOW*)

	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
	RD		*CAPX*		*Log(1+PAT)*		*Log(1+CITES)*	
VP	-0.19		-0.53		-0.04		-0.02	
	(-0.98)		(-5.00)		(-1.96)		(-2.86)	
*VP*LowVP*	-6.53		0.34		-0.19		-0.07	
	(-13.45)		(2.46)		(-7.38)		(-6.89)	
MFFLOW		-0.96		-0.28		-0.05		-0.02
		(-6.49)		(-3.30)		(-5.48)		(-6.17)
*MFFLOW*LowFLOW*		-4.87		-0.24		-0.43		-0.16
		(-8.12)		(-1.09)		(-5.52)		(-5.81)
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
N	34,211	27,791	53,719	43,015	46,871	36,551	45,893	35,651
R^2	0.3790	0.3229	0.1294	0.1182	0.4211	0.4193	0.4054	0.4058

Interaction with Overvaluation (cont.)

- Sensitivity of **inventiveness** to overvaluation within the most overvalued quintile 3-6 times greater than baseline effect

	(1)	(2)	(1)	(2)	(1)	(2)
	Novelty		Originality		Scope	
VP	-3.09		-1.08		-0.93	
	(-4.04)		(-3.56)		(-3.70)	
VP*LowVP	-9.23		-3.33		-2.67	
	(-7.00)		(-7.38)		(-5.74)	
MFFLOW		-2.51		-0.85		-0.87
		(-5.77)		(-4.13)		(-5.70)
MFFLOW*LowFLOW		-12.21		-4.03		-5.29
		(-4.50)		(-3.74)		(-6.16)
Controls	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
N	45,893	35,651	46,805	36,497	45,893	35,651
R^2	0.1467	0.1446	0.2013	0.1974	0.2412	0.2495

Social Value of Misvaluation

- Might think that if overvaluation encourages innovation, offset by undervaluation discouraging.

- But, powerful convexity in relation of innovative input, output, and inventiveness with misvaluation

    →

- Ex ante, possibility of misvaluation increases moonshots, innovation

- If positive externalities, ex ante possibility of misvaluation may *increase* social welfare

Interactions with Growth, Turnover

- Catering more effective for growth (high GS) firms

- Catering incentive stronger among firms with short-horizon managers (high turnover firms)
  - Polk & Sapienza (2009)

- Interact overvaluation with indicator for highest quintile of GS or turnover
  - HighGS or HighTURN
  - Robustness:
    - Use residual GS or turnover by filtering out VP (MFFLOW) information. Results similar.

R&D: Interaction with Growth, Turnover

- Weak evidence that growth firms, high turnover firms have higher investment sensitivity to VP (or MFFLOW):
  - Catering mainly through inventiveness

	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
			RD				CAPX	
VP	-2.20 (-11.13)		-2.45 (-12.96)		-0.42 (-3.81)		-0.34 (-3.19)	
VP*HighGS	-1.35 (-4.44)				-0.02 (-0.10)			
VP*HighTURN			0.06 (0.25)				0.19 (1.22)	
MFFLOW		-1.25 (-6.50)		-1.08 (-6.08)		-0.23 (-2.79)		-0.16 (-2.22)
MFFLOW*HighGS		-0.23 (-0.97)				-0.58 (-2.11)		
MFFLOW*HighTURN				-1.25 (-2.97)				-0.51 (-2.19)
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
N	34,211	27,791	33,477	27,791	53,719	43,015	52,516	43,015
R^2	0.3336	0.3153	0.3363	0.3197	0.1291	0.1187	0.1289	0.1248

Innovative Output: Interaction with Growth, Turnover

- Growth firms, high turnover firms have higher innovative output sensitivity to VP (or MFFLOW)

	Log(1+PAT)				Log(1+CITES)			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
VP	-0.09		-0.08		-0.04		-0.04	
	(-4.27)		(-4.62)		(-4.90)		(-5.40)	
VP*HighGS	-0.06				-0.04			
	(-3.49)				(-5.49)			
VP*HighTURN			-0.08				-0.03	
			(-2.72)				(-2.98)	
MFFLOW		-0.07		-0.05		-0.03		-0.02
		(-5.28)		(-4.98)		(-5.85)		(-5.60)
MFFLOW*HighGS		-0.03				-0.02		
		(-1.19)				(-2.00)		
MFFLOW*HighTURN				-0.24				-0.09
				(-4.84)				(-4.76)
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
N	46,871	36,551	45,685	36,551	45,893	35,651	44,709	35,651
R^2	0.4192	0.4158	0.4229	0.4173	0.4039	0.4021	0.4082	0.4040

Inventiveness: Interaction with Growth, Turnover

- Growth, high turnover firms have higher inventiveness sensitivity to VP (or MFFLOW)

	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	Novelty				*Originality*				*Scope*			
VP	-4.55 (-5.99)		-4.91 (-6.17)		-1.72 (-5.20)		-1.89 (-5.43)		-1.40 (-5.42)		-1.54 (-5.79)	
VP*HighGS	-7.60 (-7.82)				-2.18 (-7.21)				-1.95 (-5.85)			
VP*HighTURN			-4.31 (-3.41)				-1.31 (-3.40)				-1.29 (-3.28)	
MFFLOW		-2.84 (-5.59)		-2.22 (-4.92)		-1.00 (-3.86)		-0.85 (-3.76)		-1.07 (-5.37)		-0.96 (-5.54)
MFFLOW*HighGS		-4.19 (-3.23)				-0.95 (-1.93)				-1.18 (-3.43)		
MFFLOW*HighTURN				-8.40 (-4.61)				-2.97 (-4.88)				-4.01 (-4.49)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
N	45,893	35,651	44,709	35,651	46,805	36,497	45,619	36,497	45,893	35,651	44,709	35,651
R^2	0.1462	0.1438	0.1487	0.1466	0.2001	0.1966	0.2015	0.1976	0.2406	0.2478	0.2437	0.2492

2SLS Regressions with MFFLOW as IV

- Use 2SLS to further address endogeneity concerns
  - Possible reverse causality: Overvaluation due to investor misvaluation of future innovative opportunities
  - Growth controls imperfect
  - Edmans, Goldstein & Jiang (2012): MFFLOW is a valid IV for misvaluation
- 1st stage: $VP = a_1 + b_1\ MFFLOW + controls + e_1$
- 2nd stage: $RD = a_2 + b_2\ VP + controls + e_2$
- VP effects several times stronger than OLS estimation
  - Component of misvaluation unrelated to growth opportunities affects innovation

2SLS Regressions with MFFLOW as IV

	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
	RD		CAPX		Log(1+Pat)		Log(1+Cites)		Novelty		Originality		Scope	
	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS
VP	-4.39	-18.53	-0.75	-4.39	-0.17	-1.00	-0.08	-0.46	-10.63	-45.69	-3.77	-15.18	-3.14	-16.71
	(-12.74)	(-12.53)	(-3.66)	(-5.49)	(-4.95)	(-8.39)	(-5.95)	(-8.52)	(-7.64)	(-7.18)	(-6.21)	(-6.12)	(-6.93)	(-7.20)
GS	0.38	0.19	0.26	0.19	0.01	-0.00	0.01	0.00	1.41	0.92	0.25	0.11	0.28	0.07
	(5.49)	(2.50)	(4.35)	(4.67)	(4.39)	(-0.72)	(5.24)	(0.44)	(5.73)	(3.12)	(3.25)	(1.19)	(3.92)	(0.84)
CF	11.77	15.83	13.76	13.63	1.15	1.35	0.50	0.59	50.01	58.82	15.63	17.82	15.99	18.47
	(8.62)	(13.42)	(11.64)	(20.37)	(11.67)	(14.19)	(11.72)	(14.88)	(10.41)	(11.27)	(10.44)	(10.94)	(8.06)	(12.44)
Leverage	-5.46	-0.06	2.74	3.58	-0.82	-0.61	-0.34	-0.22	-29.60	-17.06	-10.93	-7.36	-11.58	-6.39
	(-10.78)	(-0.08)	(6.32)	(7.86)	(-11.41)	(-7.33)	(-12.02)	(-6.63)	(-10.95)	(-4.76)	(-10.55)	(-5.23)	(-11.13)	(-5.05)
Log(Age)	-0.76	-0.10	-0.68	-0.33	0.17	0.18	0.07	0.07	3.16	3.55	2.39	2.73	2.26	2.53
	(-5.17)	(-0.51)	(-5.11)	(-2.77)	(6.94)	(7.30)	(6.83)	(7.30)	(3.33)	(3.47)	(6.55)	(6.94)	(6.34)	(7.32)
Size	-1.29	-1.16	0.08	0.05	0.40	0.42	0.14	0.14	7.39	7.35	3.02	3.07	2.75	2.60
	(-10.38)	(-11.23)	(1.12)	(0.81)	(19.61)	(20.57)	(20.65)	(22.28)	(14.04)	(13.19)	(16.20)	(14.85)	(11.40)	(14.17)
Intercept	18.36	22.06	6.14	7.33	-1.88	-2.81	-0.56	-0.99	-3.81	-38.71	-9.34	-16.48	-0.55	-20.90
	(19.59)	(26.45)	(14.70)	(14.78)	(-12.57)	(-20.69)	(-9.68)	(-22.91)	(-0.98)	(-10.71)	(-6.45)	(-11.46)	(-0.22)	(-16.76)
N	34,658	27,982	54,445	43,253	47,295	36,598	46,296	35,701	46,296	35,701	47,228	36,544	46,296	35,701
R^2	0.3233	0.0527	0.1275	0.0701	0.4103	0.3534	0.3797	0.3072	0.1432	0.1036	0.1963	0.1651	0.2368	0.1867
1st stage F-stat (p-value)		0.0000		0.0000		0.0000		0.0000		0.0000		0.0000		0.0000

Conclusions

- Evidence supports misvaluation hypothesis
  - Two misvaluation measures that filter out growth prospects unrelated to misvaluation
  - Overvalued firms invest more in R&D
- More via non-equity-financing rather than via equity financing
- Overvaluation → high innovative output
- Overvaluation promotes ambitious moon shots—more novel, more original, wider scope
- Sensitivity of innovation to misvaluation much stronger among most overvalued firms
  - Extreme overvaluation promotes moonshots
- Also stronger among high growth, high turnover firms
- Possible **ex ante** social value to misvaluation