Does Innovation Decline Post-IPO?

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Introduction

- Question: Does innovation decline post-IPO?
- Innovation is the key driver of economic growth and productivity (Schumpeter, 1912)
- In a frictionless world, a company's legal status should have no impact on its innovation
  - Frictions including increased agency costs (Berle, 1932), disclosure costs (Arora, Belenzon, & Sheer, 2021), and short-term decision making pressure
  - Benefits include reduced financial constraints and learning from financial markets (Edmans, Goldstein, & Jiang, 2012)
- Impact of a firm's legal status on innovation an important determinant to whether the SEC shifts firms towards or away from public markets
  - Increasing regulation for public firms (Boeh & Dunbar, 2018) with concurrent increases in the ease of staying private (Ewens & Farre-Mensa, 2020) has led to a large decline in IPOs(Gao, Ritter, & Zhu, 2013) in the last 20 years

Motivation

- Prior literature finds mixed effect of a firm's public status on innovation
  - Bernstein (2015) finds that firms that successfully complete their IPO have a significant decline in innovation quality compared to firms with withdrawn IPOs from 1985 to 2004
  - Acharya and Xu (2017) finds relationship between innovation and a firm's public status depends on whether the firm is in an internal or external finance dependent industry from 1994 to 2004
- More recent IPO literature documents increasing likelihood of IPO withdrawal due to filers being acquired (Lian & Wang, 2012) or deciding to remain private and raise capital through private markets(Boeh & Dunbar, 2021)
- Larrain et al. (2021) documents a shift towards increasing commercialization using a sample of European IPOs from 1997 to 2017
- When accounting for a shift towards product-related innovation or more recent structural shifts in IPO markets do innovation declines persist?

Main Results

1. Effect of going public on innovation has a smaller effect in the modern era
   - Decline in effect size is due to the declining relevance of the stock market in explaining IPO completion
2. Firms that go successfully go public have a shift towards product-related innovation and commercialization.
3. Declining patent quality is of minimal impact to public firms
   - Patent and trademark output post-IPO are more strongly linked to profitability and stock market return performance

Contribution

1. Public versus private firm innovation literature (Acharya & Xu, 2017; Bernstein, 2015)
2. Innovation strategy literature (Asker, Farre-Mensa, & Ljungqvist, 2015; Ferreira, Manso, & Silva, 2014; Gao, Hsu, & Li, 2018; Gilje & Taillard, 2016; Phillips & Sertsios, 2017)
3. IPO literature (Busaba, Benveniste, & Guo, 2001)

IPO Data/Firm Characteristics

1. IPO filings data from SDC from 1985 to 2012
   - Require firm to have a patent in the [-3,5] year window surrounding the IPO
   - Exclude financial firms, ADRs, and spin-offs following IPO literature (Sample Reconciliation)
2. 2,700 IPOs overall with 2,221 completed and 479 withdrawn (Sample Distribution)
   - Data contains 19 SPAC IPOs(Industry Distribution)
3. Financial data and stock pricing data from CRSP/Compustat
4. Nasdaq return data from Bloomberg
5. Private equity and venture capital status data from SDC
6. IPO characteristics from Jay Ritter

Summary Statistics

	Completed			Withdrawn			Difference
	Mean	Median	SD	Mean	Median	SD	Mean
IPO Characteristics							
Principal Amount	84.76	41.25	166.22	86.93	63.75	127.72	-2.17
Ratio of VC to IPO Principal	1.04	0.65	1.31	1.34	1.13	1.04	-0.30**
Firm Age	13.95	7.00	19.01	11.66	7.00	16.17	2.29*
Venture Capital Backed	0.58	1.00	0.49	0.75	1.00	0.43	-0.17***
Private Equity Backed	0.11	0.00	0.31	0.04	0.00	0.19	0.07***
Dual Class	0.06	0.00	0.24	0.08	0.00	0.28	-0.02
NASDAQ Pre-Filing Return	0.06	0.05	0.12	0.03	0.03	0.13	0.02***
Days Registration	90.67	66.00	86.32	266.66	213.00	207.89	-175.99***
Scaled Financials							
R&D/Assets	0.17	0.11	0.22	0.41	0.27	0.43	-0.24***
Sales/Assets	0.80	0.68	0.69	0.75	0.57	0.80	0.05
Net Income/Assets	-0.12	0.01	0.38	-0.51	-0.26	0.73	0.39***
Cash/Assets	0.31	0.24	0.27	0.26	0.21	0.25	0.04
Firm Outcome Characteristics							
Bankruptcy Flag	0.03	0.00	0.16	0.02	0.00	0.13	0.01
Acquisition Flag	0.46	0.00	0.50	0.11	0.00	0.31	0.35***
Acquired Flag	0.19	0.00	0.39	0.23	0.00	0.42	-0.04*

- Firms with completed IPOs tend to be older, less reliant on venture capital funding, and are less likely to go on to be acquired
- Differences in NASDAQ pre-filing returns suggests a potential determinant of IPO completion

Patent Data

- Patents widely viewed as the best proxy for firm innovation (Hall, Jaffe, & Trajtenberg, 2001) due to their linkage to firm value and stock return performance (Hirshleifer, Hsu, & Li, 2013, 2018; Kogan et al., 2017)
- Patent data aggregated from NBER, Kogan et al. (2017), and Google Patents
  - Citation data from USPTO PatentsView data
- Patent measures include:
  1. Scaled citations: Citations received within three years post-grant scaled within patents of the same patent subsection and grant year
  2. Scaled originality: Uniqueness of a patent based on how many subsections a patent cites
  3. Scaled generality: Applicability of a patent based on the diversity of patents in various subsections that cite the focal patent(Patent Summary Statistics)

Trademark Data

- Increasing use of trademark data to better capture a firm's true level of innovation(Hsu et al., 2022; Kooli, Zhang, & Zhao, 2022; Yang & Yuan, 2022)
- Trademark data obtained from USPTO Trademark Case Files Data
- Trademark measures include:
  1. Renewal rate: Measured as the percent of trademarks renewed at the six year interval following the trademark grant date
  2. % Patents: Sum of patents scaled by the sum of a firm's patent and trademarks which captures a firm's innovation strategy(Trademark Summary Statistics)

Addressing Bias

$$Y_i^{Post} = \alpha_1 + \beta_1 IPO_i + \gamma_1 Y_i^{pre} + \delta_1 X_i^{control} + v_k + u_t + \varepsilon_{1i} \quad (1)$$

- Estimating above model results in biased β_1 estimate due to:
  1. Endogenous timing of IPO filing when firm's realization of profitability is unexpectedly high (Pástor, Taylor, & Veronesi, 2009) resulting in negative bias
     - Conditioning on a firm's initial IPO filing timing removes this bias
  2. Latent quality differences between completed and withdrawn firms due to certifying process that IPO filing process facilitates resulting in a positive bias
     - Need to identify exogenous variation in IPO completion that is uncorrelated with a firm's quality
     - Busaba, Benveniste, and Guo (2001) identifies variation in market-wide valuations to have a significant effect on IPO completion

Model Specification

- Follow Bernstein (2015) in using the two-month post-filing returns on the Nasdaq as an instrumental variable for IPO completion
- First-Stage Equation:

$$IPO_i = \alpha_2 + \beta_2 NSDQ_i + \gamma_2 Y_i^{pre} + \delta_2 X_i^{control} + v_k + u_t + \varepsilon_{2i} \quad (2)$$

- Second-Stage Equation:

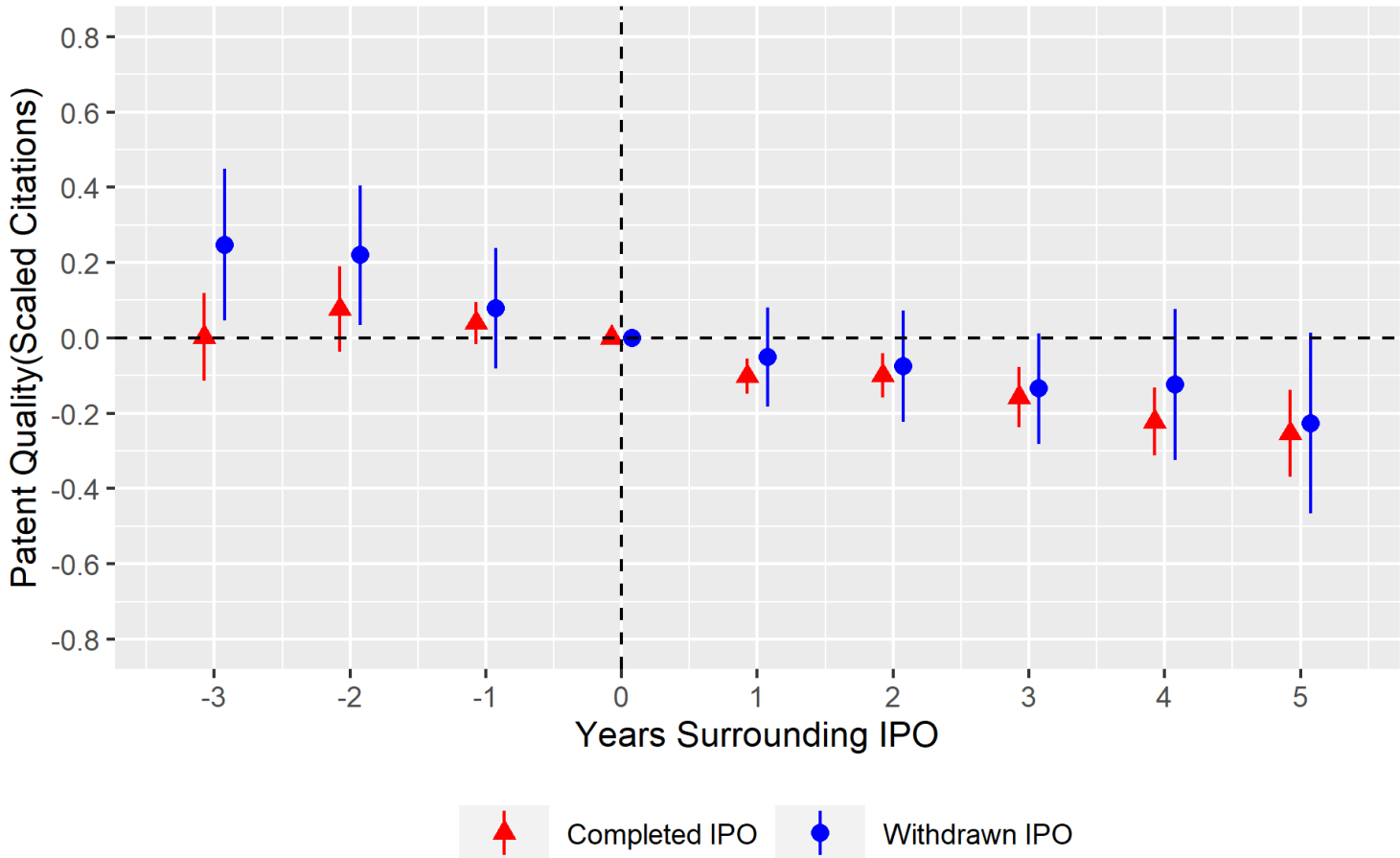
$$Y_i^{Post} = \alpha_3 + \beta_3 \widehat{IPO}_i + \gamma_3 Y_i^{pre} + \delta_3 X_i^{control} + v_k + u_t + \varepsilon_{3i} \quad (3)$$

- Y_i^{Post} is the average innovation performance in the five years following the IPO filing
- Y_i^{pre} is the equivalent measure in the three years prior and through the IPO filing year
- *IPO* indicates whether a filer goes public or stays private
- Controls include a firm's pre-filing Nasdaq returns, a firm's location in the IPO wave, pre-filing citations, and pre-filing patents
- Industry and filing year fixed effects

Identifying Assumptions

- To identify a causal estimate for the effect of going public on innovation requires the following assumptions for the IV estimator:
  1. Relevance: Post-filing returns on the Nasdaq must be correlated with IPO completion(First Stage)
  2. Independence: Post-filing returns on the Nasdaq are independent of a firm's potential innovation and a firm's potential IPO status(Balance Table)
  3. Exclusion Restriction: The only impact of the post-filing returns on the Nasdaq on a firm's future innovation is through its IPO completion likelihood(Placebo Test)
  4. Monotonicity: Post-filing returns on the Nasdaq have the same directional impact on IPO completion for all firms(Transition Matrix)
- With heterogeneous treatment effects, the IV estimator provides a local average treatment effect that is defined only for complier firms
  - Estimate is primarily identified off of firms prior to 2003

Endogenous Effect of Going Public on Innovation Quality



- Model estimates large decline in innovation quality for both completed and withdrawn firms post-IPO

Effect of Going Public on Scaled Citations

	Scaled Citations					
	1985-2003			1985-2012		
	(1)	(2)	(3)	(4)	(5)	(6)
IPO	0.09		-0.97*	0.15*		-0.66
	[0.08]		[0.53]	[0.07]		[0.59]
NASDAQ Post-Filing Return		-0.59*			-0.32	
		[0.31]			[0.28]	
Observations	1239	1239	1239	1623	1623	1623
R^2	0.20	0.20	0.07	0.22	0.21	0.14
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic	-	-	28.46	-	-	19.22

- Result from 1985 to 2003 replicates Bernstein (2015) to show estimated decline in innovation quality for public firms
- Result from 1985 to 2012 remains economically significant but loses statistical significance due to weakening of instrument

Robustness of Effect

	Panel B: Include All Firms					
	Scaled Citations					
	1985-2003			1985-2012		
	(1)	(2)	(3)	(4)	(5)	(6)
IPO	0.22***		-0.32	0.22***		-0.03
	[0.06]		[0.41]	[0.05]		[0.43]
NASDAQ Post-Filing Return		-0.20			-0.02	
		[0.26]			[0.24]	
Observations	2137	2137	2137	2700	2700	2700
R^2	0.06	0.05	0.02	0.08	0.08	0.07
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic	-	-	45.72	-	-	35.16

- When not requiring a firm to have a patent in the pre- and post-period, the effect of going public has no effect on innovation quality
- Original result requires winsorizing beyond the 4th percentile and lacks robustness to alternative specification(Winsor Results) (Alternative Model)
- Going public has no effect on other measures of patent quality(Other Measures)

Effect on Going Public on Patents

	Ln(1+Patents)					
	1985-2003			1985-2012		
	(1)	(2)	(3)	(4)	(5)	(6)
IPO	0.36***		0.59	0.39***		0.48
	[0.08]		[0.45]	[0.06]		[0.49]
NASDAQ Post-Filing Return		0.38			0.26	
		[0.29]			[0.27]	
Observations	2137	2137	2137	2700	2700	2700
R^2	0.34	0.33	0.33	0.37	0.37	0.37
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic	-	-	45.97	-	-	34.85

- Large endogenous effect of IPO completion on a firm's patented innovation but no statistically distinguishable effect size
  - Bernstein (2015) uses scaled patents and finds no effect
  - Effect size ranges between 20 to 30 percent of a firm's post-IPO patent production

Effect on Going Public on Trademarks

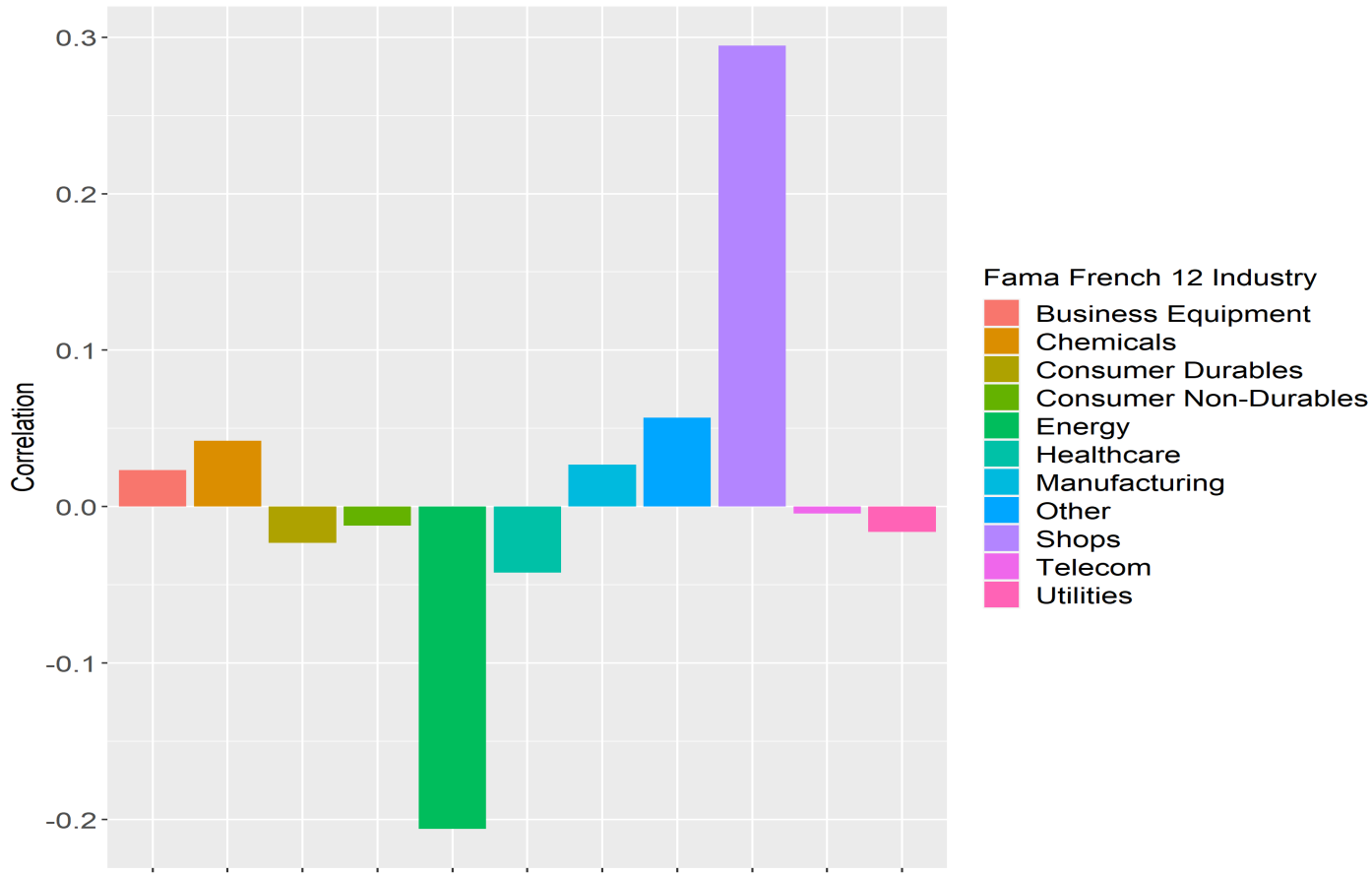
	Ln(1+Trademarks)					
	1985-2003			1985-2012		
	(1)	(2)	(3)	(4)	(5)	(6)
IPO	0.65***		0.79*	0.66***		0.65
	[0.08]		[0.48]	[0.06]		[0.52]
NASDAQ Post-Filing Return		0.50			0.34	
		[0.31]			[0.28]	
Observations	2137	2137	2137	2700	2700	2700
R^2	0.43	0.41	0.43	0.45	0.43	0.45
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic	-	-	46.36	-	-	33.89

- Going public has a significant causal impact on a firm's trademark production post-IPO
  - Effect size is 40 percent of a firm's post-IPO trademark production

Are Declines in Patent Quality Meaningful?

- Previously documented decline in innovation quality from Bernstein (2015) is not robust to alternative choices in winsorizing, sample selection, and does not extend after 2003
  - Suggestive evidence of public firms shifting their innovation strategy towards product-related innovation
- Value of a patent to a firm extends beyond the citations it receives as a patent might:
  - Insulate a firm's existing innovations (Hsu, Lee, & Zhou, 2022)
  - Provide an important incremental innovation to a firm's existing technology
- Kogan et al. (2017) provide a measure of patent economic value based on a firm's CAR surrounding the patent grant date
- Firms would be rational to pursue innovations that are less likely to be cited if scaled citations are uncorrelated with a patent's economic value or the firm's profitability and stock price performance

Correlation Between Patent Citations and Economic Value



- Correlation of patents in sample: 0.01
- Correlation of all public firm patents: 0.02

Effect of Innovation Output and Quality on Profit

	Panel A: Profitability			
	Δ ROA			
	(1)	(2)	(3)	(4)
Δ Trademarks Post-IPO	0.04***			0.02
	[0.01]			[0.01]
Δ Patents Post-IPO		0.14***		0.10***
		[0.03]		[0.04]
Δ Innovation Post-IPO			-0.01	-0.01
			[0.01]	[0.01]
Observations	2120	2120	1332	1332
R^2	0.04	0.05	0.05	0.05
Industry F.E.	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes

- No effect of changes in innovation quality on ROA in unconditional and conditional regression
- Increases in patents are positively associated with increases in ROA

Effect of Innovation Output and Quality on Returns

	Five Year Nasdaq-Adjusted Returns			
	(1)	(2)	(3)	(4)
Δ Trademarks Post-IPO	0.75***			0.56***
	[0.10]			[0.12]
Δ Patents Post-IPO		1.96***		1.67***
		[0.28]		[0.28]
Δ Innovation Post-IPO			0.07	0.12
			[0.08]	[0.08]
Observations	1625	1625	1094	1094
R^2	0.42	0.42	0.42	0.46
Industry F.E.	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes

- No effect of changes in innovation quality on a firm's stock return performance
- Increases in patents and trademarks are positively associated with increases in future stock return performance

Conclusion

1. Effects of going public on innovation quality are much less robust than previously documented
2. The decline in the Nasdaq post-filing return in explaining IPO withdrawal suggests a structural shift in IPO markets and the impact of private capital
   - Breakdown in this identification strategy suggests new approaches to address this question in the modern era
3. Firms substitute towards product-related innovation and commercialization post-IPO

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Sample Reconciliation

Filter applied	Observations Remaining
	Panel A: Traditional IPOs
(1). Traditional IPO Filing Date Between 1985-2012	12,436
(2). Exclude Financial Firms	9,791
(3). IPO Filed on NASDAQ, NYSE, AMEX	7,821
(4). Exclude REITS, ADRS, and Unit Offers	7,237
(4). Filed for Patent Within [-3,5] Year Window of IPO Filing Date	2,681
	Panel B: Traditional IPOs
(1). Traditional IPO Filing Date Between 1985-2003	9,952
(2). Exclude Financial Firms	7,981
(3). IPO Filed on NASDAQ, NYSE, AMEX	6,257
(4). Exclude REITS, ADRS, and Unit Offers	5,952
(5). Filed for Patent Within [-3,5] Year Window of IPO Filing Date	2,137
	Panel C: SPACs
(1). SPAC Announces Merger Between 1985-2012	156
(2). Target Filed for Patent Within [-3,5] Year Window of M&A Announcement	19

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Sample Distribution

	Traditional IPOs			SPAC IPOs		
	Filed	Completed	Withdrawn	Filed	Completed	Withdrawn
	(1)	(2)	(3)	(4)	(5)	(6)
1985	25	24	1	-	-	-
1986	92	88	4	-	-	-
1987	84	77	7	-	-	-
1988	35	32	3	-	-	-
1989	31	30	1	-	-	-
1990	50	44	6	-	-	-
1991	129	128	1	-	-	-
1992	131	109	22	-	-	-
1993	194	179	15	-	-	-
1994	137	117	20	-	-	-
1995	165	159	6	-	-	-
1996	253	226	27	-	-	-
1997	157	125	32	-	-	-
1998	101	72	29	-	-	-
1999	185	169	16	-	-	-
2000	266	178	88	-	-	-
2001	39	28	11	-	-	-
2002	28	14	14	-	-	-
2003	35	33	2	-	-	-
2004	92	72	20	-	-	-
2005	69	58	11	-	-	-
2006	85	65	20	3	3	
2007	94	55	39	2	1	1
2008	28	9	19	8	1	7
2009	22	16	6	4	1	3
2010	48	35	13	-	-	-
2011	61	39	22	-	-	-
2012	45	33	12	2	1	1
Total	2681	2214	467	19	7	12

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Industry Distribution

	Filed	Completed	Withdrawn	% Completed	Principal Amount
Business Equipment	1122	959	163	0.85	99.33
Chemicals	58	44	14	0.76	169.77
Consumer Durables	94	85	9	0.90	253.37
Consumer Non-Durables	67	58	9	0.87	201.83
Energy	30	23	7	0.77	390.44
Healthcare	691	527	164	0.76	54.46
Manufacturing	261	222	39	0.85	82.24
Other	218	178	40	0.82	138.98
Shops	76	58	18	0.76	89.73
Telecom	74	59	15	0.80	359.72
Utilities	9	8	1	0.89	253.08
Total	2700	2221	479	0.82	109.22

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Patent Summary Statistics

	Panel A: Pre-Filing Patent Summary Statistics							
	N	Mean	SD	Min	p25	Median	p75	Max
Patent Activity	2700	1.69	1.31	0.00	1.00	1.00	3.00	4.00
Total Patents	2700	5.92	8.69	0.00	1.00	2.00	7.00	33.00
Scaled Number of Patents	2700	1.82	3.01	0.04	0.27	0.78	2.00	19.10
Total Citations	2700	21.27	35.55	0.00	0.00	5.00	23.00	135.50
Scaled Citations	2112	1.58	1.37	0.00	0.60	1.15	2.16	5.26
Originality	2112	0.44	0.26	0.00	0.25	0.48	0.64	1.00
Generality	2112	0.42	0.24	0.00	0.23	0.46	0.61	0.89

	Panel B: Pre-Filing Patent Summary Statistics by IPO Status						
	Completed			Withdrawn			Difference
	Mean	Median	SD	Mean	Median	SD	Mean
Patent Activity	1.67	1.00	1.30	1.77	2.00	1.34	-0.10
Total Patents	5.94	2.00	8.71	5.87	2.00	8.61	0.07
Scaled Number of Patents	1.91	0.82	3.12	1.43	0.56	2.43	0.48***
Total Citations	21.92	6.00	36.06	18.26	4.00	32.95	3.67*
Scaled Citations	1.64	1.21	1.40	1.33	1.02	1.23	0.30***
Originality	0.45	0.49	0.26	0.42	0.44	0.27	0.03
Generality	0.44	0.47	0.24	0.36	0.37	0.26	0.07***

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Trademark Summary Statistics

Panel A: Pre-Filing Trademark Summary Statistics								
	N	Mean	SD	Min	p25	Median	p75	Max
Trademark Activity	2700	1.83	1.41	0.00	1.00	2.00	3.00	4.00
Number of Trademarks	2700	9.65	12.94	0.00	1.00	5.00	12.00	49.00
Trademark Renewal Rate	2053	0.45	0.35	0.00	0.13	0.44	0.75	1.00
% Patents	2503	0.45	0.37	0.00	0.09	0.38	0.79	1.00

Panel B: Pre-Filing Trademark Summary Statistics by IPO Status							
	Completed			Withdrawn			Difference
	Mean	Median	SD	Mean	Median	SD	Mean
Trademark Activity	1.85	2.00	1.43	1.77	2.00	1.35	0.08
Number of Trademarks	9.89	5.00	13.28	8.51	4.00	11.16	1.39*
Scaled Number of Trademarks	1.56	0.85	2.19	1.21	0.68	1.78	0.35***
Trademark Renewal Rate	0.42	0.38	0.34	0.59	0.67	0.35	-0.17***
% Patents	0.44	0.37	0.37	0.45	0.40	0.36	-0.01

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First Stage Regressions

Sample Instrument	Full Two Months (1)	Full Two Months (2)	Pre-2003 Two Months (3)	Pre-2003 Two Months (4)	Post-2003 Two Months (5)	Post-2003 Two Months (6)
NASDAQ Post-Filing Return	0.49*** [0.09]	0.53*** [0.09]	0.59*** [0.09]	0.63*** [0.09]	-0.15 [0.30]	-0.15 [0.31]
Citation Quality Pre-IPO		0.01*** [0.00]		0.01 [0.00]		0.03*** [0.01]
Scaled Number of Patents		0.01*** [0.00]		0.01*** [0.00]		0.01*** [0.00]
NASDAQ Pre-Filing Return		0.18** [0.07]		0.18** [0.07]		0.16 [0.29]
Observations	2700	2700	2137	2137	563	563
R^2	0.14	0.15	0.13	0.14	0.11	0.15
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	No	Yes	No	Yes	No	Yes
F-Statistic	30.37	33.22	41.53	44.64	0.24	0.24

- First-stage regressions show declining relevance post-2003

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Balance Table

Nasdaq Returns Threshold	Bottom 10% (1)	Top 90% (2)	Diff. (3)	Bottom 25% (4)	Top 75% (5)	Diff. (6)
Patent Characteristics						
Scaled Number of Patents	1.85	1.61	0.23	1.86	1.72	0.14
Scaled Citations	1.60	1.44	0.16	1.61	1.51	0.10
Originality	0.44	0.43	0.01	0.45	0.43	0.02
Generality	0.42	0.42	0.01	0.43	0.41	0.01
Trademark Characteristics						
Scaled Number of Trademarks	1.49	1.58	-0.09	1.52	1.43	0.09
Trademark Renewal Rate	0.45	0.45	-0.00	0.45	0.46	-0.01
% Patents	0.44	0.45	-0.01	0.44	0.45	-0.00
IPO Characteristics						
Principal Amount	87.03	69.78	17.26*	90.55	69.93	20.62***
Ratio of VC to IPO Principal	1.08	1.16	-0.08	1.06	1.17	-0.11
Firm Age	13.66	13.65	0.01	13.86	13.10	0.76
Venture Capital Backed	0.60	0.63	-0.04	0.59	0.64	-0.05*
Private Equity Backed	0.10	0.09	0.01	0.10	0.07	0.03*
Dual Class	0.06	0.05	0.01	0.06	0.06	0.00
NASDAQ Pre-Filing Return	0.05	0.10	-0.05***	0.04	0.09	-0.04***
Pioneer	0.04	0.03	0.00	0.04	0.03	0.00
Early Follower	0.02	0.04	-0.02	0.02	0.03	-0.00
Scaled Financials						
R&D/Assets	0.18	0.18	-0.01	0.18	0.18	-0.01
Sales/Assets	0.80	0.81	-0.01	0.80	0.81	-0.02
Net Income/Assets	-0.14	-0.14	-0.00	-0.14	-0.14	0.00
Cash/Assets	0.31	0.28	0.02	0.30	0.32	-0.02

- Sorting on instrument results in balance on most characteristics

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Placebo Test

	Scaled Citations							
	1985-2003				1985-2012			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
NASDAQ Post-Filing Return	-0.58*			-0.59*	-0.32			-0.33
	[0.31]			[0.31]	[0.28]			[0.28]
Nasdaq Post-Filing One Year Return		-0.52*		-0.53*		-0.60**		-0.61**
		[0.29]		[0.29]		[0.27]		[0.26]
Nasdaq Pre-Filing One Year Return			0.18				0.14	
			[0.23]				[0.22]	
Observations	1239	1239	1239	1239	1623	1623	1623	1623
R^2	0.20	0.20	0.20	0.21	0.21	0.22	0.21	0.22
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

- The instrument seems unlikely to affect a firm's long-term innovation through any other channels but strange result

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IPO Completion Transition Matrix

Panel A: IPO Completion 1985-2003						
Pre-filing Quintile	Post-Filing Quintile					
	(1)	(2)	(3)	(4)	(5)	(μ)
(1)	0.77	0.81	0.81	0.88	0.90	0.86
(2)	0.70	0.86	0.79	0.92	0.94	0.85
(3)	0.79	0.82	0.81	0.91	0.95	0.85
(4)	0.82	0.87	0.88	0.85	0.94	0.86
(5)	0.88	0.81	0.89	0.89	0.89	0.87
(μ)	0.81	0.83	0.83	0.89	0.92	0.82
Panel B: IPO Completion 2004-2012						
Pre-filing Quintile	Post-Filing Quintile					
	(1)	(2)	(3)	(4)	(5)	(μ)
(1)	0.62	0.80	0.67	0.66	0.63	0.66
(2)	0.45	0.84	0.93	0.83	0.58	0.69
(3)	0.64	0.74	0.80	0.69	0.60	0.70
(4)	0.72	0.74	0.72	0.53	0.60	0.68
(5)	0.68	0.71	0.79	0.78	0.00	0.72
(μ)	0.63	0.75	0.77	0.70	0.60	0.69

- Post-filing returns on the Nasdaq display strong monotonicity pre-2003 but it dissipates afterward

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Winsor Results

	Panel A: IV Estimator 1985-2003										
	$SC^{0:100}$	$SC^{1:99}$	$SC^{2:98}$	$SC^{3:97}$	$SC^{4:96}$	$SC^{5:95}$	$SC^{6:94}$	$SC^{7:93}$	$SC^{8:92}$	$SC^{9:91}$	$SC^{10:90}$
NASDAQ Return	−0.64	−0.48	−0.48	−0.59	−0.61*	−0.59*	−0.56*	−0.53*	−0.50*	−0.48*	−0.46*
	(0.55)	(0.48)	(0.43)	(0.36)	(0.33)	(0.31)	(0.29)	(0.28)	(0.26)	(0.25)	(0.24)
Observations	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239
R^2	0.21	0.21	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Panel B: Reduced Form 1985-2003										
	$SC^{0:100}$	$SC^{1:99}$	$SC^{2:98}$	$SC^{3:97}$	$SC^{4:96}$	$SC^{5:95}$	$SC^{6:94}$	$SC^{7:93}$	$SC^{8:92}$	$SC^{9:91}$	$SC^{10:90}$
IPO	−1.07	−0.79	−0.80	−0.97	−1.00*	−0.97*	−0.93*	−0.87*	−0.82*	−0.79*	−0.76*
	(0.94)	(0.79)	(0.72)	(0.61)	(0.57)	(0.53)	(0.51)	(0.48)	(0.46)	(0.44)	(0.42)
Observations	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239	1,239
R^2	0.13	0.15	0.14	0.10	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

- Reduced form effect and IV estimator only hold when winsorizing beyond the 4th percentile

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Alternative Model

	Scaled Citations					
	1985-2003			1985-2012		
	(1)	(2)	(3)	(4)	(5)	(6)
IPO × Post	-0.04		-0.38	0.01		-0.77
	[0.10]		[0.60]	[0.08]		[0.70]
Nasdaq Return × Post		-0.24			-0.38	
		[0.38]			[0.33]	
Observations	7954	7954	7954	10625	10625	10625
R^2	0.50	0.50	–	0.51	0.51	-0.02
Firm F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Event Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
FF12 × Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
IPO Month × Post F.E.	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic	-	-	30.58	-	-	18.84

- When using a firm × year panel, there is no estimated significance albeit with an economically significant coefficient estimate

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Originality/Generality

	Panel A: Originality					
	1985-2003			1985-2012		
	(1)	(2)	(3)	(4)	(5)	(6)
IPO	0.02		0.03	0.01		-0.01
	[0.02]		[0.11]	[0.01]		[0.12]
NASDAQ Return		0.02			0.00	
		[0.07]			[0.06]	
Observations	1239	1239	1239	1623	1623	1623
R^2	0.30	0.30	0.30	0.33	0.33	0.32
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic	-	-	27.04	-	-	18.41
	Panel B: Generality					
	1985-2003			1985-2012		
	(1)	(2)	(3)	(4)	(5)	(6)
IPO	0.04**		0.08	0.03**		0.09
	[0.02]		[0.09]	[0.01]		[0.11]
NASDAQ Return		0.05			0.04	
		[0.06]			[0.05]	
Observations	1239	1239	1239	1623	1623	1623
R^2	0.45	0.45	0.45	0.45	0.45	0.44
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic	-	-	27.13	-	-	18.51

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