

How Does Hedge Fund Activism Reshape Corporate Innovation?

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Outline

- 1 Overview
- 2 Data & Estimation
- 3 Evidence: Input/Output
- 4 Evidence: Patent Transactions
- 5 Evidence: Inventors
- 6 Channels/Causality
- 7 Conclusions

Background

- Evidence on the impact of hedge fund activism to date
 - ▶ Objectives and tactics
 - ▶ Liquidity and block formation
 - ▶ Short and long-term market reaction
 - ▶ Long-run profitability, and total factor productivity (TFP)
 - ▶ Firm policies (e.g., payout, governance), internal capital markets
 - ▶ Impact on other stakeholders (CEOs, employees, bondholders)
 - ▶ Impact on rival firms
 - ▶ Impact on the market for corporate control
 - ▶ Threat of hedge fund activism
 - ▶ Reputation and organizational structure
 - ▶ Causality

Motivation

- Hedge fund activists have been accused of maximizing short-term payoff at the expense of long-term profitability
- Larry Fink, Blackrock's Chairman and CEO:
 - “Delivering Long-Term Value - Letter to Corporates, March 31, 2015
“...in response to the acute pressure, growing with every quarter, for companies to meet short-term financial goals at the expense of building long-term value. This pressure originates from a number of sources—the proliferation of activist shareholders seeking immediate returns...”
“In the face of these pressures, more and more corporate leaders have responded with actions that can deliver immediate returns to shareholders, such as buybacks or dividend increases, while underinvesting in innovation, skilled workforces or essential capital expenditures necessary to sustain long-term growth.”
 - More recently, from his February 1, 2016 Letter to CEOs:
“Those activists who focus on long-term value creation sometimes do offer better strategies than management. In those cases, BlackRock's corporate governance team will support activist plans.”

Motivation

- Financial markets and technological innovation
 - Kerr and Nanda (2014), Hall and Lerner (2010)
- The role of shareholders
 - Bernstein (2014), Aghion, Van Reenen and Zingales (2013), Lerner, Sorensen and Stromberg (2011), Bushee (1998), Francis and Smith (1995), Stein (1988, 1989)
- Scope of innovation and innovation-related resource allocation
 - Hedge fund activists trigger resource allocation and refocus firm operations (Greenwood and Schor (2009), Brav et al. (2015))
 - The scope of innovation and firm boundaries matter (Lerner et al. (2011), Akcigit et al. (2013), Seru (2014), Bena and Li (2014))

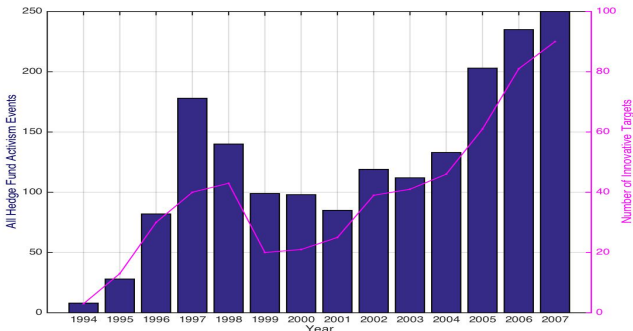
Channels?

- ⇒ Change in the target's innovation is a *by-product* of hedge fund activists' demands
- ⇒ Change in the target's innovation is part of the activist's stated agenda
 - Triun and DuPont (integrated structure of chemicals and agricultural R&D). Plan for three spin-offs from DowDuPont: Agriculture, Material Sciences, and Specialty Products
 - "DuPont's R&D Is at Center of Fight With Activist," *The Wall Street Journal*, Oct 27, 2014
"We are the go-to people because we have innovation capabilities," says Tom Connelly, DuPont's chief innovation officer. "Our relevance increases as the breadth of our offering does increase"
"If the strategy was really working, it should have manifested itself by now in superior economic performance on the income statement, and it hasn't," says Ed Garden, chief investment officer at Triun
 - Starboard Value and AOL (to Microsoft)
 - Icahn and Motorola Mobility (to Google)
 - Other interventions: Third Point and Amgen, Loeb Partners and Mosaid, Starboard Value and Tessera Technologies, Starboard Value and Openwave, Starboard Value and DSP Group

Data: Hedge fund activism

- Section 13(d) of the 1934 Securities Exchange Act requires investors who are beneficial owners of over 5% of any class of publicly traded securities, and who have an intention to influence corporate control, to disclose their ownership and intent within 10 days of crossing the 5% threshold
 - Information on the identity of the filer, filing date, ownership and its changes, cost of purchase, and the purpose of the investment
- Begin with all 13D filings over 1994-2007
 - Filter out banks, brokerage companies, regular corporations, foreign inst', trusts, individuals, insurance companies, pension funds, and other misc' categories
 - Exclude events in which the primary purpose of the filer is either to be involved in (1) the bankruptcy reorganization or the financing of a distressed firm; or (2) to engage in a merger and acquisition related risk arbitrage; or (3) the target is a closed-end fund or other non-regular corporation
 - Gather information on the hedge fund's motive, the target's response, and the development and resolution of the events

Data: Hedge fund activism



- A total of 553 “innovative” target firms over the period 1994 and 2007
- Control firms: each firm targeted in year t is matched with a non-target firm from the same year and 2-digit SIC industry using the propensity score estimated using firm size and M/B ratio measured in $t - 1$ and M/B ratio measured in $t - 3$
 - Same rate of attrition through $t + 5$

Appendix

Data: Innovation

- NBER and USPTO: standard patent information. Obtain annual patent-level information from 1991 to 2010
 - Patent assignee, patent's application and grant year, the number of citations received by the patent, the technology class of the patent
- Google Patent: patent assignments and reassignments from 1991 to 2010
 - Name of the patent buyers (assignees), the name of the patent sellers (assignors), unique patent identifiers (patent numbers), and the patents' transaction dates
- HBS Inventor Database: inventor-level information
 - Inventor-level information from 1991 to 2010. Provides the names of the inventors and their affiliation with the assignees

Summary Statistics

	Targets		Non-Targets		Difference	
	Mean	Median	Mean	Median	Target–Non-Targets	t-Statistic
Firm Assets	721.54	237.49	704.06	212.78	17.48	(0.27)
MV	631.88	222.16	627.49	234.42	4.39	(0.08)
Firm ROA	0.01	0.05	0.02	0.07	-0.01	(-0.88)
Number of New Patents	1.27	0.00	1.37	0.00	-0.10	(-0.73)
Ave. Citation of New Patents	2.22	0.00	2.20	0.00	0.02	(0.09)
R&D/Assets	0.07	0.03	0.07	0.04	0.00	(0.77)
Leverage	0.20	0.16	0.17	0.12	0.03*	(2.28)
Market-to-Book Ratio	1.52	1.23	1.60	1.28	-0.08	(-1.39)
Patent Originality	0.58	0.63	0.59	0.63	-0.01	(-0.26)
Patent Generality	0.53	0.57	0.54	0.60	-0.01	(-0.35)
Patent Portfolio Diversity	0.31	0.25	0.33	0.34	-0.02	(-1.15)
Patent Explorativeness	0.18	0.00	0.19	0.00	-0.01	(-0.38)
Patent Exploitativeness	0.29	0.00	0.29	0.00	-0.01	(-0.22)

Main Specification

- Industry and year fixed effects:

$$\begin{aligned} Innovation_{i,t} = & \beta_1 \cdot I(Target)_i + \beta_2 \cdot I(Post)_{i,t} + \beta_3 \cdot I(Target)_i \times I(Post)_{i,t} \\ & + \gamma \cdot Control_{i,t} + \alpha_t + \alpha_{SIC3} + \varepsilon_{i,t}, \end{aligned}$$

- $I(Post)_{i,t} \equiv 1$ if the firm-year (i, t) observation is within $[t + 1, t + 5]$ years of an activism event or a pseudo-event year (for the control firms)
 - $I(Target)_i \equiv 1$ if firm i was ever targeted by a hedge fund activist
- Firm and year fixed effects:

$$\begin{aligned} Innovation_{i,t} = & \beta_2 \cdot I(Post)_{i,t} + \beta_3 \cdot I(Target)_i \times I(Post)_{i,t} \\ & + \gamma \cdot Control_{i,t} + \alpha_t + \alpha_i + \varepsilon_{i,t}, \end{aligned}$$

Proxies

I. Input

- R&D

II. Output

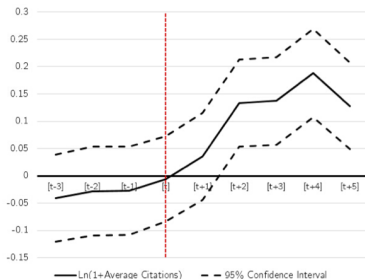
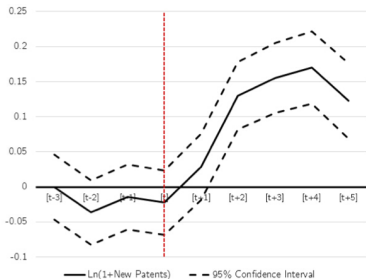
- Quantity
 - The number of patent applications in a given year
- Quality
 - Number of subsequent citations
 - Right-tail of the distribution of subsequent citations
 - Patent “originality”: 1 minus the Herfindahl index of the three-digit technology class distribution of all the patents it cites
 - Patent “generality”: 1 minus the Herfindahl Index of the three-digit technology class distribution of all the patents that cite it

Input to and Output from Innovation

	R&D/Assets (%)	R&D Exp. (\$mil)	ln(1+# New.Pat)	ln(1+Avg.Cit)	Top 20%	Originality	Generality	Yearly Innovation Value (\$mil)
l(Target) × l(Post)	-0.151 (-1.323)	-11.007*** (-3.086)	0.151*** (3.711)	0.155*** (3.071)	0.172** (2.250)	0.027*** (2.816)	0.009 (1.109)	12.260* (1.784)
l(Post)	0.061 (0.430)	4.648 (1.044)	-0.060* (-1.935)	0.007 (0.176)	-0.100 (-1.462)	-0.049*** (-3.973)	-0.003 (-0.279)	-4.593 (-0.584)
ln(MV)	-0.580*** (-13.736)	5.361*** (4.058)	0.047*** (4.076)	0.048*** (3.310)	0.096*** (3.683)	0.012*** (3.476)	0.009*** (2.963)	-0.435 (-0.151)
ln(Age)	0.014 (0.108)	-2.713 (-0.677)	-0.029 (-0.747)	-0.084 (-1.506)	-0.281*** (-3.805)	-0.022* (-1.888)	0.008 (0.715)	17.670** (2.524)
Constant	8.872*** (7.347)	8.273 (0.219)	-0.009 (-0.029)	0.432 (1.064)	0.741 (1.433)	0.198* (1.781)	0.021 (0.274)	-14.613 (-0.129)
Observations	9,817	9,817	9,817	9,817	9,817	3,218	2,763	3,218
R-squared	0.888	0.909	0.632	0.555	0.576	0.506	0.460	0.625
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Dynamics of Patents Applications and Lifetime Citations

$$Innovation_{i,t} = \sum_{k=-3}^{+5} \lambda_k \cdot d[t+k]_{i,t} + \sum_{k=-3}^{+5} \beta_k \cdot \{d[t+k]_{i,t} \times I(Target_i)\} + \gamma \cdot Control_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}$$



Innovation at Target Firms

- Diversity
 - One minus the Herfindahl index of the number of patents filed by a firm in the past three years across 2-digit technological classes defined by the NBER patent database
- Explorative
 - A patent is classified as explorative if at least 80% of its citations do not refer to existing knowledge, which includes all the patents that the firm invented and all the patents that were cited by the firm's patents filed over the past five years.
 - Compute the percentage of explorative patents filed in a given year by the firm
- Exploitative
 - A patent is classified as exploitative if at least 80% of its citations refer to existing knowledge, which includes all the patents that the firm invented and all the patents that were cited by the firm's patents filed over the past five years.
 - Compute the percentage of exploitative patents filed in a given year by the firm

Innovation at Target Firms

	ln(1+# New Patents)			ln(1+Avg Citations)		
	High Diversity	Low Diversity	F-Test	High Diversity	Low Diversity	F-Test
I(Post) × I(Target)	0.232*** (4.817)	0.062 (1.201)	5.57** (1.90%)	0.218*** (3.559)	0.092 (1.628)	2.01 (15.78%)
I(Post)	-0.077** (-2.152)	-0.042 (-0.828)		-0.008 (-0.177)	0.018 (0.351)	
ln(MV)		0.047*** (4.772)			0.048*** (3.733)	
ln(Age)		-0.016 (-0.464)			-0.065 (-1.397)	
Observations		9,817			9,817	
R-squared		0.669			0.595	
Year FE		Yes			Yes	
Firm FE		Yes			Yes	

Innovation at Target Firms

Key Tech Class: Yes		
	ln(1+# New Patents)	ln(1+Ave.Citation)
I(Target)×I(Post)	0.194*** (4.469)	0.182*** (3.444)
I(Post)	-0.055 (-0.756)	-0.031 (-0.726)
ln(MV)	0.053*** (6.011)	0.038** (2.344)
ln(Age)	-0.010 (-0.211)	-0.114** (-2.218)
Constant	-0.232 (-0.897)	0.433 (0.862)
Observations	9,817	9,817
R-squared	0.587	0.473
Year FE	Yes	Yes
Firm FE	Yes	Yes

Key Tech Class: No		
	ln(1+# New Patents)	ln(1+Avg Citations)
I(Target)×I(Post)	-0.028 (-0.525)	0.027 (0.503)
I(Post)	-0.016 (-0.455)	-0.032 (-0.747)
ln(MV)	0.046*** (3.440)	0.039** (2.379)
ln(Age)	0.117** (2.199)	-0.115** (-2.215)
Constant	-0.354 (-0.826)	0.429 (0.858)
Observations	9,817	9,817
R-squared	0.646	0.476
Year FE	Yes	Yes
Firm FE	Yes	Yes

Innovation at Target Firms

Key Tech Class: Yes		
	Explorative	Exploitative
I(Target)×I(Post)	0.040*** (2.671)	-0.045 (-0.751)
I(Post)	-0.027 (-0.829)	0.035 (0.603)
ln(MV)	0.009* (1.943)	-0.010 (-0.540)
ln(Age)	-0.022 (-1.203)	-0.092** (-2.060)
Constant	0.176 (1.237)	1.228*** (6.158)
Observations	3,218	3,218
R-squared	0.553	0.520
Year FE	Yes	Yes
Firm FE	Yes	Yes

Key Tech Class: No		
	Explorative	Exploitative
I(Target)×I(Post)	-0.028 (-0.401)	0.016 (0.267)
I(Post)	-0.014 (-0.241)	0.031 (0.555)
ln(MV)	-0.010 (-0.429)	-0.006 (-0.321)
ln(Age)	-0.087* (-1.652)	-0.089** (-2.022)
Constant	1.074*** (5.118)	1.207*** (6.982)
Observations	3,218	3,218
R-squared	0.565	0.520
Year FE	Yes	Yes
Firm FE	Yes	Yes

Patent Transactions

- Example: Starboard Value and AOL
- More generally:
 - ① Evidence on patent sales and purchases
 - ② Which patents get sold?
 - ③ Innovation efficiency of patents sold subsequent to the intervention

Patent Transaction Intensity

	<i>Patent Sales</i> <i>Patents Owned</i> (in%)		<i>Patent Purchases</i> <i>Patents Owned</i> (in%)	
I(Target) × I(Post)	0.641**	0.691**	0.012	0.084
	(2.171)	(2.428)	(0.085)	(0.633)
I(Target)	-0.350		0.140	
	(-1.257)		(1.073)	
I(Post)	0.250	-0.212	0.141	-0.037
	(0.973)	(-0.837)	(1.272)	(-0.330)
ln(MV)	0.007	-0.023	0.089***	0.024
	(0.159)	(-0.218)	(4.285)	(0.615)
ln(Age)	-0.276***	0.420	-0.261***	-0.287
	(-2.711)	(1.424)	(-3.806)	(-1.495)
Constant	0.713*	-0.797	4.734	5.041
	(1.911)	(-0.743)	(1.276)	(1.360)
Observations	9,374	9,374	9,374	9,374
R-squared	0.028	0.143	0.029	0.163
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	No	Yes	No
Firm FE	No	Yes	No	Yes

Selling Distant Patents

- Measure the distance between a patent and a firm's technology stock following Akcigit, Celik and Greenwood (2013)
 - Distance between a technology class X and Y : $d(X, Y) \equiv 1 - \frac{\#(X \cap Y)}{\#(X \cup Y)}$
 - $\#(X \cap Y)$ denotes the number of all patents that cite patents from technology classes X and Y simultaneously
 - $\#(X \cup Y)$ denotes the number of all patents that cite at least one patent from tech class X or at least one patent from tech class Y , or both
 - Distance of a patent p to a firm f 's technology stock is computed by calculating the average distance of p to each of the patents owned by f :

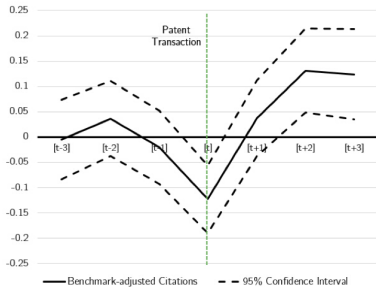
$$d_i(p, f) = \left[\frac{1}{\|P_f\|} \sum_{p' \in P_f} d(X_p, Y_{p'})^i \right]^{\frac{1}{i}}$$

Selling Distant Patents

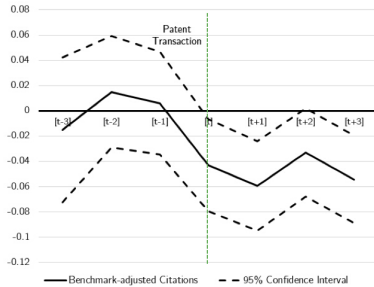
	Patent Sale (=100%)			
	Distance Measure ($\iota = 0.33$)		Distance Measure ($\iota = 0.66$)	
Distance (Patent to Firm)	0.470*** (7.990)	0.529*** (8.503)	0.710*** (10.647)	0.701*** (9.697)
Distance × After	0.132** (2.247)	0.283*** (4.723)	0.147* (1.712)	0.163* (1.918)
Distance × Before	-0.090 (-1.601)	-0.260*** (-4.444)	-0.114* (-1.787)	-0.364*** (-5.422)
After	0.443*** (10.858)	1.082*** (9.239)	0.423*** (11.238)	0.932*** (7.115)
Before	-0.383*** (-5.735)	-0.126** (-2.323)	-0.523*** (-7.208)	-0.141*** (-3.715)
Observations	929,613	929,613	929,613	929,613
R-squared	0.010	0.037	0.010	0.037
Year FE	Yes	Yes	Yes	Yes
Patent Age FE	Yes	Yes	Yes	Yes
Tech Class FE	Yes	Yes	Yes	Yes
Firm FE	No	Yes	No	Yes

Citation Dynamics of Patents Sold Post-Intervention

$$Citation_{i,t} = \sum_{k=-3}^3 \beta_k \cdot d[t+k]_{i,t} + \gamma \cdot Patent\ Age_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}.$$



Patent Sales by Targets



Patent Sales by Matched Firms

Citation Dynamics of Patents Sold Post-Intervention

	Patents Sold by Targets of HFA	Patents Sold by Control Firms	Best Patents Retained by Control Firms	Best Patents Retained by Target Firms	Patents Retained by Targets, PSM-matched
d[t-3]	-0.005 (-0.124)	-0.015 (-0.513)	-0.036 (-1.334)	-0.009 (-0.106)	-0.006 (-0.122)
d[t-2]	0.036 (0.956)	0.015 (0.666)	-0.014 (-0.441)	0.012 (0.233)	-0.024 (-0.981)
d[t-1]	-0.020 (-0.546)	0.006 (0.293)	-0.057* (-1.770)	0.022 (0.511)	-0.018 (-0.805)
d[t]	-0.123*** (-3.630)	-0.043** (-2.324)	-0.033 (-1.453)	0.024 (0.641)	-0.071** (-1.997)
d[t+1]	0.037 (0.966)	-0.060*** (-3.299)	0.009 (0.304)	0.077** (2.204)	-0.015 (-0.516)
d[t+2]	0.131*** (3.095)	-0.033* (-1.847)	0.056* (1.718)	0.144*** (3.334)	-0.046 (-1.266)
d[t+3]	0.124*** (2.711)	-0.054*** (-3.074)	0.065** (2.413)	0.194*** (5.075)	-0.025 (0.747)
Observations	1,291,915	1,291,915	1,291,915	1,291,915	1,291,915
R-squared	0.447	0.449	0.451	0.441	0.438
Year FE	Yes	Yes	Yes	Yes	Yes
Patent FE	Yes	Yes	Yes	Yes	Yes
F-Test:					
DiD([t+3]-[t])	—	6.12	4.74	8.37	5.14
p-val	—	1.34%	2.91%	0.00%	2.23%

- Event year t is the year of the patent sale (within two years post-intervention)

Inventor-level Evidence

- Redeployment of human capital
 - *Leaver*. An inventor who leaves her firm during a given year, who generates at least one patent in the firm before the year of intervention, and who generates one patent in a different firm after the year of intervention
 - *New hire*. An inventor who has been newly hired by a given firm in a given year, who generates at least one patent in a different firm before the year of intervention, and who generates at least one patent in the firm after the year of intervention
 - *Stayer*. An inventor who stays with her firm during a given year and who generates at least one patent both before and after the year of intervention

Inventor-level Mobility

	$\ln(1+\# \text{ leavers})$	$\ln(1+\# \text{ leavers})$	$\ln(1+\# \text{ new hires})$	$\ln(1+\# \text{ new hires})$
$I(\text{Target}) \times I(\text{Post})$	0.067* (1.831)	0.062* (1.664)	0.081*** (2.925)	0.086*** (3.184)
$I(\text{Target})$	0.034 (0.889)		0.008 (0.266)	
$I(\text{Post})$	-0.044 (-1.365)	-0.019 (-0.812)	-0.071*** (-2.791)	-0.047** (-2.399)
$\ln(\text{MV})$	0.094*** (9.939)	0.025*** (2.613)	0.080*** (10.090)	0.017*** (2.674)
$\ln(\text{Age})$	0.019 (0.943)	0.053 (1.275)	0.003 (0.200)	0.004 (0.144)
Constant	-0.507*** (-2.914)	-0.146 (-0.743)	-0.245 (-1.327)	0.134 (0.695)
Observations	8,016	8,016	8,016	8,016
R-squared	0.298	0.618	0.267	0.545
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	No	Yes	No
Firm FE	No	Yes	No	Yes

Inventor-level Productivity

	Δ New Patents			Δ New Patent Citations		
	Stayer	Leaver	New Hire	Stayer	Leaver	New Hire
I(Target) × I(Post)	1.088*** (8.096)	1.121* (1.867)	0.763** (2.418)	1.958*** (7.380)	3.239* (1.881)	0.510 (1.381)
I(Target)	0.530 (1.628)	0.411 (0.975)	0.140 (0.397)	-0.500 (-1.045)	-1.013 (-0.892)	-1.367 (-1.202)
I(Post)	0.852 (1.550)	0.623 (0.998)	-0.335 (-0.673)	-0.739 (-0.643)	-1.059 (-0.729)	-0.949 (-0.651)
Δln(MV)	0.155** (2.544)	0.191 (1.258)	0.245* (1.906)	-0.254 (-1.135)	-1.717*** (-2.995)	-0.478 (-0.862)
Observations	36,418	1,717	2,836	36,418	1,717	2,836
R-squared	0.068	0.099	0.067	0.043	0.043	0.036
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Potential Channel: 1. Executive career concern and incentives

	Hedge Fund Targets	Matched Firms	Difference
	Turnover		
% of Firms with at least one CEO turnover within the 3 years prior to the intervention	22.33%	26.44%	-4.11%
% of Firms with at least one CEO turnover within the 3 years subsequent to the intervention	32.69%	20.25%	12.44***
Post-Pre Difference	10.36***	-6.19%	16.55***
	Job Security		
Tenure of newly appointed CEOs within 3 years prior to the intervention (in days)	1693	1897	-204
Tenure of newly appointed CEOs within 3 years subsequent to the intervention (in days)	2076	1773	303*
Post-Pre Difference	383**	-124	507**
Tenure of incumbent CEOs surviving first 3 years <i>After</i> event (Days)	2173	1928	245
	CEO Ownership Level		
Insider ownership of CEOs within 3 years prior to the intervention	0.63%	0.64%	-0.01%
Insider ownership of CEOs within 3 years subsequent to the intervention	0.78%	0.61%	0.17%*
Post-Pre Difference	0.15%*	-0.03%	0.18%*
	Technology Officers' Ownership Level		
Insider ownership of Technology Officers within 3 years prior to the intervention	0.12%	0.11%	0.01%
Insider ownership of Technology Officers within 3 years subsequent to the intervention	0.18%	0.11%	0.07%*
Post-Pre Difference	0.06%*	0%	0.06%*

Potential Channel: 2. Expertise of newly appointed board members

	Targets	Non-Targets	Difference	t-Statistic
Age	53.594	54.067	-0.473	-2.049
Female	0.089	0.103	-0.014	-1.613
Independence	0.518	0.515	0.002	0.145

Expertise (Yes=1 or No=0)				
Innovation	0.535	0.489	0.045***	3.014
Academic	0.046	0.043	0.003	0.475
Financial	0.595	0.552	0.043***	2.866
Management	0.841	0.830	0.011	0.947
Operation	0.664	0.636	0.027*	1.917
Marketing	0.180	0.182	-0.002	-0.133
Legal	0.118	0.119	-0.001	-0.107

Expertise Score				
Innovation	0.952	0.852	0.100**	2.174
Academic	0.606	0.541	0.065	0.579
Financial	0.961	0.855	0.106***	2.746
Management	0.704	0.663	0.041**	1.980
Operation	0.917	0.882	0.034	0.994
Marketing	1.053	1.157	-0.104	-1.089
Legal	0.931	0.904	0.027	0.284

- *Expertise* is a dummy variable indicating whether the board member has the specific expertise (one of the defining keywords of expertise appears at least once in the biographical information)
- *Expertise Score* measures the weight of expertise by counting the frequency of related key words

Tests for causality

- We are interested in the question whether the target firm's innovation would have changed had it not been for the HF's effort (rather than whether hedge fund activism affects firms' innovation if funds were assigned randomly to targets)
 - The conventional IV approach which is predicated on finding exogenous shocks in targeting is not applicable – even if there are exogenous shocks that make targeting easier, HFs are still going to select among candidates that are now made easier to be targeted
 - An IV for exogenous termination of HF intervention would help, but it is not necessary to show the conditional treatment effect
- From earlier work we know that activists tend to hold concentrated stakes in target firms for an average holding period of two years. Undiversified positions together with costly engagements cannot be justified based on a pure stock picking story
- Propensity score matching
- Consider three tests to disentangle the effects of intervention from stock picking

Tests for causality

- 1 The target firm would have not implemented the changes absent the activist's intervention. Focus on hostile events only

	R&D/Assets (%)	R&D Exp. (\$mil)	ln(1+# New.Pat)	ln(1+Avg.Cit)	Top 20%	Originality	Generality
I(Target) × I(Post)	-0.135 (-1.072)	-14.014* (-1.930)	0.148* (1.686)	0.135* (1.718)	0.266** (1.977)	0.018 (1.015)	0.009 (0.579)
I(Post)	0.318 (1.345)	1.005 (0.117)	-0.047 (-0.692)	0.031 (0.412)	-0.097 (-1.523)	-0.028 (-1.305)	-0.006 (-0.344)
ln(MV)	-0.409*** (-5.598)	6.680** (2.523)	0.077*** (3.080)	0.086*** (3.201)	0.078** (2.161)	0.024*** (3.748)	0.016** (2.575)
ln(Age)	-0.085 (-0.357)	-25.890*** (-2.994)	0.057 (0.593)	0.050 (0.447)	0.057 (0.390)	0.032 (1.384)	0.027 (1.165)
Constant	7.554*** (7.668)	117.408*** (3.286)	-0.645* (-1.779)	-0.709* (-1.675)	-0.479 (-0.815)	-0.235*** (-2.603)	-0.177** (-2.070)
Observations	2,143	2,143	2,143	2,143	2,143	649	537
R-squared	0.873	0.894	0.661	0.545	0.228	0.520	0.442
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Tests for causality

- 2 Hedge funds have superior ability to select targets ("stock-picking") that are expected to experience positive changes
 - Look at hedge funds switching from a Schedule 13G, filed for passive investment purposes, to a Schedule 13D. Benchmarked to hedge funds' filing of Schedule 13Gs
 - ⇒ 13D (stock picking + potential intervention) vs. 13G (stock picking only)

	R&D/Assets (%)	ln(1+# of New.Pat)	ln(1+Ave.Cit)
13G to 13D	-0.101 (-0.215)	0.116* (1.946)	0.174** (1.968)
I(Post)	0.008 (0.064)	-0.014 (-0.713)	-0.009 (-0.304)
Controls	Yes	Yes	Yes
Observations	6,756	6,756	6,756
R-squared	0.899	0.631	0.573
Year FE	Yes	Yes	Yes
Hedge Fund FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes

Tests for causality

3 Market reaction to patent grant announcements

	Abnormal Return (in bps)			
	(1)	(2)	(3)	(4)
(months around intervention)	[t-6,t+6]	[t-3,t+3]	[t-6,t+6]	[t-3,t+3]
I(Target) × I(Post)	32.928** (2.489)	30.972* (1.712)		
I(13G to 13D)			45.444** (2.353)	36.473 (1.253)
I(Post)	-3.335 (-0.222)	4.782 (0.876)	-3.793 (-0.331)	-8.332 (-0.571)
Observations	4,885	2,527	3,338	2,384
R-squared	0.168	0.274	0.157	0.172
Monthly fixed effects of application-approval lag	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes

Conclusions

- Firms refocus their scope of innovation to key technology classes and actively reallocate innovation resources after hedge fund activism
 - (1) Innovation productivity increases overall
 - (2) Refocus on key technology areas, patents more explorative
 - (3) Active patent transactions, selling under-utilized/distant patents
 - (4) Adjustment of the inventor base, and inventor productivity increases
 - (5) Change to board composition and managerial incentives

Target Firms with at Least Five Patents

	R&D/Assets (%)	R&D Exp. (\$mil)	ln(1+# New.Pat)	ln(1+Avg.Cit)	Originality	Generality	Yearly Innovation Value (\$ mil)
l(Target) × l(Post)	-0.073 (-0.547)	-15.614*** (-3.126)	0.160*** (3.687)	0.155*** (2.701)	0.029** (2.306)	0.012 (1.004)	15.071** (2.022)
l(Post)	-0.195 (-1.234)	6.720 (1.138)	-0.051 (-1.428)	0.032 (0.679)	-0.053*** (-3.482)	-0.000 (-0.004)	-3.559 (-0.476)
ln(MV)	-0.763*** (-14.875)	7.330*** (3.831)	0.047*** (3.601)	0.036** (1.999)	0.010** (2.107)	0.007 (1.620)	0.121 (0.058)
ln(Age)	-0.001 (-0.004)	-8.530 (-1.518)	0.001 (0.014)	-0.103* (-1.780)	-0.024 (-1.631)	0.018 (1.232)	13.078** (2.100)
Constant	10.937*** (7.550)	15.711 (0.291)	0.264 (0.618)	1.241** (2.173)	0.379** (2.277)	0.099 (0.915)	-9.523 (-0.112)
Observations	6,993	6,993	6,993	6,993	2,438	2,146	2,438
R-squared	0.901	0.910	0.672	0.598	0.525	0.483	0.613
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 3

Early Subsample of Activism Events: 1994-2002

	R&D/Assets (%)	R&D Exp. (\$mil)	ln(1+# New.Pat)	ln(1+Avg.Cit)	Originality	Generality	Yearly Innovation Value (\$ mil)
I(Target) × I(Post)	-0.049 (-0.284)	-1.583 (-0.412)	0.173*** (3.047)	0.222** (2.379)	0.034* (1.837)	0.026 (1.402)	9.173 (1.555)
I(Post)	0.108 (0.575)	-4.832 (-1.143)	-0.080 (-0.883)	-0.086 (-1.196)	-0.071 (-1.576)	-0.021 (-1.054)	-8.119 (-0.934)
ln(MV)	-0.565*** (-9.734)	3.427*** (2.631)	0.049*** (3.335)	0.033 (1.339)	0.015** (2.460)	0.008 (1.405)	-0.568 (-0.274)
ln(Age)	0.134 (0.832)	4.213 (1.164)	-0.030 (-0.657)	-0.116 (-1.531)	-0.018 (-1.025)	-0.012 (-0.780)	11.235** (2.285)
Constant	8.536*** (7.296)	-10.464 (-0.399)	-0.050 (-0.159)	0.481 (1.091)	0.161 (1.342)	0.042 (0.501)	-12.882 (-0.099)
Observations	6,135	6,135	6,135	6,135	1,847	1,395	1,847
R-squared	0.913	0.883	0.734	0.567	0.528	0.487	0.576
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 3

Negative Binomial

	New Patent Counts	Patent Citations
I(Post) × I(Target)	0.098** (2.538)	0.161** (2.514)
I(Post)	0.008 (0.307)	0.056 (1.386)
ln(MV)	0.149*** (28.576)	0.087*** (9.544)
ln(Age)	-0.067*** (-6.423)	-0.164*** (-10.352)
Incidence Rate Ratio	1.103**	1.175**
Observations	9,817	9,817
Year FE	Yes	Yes
Firm FE	Yes	Yes

Table 3

Alternative Specifications for the Propensity Score Matching

	R&D/Assets (%)	R&D Exp. (\$mil)	ln(1+# New.Pat)	ln(1+Avg.Cit)	Originality	Generality	Yearly Innovation Value (\$ mil)
Panel A: PSM – by Industry, Size, ROA, M/B, M/B Lag 3							
I(Target) × I(Post)	-0.153 (-1.386)	-13.081*** (-3.038)	0.136*** (3.520)	0.141*** (2.928)	0.031*** (2.996)	0.014 (1.102)	15.171* (1.915)
I(Post)	0.102 (0.981)	4.561 (1.324)	-0.045* (-1.695)	0.003 (0.106)	-0.047*** (-4.506)	-0.003 (-0.331)	3.073 (0.469)
Panel B: PSM – by Industry, Size, ROA, ROA Lag 4, M/B							
I(Target) × I(Post)	-0.143 (-1.271)	-8.770** (-2.341)	0.181*** (4.513)	0.177*** (3.701)	0.026** (2.554)	0.011 (1.276)	9.223 (1.434)
I(Post)	0.078 (0.520)	4.156 (0.889)	-0.077** (-2.380)	0.005 (0.126)	-0.044*** (-3.466)	-0.002 (-0.211)	0.077 (0.332)
Panel C: PSM – by Industry, Size, ROA, M/B, M/B Lag 4							
I(Target) × I(Post)	-0.106 (-1.001)	-9.278*** (-2.806)	0.163*** (4.563)	0.190*** (4.543)	0.027*** (2.794)	0.011 (1.391)	10.155* (1.705)
I(Post)	0.112 (1.208)	4.244 (1.539)	-0.052** (-2.014)	-0.025 (-0.859)	-0.043*** (-3.638)	-0.005 (-0.492)	0.134 (0.778)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4

Robustness: Key (non-key) Defined at Top (bottom) 3 Tech' Classes

Key Tech Class: Yes		
	ln(1+# New Patents)	ln(1+Ave.Citation)
l(Target)×l(Post)	0.131** (2.414)	0.128** (2.592)
l(Post)	-0.053 (-1.363)	-0.016 (-0.414)
ln(MV)	0.064*** (5.647)	0.046*** (2.847)
ln(Age)	-0.001 (-0.026)	-0.137** (-2.484)
Constant	-0.276 (-0.699)	0.519 (1.230)
Observations	9,817	9,817
R-squared	0.587	0.473
Year FE	Yes	Yes
Firm FE	Yes	Yes

Key Tech Class: No		
	ln(1+# New Patents)	ln(1+Avg Citations)
l(Target)×l(Post)	0.040 (0.913)	0.031 (0.632)
l(Post)	-0.004 (-0.155)	-0.018 (-0.465)
ln(MV)	0.033*** (2.715)	0.047*** (2.862)
ln(Age)	0.153*** (3.162)	-0.136** (-2.466)
Constant	-0.346 (-1.069)	0.513 (1.216)
Observations	9,817	9,817
R-squared	0.646	0.476
Year FE	Yes	Yes
Firm FE	Yes	Yes

Table 4B

Robustness: Cutoff for Explorative & Exploitative at a 60% Threshold

Key Tech Class: Yes		
	Explorative	Exploitative
I(Target) \times I(Post)	0.033* (1.827)	-0.038 (-0.839)
I(Post)	-0.033* (-1.961)	-0.006 (-0.137)
ln(MV)	0.013** (2.228)	-0.004 (-0.231)
ln(Age)	-0.036* (-1.729)	-0.075** (-2.161)
Constant	0.220 (1.557)	1.158*** (8.947)
Observations	3,218	3,218
R-squared	0.349	0.461
Year FE	Yes	Yes
Firm FE	Yes	Yes

Key Tech Class: No		
	Explorative	Exploitative
I(Target) \times I(Post)	-0.040 (-0.768)	0.012 (0.263)
I(Post)	0.024 (0.515)	-0.002 (-0.048)
ln(MV)	0.004 (0.224)	-0.007 (-0.416)
ln(Age)	-0.107** (-2.499)	-0.072** (-2.032)
Constant	1.188*** (8.288)	1.213*** (9.506)
Observations	3,218	3,218
R-squared	0.505	0.466
Year FE	Yes	Yes
Firm FE	Yes	Yes

Table 4C

Comparison of attrition rates between target and matched firms

Innovative Sample								
Time	HFA Targets				Matched Firms			
	% Attrition	% Acquired	% Distress	% Other Reasons	% Attrition	% Acquired	% Distress	% Other Reasons
t+1	7.2	5.8	0.2	1.2	8.0	5.3	0.7	2.0
t+2	11.0	8.4	0.6	2.0	12.7	8.0	1.0	3.7
t+3	19.2	14.2	1.1	3.9	21.3	13.5	2.1	5.7
t+4	26.8	18.4	1.8	6.6	26.6	17.8	2.7	6.1
t+5	33.3	22.1	2.6	8.6	34.0	22.6	3.4	8.0

Non-Innovative Sample								
Time	HFA Targets				Matched Firms			
	% Attrition	% Acquired	% Distress	% Other Reasons	% Attrition	% Acquired	% Distress	% Other Reasons
t+1	16.7	11.1	2.2	3.4	13.2	7.2	2.7	3.3
t+2	28.6	19.4	2.9	6.3	23.7	12.9	3.5	7.3
t+3	36.2	24.0	4.1	8.2	33.7	18.9	4.6	10.2
t+4	44.3	27.8	4.9	11.6	40.7	23.3	5.3	12.2
t+5	50.5	31.4	5.9	13.2	46.1	26.7	6.0	13.4

Data

Summary statistics of patents sold by target and control firms

	Patents Sold by Targets of HFA	Patents Sold by Control Firms	Best Patents Retained by Control Firms	Best Patents Retained by Target Firms	Patents Retained by Targets, PSM-matched
Distance ($\iota = 0.33$)	0.716	0.646	0.578	0.546	0.691
Distance ($\iota = 0.66$)	0.620	0.533	0.467	0.451	0.605
Average Annual Citations Between $t - 3$ and $t - 1$	0.248	0.320	0.915	0.964	0.259
Total Citations Up to t	1.022	1.274	4.766	5.212	1.138
Age	6.219	4.726	5.243	6.067	6.422
Total Lifetime Citations	6.751	3.343	15.379	17.216	4.844

Patent citations