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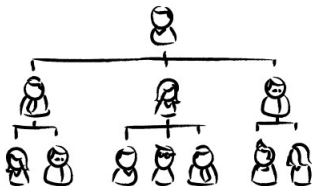
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Inventor's Incentive and Authority

Hamed Davari
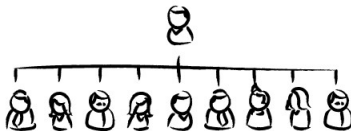
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11 May 2022

Question

Which one better incentivizes inventors?

Organization A   Organization B

"in a traditional corporate hierarchy... a junior executive comes up with a new idea that they want to try. They have to convince their boss, their boss's boss, their boss's boss's boss and so on—any 'no' in that chain can kill the whole idea."- Jeff Bezos

Why innovation needs a different organizational structure?

- Inventors (agents) have superior information about the potential projects and their quality. The boss (principal) herself either is not able to acquire this information or it is very costly to do so.

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- The principal, with authority may optimally transfer the decision right on the use of resources to the inventor to overcome three problems:
  - Discouraging effect of rejection of agent's proposal Aghion and Tirole (1997)
  - Mispresentation of quality of the project by the agent. Dessein (2002)
  - Unverifiable ("Soft") nature of information Stein(2002)

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- The principal, with authority may optimally transfer the decision right on the use of resources to the inventor to overcome three problems:
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  - Mispresentation of quality of the project by the agent. Dessein (2002)
  - Unverifiable ("Soft") nature of information Stein(2002)
- "Managerial authority replaces the price mechanism when contracting over resources is too costly." Ronald H. Coase (1937)

Testable hypotheses

Proxy for authority: number of management layers.
Spin-off/carve-outs positively and takeovers negatively shock
organizational structure and authority.

Inventor's mobility

- H1 Inventors are less (more) likely to leave the spun-off
  (acquired) firm.
- The effect is more pronounced the more distant (in hierarchy
  and geographical distance) the subsidiary is to the HQ.

Testable hypotheses

Proxy for authority: number of management layers.
Spin-off/carve-outs positively and takeovers negatively shock
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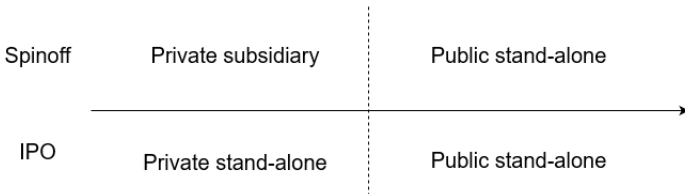## Inventor's mobility

- H1 Inventors are less (more) likely to leave the spun-off
  (acquired) firm.
- The effect is more pronounced the more distant (in hierarchy
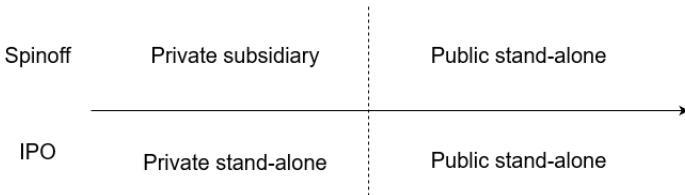 and geographical distance) the subsidiary is to the HQ.

Inventor's productivity

- H2 Stayer-inventors file more (fewer), more (less) valuable,
  more (less) radical patents in spun-off (acquired) firm.

Research design

Spinoff   Private subsidiary   Public stand-alone

IPO   Private stand-alone   Public stand-alone

Research design

| Spinoff | Private subsidiary | Public stand-alone |
| IPO | Private stand-alone | Public stand-alone |

- A panel of inventors in a clean window, (-4,4) years around the deal

- Controls: R&D intensity, size, tangibility, leverage, Tobin's Q, Profitability, Cash liquidity, # of subsidiaries, # of inventors, inventor age, inventor and time FE.

- Internal capital market: Herfindahl index based on # of inventors in each subsidiary.

- Matching: inventor age and gender, deal year, subsidiary size by # inventors, subsidiary technology class, subsidiary's pre-treatment dollar value innovation.

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Research design

| | Takeover | Public stand-alone | Private subsidiary |
| | Divestiture | Private subsidiary | Private subsidiary |
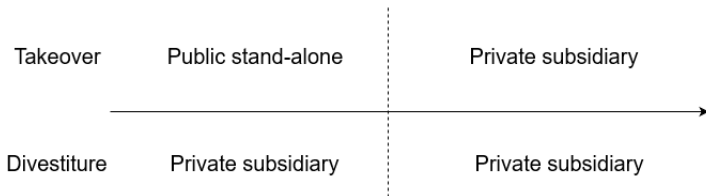
Contributions

1. An important question about an important economic agent.
2. Novel identification using positive/negative shocks.
3. At the intersection of innovation economics, organizational economics, and corporate finance.
4. First to empirically examine the effect of organizational structure and authority on inventor's choice and their innovation output.

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- Delegation dominates when authority is separate from information production and it cannot by credibly transmitted, or overruling the agent discourage taking initiative in finding good projects. Aghion and Tirole(1997), Stein(2002), Dessein (2002)

- Flat hierarchies (steep hierarchies) will prevail in human-capital-intensive (physical-capital-intensive) industries. Rajan & Zinglaes(2001)

- Adding a management layer increases quantity-based productivity, while reducing revenue-based productivity. Caliendo et al (2019)

- IPO reduces firm's innovation through an exodus of skilled inventors and a decline in productivity of stayer inventors. Bernstein (2015)

- Targets in diversifying mergers produce less innovation, mostly because the inventors become less productive due to acquirer's active internal capital market. Seru (2014)

- IPOs and takeovers ensue large restructuring of the labor force Baghai& Silva (2019) and Gehrke et al (2021)

Sample construction

Inventor-year panel, 1980 - 2015.

1. Arora et al (2021): Dynamic reassignment of patents to compustat firms, 1980 - 2015.
2. Kogan et al (2017): augment ABS with patents citation and dollar value.
3. Patentview and Kaltenberg et al (2021): inventor level data.
4. SDC: deal level chars.
5. Compustat: firm level accounting figures
6. IPO firm level controls extracted from prospectuses.

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Summary Statistics

	deal_type	n_dealid	n_inventors	n_patents
1	Takeover	637	21,958	18,714
2	Selloffs	132	2,884	2,302
3	Spin-off	148	17,476	17,574
4	IPO	1,521	21,064	18,827

Summary Stats Takeover- divestiture

	n_t	n_c	mean_t	mean_c	Q0.25_t	Q0.25_c	Q0.5_t	Q0.5_c	Q0.75_t	Q0.75_c
inventor_id	42,974	4,787	-	-	-	-	-	-	-	-
inventor_out	42,974	4,787	0.148	0.130	0	0	0	0	0	0
inventor_patcount_ann	42,974	4,787	0.961	1.156	0.333	0.333	0.500	0.583	1	1.083
inventor_cit_ann	42,974	4,787	19.232	19.760	0	0	3	2	14.711	13.333
inventor_dollar_ann	42,974	4,787	12.809	13.800	0.136	0	2.683	1.179	10.400	6.618
inventor_age	28,672	2,989	43.692	44.416	37	37	43	44	50	51
firm_innooutput_count_ann	42,974	4,787	412.653	367.132	39	67	189	238	537	662
firm_innooutput_cite_ann	42,974	4,787	20,520.450	17,546.150	1,216	2,342	5,627.500	9,065	21,391	23,228
firm_innooutput_dollar_ann	42,974	4,787	20,676.420	12,154.110	507.892	2,272.264	5,627.005	4,988.648	32,435.810	9,967.710
firm_n_inventor	42,974	4,787	617.939	615.387	66	118	306.500	429	959	1,071
firm_n_sub	42,974	4,787	10.773	11.399	1	4	7	10	16	17
firm_size	41,783	4,751	8.942	9.820	7.583	8.343	9.411	9.766	10.569	12.145
firm_rd_intensity	40,066	4,606	0.086	0.054	0.028	0.022	0.064	0.032	0.110	0.064
firm_q	41,701	4,743	2.420	2.100	1.398	1.095	1.855	1.437	2.800	2.615
firm_capx_asset	41,521	4,734	0.053	0.058	0.026	0.032	0.047	0.055	0.070	0.077
firm_tangibility	41,774	4,751	0.243	0.239	0.129	0.163	0.230	0.251	0.330	0.297
firm_cash_liquidity	41,688	4,749	0.330	0.294	0.205	0.191	0.313	0.298	0.410	0.379
firm_leverage	41,500	4,736	0.171	0.330	0.048	0.103	0.124	0.246	0.231	0.644
firm_age	15,522	558	40.122	45.529	14	16	21	24	30	30
sub_n_inventor	42,974	4,787	408.442	309.175	29	53	124	168	402	413
firm_compete1_ann	42,974	4,787	0.034	0.029	0.002	0.003	0.006	0.006	0.025	0.019

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Summary Stats Spinoff- IPO

	n_t	n_c	mean_t	mean_c	Q0.25_t	Q0.25_c	Q0.5_t	Q0.5_c	Q0.75_t	Q0.75_c
inventor_id	35,791	41,194	-	-	-	-	-	-	-	-
inventor_out	35,791	41,194	0.126	0.222	0	0	0	0	0	0
inventor_patcount_ann	35,791	41,194	1.015	0.901	0.333	0.250	0.500	0.500	1	1
inventor_cit_ann	35,791	41,194	15.136	33.158	0.667	0.667	3.500	5.221	12.477	22.333
inventor_dollar_ann	35,791	41,194	17.751	8.660	1.158	0.272	3.841	1.160	12.357	4.604
inventor_age	24,308	26,961	43.546	41.851	36	35	43	41	50	48
firm_innooutput_count_ann	35,791	41,194	518.603	137.604	122	5	382	16	751	59
firm_innooutput_cite_ann	35,791	41,194	19,342.360	7,625.850	3,751	206	10,477	918	26,633	4,393
firm_innooutput_dollar_ann	35,791	41,194	21,577.090	6,576.058	1,857.528	23.842	11,499.510	134.902	23,158.630	1,449.421
firm_n_inventor	35,791	41,194	780.041	216.528	186	10	592	27	1,231	94
firm_n_sub	35,791	41,194	12.592	3.661	3	0	9	1	20	3
firm_size	35,209	40,718	9.455	6.143	8.285	4.412	9.589	5.538	10.769	7.780
firm_rd_intensity	35,108	40,458	0.068	0.173	0.031	0.059	0.055	0.109	0.076	0.213
firm_q	35,174	40,681	2.465	3.729	1.206	1.696	1.968	2.748	3.515	4.215
firm_capx_asset	35,125	40,665	0.058	0.054	0.030	0.021	0.050	0.041	0.077	0.073
firm_tangibility	35,203	40,706	0.264	0.159	0.133	0.056	0.243	0.123	0.380	0.231
firm_cash_liquidity	35,186	40,682	0.341	0.566	0.226	0.331	0.285	0.595	0.418	0.795
firm_leverage	35,136	40,653	0.247	0.092	0.043	0.0001	0.110	0.020	0.391	0.110
firm_age	10,225	33,906	29.875	18.903	15	6	25	9	30	16
sub_n_inventor	35,791	41,194	546.060	166.886	67	8	188	20	1,002	57
firm_compete1_ann	35,791	41,194	0.015	0.078	0.001	0.009	0.002	0.029	0.008	0.083

Specification

$$Y_{it} = \alpha + \sum_{k=-4, k \neq -1}^{4} \beta_k \times treat_{ik} + X_{it}\Gamma + \phi_i + \gamma_t + \epsilon_{it}$$

The outcome variable, Y is

- H1, dummy $= 1$ if the inventor files a patent with another firm.
- H2, inventor productivity measures: patent count, citation, dollar value.

Inventor's participation response to authority

Dependent Variable:			Pr(Absent = 1)			
		Spinoff			Takeover	
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
filing__year = -4	–0.02	–0.12***	–0.13	–0.05***	–0.16	–0.11
	(–0.008)	(–12.1)	(–0.002)	(–4.7)	(–0.006)	(–0.19)
filing__year = -3	–0.02**	–0.10***	–0.07	–0.02***	–0.08	–0.06
	(–2.3)	(–11.6)	(–0.005)	(–3.1)	(–0.008)	(–0.11)
filing__year = -2	–0.02	–0.07	–0.04	–0.008	–0.03	–0.04
	(–0.010)	(–0.14)	(–0.0009)	(–1.2)	(–0.009)	(–0.2)
filing__year = 0	–0.03	–0.06	–0.06	0.02***	0.02***	0.02
	(–0.01)	(–0.06)	(–0.01)	(3.0)	(3.2)	(1.3)
filing__year = 1	0.007	–0.05	–0.05***	0.03***	0.03***	–0.01
	(0.004)	(–0.10)	(–2.8)	(4.2)	(3.5)	(–0.40)
filing__year = 2	0.02**	–0.01	–0.04*	0.07***	0.05***	0.03
	(2.1)	(–1.4)	(–1.9)	(7.7)	(5.1)	(1.2)
filing__year = 3	0.06***	0.01	–0.04*	0.09***	0.06***	0.09***
	(5.7)	(1.0)	(–1.6)	(7.2)	(4.1)	(3.6)
filing__year = 4	0.08***	0.04***	–0.007	0.10***	0.06***	0.08***
	(8.2)	(4.0)	(–0.26)	(6.9)	(3.6)	(3.0)
Fixed-effects						
inventor__id	Yes	Yes	Yes	Yes	Yes	Yes
filing__year	Yes	Yes	Yes	Yes	Yes	Yes
Controls		Yes	Yes		Yes	Yes
Matched sample			Yes			Yes
Fit statistics						
Observations	76,985	74,306	28,661	47,761	43,776	21,608
R²	0.56953	0.71592	0.86654	0.61423	0.65554	0.79033
Within R²	0.02244	0.30923	0.15901	0.02945	0.09338	0.14467

Clustered (inventor__id) co-variance matrix, t-stats in parentheses
Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

Inventor's productivity response to authority

Dependent Variables: Model:	patcount (1)	Spinoff citations (2)	dollar (3)	patcount (4)	Takeover citations (5)	dollar (6)
Variables						
filing_year = -4	0.18	17.8	8.6	0.38	13.0	-4.8
	(0.01)	(0.04)	(0.02)	(0.003)	(0.002)	(-0.002)
filing_year = -3	0.13	7.4*	20.5*	0.11	-5.2	3.9
	(0.77)	(1.7)	(1.9)	(0.82)	(-0.34)	(0.66)
filing_year = -2	0.06	5.4	29.8	-0.23	0.69	6.7
	(0.001)	(0.004)	(0.02)	(-1.2)	(0.11)	(1.5)
filing_year = 0	-0.05	6.0	-12.8	0.26*	8.1	8.3
	(-0.19)	(1.4)	(-0.88)	(1.8)	(0.80)	(1.3)
filing_year = 1	-0.64**	9.1*	-19.0**	0.19	-20.6*	18.8**
	(-2.6)	(1.7)	(-2.0)	(0.98)	(-1.9)	(2.3)
filing_year = 2	-0.26	8.8**	-27.4***	-0.08	5.9	16.8***
	(-0.88)	(2.0)	(-2.7)	(-0.33)	(0.96)	(3.1)
filing_year = 3	-0.60	12.8**	-15.2	-0.12	-19.1	2.7
	(-1.3)	(2.1)	(-1.2)	(-0.45)	(-1.3)	(0.31)
filing_year = 4	-0.47	15.5**	-17.4	0.36	-16.5	26.6***
	(-1.1)	(2.5)	(-1.5)	(1.6)	(-1.0)	(3.1)
Fixed-effects						
inventor_id	Yes	Yes	Yes	Yes	Yes	Yes
filing_year	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Matched sample	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	19,407	19,407	19,407	13,966	13,966	13,966
R²	0.29548	0.54464	0.57515	0.53396	0.67167	0.55107
Within R²	0.01750	0.03482	0.07738	0.02589	0.05218	0.07025

Clustered (inventor_id) co-variance matrix, t-stats in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

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Conclusion

- I find evidence for both hypotheses:
  - Inventors prefer organizational structures with more authority
  - Interesting nuanse about productivity; although inventors produce fewer patents when they are given the authority, they produce more original patents, measured by patent citation.