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Creative Destruction via Mergers and Acquisitions: Inventor-level Evidence

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Motivation

"Technology is unique in the sense that the pace of innovation is really fast, so rather than viewing M&A as a 'we have excess cash, let's buy something,' larger companies are looking at it as a tool to jump into a new market or ***ramp up a new technology quickly****, …* ***M&A can solve*** *time-to-market issues and* ***talent issues far quicker than internal activities can****."*

- Garrett Herbert, Managing Partner at Deloitte, May 29, 2015

Motivation

"…Red Hat is expected to bring three things to IBM: ***the world's largest portfolio of open source technology****,* ***their innovative hybrid cloud platform****, and* ***a vast open source developer community****." That's according to a spokesperson for IBM, who explained that "… This is a game-changer for the cloud industry."*

- Forbes, November 3, 2018

Research question

How do acquirers benefit from technology-driven M&As?

- We propose three mutually non-exclusive human capital-specific channels:

  1) the acquiring talent channel
     - the performance of retained target inventors
     - the area where retained target inventors are productive
     - the collaboration between retained target and incumbent acquirer inventors

  2) the knowledge spillovers channel
     - the presence and direction of knowledge spillovers
     - the innovation outcome from knowledge spillovers

  3) the risk-taking channel
     - the pursuit of impactful and radical innovation

Our contributions

- Our paper is one of the first in the literature to provide large sample inventor-level evidence on the specific channels – **acquiring talent, knowledge spillovers, and risk-taking** – through which M&As benefit corporate innovation.

- Using patent-level information, our paper sheds light on how the process of **creative destruction – impactful and radical innovation** – takes place after M&As through **recombination of knowledge domains and inventor teams**.

- Our paper helps reconcile prior mixed findings on the role of M&As in corporate innovation (Bena and Li 2014; Seru 2014).

The conceptual framework

- M&As help overcome myopia of learning—the failure to access and utilize more distant knowledge. Levinthal and March 1993
  - Innovation within a firm is often path dependent. Cohen and Levinthal 1990
  - Firms often turn to external sources to help fulfil their knowledge requirements – hiring, strategic alliances, and M&As. Mody 1993; Mowery, Oxley, and Silverman 1996; Rosenkopf and Almeida 2003; Song, Almeida, and Wu 2003
  - The advantage of M&As is that they bring completely new systems, processes, and routines into the acquiring firm, as well as the people with the management and technological skills to implement and incorporate them. Kogut and Zander 1996; Phene, Tallman, and Almeida 2012

❖ As such, M&As help overcome “myopia of learning”.

The conceptual framework

- M&A helps recombine knowledge domains and inventor teams

  – Radical innovation, by definition, is combination of knowledge from domains that might usually not be connected. Fleming 2001; Dahlin and Behrens 2005; Eggers and Kaul 2018

  – Through acquisitions, firms will be able to tap more easily into knowledge domains and people that otherwise would be inaccessible for them.

  ❖ We thus expect that M&As facilitate impactful and radical innovation.

The three channels

- **The acquiring talent channel:** Through M&As, the acquirer gains access to its target firm's inventors.

- We expect that post-merger, retained target inventors produce more patents for their acquirer, especially in the target firm's core area that potentially fills a void in the acquirer's innovative capacities (see the Red Hat quote earlier).

The three channels

- **The knowledge spillovers channel**: Through M&As, the acquirer gains access to its target firm's intellectual properties including its patents, facilitating knowledge transfer as captured by patent citations. Jaffe, Trajtenberg, and Henderson 1993

The three channels

- **The risk-taking channel**: Through M&As, the acquirer can tap into knowledge domains and people that otherwise would be inaccessible.
  - Innovation, especially radical innovation, involves the exploration of new untested approaches that are likely to fail.
  - Manso (2011) and Ederer and Manso (2013) posit that an optimal innovation-motivating incentive scheme should exhibit **an asymmetry in pay-for-performance** – sensitive to positive performance and less sensitive to negative performance.
  - Harford and Li (2007) find that following a merger, an acquirer CEO's pay and overall wealth become insensitive to negative stock performance, but her wealth rises in step with positive stock performance.

❖ A bright side of the decoupling of CEO pay from shareholder value in M&As is that it helps foster a corporate culture that is more tolerant of failure and hence encourages radical innovation.

Data

- Our M&A sample comes from the Thomson Financial's SDC Platinum Database on Mergers and Acquisitions.

- Our patent data comes from the NBER Patent Citations Data File.

- Our inventor data comes from the HBS U.S. Patent Inventor Database.
  - Allows us to examine how acquirers benefit from acquiring target talent.
  - Allows us to identify target inventors behind new innovation post-merger, which is impossible for financial performance of the combined firm.

Our sample

- Our sample consists of 358,016 inventor-year observations.
  - 58,173 incumbent acquirer inventors affiliated with 331 acquirers and
  - 8,558 retained target inventors affiliated with 430 targets,
  - 438 completed deals over the sample period 1981-1998.

Key measures

- *# of patents*
- *# of citations*
- *# of impactful patents*: A patent is impactful if its number of citations is in the top 5th percentile among patents applied for in the same technology class-year.
- *# of radical patents:* A patent is radical if it draws on knowledge that has never or rarely been used before by inventors in the same field.
  Fleming 2001; Dahlin and Behrens 2005; Eggers and Kaul 2018

Key measures

To capture knowledge spillovers, **a firm's knowledge base** refers to its portfolio of granted patents applied for during the prior five-year period and citations made by those patents.

- Spillovers from target to acquirer:

- *# of patents citing target's knowledge*.
- *% of patents citing target's knowledge.*

- Spillovers from acquirer to target:

- *# of patents citing acquirer's knowledge*.
- *% of patents citing target's knowledge.*

Summary statistics

	Target inventors			*Acquirer inventors*			*p-value*	
	Mean	*STD*	*Median*	*Mean*	*STD*	*Median*	*t-test*	*Wilcoxon*
Inventor significant co-inventor stay	0.461	0.499	0.000	0.756	0.430	1.000	0.000	0.000
Star inventor	0.057	0.232	0.000	0.052	0.223	0.000	0.074	0.074
Inventor network	2.024	1.247	2.079	2.411	1.381	2.485	0.000	0.000
Inventor specialization	0.522	0.184	0.563	0.523	0.183	0.577	0.403	0.487
# of patents up to *ayr-1*	4.355	6.570	2.000	4.344	6.528	2.000	0.882	0.644
# of citations up to *ayr-1*	68.000	140.670	25.000	73.532	137.533	30.000	0.005	0.000
Number of observations	8,558			58,173				

- Target inventors are more likely to be star inventors than acquirer inventors are.
- Acquirer inventors have larger inventor networks and receive more citations than target inventors do.

Inventor performance around M&As

Panel A: Acquirer inventors

	# of patents	*# of citations*	*# of patents*	*# of citations*
	(1)	(2)	(3)	(4)
After	0.044***	0.024***	0.037***	0.010**
	(0.002)	(0.004)	(0.002)	(0.004)
Deal fixed effects	Yes	Yes	Yes	Yes
Inventor fixed effects	No	No	Yes	Yes
Number of observations	320,733	245,119	320,733	245,119
Adjusted R-squared	0.05	0.06	0.00	0.00

Panel B: Target inventors

	# of patents	*# of citations*	*# of patents*	*# of citations*
	(1)	(2)	(3)	(4)
After	-0.048***	-0.148***	-0.055***	-0.163***
	(0.006)	(0.012)	(0.007)	(0.014)
Deal fixed effects	Yes	Yes	Yes	Yes
Inventor fixed effects	No	No	Yes	Yes
Number of observations	37,283	28,879	37,283	28,879
Adjusted R-squared	0.06	0.11	0.00	0.01

- Acquirer inventors are more productive after M&As than before M&As.
- Target inventors are less productive after M&As than before M&As.

Using matching inventors

- For each target inventor, matching acquirer inventors are identified using the following criteria:
  1) the acquirer inventor has **the same core technology class** as the target inventor, where an inventor's core class is the technology class in which the inventor has the most number of granted patents applied for up to ayr-1; and
  2) the acquirer inventor has a **similar level of patenting output** up to ayr-1 as the target inventor.

Acquiring target talent

	# of patents	*# of citations*	*# of patents in target core*	*# of citations in target core*	*# of patents in target core*	*# of citations in target core*
	(1)	(2)	(3)	(4)	(5)	(6)
Target inventor	-0.017**	-0.053***	0.034***	0.061***	0.030***	0.052***
	(0.009)	(0.018)	(0.005)	(0.011)	(0.005)	(0.011)
Target inventor × star inventor					0.101**	0.236***
					(0.045)	(0.086)
Star inventor					0.048**	0.034
					(0.024)	(0.042)
Deal fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	20,464	16,958	20,464	16,958	20,464	16,958
Adjusted R-squared	0.08	0.08	0.17	0.17	0.17	0.17

- Post-merger, relative to matching acquirer inventors, target inventors are more productive in target core technology class, especially for star target inventors, consistent with the acquiring talent channel.

Knowledge spillovers from target to acquirer

	# of patents citing target's knowledge	*% of patents citing target's knowledge*	*# of patents citing target's core knowledge*	*% of patents citing target's core knowledge*	*# of patents citing target's knowledge*	*% of patents citing target's knowledge*
	(1)	(2)	(3)	(4)	(5)	(6)
After	-0.000	-0.001***	-0.001**	-0.001***	0.004***	0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
After × inventor network size					-0.002***	-0.001***
					(0.000)	(0.000)
Inventor network size					0.004***	0.002***
					(0.000)	(0.000)
Deal fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	320,733	320,733	320,733	320,733	320,733	320,733
Adjusted R-squared	0.08	0.08	0.04	0.04	0.08	0.08

- There is no evidence of improved knowledge spillovers from target firms to acquirer inventors after M&As.

Knowledge spillovers from acquirer to target

	# of patents citing acquirer's knowledge	*% of patents citing acquirer's knowledge*	*# of patents citing acquirer's knowledge*	*% of patents citing acquirer's knowledge*
	(1)	(2)	(3)	(4)
After	0.024***	0.022***	0.016***	0.015***
	(0.003)	(0.003)	(0.004)	(0.005)
After × inventor network size			0.004*	0.004*
			(0.002)	(0.002)
Inventor network size			0.013***	0.007***
			(0.001)	(0.001)
Deal fixed effects	Yes	Yes	Yes	Yes
Number of observations	37,283	37,283	37,283	37,283
Adjusted R-squared	0.14	0.13	0.14	0.14

- There is evidence of improved knowledge spillovers from acquirers to target inventors after M&As.

Risk-taking by acquirer inventors

	# of impactful patents	*# of radical patents*	*# of impactful patents*	*# of radical patents*
	(1)	(2)	(3)	(4)
After	0.006***	0.006***	0.003	0.002
	(0.001)	(0.001)	(0.002)	(0.002)
After × inventor specialization			0.010**	0.010***
			(0.004)	(0.004)
Inventor specialization			-0.085***	-0.068***
			(0.002)	(0.002)
Deal fixed effects	Yes	Yes	Yes	Yes
Number of observations	37,283	28,879	320,733	320,733
Adjusted R-squared	0.02	0.02	0.07	0.07

- There is evidence of improved risk-taking by acquirer inventors after M&As.

Risk-taking by target inventors

Panel B: Risky innovation by target inventors

	# of impactful patents	*# of radical patents*	*# of impactful patents*	*# of radical patents*
	(1)	(2)	(3)	(4)
After	-0.009***	0.002	-0.016***	-0.026***
	(0.002)	(0.002)	(0.006)	(0.005)
After × inventor specialization			0.015	0.058***
			(0.011)	(0.010)
Inventor specialization			-0.048***	-0.069***
			(0.006)	(0.005)
Deal fixed effects	Yes	Yes	Yes	Yes
Number of observations	37,283	37,283	37,283	37,283
Adjusted R-squared	0.08	0.05	0.08	0.06

Panel C: Risky innovation in target core technology class by target inventors

	# of impactful patents in target's core	*# of radical patents in target's core*	*# of impactful patents in target's core*	*# of radical patents in target's core*
	(1)	(2)	(3)	(4)
After	-0.009***	0.002	-0.002	-0.008***
	(0.002)	(0.002)	(0.003)	(0.002)
After × inventor specialization			-0.007	0.017***
			(0.005)	(0.004)
Inventor specialization			-0.001	-0.014***
			(0.003)	(0.002)
Deal fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	37,283	37,283	37,283	37,283
Number of observations	0.08	0.05	0.12	0.06
Adjusted R-squared	-0.009***	0.002	-0.002	-0.008***

- There is no evidence of improved risk-taking by target inventors after M&As.

Acquiring talent and risk-taking

Panel A: Impactful patents and inventor teams behind

	Observations		*Statistics*			*p-value*	
	#	*%*	*Mean*	*STD*	*Median*	*t-test*	*Wilcoxon*
No target inventor	68,087	93.63	0.088	0.283	0.000		
Only target inventors	4,336	5.96	0.072	0.258	0.000	(0.000)	(0.000)
Both target and acquirer inventors	294	0.40	0.146	0.354	0.000	(0.000)	(0.000)
Total	72,717	100	0.087	0.282	0.000		

Panel B: Radical patents and inventor teams behind

	Observations		*Statistics*			*p-value*	
	#	*%*	*Mean*	*STD*	*Median*	*t-test*	*Wilcoxon*
No target inventor	68,087	93.63	0.063	0.243	0.000		
Only target inventors	4,336	5.96	0.063	0.243	0.000	(0.991)	(0.991)
Both target and acquirer inventors	294	0.40	0.139	0.347	0.000	(0.000)	(0.000)
Total	72,717	100	0.063	0.243	0.000		

- Mixed teams are associated with more risk-taking after M&As.

Acquiring talent and risk-taking

	Impactful patent	*Radical patent*
	(1)	(2)
Only target inventors	-0.027***	-0.006
	(0.006)	(0.005)
Both target and acquirer inventors	0.036*	0.060***
	(0.021)	(0.020)
Deal fixed effects	Yes	Yes
Number of observations	72,717	72,717
Adjusted R-squared	0.02	0.02

- Mixed teams are associated with more risk-taking after M&As.

Knowledge spillovers and risk-taking

Panel A: Impactful patents involving acquirer inventors

	Observations		*Statistics*			*p-value*	
	#	*%*	*Mean*	*STD*	*Median*	*t-test*	*Wilcoxon*
Not citing target's knowledge	66,710	97.56	0.087	0.282	0.000		
Citing only target's knowledge	420	0.61	0.093	0.291	0.000	(0.687)	(0.687)
Citing both firms' knowledge	1,251	1.83	0.129	0.336	0.000	(0.000)	(0.000)
Total	68,381	100	0.088	0.283	0.000		

Panel B: Radical patents involving acquirer inventors

	Observations		*Statistics*			*p-value*	
	#	*%*	*Mean*	*STD*	*Median*	*t-test*	*Wilcoxon*
Not citing target's knowledge	66,710	97.56	0.062	0.241	0.000		
Citing only target's knowledge	420	0.61	0.098	0.297	0.000	(0.003)	(0.003)
Citing both firms' knowledge	1,251	1.83	0.124	0.330	0.000	(0.000)	(0.000)
Total	68,381	100	0.063	0.243	0.000		

- Two-way knowledge spillovers are associated with more risk-taking by acquirer inventors after M&As.

Knowledge spillovers and risk-taking

	Impactful patent	*Radical patent*
	(1)	(2)
Citing only target's knowledge	-0.007	0.037***
	(0.012)	(0.013)
Citing both firms' knowledge	0.021**	0.044***
	(0.010)	(0.010)
Deal fixed effects	Yes	Yes
Number of observations	68,381	68,381
Adjusted R-squared	0.02	0.02

- Knowledge spillovers are associated with more risk-taking by acquirer inventors after M&As.

Knowledge spillovers and risk-taking

Panel D: Impactful patents involving target inventors

	Observations		*Statistics*			*p-value*	
	#	*%*	*Mean*	*STD*	*Median*	*t-test*	*Wilcoxon*
Not citing acquirer's knowledge	2,148	46.39	0.059	0.236	0.000		
Citing only acquirer's knowledge	1,445	31.21	0.096	0.295	0.000	(0.000)	(0.000)
Citing both firms' knowledge	1,037	22.40	0.086	0.280	0.000	(0.005)	(0.005)
Total	4,630	100	0.077	0.266	0.000		

Panel E: Radical patents involving target inventors

	Observations		*Statistics*			*p-value*	
	#	*%*	*Mean*	*STD*	*Median*	*t-test*	*Wilcoxon*
Not citing acquirer's knowledge	2,148	46.39	0.056	0.230	0.000		
Citing only acquirer's knowledge	1,445	31.21	0.075	0.263	0.000	(0.023)	(0.023)
Citing both firms' knowledge	1,037	22.40	0.083	0.276	0.000	(0.004)	(0.004)
Total	4,630	100	0.068	0.251	0.000		

- Knowledge spillovers are associated with more risk-taking by target inventors after M&As.

Knowledge spillovers and risk-taking

	Impactful patent	*Radical patent*
	(1)	(2)
Citing only acquirer's knowledge	0.012	0.028***
	(0.009)	(0.009)
Citing both firms' knowledge	0.004	0.016
	(0.011)	(0.011)
Deal fixed effects	Yes	Yes
Number of observations	4,630	4,630
Adjusted R-squared	0.06	0.03

- Knowledge spillovers from acquirers are associated with more risk-taking by target inventors after M&As.

Conclusions

- Using a large and unique inventor-level data set over the period 1981 to 2006, we examine post-merger inventor performance to shed light on how acquirers benefit from technology-driven mergers and acquisitions.

- Our findings suggest that **acquiring talent, knowledge spillovers, and risk-taking** are the key channels through which mergers and acquisitions benefit corporate innovation.

Constructing an inventor's career

- Use NBER and HBS databases to match each individual inventor to a unique assignee (i.e., the owner of the patents filed by the inventor) for the years when the inventor filed at least one patent.

- Augment the inventor-assignee-year sample by filling all the between-years when the inventor in that year is not linked to an assignee.

Constructing an inventor's career

- An acquirer (target) inventor is identified as the one whose active career spans *ayr – 1* and whose employer at that particular point in time (i.e., *ayr – 1*) is the acquirer (target firm).

- We then construct an unbalanced panel data set consisting of acquirer (target) inventors from *ayr – 5* to *ayr - 1* and from *cyr + 1* to *cyr + 5*.

- For each acquirer (target) inventor, the time series information about her starts from the earlier of *ayr – 5* or the first year in which her employer is the acquirer (target) and ends at the earlier of *cyr + 5* or the last year in which her employer is the acquirer (target) or the merged firm.

Radical innovation

# of radical patents

- A patent is radical if it draws on knowledge that has never or rarely been used before by inventors in the same field. Fleming 2001; Dahlin and Behrens 2005; Eggers and Kaul 2018

- The measure looks at the class-to-class citation pattern of patents to determine how rare a given citation is.
  - If patents in Class A frequently cite patents in Class B, then a new A-to-B citation would be common and expected (i.e., not rare, radical, or exploratory).
  - If, however, hardly anyone in Class A had cited a Class B patent in the last five years, then such a citation would signal an attempt at a more radical recombination.
  - At the patent-level, the measure looks at all citations the patent makes and takes the value of the MOST unlikely citation.

Target inventor relative performance

$$Inventor\ output_{i,m,t} = \alpha + \beta_1 Target\ inventor_i + Deal\ FE_m + Year\ FE_t + e_{i,m,t}$$

- The dependent variable is any of the five inventor-level patenting output measures as defined earlier.
- *Target inventor* is an indicator variable that takes the value of one for the target inventor, and zero for her matching acquirer inventors.

Knowledge spillovers over time

$$Acquirer\ patents\ citing\ target\ knowledge_{i,m,t} = \alpha + \beta_1 After + Deal\ FE_m + e_{i,m,t},$$

- The dependent variable is any of the two inventor-level knowledge spillovers measures as defined earlier.
- *After* is an indicator variable that takes the value of one for the period from *cyr+1* to *cyr+5*, and zero for the period from *ayr-5* to *ayr-1*.