Share patents, and they shall be given you:
An empirical study on consequences of patent commons

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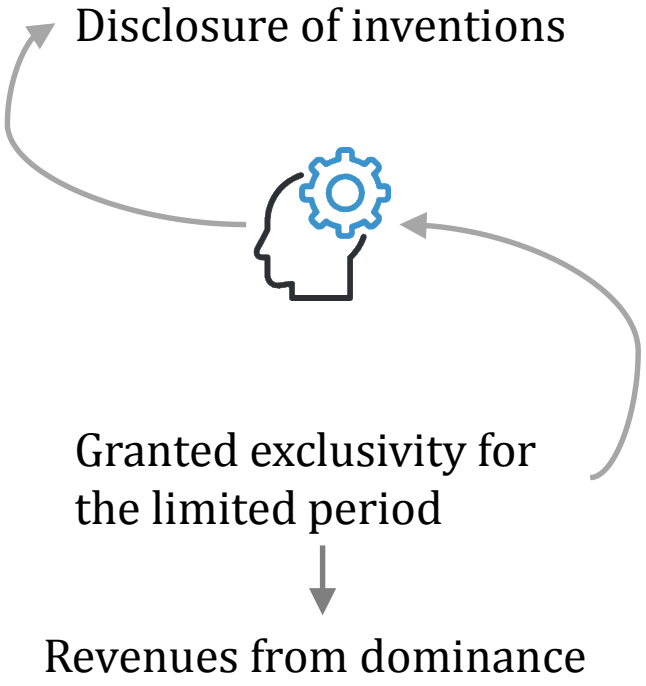
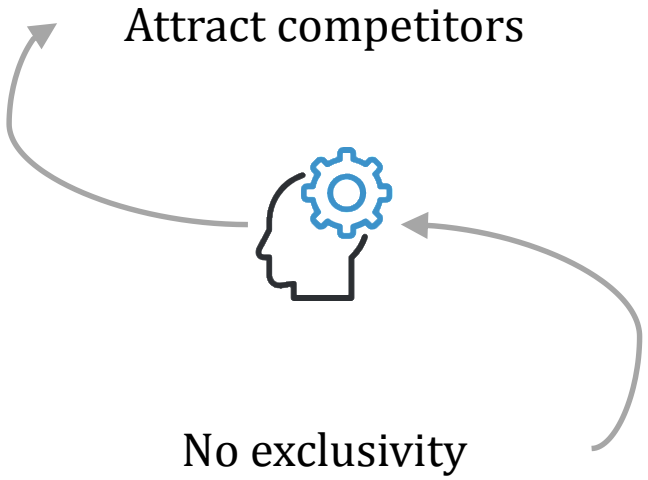
Patent commons: A contradicting behavior?

Nature of patents



Patent commons (Patent sharing with indefinite firms)



(Graphic source) FLATICON www.flaticon.com

Several recent cases of patent commons

Patent Commons Project

Eco-Patent Commons

Google Open Patent Non-Assertion Pledge

Year	Patent holder	Technology	# patents	Type
2005	IBM and others	Open source software	529	NA
2008	IBM and others	Energy/clean tech.	100	NA
2013	Google	Energy/clean tech.	150	NA
2014	Tesla	Electric vehicle	All	NA
2015	Toyota Motors	Fuel-cell vehicle and its infrastructure	5680	RF
2015	Panasonic	Internet of things	50	RF
2015	Daikin	Refrigerant for air conditioners	100	RF

NAP: Non-assertion patent declaration
RF: Royalty free license offering (= need to sign a contract)

(Source) Segawa (2016), modified by Authors

Major motivations of patent commons

	Expecting financial return	Non-financial return
Peripheral technology	**Cost cutting:** Patent donation to non-profit organizations Benefit: Reduce patent maintenance costs and get tax reductions	**Innovation catalyzing:** Patent donation to non-profit organizations Benefit: Strengthen research network, speed up innovation
Core technology	**Profit making:** Open source strategy or setting industry strategy Benefit: Improve product or network effect	**Technology providing:** Free-license to certain geographical regions or for certain application Benefit: Serve society, or earn reputation

Patent commons as a strategic tool?

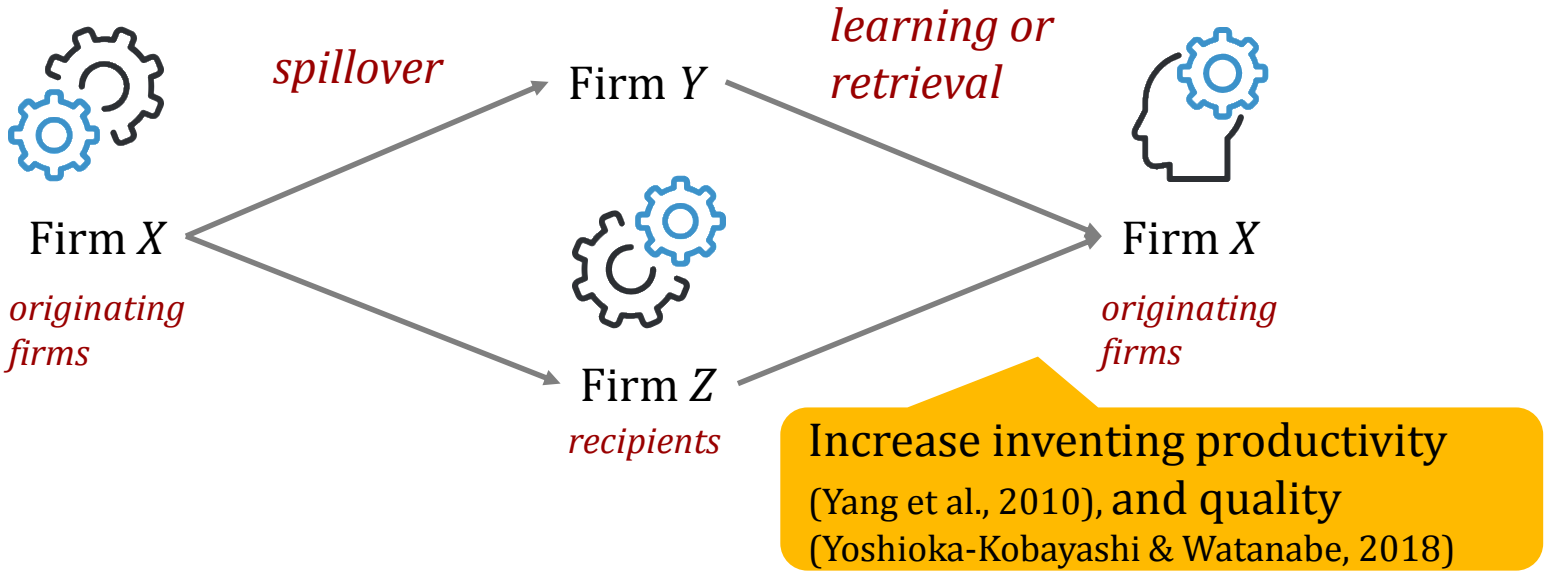
(Source) Ziegler, Gassmann, & Friesike (2014)

Potential consequences of patent commons - 1: Hard to gain financial returns even in licensing strategy

- Negative evidences in outbound technology (=licensing and selling of patents)
  - Michelino, Caputo, Cammarano, & Lamberti (2014)
    - Examined a panel data of 126 global pharmaceutical firms
    - Licensing-out/selling-out of patents lead **negative financial performance**
  - Mazzola, Bruccoleri, & Perrone (2012)
    - Examined a panel data of 105 NASDAQ listed manufacturing equipment firms
    - # of licensing-out and selling-out **decrease financial performance** and **increase # of new product introductions**
- Difficulty of outbound open innovation (Helfat & Quinn, 2006)
- Biased by market losers? or bring non-financial returns?

Potential consequences of patent commons - 2: Knowledge retrievals

- Originating firms of knowledge spillovers learn from recipients (Yang et al., 2010; Yoneyama, 2013; Alnuaimi & George, 2016; Yoshioka-Kobayashi & Watanabe, 2018)



- These firms show high market value (Belenzon, 2012)

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Theoretical background: Why knowledge retrievals are important?

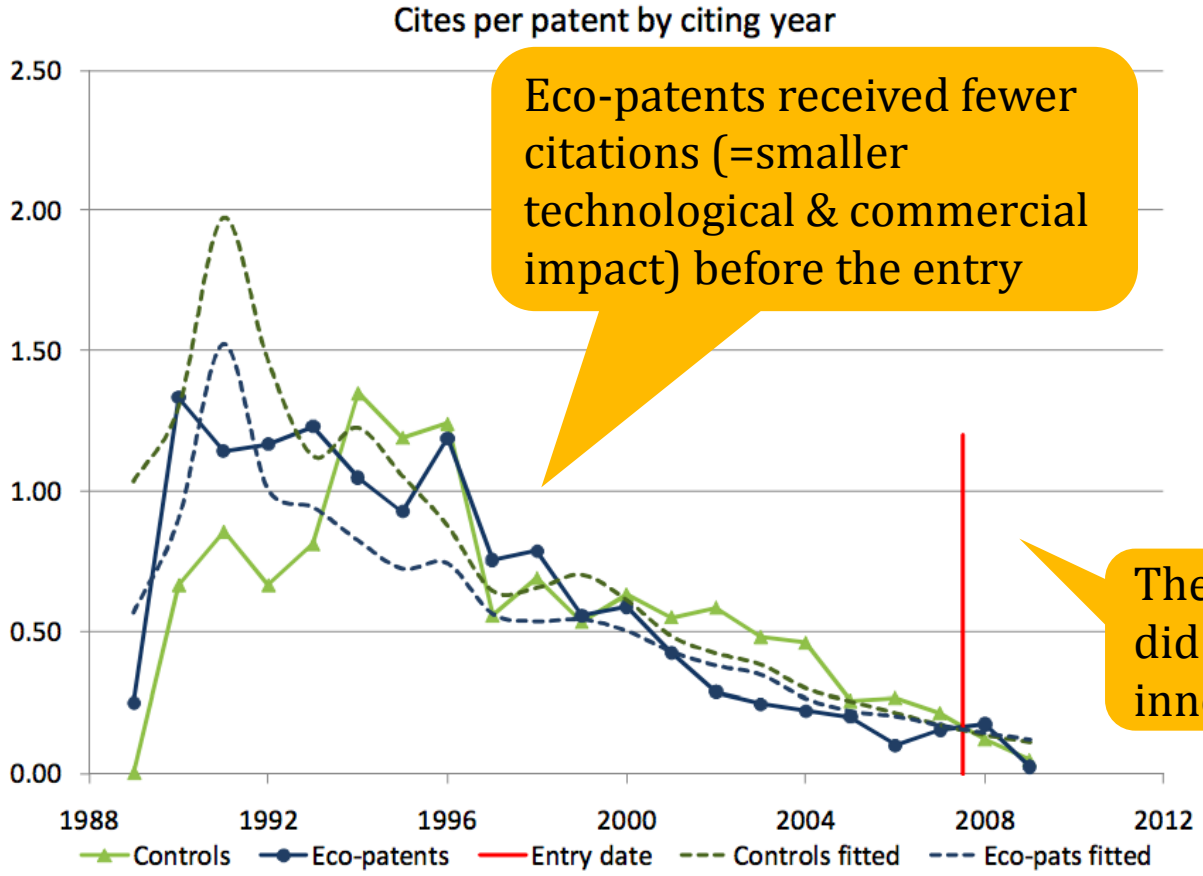
- Firms face difficulty in learning knowledge in unfamiliar technology fields
- Some firms are superior in new technological knowledge absorption = Absorptive capacity (Cohen & Levinthal, 1990)
  - Knowledge base determines the capacity

- Thus... M&As are not always succeeded
  - Technology absorption by M&As are more likely to succeed when acquires have sufficient knowledge base (Desyllus & Hughes, 2010)

(Graphic source) FLATICON www.flaticon.com

In reality:
Less-valuable patents provided

- Patents in Eco Patent Commons are less valuable than similar ones (Hall & Helmers, 2013)



Eco-patents received fewer citations (=smaller technological & commercial impact) before the entry

Controls - 1:
Patents by Eco-Patent entrants

Controls -2:
Patents share same IPCs with Eco-Patents, filed by firm

They concluded Eco-Patents did not contribute to innovation

What we do not know…

- Do patent commons have the positive impact?

Yes

- Change technological trajectory (attract other R&D oriented firms)
- Increase technological productivity of entrants (knowledge retrieval)

Patent commons motivate further technology development

No

- Only free-riders follow (only attract non-R&D-intensive firms)
- Few knowledge return

Patent commons send a negative signal that focal inventions are less valuable

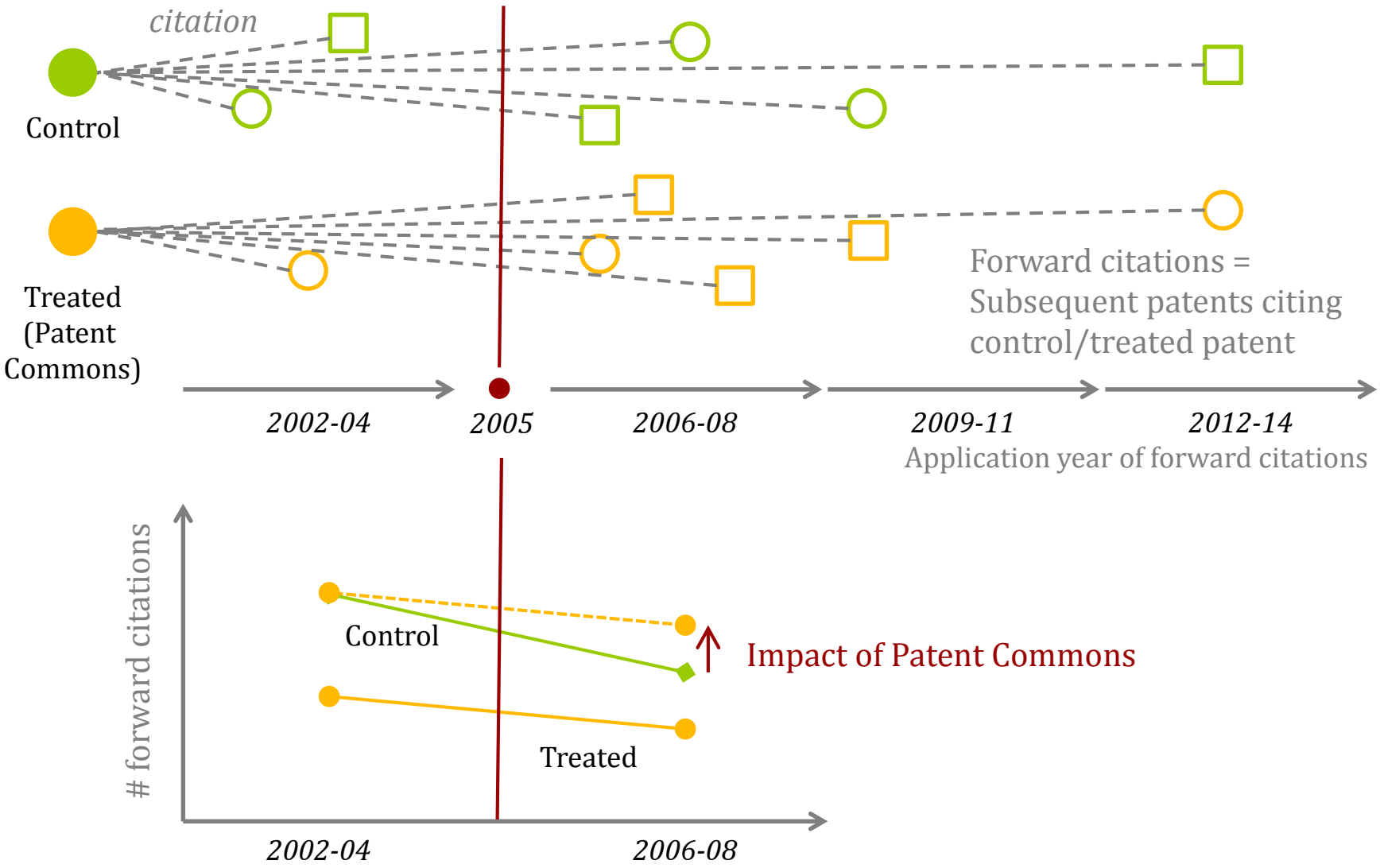
Observations

- Treated: 498 U.S. granted patents from IBM later committed to Patent Commons (established in 2005)
  - Filed between 1988 and 2002 in USPTO
  - 50 lack exact matched control groups: 448 are used in matching analysis
- Control groups: granted patents from IBM
  - with exact same application year and combination of IPC subclasses
  - the nearest in # claims
  - randomly selected 8 patterns of control groups
  - By limiting to patents from IBM, we exclude an influence from IBM's technological reputation

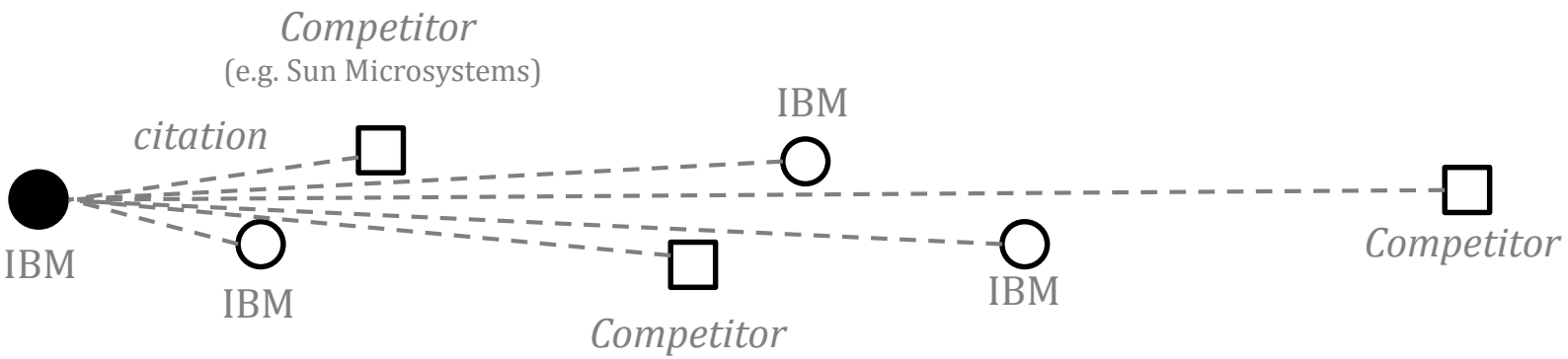
Measurements of the value of patents

- Forward citations: a proxy of the value of patents and knowledge flow
  - Patents disclose referred (related) patented inventions
    - A proxy of knowledge flow (Jaffe et al., 2000; Duguet & MacGarvie, 2005)
    - But a bit noisy (see, Jaffe & de Rassenfosse, 2017)
  - Valuable inventions attract competitors
    - Competitors develop subsequent inventions and cite focal inventions
    - At least, forward citations indicate the technological impact (Albert et al., 1991; Benson & Magee, 2015)
    - ....and often correlate with commercial value (U.S. patents: Lanjouw & Schankerman, 1999; Bessen, 2008. European patents: Harhoff et al., 1999; Harhoff et al., 2003)

Identification strategy: Difference-in-difference analysis



Terms: Self forward citation and external forward citation

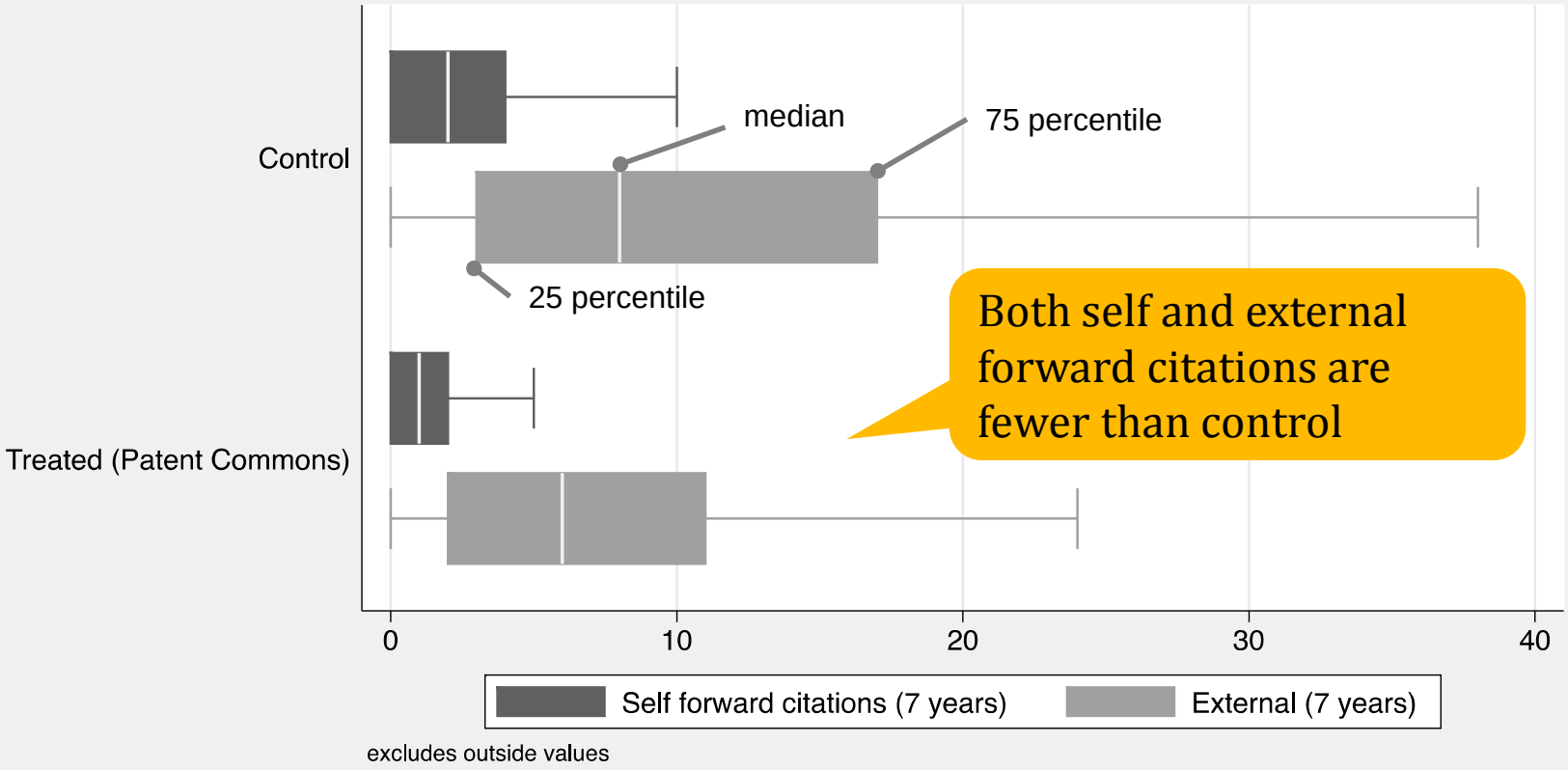


○ Self forward citations: Subsequent patents filed by IBM

□ External forward citations: Subsequent patents filed by other than IBM

Descriptive statistics (Average forward citations): Commons patents are less valuable

- Commons patents received fewer forward citations
  - IBM offered less valuable patents to Commons



Descriptive statistics (Average forward citations by periods)

Before commons

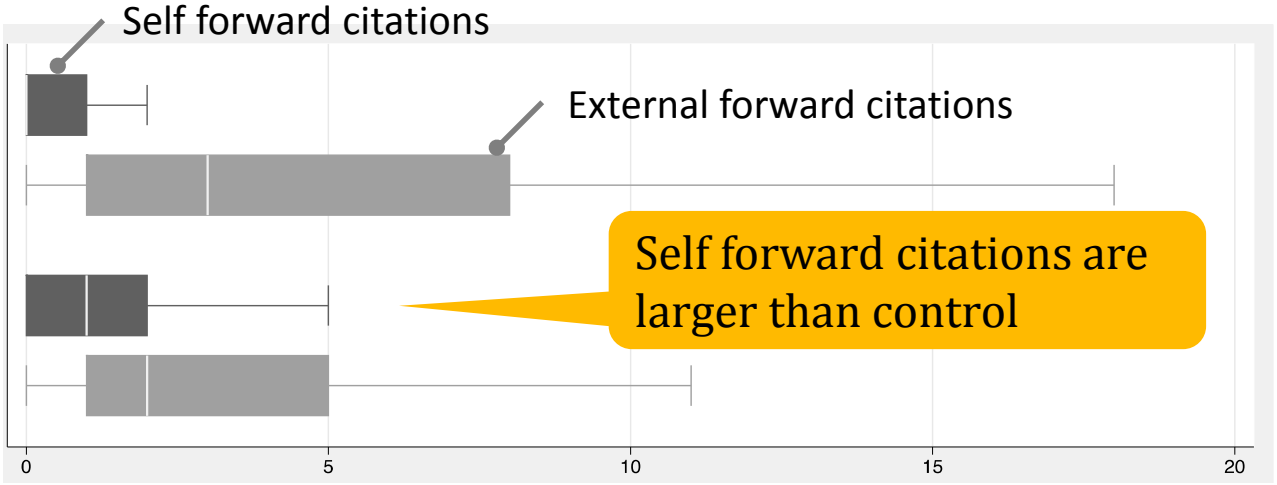
After commons

Descriptive statistics (Average forward citations by periods)

Forward citation between '09-'11

Control

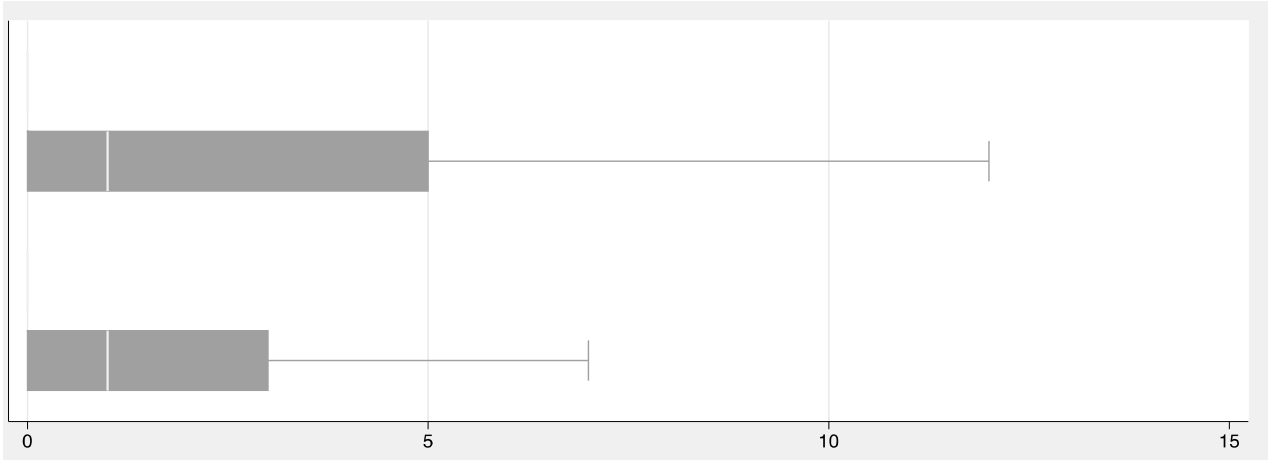
Treated (Patent Commons)



Forward citation between '12-'14

Control

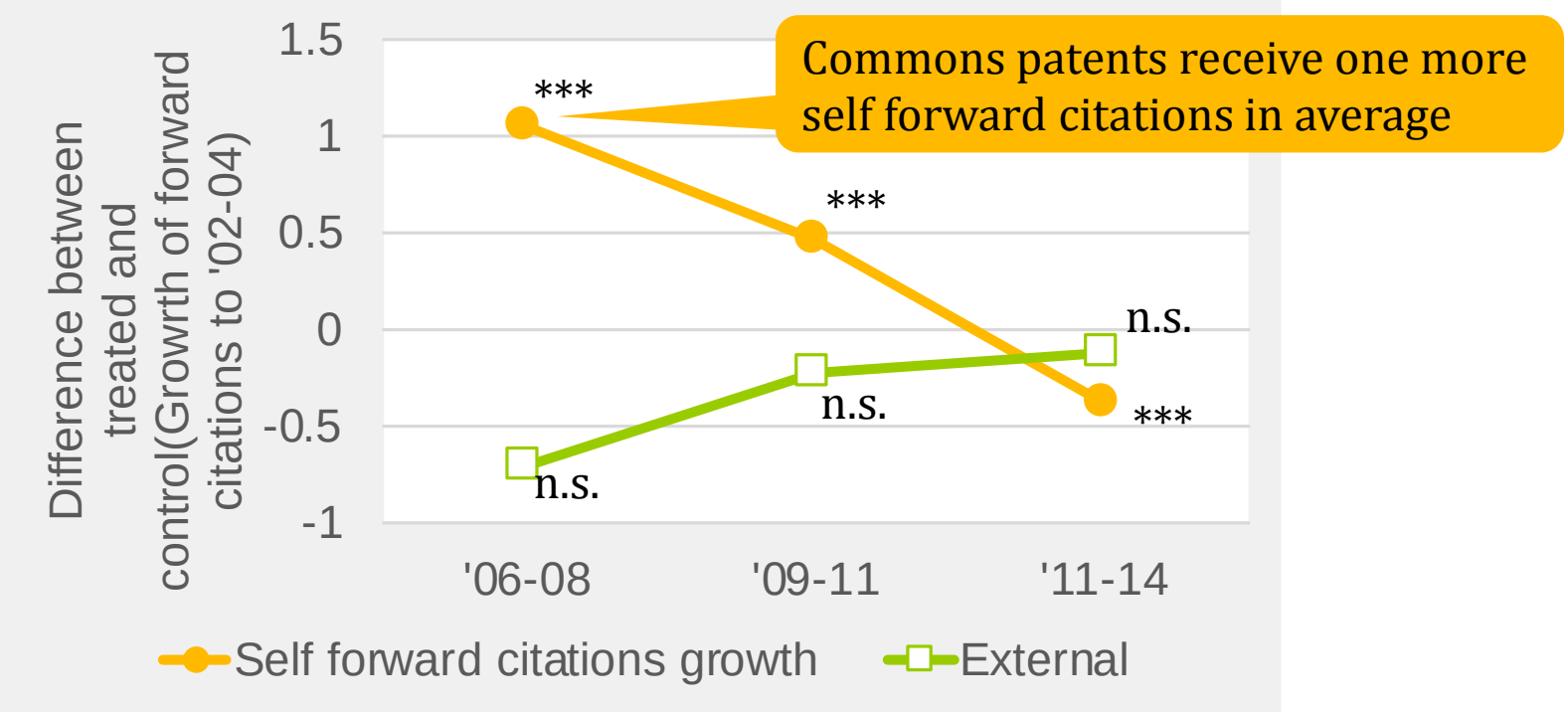
Treated (Patent Commons)



*90% of control and treated patents have no additional self-citations

Econometric analysis results: Patent Commons increases self forward citations

- Estimated impact of being in Commons
  - Cluster robust OLS regression results in a randomized control group:



*** significant at 0.1% level in the worst case, n.s. not significant
(n=878 - 884 : depend on randomize groups)

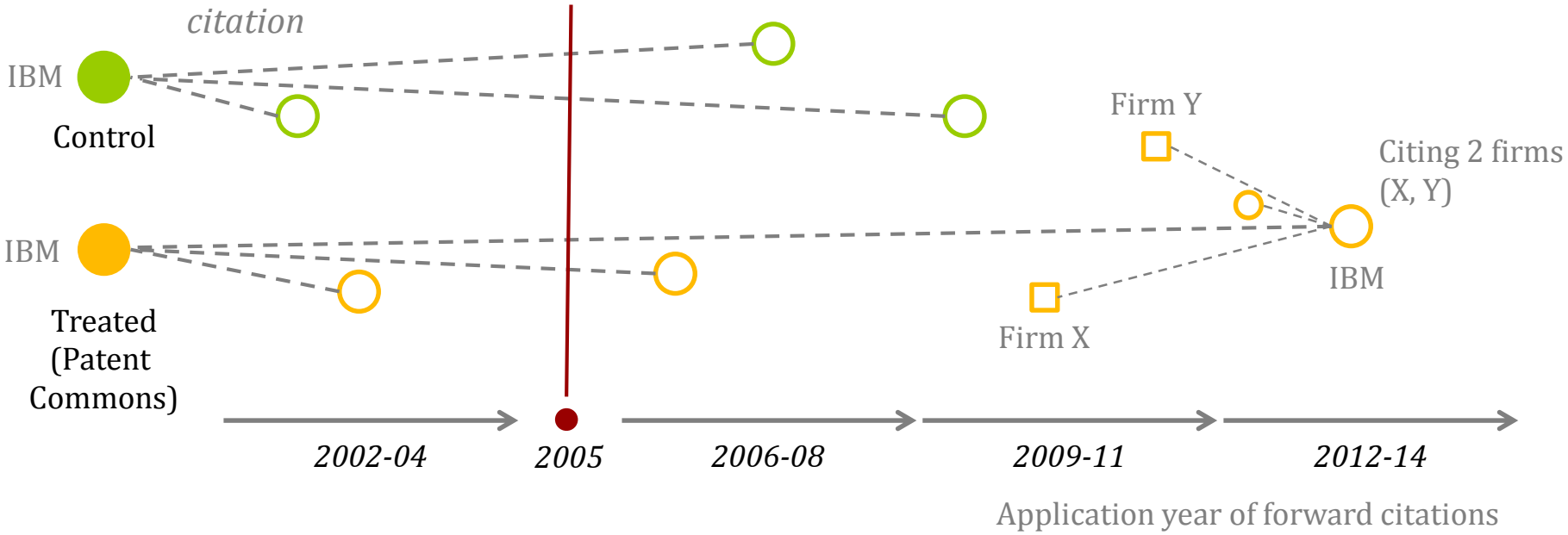
Consequence of patent commons:

- Patent commons revive unfocused technologies and stimulate further development within the entrant firm
  - Probably, patent commons stimulate organizational learning from external followers: Knowledge retrievals (Alnuaimi & George, 2016), or "learning-by-disclosure" (Yoneyama, 2013)

- No significant external impact
  - Not statistically significant, but commons potentially reduce external forward citations just after the entry

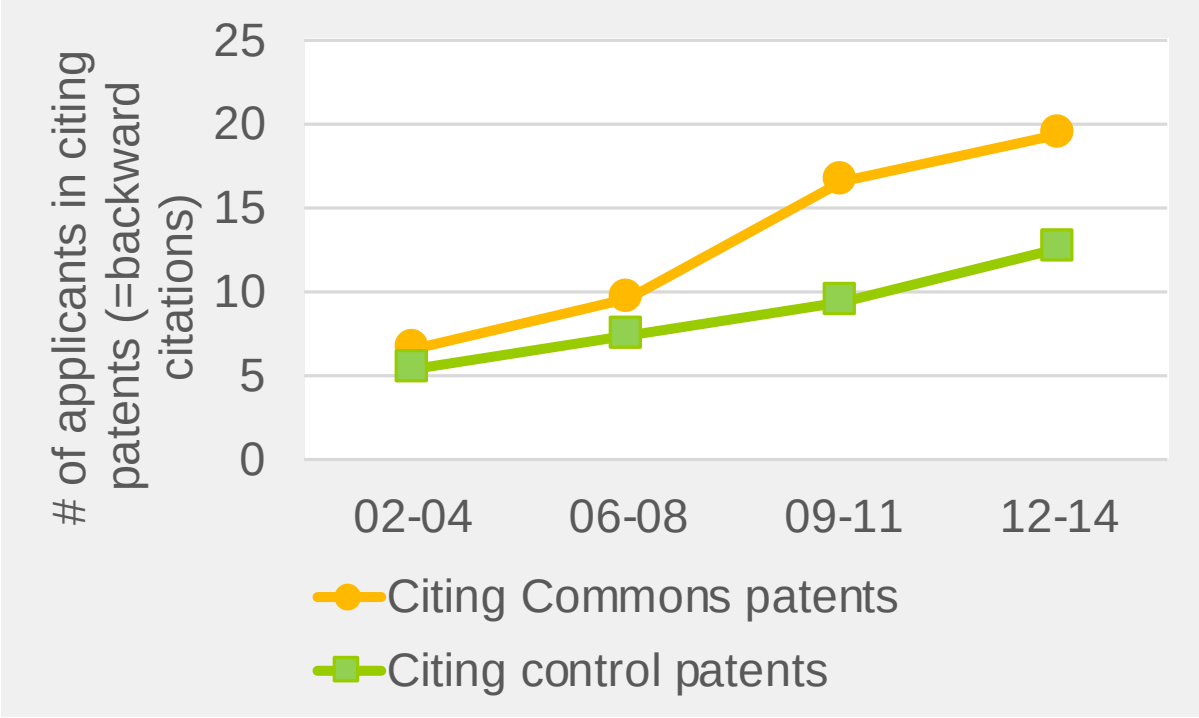
What happened?

- Stimulate knowledge retrieval?
  - Identification strategy:
    Does self forward citations of commons refer more diversified knowledge sources than those of control groups?



What happened?

- IBM's subsequent patents of Commons are more likely to refer various firms' knowledge



Why? - Several interpretations

- Software engineer communities were more likely to give feedback or share technological knowledge with IBM after Patent Commons

- IBM engineers were motivated to develop improved inventions to maintain competitiveness and, thus, become explorative

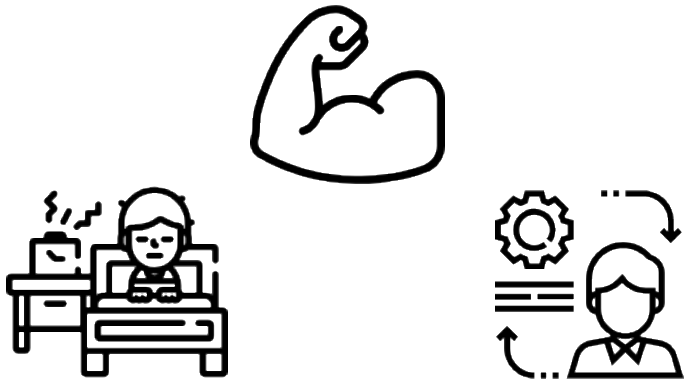
(Graphic source) FLATICON www.flaticon.com

Consequence of Patent Commons

- A measure to learn from competitors and to stimulate internal development
- Even unfocused inventions can attract subsequent inventions
- There is a direct return from Commons
  - Probably, Commons are also beneficial to a technology community (future research)

Managerial implications - 1 (Static view)

- Strategic disclosure to improve internal technology development by stimulating knowledge retrieval
- Contribute to;
  - utilize underused technological assets,
  - develop technology absorptive capacity, and
  - learn from competitors.



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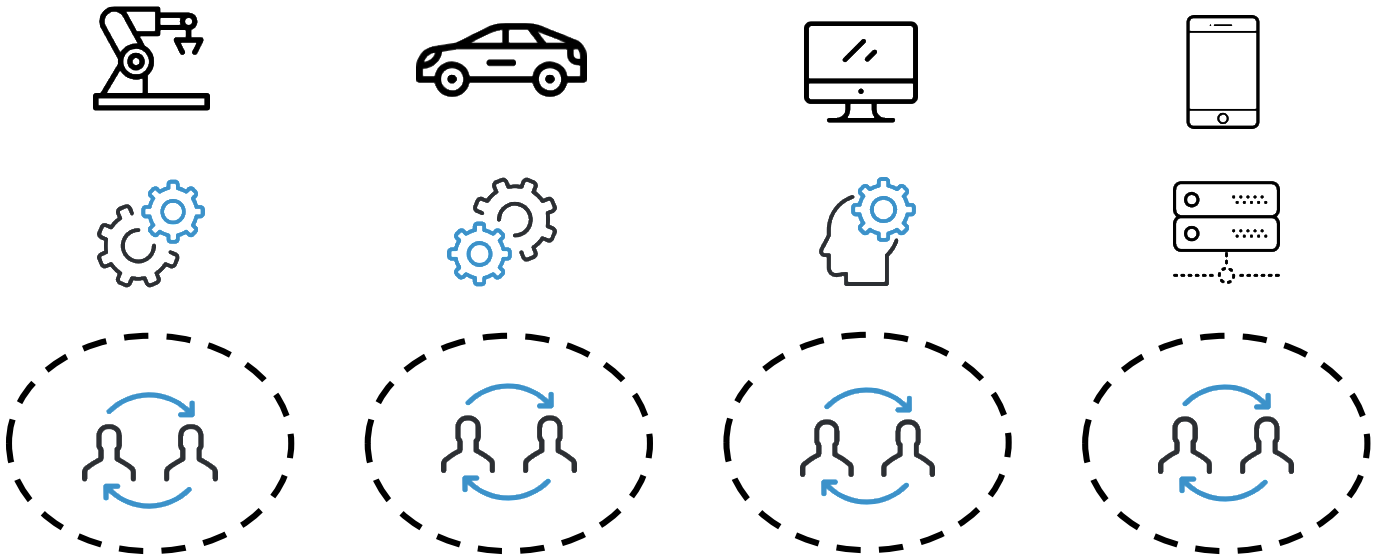
Managerial implications - 2 (Dynamic view)

- In the "Connected" society, firms need to learn more various technological knowledge
  - Acquitions are not always good solutions: Fail to absorp knowledge
- Co-opetions (=coordination & competition: Tsai, 2002) become more important?



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APPENDIX

Other major (& old) cases of patent commons

Year	Patent holder	Technology	# patents	Type
1970	Dolby	Noise-reduction technology	N/A	NAP
1999	DuPont	N/A	N/A (valued at 64M USD)	D
2000	Procter & Gamble	Aspirin drug	196	D
2005	Sun Microsystems	Operating software	1670	NAP
2008	GlaxoSmithKline	Tropical diseases drug	800	RF

NAP: Non-assertion patent declaration
D: Donation to non-profit organization
RF: Royalty free license offering (= need to sign a contract)

(Source) Ziegler, Gassmann, & Friesike (2014)

Main analysis & Robustness check

- Estimated difference in foward citations (Table 1)
  - Difference-in-difference analysis
- Estimated using 8 randomized control groups (Table 2)
- Estimated # forward citations by periods (Table 3)

- Dataset are obtained from:
  - Patents View (USPTO)

Table 1. Estimation of forward citation growth (OLS: Randomized control group 1)

	Self forward citation growth to 02-04			External forward citation growth to 02-04		
VARIABLES	06-08	09-11	12-14	06-08	09-11	12-14
Commons dummy	1.045***	0.464***	-0.381***	-0.702*	-0.221	-0.123
	(0.179)	(0.0929)	(0.0946)	(0.358)	(0.317)	(0.298)
2005 – application year	-0.0201	-0.0104	-0.0132	-0.00564	-0.00303	-0.0569
	(0.0265)	(0.0173)	(0.0135)	(0.0841)	(0.0706)	(0.0632)
# self forward citation (02-04)	-0.327**	-0.788***	-0.860***	0.142	0.302*	0.291**
	(0.147)	(0.0331)	(0.0448)	(0.180)	(0.156)	(0.146)
# external forward citation (02-04)	0.0812***	0.0235***	-0.00411	-0.338***	-0.552***	-0.615***
	(0.0210)	(0.00744)	(0.00556)	(0.0720)	(0.0606)	(0.0589)
Year gap between filing and grant	-0.0117	0.0405	-0.0131	-0.361***	-0.136	-0.0436
	(0.0614)	(0.0731)	(0.0433)	(0.124)	(0.118)	(0.0927)
# inventors	-0.0309	0.0316	-0.00678	0.101	-0.106	-0.0668
	(0.0528)	(0.0264)	(0.0169)	(0.122)	(0.110)	(0.102)
# claims	0.0103	-0.00152	0.000529	0.0198	0.0201	0.0248
	(0.0102)	(0.00455)	(0.00330)	(0.0220)	(0.0225)	(0.0186)
# IPCs	0.0185	-0.0278	0.131	0.823	0.529	0.243
	(0.137)	(0.127)	(0.112)	(0.525)	(0.393)	(0.323)
# backward citations	-0.00577	-0.00424	-0.00498**	-0.0171	0.0116	0.0113
	(0.00572)	(0.00295)	(0.00248)	(0.0145)	(0.0188)	(0.0193)
Constant	0.0838	0.140	0.476**	0.932	0.481	0.882
	(0.472)	(0.271)	(0.222)	(1.017)	(0.961)	(0.972)
Observations	884	884	884	884	884	884
R-squared	0.114	0.516	0.579	0.178	0.399	0.475

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 2. Estimation of forward citation growth (OLS: Comparison between randomized groups)

		Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
Self	06-08	1.045***	1.023***	0.928***	1.046***	1.114***	1.053***	0.993***	1.032***
		(0.179)	(0.181)	(0.199)	(0.174)	(0.178)	(0.180)	(0.194)	(0.187)
	09-11	0.464***	0.359***	0.422***	0.422***	0.397***	0.433***	0.344***	0.360***
		(0.093)	(0.104)	(0.104)	(0.090)	(0.105)	(0.091)	(0.107)	(0.101)
	12-14	-0.381***	-0.457***	-0.404***	-0.401***	-0.414***	-0.381***	-0.349***	-0.447***
		(0.095)	(0.089)	(0.075)	(0.063)	(0.079)	(0.072)	(0.072)	(0.094)
External	06-08	-0.702*	-0.829**	-0.919**	-1.112***	-1.132***	-0.512	-0.49	-0.663*
		(0.358)	(0.337)	(0.370)	(0.376)	(0.371)	(0.342)	(0.325)	(0.370)
	09-11	-0.221	-0.143	-0.423	-0.505	-0.384	-0.0667	0.0616	-0.335
		(0.317)	(0.316)	(0.386)	(0.405)	(0.326)	(0.320)	(0.286)	(0.394)
	12-14	-0.123	-0.206	-0.54	-1.102**	-0.682*	-0.139	-0.105	-0.551
		(0.298)	(0.309)	(0.428)	(0.474)	(0.353)	(0.301)	(0.294)	(0.431)
		884	879	883	882	879	878	881	882

Table 3. Estimation of forward citations (Negative binomial GML: in Randomized control group 1)

	# self forward citations			# external forward citations		
VARIABLES	06-08	09-11	12-14	06-08	09-11	12-14
Commons dummy	0.726***	0.692***	-1.402***	-0.0670	0.0925	0.121
	(0.121)	(0.147)	(0.230)	(0.0820)	(0.0949)	(0.0993)
2005 – application year	-0.0467**	-0.0273	-0.0257	-0.00815	-0.0165	-0.0324
	(0.0203)	(0.0248)	(0.0385)	(0.0156)	(0.0189)	(0.0198)
# self forward	0.255***	0.221***	0.255***	0.0957***	0.134***	0.109***
citation (02-04)	(0.0347)	(0.0482)	(0.0815)	(0.0302)	(0.0325)	(0.0309)
# external forward	0.0435***	0.0299***	0.0137	0.0862***	0.0838***	0.0797***
citation (02-04)	(0.00672)	(0.00795)	(0.0128)	(0.00686)	(0.00794)	(0.00764)
Year gap between filing	0.0253	0.0826	0.0543	-0.0680**	-0.0251	-0.0268
and grant	(0.0454)	(0.0751)	(0.0738)	(0.0285)	(0.0323)	(0.0360)
# inventors	-0.0173	0.0324	-0.0354	0.0149	-0.0151	0.00365
	(0.0340)	(0.0348)	(0.0506)	(0.0227)	(0.0262)	(0.0304)
# claims	0.00688	-0.00374	0.0102	0.00360	0.000708	0.00933*
	(0.00525)	(0.00636)	(0.00903)	(0.00412)	(0.00452)	(0.00546)
# IPCs	0.119	-0.0432	0.600**	0.130	0.164	0.0684
	(0.0996)	(0.178)	(0.259)	(0.0950)	(0.103)	(0.112)
# backward citations	-0.00889	-0.0112	-0.0294*	-0.00233	0.00123	0.000355
	(0.00593)	(0.00797)	(0.0152)	(0.00299)	(0.00466)	(0.00613)
Constant	-0.474	-1.093**	1.554***	-0.0512	0.239***	0.413
	(0.344)	(0.152)	(0.575)	(0.0708)	(0.291)	(0.0760)
Observations	884	884	884	884	884	884
Pseudo R2	0.0787	0.0493	0.0700	0.0832	0.0702	0.0593
Log Lik	-1317	-940.8	-510.4	-2102	-1886	-1823

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Additional analysis

- Used 10,087 self forward citations of treatments and controls (filed from 1992 to 2018)
  - In this selection, we included examiner forward citations
- Calculated the number of applicants appeared in their backward citations
  - In this calculation, we excluded examiner backward citations
  - We only used patents filed by organization (excluded individuals)
- Poisson model regress results are shown at Table 4

Table 4. Estimation of # applicants in backward citations of forward citations of treatments and controls (Poisson GML)

	# applicants in backward citations (by application year of forward citation patents)			
	'02-04	'06-08	'09-11	'12-14
Forward citations of Commons (dummy)	1.283***	1.396***	1.796***	1.553***
	(0.0347)	(0.0304)	(0.0280)	(0.0227)
Application year	1.069***	1.259***	0.995	0.968***
	(0.0173)	(0.0165)	(0.00940)	(0.00809)
# Claims	1.007***	1.014***	1.018***	1.020***
	(0.000870)	(0.000711)	(0.000534)	(0.000719)
Observations	1,461	1,541	1,915	1,713
Pseudo R2	0.0124	0.0335	0.0597	0.0397
Log Likelihood	-6421	-10018	-18204	-18867

Incident rate ratio in parentheses *** p<0.01, ** p<0.05, * p<0.1