Heterogeneity in Knowledge Flows of Regions: Impact on Invention Quality

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Outline

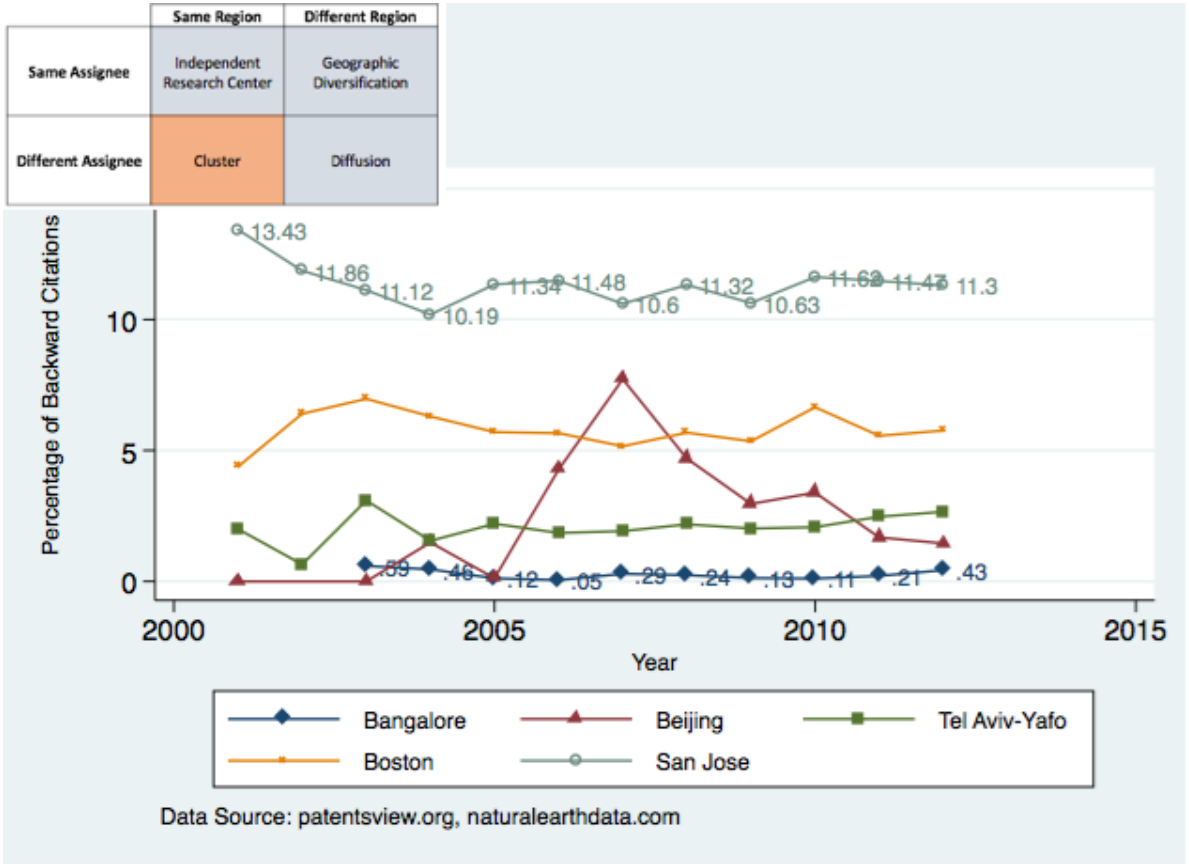
Knowledge flows as outcome of search?

Region and firm boundaries

	Same Region	**Different Region**
Same Assignee	Independent Research Center	Geographic Diversification
Different Assignee	Cluster	Diffusion

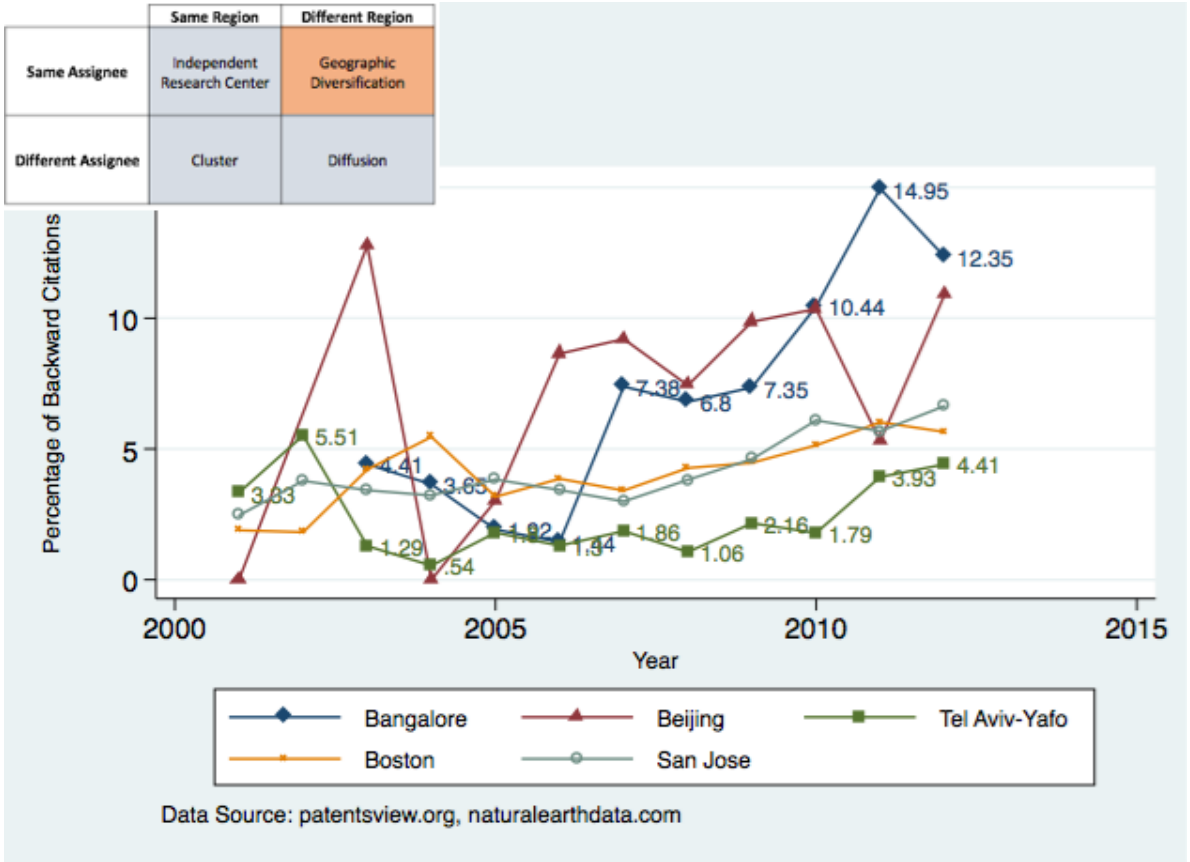
Categories of knowledge flows

Heterogeneity in knowledge flows of clusters



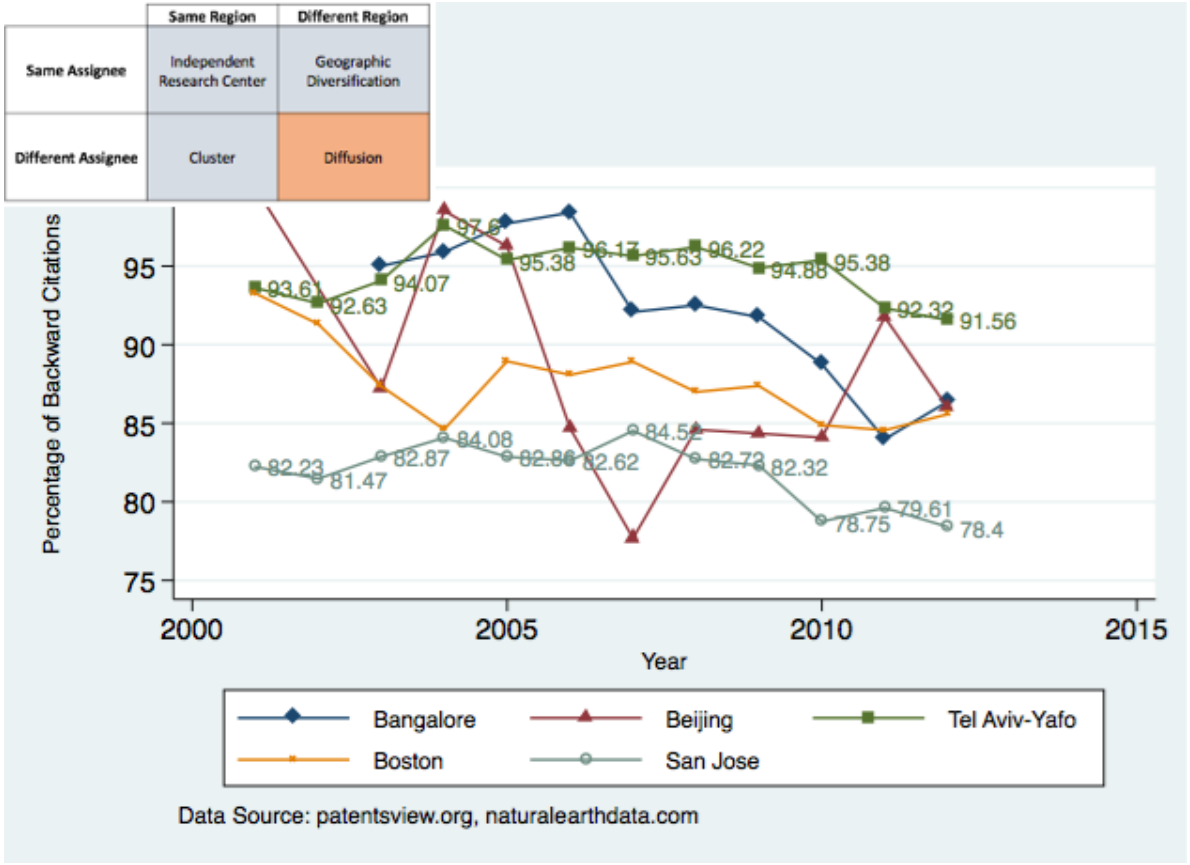
Clusters

Heterogeneity in knowledge flows in geographic diversification



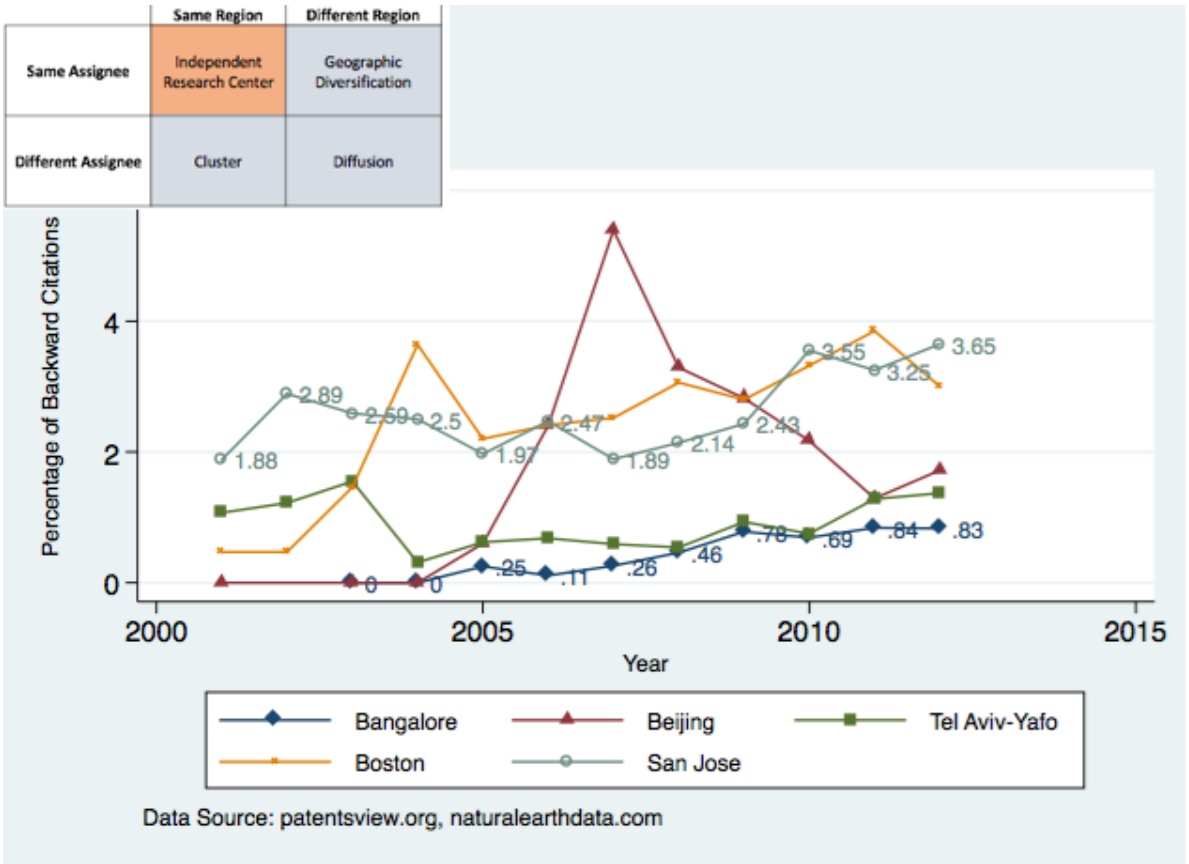
Geographic Diversification

Heterogeneity in knowledge flows under diffusion



Diffusion

Heterogeneity in knowledge flows of independent research centers



Independent Research Centers

Prior art on knowledge flows

Patent citation analysis

Economic Geography Literature

- Knowledge spillovers are localized (Jaffe, Trajtenberg, & Henderson, 1993)
- Innovation is more spatially concentrated than is production (Feldman, 1994)

International Business Literature

- Firms profit from offshoring R&D by leveraging better organizational linkages (Zhao, 2006)
- Subsidiary - MNC parent flows are as strong as MNC parent - Subsidiary knowledge flows (Singh, 2007)

Research Question

How do the **nature** *of knowledge flows in a region affect the* **quality** *of inventions generated in the region?*

Underlying effects across region and firm boundaries

	Same Region	Different Region
Same Assignee	(+) Specialization (-) Lack of Related Variety	(+) Agglomeration Benefits (+) Complementary Assets
Different Assignee	(+/-) Marshallian Externalities (+/-) Jacobs Externalities (-) Incremental Innovation (Schumpeter 1942)	(+/-) Social proximity (+/-) Complexity of search

Underlying effects affecting of knowledge flows

Summary of Preliminary Findings

- Localized knowledge flows do not seem to improve invention quality
- Geographical diversification is seen to improve invention quality
- Results differ between applicant only citations data and applicant and examiner citations dataset echoing concerns raised by Alcácer & Gittelman (2006)
- Much additional research required to distill any stylized facts on the impact of geography and firm boundaries on invention quality

On the Nature of Knowledge Spillovers

- Rent Spillovers vs. Pure Spillovers (Griliches, 1979)
- Knowledge as a private good and a public good (Arrow, 1962)
- Knowledge flows are invisible (Krugman, 1991)
- Knowledge flows sometimes leave a paper trail in the form of patent citations (Jaffe et al., 1993)

On the Localization of Knowledge Spillovers

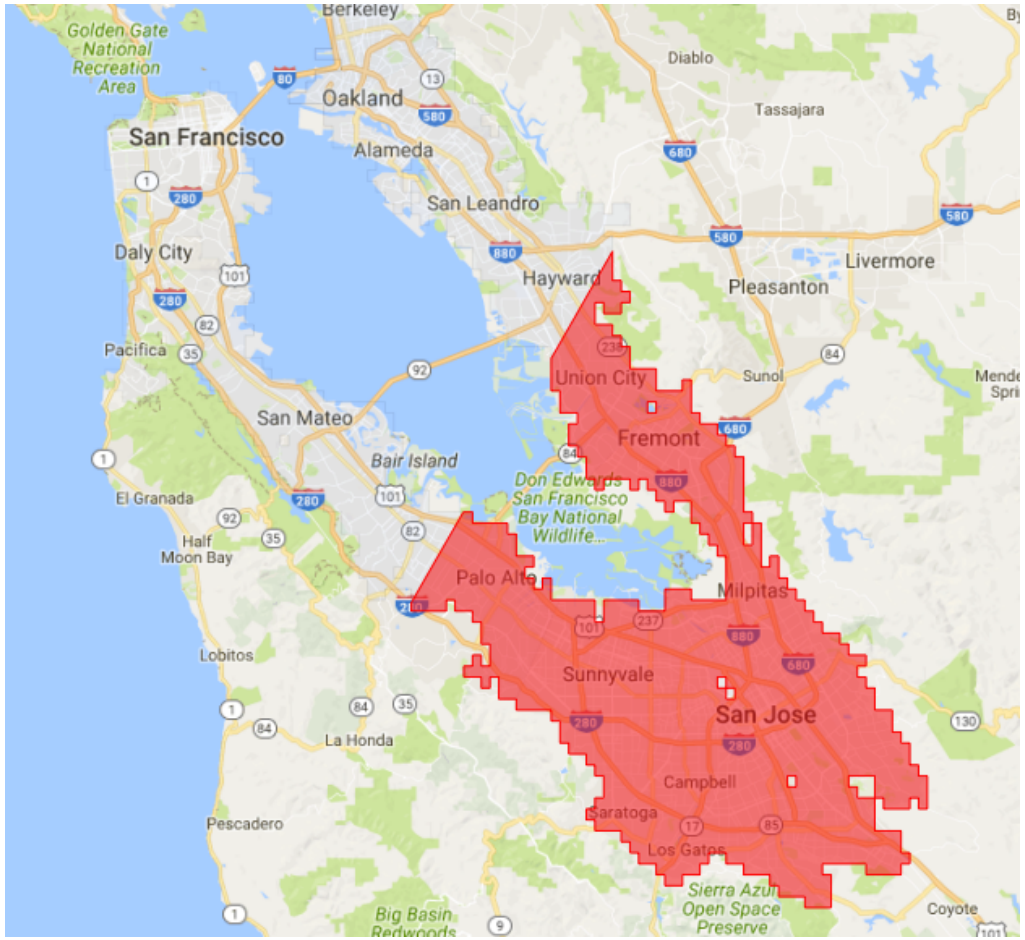
- Proximity is beneficial due to lower costs of collaboration, opportunities for serendipitous encounters
- Tacit knowledge is not easily transferred across long distances
- Institutions and Regional innovation systems contribute to localization of knowledge flows
- Related variety (Boschma & Iammarino, 2009; Frenken, Oort, & Verburg, 2007; Jacobs, 1969) in urban clusters promotes generation of new ideas

On Knowledge Flows across Countries

- Political borders may constrain flows of knowledge (Singh & Marx, 2013)
- Inventor mobility improves innovation outcomes (Alnuaimi et al., 2012)
- MNC subsidiary location choices influenced by regional innovation systems (Andersen & Christensen, 2005), organizational linkages (Zhao, 2006), and higher independence and ownership (Pearce, 1999)

Geographic Mapping

San Jose



Geographic Definition of San Jose, CA

Summary Statistics

Applicant only citations

Variable	Mean	Std. Dev.	N
Citations Received	1630.527	8200.133	9358
Non-Self Citations Received	917.342	4958.117	9358
Self Citations Received	248.898	1312.542	9358
Share Citations Made[Same Region, Same Assignee]	0.013	0.034	9358
Share Citations Made[Same Region, Different Assignee]	0.013	0.039	9358
Share Citations Made[Different Region, Same Assignee]	0.038	0.076	9358
Share Citations Made[Different Region, Different Assignee]	0.509	0.2	9358
Share Citations Made[Other]	0.428	0.202	9358
Share Citations Made[Same Region]	0.026	0.054	9358
Share Citations Made[Same Assignee]	0.051	0.087	9358
Log (Total Citations Made)	4.92	2.411	9358
Log (Num Patents)	3.719	1.954	9358
Log (Patent Pool Size)	6.496	2.048	9358

Methodology

- Data Source: Patents from USPTO, source: patentsview.org
- Data Source: Regions using Remote Sensing Data, source: naturalearthdata.com
- Unit of Analysis: Region-Year
- Dependent Variables: Total Citations Received, Non-Self Citations Received
- Independent Variables: Share of citations made within/outside region, within/outside assignee
- Control Variables: Technology subcategories (Hall, Jaffe, & Trajtenberg, 2001), Region fixed effects, Year effects
- Estimation Method: Negative Binomial

Results

Applicant only citations

	(1) Total Citations Received	(2) Total Citations Received	(3) Total Citations Received	(4) Non-Self Citations Received	(5) Non-Self Citations Received	(6) Non-Self Citations Received
Share Citations Made[Same Region, Same Assignee]	-0.125	-0.156	-0.0437	-0.0698	-0.0575	-0.113
	(0.372)	(0.468)	(0.809)	(0.613)	(0.782)	(0.560)
Share Citations Made[Same Region, Different Assignee]	-0.0501	-0.250	0.0494	0.214	0.0341	0.267
	(0.677)	(0.305)	(0.704)	(0.052)	(0.889)	(0.035)
Share Citations Made[Different Region, Same Assignee]	0.260	0.316	0.326	0.215	0.209	0.247
	(0.002)	(0.015)	(0.003)	(0.013)	(0.105)	(0.040)
Share Citations Made[Different Region, Different Assignee]	0.00251	0.0382	0.0123	0.0426	0.0336	0.0615
	(0.933)	(0.383)	(0.760)	(0.160)	(0.447)	(0.143)
Log (Total Citations Made)	0.0194	0.0126	0.0220	0.0131	0.00662	0.0152
	(0.000)	(0.031)	(0.000)	(0.002)	(0.258)	(0.012)
Log (Num Patents)	0.788	0.860	0.830	0.799	0.826	0.849
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log (Patent Pool Size)	-0.124	-0.303	-0.110	-0.0871	-0.157	-0.108
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-0.911	0.510	-1.368	-1.296	-0.557	-1.677
	(0.000)	(0.002)	(0.000)	(0.000)	(0.002)	(0.000)
Observations	9358	3974	5384	9037	3868	5169
Groups	1359	539	820	1255	503	752
Sample	All Locations	U.S. Locations	Non-U.S. Locations	All Locations	U.S. Locations	Non-U.S. Locations

p-values in parentheses

All models include region fixed effects, year dummies and technology subcategory controls

Addressing Potential Issues

Applicant and Examiner Citations

	(1) Total Citations Received	(2) Total Citations Received	(3) Total Citations Received	(4) Non-Self Citations Received	(5) Non-Self Citations Received	(6) Non-Self Citations Received
Share Citations Made[Same Region, Same Assignee]	0.818	0.463	1.258	1.403	1.294	1.641
	(0.000)	(0.126)	(0.000)	(0.000)	(0.000)	(0.000)
Share Citations Made[Same Region, Different Assignee]	-0.846	-1.158	-0.444	0.0468	-0.433	0.227
	(0.004)	(0.006)	(0.268)	(0.885)	(0.374)	(0.606)
Share Citations Made[Different Region, Same Assignee]	0.652	0.365	0.843	1.139	0.792	1.192
	(0.000)	(0.055)	(0.000)	(0.000)	(0.001)	(0.000)
Share Citations Made[Different Region, Different Assignee]	0.0517	0.230	0.109	0.994	1.354	0.920
	(0.195)	(0.000)	(0.037)	(0.000)	(0.000)	(0.000)
Log (Total Citations Made)	0.0656	0.0290	0.0858	-0.0349	-0.0813	0.0387
	(0.000)	(0.031)	(0.000)	(0.000)	(0.000)	(0.005)
Log (Num Patents)	0.730	0.820	0.755	0.845	0.919	0.805
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log (Patent Pool Size)	-0.0982	-0.273	-0.102	-0.0571	-0.145	-0.0743
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-0.185	1.003	-0.547	-1.000	-0.390	-1.312
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	18102	6850	11252	17730	6749	10981
Groups	2006	631	1375	1896	610	1286
Sample	All Locations	U.S. Locations	Non-U.S. Locations	All Locations	U.S. Locations	Non-U.S. Locations

p-values in parentheses

All models include region fixed effects, year dummies and technology subcategory controls

Limitations

- The use of patent citations as a measure of knowledge flows may be subject to error (Arora et al., 2017)
- Any systematic biases in our definition of regions (Urban Centers from Natural Earth Data) can create biases in measures of knowledge flows

Future Work

- Examine the effects of search on technology domain (Rosenkopf & Nerkar, 2001)
- Investigate the effect on alternate outcomes, e.g., breakthrough inventions
- Identify the mechanisms underlying the impact of knowledge flows on invention quality

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