The Paper Trail of Knowledge Spillovers: Evidence from Patent Interferences

Ina Ganguli
UMass Amherst

Jeffrey Lin
FRB Philadelphia

Nicholas Reynolds
Brown University

June 2019

Why do inventors cluster? Carlino and Kerr, 2015

Benefits from localized knowledge spillovers? Marshall, 1890

Agglomeration $\rightarrow$ interactions, spread of (tacit) knowledge.

Two identification challenges Krugman 91, Duranton & Puga 04

"No *paper trail* by which they may be measured or tracked."

Other agglomeration sources are "*observationally equivalent*."

New evidence of localized knowledge spillovers

U.S. patent interference decisions

"Multiple inventions" — *simultaneous, independent, identical*.

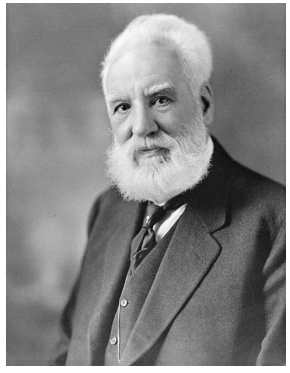
Common invention suggests common knowledge inputs

If knowledge spillovers are localized,

then local inventors likely share input knowledge & interfere.

If not, interference as likely between distant, local inventors.

Common invention suggests common knowledge inputs



Alexander Graham Bell

Elisha Gray

"In the air, products of the intellectual climate of a specific time and place"

"They arrived at electric speech by more or less the same pathway. They were trying to find a way to send more than one message at a time along a telegraph wire—which was then one of the central technological problems of the day. They had read the same essential sources—particularly the work of Phillipp Reis, the German physicist who had come startlingly close to building a working telephone back in the early eighteen-sixties." Gladwell, 2008

Contributions to work on "paper trail" of citations

We measure identical *output*

JTF 00, JTH 93

"One-half of all citations do not correspond to any spillover."

"An enormous number of spillovers [occur] with no citation."

Interference requires many shared (tacit) knowledge inputs.

It doesn't matter from whom input knowledge originates

Citation $\stackrel{?}{=}$ knowledge "spilled over" from cited to citer.

Interfering inventors share knowledge inputs, some localized.

What we find

Interfering inventor pairs are geographically concentrated

Interfering inventor pairs are *1.4–4*×s more likely to be located in the same locality vs. *matched control pairs*. JTH 93

Robust to matching on *3- or 6-digit tech class*, *other observables*, *distance-based tests,* and controlling for *ties*.

Even more clustered vs. *citation-linked* inventors!

Localized knowledge spillovers, especially of tacit knowledge

Empirical strategy

Empirical strategy

Compare proximity of interfering inventor pairs

Two *independent* inventors making *identical* claims in *simultaneous* patent applications.

Versus control inventor pairs

One interfering application and one control issued patent.

Idea — Control for all factors exc. common knowledge inputs.

Methodology

Regression — Does co-location predict interference? JTH 93

Non-parametric — Is *dist'n* of int. distances localized? MNOT 14

When are localized knowledge spillovers not identified?

Control pairs may imperfectly capture unobservable factors

JTH geomatch test sensitive to tech class. Thompson & Fox-Kean 05

"Distance-based" tests — Bias ↑ from *imperfect matching* dwarfed by bias ↓ from *border & scale* problems. Murata et al. 14

Similar inventions may benefit from shared *non*-knowledge inputs

E.g., labor pooling of *very* specialized skills.

Still identified if "transport cost" of ideas $>$ other factors.

Data and methodology

Patent interferences

Background

First to invent vs. first to file. until 3/16/2013

Not infringement — Suggested by *examiner* when ≥ 2 simultaneous applications contained identical claims.

Independent corroboration heard by Board of Interferences.

Cases *decided on priority* or terminated for some other reason.

Our data

1,329 *decisions* issued 1998–2014 with information about *case, parties, applications, claims, inventors*.

1/4 of interf. inventor locations from decisions, eFile, PAIR.

Interference practice rules out some confounders

Common ownership not allowed.

"No interference in fact."

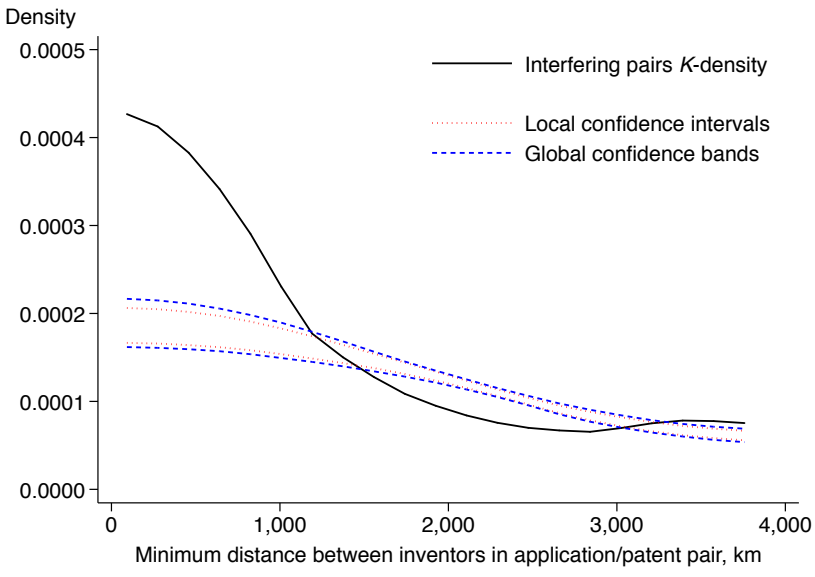
Otherwise, high overlap at claim level.

Intentional delay or stealing rule out priority.

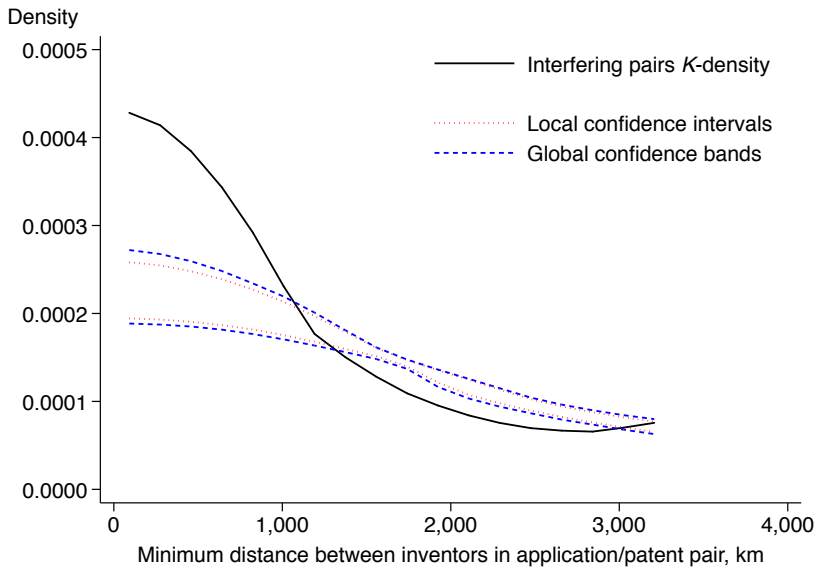
Disposition	*Full sample*		*eFile*
Number of cases	1,329		977
Decision on priority	260	19.6%	19.7%
Conceded, total	781	58.8	58.1
. . . settled	.	.	32.8
. . . abandoned	92	6.9	5.5
. . . all other reasons	.	.	19.8
No interference in fact	46	3.5	3.4
Common ownership	64	4.8	4.7
Unpatentable	122	9.2	9.6
Other	56	4.2	4.5

Results

Interfering pairs are localized compared with control pairs



3-digit control pairs



6-digit control pairs

Local CI: 90% of K-densities fall inside this interval at each distance.
Global CI: 90% of K-densities fall inside this interval across all distances.
Decisions on priority and concessions.

Interfering pairs are co-located compared with control pairs

Share of inventor pairs with same place, town or city of residence		
Interfering pairs	3-digit control pairs	6-digit control pairs
2.7%	0.8% (0.4, 1.4)	2.0% (1.3, 2.9)
Share of inventor pairs with places of residence within 100mi		
Interfering pairs	3-digit control pairs	6-digit control pairs
13.8%	5.2% (4.0, 6.4)	2.0% (6.7,9.7)

Interfering inventor pairs are **1.4–4.0**×s more likely to match city or location compared with control pairs.

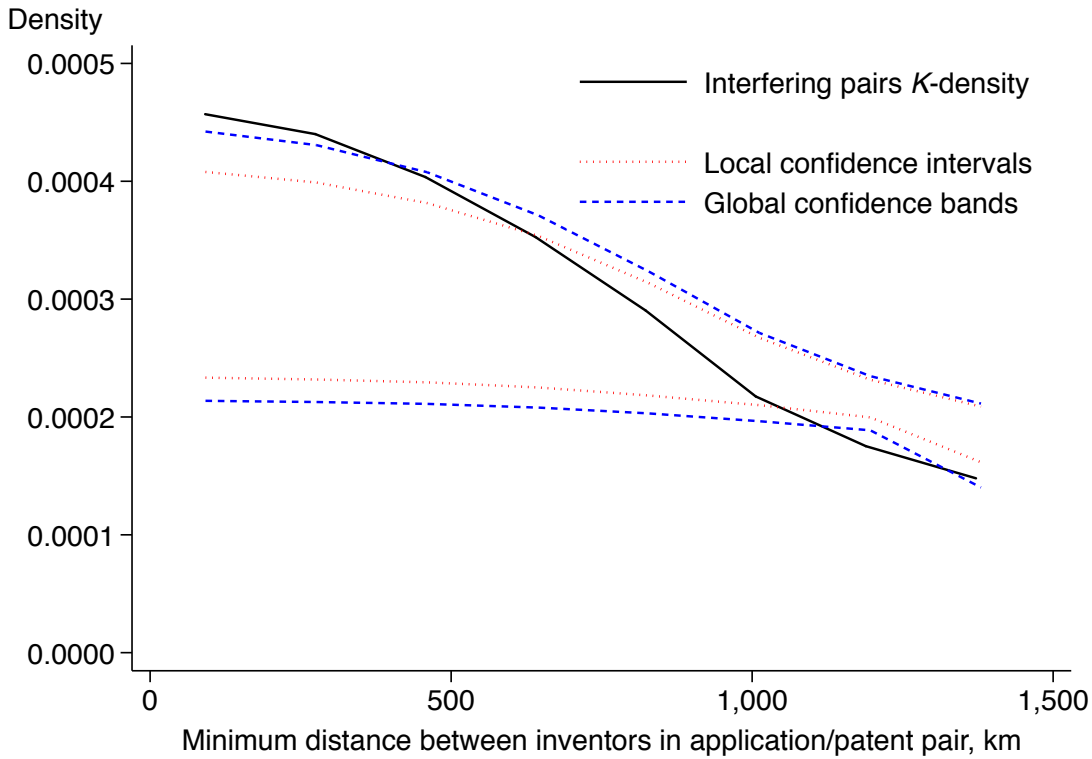
JTH: Cited-citing pairs are 2.4–7.3×s more likely to match metro area compared with control pairs (Table III).

Robustness to bibliographic controls

DV: $1(Interference) \times 100$	μ [σ]	(1)	(2)
1(Co-located within 161km)	0.057	0.043^{c}	0.030^{c}
	[0.232]	(0.007)	(0.007)
No. shared classes	0.812		-0.012^{c}
	[0.662]		(0.003)
No. shared subclasses	0.130		0.166^{c}
	[0.502]		(0.015)
No. shared citations	0.011		0.099^{a}
	[0.631]		(0.057)
Pairs	5,712,342	5,712,342	5,712,342
Pair-groups		831	831

Sample: Interfering pairs and matched 3-digit control pairs. Decisions on priority and concessions. DV mean is 0.04 percent.

Robust to selecting matched controls on citation links



Citations are a *lower bound* on localized knowledge spillovers.

Conclusions

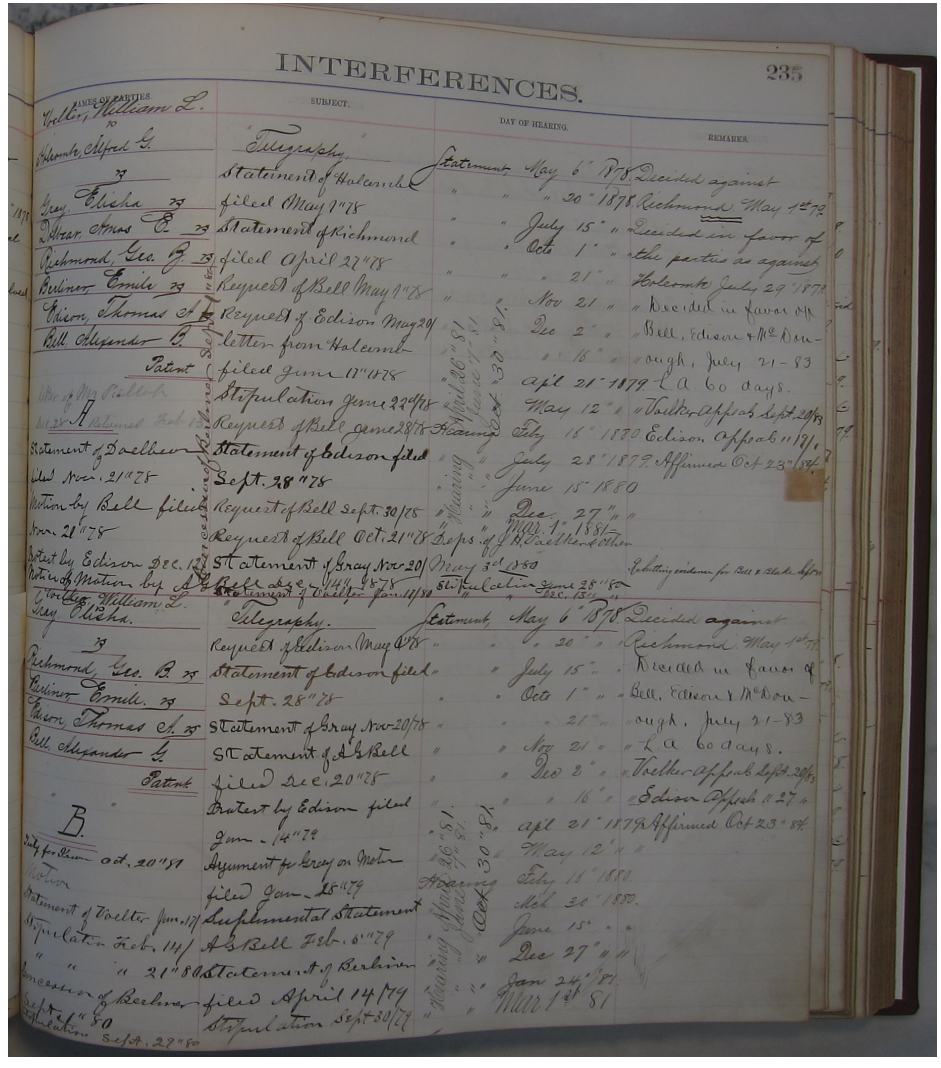
Evidence of localized knowledge spillovers from interferences.

Distance matters, especially for sharing *tacit* knowledge.

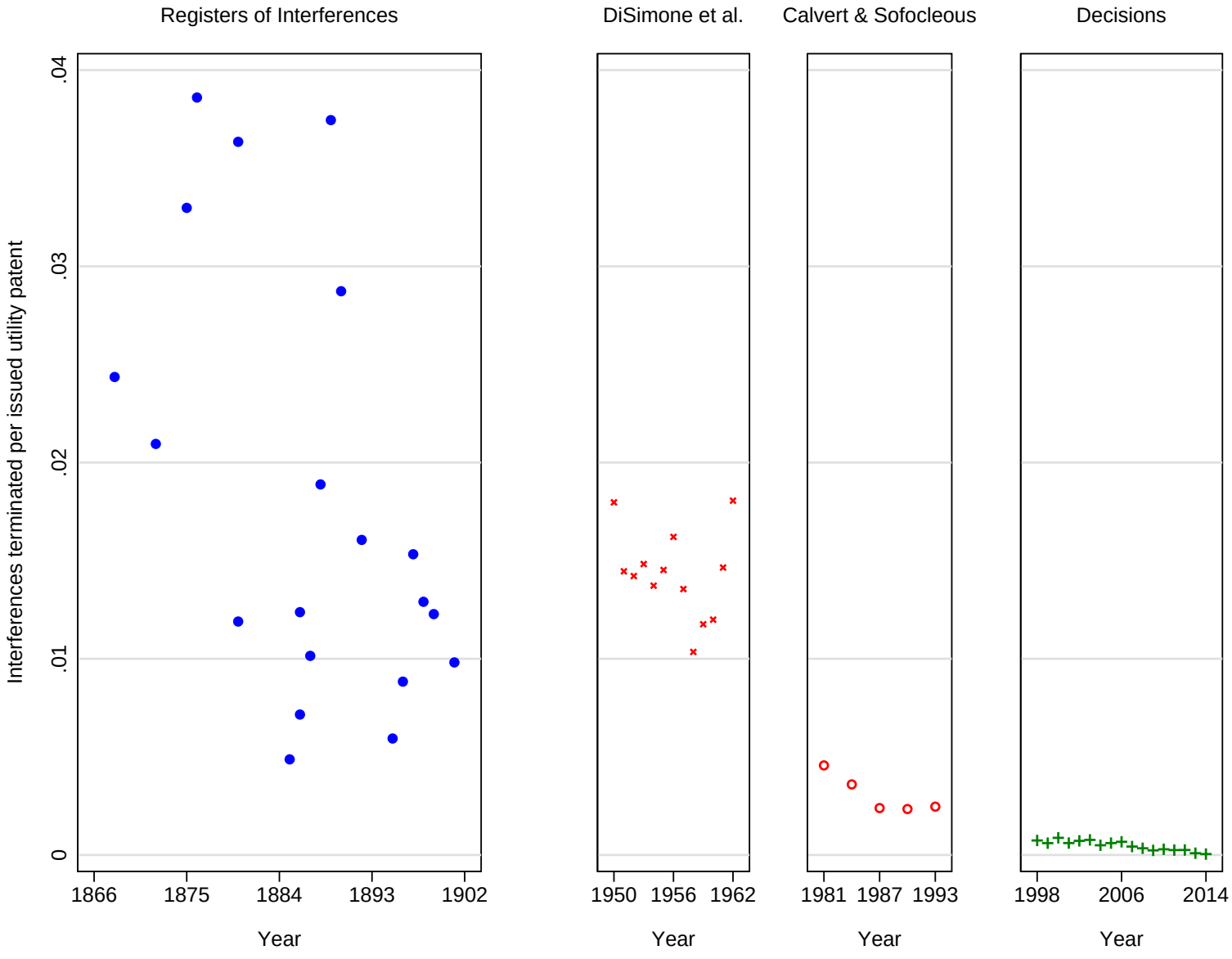
Current and future work

What is the effect of patent protection on inventors?

The causes and consequences of declining invention similarity.



Interference registers, 1860s–1900s, showing inventor names, invention, dispositions.



Mean interferences per year: Registers—497, DiSimone—650, Calvert—237, Decisions—76.