

The impact of high-speed rail on Innovation

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Background

- Distance is a crucial impediment of knowledge spillovers.
 - E.g., Jaffe, Trajtenberg, and Henderson, 1993, Murata, Nakajima, Okamoto, and Tamura, 2015, Kerr and Kominers, 2015, Inoue, Nakajima, and Saito, 2013
- A part of knowledge spillovers occurred by the face-to-face communications between researchers and engineers.
- The travel cost of them working in remote regions should be a crucial impediment of knowledge spillovers between them.
- This implies the possibility that the large investment for transportation infrastructure which drastically decline travel time would facilitate the knowledge spillovers between regions connected by the transportation infrastructure.

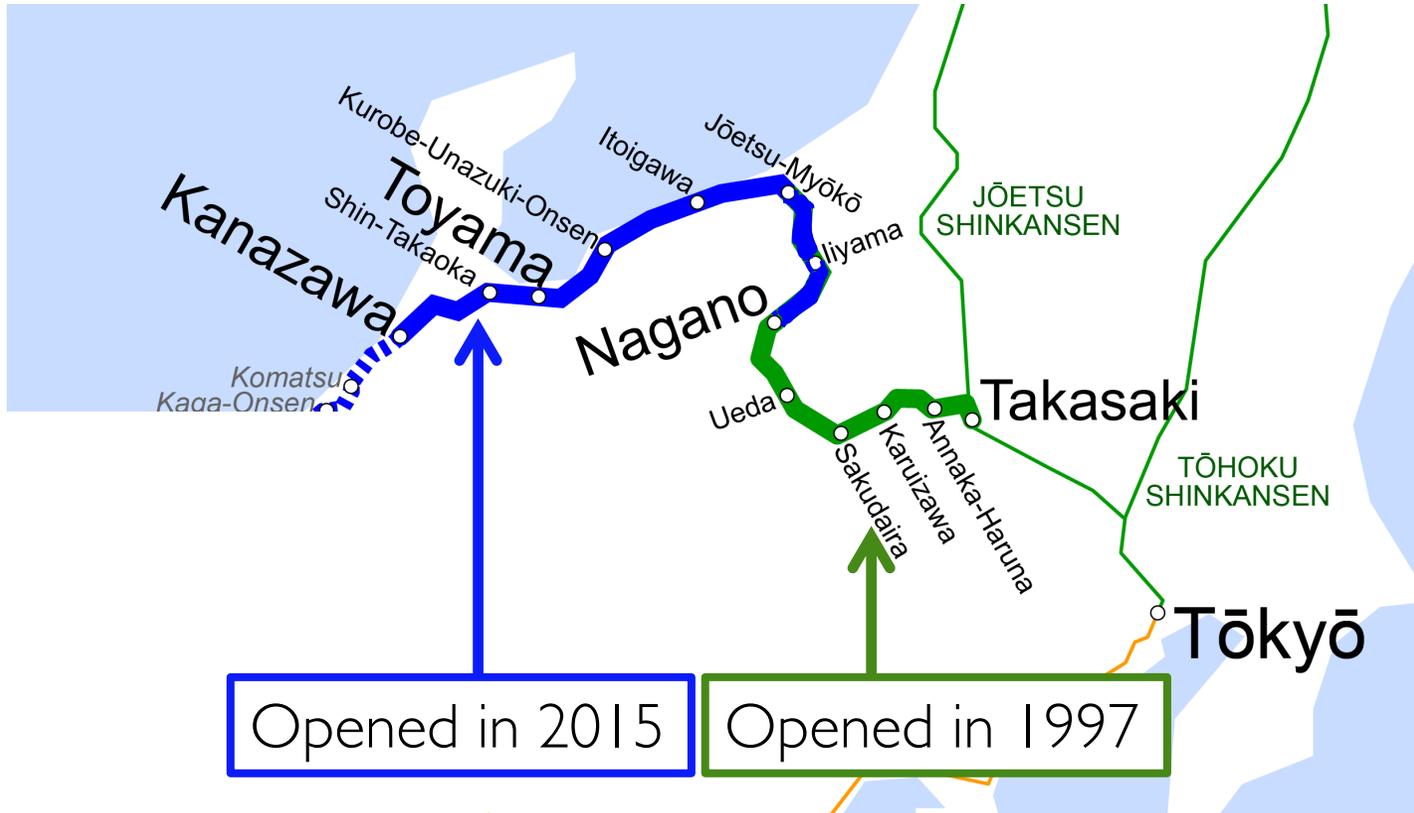
Our paper

- Focus on the case of opening of high-speed rail, “Nagano-Shinkansen,” in Japan in 1997.
- This rail connects Tokyo and Nagano,
 - a provincial city located in the middle of Japan.
- This opening of the high-speed rail dramatically reduces the travel time between Tokyo and Nagano,
- We estimate the impact of the opening of the rail on innovative activities by establishments along the line.

Difficulty of estimating impact of infrastructure

- Demand induces the infrastructure.
- The comparison between regions where have HSR and those do not have HSR is nonsense.
 - These regions are totally different in the sense of economic characteristics.
 - High-performance of economy itself induces HSR.
- Focus on the unique feature of the process of opening of Nagano-Shinkansen.
 - The Nagano Shinkansen was a part of Hokuriku opened in 2015.
 - Nagano Shinkansen which connects Tokyo and Nagano was opened earlier than the full line of the Hokuriku Shinkansen.

Idea of identification of the HSR effect



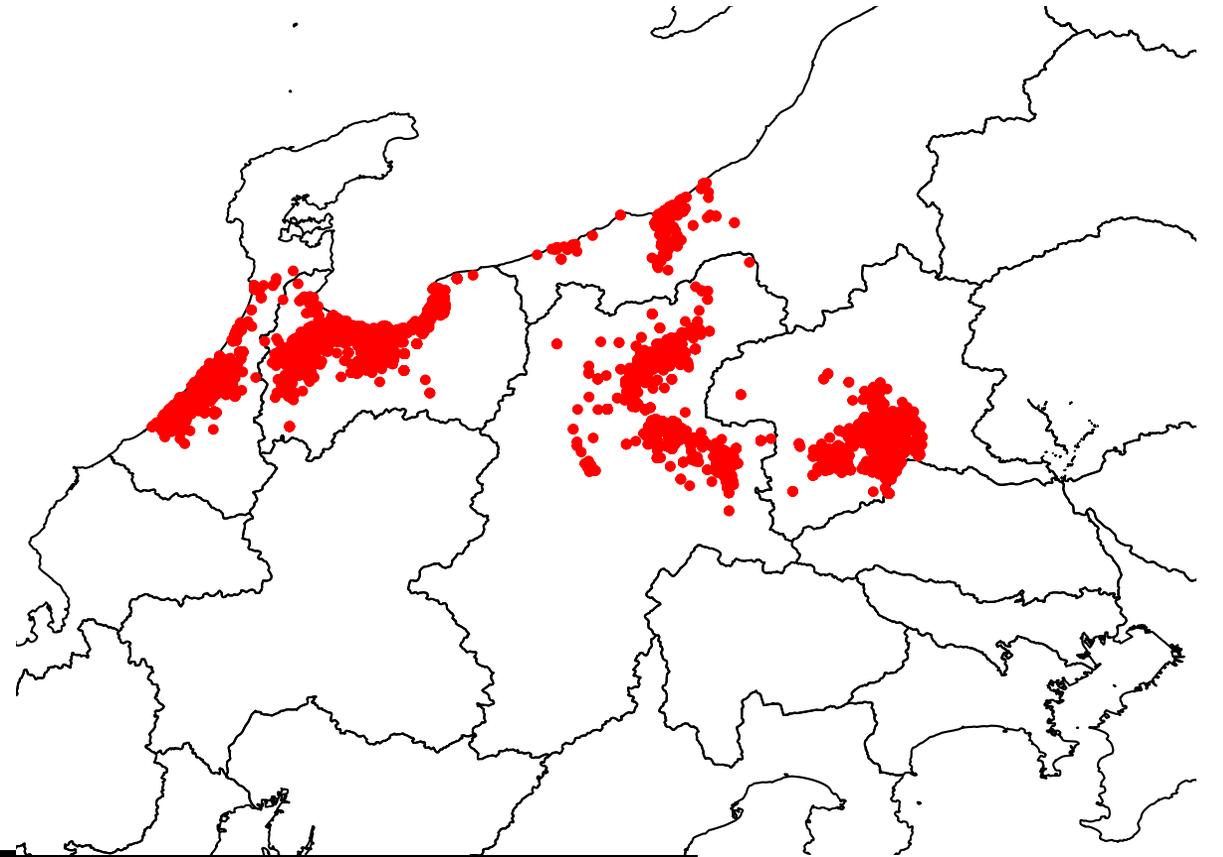
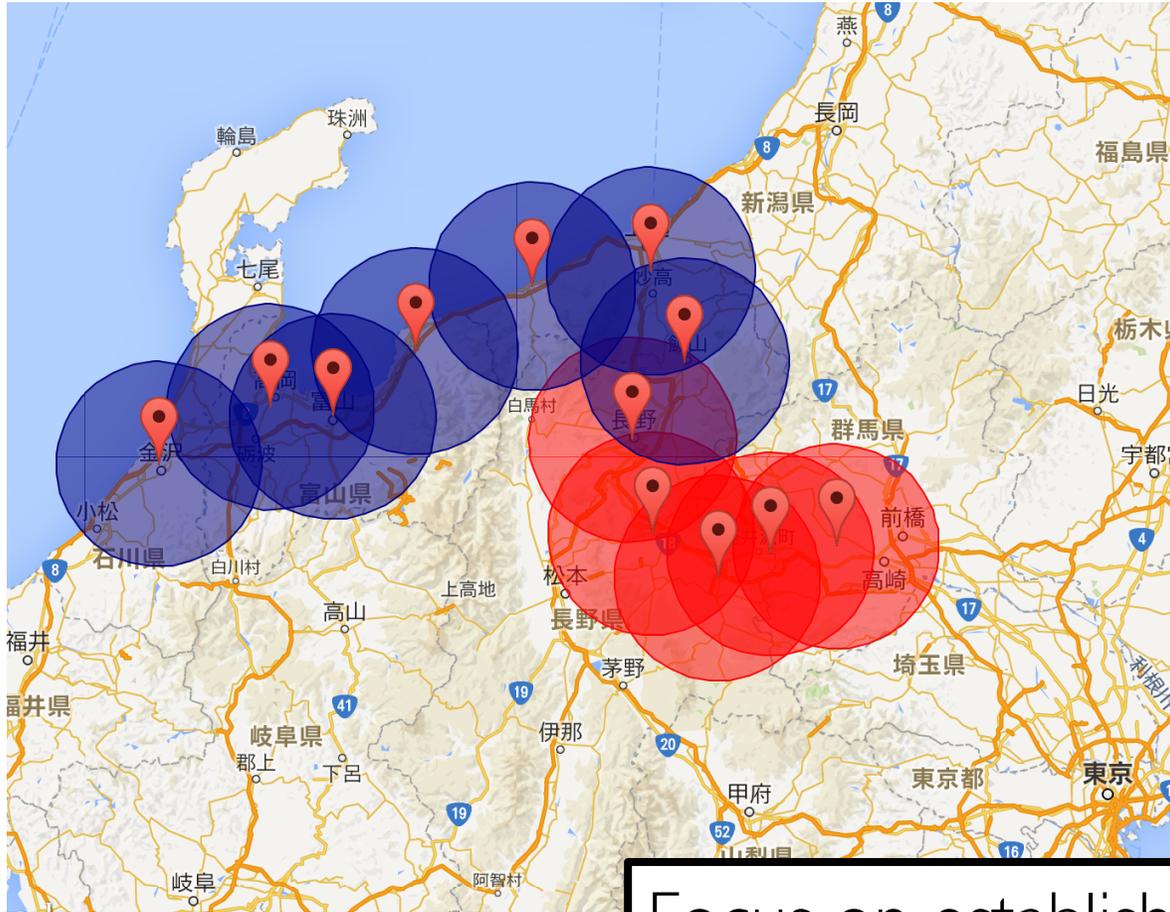
	1990-1996	1997-2014	2014-
Nagano	×	○	○
Hokuriku	×	×	○

Compare the innovation activities between two regions especially focusing on the before-after opening of Nagano shinkansen

Data

- All the patents submitted in Japan.
 - IIP patent database (Goto and Motohashi, 2007)
- Periods: 1990-2006
- By using Japanese convention in patent submission, we develop establishment-level patent publication database
 - Japanese inventors register the address of the establishments to which they belong as their address information
- We use establishment-level data on the followings as the measure of establishment-level innovative activities
 - Numbers of patents
 - Numbers of citations received

Targeted establishments



Focus on establishments located in 30 km from nearest stations of Shinkansen

Estimation equation

$$y_{it} = \beta \text{BulletTrain}_i + \gamma (\text{BulletTrain}_i \times I[t \geq 1997]) + \xi_i + \zeta_t + \varepsilon_{it}$$

↑

= 1 if establishment i
locates near the
Nagano Shinkansen Station
= 0 if establishment i
locates near the
Hokuriku Shinkansen Station

↑

= 1 if period t is later than 1997
= 0 if period t is before 1997

γ captures the impact of opening of Nagano shinkansen on innovative activities.

Baseline results

	(1)	(2)	(3)
Dependents	ln(No. of patents)	No. of citations received per patent	Impacts per patent
I($t \geq 1997$)	0.158*** (0.0198)	-0.102*** (0.0165)	0.0754 (0.0558)
Treat \times I($t \geq 1997$)	0.0463*** (0.0176)	0.137*** (0.0225)	0.106*** (0.0231)
Constant	0.0856*** (0.00826)	0.0881*** (0.0109)	0.0646*** (0.00981)
Year FE	yes	yes	yes
Establishment FE	yes	yes	yes
Municipality-year effects	yes	yes	yes
Observations	28390	28390	28390
R-squared	0.604	0.153	0.105

The opening of Nagano shinkansen

- increases the submission of patents by establishments along the line 4.6%.
- increases the impacts of patents (quality is improved)

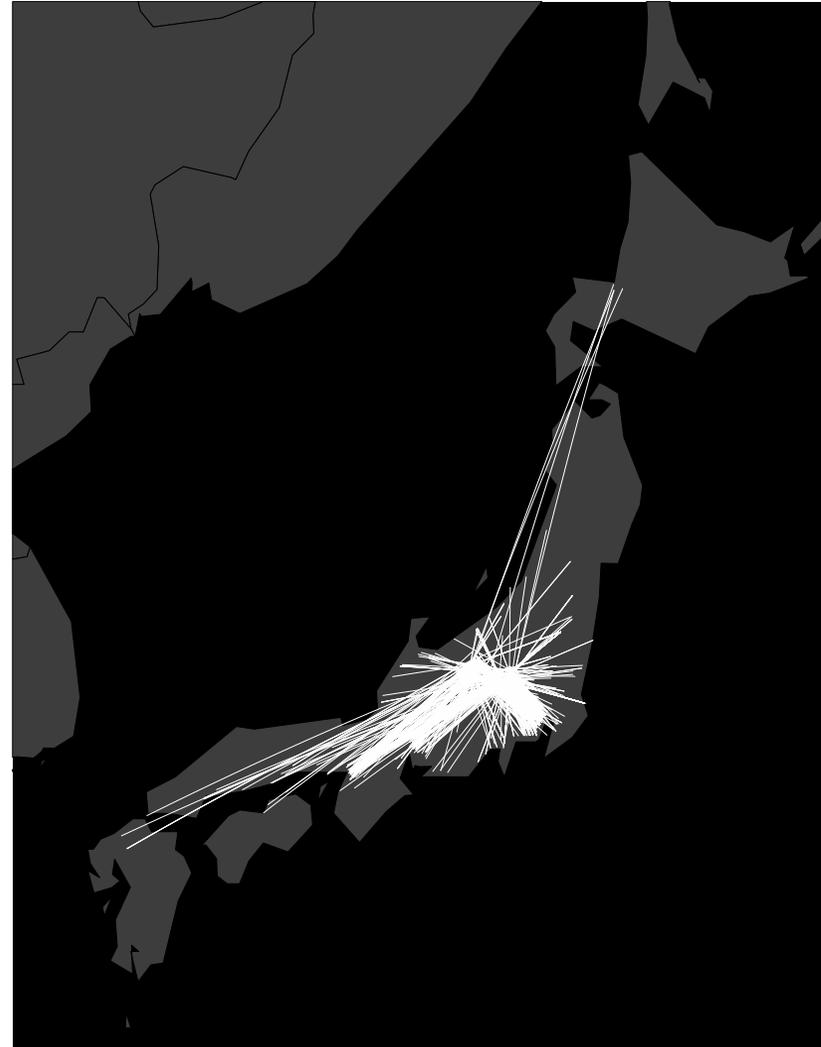
Possible channels

- Collaborations with remote establishments.
 - This would be represented as the number of collaborations with establishments in Tokyo.
- Knowledge spillovers through easy access to Tokyo
 - This would be represented as the citation of patents that is published by the establishments in Tokyo.

Collaborations with establishments in Nagano



Before



After

Results | Collaborations

	(1)	(2)	(3)	(4)
Dependents	ln(No. of patent by single)	ln(No. of patent by collaboration)	ln(No. of patent with establishments in Tokyo)	ln(No. of patent with establishments along shinkansen)
I($t \geq 1997$)	0.146*** (0.0192)	0.0595*** (0.00832)	0.0154*** (0.00317)	0.0101*** (0.00328)
Treat \times I($t \geq 1997$)	0.0456*** (0.0174)	-0.00566 (0.00614)	-0.00167 (0.00228)	0.00603** (0.00297)
Constant	0.0799*** (0.00813)	0.0240*** (0.00386)	0.00448*** (0.00114)	0.00437*** (0.00166)
Year FE	yes	yes	yes	yes
Establishment FE	yes	yes	yes	yes
Municipality-year effects	yes	yes	yes	yes
Observations	28390	28390	28390	28390
R-squared	0.613	0.523	0.265	0.318

The opening of Nagano Shinkansen

- increases the collaborations with establishments along the Shinkansen

Results | Citations

	(1)	(2)	(3)
Dependents	ln(No of citations)	Share of citations of Tokyo patent	Share of citations of patent along shinkansen
I(t ≥ 1997)	0.994** (0.434)	0.0552*** (0.00987)	0.0342*** (0.00714)
Treat × I(t ≥ 1997)	0.630 (0.435)	0.0196* (0.0115)	-0.00319 (0.00763)
Constant	0.0689*** (0.00960)	0.000350 (0.000577)	0.000267 (0.000501)
Year FE	yes	yes	yes
Establishment FE	yes	yes	yes
Municipality-year effects	yes	yes	yes
Observations	28390	28390	28390
R-squared	0.515	0.148	0.223

The opening of Nagano Shinkansen

- increases the the citation of patents which is published by the establishments in Tokyo

Knowledge in Tokyo is diffused to establishments in Nagano

Remarks

- This paper estimates the impact of the opening of the Nagano Shinkansen on innovative activities by establishments along the rail.
 - By exploiting unique feature of process of opening of the rail.
- The opening of Nagano Shinkansen significantly increases the innovative activities of the establishments along the rail in both quantity and quality.
- Collaborations with establishments along the line and citations of patents submitted by establishments in Tokyo are significantly increased.
- These imply that the opening of the Nagano Shinkansen improves the knowledge production of establishments along the rail through knowledge diffusion by collaboration and citations.

From the policy viewpoints

- The economic impact of inter-city HSR is difficult to evaluate.
 - There is no impact of commuting.
 - In most of the case, HSR is only for passengers. Thus, there is no impact on freight distributions.
- Human interactions are the crucial source of innovations which are the crucial source of economic development in the knowledge intensive economy.
- Passenger transportation infrastructure has an impact on innovation through facilitating the human interactions between remote areas.