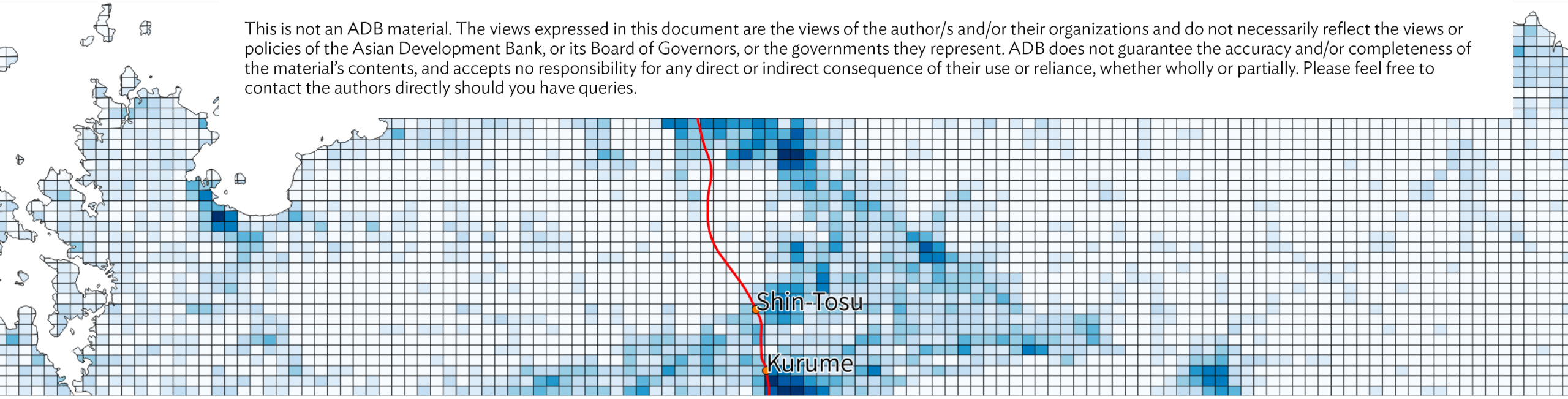

Modeling spatiotemporal urban spillover effect of high speed rail infrastructure development

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2018-11-15

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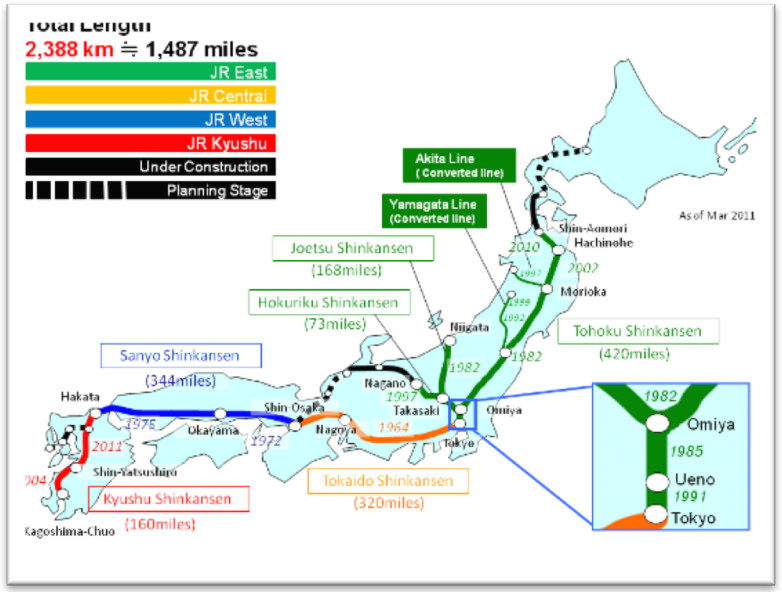
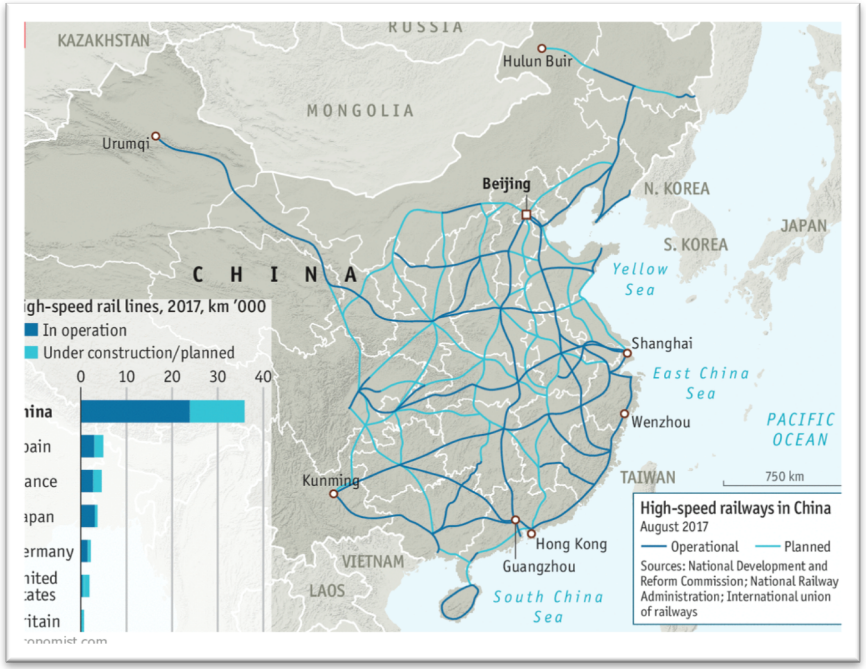
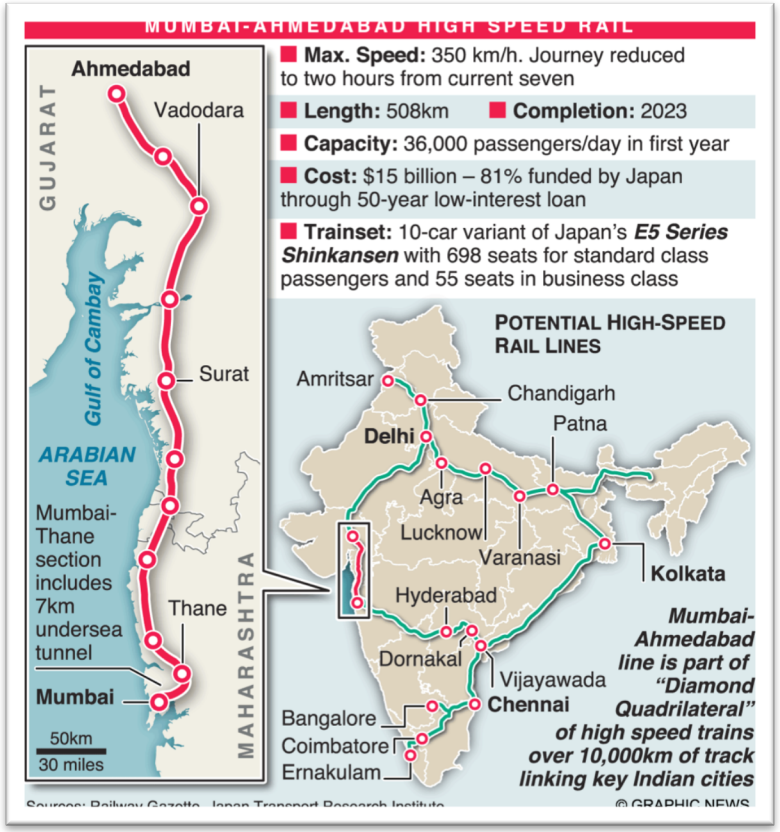
Creative Research and Planning Co.,Ltd.

High Speed Rail projects







HSR projects have key role in regional development
Demographic and economic impact

http://www.mlit.go.jp/en/tetudo/tetudo_fr2_000000.html
https://www.economist.com/graphic-detail/2017/09/01/chinas-high-speed-trains-are-back-on-track
https://www.graphicnews.com/en/pages/35670/TRANSPORT-India-first-bullet-train-

Background

Journal of Infrastructure, Policy and Development (2017) Volume 1 Issue 2, pp.129-148.
doi: 10.24294/jipd.v1i2.69

ORIGINAL ARTICLE

Impact of infrastructure on tax revenue: Case study of high-speed train in Japan

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[1] *Dean, Asian Development Bank Institute*
[2] *Researcher, Asian Development Bank Institute*

ABSTRACT

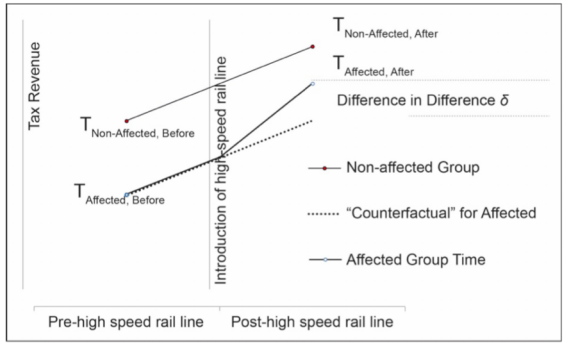
This study analyzes the impact of a high-speed rail line on tax revenues and on the economy of affected regions within the country. The economic impact of infrastructure investment can be induced by changes in tax revenues when the infrastructure is in operation. Accurate regional GDP data are not necessarily available in many Asian countries. However, tax data can be collected. Therefore, this study uses tax revenue dates in order to estimate spillover effects of infrastructure investment. The Kyushu high-speed rail line was constructed in 1991 and was completed in 2003. In 2004, the rail line started operating from Kagoshima to Kumamoto. The entire line was opened in 2011. We estimated its impact in the Kyushu region of Japan by using the difference-in-difference method, and compared the tax revenues of regions along the high-speed railway line

Table 1: Prefectures Assumed to be Affected by the Construction and Operation of the Kyushu High-Speed Rail

Spillover Effects by Region				Spillover Effects by Adjacency				Spillover Effects by Connectivity	
Group 1		Group 2		Group 3		Group 4		Group 5	
1.	Kagoshima	1.	Kagoshima	1.	Kagoshima	1.	Kagoshima	1.	Osaka
2.	Kumamoto	2.	Kumamoto	2.	Kumamoto	2.	Kumamoto	2.	Hyogo
		3.	Fukuoka	3.	Fukuoka	3.	Fukuoka	3.	Okayama
				4.	Oita	4.	Oita	4.	Hiroshima
				5.	Miyazaki	5.	Miyazaki	5.	Yamaguchi
						6.	Saga	6.	Fukuoka
						7.	Nagasaki	7.	Kumamoto
								8.	Kagoshima

Source: Authors' analysis.

Figure 1: Illustration of the Difference-in-Difference Method with the Outcome Variable of Tax Revenue



Source: Authors.

Table 2: Construction and Operation Timeline of the High-Speed Rail Line

Period	Preconstruction	Construction	Operation I	Operation II
Years	1982–1990	1991–2003	2004–2010	2011–2013

Source: Authors' analysis; Ministry of Land, Infrastructure, Transport and Tourism.

- "**Positive impact on the region's tax revenue** following the connection of the Kyushu rapid train with large cities, such as Osaka and Tokyo"
- "how **incremental tax revenues** created by the **spillover effects** of infrastructure will improve the performance of **private investors** in infrastructure investment"

- Yoshino, Naoyuki, and Umid Abidhadjaev. 2017. "Impact of Infrastructure on Tax Revenue: Case Study of High-Speed Train in Japan." Journal of Infrastructure, Policy and Development 1 (2): 1–20. https://doi.org/10.24294/jipd.v1i2.69.

Background

Transport Policy 35 (2014) 211–219

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Does high-speed rail generate spillovers on local budgets? ☆

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ABSTRACT

High-Speed Rail (HSR) infrastructure is costly and requires high investment during the construction and operation periods, which is mainly financed with public funds. This economic effort is seldom set off, which leads to subsidies with the money collected from public debt growth or tax pressure increases. The question that immediately emerges is whether the entrance of this new infrastructure generates economic spillovers at the local level and, consequently, improves local public budgets. To solve this question we use local data on economic activity, municipalities' characteristics and local financial data in Spain for the past decade (2001–2010). Our estimations by difference-in-difference analysis and using spatial data yield a general conclusion: when HSR comes to town, both local revenues and the local fiscal gap improve by mean 10% and 16%, respectively. These improvements primarily affect municipalities located within 5 km of an HSR station.

Table 3
DiD estimation of revenues per capita on the entrance of HSR.

Entrance of HSR in…	Observations	HSR station	HSR station + buffer 5 kms	[5–10 km]	[10–20 km]
2003	28,707	**39.56 (20.98)***	**70.36 (32.45)****	**301.59 (80.26)*****	30.43 (31.18)
2005	28,236	**60.17 (22.29)*****	**34.78 (21.35)***	**74.20 (31.50)****	6.34 (16.89)
2006	28,174	**83.32 (26.91)*****	**47.21 (26.41)***	11.47 (78.72)	17.11 (25.19)
2007	28,760	**38.87 (24.70)(!*)**	**47.15 (25.17)***	−18.23 (44.78)	−19.41 (13.13)
2008	28,425	**69.11 (33.21)****	**52.33 (23.65)****	−11.36 (26.80)	−0.28 (16.32)

Note 1: Identifying assumption is satisfied in bolded rows.
*** 1% significance test. Standard deviation in brackets.
** 5% significance test. Standard deviation in brackets.
* 10% significance test. Standard deviation in brackets.

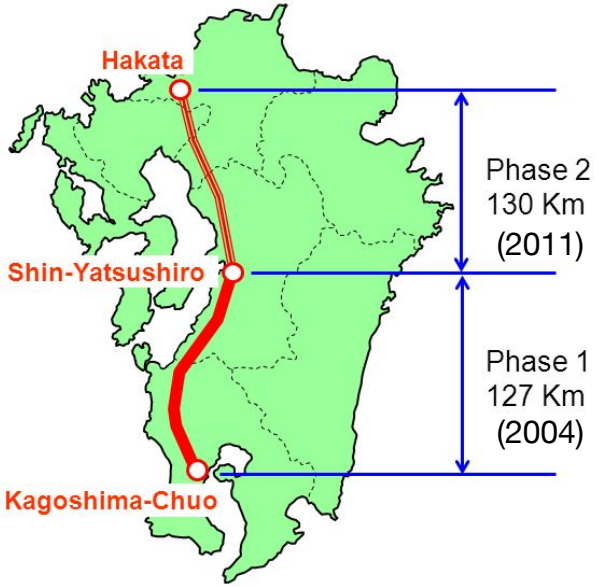
- "By focusing on cities with HSR, we find that the **yearly property tax does not vary**, which implies a **pressure on real estate to keep constant before and after the entrance of HSR**."
- "The difference-in-difference estimations **show that there is an improvement in the public revenues and the fiscal gap**, … Moreover, this effect is most noticeable in **those municipalities located within a 5 km radius** of an HSR station."

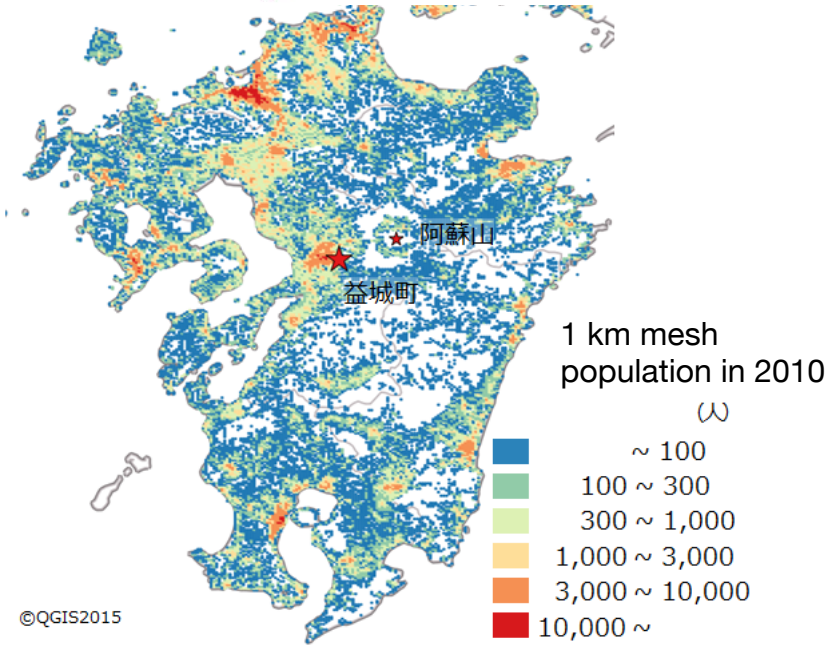
- Hernández, A. and Jiménez, J. L. (2014) 'Does high-speed rail generate spillovers on local budgets?', *Transport Policy*. Elsevier, 35, pp. 211–219. doi: 10.1016/j.tranpol.2014.06.003.

Case Study: Kyushu Shinkansen

Why Kyushu Shinkansen?

- Data availability
  - To check before and after effect
- Application to other countries
  - Population in the corridor is not so high
    - Could be an example to other countries which number of population is not so high
  - Far from the main economic center (Tokyo Metro. Area)
    - Independent; less spillover effect from other regions
    - HSR is mainly used for intra-zonal trip (within island)



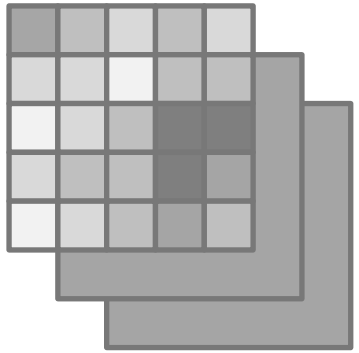


Estimate spatial extent of spillover effect

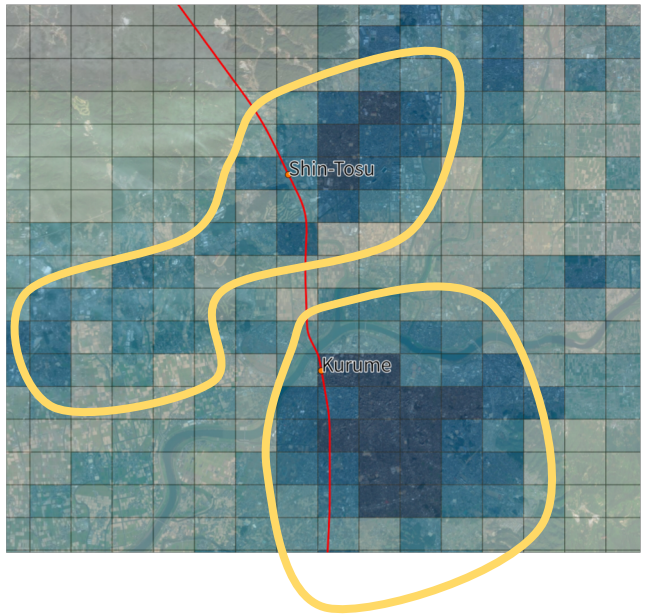
Table 2: Construction and Operation Timeline of the High-Speed Rail Line

Period	Preconstruction	Construction	Operation I	Operation II
Years	1982–1990	1991–2003	2004–2010	2011–2013

Source: Authors' analysis; Ministry of Land, Infrastructure, Transport and Tourism.



Spatiotemporal estimation of spillover effect



Spillover effect spatial extent estimation

- Land cover -> building area density
- Land price
- Property tax revenue

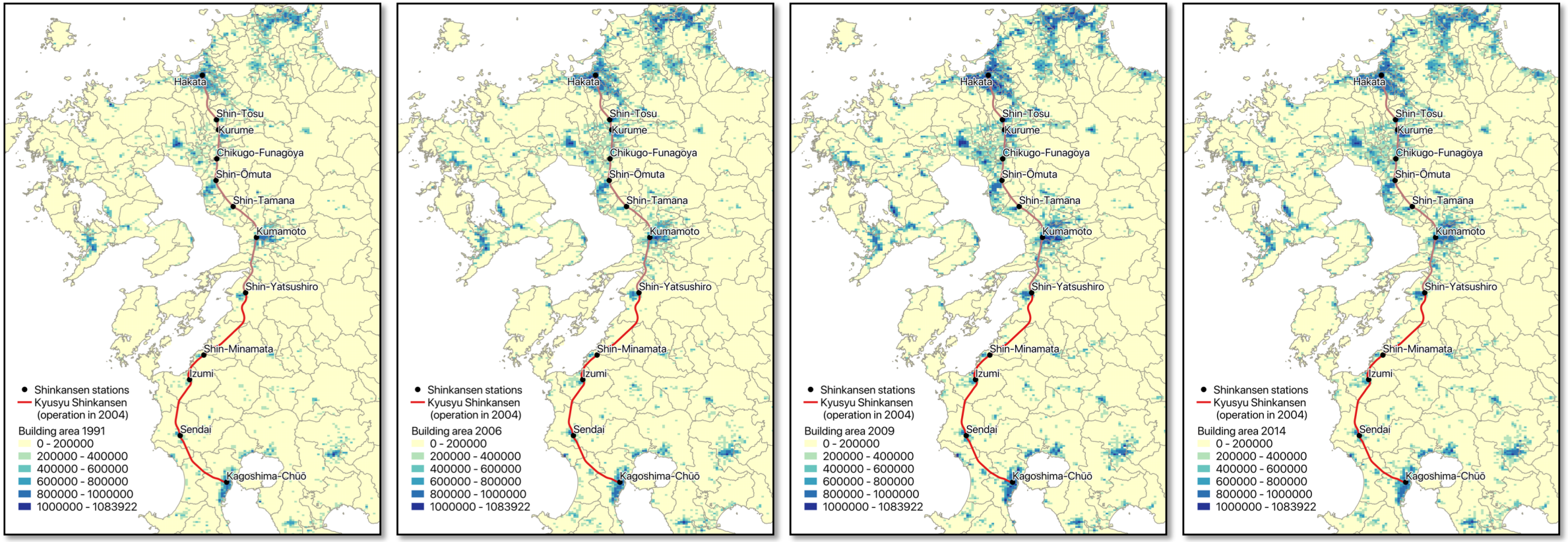
The general concept is to develop an spatial extension of the spillover effect using time series geospatial data including land price, land cover / use, night time light, and property tax revenue.

Data

- Land use classes -> building area density in 1km grid
- Land price panel data
- Municipality property tax revenue
- Compound annual growth rate

Period	Preconstruction	Construction (and operation I)	Operation I	Operation II
Years	1982-1990	1991-2003	2004-2010	2011-2013
Land cover change (from-to)	1987-1991	1991-2006	2006-2009	2009-2014
Land price change (from-to)	1987-1991	1991-2006	2006-2009	2009-2014
Tax revenue change (from-to)	**1989**-1991	1991-2006	2006-2009	2009-2014

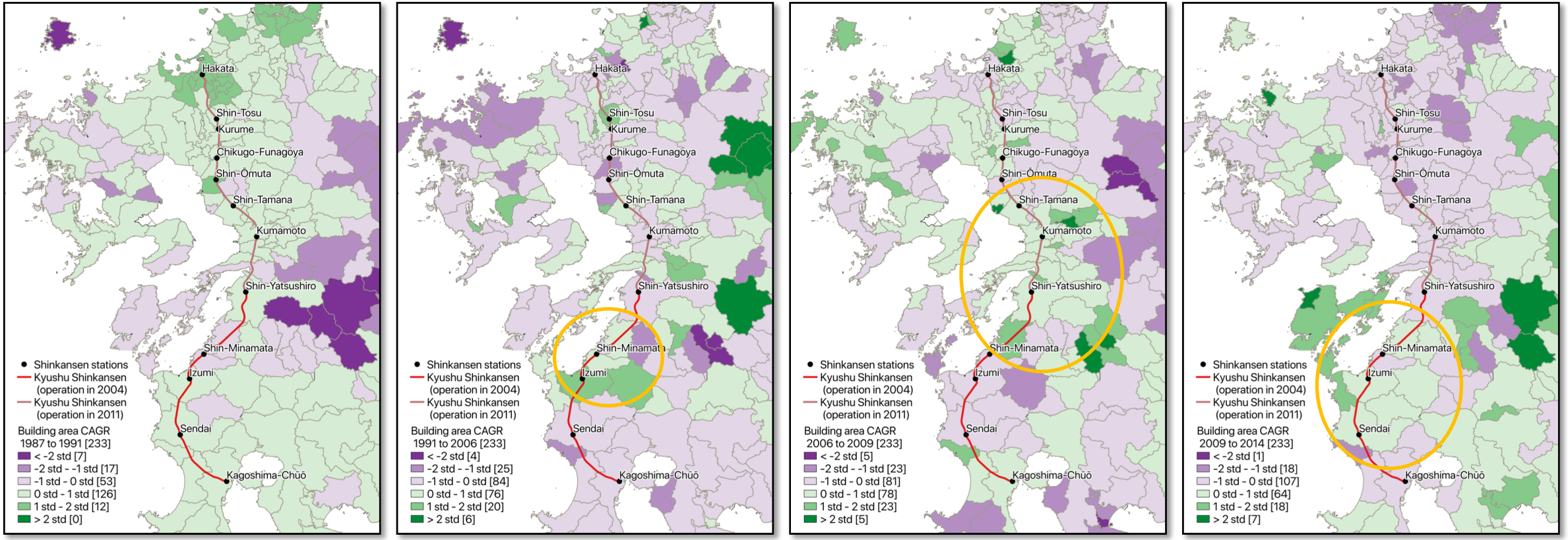
Building area density



1991 2006 2009 2014

- Building area in each cell shows the proportion of the urban area and how the urban area is distributed along the Kyushu Shinkansen.
- Time series comparison shows temporal trend of development and the expansion of urban area.

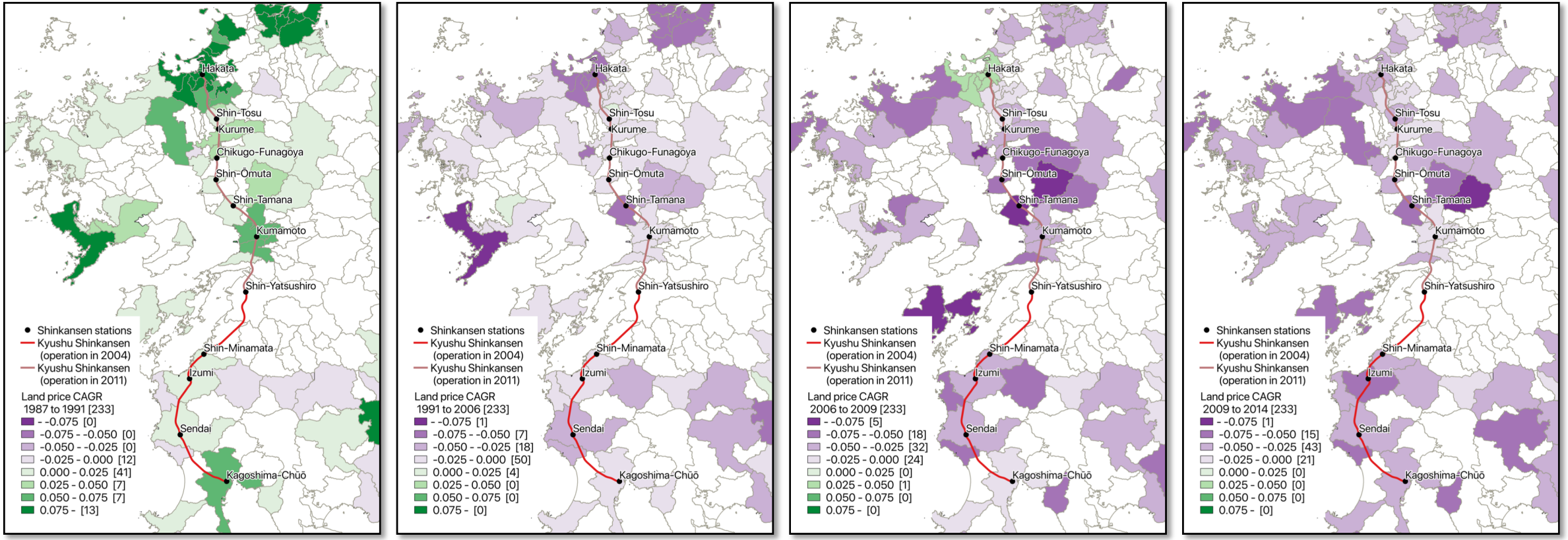
Building area density CAGR (classified based on the mean and standard deviation)



1987 - 1991 | 1991 - 2006 | 2006 - 2009 | 2009 - 2014

- During the preconstruction phase, the CAGR of building area around the rail was significantly higher than the average of the region.
- In the following phases, the CAGR of building area around smaller stations such as Shin-Tosu and Shin-Tamana was also significantly higher than the average.

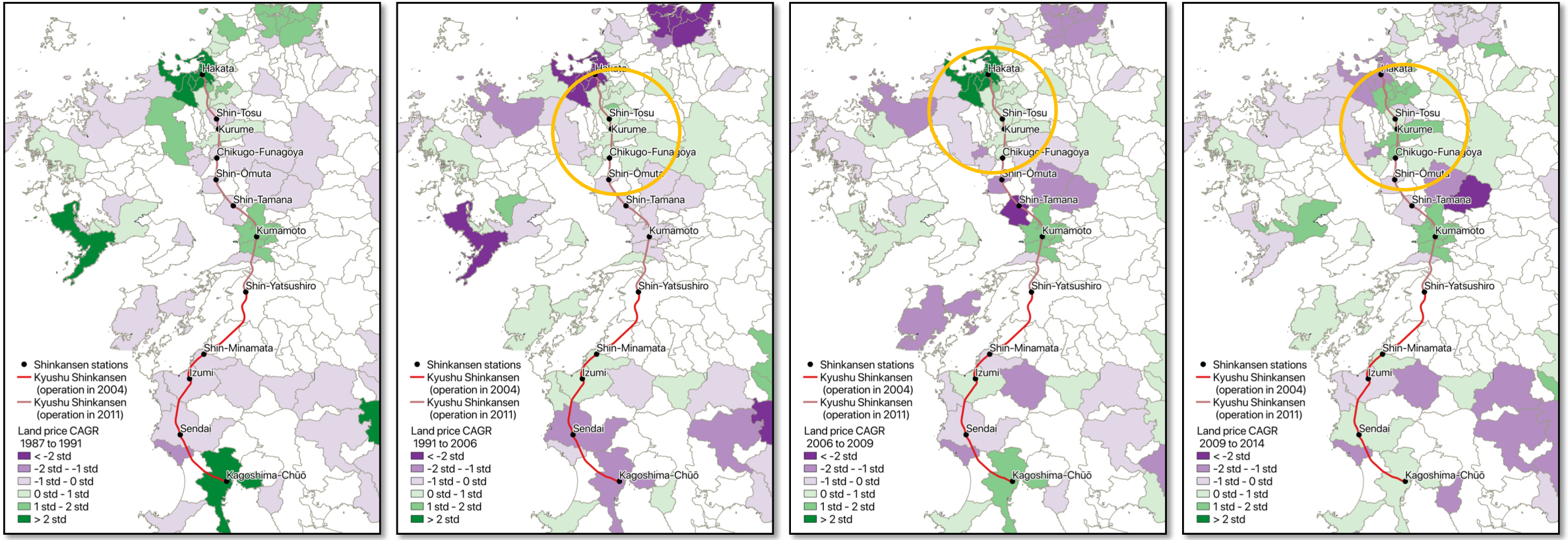
Land price CAGR



1987 - 1991 1991 - 2006 2006 - 2009 2009 - 2014

- The overall trend is positive in the preconstruction phase and negative in following phases.
- Large cities (Fukuoka, Kumamoto, and Kagoshima) tend to have more positive trend than rest of the region

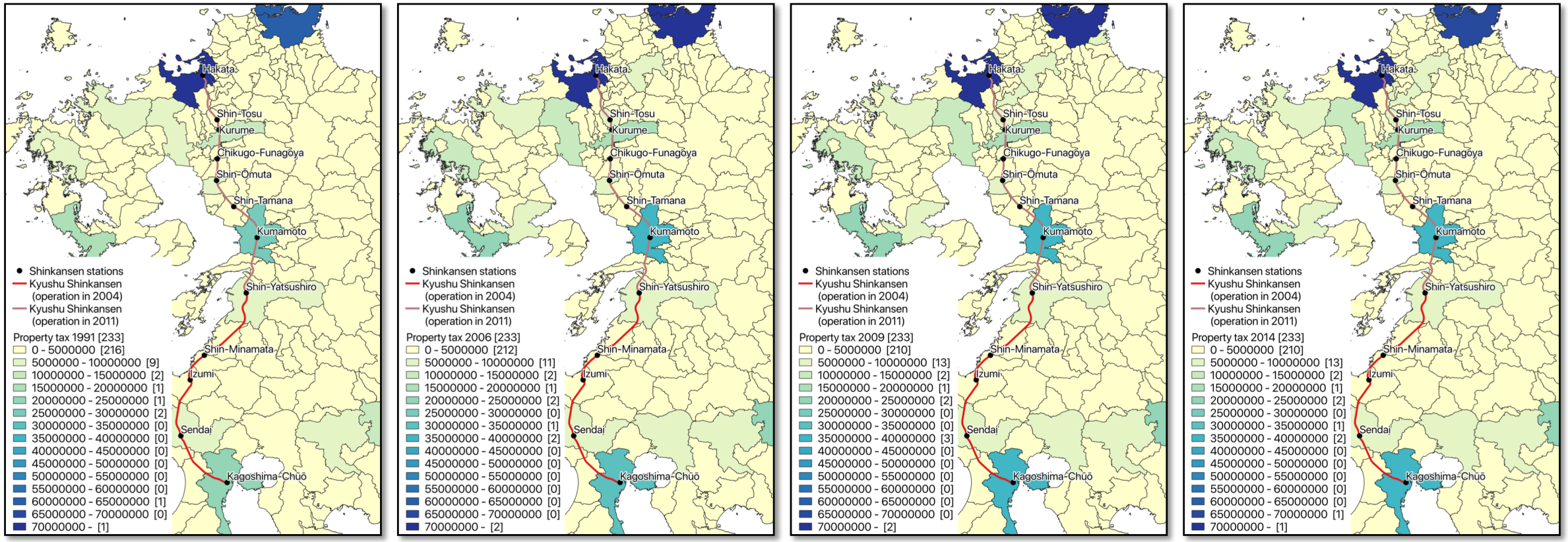
Land price CAGR (classified based on the mean and standard deviation)



1987 - 1991 | 1991 - 2006 | 2006 - 2009 | 2009 - 2014

- The growth in smaller cities around Kyushu Shinkansen was more positive than some larger cities during construction and following phases.
- The construction and operation of HSR may have stimulated investment in the land market of those smaller cities.

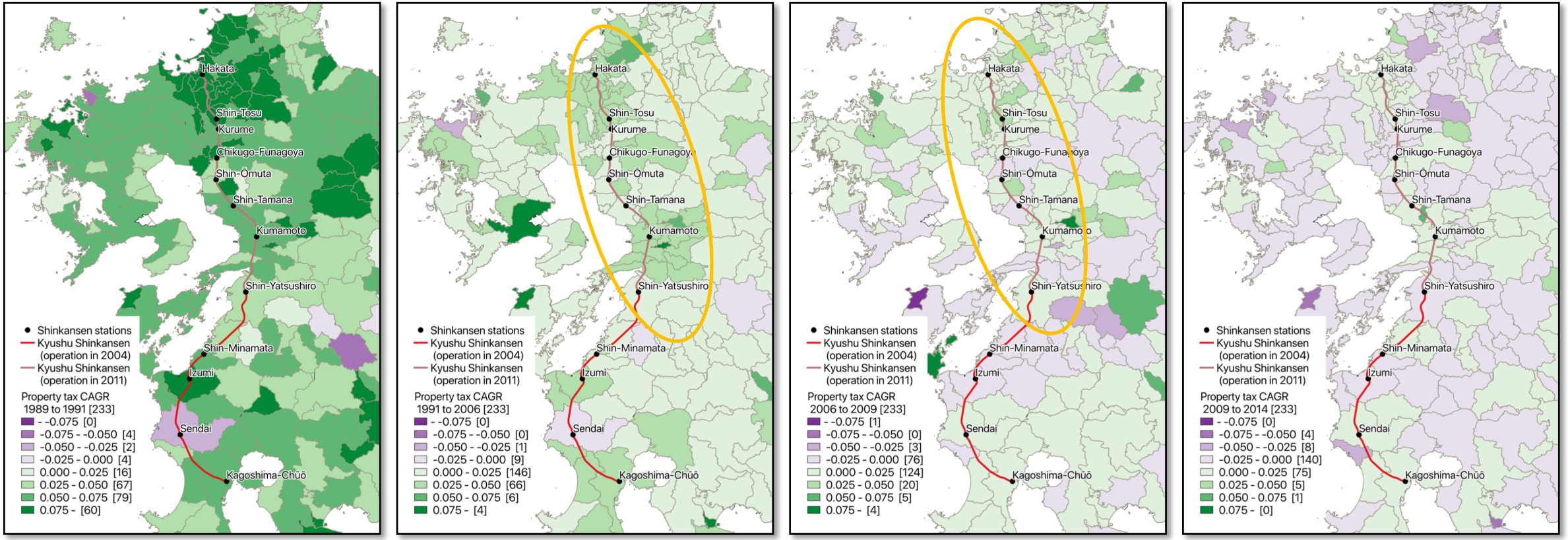
Property tax revenue



1991 2006 2009 2014

“地方財政状況調査 > 市町村分 > 市町村税の徴収実績1 >**固定資産税 (property tax)**” from e-Stat
“Settlement” (調定) value of property tax revenue.
Administration boundaries in 2014 are used for the analysis.

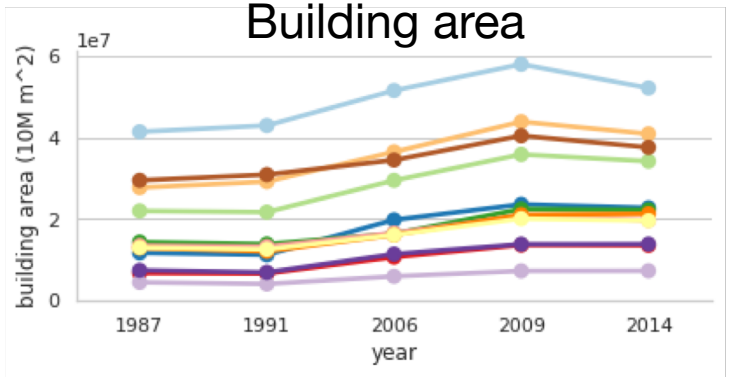
Property tax CAGR

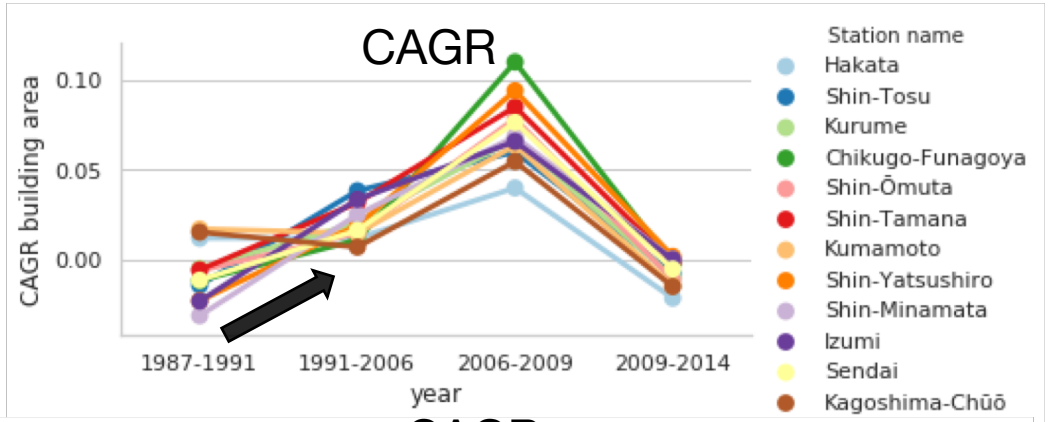


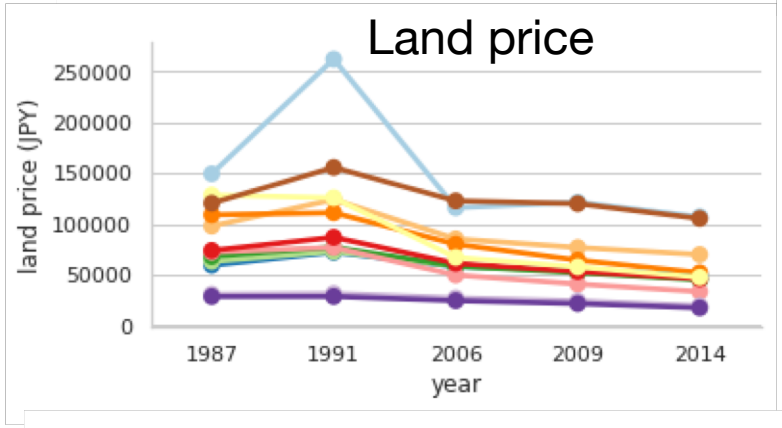
1989 - 1991 | 1991 - 2006 | 2006 - 2009 | 2009 - 2014

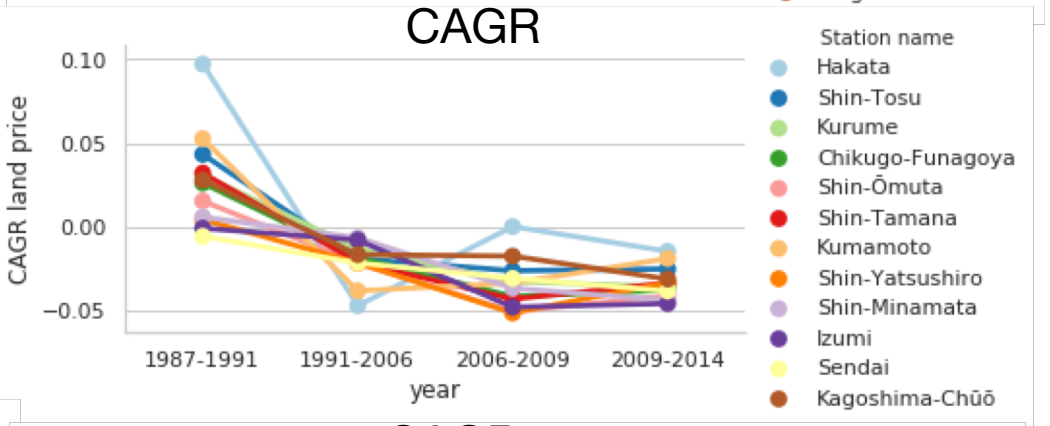
- The overall trend is the transition from positive growth to negative growth, however, some of the municipalities keep the positive growth in recent phases.
- During the construction phase, most municipalities with highest growth rate are those around the Kyushu Shinkansen.

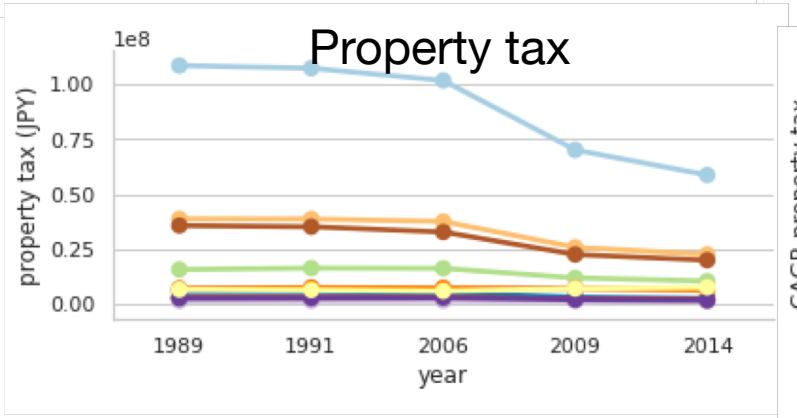
Station area buffer analysis

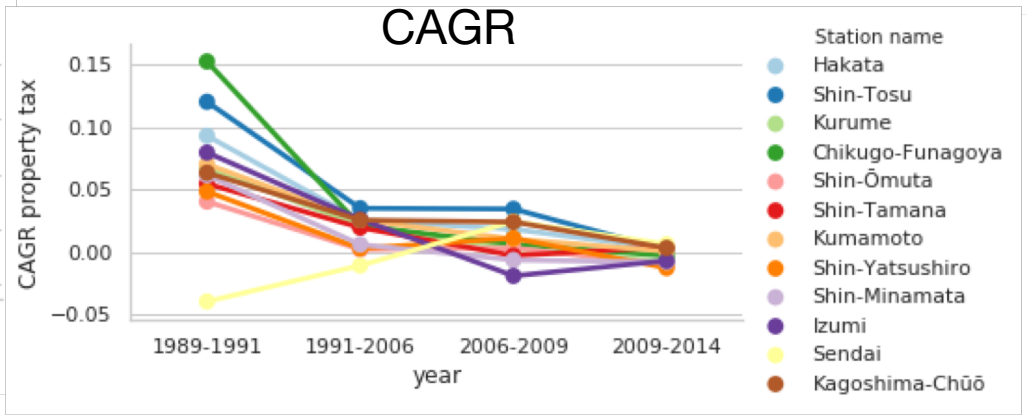












- CAGR of building area around most smaller stations (e.g. Shin-Tosu) surpassed the large stations during the construction phase (1992-2006) and stayed higher after the operation phase.
- CAGR of property tax revenue during the preconstruction phase varied significantly (mostly positive) but becomes very similar over time. From this result, it is hard to highlight the biggest beneficiaries from other stations.

Shin-Yatsushiro sta. from 1991 to 2006

1991

Building area CAGR

2006

- Rapid development is observed in construction period.

Future work

- Difference-in-difference estimation model
  - Choose control group in Kyushu region
- Aggregation (Region of Interest Clustering)
  - Characteristics of each station area
  - Spillover extent shape