Regional Economic Effect of Development of Hokuriku Shinkansen Considering Actual Change in Tourist Behavior

Tetsuji SATO [a], Shoichi YOSHITOMI [b]

[a,b] *Department of Architecture and Civil Engineering, Chiba Institute of Technology, 2-17-1 Tsudanuma, Narashino-shi, Chiba, 275-0016, Japan*
[a] *E-mail: tetsuji.sato@it-chiba.ac.jp*
[b] *E-mail: s1224337sb@s.chibakoudai.jp*

Abstract: Part of Hokuriku Shinkansen, high speed rail between Tokyo and Kanazawa, was open to the public on March 2015. On December 2016, Ishikawa Prefecture, whose capital is Kanazawa, published data of the number of tourists visiting Ishikawa in 2015. In this paper, the regional econometric model for Ishikawa Prefecture is developed, and the questionnaire survey for tourists to Kanazawa from other regions in Japan and foreign countries which ask expenditure in the trip in the cases with and without Hokuriku Shinkansen is conducted. Using the model and data of the number of tourists and expenditure per person without and with the Shinkansen, we estimate the regional economic effect of developing the Shinkansen. As a result, it is indicated that the flow effect per year in the construction period is about 60 billion yen and the stock effect per year after the opening is about 22 billion yen.

Keywords: High speed railway, Sightseeing behavior, Regional economy, Econometric model

1. INTRODUCTION

In recent years, the construction of high-speed rail lines in Asian countries has been proceeding rapidly. In Japan, Kyushu Shinkansen (between Hakata and Kagoshima-Chuo) was completed in March 2011, part of Hokuriku Shinkansen (between Takasaki and Kanazawa) opened in March 2015, and the Shin-Aomori to Shin-Hakodate-Hokuto section of Hokkaido Shinkansen opened in March 2016. In addition, more lines are scheduled to open in the future, including Hokuriku Shinkansen (between Kanazawa and Tsuruga) in 2025, Chuo Shinkansen (MAGLEV) (between Tokyo and Nagoya) in 2027, and another section of Hokkaido Shinkansen (between Shin-Hakodate-Hokuto and Sapporo) in 2035. Subsequently, the Nagoya to Shin-Osaka section of Chuo Shinkansen and the Tsuruga to Shin-Osaka section of Hokuriku Shinkansen will be opened. Figure 1 illustrates the existing and future network for Japan's Shinkansen lines.

High-speed rail lines drastically reduce travel times between regions so that regional economies benefit greatly from higher tourism spending due to an increase in the number of tourists from other regions and changes in sightseeing activity. Existing studies that use economic modeling to analyze the impact of high-speed rail lines on regional economies are roughly divided into those that use spatial computable general equilibrium (SCGE) models and those that use regional econometric models.

Prior research that used SCGE models to measure the economic impact of high-speed rail lines include that by Tsuchiya et al. (2009), which analyzed the impact of high-speed rail construction in Taiwan; that by Miyashita et al. (2009), which conducted a comparative analysis of the impact of high-speed rail line construction in South Korea and construction of Chuo Shinkansen in Japan; and that by Sato (2013), which was a time-series impact analysis

Figure 1. The route map of Shinkansen (high speed railway) in Japan in 2017

of development of Chuo Shinkansen (MAGLEV) considering regional population movements. However, these studies did not consider the effect of high-speed rail development on the number of tourists or changes in sightseeing activity.

Sato (2015) developed a regional econometric model that enables to analyze the time-series impacts of the number of tourists from both within and outside the region and changes in sightseeing activity on the regional economy resulting from the construction of Shinkansen and other high-speed rail lines. Constructing an empirical model focused on Hokkaido, it analyzed the impact of development of Hokkaido Shinkansen, which is scheduled for completion in 2035. It used a gravity model to estimate the increasing number of tourists and assumed that the change in expenditure per person would be the same as that in the Kyushu region around the time Kyushu Shinkansen went into operation.

It has been reported by news media in Japan that the number of tourists rose dramatically in Ishikawa Prefecture after the Takasaki-Kanazawa section of Hokuriku

Shinkansen opened in March 2015. Because it is considered that the impact of development of Hokuriku Shinkansen on the economy of Ishikawa Prefecture through increasing tourists is very large, this study focuses on the economic effect caused by tourism. The change in the number of tourists before and after the new rail line went into operation became apparent in December 2016, when Ishikawa Prefecture published the numbers of visitors for 2015 (from inside and outside the prefecture and from abroad, respectively). This study develops a regional econometric model according to Sato (2015) focusing on Ishikawa Prefecture to analyze the economic impact of Hokuriku Shinkansen based on the number of tourists and changes in expenditure per person. Regarding changes in expenditure per person, we estimates based on results of a questionnaire survey for tourists traveling to Ishikawa Prefecture by Hokuriku Shinkansen which ask the actual sightseeing activity and tourism consumption and what sightseeing activity and consumption levels would have been if the Shinkansen had not been constructed.

2. THE REGIONAL ECONOMETRIC MODEL

2.1 Outline of the Model

We develop the regional econometric model that considers change in tourist behavior, i.e. change in the number of the tourists and expenditure per person, according to basically Sato (2015).

Figure 2 shows the flow chart of the model that considers change in tourist behavior.

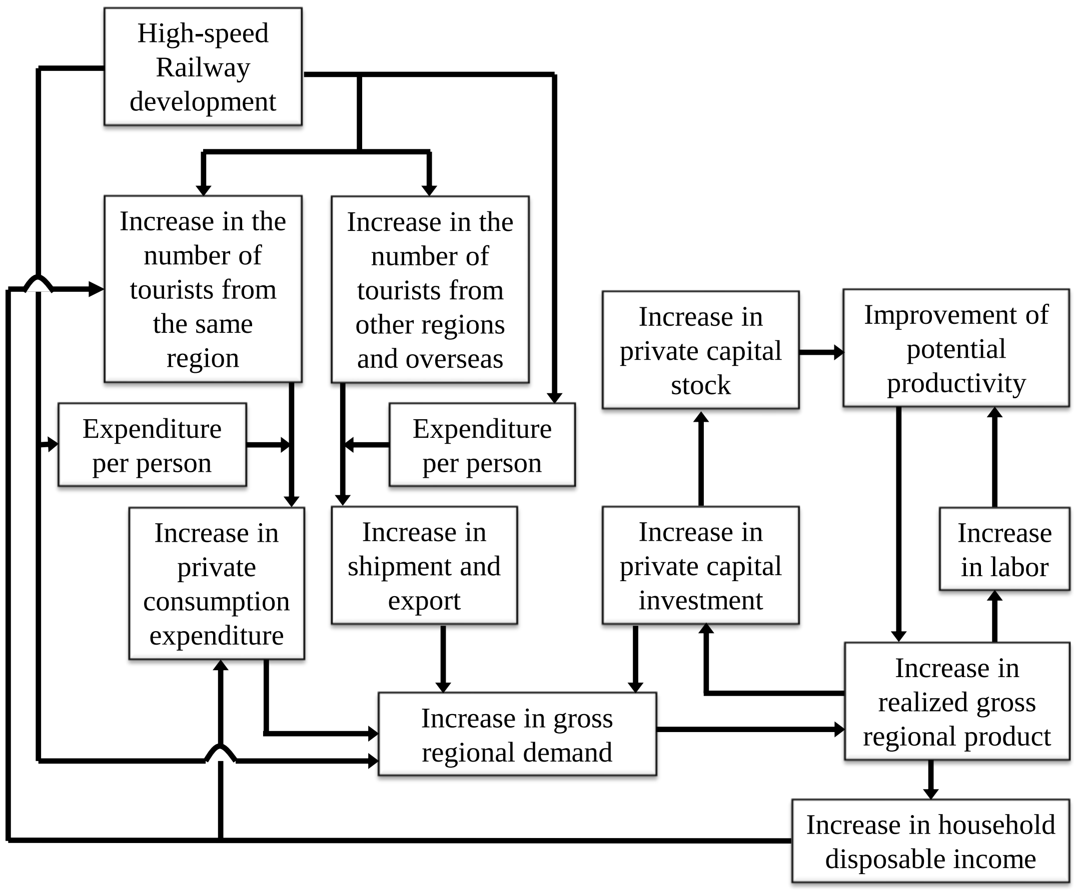


Figure 2. The flow chart of the model that considers change in tourist behavior

2.2 Formulating the Model

We formulate the model according to the model flow chart in Figure 2. Each function is described below. The subscript *t* on each function represents the year.

2.2.1 Private consumption expenditure that considers tourism consumption within the region

Regarding consumption expenditure by tourists from within the region, we assume that this is able to be determined by classifying the number of visitors into those staying overnight and those on day trips and by multiplying the number of each by each value of expenditure per person. We assume that the number of visitors both staying overnight and on day trips is determined by their household disposable income. Furthermore, we set a function for per-capita consumption expenditure on goods and services other than tourism, considering a future population decline, and assume that this is affected by per-capita household disposable income.

Private consumption expenditure that considers tourism consumption within the region is expressed by Equation (1)-(5).

$$CP_t = CP_t^{Tourism} + CP_t^{Other} \tag{1}$$

$$CP_t^{Tourism} = u_t^L NT1_t^L + u_t^D NT1_t^D \tag{2}$$

$$NT1_t^L = NT1_t^L\left(YH_t\right) \tag{3}$$

$$NT1_t^D = NT1_t^D\left(YH_t\right) \tag{4}$$

$$\frac{CP_t^{Other}}{POP_t} = \frac{CP_t^{Other}}{POP_t}\left(\frac{YH_t}{POP_t}\right) \tag{5}$$

where,

- CP : private consumption expenditure,
- $CP^{Tourism}$: consumption expenditure associated with tourism from the region,
- CP^{Other} : consumption expenditure not associated with tourism,
- $NT1^L$: the numbers of tourists staying overnight from the region,
- $NT1^D$: the numbers of day-trippers from the region,
- u^L : expenditure per person of tourists staying overnight,
- u^D : expenditure per person of day-trippers,
- YH : household disposable income, and
- POP : population.

2.2.2 Shipment and export that consider tourism consumption from other regions

It is assumed that consumption expenditure by tourists from outside the region is determined by classifying visitors into those staying overnight domestically, those on day trips, and those coming from abroad and multiplying the number of each by each value of expenditure per person. Furthermore, we assume that non-tourism shipment and export are affected by gross domestic product and currency exchange rates.

Shipment and export that consider tourism consumption from other regions are expressed by Equation (6)-(8).

$$E_t = E_t^{Tourism} + E_t^{Other} \tag{6}$$

$$E_t^{Tourism} = u_t^J \left(NT2_t^J + dNT2_t^J \right) + u_t^F \left(NT2_t^F \right) \tag{7}$$

$$E_t^{Other} = E_t^{Other} \left(GDP_t, FXS_t \right) \tag{8}$$

where,

E	: shipment and export,
$E^{Tourism}$	: consumption expenditure associated with tourism from other regions,
E^{Other}	: shipment and export not associated with tourism,
$NT2^J$	: the number of tourists from other regions in the country,
$NT2^F$	: the number of tourists from overseas,
$dNT2^J$	: the increase in the number of tourists from other regions in the country triggered by the shortened time required for traveling between regions,
u^J	: expenditure per person of tourists from other regions in the country,
u^F	: expenditure per person of tourists from overseas,
GDP	: gross domestic product, and
FXS	: exchange rate.

2.2.3 Other

For functions other than private consumption expenditure and shipment and export, we basically follow the functions of Sato (2015). Other functions are shown in Equation (9)-(16). Equation (9) indicates that gross regional product is realized as the average of regional potential productivity of all industries and gross regional expenditure. Equation (10) is the production function. Equation (11) and (14) are the definitions of private capital stock and gross regional expenditure respectively. Equation (12) is the private capital investment function which considers the stock adjustment process and the acceleration process. For Equation (13) and (15), we assume that the number of workers and private housing investment are affected by population trends. Equation (16) indicates that household disposable income is determined by gross regional product.

$$GRP_t = \mathrm{AVERAGE}\left(\sum_i X_{i,t}, GRE_t \right) \tag{9}$$

$$X_{i.t} = X_{i.t}\left(ROW_{i.t} \cdot KP_{i.t}, LHR_{i.t} \cdot NW_{i.t} \right) \tag{10}$$

$$KP_{i.t} = (1-\eta) KP_{i.t-1} + IP_{i.t} \tag{11}$$

$$IP_{i.t} = IP_{i.t}\left(GRP_{i.t-1}, KP_{i.t-1} \right) \tag{12}$$

$$NW_{i.t} = NW_{i.t}\left(POP_{i.t} \right) \tag{13}$$

$$GRE_t = CP_t + \sum_i IP_{i,t} + IHP_t + CG_t + IG_t + \Delta IG_t + Z_t + E_t - M_t \tag{14}$$

$$IHP_t = IHP_t\left(POP_t \right) \tag{15}$$

$$YH_t = YH_t\left(GRP_t \right) \tag{16}$$

where,

i	: industry (1: primary industry, 2: secondary industry, 3: tertiary industry),
GRP	: realized gross regional product,
X	: regional potential productivity,

GRE	: gross regional expenditure,
ROW	: the rate of capital utilization,
KP	: private capital stock,
LHR	: the average working hours,
NW	: the number of workers,
η	: depreciation rate of private capital stock,
IP	: private capital investment,
Z	: inventory increase,
M	: import,
IHP	: private housing investment,
CG	: public consumption expenditure, and
IG	: public capital investment.

3. EMPIRICAL ANALYSIS FOR ISHIKAWA PREFECTURE AND HOKURIKU SHINKANSEN

3.1 Change in the Number of Tourists and Expenditure per Person from Outside the Region

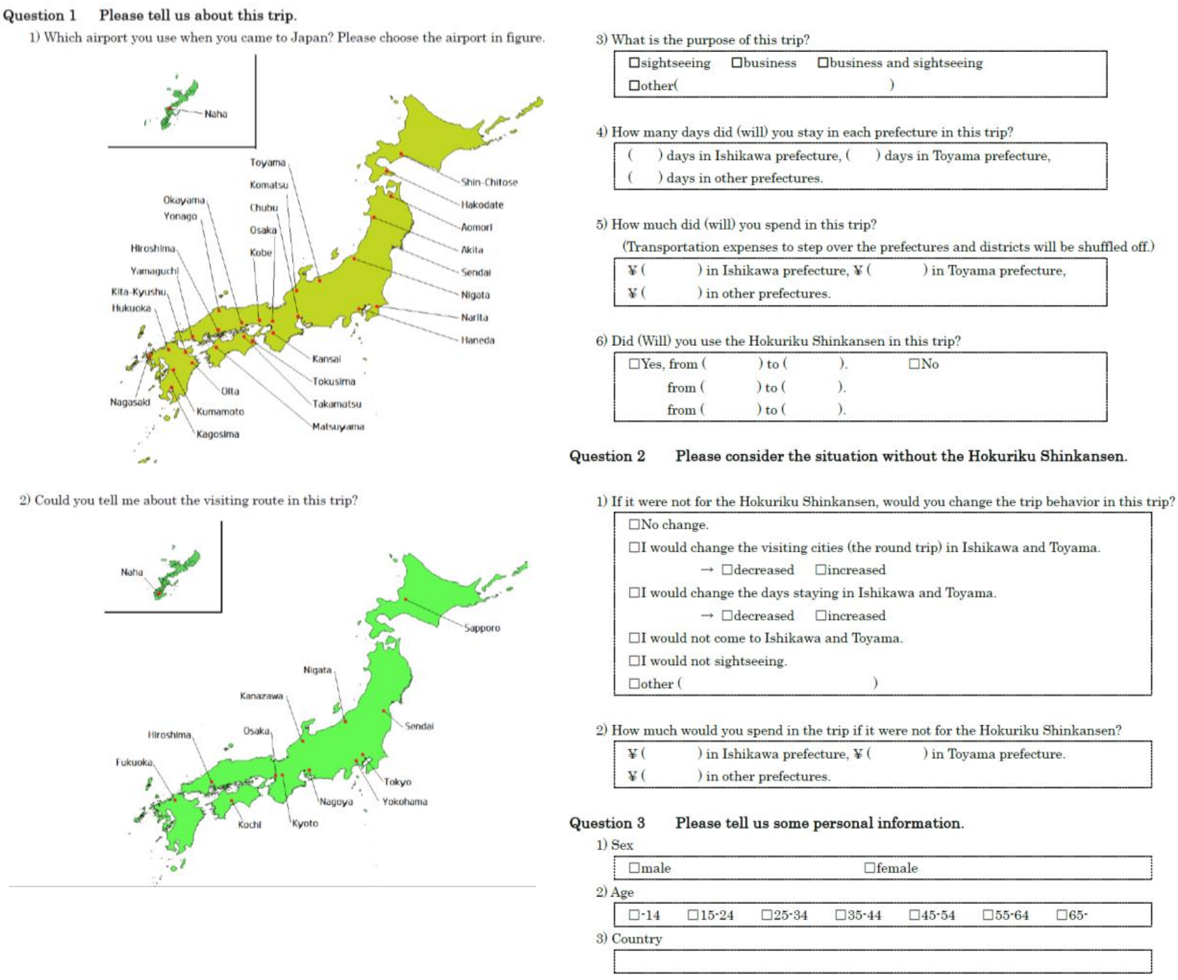
3.1.1 Change in the number of tourists

For the number of visitors from outside the region from 2002 to 2014, we use statistical data from the Japan Tourism Agency (Common Standards for Statistics on Tourists, 2002–2014). The number of tourists for 2015 and thereafter in the case with Hokuriku Shinkansen is estimated using Japan Tourism Agency's actual numbers of tourists for 2014 and the number of tourists for 2015 (cumulative total) which is published by the Tourism Planning Section of Ishikawa Prefecture's Tourism Strategy Promotion Department. The number of tourists for 2015 and thereafter in the case without Hokuriku Shinkansen is assumed to be equal to the number for 2014.

3.1.2 Change in expenditure per person

To understand how development of Hokuriku Shinkansen affected sightseeing activity and consumption expenditure, we hired an external research firm to conduct an online survey in November 2015 for people who registered as monitor of the firm and took the Shinkansen line to visit Ishikawa Prefecture for sightseeing after April 2015. We set the number of respondents to 300 considering statistical significance. The survey asked respondents about the duration of their sightseeing trip (number of days), their sightseeing activities, spending by prefecture, and what tourism activity they would have engaged in if Hokuriku Shinkansen did not exist. Figure 3 presents the questionnaire survey sheet.

An online questionnaire survey could not grasp sightseeing activity and tourism consumption expenditure of foreign tourists, so we conducted interviews with foreign tourists in Ishikawa Prefecture's Kanazawa City (at Kanazawa Station, Kenrokuen Garden, and Kanazawa Castle) from December 4 Friday, 2015 to December 5 Saturday, 2015. The interview questions were the same as those for the online survey. The number of respondents was 26.



Question 1 Please tell us about this trip.

1) Which airport you use when you came to Japan? Please choose the airport in figure.

2) Could you tell me about the visiting route in this trip?

3) What is the purpose of this trip?

☐sightseeing ☐business ☐business and sightseeing
☐other( )

4) How many days did (will) you stay in each prefecture in this trip?

( ) days in Ishikawa prefecture, ( ) days in Toyama prefecture,
( ) days in other prefectures.

5) How much did (will) you spend in this trip?

(Transportation expenses to step over the prefectures and districts will be shuffled off.)

¥ ( ) in Ishikawa prefecture, ¥ ( ) in Toyama prefecture,
¥ ( ) in other prefectures.

6) Did (Will) you use the Hokuriku Shinkansen in this trip?

☐Yes, from ( ) to ( ). ☐No
from ( ) to ( ).
from ( ) to ( ).

Question 2 Please consider the situation without the Hokuriku Shinkansen.

1) If it were not for the Hokuriku Shinkansen, would you change the trip behavior in this trip?

☐No change.
☐I would change the visiting cities (the round trip) in Ishikawa and Toyama.
→ ☐decreased ☐increased
☐I would change the days staying in Ishikawa and Toyama.
→ ☐decreased ☐increased
☐I would not come to Ishikawa and Toyama.
☐I would not sightseeing.
☐other ( )

2) How much would you spend in the trip if it were not for the Hokuriku Shinkansen?

¥ ( ) in Ishikawa prefecture, ¥ ( ) in Toyama prefecture.
¥ ( ) in other prefectures.

Question 3 Please tell us some personal information.

1) Sex

☐male ☐female

2) Age

☐-14 ☐15-24 ☐25-34 ☐35-44 ☐45-54 ☐55-64 ☐65-

3) Country

Figure 3. Questionnaire survey sheet for tourists to Ishikawa Prefecture by Shinkansen

Table 1 shows the descriptive statistics of the rate of change in consumption expenditure between the cases with and without Hokuriku Shinkansen collected by the questionnaire surveys.

Table 1. The descriptive statistics of the rate of change in consumption expenditure collected by the questionnaire surveys

(%)

	from other regions in the country		from overseas
	day-trippers (N=26)	trippers staying overnight (N=115)	trippers staying overnight (N=9)
Max	0.00	40.23	0.00
Min	0.00	0.00	0.00
Average	0.00	1.06	0.00
Standard deviation	0.00	5.74	0.00

Note: The number of respondents does not contain respondents who would not come to Ishikawa Prefecture if it were not for Hokuriku Shinkansen.

We estimate the consumption level after the Shinkansen went into operation using expenditure per person for 2014 according to the Japan Tourism Agency and the rate of change in consumption expenditure between the cases with and without Hokuriku Shinkansen obtained from the online and interview surveys. The results are shown in Table 2. Here, we assume that expenditure per person of tourists from within Ishikawa Prefecture remained unchanged. We also assume that all tourists from overseas stayed overnight.

Table 2. Estimation results of expenditure per person without and with development of Hokuriku Shinkansen

(yen)

	from within Ishikawa Prefecutre		from other regions in the country		from overseas	
	day-trippers	trippers staying overnight	day-trippers	trippers staying overnight	day-trippers	trippers staying overnight
without	22,726	5,229	10,212	31,859	−	67,877
with	22,726	5,229	10,212	32,198	−	67,877

Note: The exchange rate 1 Japanese yen = 0.008808 US$ (on July 7, 2017).

Expenditure per person of tourists staying overnight from other regions in the country with Hokuriku Shinkansen is larger than that without Shinkansen. In the case with Shinkansen, tourists from other regions in the country may increase consumption in Ishikawa Prefecture because of decrease in travel time to Ishikawa Prefecture and increase in staying time.

3.2 Parameter Estimation

To estimate parameters for each function of the regional econometric model, we collect the time-series data of explained variables and explanatory variables for fiscal 2001-2012 from sources such as the Annual Report on Prefectural Accounts (Cabinet Office of Japan). Table 3 shows the data sources and descriptive statistics for each variable.

Using time-series data to estimate the parameters for each function requires that data of the explained variable and all explanatory variables are stationary. For example, in Equation (17) time series data x are stationary if parameter ρ is not 1. If the time-series data are not stationary, the result of the parameter estimates has little reliability.

$$x_t = \rho x_{t-1} + \varepsilon_t \tag{17}$$

where,

ε : the error term.

We use ADF (Augmented Dickey-Fuller) test to verify stationarity referencing Maddala (1992). ADF test examines whether ρ equals 1 in Equation (18) which considers constant term, trend term and lag terms.

$$x_t = \alpha + \beta t + \rho x_{t-1} + \sum_{j=1}^{k} \theta_j \Delta x_{t-j} + \varepsilon_j \tag{18}$$

Table 3. The data sources and descriptive statistics for each variable

	Industry	Source	Unit	Max	Min	Average	Standard Deviation
$NT1^L$		Tourist statistics by the common standard (Tourism Agency)	people	1,658,260	1,074,381	1,208,874	157,114
$NT1^D$		Tourist statistics by the common standard (Tourism Agency)	people	5,812,000	3,041,000	4,236,370	911,592
CP^{Other}		Prefectural Accounts (Cabinet Office)	million Yen	3,038,242	2,723,554	2,876,837	97,940
E^{other}		Prefectural Accounts (Cabinet Office)	million Yen	3,710,980	2,948,439	3,323,545	249,284
GDP		National Accounts (Cabinet Office)	million Yen	525,469,900	474,685,400	503,371,817	15,219,922
POP		Prefectural Accounts (Cabinet Office)	people	1,181,868	1,162,919	1,173,381	5,439
IHP		Prefectural Accounts (Cabinet Office)	million Yen	166,088	101,917	137,184	22,582
YH		Prefectural Accounts (Cabinet Office)	million Yen	2,980,752	2,711,058	2,855,797	100,823
GRP		Prefectural Accounts (Cabinet Office)	million Yen	4,910,208	4,509,697	4,705,417	117,562
KP_i	Primaty	Prefectural Accounts (Cabinet Office)	million Yen	1,558,844	1,447,841	1,490,127	28,572
	Secondary	Prefectural Accounts (Cabinet Office)	million Yen	3,638,054	3,066,467	3,293,868	189,075
	Tertiary	Prefectural Accounts (Cabinet Office)	million Yen	5,280,552	4,620,026	5,030,430	202,972
IP_i	Primaty	Prefectural Accounts (Cabinet Office)	million Yen	6,554	4,780	5,741	554
	Secondary	Prefectural Accounts (Cabinet Office)	million Yen	167,409	102,632	140,859	18,391
	Tertiary	Prefectural Accounts (Cabinet Office)	million Yen	449,917	345,045	395,558	34,457
NW_i	Primaty	Prefectural Accounts (Cabinet Office)	million Yen	22,213	19,204	20,927	1,181
	Secondary	Prefectural Accounts (Cabinet Office)	million Yen	193,759	161,204	175,516	9,343
	Tertiary	Prefectural Accounts (Cabinet Office)	million Yen	411,833	406,659	408,755	1,264
LHR_i	Secondary	Monthly labor statistical survey (MHLW)	million Yen	103.6	94.1	101.2	2.4
	Tertiary	Monthly labor statistical survey (MHLW)	million Yen	108.1	98.0	102.5	3.1
ROW_i	Secondary	Indices of Industrial Production (METI)	million Yen	109.6	73.3	94.8	12.0
	Tertiary	Indices of Tertiary Industry Activity (METI)	million Yen	103.8	99.2	101.7	1.6
FXS		Financial Markets (Bank of Japan)	yen/US$	125.1	79.0	104.4	15.1

Note: MHLW indicates Ministry of Health, Labor and Welfare. METI indicates Ministry of Economy, Trade and Industry.

We regard the data as stationary when the p value of ρ is less than 0.15. If the original data are not stationary, we examine whether the first difference data of the variable are stationary. Table 4 gives the results of the stationarity test. Values in Table 4 indicate the p values for the original data and the first difference data. As results of the test, the original data are not stationary and the first difference data are stationary for private capital stock for secondary industry and gross regional product while the original data of other variables are stationary.

We specified each function to estimate the parameters considering the results of the test. In equation (16), we reformulate the function with variables taking the first difference. As for equation (11), because it is the definition of private capital stock, we estimate the original function. The specified functions are shown in equations (3)'-(16)'. Here, we use the cobb-douglas function for the production function (Equation (10)') while the linear functions are used for other functions following the functions of previous studies such as Sato (2015).

$$NT1_t^L = \beta YH_t + \delta DUM1_t \tag{3'}$$

$$NT1_t^D = \beta YH_t + \delta DUM2_t \tag{4'}$$

$$\frac{CP_t^{Other}}{POP_t} = \alpha + \beta \frac{YH_t}{POP_t} + \delta DUM3_t \tag{5'}$$

$$E_t^{Other} = \alpha + \beta GDP_t + \gamma FXS_t \tag{8'}$$

$$\ln\left(\frac{X_{i.t}}{ROW_{i.t} \cdot KP_{i.t}}\right) = \alpha + \beta \ln\left(\frac{LHR_{i.t} \cdot NW_{i.t}}{ROW_{i.t} \cdot KP_{i.t}}\right) + \delta DUM4_t \tag{10'}$$

$$KP_{i.t} - IP_{i.t} = \beta KP_{i.t-1} \qquad (11)'$$

$$IP_{i.t} = \alpha + \beta GRP_{i.t} + \gamma KP_{i.t-1} + \delta\, DUM5_{i,t} \qquad (12)'$$

$$NW_{i.t} = \alpha + \beta POP_{t} + \gamma GRP_{i.t-1} + \delta\, DUM6_{i,t} \qquad (13)'$$

$$IHP_{t} = \beta POP_{t} + \delta\, DUM7_{t} \qquad (15)'$$

$$YH_{t} - YH_{t-1} = \alpha + \beta\left(GRP_{t} - GRP_{t-1}\right) + \delta\, DUM8_{t} \qquad (16)'$$

Table 4. The results of the stationarity test

	Industry	Original	Constant	Trend	MaxLag	First difference	Constant	Trend	MaxLag
$NT1^{L}$		0.003	✓	✓	1	-	-	-	-
$NT1^{D}$		0.123	✓	✓	3	-	-	-	-
CP^{Other}/POP		0.065	✓		0	-	-	-	-
YH/POP		0.080	✓	✓	1	-	-	-	-
E^{Other}		0.005	✓		2	-	-	-	-
GDP		0.004	✓	✓	1	-	-	-	-
FXS		0.043	✓		1	-	-	-	-
$\ln\left(\frac{X_i}{ROW_i \cdot KP_i}\right)$	Primaty	0.004	✓		4	-	-	-	-
	Secondary	0.029	✓		3	-	-	-	-
	Tertiary	0.071	✓		3	-	-	-	-
$\ln\left(\frac{LHR_i \cdot NW_i}{ROW_i \cdot KP_i}\right)$	Primaty	0.000	✓		4	-	-	-	-
	Secondary	0.000	✓		4	-	-	-	-
	Tertiary	0.001	✓		3	-	-	-	-
KP_i - IP_i	Primaty	0.000	✓		4	-	-	-	-
	Secondary	0.001	✓		4	-	-	-	-
	Tertiary	0.000	✓		4	-	-	-	-
KP_i	Primaty	0.117	✓		2	-	-	-	-
	Secondary	0.158	✓	✓	3	-	-	-	-
	Tertiary	0.125	✓		4	-	-	-	-
IP_i	Primaty	0.041	✓		4	-	-	-	-
	Secondary	0.113	✓		1	-	-	-	-
	Tertiary	0.053	✓		3	-	-	-	-
GRP_i	Primaty	0.035	✓		2	-	-	-	-
	Secondary	0.097	✓		3	-	-	-	-
	Tertiary	0.000	✓		4	-	-	-	-
NW_i	Primaty	0.041			0	-	-	-	-
	Secondary	0.001	✓		1	-	-	-	-
	Tertiary	0.001	✓	✓	2	-	-	-	-
POP		0.000			0	-	-	-	-
IHP		0.042			1	-	-	-	-
YH		0.000	✓	✓	4	0.022	✓		1
GRP		0.156	✓		1	0.099	✓		0

Note: Each figure in "original" and "first difference" columns indicates the probability that each variable is not stationary (p value).
Each check mark in "Constant" and "Trends" columns indicates that constant term and parameter of trend term in the estimated function are not 0 respectively, while each figure in "MaxLag" column indicates maximum degree of lag terms in the estimated function.
indicates beeing not stationary at 15% level.

Parameter estimation results are shown in Table 5.

Table 5. The results of parameter estimations

	Industry	α	β	γ	δ	D.W.	R^2	Estimated Period
(3)'			0.3945		422,462	2.580	0.751	2002-2012
			(39.647**)		(6.306**)			
(4)'			1.3153		1,696,734	0.902	0.762	2002-2012
			(21.626**)		(5.075**)			
(5)'		0.9398	0.5867		0.1532	3.209	0.860	2004-2012
		(1.891)	(2.937**)		(5.635**)			
(8)'		-7,329,383	0.0197	6,507		2.009	0.911	2002-2012
		(-6.122)	(9.050**)	(6.204**)				
(10)'	Primaty	-2.2060	0.7149		0.0959	2.518	0.623	2001-2012
		(-2.161)	(2.991**)		(2.614**)			
	Secondary	0.3164	0.5597			1.017	0.902	2001-2012
		(1.653)	(8.567**)					
	Tertiary	1.0184	0.4341			1.341	0.828	2001-2012
		(6.491)	(6.928**)					
(11)'	Primaty		0.9995			1.501	0.999	2002-2011
			(207.863**)					
	Secondary		0.9645			2.014	0.998	2002-2012
			(81.482**)					
	Tertiary		0.9304			2.581	0.999	2002-2012
			(166.327**)					
(12)'	Primaty	720	0.1063		-962	1.662	0.740	2002-2012
		(0.427)	(3.138**)		(-4.094**)			
	Secondary	-3,250	0.1250		-21,681	1.581	0.898	2002-2012
		(-0.116)	(5.578**)		(-4.716**)			
	Tertiary	716,787		-0.0692	61,289	1.957	0.949	2002-2012
		(10.415)		(-5.063**)	(10.751**)			
(13)'	Primaty		0.0168		2,060	1.967	0.875	2002-2012
			(95.318**)		(7.361**)			
	Secondary		0.1471		17,694	1.154	0.634	2001-2012
			(88.010**)		(3.684**)			
	Tertiary	385,037		0.0078	-3,117	0.927	0.717	2002-2012
		(21.456)		(1.494**)	(-4.165**)			
(15)'			0.0927		42,595	0.985	0.831	2001-2012
			(21.317**)		(6.814**)			
(16)'		10,827	0.1953		52,983	2.365	0.738	2002-2012
		(1.328)	(3.281**)		(2.721*)			

Note: The figures in parentheses indicate the t value.
**indicates signficance at 1%level and *indicates signficance at 5%level.
DUM 1:1(2002-2003), 0(other years)
DUM 2:1(2008-2010), 0(other years)
DUM 3:1(2005-2008), 0(other years)
DUM 4:1(2006-2008), 0(other years)
DUM 5(Primaty):1(2008-2010), 0(other years)
DUM 5(Secondary):1(2008-2011), 0(other years)
DUM 5(Tertiary):1(2004-2007, 2012), 0(other years)
DUM 6(Primaty):1(2002-2007), 0(other years)
DUM 6(Secondary):1(2001-2002), 0(other years)
DUM 6(Tertiary):1(2002-2011), 0(other years)
DUM 7:1(2002-2008), 0(other years)
DUM 8:1(2005-2006), 0(other years)

3.3 Comparison of Estimated and Actual Values

Figure 4 shows the comparison of estimated and actual values for gross regional product in Ishikawa Prefecture from 2002 to 2012 using the model that employs the all functions that we estimated. The mean absolute percentage of error (MAPE) for the estimated values and the actual values is 1.075%, so the model is considered to possess good replicability.

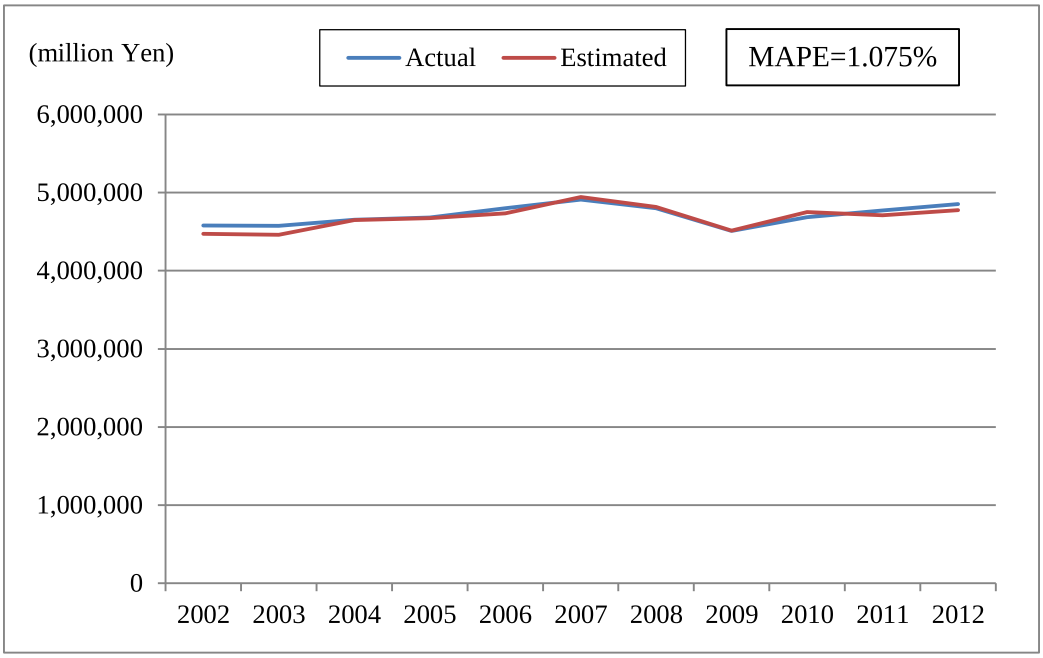


Figure 4. Comparison of estimates and actual data for gross regional product

3.4 Simulation Analysis

Running a simulation using the regional econometric model that we built enables us to analyze the Shinkansen line's impact on the regional economy. In the analysis, we regard the construction cost of the Shinkansen as an increase in public capital investment for each year of the construction period, and assume that the transportation network will not change after the opening of the Shinkansen between Takasaki and Kanazawa in 2015. As population data after 2013 in Equation (5)', (13)' and (15)', data from the National Institute of Population and Social Security Research of Japan are used considering the future population decline. As for other exogenous variables such as *CG*, *Z*, *ROW* and *LHR*, it is assumed that the values after 2013 equal to the values in 2012.

Figure 5 shows the result of the simulation for GRP in the cases with and without Hokuriku Shinkansen from 2002 to 2040. Table 6 shows the impact of development of Hokuriku Shinkansen on Ishikawa Prefecture's gross regional product and per-capita household disposable income from 2002 to 2040.

The increase in gross regional product is approximately 60.3 billion yen (531 million US$) in 2014 (the year before the Hokuriku Shinkansen was opened between Takasaki and Kanazawa) and approximately 22.7 billion yen (200 million US$) in 2015 (the year of the line's opening). This indicates that the flow effect per year of developing Hokuriku Shinkansen is greater than the stock effect per year. We can also see that construction of Hokuriku Shinkansen helps increase gross regional product and per-capita household disposable income.

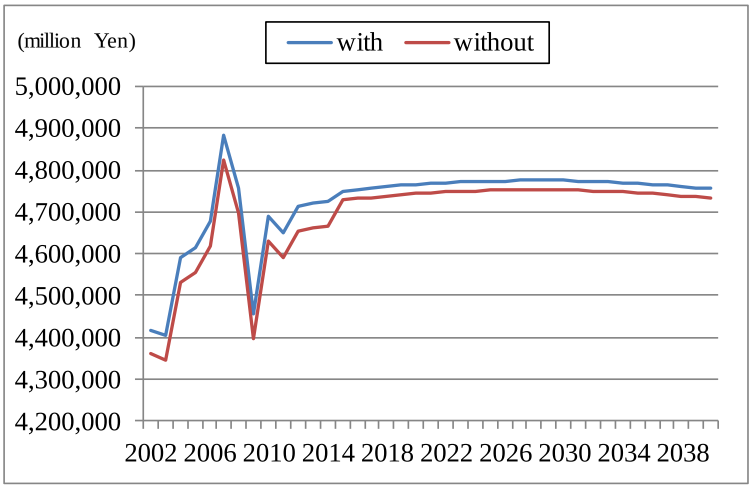


Figure 5. Gross regional product in the cases with and without Hokuriku Shinkansen

Table 6. The impacts of development of Hokuriku Shinkansen

	Gross regional product (million Yen)	Household disposable income per person (Yen)
2002	56,769	9,379
2003	57,789	9,567
2004	58,037	9,622
2005	58,299	9,696
2006	58,591	9,753
2007	58,876	9,802
2008	58,985	9,826
2009	58,681	9,788
2010	59,375	9,910
2011	59,697	9,994
2012	59,857	10,050
2013	60,106	10,120
2014	60,296	10,182
2015	22,659	3,838
2016	22,166	3,769
2017	22,180	3,789
2018	22,206	3,810
2019	22,232	3,831
2020	22,256	3,853
2021	22,278	3,878
2022	22,299	3,904
2023	22,319	3,929
2024	22,338	3,956
2025	22,356	3,982
2026	22,372	4,012
2027	22,388	4,043
2028	22,402	4,072
2029	22,415	4,102
2030	22,429	4,133
2031	22,439	4,167
2032	22,449	4,202
2033	22,458	4,237
2034	22,467	4,272
2035	22,474	4,307
2036	22,479	4,347
2037	22,484	4,386
2038	22,488	4,427
2039	22,491	4,467
2040	22,494	4,508

4. CONCLUSION

We used Ishikawa Prefecture data on tourists in 2015 and the results of questionnaire surveys of domestic and overseas tourists to calculate how development of Hokuriku Shinkansen affects tourism consumption spending in Ishikawa Prefecture. Furthermore, we built a regional econometric model that considers tourism consumption expenditure focusing on Ishikawa Prefecture to analyze how development of Hokuriku Shinkansen affects the regional economy in Ishikawa Prefecture. According to the results of our analysis, development of Hokuriku Shinkansen causes gross regional product to increase by about 60 billion yen (528 million US$) during the construction period and by about 22 billion yen (194 million US$) after the opening, indicating that the flow effect per year is more than the stock effect per year. However, the stock effect will continue as long as the Shinkansen is in service. Besides, the Tsuruga to Shin-Osaka section which is planned to be open in 2046 will connect the Japanese best sightseeing cities such as Kyoto, Osaka and Kanazawa so that remarkable increase in the number of tourists and the economic effects along the line are expected.

Although this study focused on regional economic impact of development of Shinkansen caused by increase in the number of tourists, development of high speed rail may also change location of firms, behavior of residents, etc., and these changes may have regional economic effects. Besides, it is considered that development of Hokuriku Shinkansen increases the number of tourists not only in Ishikawa Prefecture but also in Toyama and other prefectures along the rail line so that the economies of these prefectures benefit as well. Future research could entail developing a model considering changes in not only the number of tourists but also location of firms, behavior of residents, etc., and building a model that focuses on the other prefectures along Hokuriku Shinkansen.

ACKNOWLEDGEMENT

This study was supported by JSPS KAKENHI Grant Number JP15K06257. We wish to express our gratitude to the support.

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