Analyzing Effects of Mega Transportation Projects on Regional Economies of Northeast Asian Countries

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ABSTRACT

We develop a Multinational Multiregional Computable General Equilibrium (MMCGE) Model to analyze economic impacts of the Asian Highway 1 and Korea-Japan Tunnel on regional economic growth of Northeast Asian countries. The growth sources from the construction of the highway originating from Japan to China via Korean peninsula are classified into two components; (1) reduction in the travel time (cost), and (2) a decrease in transportation cost per time (distance). The direct and indirect effects on economic benefits are generated through the supply and demand linkages among economic agents. Overall, the construction of missing link of Asian Highway #1 in North Korea's section and Korea-Japan Tunnel has the large effects on the GRP of Dongbei in China, Seoul Area in Korea, and Kyushu in Japan. The simulation of the MMCGE model can provide public agents and stockholders with analytical and strategic insights into the investment efficiency, effectiveness and priority of the highway project in terms of income growth. This numerical model is expected to practically assess transportation investment programs and development strategies with the national and regional economic goals.

Key words: cross-border cooperation, infrastructure investment, regional economic growth

JEL code: O18, R11, F42

1. Introduction

Since the early 1990s, there have been lots of discussions on how to make an economic complementarity among Northeast Asian countries for transnational economic development; human resources and labor supplies of China, investment and management experiences of Japan, and technology and production capacities of South Korea (Korea hereafter). They have made themselves economically dependent on each other, implementing outward-looking development policies aimed at promoting trades. Although Korea is geographically separated from China by North Korea and from Japan by the East Sea (Sea of Japan), these regional production networks and supply chains have contributed to increasing development potentials to them all. They have resulted from expansion of scopes of spatial markets for goods and services, exploitation of economies of scale and industrial specialization, enhancement of regional competitiveness, and reduction in trade and production costs (ADB, 2015). The economic cooperation would be more intensified with deregulations on trade and investments, and the development of the transportation network such as Asian Highway Network (AHN).

The transportation costs and travel distance are the main output of the transportation network and system. They determine the locational advantage of an area relative to others, affecting the benefits of households and firms to use transportation infrastructure services. They can be transformed into a spatial accessibility which positively depends on the activities or opportunities of the origin and the destination and negatively on the time, the distance or the cost (see Appendix). The reduction in the transportation and trade costs or the improvement in the spatial accessibility have positive effects on the interregional specialization, as theoretically discussed in Krugman (1991), Deardorff (1995), Henderson et al. (2001), Hummels et al. (2001), Venables and Limao (2002). In particular, the impacts of the transportation investments on the economic growth tend to be clearly positive through lowering unit transportation costs and reducing shipment and logistic times. For example, the ADB (2015) found that the increase in the income from a 5% reduction in transportation costs between Southeast Asia and South Asia through 2030 could be 1.4% of Gross Domestic Product (GDP) for South Asia (roughly $59 billion) and 1.0% of GDP for Southeast Asia (roughly $30 billion) higher than the estimated costs. If transportation costs were reduced by 15%, net benefits would increase dramatically to 5.7% of GDP for South Asia (roughly $240 billion) and 3.9% of GDP for Southeast Asia (roughly $118 billion). This AHN consists of multinational projects to maximize service potentials of existing highways with new construction of missing routes, thus increasing interregional trades and interactions, and connectivity of major container terminals.

Among the links, the Asian Highway 1 (AH1) is the longest route running 20,557 kilometers (12,774 miles) to extend from Tokyo to the border between Turkey and Bulgaria west of Istanbul, passing through South and North Koreas, China and other countries in Southeast, Central and South Asia.

The purpose of this paper is to analyze impacts of the development of the AH1 on the regional economic growth of Korea and China. We develop a Multinational Multiregional Computable General Equilibrium (MMCGE) Model for 20 regions of three nations (seven regions of China, nine regions of Japan, and four regions of Korea). In general, the CGE model is an analytical and numerical tool based on Walrasian equilibrium theory to estimate the impacts of economic policies on growth and regional equity. The model accounts for functional interactions of economic agents in a market-based system, and has been applied to development issues such as public finance, structural adjustment, trade liberalization, human capital and education, labor market and migration, infrastructure investment, climate change, and population ageing. This MMCGE model is composed of several blocks of production, consumption, savings and investment, government revenue and expenditure, foreign and interregional trade, and capital mobility in the real side economy. The growth sources from the construction of the highway originating from Korea to China via North Korea are classified into three components such as (1) reductions in the travel times (costs), (2) and in transportation cost per time (distance), and (3) an increase in the regional investments on border lines of Capital Area of Korea and Dongbei of China. The direct and indirect effects on economic benefits are generated through the supply and demand linkages among economic agents. In addition, this paper attempts to explicitly include an economic activity of transportation sector at each national level and a FOB/CIF price structure based on a spatial price equilibrium in the MMCGE model. This MMCGE model has two distinguishing features from conventional analytical tools such as production and cost functions to assess the long-term effects of transportation investments. One is to carry out the evaluation of economic policies in a general equilibrium framework that incorporates factor mobility and institutional rigidities in the real side of regional markets. Another is to measure the economic impacts of transportation investments using the travel time (distance) based on the transportation network (quality side) as well as investment amounts (quantity side). The paper shows how the reduction in the travel time (distance) though improvement in the transportation network affect economic behavior of consumers and producers and how these decisions in turn shape the spatial distribution of economic activities. The benchmark year of the MMCGE model is 2005, the most recent year that a Transnational

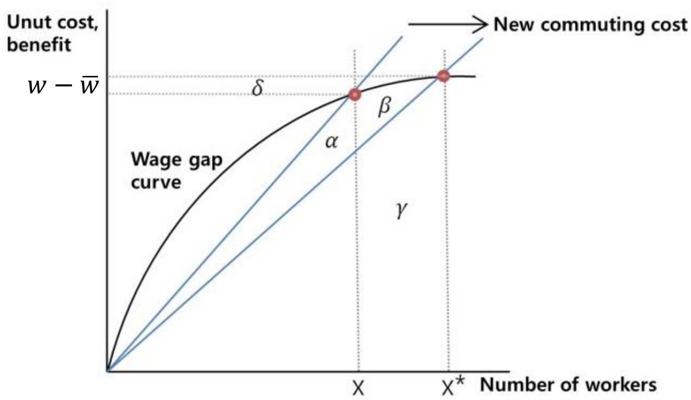
Interregional Input-Output Table for China, Japan and Korea by IDE (2015) was available. The rest of the paper is structured as follows. Major research studies are reviewed on the Asian Highway projects and impact analysis of transportation investments in the next section. Section 3 develops the MMCGE model for the investment analysis of the AH1 highway, and carries out counterfactual simulations as case studies. Conclusions and suggestions for further research are discussed in the final section.

2. Economic Impacts of Transportation Investments and Asian Highway System

1) Transportation Investments and Regional Growth

In general, the transportation investment has both generative and distributive effects on economic activities in terms of space. Moreover, these effects can be classified into construction (temporary or short-term) and operation and maintenance (structural or long-term) impacts with respect to time span. The former refers to impacts of investment expenditures on outputs and prices through the demand channel of the commodity and service markets during the construction phase. The latter includes the increase in the production potential and the reduction in the average production costs as a result of the relocation of economic activities to the places where utility and profit levels of economic agents can be maximized during the operation and maintenance phase (Kim *et al.*, 2004). These long-term benefits arise from a combination of direct and indirect effects. The sources of direct effects are reductions in travel times and transportation costs, and those of the indirect effects are concerned with changes in productivities, location patterns, industrial agglomeration, spatial range of commuting and travel behavior, migration, spatial business opportunity, and knowledge sharing (Koike et al., 2015; Koopmans and Oosterhaven, 2011).

The transportation investment typically changes the effective density of people and jobs that are accessible to the economy of that area with associated implications for productivity and efficiency (Graham, 2006). Venables (2007) developed a computational model of an urban economy that links productivity to transportation investment via effects on city size. The theoretical model illustrated net gains from transportation improvement with agglomeration externalities. (Figure1) The vertical axis of which measures costs and benefits per worker, and the horizontal axis measures the number of workers who each occupy one unit of land in a linear city with linear commuting costs. The horizontal axis is therefore also distance from the CBD, point 0. In figure the upward sloping rays through the origin are the costs of commuting to the CBD from each of these locations. The wage gap between city workers and outsiders is constant at $(w - \overline{w})$, illustrated by the horizontal line. The size of the city is determined at point X, where the wage gap is equal to the commuting costs of the most distant city worker. At point X, no further workers want to be employed in the city. Workers located closer to the CBD face lower commuting costs but higher rents, as given by the distance between the horizontal line $(w - \overline{w})$ and the commuting cost curve. Clearly there is a rent gradient, with rents falling from the center to the edge of the city. When a transportation improvement is made commuting costs are shifted downwards and consequently the city expands to point X*. The total change in the resources used in commuting is $\gamma - \alpha$, which combined with the change in output $(\beta - \gamma)$, yields a net benefit from the transportation improvement of $\alpha + \beta$. Venables (2007) considers the implications of the existence of a city size–productivity gradient. If larger cities have higher productivity due to agglomeration externalities then the wage gap can be expressed, not as a constant gap, but as a concave curve that increases with city size. Equilibrium is found at the intersection of the commuting cost and wage gap curves. The fact that productivity is non-constant with respect to city size means that the real income gain from a transportation improvement is $\alpha + \beta + \delta$; where δ measures the increase in productivity experienced by city workers and is akin to a measure of the elasticity of productivity with respect to city size. In this way Venables (2007) demonstrated that there were external benefits from transportation investment related to agglomeration and that these could be quantified from elasticities of productivity with respect to some measure of urban density. Of course, the assumption is that transportation investment raises densities or increases city size.



Area α Direct cost saving
Area β Extra output from new city workers
Area γ Commuting cost of new city workers
Area δ Induced productivity gain

Figure 1 Net Gain from Transportation Improvement with Endogenous Productivity

2) Asian Highway System

The AHN is a regional transport cooperation initiative aimed at enhancing the efficiency and development of the road infrastructure in Asia, supporting the development of Euro-Asia transport linkages and improving connectivity for landlocked countries. The AH project was initiated in 1959. During the first phase of the project (1960-1970) considerable progress was achieved, however, progress slowed down when financial assistance was suspended in 1975. Entering into the 1980s and 1990s, regional political and economic changes spurred new momentum for the AH project. It became one of the three pillars of Asian Land Transport Infrastructure Development (ALTID) project, endorsed by the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) Commission at its forty-eight session in 1992, comprising Asian Highway, Trans-Asian Railway (TAR) and facilitation of land transport projects (ABDI, 2009). The ESCAP initiated the ALTID project with the aim of improving and expanding transport and communications links within the region, as well as with other regions. At the initial stages of the ALTID project implementation, the main emphasis was placed on the formulation of the AH and TAR networks and the establishment of related standards and requirements. AH and TAR could become the major building blocks of the development of an international integrated intermodal transport system in Asia and beyond (ABDI, 2009).

The process of identifying the AH routes began in the late 1950s, but it has only seen relatively better progress only after 1992 when the ALTID project was initiated. Initially, 69,000 km of AH routes were identified with the participation of 18 member countries: Afghanistan, Bangladesh, Cambodia, the CHINA, India, Indonesia, the Islamic Republic of Iran, Lao PDR, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, and Viet Nam (ESCAP, 1995). From 1995 to 2002, an additional 72,000 routes were identified and added to the AH7 with participation of new members from Central Asia and the South Caucasus, the Russian Federation, and the remaining part of Asia. These routes formed the northern corridor of the AH, effectively linking Northeast Asia with Central Asia, the Caucasus, and Europe. Finally, with the participation of Japan in 2003, the entire network of the AH was extended to cover a total of 141,000 km of highways in 32 countries.

Figure 2 Asian Highway Network

With progress in the formulation of the AH, it was considered necessary to formalize the network through an inter-governmental agreement to ensure effective coordination of national planning with regional requirements and regular region-wide reviews and updating of the network. Following a series of negotiation meetings among experts and representatives of member states, the Inter-governmental Agreement on the AH Network was adopted at an inter-governmental meeting held in November 2003, followed by a signing ceremony organized during the 68th session of ESCAP in Shanghai, China in April 2004. Finally, the Inter-governmental Agreement on the AH Network entered into force on 4 July 2005, and as of 31 March 2008, the agreement has been signed by 28 countries, of which 22 are contracting parties. The main obligations of the contracting parties to the AH agreement are to adopt the AH network as a coordinated plan for the development of highway routes of international importance, to bring the AH routes in their respective countries in conformity with classification and design standards as provided by the agreement, and to facilitate navigation along the routes through the placement of adequate signage. Based on the agreement, the AH network consists of highway routes of international importance within Asia, including those that are (i) substantially crossing more than one subregion; (ii) located within subregions, including those connecting to neighboring subregions; (iii) and located within member states and providing access to capitals; main industrial and agricultural centers; major air, sea, and river ports; major container terminals and depots; and major tourist attractions. The upgrading and development of the AH has been receiving priority attention from member countries and is being incorporated into national plans. For example, the Fourth Five-year Development Plan (2005–2009) of the Islamic Republic of Iran envisages development of the AH; the AH routes have received priority attention in the Association of Southeast Asian Nations (ASEAN), with the result that the AH routes in Indonesia, Malaysia, Singapore, and Thailand now conform to the AH or higher standards, and all AH routes in Cambodia and Lao PDR are committed for upgrading with construction in progress; the AH connecting four metropolitan cities, New Delhi, Mumbai, Kolkata, and Bangalore, and the North-South corridor are being upgraded to four lanes under the National Highways Development Project in India; the international community is assisting Afghanistan in rehabilitating and restoring most of the AH routes to re-establish regional connectivity; Mongolia is implementing the Millennium Road Project which includes the development of all AH routes in Mongolia; and China is developing 35,000 km of a high-standard national truck highway system which includes the majority of AH routes in China. The AH will continue to serve as a coordinated plan for the development of the road network in Asia, being given priority for development, upgrading, and financing.

Table 1 Signatories of Asian Highway Network (as of 31 March 2009)

No	Signatory	Date of signature	Date of entry into force
1	Afghanistan	26 April 2004	8 April 2006
2	Armenia	26 April 2004	5 September 2005
3	Azerbaijan	28 April 2004	3 August 2005
4	Bhutan	26 April 2004	16 November 2005
5	Cambodia	26 April 2004	4 July 2005
6	PRC	26 April 2004	4 July 2005
7	Georgia	26 April 2004	9 March 2006
8	India	27 April 2004	17 May 2006
9	Indonesia	26 April 2004	
10	The Islamic Republic of Iran	26 April 2004	
11	Japan	26 April 2004	4 July 2005
12	Kazakhstan	26 April 2004	30 January 2008
13	Kyrgyzstan	26 April 2004	28 November 2006
14	Lao PDR	26 April 2004	
15	Malaysia	24 September 2004	
16	Mongolia	26 April 2004	23 October 2005
17	Myanmar	26 April 2004	4 July 2005
18	Nepal	26 April 2004	
19	Pakistan	26 April 2004	17 January 2006
20	Philippines	2 November 2005	17 March 2008
21	Republic of Korea	26 April 2004	4 July 2005
22	Russian Federation	27 April 2004	4 July 2005
23	Sri Lanka	26 April 2004	4 July 2005
24	Tajikistan	26 April 2004	9 July 2006
25	Thailand	26 April 2004	11 June 2006
26	Turkey	26 April 2004	
27	Uzbekistan	26 April 2004	4 July 2005
28	Viet Nam	26 April 2004	4 July 2005

Source: ADBI (2009)

The AH classification and design standards provide the minimum standards and guidelines for the construction, improvement and maintenance of AH routes. Parties shall make every possible effort to conform to these provisions both in constructing new routes and in upgrading and modernizing existing ones. These standards do not apply to built-up areas. "Primary" class in the classification refers to access-controlled highways. Access controlled highways are used exclusively by automobiles. Access to the access-controlled highways is at grade-separated interchanges only. Mopeds, bicycles and pedestrians should not be allowed to enter the access-controlled highway in order to ensure traffic safety and the high running speed of automobiles. At-grade intersections should not be designed on the access-controlled highways and the carriageway should be divided by a median strip. "Class III" should be used only when the funding for the construction and/or land for the road is limited. The type of pavement should be upgraded to asphalt concrete or cement concrete as soon as possible in the future. Since Class III is also regarded as the minimum desirable standard, the upgrading of any road sections below Class III to comply with the Class III standard should be encouraged.

Table 2 Summary of AH Design Standard

Classification	Number of Lanes	Width of Lanes(Meters)	Pavement type
Primary	4 or more	3.50	Asphalt or cement concrete
Class I	4 or more	3.50	Asphalt or cement concrete
Class II	2	3.50	Asphalt or cement concrete
Class III	2	3.00~3.25	Double bituminous treatment

Note: Primary class refers to access controlled highways (used exclusively by automobiles).
Source: ESCAP (2003).

Table 3 Status of the AH Network in Member States in 2016 (unit: km)

Country	Primary	Class I	Class-II	Class III	Below Class III	Other	Total	Status
Afghanistan	0	10	2549	0	1461	0	4020	2015
Armenia	0	147	721	58	40	0	966	2013
Azerbaijan	0	291	1174	0	0	0	1465	2013
Bangladesh	0	311	1400	44	5	0	1760	2015
Bhutan	0	7	116	0	47	0	170	2015
Cambodia	0	0	610	1346	0	0	1956	2015
China**	8437	230	1855	321	4	0	10847	2015
North Korea	0	492	15	0	220	735	1462	2008
Georgia	0	64	877	160	0	0	1101	2015
India	90	7067	1071	3556	117	0	11901	2015
Indonesia	409	603	3045	0	0	34	4091	2010
Iran	1885	4179	5070	0	0	0	11134	2015
Japan	1138	0	0	0	0	0	1138	2015
Kazakhstan	0	557	5407	6389	475	0	12828	2010
Kyrgyzstan	0	0	303	1324	136	0	1763	2013
Laos	0	0	244	2307	306	0	2857	2010
Malaysia	795	61	817	0	0	0	1673	2010
Mongolia	0	8	1702	158	2450	0	4318	2013
Myanmar	0	320	575	1702	1928	0	4525	2015
Nepal	0	0	218	1082	13	0	1313	2013
Pakistan	357	1116	275	2442	1138	0	5328	2015
Philippines	0	380	2310	691	0	0	3381	2015
Korea	457	423	40	0	0	0	920	2015
Russian Federation	0	2367	12080	1617	814	434	17311	2015
Singapore	13	6	0	0	0	0	19	2015
Sri Lanka	0	60	519	71	0	0	650	2015
Tajikistan	0	20	978	0	914	0	1912	2015
Thailand	617	4123	598	202	0	0	5540	2014
Turkey	1451	2991	50	770	0	0	5262	2015
Turkmenistan	0	60	0	2120	24	0	2204	2008
Uzbekistan	0	1195	1101	670	0	0	2966	2008
Viet Nam	0	967	1872	281	0	0	3121	2015
Total	15649	28055	47592	27311	10092	1203	129902	

Source: Asian Highway Database (2016)

AH 1 is the longest route of the AH Network, running 20,557 km (12,774 mi) from Tokyo, Japan via Korea, China, Hong Kong, Southeast Asia, Bangladesh, India, Pakistan, Afghanistan and Iran to the border between Turkey and Bulgaria west of Istanbul where it joins end-on with European route E80 that already connects the western part of Europe with the eastern part. AH1 makes it possible to drive directly from Tokyo to Lisbon, Portugal without taking major detours or back-roads. However, it is now impossible to pass through the AH1 from Japan to China by land transport because of two missing-link, which one is in sea between Japan and Korea, other is in North Korea. This paper concerns this section of AH1 to connect China with Japan via Korea peninsula. (figure1) In order to solve first missing-link between Japan and Korea, both country considered of undersea tunnel project that connect Japan with Korea via an undersea tunnel crossing the Korea Strait using the strait islands of Iki and Tsushima in Japan. However this project is died down for negative result to analysis the economic impact of regional development project. So, although the AH1 starts from Japan, in terms of continent practical starting point is Pusan in Korea because it must transport by ferry between Korea and Japan. The other missing-link of AH1 is the section in North Korea. This is political problem caused by the division of the Korean peninsula. This routes make Korea access to numerous countries in mainland Asia. Viewed in this way, The AH1 routes in North Korea is critical for Korea, because the AH1 routes in North Korea link Korea to China, the Russian Federation. The AH1 in Korea links from the Pusan to North Korea and China, extending to Kazakhstan, Lao People's Democratic Republic, Mongolia, Myanmar, Nepal, Pakistan, the Russian Federation, Thailand and Viet Nam. In other words, development of the AH1 in North Korea is essential to connect the Korean Peninsula and mainland Asia.

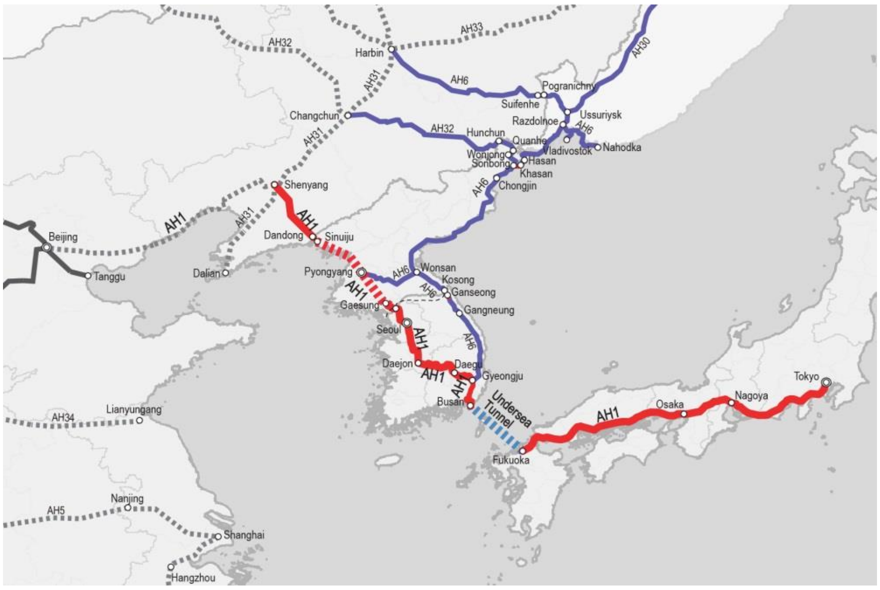


Figure 3 Asian Highway 1 in Korea and Japan

3. Model

We develop a multinational-multiregional CGE (MMCGE) Model for three nations of China, Japan and (South) Korea with building an external module to measure a minimum travel time among the regions. However, North Korea, a key member in the Northeast Asian countries cannot be included in this economic analysis of the highway development due to limitations on availability of socio-economic data such as Input-Output Table and sectoral economic indications such as labor inputs, capital stocks and transportation costs. The structure of the MMCGE model is based on a series of works on transportation network models of Kim *et al.* (2004), Kim and Hewings (2009), and Kim *et al.* (2011). They measured the dynamic economic effects of highway projects on the economic growth and the regional disparity in Korea using a transportation network–multiregional CGE model. This model captured the interactions between the quantity and the prices in regional economies, and there were five stages in estimating the economic impacts of transportation investments: (1) calculation of an interregional minimum distance matrix and the construction cost by highway project; (2) calculation of an accessibility index by highway project; (3) injection of the investment expenditures and the resulting changes in the accessibility to the multiregional CGE model; and (4) calibration of the economic effects of the highway project on GDP, exports, the price level, and the variation of the regional disparities for wages and population. It was possible to determine which highway development deserved the priority for investment with respect to economic efficiency and interregional disparity in the long run.

The MMCGE model specifies economic interactions of commodities and factor inputs among regions of three nations. According to Transnational Interregional Input-Output Table for China, Japan and Korea of 2005 by IDE (2015), each country is disaggregated into multiple regions: seven regions (Dongbei, Huabei, Huadong, Huanan, Huazhong, Xibei, and Xinan) of China, nine regions (Hokkaido, Tohoku, Kanto, Chubu, Kinki, Chugoku, Shikoku, Kyushu, and Okinawa) of Japan, and four regions (Seoul Area, Central Area, Southeastern Area, and Southwestern Area) of Korea. We assume that each region has a producer, a household, and a local government, while each nation having corresponding central government and consolidated capital market. The commodities and services are traded not only within each region but also between regions. It implies that the economic institutions are represented by 21 household groups, 21 production sectors, 24 local and national governments, three investors, and the rest of the world.

Figure 4 Geographical Classification in China, Japan, and Korea

Table 4 Regional Income and Population Size in 2005

	Area (1000 ㎢)	Population (million person)	Number of workers (million person)	Population density (person/㎢)	GRP (billion US$)	GRP per Capita (US$)	Wage per worker (US$)
Dongbei	788.1	106.2	47.0	134.8	198.1	1,864	1,673
Huabei	373.0	241.7	99.3	648.0	435.9	1,804	1,659
Huadong	210.7	132.1	79.4	627.1	467.0	3,534	2,325
Huanan	336.6	117.8	69.5	349.9	338.4	2,,873	1,983
Huazhong	1025.4	265.3	190.7	258.8	435.1	1,640	1,036
Xibei	4265.5	117.5	56.0	27.5	161.3	1,373	1,353
Xinan	2602.7	300.8	138.4	115.6	237.2	788	791
Capital area	11.7	22.8	8.2	1940.9	401.7	17,643	23,745
Central area	33.2	6.3	2.5	188.6	111.8	17,871	20,197
Southeastern Area	32.3	12.7	4.7	393.8	225.5	17,754	22,075
Southwestern Area	22.5	5.6	2.2	247.3	92.9	16,729	17,614

This model has microeconomic foundations in which the economic agent's behavior and the pricing mechanism take into account constraints of budgets and resources. There are two primary assumptions regarding the economic behavior of producers and consumers. One is that each producer and household attempts to maximize profits (value-added) and utilities respectively. Another is that market equilibrium between the demand and the supply is achieved for each account; the current account of government, the current account of the balance of payments of the rest of the world, and the capital account of savings and investments. That is, each commodity and factor input price is assumed to adjust toward a balance between supply and demand in the market, reaching an equilibrium in the economic system. The commodities are composed of intraregional demands (supplies), and regional and foreign imports in terms of product origin, whereas the products are spatially distributed among domestic (intraregional and interregional) supplies and foreign exports in terms of product destination.

Our production structure model has two stages. At the top of the structure, the gross output by regional industry is determined by a value-added element and intermediate inputs. The value-added is determined by a production function of labor and private capital inputs, and an agglomeration factor of population density. The basic idea for the model specification is derived from Richardson (1973) and Kim *et al.* (2014) as shown in Figure 4. The value-added curve is assumed to be S-shaped; the benefit of region increases faster than the population density growth at the first stage and at a diminishing rate at the second stage, but decreases in the final stage. It implies that the value-added is a quadratic equation of the population density as a proxy for agglomeration (urbanization) economies, inverted U-shaped as suggested by the literature. Thus, we expect the signs of linear term and the quadratic term of the population density in the value–added equation to be positive and negative, respectively. In Figure 4, the population level P_2 is defined as an optimal size to maximize net benefits under the fixed total population size, and P_1 and P_3 are lower and upper ceilings of the efficient population size, respectively.

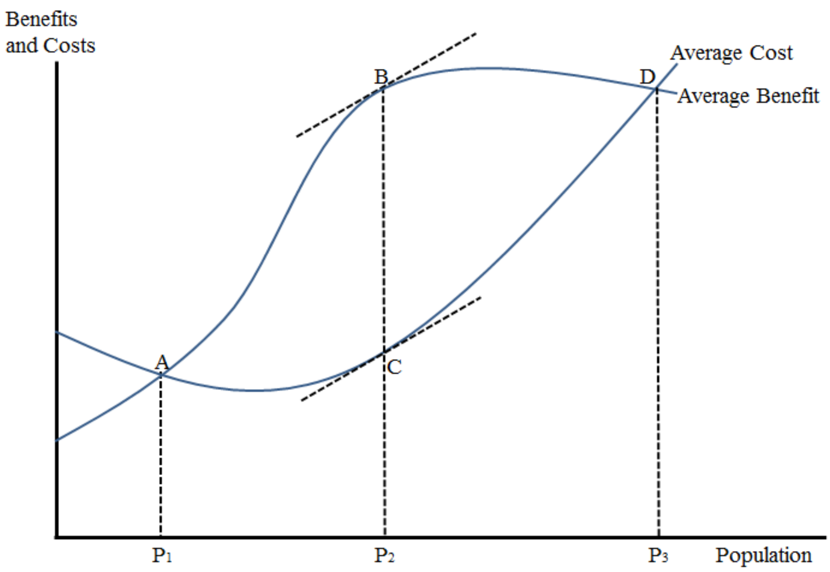


Figure 4 Average Benefit and Average Cost of Population
Source: Kim *et al.* (2014).

The intermediate inputs are derived from the maximization of output values. According to the first order condition, the interregional trade volumes are positively dependent on the input coefficient, the production output of the destination, and the output price, and negatively on the CIF price of the intermediate inputs. Sources of interregional price differentials are the travel time (distance), and the transportation costs per distance, so the division of the price into two factors, the FOB price and the CIF price, is critical for analyzing effects of the transportation investment on the spatial economies. The CIF price is defined as a sum of production price (cost) at origin (production area) and transportation cost from the origin to destination (market area) points, while the latter cost is determined by the travel time (distance) and the transportation cost per time (distance). So, the producers and households buy more commodities to have the lowest CIF price if the qualities of competing commodities are perfectly homogeneous. The FOB and CIF prices are distinguished through explicit consideration of transportation firms.

The labor input is assumed to be homogeneous and mobile within each nation, while the capital stock to be fixed in the short run. The labor demand by industry is derived from the producer's value-added maximization of the first order condition; each producer requires a set of factor inputs in which the marginal revenue of each factor input is equal to its factor input price. In the value-added production function, each sector has different shift and elasticity parameters for the factor inputs across the regions, implying that factor productivities and wage rates are heterogeneous. The region-specific wage in each nation is composed of the average wage rate, derived by balancing out total labor demand against total labor supply, and an industry-specific wage distortion term (Iqbal and Siddiqui, 2001).

For the second stage of the production structure, the domestic market is assumed to be a price taker at the given world price. That is, the foreign trade follows a small-country assumption, adopting an Armington approach. Imperfect substitutions are allowed between regionally produced goods and foreign imports on the demand side as well as between the regional supplies and the foreign exports on the supply side because of intra-industrial trades and aggregation problems of industrial sectors. The difference between total exports and total imports for each nation is defined as foreign savings (the current account deficit).

The total demand for goods and services consists of intermediate demands, household and government consumption expenditures, and the investment. The household incomes include wages and capital returns. Households pay taxes, and allocate their disposable income between consumption and savings. Government expenditures are composed of consumption and investment expenditures (savings), subsidies to producers, and transfers to the rest of the world, and savings. Revenue sources are tax revenues from household incomes, value-added, and foreign imports. The macroeconomic closure rule is used to account for how to achieve equilibrium in the macroeconomic balances for the government, the rest of the world, and the capital account of savings and investments (Iqbal and Siddiqui, 2001). In this paper, the government saving (a difference between the government revenues and the government consumption expenditures) is endogenous while all tax rates are exogenous. The real exchange rate is flexible while the foreign savings is fixed in the model. The closure rule for the capital account is saving-driven, which means that the investment expenditures increase or decrease so as to meet the required savings.

We restructured the 2005 Transnational Interregional Social Accounting Matrix for China, Japan and Korea as a benchmark for the development of the MMCGE model, using IDE (2015). This SAM is treated as an initial equilibrium for the model, and the values of some parameters are adjusted to replicate the equilibrium conditions for the base year, 2005. Economic activities are largely disaggregated into six balanced expenditure-receipt accounts: factor inputs, households, production, government, capital, and the rest of the world. The MMCGE model consists of a two-step dynamic process including a within-period model and a between-period model. We select an adaptive and recursive pattern, commonly used in the CGE applications, for the dynamics of the model due to the computation problems by multi-sectoral classifications of the regions and nations. The within-period model determines equilibrium quantities and prices under constraints for each economic agent in the context of a static model. The between-period model finds a sequential equilibrium path for the within-period model over the multiple periods by updating the values of all exogenous variables using growth rate and adaptive expectation methods of Devarajan and Robinson (2013). On the real side, the current capital stock is expanded with new investment but also reduced by a constant depreciation rate. The within-period model is a square system of equations with 1307 behavior and identity equations, and the exogenous variables include world market prices and labor supply. The *numeraire* of the model is set as an average of the consumer price index (CPI) for three nations. Since the standard CGE model is not regarded as a stochastic model, we examine model reliability with a sensitivity analysis of the results to changes in the values of key parameters as such as elasticities of substitution and transformation. If the parameter values of elasticities of substitution decrease by 10%, the GDP for three nations could change by 0.05% (Korea) to 0.53% (China). Also, this alternative parameterization results in the increases of the CPI by 1.27% (Korea) to 1.72% (China). It implies that the MMCGE model is relatively reliable for the simulation analyses.

Table 5 Major Equations of the MMCGE Model

Output	Output = CD (Value added, Intermediate demand)
Value added	Value added = POP(Population density)*CD (Capital stock, Labor)
Intermediate demand	Intermediate demand=ID(Output, Production price, Input coefficient)
Supply	Output = CET (Foreign exports, Domestic supply)
Demand	Demand = Armington (Foreign imports, Domestic demand)
Labor demand	Labor demand = LD (Wage, Value added, Net price)
Incomes	Incomes = Wage + Capital returns
Consumption	Consumption by commodity = CC (Price, Incomes)
Government revenues	Government revenues = Indirect tax + Direct tax + Tariff
Government expenditures	Government expenditures = Current expenditure + saving
Labor market equilibrium	Labor demand = Labor supply
Capital market equilibrium	Savings = Total investments
Commodity market equilibrium	Supply of commodities = Demand for commodities
Government budget equilibrium	Government expenditures = Government revenues

2) Simulation

As examples of counterfactual analysis, the MMCGE model is applied to the following five scenarios. In this paper, the AH1 is assumed to construct the missing section from Seoul of Korea to Gaesung–Pyongyang–Sinuiju highway in North Korea which follows the existing Seoul–Busan highway. In fact, there is another missing section in the AH1 highway; a line between Busan in Korea and Fukuoka in Japan. This can be linked through development of Korea–Japan Undersea Tunnel or operation of the Camellia Line ferry, which is not easy to be realized due to the construction costs and political debates between two countries. The highway could lead to reductions of the travel time (distance) between Korea and China by 11.1%-63.3% as shown in the following Table.

Option 1: Reduction in the travel time (distance) due to the highway construction (see Table 3)
Option 2: Option 1 + reduction in the transportation cost per time (distance) by 10%
Option 3: Option 2 + increases in the investments of Seoul Area in Korea and Dongbei in China by 10% of regional investment in the base year
Option 4: Option 2 + increases in the investments of Seoul Area in Korea and Dongbei in China by 30% of regional investment in the base year
Option 5: Option 2 + increases in the investments of Seoul Area in Korea and Dongbei in China by 50% of regional investment in the base year

Table 6 Reduction Rate of Distance after Construction of AH1 Highway (unit: %)

Region		Korea			
		Seoul Area	Central Area	Southeastern Area	Southwestern Area
China	Dongbei	63.3	60.2	51.5	52.7
	Huabei	48.6	46.2	36.6	37.4
	Huadong	18.7	16.7	0.0	0.0
	Huanan	14.4	13.1	0.0	0.0
	Huazhong	36.5	34.6	24.3	24.9
	Xibei	28.0	26.4	16.3	16.6
	Xinan	21.0	19.9	10.7	11.1

The MMCGE model with a base year of 2005 is designed to run for ten years in a recursive pattern. The current stock variable on capital is determined by one period lagged stock and current flows of investment. There are two kinds of temporal effects on economic sectors generated in this period, as discussed in the previous section. One is the short-term or construction-flow effect; changes in employment and income during the construction period are generated through the demand side. The magnitude of the effect depends on the size of the investment expenditure. Another is the long-term or operation-stock effect: changes in the distribution of economic resources through capital accumulation, and the economic gains are realized through reduction in the travel time (distance), the transportation cost per time (distance), and the increases in the regional investments. We assume that the highway construction is done at the base year (period 0) for a simplification of the dynamic adjustment process in the MMCGE model. It implies that the highway is assumed to be fully operated for the ten periods for the analysis.[1] The economic effects of each option under different shocks are compared with the base case without the transportation developments. All exogenous variables of each case have the same values as in the base case. The major input variables for the simulation of the MMCGE model are (1) the travel time (distance), (2) the transportation cost per time (distance), and (3) the regional investment expenditure by region.

The following four tables summarize the resulting outcomes of the options on the gross regional product (GRP), total value-added for ten periods. Overall, the highway project has the largest effect on the GRP of Dongbei by 0.15% points (Option 1) to 3.78% (Option 5). The next is followed by Seoul Area (0.20% for Option 1 to 2.53% for Option 5), Xibei (0.09% for Option 1 to 2.39% for Option 5), and Huabei (0.13% for Option 1 to 2.25% for Option 5). There would be slight regional economic growth in Kinki, Chugoku, and Kyushu in Japan. This outcome would be due to China's large market potential to generate economic benefits to Japan and Korea, which in the long run could lead to national economic recovery process from both countries' low economic growth.

[1] Obviously, the project life will extend beyond ten periods but the impacts are likely to have been fully realized by this time.

Table 7 Impacts of Distance Reduction on GRP of Three Nations

	1	2	3	4	5	6	7	8	9	10	Average
Dongbei	100.10	100.11	100.12	100.13	100.14	100.16	100.17	100.19	100.20	100.22	100.15
Huabei	100.10	100.10	100.11	100.12	100.13	100.14	100.15	100.16	100.17	100.18	100.13
Huadong	100.05	100.05	100.06	100.06	100.07	100.07	100.07	100.08	100.08	100.07	100.06
Huanan	100.05	100.06	100.06	100.07	100.07	100.08	100.08	100.08	100.08	100.07	100.07
Huazhong	100.06	100.07	100.07	100.08	100.08	100.09	100.09	100.10	100.09	100.09	100.08
Xibei	100.06	100.07	100.08	100.08	100.09	100.10	100.11	100.12	100.12	100.13	100.09
Xinan	100.06	100.06	100.07	100.08	100.09	100.10	100.11	100.11	100.12	100.12	100.09
Hokkaido	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
Tohoku	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
Kanto	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Chubu	100.01	100.01	100.01	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Kinki	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Chugoku	100.01	100.01	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Shikoku	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Kyushu	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Okinawa	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
Seoul Area	100.20	100.20	100.20	100.20	100.20	100.20	100.20	100.20	100.20	100.20	100.20
Central Area	100.13	100.13	100.13	100.13	100.13	100.13	100.13	100.13	100.13	100.14	100.13
S.W Area	100.11	100.11	100.11	100.11	100.11	100.11	100.11	100.11	100.11	100.11	100.11
S.E. Area	100.10	100.10	100.10	100.10	100.11	100.11	100.11	100.11	100.11	100.11	100.11
Total	100.04	100.04	100.04	100.04	100.04	100.04	100.04	100.04	100.04	100.04	100.04

Table 8 Impacts of Reductions in Transportation Cost (10%) and Distance on GRP of Three Nations

	1	2	3	4	5	6	7	8	9	10	Average
Dongbei	100.36	100.39	100.43	100.48	100.53	100.58	100.64	100.71	100.77	100.84	100.55
Huabei	100.33	100.36	100.39	100.43	100.47	100.52	100.56	100.60	100.64	100.66	100.49
Huadong	100.27	100.30	100.33	100.36	100.39	100.42	100.44	100.47	100.48	100.48	100.39
Huanan	100.33	100.35	100.38	100.41	100.44	100.46	100.49	100.51	100.52	100.52	100.43
Huazhong	100.30	100.32	100.35	100.39	100.42	100.45	100.48	100.50	100.50	100.49	100.41
Xibei	100.32	100.35	100.39	100.43	100.47	100.51	100.56	100.61	100.65	100.68	100.48
Xinan	100.31	100.34	100.38	100.42	100.47	100.52	100.58	100.64	100.69	100.73	100.49
Hokkaido	99.98	99.98	99.98	99.98	99.98	99.98	99.98	99.98	99.98	99.97	99.98
Tohoku	99.98	99.98	99.98	99.98	99.98	99.98	99.97	99.97	99.97	99.97	99.98
Kanto	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.98	99.98	99.99
Chubu	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99	100.00
Kinki	100.01	100.01	100.01	100.01	100.01	100.01	100.01	100.01	100.00	100.00	100.01
Chugoku	100.02	100.02	100.02	100.02	100.02	100.01	100.01	100.01	100.01	100.01	100.01
Shikoku	100.00	100.00	100.00	100.00	99.99	99.99	99.99	99.99	99.99	99.99	99.99
Kyushu	100.01	100.01	100.00	100.00	100.00	100.00	100.00	100.00	99.99	99.99	100.00
Okinawa	99.97	99.96	99.96	99.96	99.96	99.96	99.96	99.96	99.96	99.96	99.96
Seoul Area	100.34	100.35	100.34	100.34	100.34	100.33	100.32	100.31	100.29	100.28	100.32
Central Area	100.22	100.22	100.22	100.22	100.22	100.21	100.21	100.20	100.20	100.19	100.21
S.W Area	100.21	100.21	100.21	100.21	100.20	100.20	100.19	100.18	100.17	100.16	100.19
S.E. Area	100.19	100.19	100.19	100.19	100.18	100.18	100.17	100.17	100.16	100.15	100.18
Total	100.12	100.13	100.13	100.14	100.15	100.15	100.15	100.16	100.15	100.15	100.14

Table 9 Impacts of Reductions in Transportation Cost (10%) and Distance and Increase in Investments (10%) on GRP of Three Nations

	1	2	3	4	5	6	7	8	9	10	Average
Dongbei	100.67	100.71	100.74	100.79	100.84	100.90	100.96	101.03	101.10	101.17	100.87
Huabei	100.38	100.42	100.46	100.50	100.54	100.59	100.64	100.69	100.72	100.75	100.56
Huadong	100.31	100.34	100.37	100.41	100.44	100.47	100.50	100.52	100.53	100.53	100.44
Huanan	100.36	100.39	100.42	100.45	100.49	100.52	100.54	100.57	100.57	100.57	100.48
Huazhong	100.34	100.37	100.41	100.44	100.48	100.52	100.55	100.57	100.57	100.55	100.47
Xibei	100.37	100.41	100.45	100.49	100.54	100.59	100.64	100.69	100.73	100.76	100.55
Xinan	100.36	100.40	100.44	100.49	100.54	100.60	100.66	100.72	100.78	100.82	100.56
Hokkaido	99.98	99.98	99.98	99.98	99.98	99.98	99.98	99.98	99.98	99.98	99.98
Tohoku	99.98	99.98	99.98	99.98	99.98	99.97	99.97	99.97	99.97	99.97	99.98
Kanto	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.98	99.98	99.99
Chubu	100.00	100.00	100.00	100.00	100.00	99.99	99.99	99.99	99.99	99.99	99.99
Kinki	100.02	100.02	100.01	100.01	100.01	100.01	100.01	100.01	100.01	100.00	100.01
Chugoku	100.02	100.02	100.02	100.02	100.02	100.02	100.01	100.01	100.01	100.01	100.02
Shikoku	100.00	100.00	100.00	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
Kyushu	100.01	100.01	100.00	100.00	100.00	100.00	100.00	100.00	99.99	99.99	100.00
Okinawa	99.97	99.96	99.96	99.96	99.96	99.96	99.96	99.96	99.96	99.96	99.96
Seoul Area	100.68	100.68	100.68	100.68	100.67	100.67	100.66	100.65	100.64	100.64	100.67
Central Area	100.32	100.32	100.33	100.33	100.34	100.34	100.34	100.34	100.33	100.33	100.33
S.W Area	100.30	100.31	100.31	100.31	100.31	100.31	100.30	100.30	100.29	100.29	100.30
S.E. Area	100.27	100.27	100.28	100.28	100.28	100.28	100.28	100.28	100.27	100.27	100.28
Total	100.17	100.17	100.18	100.19	100.19	100.20	100.20	100.20	100.20	100.20	100.19

Table 10 Impacts of Reductions in Transportation Cost (10%) and Distance and Increase in Investments (10% / 30% / 50%) on GRP of Three Nations

	Distance	Distance + Tariff	Distance + Tariff + Investment (10%)	Distance + Tariff + Investment (30%)	Distance + Tariff + Investment (50%)
Dongbei	100.15	100.55	100.87	102.32	103.78
Huabei	100.13	100.49	100.56	101.40	102.25
Huadong	100.06	100.39	100.44	101.19	101.94
Huanan	100.07	100.43	100.48	101.31	102.14
Huazhong	100.08	100.41	100.47	101.26	102.05
Xibei	100.09	100.48	100.55	101.47	102.39
Xinan	100.09	100.49	100.56	101.51	102.45
Hokkaido	99.99	99.98	99.98	99.95	99.92
Tohoku	99.99	99.98	99.98	99.94	99.90
Kanto	100.00	99.99	99.99	99.96	99.94
Chubu	100.00	100.00	99.99	99.98	99.96
Kinki	100.00	100.01	100.01	100.03	100.05
Chugoku	100.00	100.01	100.02	100.04	100.07
Shikoku	100.00	99.99	99.99	99.98	99.97
Kyushu	100.00	100.00	100.00	100.00	100.01
Okinawa	99.99	99.96	99.96	99.91	99.86
Seoul Area	100.20	100.32	100.67	101.60	102.53
Central Area	100.13	100.21	100.33	100.73	101.13
S.W Area	100.11	100.19	100.30	100.68	101.06
S.E. Area	100.11	100.18	100.28	100.62	100.96
Total	100.04	100.14	100.19	100.49	100.78

4. Summary and further research

The main contribution of this research is to demonstrate the MMCGE model to analyze the economic impacts of the construction of the missing section of the AH1 highway of North Korea on regional economic growth in three northeast Asian countries. Overall, this highway project has the large effects on the GRP of Dongbei, Xibei, and Huabei in China, and Seoul Area in Korea. The simulation of the MMCGE model can provide public agents and stockholders with analytical and strategic insights into the investment efficiency, effectiveness and priority of the highway project in terms of income growth. This numerical model is expected to practically assess transportation investment programs and development strategies with the national and regional economic goals.

Regarding further research directions, it would be worthwhile to examine how a set of different macroeconomic closure rules for the labor and capital markets affect the GRP changes of the highway project in the MMCGE model. For example, the savings-driven neoclassical closure rule in this paper assumes that the investment is determined by total savings, which is expected to have quite different impacts on the economy from a case of investment-driven Johansen closure rule (Hans *et al*., 2002). Also, external shocks such as Foreign Direct Investments (FDI) under the full-employment condition in the factor market have effects on sectoral compositions of total demand, but not on the income. On the contrary, the FDI under the Keynesian macroeconomic closure rule increases the labor demand and the income at the expense of the wage reduction. These experiments on the closure rules can examine what economic conditions in the labor and capital markets are required to maximize the economic benefits of the transportation projects.

Another challenge is to address distributional issues i.e. how the construction cost of the AH1 should be shared between two trading partners, China and Korea. This is an important issue because the highway can be viewed as an international public good since investment by one country has spillover benefits for other countries. The investments reduce transportation costs with all trading partners; its benefits are clearly multilateral; thus a three national model seems to underestimate its overall benefits. In addition, it is possible to examine optimal allocation of resources under imposing an optimizing behavior on the government. In this paper, each producer and household is assumed to be a price-taker, choosing an optimal set of factor inputs and commodity demands under the maximization principles of constrained profit and private utility, respectively.

Finally, the risk analysis needs to be taken into account in the economic evaluation of the highway project because of the prevailing political and economic uncertainty. A simple Monte Carlo or a Monte Carlo Filtering approach as a stochastic simulation model can be applied to risky variables such as the construction costs and the world prices of exporting or importing commodities. Iterative simulations of the MMCGE model with the generated random numbers on each stochastic variable can create the probability distributions of the economic impacts of the project, and this analysis reveals what variables are risky factors in the economic assessment.

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Appendix: Accessibility and distance

As discussed, an accessibility index is used to estimate the economic impact of transportation investment, because it measures the "opportunity potential" through spatial interaction or contact with economic activities (Kim *et al*., 2004; Kim and Hewings, 2011; Lee and Kim, 2014). The opportunity potential is conceived to be proportional to the size of destination node and inversely related to transportation cost between the origin and the destination. The generalized description of the indicator is given by:

$$Acc_i = \sum_j M_j f(C_{ij}) \quad (1)$$

Acc_i : Accessibility of origin (zone *i*)
M_j : Mass of destination (zone *j*)
$f(C_{ij})$: Decay function of generalized travel cost from zone *i* to zone *j* where the mass of a destination is commonly measured by population.

The decay function describes to travel by the increase in the generalized travel cost. Exponential or power function has been a traditional measure of the decay. Given that an inverse power function tended to show too drastic decline at short travel distances (Geurs and Ritsema van Eck, 2001), we adopt exponential function to describe the resistance to travel by the increase in the interregional travel time (equation 2)

$$f(C_{ij}) = \exp(-\beta \times T_{ij}) \ , (\beta > 0) \quad (2)$$

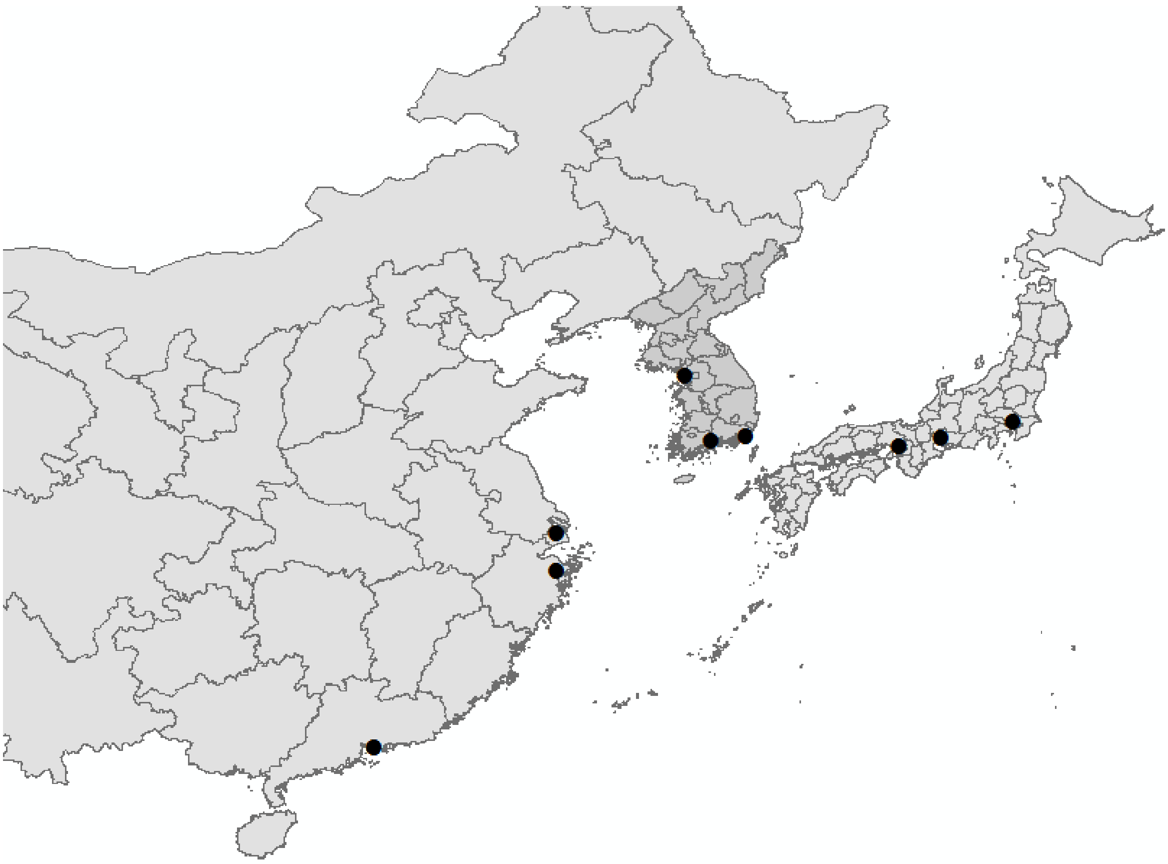
As of the decay parameter (β), we apply 0.005775, which was adopted by Stępniak and Rosik (2013) to measure the changes in the degree of spatial interactions in European level due to the development of a road network. The travel cost between origin and destination is replaced by transportation time between an origin and a destination. For advanced measure of the accessibility index, shortest travel time based on transportation network analysis would be preferable. However, due to the lack of complete transportation networks over three countries in consistent degree of precision, travel time is calculated based on centroid distances between regions and speed of transport mode in use. As we assume that the investment in the AH1 provides land transportation option to the trade between China and Korea, and the choice of mode is solely based on transportation time of the mode, we calculate both marine and land transportation time between regions of two countries. The two modes are differentiated by travel speed, freight charge, and loading/unloading time. Table 1 describes the attributes and a formula of transportation time of each mode.

Appendix Table 1 Calculation of Land and Marine Transportation Time

	Speed	Fright charge	Loading/unloading time	Transportation time applied
Land	80km/hr	1.60		(Distance ÷ 80)×1.60
Marine	46km/hr	1.00	10 hours	(Distance ÷ 46) + 10 hours

The trade between China and Korea using marine transportation is assumed to be treated by three representative ports of each county (Figure 1). The ports are selected based on international trade volume statistics. For the case of marine transportation, we assume that the choice of ports by each origin and destination pair is determined under the principle of the minimization of total transportation time, and the access time to/from ports is covered by road transportation. For example, to treat the trades between Seoul and Beijing, Seoul-Incheon port-Thenjin port-Beijin route is selected among 9 different routes which are the combinations of three Korean ports and the other three Chinese ports.

Appendix Figure 1 Representative Ports of China and Korea Selected based on Trane Volume



After the completion of AH1, the trans-border road network is assumed to connect China and Korea. Similar to the case of marine transportation, transportation time between each Chinese and Korean region is by adding the transportation time on AH1 to the sum of the transportation time between the origin to the starting point of AH1 and that between the terminus point of AH1 and the destination region. International trades between China and Japan, and Korea and Japan are treated by marine transportation, and assumed not to be affected by the investment in AH1. Domestic trades are treated by road transportation, and intra-regional travel time is counted as well using the radius of the area with the assumption that each region is in circular shape. Table 2 shows the accessibility index of each region of the three countries before and after the completion of AH1.

Appendix Table 2 Accessibility Index of Each Region of China, Korea, and Japan before and after the Completion of AH1

Country	Region	Accessibility index (×0.000001)		Change
		Before AH1	After AH1	
China	C1	89.4	89.6	0.29%
	C2	198.8	198.8	0.02%
	C3	111.1	111.1	0.03%
	C4	106.7	106.7	0.00%
	C5	212.9	212.9	0.00%
	C6	120.1	120.1	0.00%
	C7	192.7	192.7	0.00%
Korea	K1	23.9	25.3	6.15%
	K2	23.8	24.6	3.35%
	K3	17.2	17.5	1.78%
	K4	18.7	19.1	2.19%
Japan	J1	6.1	6.1	0.00%
	J2	12.8	12.8	0.00%
	J3	30.5	30.5	0.00%
	J4	37.8	37.8	0.00%
	J5	34.2	34.2	0.00%
	J6	23.4	23.4	0.00%
	J7	20.7	20.7	0.00%
	J8	12.1	12.1	0.00%
	J9	1.5	1.5	0.00%