Economic Impacts of Economic Corridors in Mongolia: An Application of IDE-GSM

Researchers: Satoru Kumagai, Director of Economic Geography Studies Group, IDE
Odbayar Erdenetsogt, Ambassador at-Large, ITT for LLDCs
Souknilanh Keola, Research Fellow, IDE
Toshitaka Gokan, Research Fellow, IDE

2017

Economic Impacts of Economic Corridors in Mongolia:

An Application of IDE-GSM

Introduction

Infrastructure development as well as logistics enhancement is one of the most important key drivers for economic development, especially for the countries that are landlocked and the sea transport cannot be used as a main mode of transport. To pursue higher economic development with less inequality in land-locked Mongolia, the improvement of land transport is crucial.

This paper tries to provide some policy implications for better transport infrastructure in Mongolia by using Geographical Simulation Model developed by IDE-JETRO (IDEGSM). IDE-GSM is a simulation model based on spatial economics, also known as new economic geography(NEG). It can be used as a tool for policy makers to decide what kinds of trade and transport measures (TTFMs) are needed for target regions and how to prioritise them. The model has an original economic model with general equilibrium setting, based on the dataset consists of more than 2,000 regions, 6,500 nodes and 12,000 routes, and several parameters obtained by econometric techniques. It covers 18 countries/economies in East Asia; Bangladesh, Brunei Darussalam, Cambodia, China, Hong Kong, India, Indonesia, Japan, Korea, Lao PDR, Macao, Myanmar, Malaysia, the Philippines, Singapore, Taiwan, Thailand, and Vietnam, as well as 8 Central and Western Asian countries with Russia and Mongolia. The model makes it possible to predicts the agglomerations in population and industries, and estimate the economic impacts of various TTFMs on each region at the sub-national level.

This paper is structured as follows: Section 1 briefly introduces the model beneath and the structure of IDE-GSM. Section 2 constructs the baseline scenario and explains its assumptions, then describe each development scenario for Mongolia. Section 3 shows the calculated economic impacts of the corridors graphically and numerically. Section 4 analyses the simulation results and propose some policy implications. The last section concludes the paper with future research agenda.

1. The Model

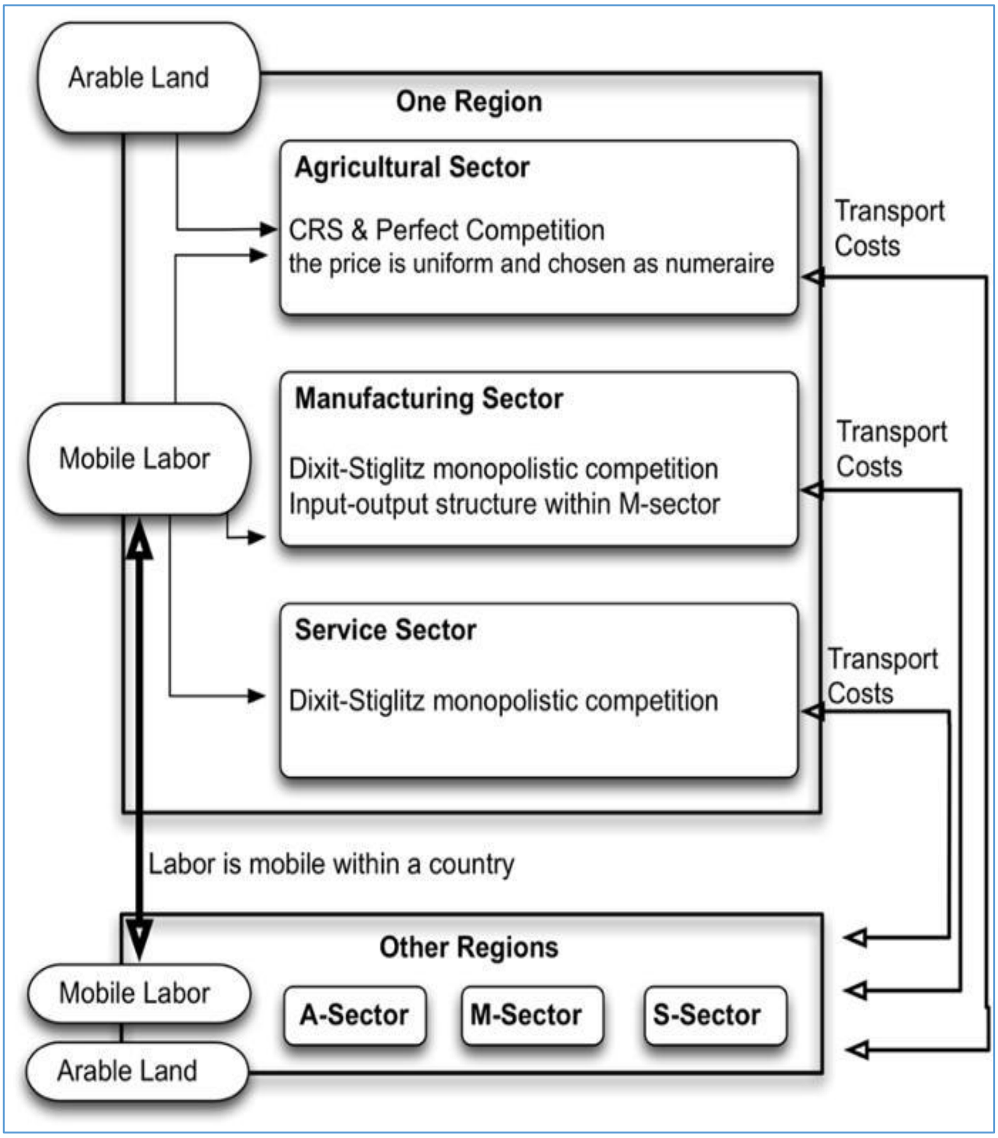
The models based on spatial economics or NEG, either theoretical or empirical, tends to be complex and hard to solve mathematically. So NEG studies frequently use numerical simulation. The very basic model, the Core-Periphery (CP) model by Krugman (1991) also uses numerical solutions to show the fundamental characteristics of the NEG model. The basic CP model is two-location-two-goods model, setting one goods (typically assumed as agricultural goods) as numeraire, produced by constant return to scale technology, incurs zero transport costs, while the other goods produced by increasing return to scale technology (typically assumed as manufacturing goods), incurs positive transport costs.

The beauty of the CP model in many locations is its simplicity with rich implications applicable to the real world setting. Indeed, IDE-GSM has started, as a branch of the CP model with many locations, except for the geography is not the “race track” but a realistic network of the cities.

IDE-GSM was developed based on this CP model, with two main objectives, namely, (1) to simulate the dynamics of the locations of populations and industries in East Asia over the longterm, and, (2) to analyse the impact of specific TTFMs on regional economies at sub-national levels. In our simulation model, there are more than 2,000 regions included. There are two endowments: labour and land. Labour is mobile within a country, but prohibited to migrate to other countries, at this moment. Land is unequally spread in all regions and jointly owned by all the labours of the region.

Figure 1 shows the structure of the model in IDE-GSM. All products in the three sectors are tradable. Transport costs are supposed to be of the iceberg type; that is, if one unit of product is sent from one region to another, the unit with less than one portion arrives. Depending on the lost portion, the supplier sets a higher price. The increase in price compared to the producer's price is regarded as the transport cost. Transport costs within the same region are considered negligible.

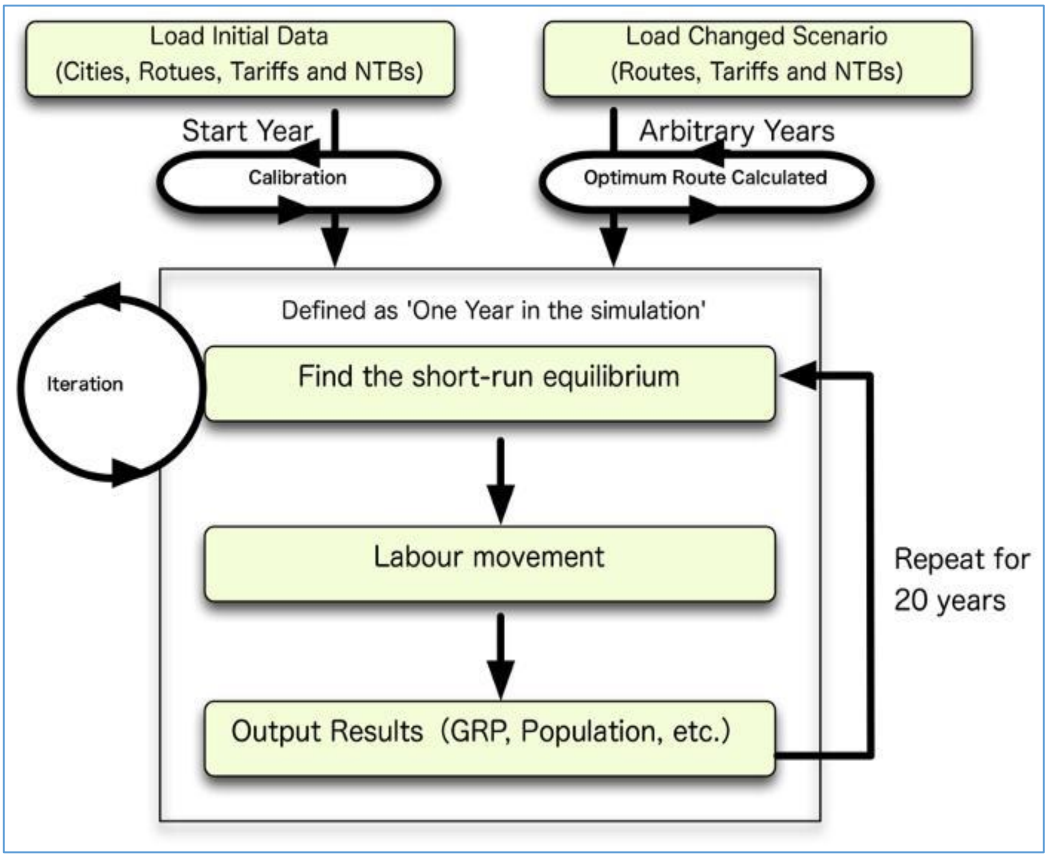
Figure 1: Structure of the Model



Source: Isono et al (2015).

The simulation procedures are shown in Figure 2. First, with given distributions of employment and regional GDP by sector and regions according to the actual data, shortrun equilibrium is obtained. Observing the achieved equilibrium, workers migrate among regions and industries, according to the differences in the real wages; Workers move to the sectors that offer higher real wage rates in the same region, and move to the regions that offer higher real wages within the same country. We obtain the new distribution of workers and economic activities. With this new distribution and predicted population growth, the next short-run equilibrium is obtained for a following year, and we observe migration again. These computations are repeated for typically 20 years to from year 2010 to 2030.

Figure 2: Procedures of the Simulation



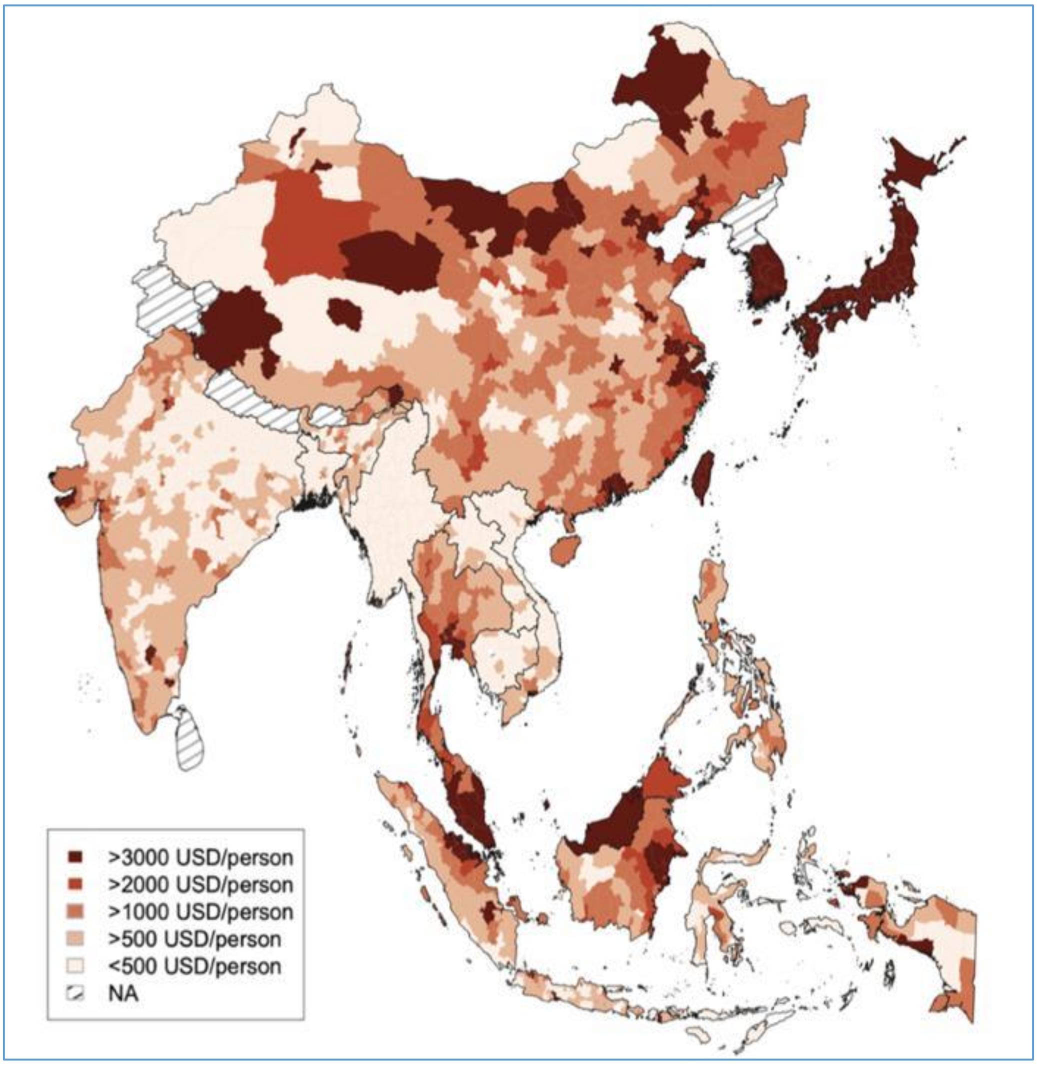
Source: Isono et al (2015).

Primarily based on official statistics, we derive gross regional product (GRP) for the agriculture sector, mining sector, five manufacturing sectors, and the service sector for 2010. The five manufacturing sectors are food processing, garments and textiles, electronics, automotive, and other manufacturing. Population and area of arable land for each region are compiled from official statistical sources. Figure 3 shows the GRP per capita for each region in 2010.

The number of routes included in the simulation is more than 10,000 (land: 6,500, sea: 950, air: 2,050 and railway: 450). The route data consists of start city, end city, distance between the cities, the speed of the vehicle running on the route, etc. The land routes between cities are based mainly on the “Asian Highway” database of the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP). The actual road distances between cities are used; if the road distances are not available, the distances between cities in a straight line are employed.

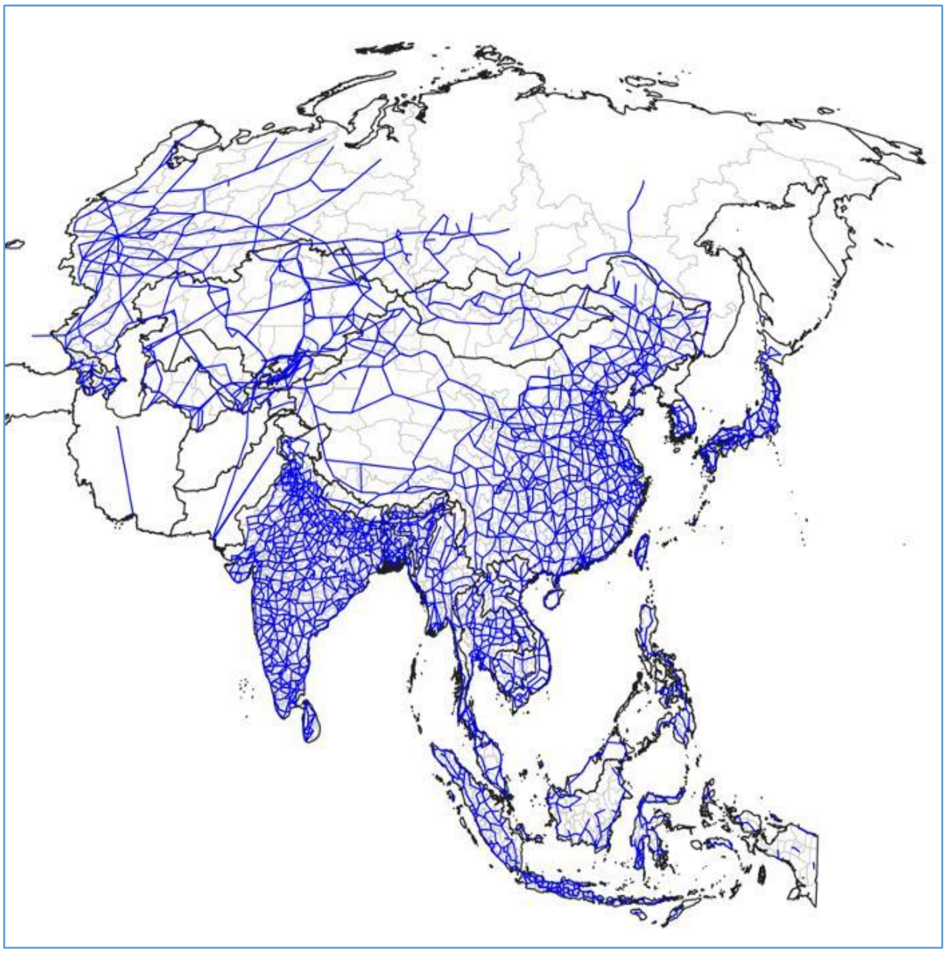
Figure shows the land route networks incorporated in IDE-GSM. The data on air and sea routes are compiled from Nihon Kaiun Shukaijo(1983) and the data set assembled by the team of the Logistics Institute - Asia Pacific (TLIAP), and 950 sea routes and 2,050 air routes are selectively included in the model. The railway data is adopted from various sources, such as maps and the official websites of railway companies.

Figure 3: GRDP per Capita in East Asia, 2010



Source: Figure 3, Isono et al (2015).

Figure 4: Land Route Network Data in the IDE-GSM



Source: Authors.

2. Scenarios

To calculate the economic impacts of TTFMs by the IDE-GSM, we take the differences of GDPs/GRPs between the baseline scenario and an alternative scenario. The baseline scenario contains minimal additional infrastructure development after 2010. The alternative scenario contains specific TTFMs, in addition to all the development in the baseline scenario. We compare the GDPs or GRPs between two scenarios in 2030. If the GRP of a region in a scenario with specific TTFMs is higher (lower) than that in the baseline scenario, we regard this surplus (deficit) as the positive (negative) economic impacts of the TTFMs.

In the baseline scenario, we assume a kind of business-as-usual situation. The following assumptions are maintained in all scenarios, including the baseline case, even if they are not explicitly cited in a specific scenario:

- The national population of each country is assumed to increase at the rate forecast by the United Nations Population Division until 2030.
- International labor migration is prohibited.
- Tariffs, non-tariff barriers, and services barriers change based on FTA/economic partnership agreements (EPAs) currently in effect and according to the phased-in tariff reduction schedule by the FTAs/EPAs and Hayakawa and Kimura (2015).

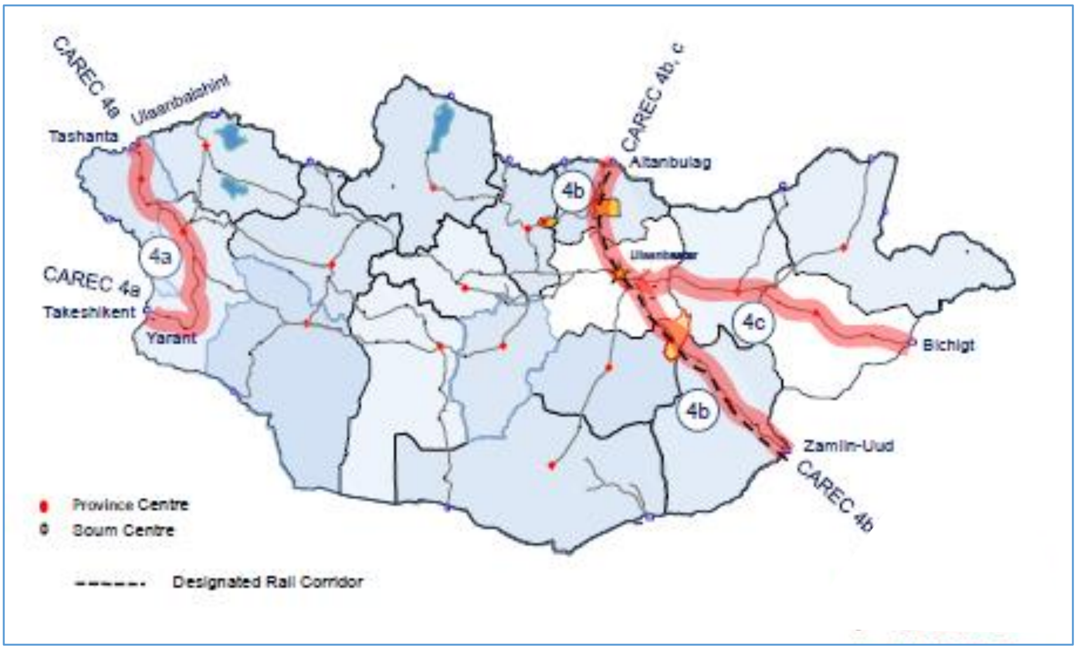
- We give different exogenous growth rates for the technological parameters for each country to calibrate the GDP growth trend from 2010 to 2020, which is estimated and provided by the International Monetary Fund.

It should be noted that even if trade and transport facilitation measures negatively impact a region's economy according to the simulation scenario, this does not necessarily mean that the region is worse off than the current situation. Most of the countries in Asia are expected to grow faster in the next few decades, and the negative economic impacts offset a part of the gains from the expected economic growth. For any alternative scenario, we change the settings relating to the logistics infrastructure and/or other parameters pertaining to trade and production. Figure 5 shows the three economic corridors that are simulated in this paper, namely, CAREC 4a, 4b and 4c corridors. CAREC Corridor 4a connects China and Russia through the western part of Mongolia. In this scenario, we suppose that the road specified as CAREC Corridor 4a are implemented and completed in 2020. CAREC Corridor 4b connects China and Russia through Ulaanbaatar, the capital of Mongolia. In this scenario, we suppose that the road specified as CAREC Corridor 4b are implemented and completed in 2020. CAREC Corridor 4c connects Bichigt and Ulaanbaatar. In this scenario, we suppose that the road specified as CAREC Corridor 4c are implemented and completed in 2020.We also run 'All' scenario to implement the thee corridors specified above are implemented all together and completed in 2020.

We suppose the following improvements are implemented along each corridor specified above.

- Highway: Raise the average speed of the specified roads in the corridor from 19.25km/h to 38.5km/h
- Railway: Raise the average speed of the specified railways in the corridor from 19.1km/h to 40.0km/h
- Customs Facilitations: In addition to highway and railway development, we conduct customs facilitation(CF) in the simulation, by reducing the time and money costs crossing the national borders in the corridors in half.

Figure 5: Three Economic Corridors in Mongolia



Source: Ministry of Road and Transport of Mongolia

3. Results on the Simulation

3.1 Corridor 4a

Table 1 shows the economic impacts by country and by industry for Corridor 4a Scenario. For Mongolia, the economic impacts are highest in services (USD18.6 million), followed by food processing industry (USD4.2 million) and mining sector (USD0.7 million). It should be noted that the impact is for the year of 2030 and against the base line scenario. According to the model, the impact begins at the year of completion of infrastructure in alternative scenario, or 2020 for Corridor 4a Scenario, and continue onward. The total impact should be considered as aggregation of them. By country, China benefits most from Corridor 4a. Most of the economic impacts come from services (USD889.9 million), followed by food processing industry (USD30.7 million).

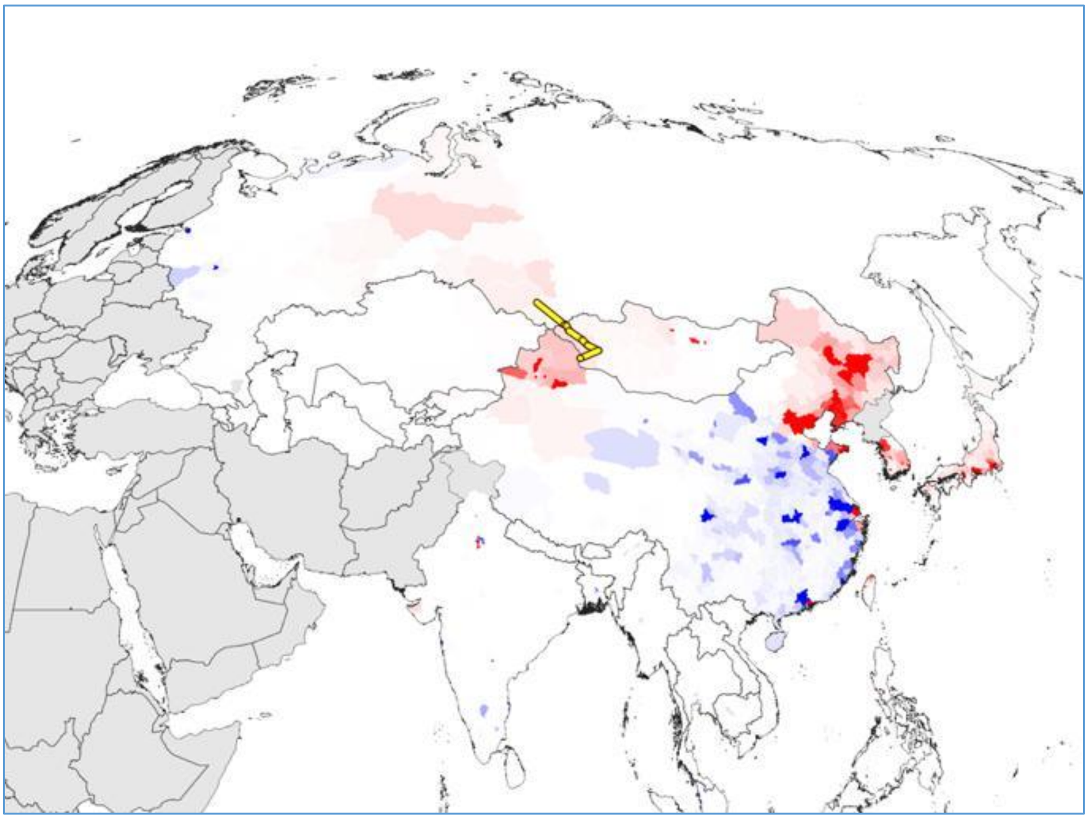
Table 1: Economic Impact of Corridor 4a (2030, against baseline, million USD)

	Agriculture	Automotive	E&E	Textile	Food Proc.	Oth. Mfg.	Services	Mining	Total
Mongolia	-1.0	0.0	0.3	0.4	4.2	-1.8	18.6	0.7	21.3
China	0.4	-0.8	14.1	8.7	30.7	18.6	889.9	0.4	962.1
Russia	0.0	0.3	10.5	0.3	3.2	-1.7	43.7	0.5	56.9
Japan	0.3	4.9	9.8	0.6	1.7	13.4	-4.3	-0.1	26.3
Korea	0.1	1.1	9.7	0.3	0.2	3.4	0.7	0.0	15.5
Taiwan	0.0	0.0	1.4	0.0	0.0	0.4	0.2	0.0	2.1
India	0.6	2.5	-2.2	0.3	0.5	4.8	-8.7	-0.2	-2.3
ASEAN10	0.3	0.3	-3.4	0.1	0.0	-0.3	1.8	0.1	-1.2
United States	0.1	-0.4	-8.0	-0.2	-1.3	-3.9	2.4	-0.2	-11.5
EU	0.2	0.7	-9.9	-0.2	0.5	2.2	-2.0	-0.3	-8.9
World	1.6	7.6	16.0	10.3	40.6	34.2	942.6	3.9	1,056.7

Source: Estimated by IDE-GSM.

Figure 6 shows the geographical representation of economic impacts from Corridor 4a in 2030, compared with the baseline scenario. Red (Blue) regions have positive (negative) impacts from the development, in terms of the economic impacts for each square km, or impact density. For Mongolia, the economic impacts appear mainly in the western side of the country. The positive economic impacts are observed in the Northeast and Northwestern China, while other parts of China have some negative impacts from the development.

Figure 6: Economic Impact of Corridor 4a (2030, against baseline, impact density)



Source: Estimated by IDE-GSM.

Table 2 shows the top 10 gainer regions by the development of Corridor 4a. The region most benefited from the Corridor 4a is Karamay, China, with the impacts of USD302.4 million, followed by Beijing, China (USD277.2 million) and Urumqi, China (USD171.7 million). Khanty-Mansiy, Russia also has a positive impact of USD35.2. No Mongolian region appeared on the top 10 list. For most regions the positive impacts are forecasted in services, although, positive impacts are expected in textile, food and other manufacturing, in the top 1 gainer region, the Karamay in China.

Table 2: Top 10 gainers from Corridor 4a (2030, against baseline, million USD)

	Region	Country	Agri	Auto	EE	Text	Food	OthM	Svs	Mining	Total
1	Karamay	China	0.0	0.0	0.0	12.0	23.9	19.1	246.4	0.9	302.4
2	Beijing	China	0.0	-0.1	0.3	0.0	-0.1	-0.5	277.6	0.0	277.2
3	Urumqi	China	0.0	0.0	0.1	-0.5	-0.6	-6.9	178.9	0.6	171.7
4	Shanghai	China	0.0	-0.1	1.4	-0.4	-0.1	-0.7	126.0	-0.1	126.0
5	Tianjin	China	0.0	-0.1	0.3	-0.1	-0.1	-0.7	64.5	-0.1	63.8
6	Khanty-Mansiy	Russia	0.0	0.0	2.2	0.0	0.1	0.0	33.0	0.1	35.2
7	Shenyang	China	0.0	0.0	-0.1	0.0	-0.1	-0.6	32.5	0.0	31.7
8	Harbin	China	0.0	0.0	-0.1	0.2	0.6	-0.8	29.8	0.0	29.7
9	Changchun	China	0.0	0.0	0.0	0.0	-0.1	-0.8	23.5	0.0	22.5
10	Hulunbuir	China	0.0	0.0	0.0	0.1	1.6	-0.5	20.3	0.0	21.4

Source: Estimated by IDE-GSM.

3.2 Corridor 4B

Table 3 shows the economic impacts by industry for Corridor 4b Scenario. The total global impacts of Corridor 4b Scenario is about five time larger than that of Corridor 4b Scenario in 2030. The impact for Mongolia is also relative large, next to only China, EU and Russia among selected countries and regions in Table 3. For Mongolia, the economic impacts are highest in services (USD243.2 million), followed by mining sector (USD79.7 million) and food processing industry (USD59.4 million). In other words, while benefit for Mongolia are mainly expected in services in Corridor 4a Scenario, substantial impacts are also forecasted for manufacturing and mining industries in Corridor 4b Scenario. In simulation analyses using IDE-GSM in general, positive impacts on manufacturing is often forecasted for infrastructure that locates in or connects with the capital city of a country, which in turn tends to host larger share of non-agricultural activities. By country, the economic impacts are the largest for China (USD3149.6 million), followed by EU (USD 2764.2 million) and Russia (USD360.7 million). Furthermore, negative impacts are forecasted for Japan, Korea, India, ASEAN and the United States of America.

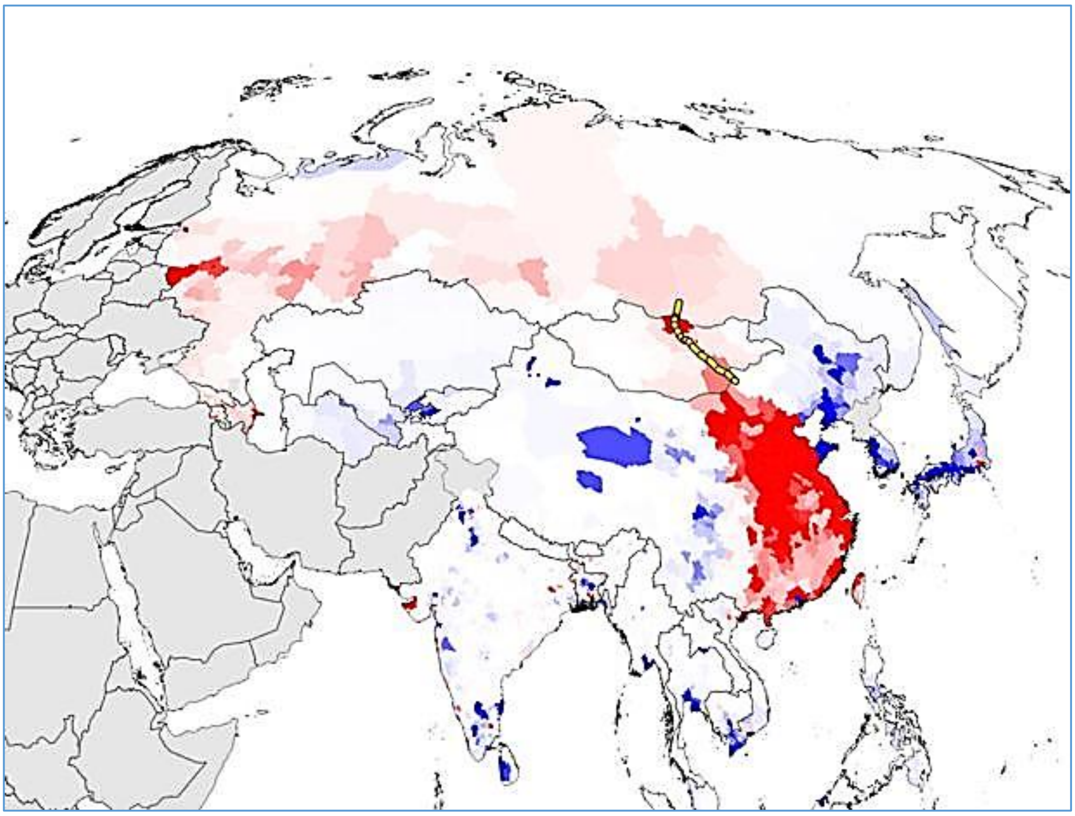
Table 3: Economic Impact of Corridor 4b (2030, against baseline, million USD)

	Agriculture	Automotive	E&E	Textile	Food Proc.	Oth. Mfg.	Services	Mining	Total
Mongolia	-1.5	0.2	0.2	18.4	59.4	20.2	243.2	79.7	419.7
China	-12.8	1,334.4	-105.5	1,520.3	711.2	-664.9	-160.4	527.2	3,149.6
Russia	-0.3	41.8	21.1	13.6	153.8	233.2	-8.9	6.4	460.7
Japan	0.0	-123.8	8.3	-17.9	-10.2	16.1	1.2	-15.3	-141.7
Korea	0.1	-54.1	7.0	-6.4	-7.4	4.9	1.2	-4.1	-58.8
Taiwan	-0.1	13.3	-1.0	4.3	7.9	-1.6	-0.4	0.0	22.3
India	2.6	-129.3	-1.4	-141.0	-38.7	77.2	98.4	-12.3	-144.6
ASEAN10	1.9	-64.2	0.1	-140.8	-46.5	63.6	80.4	-32.5	-138.0
United States	0.3	-277.0	4.1	-85.0	-182.1	144.1	20.2	-31.5	-406.9
EU	-0.6	1,147.7	-40.2	1,375.7	339.6	-70.7	58.4	-45.6	2,764.2
World	-1.7	2,186.2	-108.2	2,199.2	956.3	-26.9	509.0	88.8	5,802.8

Source: Estimated by IDE-GSM.

Figure 7 shows the geographical representation of economic impacts from Corridor 4b in 2030, compared with the baseline scenario. For Mongolia, the economic impacts appear mainly along the corridor. The positive economic impacts are observed in North to East China, while other parts of China have some negative impacts from the development. The regions along the Trans-Siberian Railway in Russia benefited from the corridor. At a glance the positive impacts are forecasted along the Corridor 4b, one the one hand stretches Southward to Southern coastline of China, and on the other extends Westward all the way to Western part of Russia.

Figure 7: Economic Impact of Corridor 4b (2030, against baseline, impact density)



Source: Estimated by IDE-GSM.

Table 4 shows the top 10 gainer regions by Corridor 4b Scenario. The region most benefited from the corridor is Beijing, China, with the impacts of USD322.6 million, followed by Shanghai, China (USD231.7 million) and Tianjin, China (USD193.2 million). Nonetheless, Mongolian regions namely Ulanbaatar and Orkhon placed 5th and 6th with the impacts of USD143.4 million and USD134.0 million respectively. If one focuses on services, the impacts are highest in Orkhon and Ulaanbaatar, both in Mongolia, while the rest of the top 10 gainer regions expect negative impacts. Impacts on Mining and Food industries are also relative large for both Orkhon and Ulaanbaatar among top 10 gainer regions.

Table 4: Top 10 gainers from Corridor 4b (2030, against baseline, million USD)

	Region	Country	Agri	Auto	EE	Text	Food	OthM	Svs	Mining	Total
1	Beijing	China	0.0	146.8	-0.5	119.2	50.0	-12.1	-10.4	29.7	322.6
2	Shanghai	China	-0.1	133.4	-2.5	156.7	23.9	-71.1	-10.1	1.4	231.7
3	Tianjin	China	0.0	75.4	-0.6	102.1	23.8	-16.1	-6.4	14.9	193.2
4	Suzhou	China	0.0	62.2	-0.9	147.5	8.8	-44.7	-3.6	-1.5	167.7
5	Ulaanbaatar	Mongolia	0.0	0.1	0.2	13.9	34.7	11.3	50.3	33.0	143.4
6	Orkhon	Mongolia	0.0	0.0	-0.1	1.7	1.4	5.0	96.0	30.1	134.0
7	Wuxi	China	0.0	48.8	-0.6	118.6	7.0	-36.4	-3.2	-2.3	132.0
8	Hangzhou	China	0.0	47.7	-0.4	75.7	9.3	-13.6	-4.0	4.4	119.1
9	Baotou	China	0.0	46.3	0.0	18.1	8.0	19.3	-1.5	12.2	102.5
10	Dongying	China	0.0	66.5	-0.4	10.3	34.8	-15.4	-0.3	5.1	100.5

Source: Estimated by IDE-GSM.

3.3 Corridor 4C

Table 5 shows the economic impacts by industry for Corridor 4c Scenario. This scenario involves Ulaanbaatar, the capital city of Mongolia, so one may expect relatively large impacts for Mongolia, as stated in previous section. The result suggests that the aggregated impact by country is relative large in Mongolia among selected countries and regions in Table 5, though far behind China. For Mongolia, the economic impacts are the highest in services (USD37.8 million), followed by food processing industry (USD12.5 million) and mining sector (USD10 million). For China, the economic impacts are the highest in services (USD322.5 million) followed by other manufacturing (USD43.9 million) and food processing (USD 39.5 million).

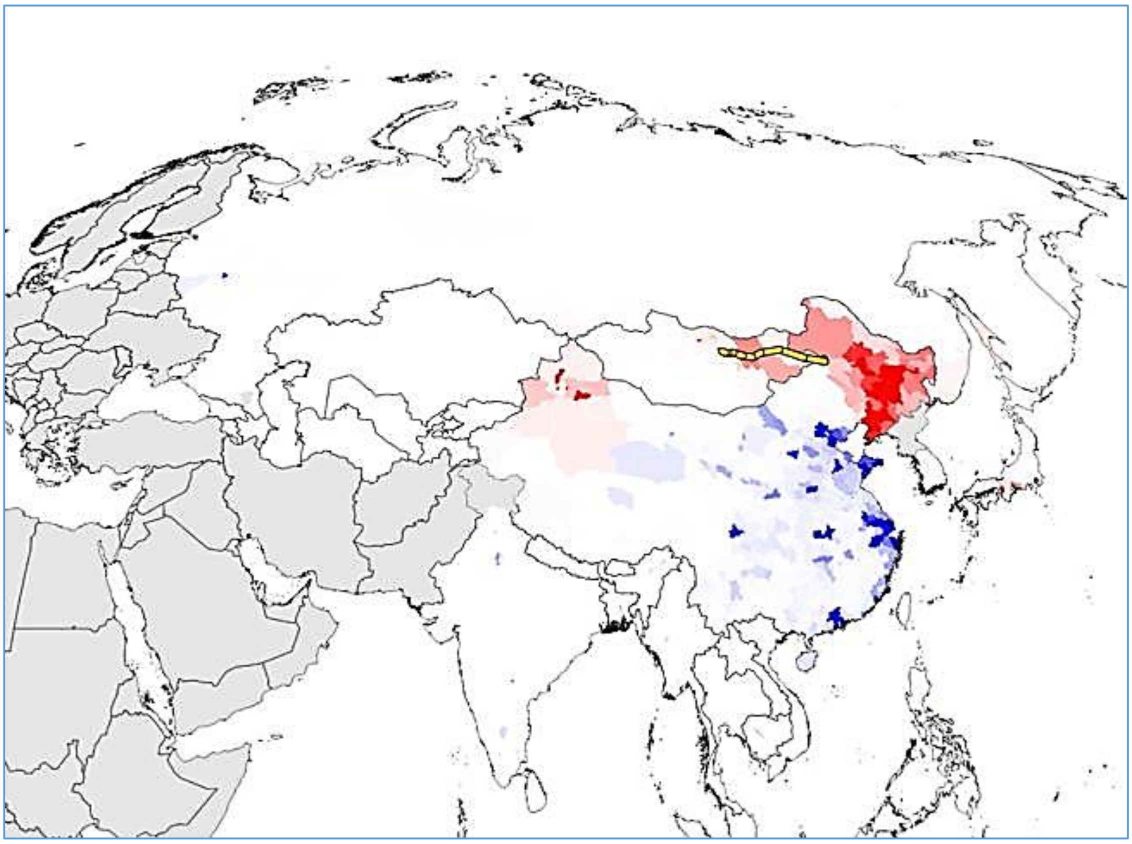
Table 5: Economic Impact of Corridor 4c (2030, against baseline, million USD)

	Agriculture	Automotive	E&E	Textile	Food Proc.	Oth. Mfg.	Services	Mining	Total
Mongolia	-0.5	0.1	0.0	2.1	12.5	1.3	37.8	10.0	63.4
China	0.0	1.8	6.5	16.2	39.5	43.9	322.5	12.7	443.0
Russia	0.0	0.0	0.7	0.0	-0.1	1.0	0.1	1.0	2.7
Japan	0.0	-0.1	-0.8	-0.1	5.1	0.6	-0.9	1.1	4.8
Korea	0.0	-0.1	-0.3	0.0	1.2	0.2	-0.3	0.1	0.7
Taiwan	0.0	0.0	-0.1	0.0	0.0	0.1	-0.1	0.0	-0.2
India	0.1	0.0	-0.1	0.0	0.0	0.8	-3.7	-0.2	-3.2
ASEAN10	0.1	0.0	-0.3	0.0	-0.3	0.2	-1.9	-0.1	-2.3
United States	0.0	-0.9	-1.3	-0.2	-0.3	-3.2	-3.8	0.2	-9.5
EU	0.0	-1.3	-1.3	-0.8	-1.1	-3.9	-1.2	0.4	-9.1
World	-0.3	-1.4	2.5	17.1	55.8	38.2	343.5	27.5	483.0

Source: Estimated by IDE-GSM.

Figure 8 shows the geographical representation of economic impacts from Corridor 4c in 2030, compared with the baseline scenario. For Mongolia, the economic impacts appear mainly in the eastern part of the country. The positive economic impacts are observed in Northeast China and Xinjiang Uyghur Autonomous Region, while other parts of China have slightly negative impacts from the development. At a glance the impacts are extend are forecasted along Corridor 4c, extends Eastward to Northeastern part of China, and with less extend to the West of Mongolia.

Figure 8: Economic Impact of Corridor 4c (2030, against baseline, impact density)



Source: Estimated by IDE-GSM.

Table 6 shows the top 10 gainer regions by Corridor 4c. Karamay, China, gains most from the development, with the impacts of USD162.4 million. The second largest impacts are on Urumqi, China (USD148.3 million) then Harbin, China (USD77 million). For Mongolian regions, Ulanbaatar and Khentii placed 9th and 10th with the impacts of USD 20.5 million and USD 17.8 million respectively.

Table 6: Top 10 gainers from Corridor 4c (2030, against baseline, million USD)

	Region	Country	Agri	Auto	EE	Text	Food	OthM	Svs	Mining	Total
1	Karamay	China	0.0	0.0	0.0	8.7	27.0	9.3	117.4	0.1	162.4
2	Urumqi	China	0.0	0.0	-0.1	-0.4	-0.4	-5.2	154.3	0.0	148.3
3	Harbin	China	0.0	-0.1	0.0	0.4	1.3	-2.0	75.7	1.7	77.0
4	Shenyang	China	0.0	0.0	0.7	0.2	0.1	-0.8	67.2	1.8	69.1
5	Changchun	China	0.0	0.0	0.1	0.1	0.5	-2.2	64.1	1.7	64.2
6	Hulunbuir	China	0.0	0.0	0.0	0.1	2.2	-1.2	49.5	0.7	51.3
7	Daqing	China	0.0	0.3	0.2	1.5	4.8	2.2	38.6	1.7	49.3
8	Ili(Kazakh)	China	-0.2	-0.1	0.0	-0.3	-0.4	-1.7	29.3	0.0	26.7
9	Ulaanbaatar	Mongolia	0.0	0.0	0.0	1.6	6.9	0.5	9.1	2.4	20.5
10	Khentii	Mongolia	-0.2	0.0	0.0	0.0	-0.6	-0.1	18.7	0.0	17.8

Source: Estimated by IDE-GSM.

3.4 All Corridors

Table 7 shows the economic impacts by industry for All Corridors Scenario. For Mongolia, the economic impacts are highest in services (USD163.7 million), followed by mining sector (USD84.4 million) and food processing industry (USD66.2 million). By country China (USD4682.1 million) has the largest positive impacts from the development, and EU(USD2747.0Million) follows. By industry, Textile and Automotive sectors in China and EU benefited most, then services and food processing sectors follow.

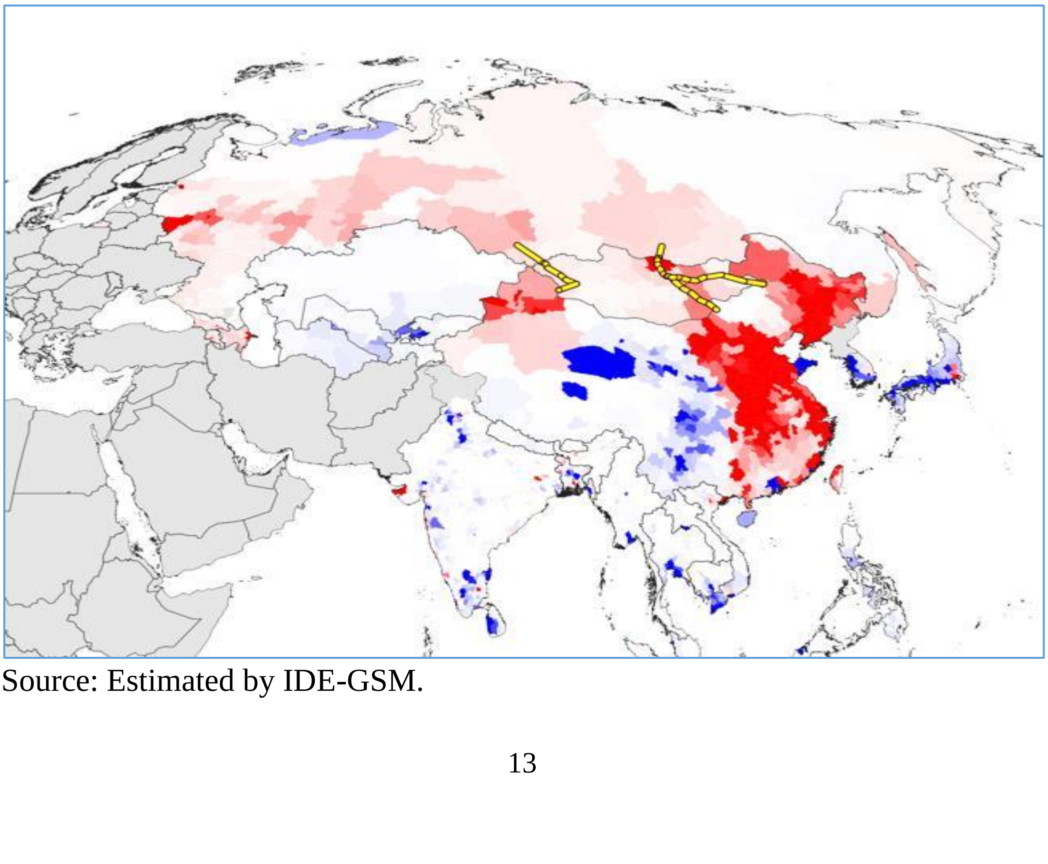
Table 7: Economic Impact of All Corridors (2030, against baseline, million USD)

	Agriculture	Automotive	E&E	Textile	Food Proc.	Oth. Mfg.	Services	Mining	Total
Mongolia	-2.8	0.2	0.4	19.7	65.7	18.3	295.6	85.0	482.1
China	-12.4	1,336.6	-98.7	1,553.6	811.8	-588.4	1,146.6	533.1	4,682.1
Russia	-0.2	41.9	23.7	13.8	156.7	234.9	41.1	6.6	518.5
Japan	0.2	-117.9	14.1	-17.4	-6.9	29.1	-4.4	-15.3	-118.5
Korea	0.2	-53.0	12.6	-6.2	-7.1	8.6	1.5	-4.1	-47.5
Taiwan	-0.1	13.4	-0.7	4.3	7.9	-1.1	-0.4	0.0	23.2
India	3.3	-127.0	-1.5	-140.7	-38.6	82.6	84.8	-12.6	-149.7
ASEAN10	2.3	-64.1	-1.2	-140.7	-47.3	63.4	79.2	-32.6	-141.0
United States	0.4	-278.1	0.4	-85.0	-180.1	134.0	17.8	-31.6	-422.3
EU	-0.4	1,145.6	-43.4	1,373.5	337.2	-74.6	55.0	-45.8	2,747.0
World	-0.3	2,192.2	-96.8	2,232.3	1,070.7	52.6	1,885.9	102.0	7,438.7

Source: Estimated by IDE-GSM.

Figure 9 shows the geographical representation of economic impacts from All Corridors in 2030, compared with the baseline scenario. For Mongolia, most of the regions benefited from the development. The positive economic impacts are observed in North to East China, as well as Xinjiang Uyghur Autonomous Region while other parts of China have some negative impacts from the development. The regions along the TransSiberian Railway in Russia benefited from the corridor.

Figure 9: Economic Impact of All Corridors (2030, against baseline, impact density)



Source: Estimated by IDE-GSM.

Table 8 shows the top 10 gainer regions by All Corridors Scenario. Beijing, China, gains most from the scenario, with the impacts of USD523.3 million. The second largest impacts are on Karamay, China (USD391.3 million) then Urumqi, China (USD350.3 million). For Mongolian regions, Ulanbaatar and Orkhon placed 6th and 8th with the impacts of USD 158.7 million and USD 135.5 million respectively.

Table 8: Top 10 gainers from All Corridors (2030, against baseline, million USD)

	Region	Country	Agri	Auto	EE	Text	Food	OthM	Svs	Mining	Total
1	Beijing	China	0.0	147.2	-0.4	119.5	49.9	-10.6	188.2	29.5	523.3
2	Karamay	China	0.0	0.0	0.0	-48.9	44.0	7.3	388.6	0.1	391.3
3	Urumqi	China	0.0	0.0	0.0	-5.2	-0.9	-14.7	371.2	0.1	350.3
4	Shanghai	China	-0.1	133.5	-2.1	156.5	23.7	-67.6	55.6	1.3	300.8
5	Tianjin	China	0.0	75.6	-0.5	102.3	23.7	-14.5	27.4	14.9	229.0
6	Ulaanbaatar	Mongolia	-0.1	0.1	0.3	14.8	34.2	10.4	64.9	34.1	158.7
7	Suzhou	China	0.0	62.3	-0.7	147.3	8.7	-42.3	-25.4	-1.6	148.3
8	Orkhon	Mongolia	0.0	0.0	0.0	1.8	1.2	3.9	97.7	30.9	135.5
9	Harbin	China	-0.1	-1.9	0.0	-3.5	0.7	-6.9	118.8	-1.3	105.8
10	Dongying	China	0.0	66.5	-0.2	10.3	34.7	-13.9	-3.2	5.1	99.1

Source: Estimated by IDE-GSM.

4. Analysis and Policy Implications

Table 9 compares the economic impacts by country and scenario. For Mongolia, the economic benefits are the largest for All scenario (USD482.1 million). Among three corridors, the economic impacts are the largest for Corridor 4b(USD419.7), followed by 4c (USD63.4 million) and 4a(USD21.3 million). The economic impacts for Corridor 4b are the largest for China (USD3149.6 million), EU (USD2764.2 million) as well as Russia (USD460.7 million). The development of Corridor 4b benefit large number of countries, thus eligible to be developed as an international development project with China, EU and Russia.

As provided in Table 3, the development of the corridor benefits automotive and textile industries most, especially for China and EU. The utilization of Trans-Siberian Railway seems to be a key; thus, the cooperation of Russia is also indispensable. For Mongolia, service sector, food processing and textile industry seem to have some potential to benefit from the corridor. The industrial development policy for these sectors may complement the Corridor 4b project to unlock the potential.

For Corridor 4a, most of the economic benefits goes to China, thus China may have an incentive to finance the project. Corridor 4c has the positive impacts for China and Mongolia, thus the cooperation of two countries might be desirable for the development.

Table 9: Economic Impact by scenario (2030, against baseline, million USD)

	4A	4B	4C	All
Mongolia	21.3	419.7	63.4	482.1
China	962.1	3,149.6	443.0	4,682.1
Russia	56.9	460.7	2.7	518.5
Japan	26.3	-141.7	4.8	-118.5
Korea	15.5	-58.8	0.7	-47.5
Taiwan	2.1	22.3	-0.2	23.2
India	-2.3	-144.6	-3.2	-149.7
ASEAN10	-1.2	-138.0	-2.3	-141.0
United States	-11.5	-406.9	-9.5	-422.3
EU	-8.9	2,764.2	-9.1	2,747.0
World	1,056.7	5,802.8	483.0	7,438.7

Source: Estimated by IDE-GSM.

5. Conclusion

In this paper, we tried to estimate the economic impacts of Corridor 4a, 4b and 4c projects by IDE-GSM, a computational general-equilibrium model based on spatial economics. The estimation results show that the economic impacts are the highest for Corridor 4b compared with other two corridors. The economic impacts of Corridor 4b are large for China, EU as well as Russia, other than Mongolia, then the cooperation including these four party might be a suitable arrangement for the development.

The evaluation of large-scale economic corridor developments is not very easy without a proper tool like IDE-GSM. This paper shows the usefulness of the simulationbased policy analysis and we hope the analyses provided here will be valuable input to the policy formulation process to shape the better development plan for Mongolia.

References

Bosker, M., Brakman, S., Garretsen, H., Schramm, M., 2010. Adding geography to the new economic geography: bridging the gap between theory and empirics. *Journal of Economic Geography*, 10(6), 793-823. Cormen, T.H., Leiserson, C.E., Rivest, R.L., Clifford, S., 2001. Introduction to Algorithms, MIT Press. Fingleton, Bernard. 2006. The new economic geography versus urban economics: an evaluation using local wage rates in Great Britain. *Oxford Economic Papers* 58. 501 530. Fujita, M. and Mori, T. 2005. Frontiers of the New Economic Geography. *Journal of Public Economic Theory* 5, 279-304. JETRO. 2013. *Zai-Azia-Oseania Nikkei Kigyo Gittai Chosa*

（http://www.jetro.go.jp/jfile/report/07001539/0700153901a.pdf） Head, K., and Mayer, T. 2000. Non-Europe: the magnitude and causes of market fragmentation in the EU. *Weltwirtschaftliches Archiv*, *136*(2), 284-314. Hummels, D., 1999. Toward a geography of trade costs. GTAP Working Paper No. 17. Isono, I., Kumagai, S., Hayakawa, K., Keola, S., Tsubota, K., Gokan, T. 2016. Comparing the economic impacts of Asian integration by computational simulation analysis, IDE-Discussion Paper No. 567. Krugman, P. 1991. Increasing Returns and Economic Geography, *Journal of Political Economy*,99, 483-99. Krugman, P. 1993, On the number and location of cities. *European Economic Review*, 37(2), 293-298. Kumagai, S., K. Hayakawa, I. Isono, S. Keola and K. Tsubota. 2013. Geographical Simulation Analysis for Logistics Enhancement in Asia. *Economic Modelling* 34, 145–153. Kumagai, S., and Isono, I. 2011. Economic Impacts of Enhanced ASEAN-India Connectivity: Simulation Results from IDE/ERIA-GSM. *ASEAN-India Connectivity: The Comprehensive Asia Development Plan, Phase II*. Nihon Kaiun Shukaijo.1983. *Distance Tables for World Shipping (Eighth edition)*. Nihon Kaiun Shukaijo. Puga, D. 1999. The rise and fall of regional inequality. *European Economic Review* 43, 303-334. Stelder, D., 2005. Where do cities form? A geographical agglomeration model for Europe. *Journal of Regional Science*, 45(4), 657-679. Teixeira, A. C. 2006. Transport policies in light of the new economic geography: The Portuguese experience. *Regional Science and Urban Economics* 36, 450-46