Economic impacts of economic corridors in Mongolia : an application of IDE-GSM

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March 2018

Abstract

In this paper, we tried to estimate the economic impacts of the Central Asia Regional Economic Cooperation (CAREC) Economic Corridor 4a, 4b, and 4c projects, which enhance the connectivity between Mongolia and its surrounding countries, using a computational general equilibrium model based on spatial economics. The estimation results show that the economic impacts for Corridor 4b, which connects China and Russia through Ulaanbaatar, the capital of Mongolia, are the highest compared with the other two corridors. Apart from Mongolia, Corridor 4b also economically impacts China, EU, and Russia; thus, cooperation among these four parties might be a suitable arrangement for development. The evaluation of large-scale economic development of corridors is not very easy without proper evaluation tools.

Keywords: Simulation, new economic geography, Mongolia

JEL classification: R12, R13, R42

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

Satoru Kumagai, Toshitaka Gokan and Souknilanh Keola

Abstract

In this paper, we tried to estimate the economic impacts of the Central Asia Regional Economic Cooperation (CAREC) Economic Corridor 4a, 4b, and 4c projects, which enhance the connectivity between Mongolia and its surrounding countries, using IDE-GSM, a computational general equilibrium model based on spatial economics. The estimation results show that the economic impacts for Corridor 4b, which connects China and Russia through Ulaanbaatar, the capital of Mongolia, are the highest compared with the other two corridors. Apart from Mongolia, Corridor 4b also economically impacts China, EU, and Russia; thus, cooperation among these four parties might be a suitable arrangement for development. The evaluation of large-scale economic development of corridors is not very easy without proper evaluation tools. This paper shows the efficacy of this simulation-based policy analysis to shape better development plans for Mongolia.

Introduction

Infrastructure development as well as logistics enhancement is one of the most important drivers for economic development, especially for countries that are land-locked and where waterways 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 the Geographical Simulation Model developed by IDE-JETRO (IDE-GSM). IDE-GSM is a simulation model based on spatial economics and is 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 required for target regions and how to prioritize them. The model has an original economic model with a general equilibrium setting based on a dataset comprising more than 2,000 regions, 6,500 nodes, and 12,000 routes, and several parameters obtained by econometric techniques. It covers the provinces or cities of 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 eight Central and Western Asian countries and Russia and Mongolia. The model makes prediction of the spatial structure of economic activities and estimation of the economic impacts of various TTFMs on each region at the sub-national level possible.

This paper is structured as follows: Section 1 briefly introduces the structure of IDE-GSM; Section 2 constructs the baseline scenario, explains its assumptions, and describes each development scenario for Mongolia used in the empirical analysis; Section 3 shows the results of numerical analysis on each scenario; and Section 4 analyses the economic impacts of the corridors and proposes some policy implications. The last section concludes the paper with a future research agenda.

1. The structure of IDE-GSM

IDE-GSM can be regarded as a combination of data, the estimation of parameters, a model for NEG, and a simulation procedure to analyze the impact of specific TTFMs on regional economies in East Asia at a sub-national level.

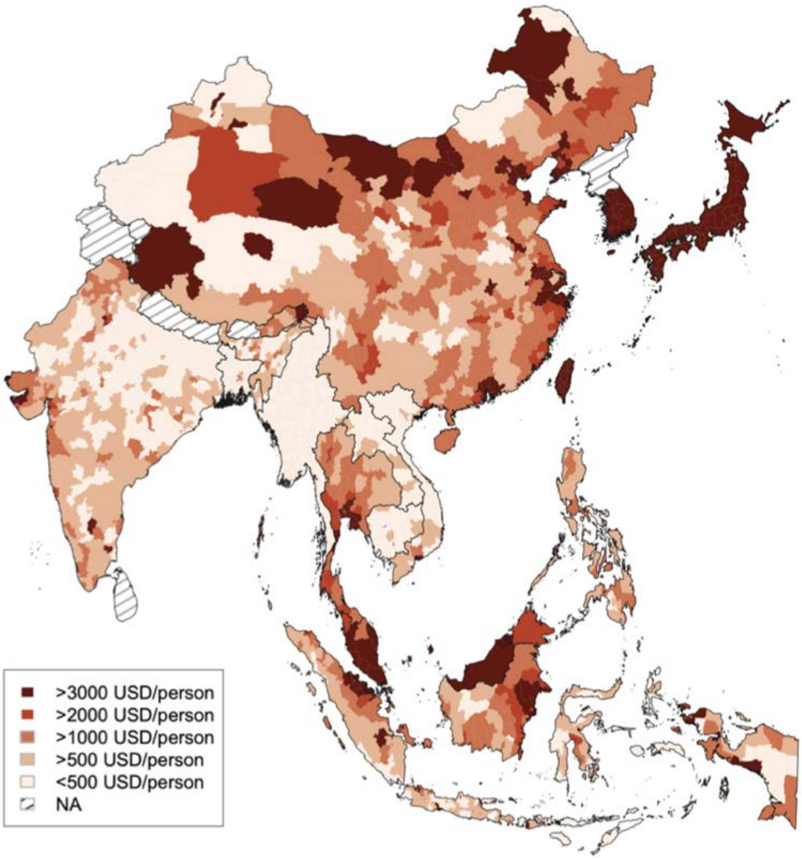
Primarily based on official statistics, we derive the gross regional product (GRP) for the agricultural, mining, service sectors and five manufacturing sectors in 2010. The five manufacturing sectors are food processing, garments and textiles, electronics, automotive, and other manufacturing. Population and area of arable land for each region are compiled from official statistical sources. Figure 1 shows the GRP per capita for each region in 2010.

The geography of our simulation model consists of connected points in more than 2,000 regions. 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 comprise the 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, then the distances between cities in a straight line are employed.

Figure 2 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 dataset 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 are adopted from various sources, such as maps and the official websites of railway companies.

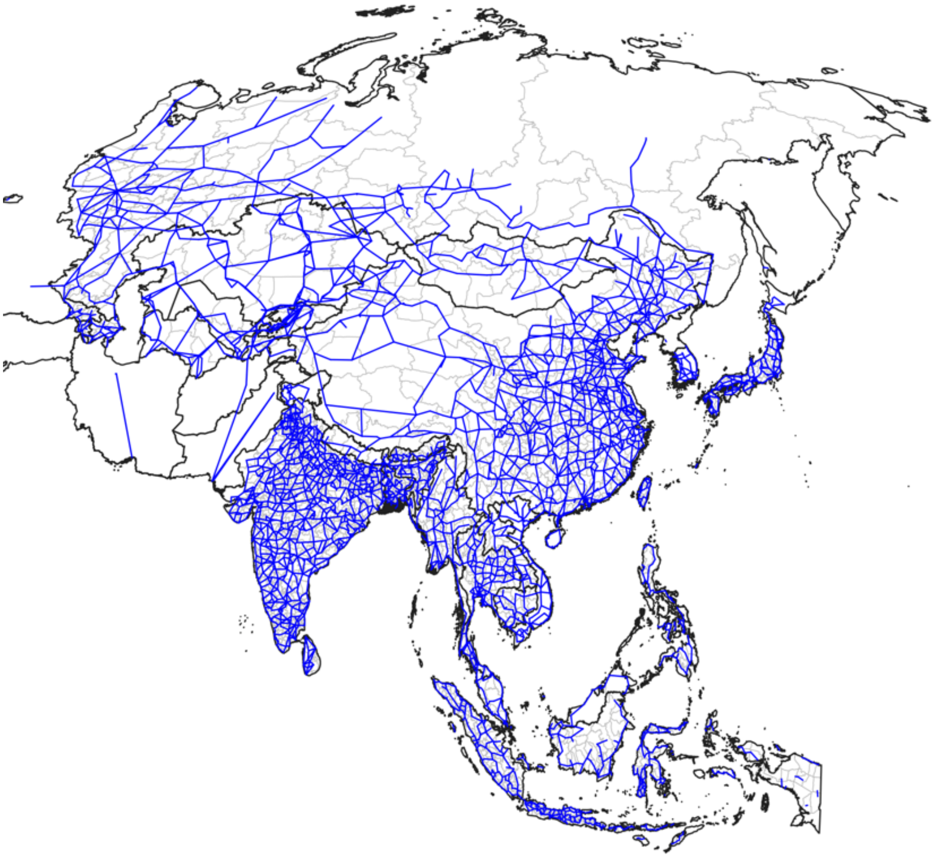
Furthermore, we estimated the costs per kilometer in US dollars (USD) and domestic and international loading costs for air transport, marine transport, trucking and railway transport, and also the parameters on the modal choice between three transport modes by econometric techniques.

Figure 1: GRDP per Capita in East Asia, 2010



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

Figure 2: Land Route Network Data in the IDE-GSM



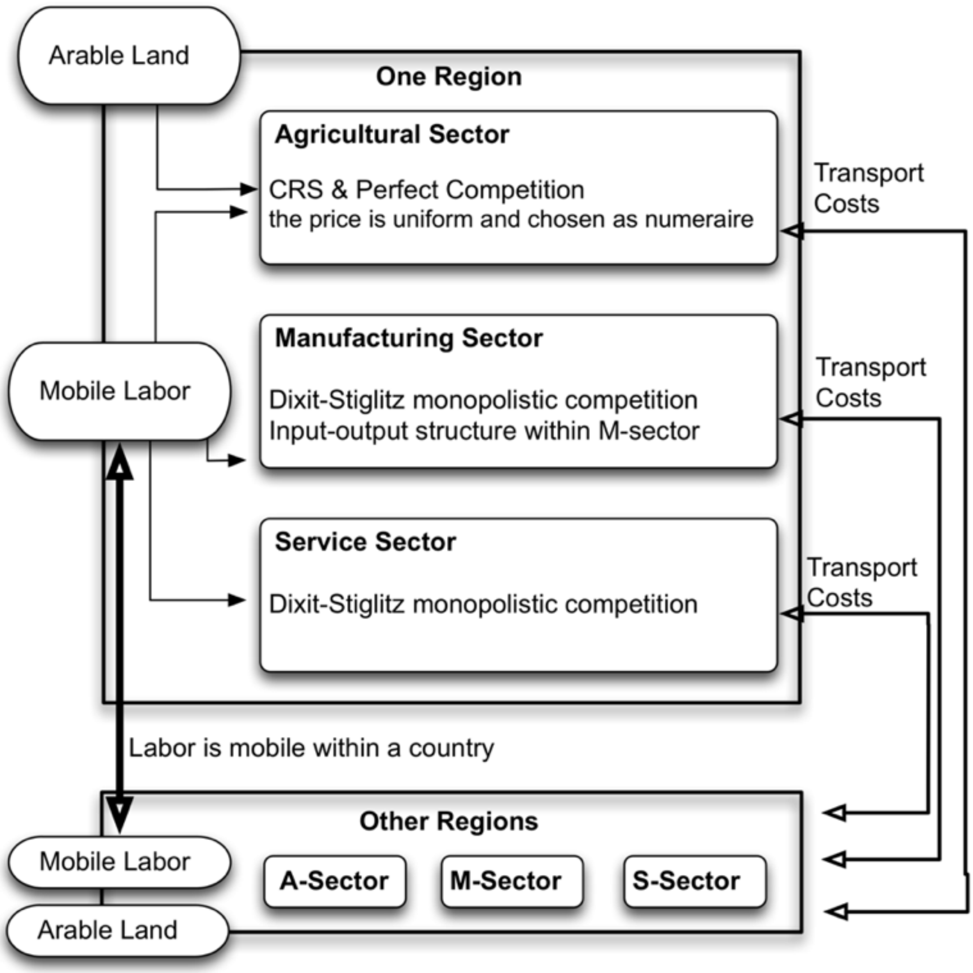
Source: Authors

An NEG model in IDE-GSM provides the source of the spatial dynamics on populations and industries. The original NEG model, the Core-Periphery (CP) model by Krugman (1991), uses numerical solutions to show its fundamental characteristics. The basic CP model features a two-location/two-goods model, setting one good (typically assumed as an agricultural good) as numeraire, which is produced by a constant returns to scale technology and incurs zero transport costs while the other good is produced by increasing returns to scale technology (typically assumed as manufacturing goods) and incurs positive transport costs. IDE-GSM was developed based on this CP model.

The economy in IDE-GSM features two endowments: labor and land. Labor is mobile within a country, but is prohibited to migrate to other countries. Further, labor can choose the industry to work in. Land, which is unequally dispersed in all regions, is jointly owned by all the laborers of the region. Figure 3 shows the model structure of IDE-GSM.

All products in the three sectors are tradable. Transport costs are supposed to be of the iceberg type to omit the transport sector. 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 an additional charge on the mill price of transported goods. The increase in price compared with the mill price is regarded as the transport cost. Transport costs within the same region are considered negligible.

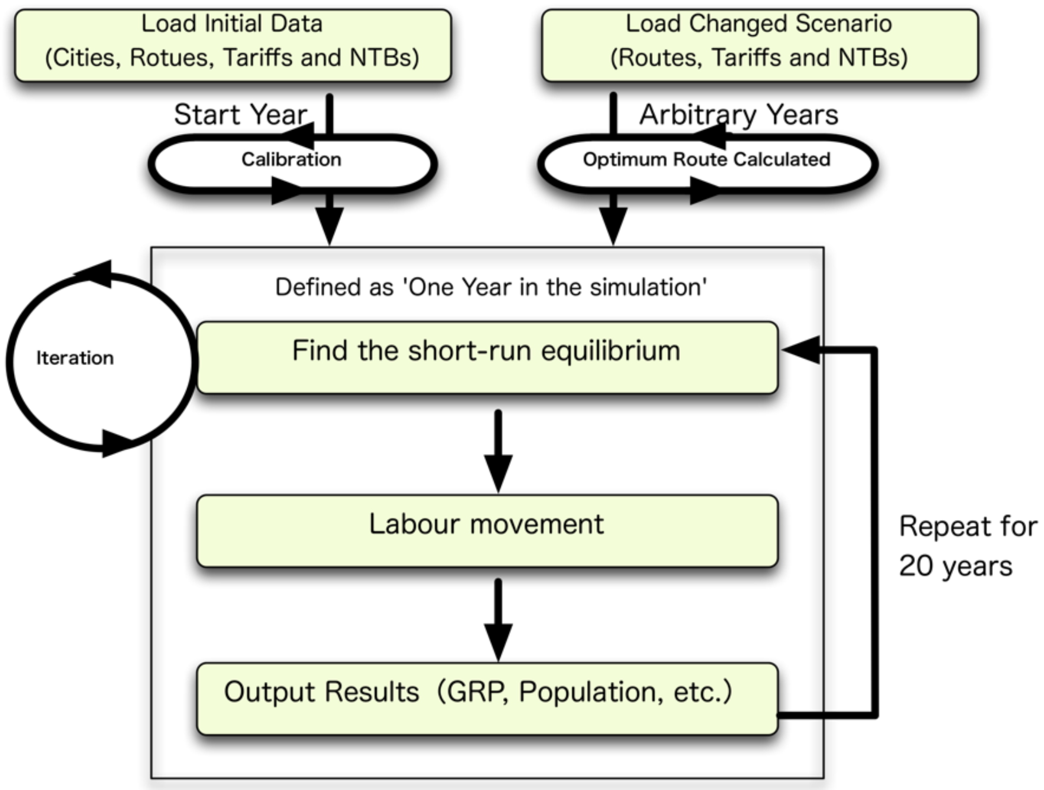
Figure 3: Model Structure



Source: Isono et al. (2015)

The dynamics for the spatial distribution of populations and industries in the long-term by IDE-GSM are illustrated in Figure 4. First, with a given distribution of employment and regional GDP by sector and regions according to actual data, a short-run equilibrium is obtained. Observing the achieved equilibrium, workers migrate between regions and choose industries in which to work, according to the differences in real wages. Workers move to sectors that offer higher real wage rates in the same region and move to regions that offer higher real wages within the same country. As a result, another distribution of workers and economic activities emerges. With this new distribution and predicted population growth, the next short-run equilibrium is obtained for the following year and counted in terms of migration speed, where we again observe migration. These computations are repeated for typically 20 years, e.g., from 2010 to 2030.

Figure 4: Simulation Procedures

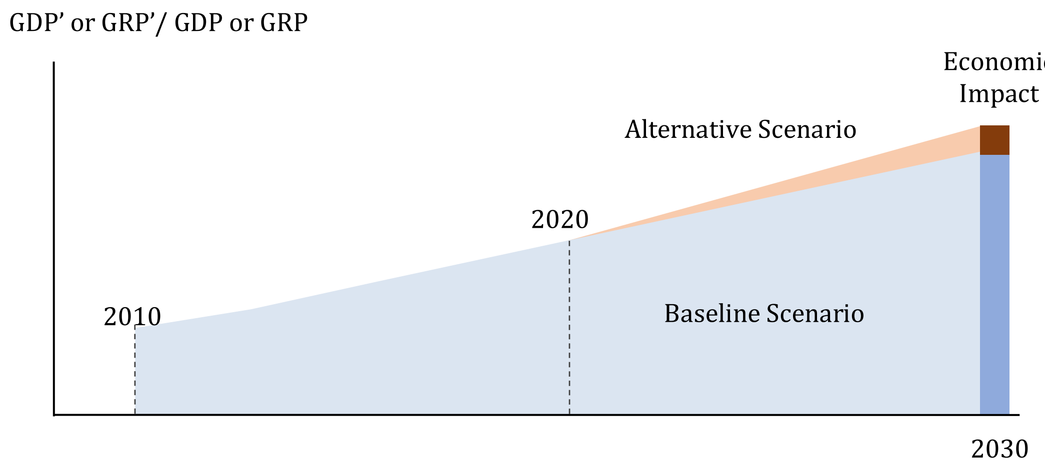


Source: Isono et al. (2015)

2. Scenarios

To calculate the economic impacts, we take the differences in the baseline and alternative scenarios (Figure 5). The baseline scenario assumes minimal additional infrastructure development after 2010. The alternative scenario assumes the completion of corridors in 2020 and beyond. We compare and show the differences between GDP (for countries) or GRP (for sub-national regions), based on alternative scenarios, against GDP (for countries) or GRP (for sub-national regions) of baseline scenarios for the year 2030. If a country/region under alternative scenarios has a higher (or lower) GDP/GRP than under the baseline scenario, then we regard this surplus (or deficit) as a positive (or negative) economic impact of the corridor developments.

Figure 5: Evaluation of Economic Impacts by Countries or Sub-national Regions



Source: Adapted from Isono and Ishido (2016)

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 states in a specific scenario:

- The national population of each country is assumed to increase at the rate forecasted 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.

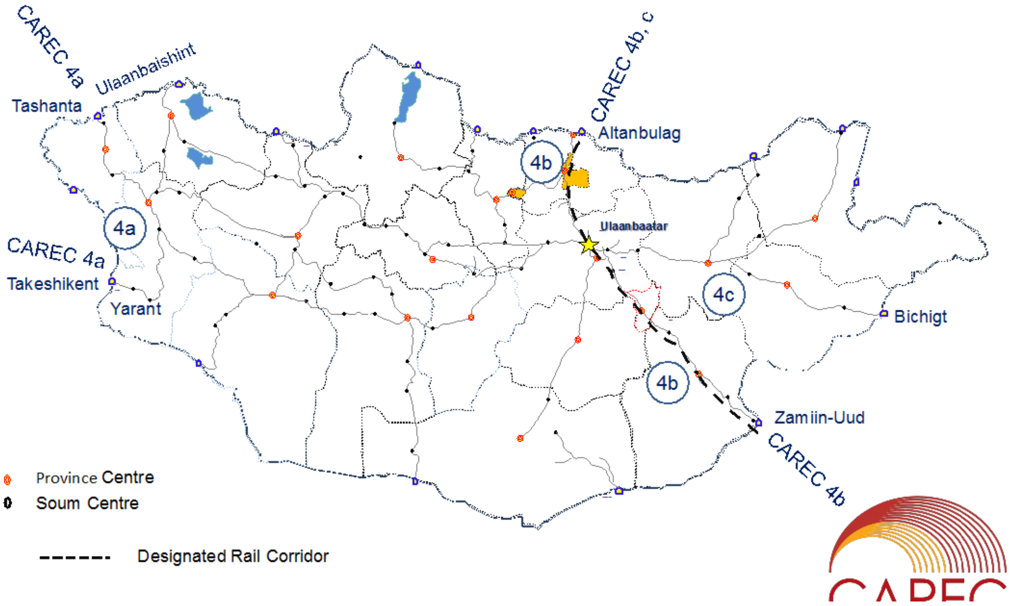
It should be noted that even if trade and transport facilitation measures negatively impact a region's economy according to the simulation scenario, this does not necessarily mean that the region is worse off than the current situation. Most of the countries in Asia are expected to grow faster in the next few decades and the negative economic impacts offset 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 6 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 is implemented and completed in 2020. CAREC Corridor 4c connects Bichig and Ulaanbaatar. In this scenario, we suppose that the road specified as CAREC Corridor 4c is implemented and completed in 2020. We also run an "All" scenario to implement the three corridors specified above 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 in the simulation by reducing by half the time and money costs crossing national borders.

Figure 6: 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 the Corridor 4a scenario. For Mongolia, the economic impacts are highest in services (USD 8.8 million) followed by the food processing industry (USD 6.0 million) and mining sector (USD 1.7 million). It should be noted that the impact is for the year 2030 and against the baseline scenario. According to the model, the impact begins at the year of completion of infrastructure in the alternative scenario or 2020 for the Corridor 4a scenario, and continues onward. The total impact should be considered as an aggregation of these impacts. By country, China benefits most from Corridor 4a. Most of the economic impacts come from services (USD 1,198.6 million) followed by the other manufacturing (USD 56.5 million).

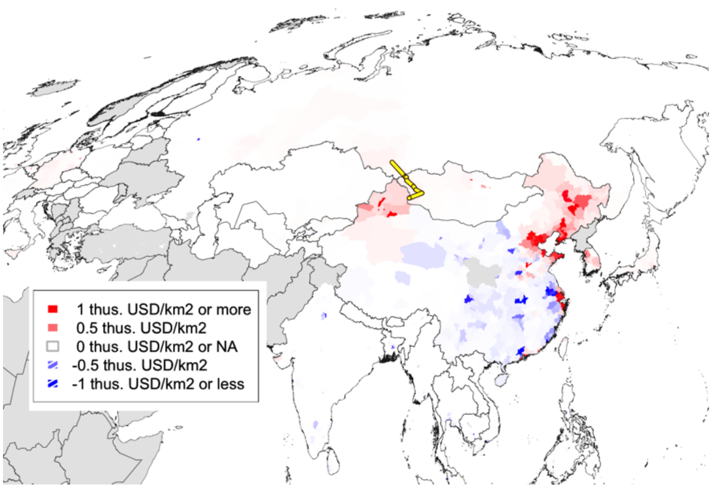
Table 1: Economic Impact of Corridor 4a (2030, against baseline, million USD)

	Agriculture	Automotive	E&E	Textile	Food Proc.	Oth. Mfg.	Services	Mining	Total
Mongolia	-0.7	0.0	0.2	0.5	6.0	-0.1	8.8	1.7	16.5
China	0.1	18.1	21.1	15.8	51.1	56.5	1,198.6	-2.1	1,359.2
Russia	0.0	0.9	15.9	0.5	5.7	-1.4	8.5	3.5	33.6
Japan	0.1	-1.3	6.4	0.1	-0.4	5.8	-5.5	-0.2	5.1
Korea	0.0	-0.9	12.6	0.0	-0.4	0.6	-1.1	0.0	10.8
Taiwan	0.0	-0.1	0.8	0.1	0.0	0.1	-0.1	0.0	0.8
India	0.4	-0.6	-3.1	-2.7	-0.8	4.6	-2.2	-0.4	-4.9
ASEAN10	0.2	-1.3	-4.1	-2.9	-2.3	1.2	3.6	0.1	-5.5
United States	0.0	-6.1	-10.1	-1.6	-6.9	1.8	2.5	-0.4	-20.7
EU	0.0	13.8	-12.2	10.1	4.4	0.0	0.0	-0.6	15.6
World	0.5	30.9	19.8	15.8	54.9	72.6	1,216.4	5.9	1,416.8

Source: Estimated by IDE-GSM

Figure 7 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 impact density in economic impacts per square kilometer. For Mongolia, the economic impacts appear mainly in the western side of the country. The positive economic impacts are observed in northeast and northwestern China, whereas other parts of China have some negative impacts from the development.

Figure 7: 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 Corridor 4a is Karamay, China, with the impacts of USD 393.7 million followed by Beijing, China (USD 266.3 million) and Urumqi, China (USD 246.4 million). 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 gainer region, 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	14.1	26.7	27.2	324.6	1.0	393.7
2	Beijing	China	0.0	-0.2	0.3	-0.9	-0.1	0.7	266.7	-0.2	266.3
3	Urumqi	China	0.0	0.0	0.0	-0.9	-1.0	-10.2	257.7	0.7	246.4
4	Shanghai	China	0.0	-0.4	1.2	-3.5	-0.2	1.5	152.6	-0.3	150.9
5	Tianjin	China	0.0	-0.2	0.3	-1.1	-0.1	0.4	89.9	-0.1	89.2
6	Shenzhen	China	0.0	-0.1	8.7	-1.9	-0.1	0.1	54.4	-0.1	60.9
7	Ili(Kazakh)	China	-0.4	-0.2	0.0	-0.7	-1.0	-3.1	40.6	0.3	35.5
8	Harbin	China	0.0	0.0	0.0	0.1	0.6	-0.3	29.7	-0.1	30.1
9	Shenyang	China	0.0	0.0	0.2	-0.1	-0.1	0.1	29.8	-0.1	29.9
10	Changchun	China	0.0	0.0	0.0	0.0	-0.1	-0.3	25.8	-0.1	25.5

Source: Estimated by IDE-GSM

3.2 Corridor 4B

Table 3 shows the economic impacts by industry for the Corridor 4b scenario. The total global impacts of the Corridor 4b scenario are about five times larger than that of the Corridor 4a scenario in 2030. The impact for Mongolia is also relatively large, next only to China, the EU, and Russia among selected countries and regions in Table 3. For Mongolia, the economic impacts are highest in services (USD 125.0 million) followed by the mining sector (USD 79.7 million) and the food processing industry (USD 43.7 million). In other words, while benefits for Mongolia are mainly expected in services in the Corridor 4a scenario, substantial impacts are also forecasted for manufacturing and mining industries in the Corridor 4b scenario. In simulation analyses using IDE-GSM in general, positive impacts on manufacturing are often forecasted on infrastructure that locates in or connects with the capital city of a country, which in turn tends to host a larger share of non-agricultural activities. By country, the economic impacts are the largest for China (USD 2,862.0 million) followed by the EU (USD 2,117.8 million) and Russia (USD 454.4 million). Furthermore, negative impacts are forecasted for Japan, Korea, India, ASEAN countries, and the United States.

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

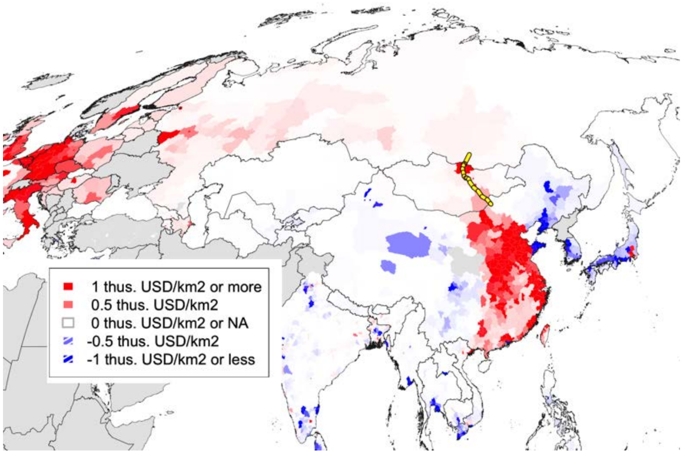
	Agriculture	Automotive	E&E	Textile	Food Proc.	Oth. Mfg.	Services	Mining	Total
Mongolia	-1.2	0.1	0.2	13.9	43.7	19.2	125.0	79.7	280.7
China	-13.7	1,307.0	-122.4	1,416.4	839.5	-893.2	-83.9	412.3	2,862.0
Russia	-0.2	45.7	16.3	12.1	172.1	116.0	-4.6	96.9	454.4
Japan	-0.2	-122.1	2.4	-10.0	-12.1	2.8	3.1	2.4	-133.7
Korea	0.0	-57.9	3.6	0.3	-11.3	2.6	0.0	0.1	-62.5
Taiwan	-0.2	15.9	-4.0	7.5	14.5	-5.6	-1.2	0.0	27.0
India	3.4	-153.0	2.6	-174.1	-53.0	77.0	102.6	8.0	-186.5
ASEAN10	3.1	-68.0	6.8	-171.9	-75.4	44.4	84.7	4.0	-172.1
United States	0.5	-309.1	13.1	-90.9	-279.8	138.6	33.2	6.1	-488.3
EU	-1.5	1,017.0	-33.7	874.6	318.8	-67.7	-0.4	10.6	2,117.8
World	0.7	2,101.5	-111.5	1,625.1	912.3	-388.9	402.6	691.2	5,233.0

Source: Estimated by IDE-GSM

Figure 8 is a 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, whereas other parts of China have some negative impacts from the development. The regions along the Trans-Siberian Railway in Russia benefit from the corridor. At a glance, the positive impacts are forecasted along Corridor 4b, where one branch stretches southward to the southern coastline of China and the other extends westward all the way to the western part of Russia.

Table 4 shows the top 10 gainer regions under the Corridor 4b scenario. The region most benefited from the corridor is Beijing, China, with the impact of USD 291.4 million followed by Shanghai, China (USD 170.7 million) and Tianjin, China (USD 170.0 million). Nonetheless, Mongolian regions, namely, Ulanbaatar, placed 8th with the impacts of USD 101.6 million. If one focuses on services, then the impacts are highest in the Mongolian capital city of Ulaanbaatar while the rest of the top 10 gainer regions expect negative impacts. Impacts on the mining and food industries are also relatively large for Ulaanbaatar.

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



Source: Estimated by IDE-GSM

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	140.5	-0.8	108.8	54.9	-20.1	-8.4	16.4	291.4
2	Shanghai	China	-0.1	121.3	-4.0	112.1	26.2	-86.3	-3.5	5.0	170.7
3	Tianjin	China	0.0	74.1	-1.0	94.2	26.4	-25.9	-5.2	7.3	170.0
4	Guangzhou	China	-0.1	76.2	-17.2	71.8	31.5	-6.8	-5.7	15.7	165.5
5	Suzhou_Jiangsu	China	0.0	58.4	-1.8	117.6	9.6	-56.8	-1.2	2.3	128.1
6	Wuxi	China	0.0	47.7	-1.2	105.6	7.7	-43.4	-1.2	1.8	117.0
7	Moscow City	Russia	-0.1	13.7	-1.7	2.8	46.3	32.5	-8.9	17.3	101.9
8	Ulaanbaatar	Mongolia	0.0	0.0	0.1	10.5	27.0	9.6	21.0	33.4	101.6
9	Hangzhou	China	0.0	44.4	-0.7	60.9	10.1	-19.5	-2.5	1.5	94.2
10	Puyang	China	-0.1	94.3	-0.1	1.2	0.9	-1.5	-4.0	1.4	92.1

Source: Estimated by IDE-GSM

3.3 Corridor 4C

Table 5 shows the economic impacts by industry for the Corridor 4c scenario. This scenario involves Ulaanbaatar, the capital city of Mongolia, so one may expect relatively large impacts for Mongolia, as stated in the previous section. The result suggests that the aggregated impact by country is relatively 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 (USD 25.7 million) followed by mining sector (USD 9.9 million) and the food processing industry (USD 9.6 million). For China, the economic impacts are the highest in services (USD 385.0 million) followed by other manufacturing (USD 61.6 million) and food processing (USD 40.0 million).

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

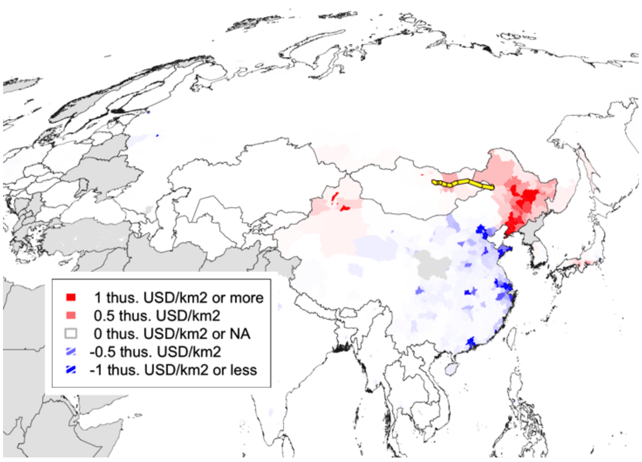
	Agriculture	Automotive	E&E	Textile	Food Proc.	Oth. Mfg.	Services	Mining	Total
Mongolia	-0.3	0.0	0.0	1.8	9.6	1.2	25.7	9.9	47.8
China	0.1	2.3	9.0	19.3	40.0	61.6	385.0	14.7	532.0
Russia	0.0	0.0	1.1	0.0	-0.2	1.1	5.5	1.6	9.1
Japan	0.0	-0.2	-1.1	-0.1	5.8	0.8	-0.9	1.0	5.4
Korea	0.0	-0.1	-0.5	0.0	1.2	0.1	-0.2	0.0	0.6
Taiwan	0.0	0.0	-0.2	0.0	-0.1	0.1	-0.1	0.0	-0.3
India	0.1	-0.5	-0.2	0.0	-0.2	-0.1	-2.4	-0.2	-3.6
ASEAN10	0.1	-0.1	-0.4	0.0	-0.6	-0.1	-1.0	-0.2	-2.3
United States	0.0	-1.2	-1.6	-0.2	-0.9	-4.0	-3.0	0.2	-10.7
EU	0.0	-1.3	-1.6	-0.5	-1.0	-3.3	-2.5	0.8	-9.4
World	0.0	-2.2	3.8	20.0	52.7	53.3	402.9	30.2	560.7

Source: Estimated by IDE-GSM

Figure 9 is a 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, whereas other parts of China have slightly negative impacts from the development. At a glance, the impacts forecasted along Corridor 4c extend eastward to the northeastern part of China and, to a lesser extent, to western Mongolia.

Table 6 shows the top 10 gainer regions by Corridor 4c. Karamay, China, gains most from the development, with the impacts of USD 171.9 million. The second largest impacts are on Urumqi, China (USD 158.1 million) then Harbin, China (USD 87.3 million).

Figure 9: Economic Impact of Corridor 4c (2030, against baseline, impact density)



Source: Estimated by IDE-GSM

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	9.2	26.6	10.6	125.3	0.1	171.9
2	Urumqi	China	0.0	0.0	-0.1	-0.4	-0.4	-5.5	164.5	0.0	158.1
3	Shenyang	China	0.0	0.0	0.8	0.2	0.1	-0.6	84.7	2.0	87.3
4	Harbin	China	0.0	0.0	0.2	0.5	1.3	-1.3	70.2	2.0	73.0
5	Changchun	China	0.0	0.0	0.1	0.1	0.5	-1.4	63.0	2.0	64.3
6	Hulunbuir	China	0.0	0.0	0.0	0.1	2.1	-1.0	50.8	0.8	52.8
7	Daqing	China	0.0	0.3	0.4	1.5	4.7	3.2	36.3	2.0	48.5
8	Dalian	China	0.0	0.0	0.7	0.9	0.3	0.8	34.5	1.4	38.5
9	Ili(Kazakh)	China	-0.3	-0.1	0.0	-0.4	-0.7	-2.4	39.1	0.0	35.1
10	Anshan	China	0.0	0.0	0.1	0.2	0.0	-0.1	25.8	0.7	26.7

Source: Estimated by IDE-GSM

3.4 All Corridors

Table 7 shows the economic impacts by industry for the All Corridors scenario. For Mongolia, the economic impacts are highest in services (USD 155.5 million) followed by the mining sector (USD 85.6 million) and food processing industry (USD 51.4 million). By country, China (USD 4,889.1 million) has the largest positive impacts from the development and the EU (USD 2,094.8 million) follows. By industry, the textile and automotive sectors in China and the EU benefit most followed by services and the food processing sector.

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

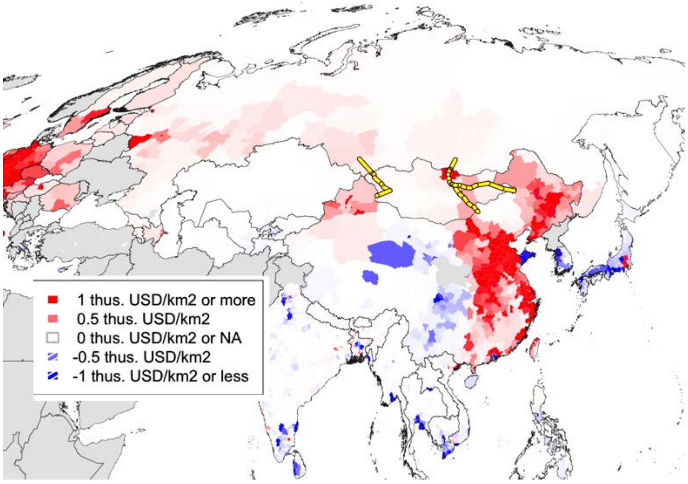
	Agriculture	Automotive	E&E	Textile	Food Proc.	Oth. Mfg.	Services	Mining	Total
Mongolia	-2.0	0.2	0.4	15.2	51.4	18.7	155.5	85.7	325.0
China	-13.1	1,311.1	-97.2	1,462.8	947.4	-742.5	1,612.9	417.7	4,899.1
Russia	-0.1	45.8	28.9	12.4	175.1	118.9	22.0	97.3	500.2
Japan	-0.1	-119.2	6.1	-9.8	-10.2	8.1	-3.6	2.2	-126.6
Korea	0.1	-57.9	13.9	0.2	-11.4	3.3	-1.3	0.0	-53.0
Taiwan	-0.2	15.9	-3.7	7.4	14.5	-5.4	-1.4	0.0	27.2
India	3.8	-150.7	0.2	-174.0	-53.3	80.0	95.6	7.6	-190.8
ASEAN10	3.4	-68.1	3.0	-171.9	-76.4	44.6	85.2	3.8	-176.3
United States	0.5	-310.1	3.2	-90.7	-277.2	131.4	31.2	5.8	-505.9
EU	-1.5	1,014.7	-43.9	873.4	316.4	-70.9	-3.5	10.0	2,094.8
World	1.5	2,105.1	-91.5	1,671.0	1,032.3	-241.9	2,133.2	703.6	7,313.2

Source: Estimated by IDE-GSM.

Figure 10 is a geographical representation of economic impacts from All Corridors in 2030 compared with the baseline scenario. For Mongolia, most of the regions benefit from the development. The positive economic impacts are observed in north to east China as well as Xinjiang Uyghur Autonomous Region, whereas other parts of China have some negative impacts from the development. The regions along the Trans-Siberian Railway in Russia benefit from the corridor.

Table 8 shows the top 10 gainer regions by the All Corridors scenario. Karamay, China, gains most from the scenario, with the impact of USD 480.4 million. The next largest impacts are on Beijing, China (USD 469.1 million) then Urumqi, China (USD 439.6 million). For Mongolian regions, Ulanbaatar placed 8th with the impacts of USD 109.4 million.

Figure 10: Economic Impact of All Corridors (2030, against baseline, impact density)



Source: Estimated by IDE-GSM

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	Karamay	China	0.0	0.0	0.1	-61.0	40.6	15.1	484.7	0.9	480.4
2	Beijing	China	0.0	141.0	-0.5	109.2	54.9	-16.7	164.9	16.2	469.1
3	Urumqi	China	0.0	0.0	-0.1	-6.5	-1.6	-18.4	465.5	0.7	439.6
4	Shanghai	China	-0.1	121.6	-2.7	112.6	26.1	-78.7	86.2	4.8	269.8
5	Tianjin	China	0.0	74.4	-0.6	94.6	26.4	-22.2	48.4	7.2	228.3
6	Suzhou_Jiangsu	China	-0.1	58.5	-1.0	118.3	9.6	-51.4	-9.1	2.2	127.2
7	Shenyang	China	0.0	0.0	0.9	-9.2	-3.2	-10.4	137.0	1.0	116.1
8	Ulaanbaatar	Mongolia	0.0	0.0	0.2	11.4	27.4	9.3	26.6	34.5	109.4
9	Harbin	China	-0.1	-1.9	0.3	-4.3	0.0	-5.9	113.1	0.9	102.1
10	Moscow City	Russia	0.0	13.5	-0.8	2.7	46.3	33.3	-18.0	16.6	93.7

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 the All Corridors scenario (USD 325.0 million). Among the three corridors, the economic impacts are the largest for Corridor 4b (USD 280.7) followed by Corridors 4c (USD 47.8 million) and 4a (USD 16.5 million). The economic impacts for Corridor 4b are the largest for China (USD 2,862.0 million) and the EU (USD 2,117.8 million) as well as Russia (USD 454.4 million). The development of Corridor 4b benefits a large number of countries and is, thus, eligible to be developed as an international development project with China, the EU, and Russia.

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

	4A	4B	4C	All
Mongolia	16.5	280.7	47.8	325.0
China	1,359.2	2,862.0	532.0	4,899.1
Russia	33.6	454.4	9.1	500.2
Japan	5.1	-133.7	5.4	-126.6
Korea	10.8	-62.5	0.6	-53.0
Taiwan	0.8	27.0	-0.3	27.2
India	-4.9	-186.5	-3.6	-190.8
ASEAN10	-5.5	-172.1	-2.3	-176.3
United States	-20.7	-488.3	-10.7	-505.9
EU	15.6	2,117.8	-9.4	2,094.8
World	1,416.8	5,233.0	560.7	7,313.2

Source: Estimated by IDE-GSM

As provided in Table 3, the development of the corridor benefits automotive and textile industries most, especially for China and the EU. Utilization of the Trans-Siberian Railway seems to be a key; thus, the cooperation of Russia is also indispensable. For Mongolia, the service sector and food processing and textile industries 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 go 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 these two countries might be desirable for the development.

5. Conclusion

In this paper, we tried to estimate the economic impacts of Corridors 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 the other two corridors. The economic impacts of Corridor 4b are large for China, the EU, and Russia, other than Mongolia; therefore, cooperation including these four parties 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 this simulation-based policy analysis and we hope the analyses provided here will be valuable input to the policy formulation process to shape a better development plan for Mongolia.

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