Chapter 6

The Second Generation of Geographical Simulation Model: Predicting the Effects of Infrastructure Development by Industry

Satoru Kumagai
Institute of Developing Economies (IDE/JETRO), Japan

Toshitaka Gokan
Institute of Developing Economies (IDE/JETRO), Japan

Ikumo Isono
Institute of Developing Economies (IDE/JETRO), Japan

Souknilanh Keola
Institute of Developing Economies (IDE/JETRO), Japan

March 2009

This chapter should be cited as

Kumagai, S., T. Gokan, I. Isono and S. Keola (2009), 'The Second Generation of Geographical Simulation Model: Predicting the Effects of Infrastructure Development by Industry', in Limskul, K. (ed.), *Development of Regional Production and Logistic Networks in East Asia*. ERIA Research Project Report 2008-4-1, pp.326-360. Jakarta: ERIA.

6

The Second Generation of Geographical Simulation Model: Predicting the Effects of Infrastructure Development by Industry

Satoru Kumagai, Toshitaka Gokan, Ikumo Isono and Souknilanh Keola

Abstract

The original IDE Geographical Simulation Model (IDE-GSM) has been developed with two major objectives: (1) to determine the dynamics of locations of populations and industries in East Asia in the long term, and (2) to analyze the impact of specific infrastructure projects on the regional economy at sub-national levels. The second generation of IDE-GSM has been expanded to predict changes in the location of populations and industries in regions for seven sectors, namely, agriculture, automotive, electric and electronics, textile and garment, food processing, other manufacturing and service. The simulations revealed that the effects of infrastructure development on each region are significantly different by industry. The economic impacts of such development depend on the initial distribution and characteristics of each industry. Determining such impacts is a complex process that is hard to predict without accurate data and a solid simulation model. As such, the IDE-GSM must be developed further while coordination of geographical statistical systems among Economic Research Institute for ASEAN and East Asia (ERIA) member countries must be facilitated.

1. INTRODUCTION

The original IDE Geographical Simulation Model (IDE-GSM) was developed with two major objectives: (1) to determine the dynamics of locations of populations and industries in East Asia in the long-term, and (2) to analyze the impact of specific infrastructure projects on the regional economy at sub-national levels.

The simulations using IDE-GSM revealed that (1) border costs play a big role and (2) nominal wages matter more than expected. In the simulations, the elimination of border costs seems to be much more effective than the development of physical infrastructure only. In continental South-East Asia (CSEA), there are huge disparities in nominal wages, not only internationally but also intra-nationally. They are so large that small advantages in location cannot counter the centripetal force of some central regions that induces the inflow of population and is caused by higher nominal wages.

Based on this study, Bangkok and its satellite regions, Ho Chi Minh and its satellite regions, and other capital cities and surrounding regions provide higher nominal wages than the national average, and most of these areas have location advantages (Kumagai *et al.* 2008).

To make it possible for IDE-GSM to derive more concrete policy implications, the model is further developed in this year's study. Most notably, the industrial sectors in the model are extended from three to seven. This extension allows a more precise prediction of the impacts of infrastructure development on each industry and more industry-specific policy implications.

This study is organized as follows: Section 1 shows the details of expansion of IDE-GSM. Section 2 explains the model and parameters used in the simulations. Section 3 explains scenarios and results of the simulations. The concluding section, 4, outlines the policy implications of this study.

2. POINTS OF EXPANSION FOR SECOND-GENERATION IDE-GSM

The first generation of IDE-GSM has three sectors: (1) agriculture, (2) manufacturing, and (3) service. On the other hand, the second generation of IDE-GSM is expanded to predict changes in the location of populations and industries in regions for seven sectors, namely, (1) agriculture, (2a) automotive, (2b) electric and electronics, (2c) textile and garment, (2d) food processing, (2e) other manufacturing and (3) service.

Dividing manufacturing sector into five sub-sectors enables various analyses that are not possible in the first generation of the model. For instance, now we can predict which industry locates where more precisely. We also estimate the impacts of a specific infrastructure project, e.g., East West Economic Corridor (EWEC) on a specific industry in a specific location, e.g., automotive industry in Bangkok.

3. UNDERSTANDING THE MODEL AND ITS PARAMETERS

The basic structure of the model is unchanged from the first generation of IDE-GSM, which is basically based on the model introduced in Fujita-Krugman-Venables (FKV) (1999).

The biggest difference between the first and the second generation of IDE-GSM lies in the definition of the manufacturing sector. In the first generation model, the sector is defined as one sector, with its own product and labor as inputs. In the second-generation model, the sector is divided into five sub-sectors, as earlier mentioned. Each sub-sector uses its own product and labor as inputs. This means that the input-output table in this world is zero-filled except for the diagonal elements. It seems to be a radical simplification, but not too unrealistic, since the five sub-sectors are sufficiently differentiated from each other.

3.1. Specifications for Five Sub-sectors in the Manufacturing Sector

The biggest problem is how to differentiate these five sub-sectors in the model. In addition to the initial geographical distribution of each sector, there are four possible sources of differences for this model:

- Transport costs (T)
- Elasticity of substitution (σ)
- Share of labor input (β)
- Share in consumption (μ)

Based on the foregoing sources, Table 1 shows the parameters for each sector, which are assumed to be common in all countries.

Table 1: Parameters specifying each industry

	T	σ	β	μ
Automotive	1.153	7	0.262	0.050
Electronics & Electric	1.071	10	0.228	0.063
Textile, Garment	1.153	8	0.329	0.045
Food Processing	1.218	5	0.303	0.046
Others	1.089	5	0.281	0.079

Source: Authors.

3.2. Parameters

3.2.1. Transport costs

Transport costs are defined by industry. (1) For the manufacturing sector, transport costs are presented in Table 1. These are based on the domestic-trade cost margin data from the Asian Input Output Table by Institute of Developing Economies (2006). Transport costs are standardized by assuming that goods are moving 634km, the average distance of arbitrary two points in the region covered by the model[i]. Thus, T=1.153 means that 1.00 out of 1.153 units of goods shipped from one part of continental South East Asia (CSEA) arrived in other parts of CSEA. It can be assumed that bringing goods from one part of CSEA to another requires a 15.3 percent overhead cost on the price of the goods. (2) T_S stands for the service sector and is typically equal to 50. T_S= 50 means that bringing a service to another place is exorbitantly costly; most service is consumed where the service is provided.

3.2.2. Elasticity of substitution

Elasticity of substitution between goods is also defined by industry. The elasticities for manufacturing sectors are defined in Table 1. These are based on the estimation by Hummels (1999). σ_S represents the service sector and typically equals 50[ii]. If σ=1.0, then two goods are perfectly differentiated and cannot be substituted for one another. Conversely, $\sigma = \infty$ means that the two goods are perfect substitutes for each other. Thus, σ_M=5 to 10 implies that goods are highly differentiated in the manufacturing sector, and σ_S=50 indicates that services are not highly differentiated; one can enjoy similar services wherever one is located.

3.2.3. Parameters for labor mobility

Parameters within a region for labor mobility are set in three levels: (1) international labor mobility (γ_N), (2) intra-national (or inter-city) labor mobility (γ_C), and (3) inter-industry labor mobility (γ_I). A value of $\gamma = 1.0$ indicates that a country or region having two times higher real wages than average induces 100 percent labor inflow in a year.

If γ_N=0 is set, international migration of labor is prohibited. Although this looks like an extreme assumption, it is reasonable given that most Association of Southeast Asian Nations or ASEAN countries strictly control incoming foreign labor[iii].

If γ_C=0.02 is set, a region having two times higher real wages than the national average will induce 2 percent labor inflow in a year.

If γ_I=0.05 is set, an industrial sector with two times higher real wages than average in the region will induce 5 percent labor inflow from other industrial sectors in a year.

3.2.4. Other parameters

The consumption shares of manufactured goods are shown in Table 1 and that of services (ν) is at 0.612. That of the agricultural good is at 0.105. These must be calibrated and differentiated for each country. However, for simplicity, an identical utility function is used for consumers in all countries, based on an aggregated consumption share of the CSEA regions in the model.

Set the cost share of labor in the production of agricultural good (α) at 0.633 and that of manufactured goods (β) at the values indicated in Table 1. The input share of intermediate goods in manufactured goods production is 1-β. In the future, these parameters should be more carefully calibrated for each industry. These are set based on the Input-Output table for Thailand[iv].

4. COMPARING INDUSTRY PERFORMANCE IN SPECIFIC SCENARIOS

Comparing the performance of each industry under certain scenarios poses some difficulty. If we use the absolute value of output or number of employees of a specific industry for each region in order to compare the performance of industrial sectors, big cities such as Bangkok and territories like Hong Kong will always emerge as outperforming other small regions. This problem is caused by the lack of uniform rules on division of region like the Nomenclature of Territorial Units for Statistics (NUTS) established more than 25 years ago by EUROSTAT.

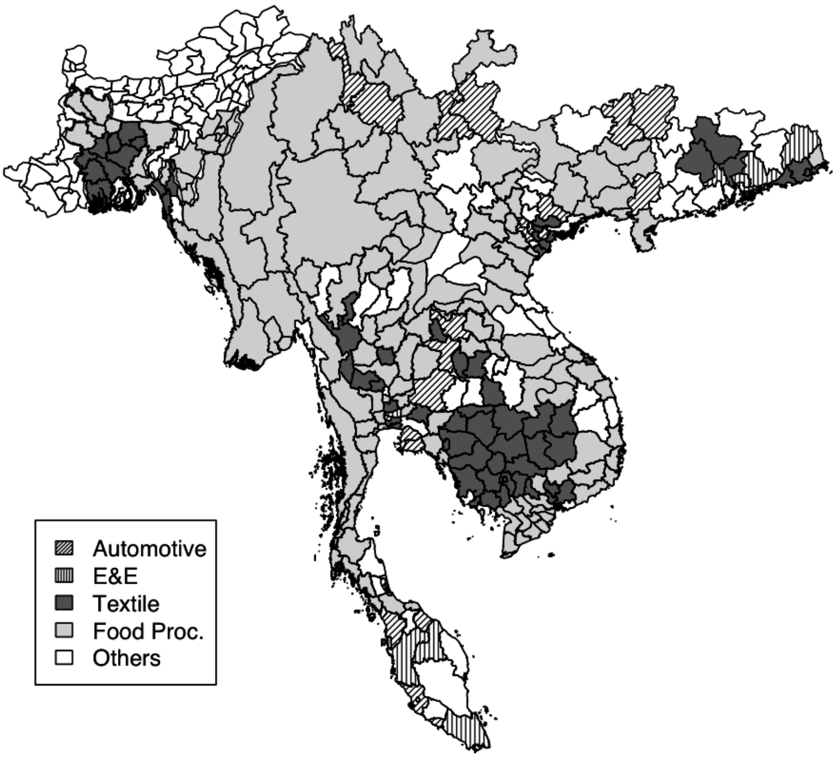
The growth rate of output or number of employee also has poses problems, because each region significantly differs from each other in size. The region whose automotive industry has very small production may initially grow at an extremely high rate, but the absolute value of production will still be very small even after such growth is achieved.

This paper essentially applies the relative importance of each industrial sector within a region. More specifically, it has used to a large extent, the Revealed Symmetry Comparative Advantage (RSCA[v]) index to determine the relative importance of each industrial sector in each region. The RSCA takes the value between -1 to +1. If the share of an industrial sector in a region exactly matches the CSEA regional average, the RSCA takes 0, meaning the industry in that region has neither advantage nor disadvantage. If the share of an industry in the region is larger than the CSEA average, the RSCA for the industry takes a positive value, and vice versa.

Figure 1 shows which of the five manufacturing sectors is in the most advantageous position in each region. It is 1) the electronics sector in Singapore, some regions in Malaysia, and some parts of China; 2) the automotive sector in Bangkok and northern Thailand, Selangor and Malacca in Malaysia, and northern Vietnam; 3) the textile and garment sector in Cambodia, northern Thailand, and some parts of Bangladesh; 4) while it is the food processing sector in many regions in CSEA, except for Singapore and Malaysia.

Figure 1 significant and even revolutionary because nothing comparable is available so far that could help one determine at a glance the geographical distribution of the manufacturing sectors in the CSEA region. The source data were compiled from various national statistics by the authors. Compiling these data was met with various difficulties such as the non-existence of standards for the generation of geo-economic data published by each government in the ERIA countries.

Figure 1: Most advantageous industry in each region (2005)



Source: Compiled from various national statistics by the authors.

5. SCENARIOS AND RESULTS

5.1. Scenarios

Two scenarios reveal the effects relative to the EWEC.

5.1.1. Baseline scenario with assumptions maintained

Several macroeconomic and demographic parameters may be held constant, and only logistic settings (by scenario) changed. The following macro parameters are then maintained across scenarios:

- Other things being equal, the gross domestic product (GDP) per capita of each country is assumed to increase by the average rate for the years 2000-2005[vi];
- The national population of each country is assumed to increase at the rate forecast

by the United Nations Population Fund until year 2025;

- There is no immigration between CSEA and the rest of the world.

The assumptions in the baseline scenario are as follows:

- Asian highway networks exist, and cars can run at 40km/h.
- Border costs, or times required for custom clearance, are as follows:

Singapore – Malaysia	2.0 hours
Malaysia – Thailand	8.0 hours
All other national borders	24.0 hours

5.1.2. East West Economic Corridor with customs facilitation

Following are the specific assumptions in this scenario:

- Cars can run in the EWEC at 80km/h after 2011 and on other Asian highways at 40km/h.
- Border controls along the EWEC are as efficient as those at the Singapore-Malaysia border (taking 2.0 hours to cross national borders) after 2011.

5.2. Results

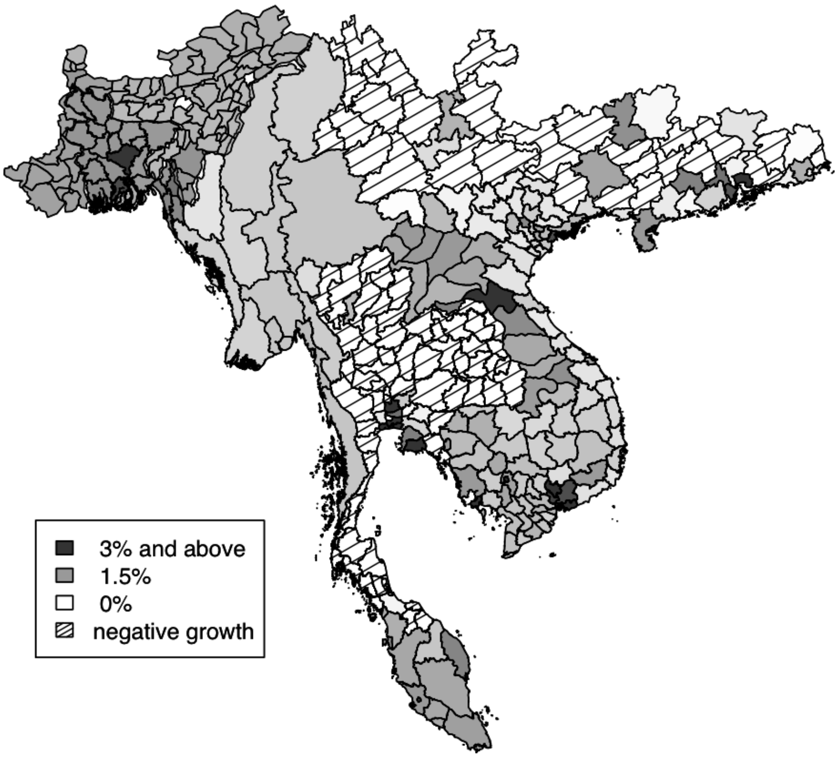
5.2.1. Baseline scenario

Population

Figure 2 shows the average population growth rate of each region from 2005 to 2025 under the baseline scenario**.** A clear trend in the agglomeration of population emerges. That is, a few regions gain population such as those surrounding Bangkok, Ho Chi Minh, and Dongguan as well as Vientiane and Krong Preah Sihanouk.

On the other hand, some regions lose population such as northern Thailand and some regions in China. Thailand seems to be a monocentric country in 2025, and China appears to have clear “core-periphery” structure at that time. The basic tendency of the population dynamics is unchanged from the first generation of IDE-GSM.

Figure 2: Average Population Growth Rate (2005-2025)



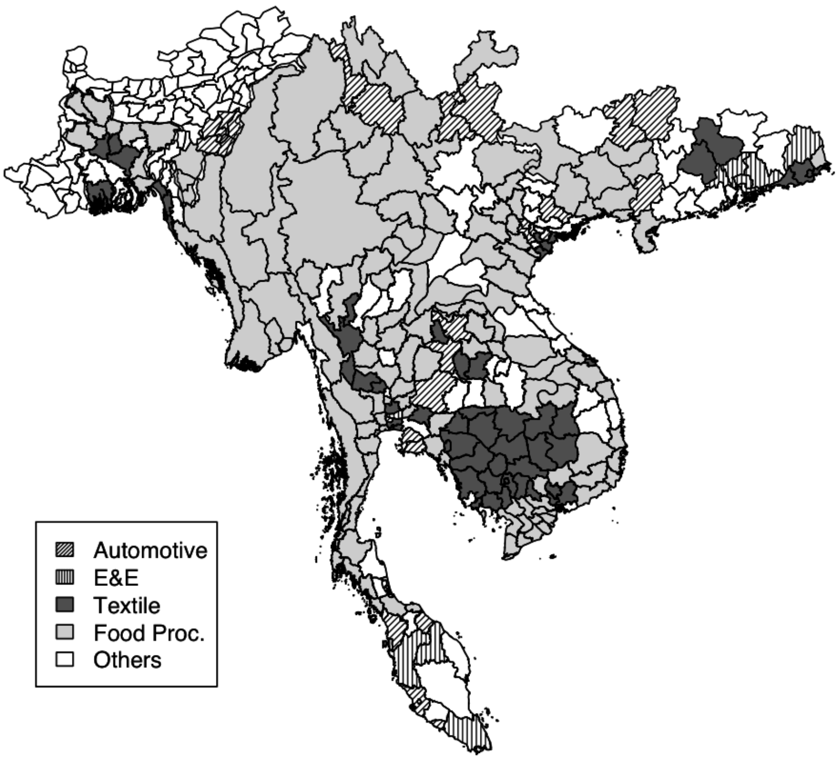
Source: IDE-GSM.

Most advantageous industry

Figure 3 shows which of the five manufacturing sectors is expected to be the most advantageous in 2025 according to the IDE-GSM. Figure 3 is not significantly different from Figure 1, which means that the advantageous sector is fairly stable in many regions.

However, some interesting changes arise, especially in the automotive sector, which is considered in an advantageous position in some regions in India. This is somewhat "mysterious" but it is understood that as India has a large population, it has a large demand for the automotive sector (partly because of homothetic consumption function across the region). This, while initial production of the sector is quite small. So, it is economically rational to start the production of automotive goods in India.

Figure 3: Most Advantaged Industry in Each Region (2025)



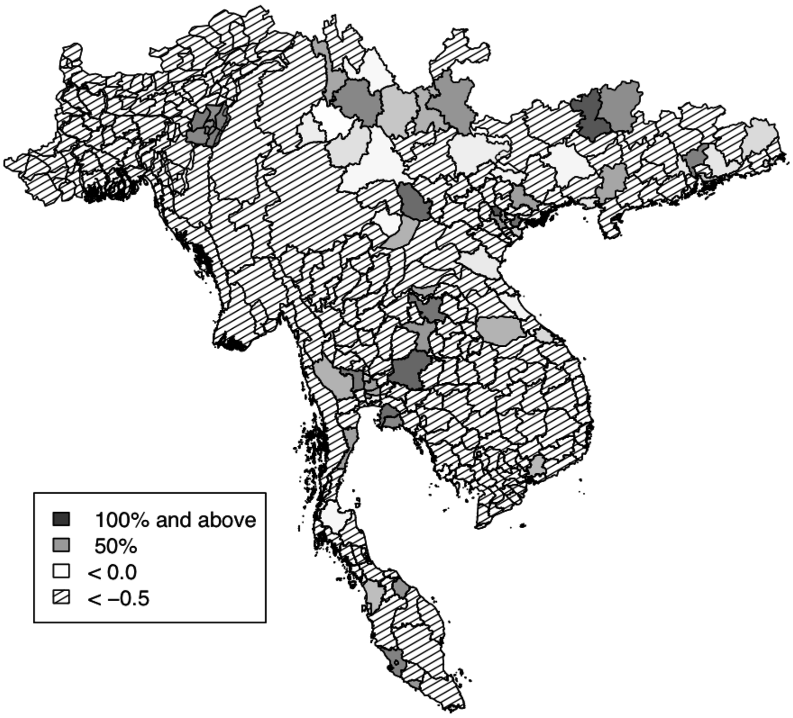
Source: IDE-GSM.

RCSA for each industry

(a) Automotive Industry.

Figure 4 shows the RSCA of automotive industry in each region in 2025. The regions that have a comparative advantage in the automotive industry are Bangkok and some areas in northern Thailand, the regions around Ho Chi Minh, Selangor and Malacca of Malaysia, and some parts of India and China. Table 2 shows the top 20 highest RSCA regions in the automotive industry. Liuzhou of China tops the rank, followed by Vinh Phuc (Vietnam) and Nakhon Ratchasima (Thailand).

Figure 4: RSCA of Automotive Industry (2025)



Source: IDE-GSM.

Table 2: Top 20 Highest RSCA Regions in Automotive Sector (2025)

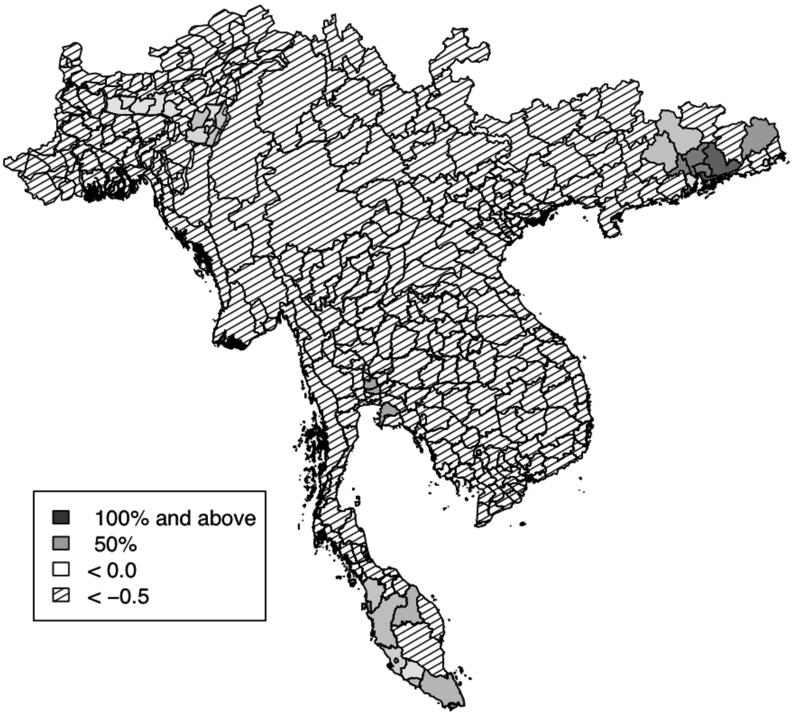
Rank	Region	Country	RSCA (2025)	RSCA (2005)
1	Liuzhou	China	0.83	0.82
2	Vinh Phuc	Vietnam	0.82	0.82
3	Nakhon Ratchasima	Thailand	0.75	0.78
4	Phongsali	Laos	0.73	0.70
5	Hai Duong	Vietnam	0.71	0.71
6	Chon Buri	Thailand	0.71	0.67
7	Udon Thani	Thailand	0.68	0.66
8	Suphan Buri	Thailand	0.67	0.68
9	Tamenglong	India	0.65	-0.79
10	Chandel	India	0.63	-0.80
11	Ukhrul	India	0.63	-0.81
12	Guangzhou	China	0.63	0.50
13	Selangor	Malaysia	0.61	0.65
14	Bishnupur	India	0.59	-0.83
15	Dali Baizu Zizhizhou	China	0.59	0.59
16	Churachandpur	India	0.58	-0.84
17	Rayong	Thailand	0.58	0.61
18	Hong Kong	Hong Kong	0.56	0.52
19	Guilin	China	0.56	0.57
20	Senapati	India	0.55	-0.86

Source: IDE-GSM.

(b) Electronics Industry

Figure 5 shows the RSCA of the electronics industry in each region. The regions that have a comparative advantage in the industry are concentrated in Singapore and Malaysia, a part of Thailand and China. Table 3 shows the top 20 highest RSCA regions in the electronics industry. Shenzhen tops the rank, followed by Heizhou (China) and Guangzhou (China). The top seven regions are in China.

Figure 5: RSCA of Electronics Industry (2025)



Source: IDE-GSM.

Table 3: Top 20 Highest RSCA Regions in Electronics Sector (2025)

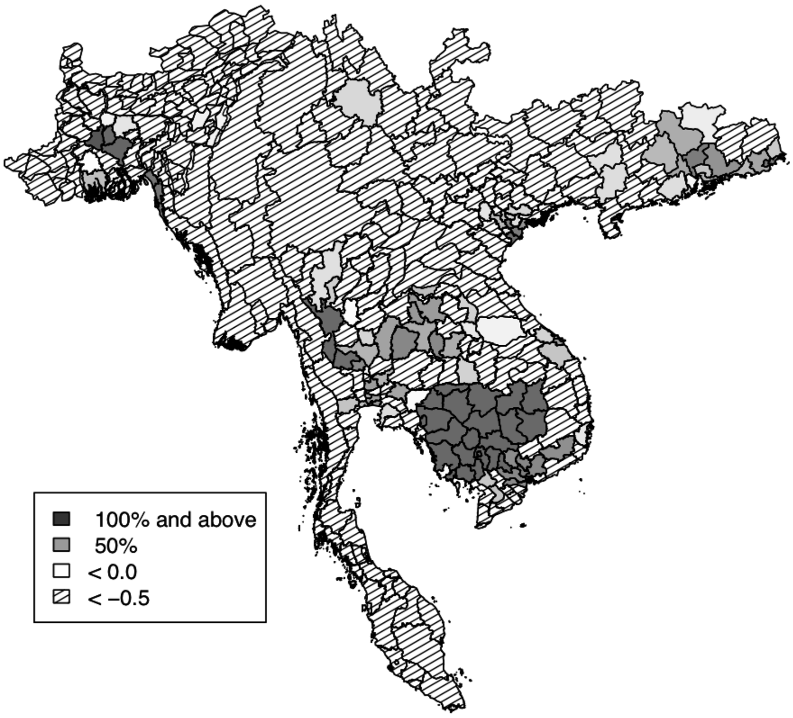
Rank	Region	Country	RSCA(2025)	RSCA(2005)
1	Shenzhen	China	0.85	0.75
2	Heizhou	China	0.79	0.69
3	Guangzhou	China	0.66	0.52
4	Zhuhai	China	0.65	0.57
5	Dongguan	China	0.63	0.56
6	Foshan	China	0.62	0.53
7	Meizhou	China	0.50	0.45
8	Pulau Pinang	Malaysia	0.50	0.54
9	Singapore	Singapore	0.45	0.51
10	Phra Nakhon Si Ayutthaya	Thailand	0.45	0.42
11	Chon Buri	Thailand	0.45	0.44
12	Pathum Thani	Thailand	0.43	0.45
13	Kelantan	Malaysia	0.37	0.41
14	Johor	Malaysia	0.36	0.42
15	Melaka	Malaysia	0.34	0.40
16	Perak	Malaysia	0.32	0.39
17	Zhaoqing	China	0.31	0.25
18	Tamenglong	India	0.30	-0.96
19	Qingyuan	China	0.29	0.22
20	Chandel	India	0.29	-0.96

Source: IDE-GSM.

(c) Textile/Garment Industry

Figure 6 shows the RSCA of the textile/garment industry in each region. The regions that have comparative advantage are dispersed in Cambodia, Vietnam, Thailand, China and Bangladesh. Table 4 shows the top 20 highest RSCA regions in the textile/garment industry. Pabna of Bangladesh tops the rank, followed by Dhaka (Bangladesh) and Phnom Penh (Cambodia). Bangladesh and Cambodia together occupy the top 20 regions.

Figure 6: RSCA of Textile/Garment Industry (2025)



Source: IDE-GSM.

Table 4: Top 20 Highest RSCA Regions in Textile/Garment Industry (2025)

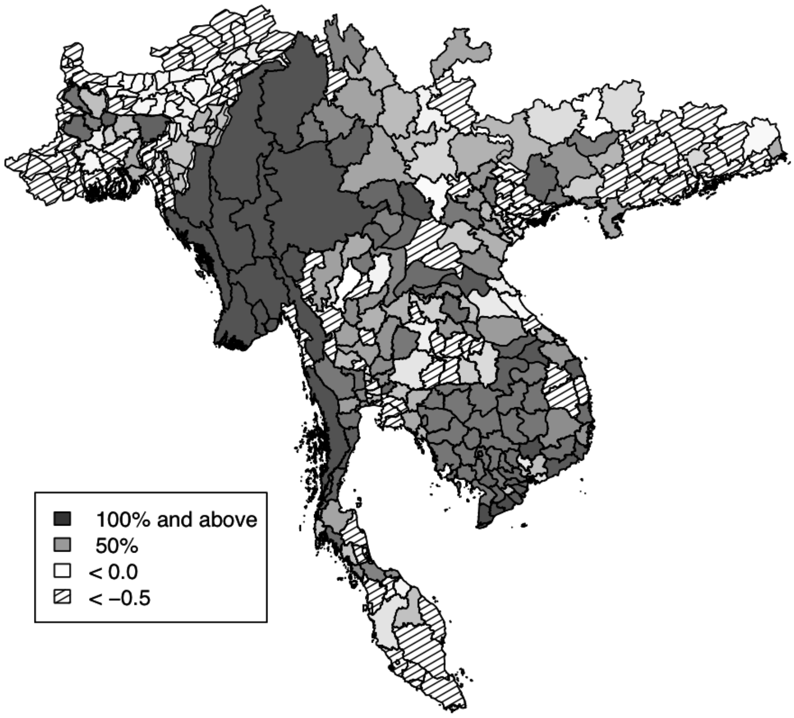
Rank	Region	Country	RSCA(2025)	RSCA(2005)
1	Pabna	Bangladesh	0.83	0.79
2	Dhaka	Bangladesh	0.75	0.76
3	Phnom Penh	Cambodia	0.74	0.69
4	Krong Pailin	Cambodia	0.74	0.69
5	Pouthisat	Cambodia	0.74	0.69
6	Batdambang	Cambodia	0.74	0.69
7	Kampong Chhnang	Cambodia	0.74	0.69
8	Krong Preah Sihanouk	Cambodia	0.74	0.69
9	Mondul Kiri	Cambodia	0.74	0.69
10	Otdar Mean Chey	Cambodia	0.74	0.69
11	Kaoh Kong	Cambodia	0.74	0.69
12	Kampong Thum	Cambodia	0.74	0.69
13	Siemreab	Cambodia	0.74	0.69
14	Kandal	Cambodia	0.74	0.69
15	Banteay Meanchey	Cambodia	0.74	0.69
16	Svay Rieng	Cambodia	0.74	0.69
17	Preah Vihear	Cambodia	0.74	0.69
18	Kampot	Cambodia	0.74	0.69
19	Kampong Speu	Cambodia	0.74	0.69
20	Kampong Cham	Cambodia	0.74	0.69

Source: IDE-GSM.

(d) Food Processing Industry

Figure 7 shows the RSCA of the food processing industry in each region. The regions that have a comparative advantage are scattered all over the CSEA. Table 5 shows the top 20 highest RSCA regions in the food processing industry. Ca Mau of Vietnam tops the rank, followed by Soc Trang (Vietnam) and Bac Lieu (Vietnam). Vietnam and Myanmar together occupy the top 10 regions.

Figure 7: RSCA of Food Processing Industry (2025)



Source: IDE-GSM.

Table 5: Top 20 Highest RSCA Regions in Food Processing Industry (2025)

Rank	Region	Country	RSCA(2025)	RSCA(2005)
1	Ca Mau	Vietnam	0.87	0.86
2	Soc Trang	Vietnam	0.87	0.86
3	Bac Lieu	Vietnam	0.87	0.86
4	Binh Phuoc	Vietnam	0.86	0.85
5	Mon	Myanmar	0.85	0.84
6	Tanintharyi	Myanmar	0.85	0.84
7	Kayin	Myanmar	0.85	0.84
8	Kayah	Myanmar	0.85	0.84
9	Shan	Myanmar	0.85	0.84
10	Bago	Myanmar	0.85	0.84
11	Yangon	Myanmar	0.85	0.84
12	Ayeyarwady	Myanmar	0.85	0.84
13	Mandalay	Myanmar	0.85	0.84
14	Sagaing	Myanmar	0.84	0.84
15	Magway	Myanmar	0.84	0.84
16	Kachin	Myanmar	0.84	0.84
17	Rakhine	Myanmar	0.84	0.84
18	Chin	Myanmar	0.84	0.84
19	Phongsali	Laos	0.83	0.83
20	Xekong	Laos	0.82	0.82

Source: IDE-GSM.

All in all, the electronics and automotive industries tend to agglomerate in a small number of regions while food processing and textile/garment industries tend to disperse.

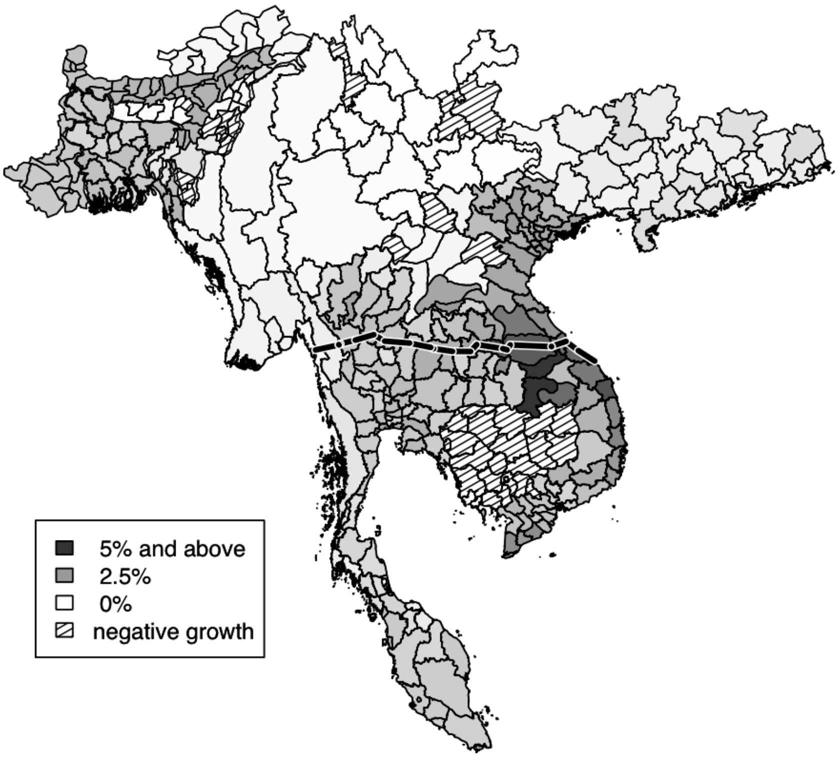
5.2.2. East West Economic Corridor with customs facilitation

Impacts on GDP

Figure 8 shows the differences from 2011 (the date the EWEC was supposed to have completed the simulation) up to 2025 in the average GDP growth rate between EWEC with customs facilitation and the baseline scenario in each region. Table 6 lists the top 10 GDP gainers for this scenario relative to the baseline. The top gainer in GDP growth is Champasak of Laos (gaining 6.1 percent growth a year, from 2011 to 2025) when compared with the baseline[vii]. The EWEC with customs facilitation mainly benefits some areas of Laos, Vietnam and northern Thailand, because EWEC connects and vitalizes them. What is interesting is that the geographical periphery of the region (specifically West India and Bangladesh, the Malay Peninsula, and Guangxi and Guandong provinces of China) benefits from the EWEC. This is because the EWEC reduces transport costs across all regions by going through four countries located in the center of the CSEA. This result is likely to remain unchanged from the first generation of IDE-GSM.

It should be also noted that many regions in Cambodia suffer a drop in GDP relative to the baseline scenario. This is exactly the feature of the model using new economic geography. The formation of agglomerations in a region could adversely affect the industry in neighboring regions.

Figure 8: GDP difference by EWEC with Customs Facilitation (2011-2025)



Source: IDE-GSM.

Table 6: Top 10 Regions Gaining GDP by EWEC with Customs Facilitation

(million USD)

Rank	Region	Country	Gain/year	Baseline	EWEC
1	Champasak	Laos	6.1%	1,288	3,118
2	Saravan	Laos	4.9%	779	1,607
3	Quang Ngai	Vietnam	4.2%	997	1,854
4	Mukdahan	Thailand	4.1%	556	1,010
5	Savannakhet	Laos	4.0%	4,294	7,752
6	Thua Thien-Hue	Vietnam	3.7%	899	1,549
7	Attapu	Laos	3.6%	271	463
8	Quang Tri	Vietnam	3.6%	511	863
9	Quang Nam	Vietnam	3.3%	1,156	1,875
10	Khammouan	Laos	3.3%	665	1,076

Source: IDE-GSM.

Impacts by industry

Tables 7 to 10 show the effects of the EWEC with customs facilitation on the RSCA of different industries in each region. They also show the top 20 regions in RSCA. All in all, regions in Vietnam, Laos and Thailand tend to gain ranks while those in the other countries tend to lose. The EWEC does not significantly boost the industrial development of the automotive and electronics industries, which is in contrast to its largely positive impact on the development of textile/garment and food processing industries. In case of the first two industries, the EWEC tends to improve once disadvantaged regions become slightly advantaged. In the case of the latter two industries, EWEC tends to further the development of already advantageous regions with some exceptions.

Table 7: Top 20 Highest RSCA Regions in Automotive Industry by EWEC (2025)

Rank	Region	Country	RSCA(EWEC)	Change
1	Vinh Phuc	Vietnam	0.90	0.08
2	Liuzhou	China	0.87	0.04
3	Hai Duong	Vietnam	0.82	0.11
4	Selangor	Malaysia	0.72	0.11
5	Chon Buri	Thailand	0.67	-0.03
6	Phra Nakhon Si Ayutthaya	Thailand	0.61	0.14
7	Rayong	Thailand	0.59	0.01
8	Melaka	Malaysia	0.59	0.07
9	Nakhon Ratchasima	Thailand	0.58	-0.17
10	Ha Tay	Vietnam	0.57	0.05
11	Guilin	China	0.56	0.00
12	Pathum Thani	Thailand	0.52	0.09
13	Lang Son	Vietnam	0.50	0.03
14	Khon Kaen	Thailand	0.46	-0.04
15	Guangzhou	China	0.46	-0.17
16	Dong Nai	Vietnam	0.44	0.09
17	Meizhou	China	0.43	0.25
18	Thai Binh	Vietnam	0.41	0.15
19	Kedah	Malaysia	0.40	0.08
20	Prachuap Khiri Khan	Thailand	0.40	-0.07

Source: IDE-GSM.

Table 8: Top 20 Highest RSCA Regions in Electronics Industry by EWEC (2025)

Rank	Region	Country	RSCA(EWEC)	Change
1	Shenzhen	China	0.76	-0.09
2	Heizhou	China	0.70	-0.09
3	Phra Nakhon Si Ayutthaya	Thailand	0.63	0.18
4	Pulau Pinang	Malaysia	0.62	0.12
5	Meizhou	China	0.61	0.11
6	Foshan	China	0.61	-0.01
7	Zhuhai	China	0.60	-0.05
8	Pathum Thani	Thailand	0.56	0.13
9	Dongguan	China	0.55	-0.09
10	Johor	Malaysia	0.53	0.17
11	Singapore	Singapore	0.48	0.03
12	Selangor	Malaysia	0.47	0.23
13	Melaka	Malaysia	0.47	0.13
14	Chon Buri	Thailand	0.45	0.00
15	Kedah	Malaysia	0.42	0.14
16	Guangzhou	China	0.41	-0.25
17	Perak	Malaysia	0.40	0.08
18	Negeri Sembilan	Malaysia	0.33	0.18
19	Kelantan	Malaysia	0.25	-0.12
20	Zhongshan	China	0.21	0.05

Source: IDE-GSM.

Table 9: Top 20 Highest RSCA Regions in Textile/Garment Industry by EWEC (2025)

Rank	Region	Country	RSCA(EWEC)	Change
1	Mondul Kiri	Cambodia	0.83	0.09
2	Hung Yen	Vietnam	0.82	0.19
3	Pabna	Bangladesh	0.81	-0.02
4	Nam Dinh	Vietnam	0.80	0.10
5	Thai Binh	Vietnam	0.78	0.14
6	Stung Treng	Cambodia	0.78	0.05
7	Binh Duong	Vietnam	0.74	0.15
8	Dhaka	Bangladesh	0.73	-0.02
9	Dong Nai	Vietnam	0.72	0.13
10	Ratanakiri	Cambodia	0.70	-0.03
11	Otdar Mean Chey	Cambodia	0.70	-0.04
12	Preah Vihear	Cambodia	0.70	-0.04
13	Krong Pailin	Cambodia	0.70	-0.04
14	Phra Nakhon Si Ayutthaya	Thailand	0.67	0.18
15	Samut Prakan	Thailand	0.66	0.17
16	Tak	Thailand	0.66	-0.07
17	Shantou	China	0.66	0.00
18	Haiphong	Vietnam	0.65	0.14
19	Chittagong	Bangladesh	0.63	-0.05
20	Kandal	Cambodia	0.62	-0.12

Source: IDE-GSM.

Table 10: Top 20 Highest RSCA Regions in Food Processing Industry by EWEC (2025)

Rank	Region	Country	RSCA(EWEC)	Change
1	Soc Trang	Vietnam	0.92	0.05
2	Ca Mau	Vietnam	0.92	0.04
3	Champasak	Laos	0.90	0.13
4	Bac Lieu	Vietnam	0.89	0.02
5	Saravan	Laos	0.88	0.12
6	Vientiane Capital	Laos	0.88	0.17
7	Vientiane	Laos	0.88	0.17
8	Binh Phuoc	Vietnam	0.87	0.01
9	Quang Ngai	Vietnam	0.82	0.03
10	Attapu	Laos	0.82	0.17
11	Ninh Thuan	Vietnam	0.82	0.03
12	Tra Vinh	Vietnam	0.81	0.01
13	Binh Thuan	Vietnam	0.81	0.00
14	Long An	Vietnam	0.80	0.07
15	Can Tho	Vietnam	0.80	0.07
16	Savannakhet	Laos	0.79	0.30
17	An Giang	Vietnam	0.79	0.03
18	Ben Tre	Vietnam	0.78	-0.01
19	Kien Giang	Vietnam	0.77	0.11
20	Tay Ninh	Vietnam	0.77	0.07

Source: IDE-GSM.

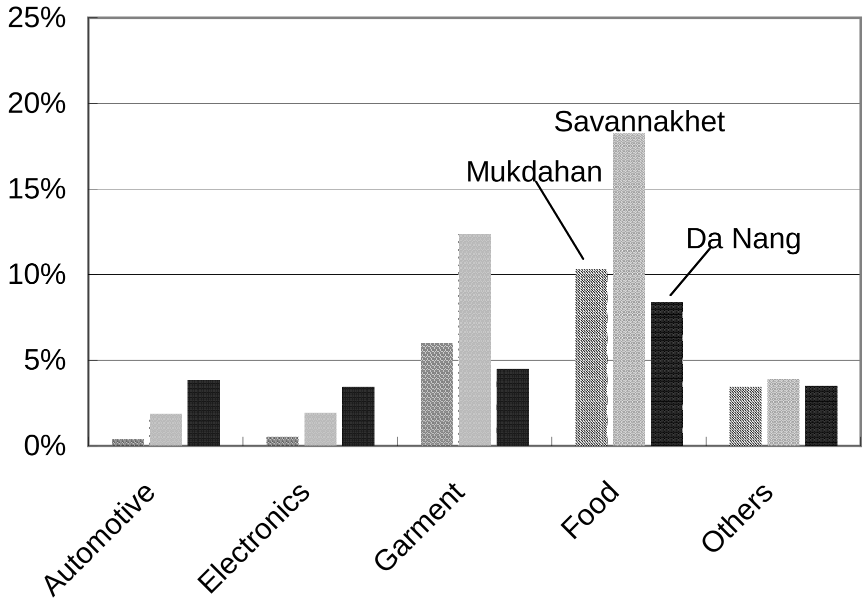
6. CONCLUSION AND POLICY IMPLICATIONS

6.1. Setting Target Industries

The simulations revealed that the effects of infrastructure development on each region are very much different by industry. For example, in Savannakhet of Laos, the development of the EWEC is expected to increase the GDP shares of the following sectors: automotive, by 1.9 percent; electronics, by 1.9 percent; textile and garment, by 12.4 percent; and food processing, by 18.2 percent (Figure 9). The development of the EWEC is also projected to reduce Savannakhet's RSCA of the automotive and electronics sectors by 0.42, and 0.17, respectively, while it will increase its RSCA of the textile and garment and food processing sectors by 0.28 and 0.30, respectively (Figure 10). The economic impact depends on the initial distribution and characteristics of each industry.

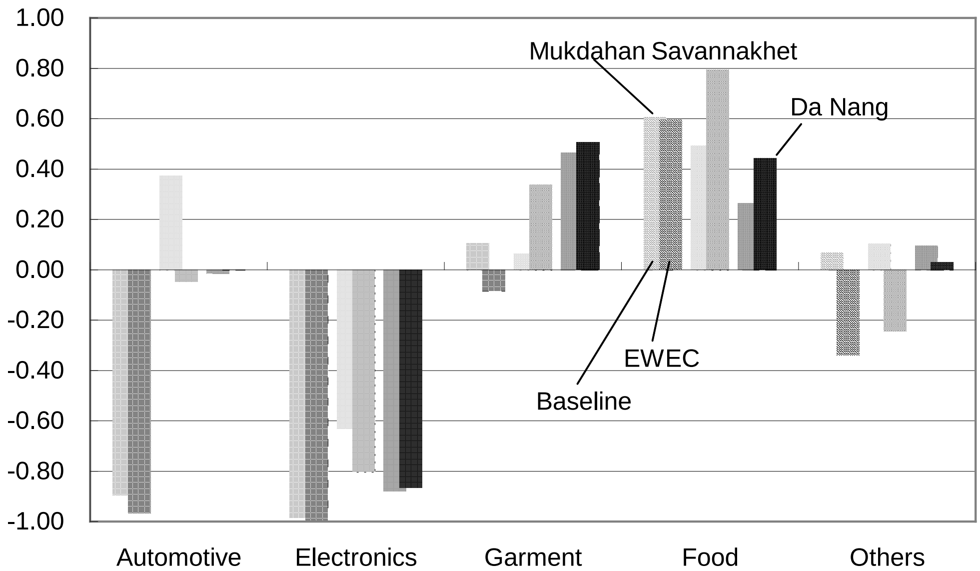
National and local governments need to set target industries to develop them properly. The IDE-GSM is "potentially" useful to find the target industries for each region with proper infrastructure development plan. If the government fosters the growth of an industry that has higher comparative advantage in that region, that industry is more likely to prosper.

Figure 9: Gaining GDP/year by EWEC with Customs Facilitation



Source: IDE-GSM.

Figure 10: RSCA of Baseline and EWEC with Customs Facilitation



Source: IDE-GSM.

6.2. The Need for Balanced and Strategic Development of Economic Corridors

As previously pointed out, the EWEC has been a bane to the development of many regions in Cambodia, as reflected in the decline of GDP vis-à-vis the baseline scenario. The formation of agglomerations by the development of corridors in neighboring regions may sometimes lead to deprive the industry.

Kumagai et al. (2008) revealed that the EWEC, the North-South economic corridor (NSEC), and the Southern economic corridor (SEC) are highly complementary projects. By implementing all three, most of the regions in the Greater Mekong sub-region are expected benefit.

The plans and implementation of infrastructure development need to be coordinated regionally. In this light, the establishment of an international body for planning and coordinating balanced and strategic development of infrastructure is highly recommended.

6.3. Establishment of Geographical Economic and Social Database in East Asia

The IDE-GSM is a complex system, making it difficult to make projections without accurate data and solid simulation model. This can be addressed by developing the IDE-GSM further and facilitating the coordination of a geographical statistical system among the ERIA member countries.

To conduct more accurate simulations with richer implications, more precise regional economic and demographic data are required at the sub-national level in each country and at the sub-provincial level in China and India. The establishment of uniform territorial units for geographical statistics like the NUTS in the European Union is needed. East Asia needs harmonized data as well as harmonized data collection method. The ERIA is a suitably equipped body to conduct capacity building for officials in national corridors connecting regions.

Just as important are more precise data on routes and corridors connecting regions. Information on the main routes between cities, times and modes of transport (road, railway, sea and air) appears indispensable. Data on border costs such as tariffs and non-tariff barriers due to inefficient customs clearance seem crucial as well.

NOTES

[i] Calculating the average distance between arbitrary two points in circle will yield $0.66(area/\pi)^{1/2}$. Put the area of CSEA, 2,902,093 km2, into the formula, and one will derive 634km.

[ii] Agricultural goods are treated as homogeneous goods and are not at all differentiated.

[iii] Despite the large numbers of foreign workers in Singapore and Malaysia, these two countries set strict quotas on foreign workers.

[iv] Since there is no explicit “capital” in this model, the difference between total output and intermediate input was assumed as the labor input.

[v] RCSA is compiled from well-known RCA (Revealed Comparative Advantage) indexes. RCSA is defined as (RCA-1)/(RCA+1).

[vi] For various reasons, the growth rate of GDP per capita in each city is likely to differ from the national average, and this is reflected in the simulation.

[vii] Note that GDP’s are nominal and equated in US dollars.

REFERENCES

Fujita, M., P. Krugman and A.J. Venables. 1999. *The Spatial Economy: Cities, Regions, and International Trade.* Cambridge, MA: MIT Press.

Haig, R.M. 1926. Toward an understanding of the metropolis. *The Quarterly Journal of Economics*, 40(2):179-208.

Hummels, D. 1999. Toward a Geography of Trade Costs. GTAP Working Papers 1162, Indiana: Purdue University.

Hirschman, A.O. 1958. *The Strategy of Economic Development.* Yale University Press: New Heaven.

Institute of Developing Economies. 2006. *Asian international input—output table 2000 Volume1*. *Explanatory Notes*, Chiba: IDE-JETRO

Krugman, P. 1991. Increasing returns and economic geography. *Journal of Political Economy* 99(3): 483-499.

Kumagai, S., T. Gokan, I. Isono and S. Keola. 2008. Geographical Simulation Model for ERIA: Predicting the Long-run Effects of Infrastructure Development Projects in East Asia," edited by N. Kumar. *International Infrastructure Development in East Asia:Towards Balanced Regional Development and Integration.* ERIA Research Report 2007 3:360-394. Chiba: IDE-JETRO.

Marshall, A. 1890. *Principles of Economics.* London: Macmillan, 8th edition, published in 1920.

Midelfart-Knarvik K.H., H.G. Overman, S. Redding and A.J.Venables. 2002. Integration and industrial specialisation in the European Union. *Revue Économique* 53(3):469-481.

Thien, Myat. 2004. *Economic Development of Myanmar*. Singapore: Institute of Southeast Asian Studies.

United Nations Economic and Social Commission in Asia and the Pacific. (2008). About the Asian Highway. [online] ://www.unescap.org/ttdw/?MenuName=AsianHighway [Accessed **April, 2008**]

APPENDIX: DATA COLLECTION

Bangladesh

The data on this country are based on three-sector (primary, manufacturing and service) GDP data by state from various sources. The manufacturing sector is divided into five sub-sectors, using value added data based on an industrial census in 2002 and 2003.

Cambodia

Japan International Cooperation Agency estimated provincial incomes and employee shares of three industries, namely, primary, secondary and tertiary based on the Cambodia Socio-Economic Survey (between 2003 and 2005). Provincial gross value added by industry was calculated by applying this income ratio to the national GDP. Nationwide M1 to M5 were calculated based on Socio-Economic Survey 2004 by National Institute of Statistics, and were used as coefficients to divide the provincial GDP of secondary industry in to five sectors.

China

In the case of China, regional GDP are divided by the employee share in industries, and then the derived values are regarded as industrial GDP in the region. The GDPs about the subdivisions of provinces are collected from the provincial statistical yearbooks 2004. The Employment data are collected from the provincial economic census yearbooks 2004.

Hong Kong

In the case of Hong Kong, Hong Kong report on the 2003 annual survey of industrial production and social and economic trends provided data on GDP and employment. Following the same procedure as China, simulation data are generated.

Macau

In the case of Macau, the 2005 yearbook of statistics was used. However, only the number of employments only in textile industries are could be collected from the statistics. Simulation data were obtained in the same manner as those of China.

India

The relevant data were taken from the Census of India website, http://www.censusindia.gov.in/.

Laos

Provincial-level industrial statistics on Laos were generated from several sources. First, population and value-added data on each province were culled mostly from the unpublished Annual Provincial Report on the Implementation of Socio-Economic Plan (between fiscal 2004 and 2006). These data are classified by industry, namely, agriculture, industry and service, in source. The value added by industry in each province was than used to create five value-added sectors by splitting them according to the provincial share of labor in M1 to M5. The labor share in M1 to M5 for each province was calculated based on nationwide business establishment survey of National Statistical Center.

Malaysia

Data on Malaysia were based on three-sector (Primary, Manufacturing and Service) GDP data by state from various sources. The manufacturing sector is then divided into five sub-sectors using value added data from the establishment survey provided by Department of Statistics, Malaysia.

Myanmar

Three-sector GDP data on Myanmar were compiled from the national three-sector GDP data and income par capita by state based on *Report of 1997: Household Income and Expenditure Survey,* which was prepared by the Central Statistical Organization. The manufacturing sector was divided into five using the data from Table 6.11 in *Economic development of Myanmar* (Thein 2004).

Singapore

Data on this city-state were based on the sectoral GDP data from the Economic Survey of Singapore, which divided the transport sector into automotive and others using the data provided by Singstat.

Thailand

The employments data were collected from manufacturing industrial survey for Bangkok and the statistical report of changwat: Chonburi in 1999; Ayutaya, Chaiyaphum, Chanthaburi, Chiangrai, Chumphon, Krabi, Lopburi, Mae Hong Son, Mukudahan, Nan, Songkhla, Yala and Yasothon in 2000; Nakhon Panom in 2002; Nakhon Ratchasima in 2005; and the other provinces in 2001. In some provincial data, the data on transport equipment were used for automobiles: the number of employments in automotive industries does not exists in the data source, but that in transport equipments. The small number of establishments in specific industries might be included in the group expressed as "Others."

Vietnam

Data on Vietnam were based on three-sector (primary, manufacturing and service) GDP data by state from various sources. The manufacturing sector is divided into five sub-sectors using value added data from the establishment survey.

REFERENCES

Fujita, M., P. Krugman and A.J. Venables. 1999. *The Spatial Economy: Cities, Regions, and International Trade.* Cambridge, MA: MIT Press.

Haig, R.M. 1926. Toward an understanding of the metropolis. *The Quarterly Journal of Economics*, 40(2):179-208.

Hummels, D. 1999. Toward a Geography of Trade Costs. GTAP Working Papers 1162, Indiana: Purdue University.

Hirschman, A.O. 1958. *The Strategy of Economic Development.* Yale University Press: New Heaven.

Institute of Developing Economies. 2006. *Asian international input—output table 2000 Volume1*. *Explanatory Notes*, Chiba: IDE-JETRO

Krugman, P. 1991. Increasing returns and economic geography. *Journal of Political Economy* 99(3): 483-499.

Kumagai, S., T. Gokan, I. Isono and S. Keola. 2008. Geographical Simulation Model for ERIA: Predicting the Long-run Effects of Infrastructure Development Projects in East Asia," edited by N. Kumar. *International Infrastructure Development in East Asia:Towards Balanced Regional Development and Integration.* ERIA Research Report 2007 3:360-394. Chiba: IDE-JETRO.

Marshall, A. 1890. *Principles of Economics.* London: Macmillan, 8th edition, published in 1920.

Midelfart-Knarvik K.H., H.G. Overman, S. Redding and A.J.Venables. 2002. Integration and industrial specialisation in the European Union. *Revue Économique* 53(3):469-481.

Thien, Myat. 2004. *Economic Development of Myanmar*. Singapore: Institute of Southeast Asian Studies.

United Nations Economic and Social Commission in Asia and the Pacific. (2008). About the Asian Highway. [online] ://www.unescap.org/ttdw/?MenuName=AsianHighway [Accessed **April, 2008**]

APPENDIX: DATA COLLECTION

Bangladesh

The data on this country are based on three-sector (primary, manufacturing and service) GDP data by state from various sources. The manufacturing sector is divided into five sub-sectors, using value added data based on an industrial census in 2002 and 2003.

Cambodia

Japan International Cooperation Agency estimated provincial incomes and employee shares of three industries, namely, primary, secondary and tertiary based on the Cambodia Socio-Economic Survey (between 2003 and 2005). Provincial gross value added by industry was calculated by applying this income ratio to the national GDP. Nationwide M1 to M5 were calculated based on Socio-Economic Survey 2004 by National Institute of Statistics, and were used as coefficients to divide the provincial GDP of secondary industry in to five sectors.

China,

In the case of China, regional GDP are divided by the employee share in industries, and then the derived values are regarded as industrial GDP in the region. The GDPs about the subdivisions of provinces are collected from the provincial statistical yearbooks 2004. The Employment data are collected from the provincial economic census yearbooks 2004.

Hong Kong

In the case of Hong Kong, Hong Kong report on the 2003 annual survey of industrial production and social and economic trends provided data on GDP and employment. Following the same procedure as China, simulation data are generated.

Macau

In the case of Macau, the 2005 yearbook of statistics was used. However, only the number of employments only in textile industries are could be collected from the statistics. Simulation data were obtained in the same manner as those of China.

India

The relevant data were taken from the Census of India website, http://www.censusindia.gov.in/.

Laos

Provincial-level industrial statistics on Laos were generated from several sources. First, population and value-added data on each province were culled mostly from the unpublished Annual Provincial Report on the Implementation of Socio-Economic Plan (between fiscal 2004 and 2006). These data are classified by industry, namely, agriculture, industry and service, in source. The value added by industry in each province was than used to create five value-added sectors by splitting them according to the provincial share of labor in M1 to M5. The labor share in M1 to M5 for each province was calculated based on nationwide business establishment survey of National Statistical Center.

Malaysia

Data on Malaysia were based on three-sector (Primary, Manufacturing and Service) GDP data by state from various sources. The manufacturing sector is then divided into five sub-sectors using value added data from the establishment survey provided by Department of Statistics, Malaysia.

Myanmar

Three-sector GDP data on Myanmar were compiled from the national three-sector GDP data and income par capita by state based on *Report of 1997: Household Income and Expenditure Survey,* which was prepared by the Central Statistical Organization. The manufacturing sector was divided into five using the data from Table 6.11 in *Economic development of Myanmar* (Thein 2004).

Singapore

Data on this city-state were based on the sectoral GDP data from the Economic Survey of Singapore, which divided the transport sectorinto automotive and others using the data provided by Singstat.

Thailand

The employments data were collected from manufacturing industrial survey for Bangkok and the statistical report of changwat: Chonburi in 1999; Ayutaya, Chaiyaphum, Chanthaburi, Chiangrai, Chumphon, Krabi, Lopburi, Mae Hong Son, Mukudahan, Nan, Songkhla, Yala and Yasothon in 2000; Nakhon Panom in 2002; Nakhon Ratchasima in 2005; and the other provinces in 2001. In some provincial data, the data on transport equipment were used for automobiles: the number of employments in automotive industries does not exists in the data source, but that in transport equipments. The small number of establishments in specific industries might be included in the group expressed as “Others.”

Vietnam

Data on Vietnam were based on three-sector (primary, manufacturing and service) GDP data by state from various sources. The manufacturing sector is divided into five sub-sectors using value added data from the establishment survey.