Chapter 8
Long-Run Economic Impacts of Thai Flooding on Markets and Production Networks: Geographical Simulation Analysis

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1 Introduction

After the Great East Japan Earthquake and the flooding in Thailand in 2011, many media outlets reported interruptions in production networks and manufacturing industries in Japan and Thailand. Disruption of a single factory in a value chain may lead to the halt of the total production and sales chains, and the media claimed that the vulnerability in production networks must be a serious risk to Japan and Thailand. However, as Ando (2014) pointed out, production networks have recovered very quickly and have demonstrated the inherent resiliency of the value chain as the value chain itself has a strong self-recovering function from disconnection.

This chapter discusses another aspect of the economic impacts of disasters, namely, the long-term economic impact of natural disasters on markets and producers in affected countries. If the damage caused by disasters is severe, industries will move out from the countries in question, and the outflow of economic activities may cause a negative impact on the national economies in the long run. By using quantitative modeling based on spatial simulations we can estimate the seriousness of the disasters in terms of the long-term economic performance.

IDE/ERIA-GSM, a simulation model based on spatial economics, is also known as new economic geography. The model is used as a tool for policy makers to judge what sorts of trade and transport measures (TTFMs) must be

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undertaken, how to prioritize them and how to combine them. It can also simulate possible negative impacts of disasters in the long run. The model consists of an original microeconomic model with a general equilibrium setting, original simulation programs, a huge dataset including 1,654 regions, 3,156 nodes and 5,029 routes, and several parameters obtained by econometric estimations. It covers 16 countries/economies in Asia and two non-Asian economies, namely; Bangladesh, Brunei Darussalam, Cambodia, China, Hong Kong, India, Indonesia, Japan, Lao PDR, Macao, Myanmar, Malaysia, the Philippines, Singapore, Thailand, Vietnam, the United States and the European Union (EU). The model provided the theoretical foundation for the prioritization of infrastructure projects in the Comprehensive Asia Development Plan (CADP) and was also referred to in the Master Plan on ASEAN Connectivity (MPAC) report (ERIA 2010; ASEAN 2010).

We adopt the same methodology as Isono and Kimura (2011) to estimate the economic impacts of the 2011 flooding in Thailand. Isono and Kimura (2011) assessed the economic effects of the Great East Japan Earthquake and concluded that the earthquake might cause a shift of industrial structure from the east to the west of Japan, and to China and other East Asian counties. They claimed that further enhancement of the linkages between Japan and East Asia could mitigate this shift and for Fukushima, Miyagi and Iwate prefectures, tighter connections between Sendai Airport and Okinawa's logistics hub would positively stimulate electronics industries in the Tohoku area.

In addition to adopting the methodology in Isono and Kimura (2011), we reinforced our base settings with using the Current Quarter Model (CQM) by Kumasaka (forthcoming, 2014). By applying this short-run forecast as of December 2011 for the GSM, we can obtain a rough image of the magnitude of the damage to Thailand at a very early stage following the disaster. Here we estimate the long-run impacts and show that these long-run impacts would be moderate because many companies' first reaction to the flood is to seek possible relocation of their production sites within Thailand. In fact, simulation results reveal that, at the national level, because some provinces in Thailand experienced positive economic impacts following the flood, it mitigated the negative impacts on the affected provinces. At the time of writing, observations and surveys on the ground in Thailand report that some companies, including multinational enterprises, are relocating from the affected areas to safer provinces in Thailand, which clearly supports our estimations.

This chapter is structured as follows: Sect. 2 gives a brief explanation of the model. Section 3 provides the baseline scenario, the flooding scenario and alternative scenarios concerning recovery from the flood by enhancing connectivity. Section 4 concludes with some policy implications.

2 Simulation Model

2.1 *Basic Structure of Our Simulation Model*[1]

In our economic model, there are 1,654 locations, indexed by *r* in 18 countries/ economies. There are two productive factors: labor and arable land. Labor is mobile within a country but stays immobile across countries.

Consumer preferences, which are identical across the world, are described by a Cobb-Douglas consumption function for an agricultural product, a manufacturing aggregate and a services aggregate. The manufacturing aggregate and services aggregate are expressed by a constant elasticity of substitution (CES) consumption function for individual manufactured goods or services. There are three sectors: agriculture, manufacturing, and services, and the manufacturing sector is divided into five sub-sectors; automobile, electronics and electrical appliances, garment and textile, food processing and other manufacturing. The agricultural sector produces a single and homogeneous agricultural product from arable land and labor, using a constant-returns technology under perfect competition. Manufacturing firms produce differentiated products using an increasing-returns technology under monopolistic competition where they use their labor forces and intermediate goods as inputs. Manufacturing intermediaries are procured from all manufacturing firms. Services are produced with using an increasing-returns technology under conditions of monopolistic competition where they use labor only. Economies of scale arise at factory levels. Labor can move to the sectors that offer higher nominal wage rates within the region.

All products in the three sectors are tradable. Transport for an agricultural good is assumed to be costless. Note that the price of an agricultural good selected in such a way that the price of the good is unitary across regions. Transport costs for manufactured goods and services are supposed to be of the iceberg type. An increase in purchaser's price compared to the manufacturer's price is regarded as the transport cost. Transport costs within a region are considered to be negligible.

2.2 *Parameters*

We have a number of critical parameters in the model. The consumption share of consumers by industry is uniformly determined for the entire region in the model. Of the seven industries in the model, the service industry takes up the largest share (0.55) while the automotive industry takes up the smallest (0.009); agriculture comes in second (0.16) with other manufacturing after (0.15).

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[1] This section is excerpted and modified from Kumagai et al. (forthcoming, 2014)

The labor input share for each industry is uniformly determined for the entire region in the model, according to that of Thailand in the year 2000, taken from the International Input Output Table by IDE-JETRO. Because the simulation is run for more than 20 years, however, it may not be realistic to fix the labor input share for such a long period of time, especially for a developing country. However, we do not have a method to change the share with confidence. We therefore decided to use an "average" value, in this case that of Thailand as a country at the middle-stage of economic development. Labor input is largest for the service industry (1.0) followed by the food processing industry (0.796); the smallest share comes from the automotive industry (0.621).

We adopt the elasticity of substitution for manufacturing sectors from Hummels (1999) and estimate that for services as follows: 5.1 for food, 8.4 for textiles, 8.8 for electronics, 7.1 for transport, 5.3 for other manufacturing, and 5.0 for services. The estimates for the elasticity for services are obtained from the estimation of the usual gravity equation for services trade, including importer's GDP, exporter's GDP, importer's corporate tax, geographical distance between countries, a dummy for free trade agreement, a linguistic commonality dummy, and the colonial dummy as independent variables.

For the transport costs, we first estimate the multinomial logit model of firms' behavior in shipping their products by using firm-level data, based on the Establishment Survey on Innovation and Production Network (Intarakumnerd 2010). Next, we estimate some parameters such as holding time across borders. By employing these estimates in addition to the multinomial logit results, we specify a transport cost as a function for calculating the transport costs between regions. After that, we estimate Policy and Cultural Barriers (PCBs). Finally, we derive the transport costs between regions to be used in the simulation. Specifically, the transport cost in industry s by mode M between regions i and j is assumed as

$$C_{ij}^{s,M} = \underbrace{\left[\left(\frac{dist_{ij}}{Speed_M}\right) + \left(1 - Abroad_{ij}\right) \times ttrans_M^{Dom} + Abroad_{ij} \times ttrans_M^{Intl}\right]}_{Total\ Transport\ Time} \times ctime_s + \underbrace{dist_{ij} \times cdist_M}_{Physical\ Transport\ Cost} + \underbrace{\left(1 - Abroad_{ij}\right) \times ctrans_M^{Dom} + Abroad_{ij} \times ctrans_M^{Intl}}_{Physical\ Transshipment\ Cost}$$

where $dist_{ij}$ is the travel distance between regions i and j, $Speed_M$ is travel speed per one hour by mode M, $cdist_M$ is physical travel cost per one kilometer by mode M, and $ctime_s$ is time cost per one hour perceived by firms in industry s. The parameters $ttrans_M{}^{Dom}$ and $ctrans_M{}^{Dom}$ are the holding time and cost, respectively, for domestic transshipment at ports or airports. Similarly, $ttrans_M{}^{Intl}$ and $ctrans_M{}^{Intl}$ are the holding time and cost, respectively, for international transshipment at borders, ports, or airports. The parameters in the transport function are determined by estimation and adaptation from the ASEAN Logistics Network Map 2008 by

JETRO (2008, 2009). $Abroad_{ij}$ is a dummy taking a value of one if the transaction is international while zero if domestic.

In addition, $ttrans^{Dom}$ and speed of railway are estimated by the same dataset and the same estimating equation. Due to the minimal usage of railways in international transactions in the dataset, we adopted the same value for the time and cost of international transactions. Finally, we set the cost per km as half the value of road transport.[2] We use the estimated values as a general rule and additionally set the speed of land, sea, air and rail transport of each section differently from the data from UNESCAP and other various institutions, reflecting the gaps of the quality of infrastructure and the frequency of transport modes. For example, we assume most land trunk routes in Thailand can be run at 60 km/h, while some mountainous routes or poor roads can be run at only 19 km/h.

So far, we have estimated several components of transport costs including cost for transportation time, cost for transshipment time (holding time), physical transport cost, and physical transshipment cost. These costs are collectively called “GSM transport cost” in this subsection. However, some important components of the broadly defined “transport costs” remain excluded in the model. Examples include tariffs, non-tariff trade barriers (e.g. quota restrictions), procedures before shipping, costs arising from political situations or from certain risks, cost arising from preference differences and cost arising from commercial customs differences. We call these collectively “Policy and Cultural Barriers” (PCBs). We employ the “log odds ratio approach”, as initiated by Head and Mayer (2000), in order to avoid the problem of data availability in the estimation of the model, similar to our GSM model. We first estimate the values for Thailand, the Philippines, Malaysia, and Indonesia by using per capita GDP data from the World Development Indicator (World Bank) and input–output data from the Asian International Input–output Table published by the Institute of Developing Economies, JETRO (IDE-JETRO). We regress days for customs clearance in importing (Days), for which data are drawn from the “Doing Business Indicator” from the World Bank, to get the other sample countries’ PCBs.

We are then able to obtain the transport costs between regions, by industry, to be used in the simulation, using the transport cost function, several parameters, and PCBs. Firstly, we choose the economically shortest routes between regions by industry, adopting the transport cost function to all possible routes between regions. The shortest routes and utilized modes may differ among industries, even in the same regional pairs. Next, we calculate the transport costs between regions by industry. This cost is defined as the monetary cost when shipping products using a 20-ft container. Due to the fact that transport costs in this simulation are the ratio associated with the value of products being shipped, we need to transform the costs

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[2] The ASEAN Logistics Network Map 2008 offers an example where the cost per km for railway is 0.85 times that of trucks. However, this is only the case when we ship a quantity that can be loaded onto a truck. Railways have much greater economies of scale than trucks in terms of shipping volume, so some industries such as coal haulage incur much lower cost per ton-kilometer. Therefore, we need to deduct this from the value in the ASEAN Logistics Network Map 2008.

Table 8.1 Average value in 20-ft container (USD)

	# of Sample	Average value
Automobile	6	89,691
E & E	11	92,746
Garment and textile	10	34,560
Agro and food processing	9	37,233
Others	8	59,450
Total	44	

Source: Preliminary survey results of FY2010 ERIA-GSM Project

to fit into the simulation. Except for the electronics and electrical appliance industry, we adopt the average values in a 20-ft container from the preliminary survey results of the FY2010 ERIA-GSM Project, as in Table 8.1. In the case of the electronics and electric appliance industry, we assumed that firms ship 2 t per 20-ft container. The value in 20-ft container for the electronics and electric appliance industries is calculated independently as USD 376,611 based on the trade value and volume data in Thailand. The reason why we adopt another value for those industries is the fact that some electronics firms answered in the survey that they selected mainly air transport, and that they did not utilize containers. This implies the existence of a sample selection bias in this survey for those industries. Finally, we transform the transport costs associated with the value of the products. PCBs are multiplied by the factors when the products are imported to corresponding countries.

Wage equations in the model include the variable A, which represents technology, or the productivity of each region, and is set by industry. A is calibrated at the beginning of the simulation to match the expected wage rate from the wage equation and the actual wage rate. It is a kind of "residual," including everything that affects the wage level, other than the variables explicitly included in the wage equation.

The parameters for labor mobility are set out at three levels, namely, international labor mobility (γ_N), intra-national (or intercity) labor mobility (γ_C), and inter industry labor mobility (γ_I) within a region. If $\gamma = 0.1$, it means that a country/region/industry with twice as high real wages as the average attracts 10 % labor inflow per year.

We set γ_N at 0. This means that the international migration of labor is prohibited. Although this looks like a rather extreme assumption, it is reasonable enough, taking into account the fact that most ASEAN countries strictly control incoming foreign labor. We set γ_C as 0.02. This means that a region with twice as high real wages as the national average induces 2 % labor inflow a year. Finally, we set γ_I to 0.05 too. This means that an industrial sector with twice as high real wages as the average in the region induces 5 % labor inflow from other industrial sectors per year.

We assume exogenous population growth, given the predicted rate of population growth provided by the United Nation Population Division

3 Baseline Scenario, Flood Scenario and Recovery Scenarios

In this section, we provide simulation results based on the settings and assumptions in the last section. The relationships between scenarios in terms of economic impacts are shown in Fig. 8.1. Every simulation starts from 2005. We assume that there were some infrastructure projects completed by 2010. In the baseline scenario, we do not assume additional damage or infrastructure development and run a simulation toward 2020. In the alternative scenario of flooding in Thailand, we assume damage to production in 2011 and recovery in 2012, and run a simulation up to 2020. We compare the economic situations between the baseline scenario and the alternative scenario in 2020 and derive the economic impact of the flooding as a difference between the two scenarios. We also conduct various simulations to identify effective recovery measures, assuming various physical and institutional connectivity enhancements in addition to the damage caused by the flood.

3.1 Flood Scenario

First we set the flood scenario (Scenario 0). We assume that local infrastructure including the production infrastructure of the factories in affected provinces were damaged in 2011 and recovered in 2012. We describe the situation by lowering the technological parameter A in 2011 and restoring it in 2012. Parameter A includes elements as follows:

- Education level/skill level
- Logistics infrastructure within the region
- Communications infrastructure within the region
- Electricity and water supply

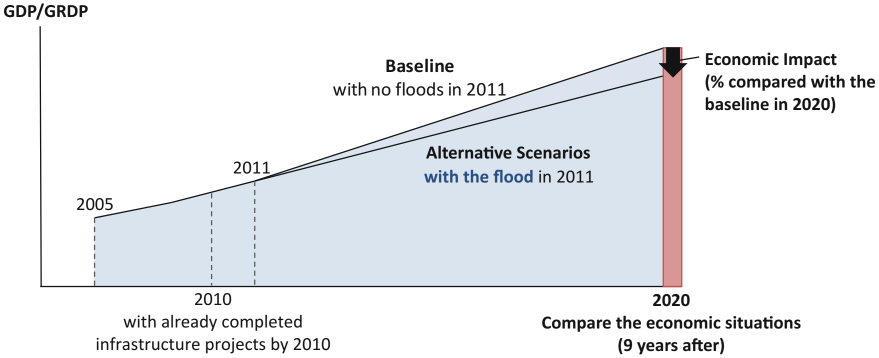

Fig. 8.1 Baseline scenario and alternative scenarios. *Source*: Authors

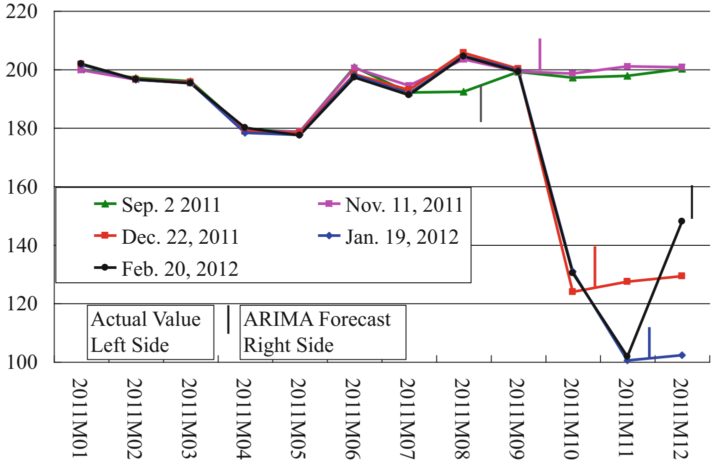

Fig. 8.2 Production value index by CQM. *Source*: Kumasaka (forthcoming, 2014)

- Equipment in firms
- Utilization ratio/efficiency of this infrastructure and equipments

To set the magnitude of the damage, we use CQM of Thailand by Kumasaka (forthcoming, 2014). CQM, updating estimations by an ARIMA type analysis from various partially available information, can estimate very short run impacts of economic shocks to production or GDP. It can provide estimated values before actual official reports are released. As of December 22, 2011, CQM estimated the impacts on real and nominal GDP values in Q4 in 2011, where we had no official reports on GDP yet.

Figure 8.2, the estimated production value index of Thailand, explains how CQM adjusts the estimated values using available sources. After getting additional available data, CQM updates its estimations to more reliable values. On September 2 and November 11, CQM did not have data of the damage caused by the flood and it could not assess the possibility of decreasing production. On December 22, CQM got partial information on the damage and revised the estimation values. Also, on January 19 and February 20, CQM revised its values accordingly from additionally obtained information.

We assume that the damage calculated in Q4 is proportionally distributed in the provinces affected by the flood, based on the total share of these provinces of the country in each industry. Finally, we get the value used in the assumptions of the simulations. We assume that each affected province has the same level of damage, as seen in Table 8.2.

In summary, Scenario 0 is described as follows: Technological parameters of affected provinces as shown in Fig. 8.3 decrease by the percentage provided in Table 8.2 in 2011 and recover to the former value in 2012.

Figure 8.3 illustrates the economic impacts of the flood evaluated in the year 2020, compared with the baseline scenario. Filled regions have positive impacts

Table 8.2 Assumptions of damage in the technological parameters in 2011

Agriculture	−17.6%
Automotive	−19.8%
Electronics and electrical appliances	−15.0%
Textiles and garments	−11.1%
Food processing	−13.6%
Other manufacturing	−13.6%
Services	−2.8%

Source: Author derived based on CQM short-run forecasts

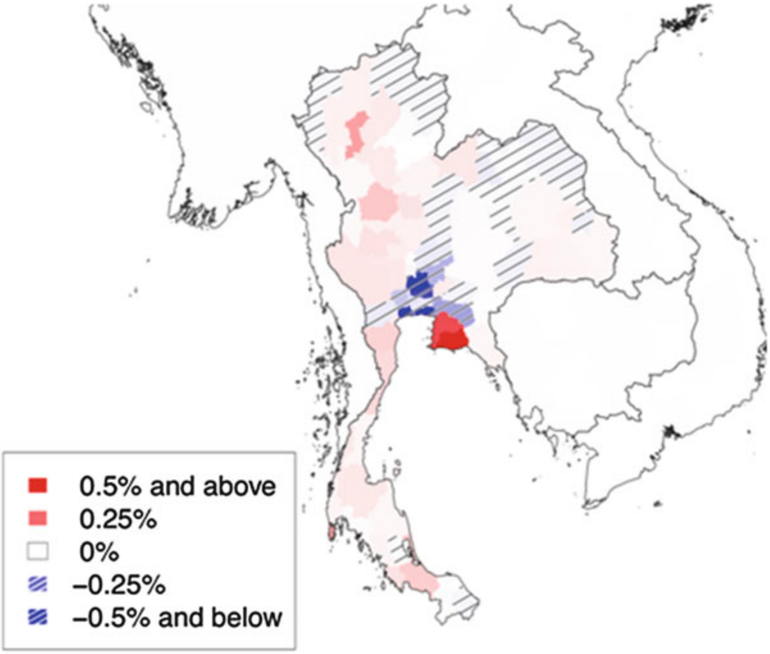

Fig. 8.3 Economic impacts of the flood (2020). *Source*: IDE/ERIA-GSM 4

and slashed regions have negative impacts. As explained in Fig. 8.1, a negative impact does not necessarily mean a GDP below the present level. Samut Sakhon, Samut Prakarn and Ayutthaya provinces have larger negative impacts, because they have large scale electronics industries. Bangkok has a slight negative impact, reflecting the idea that service industries had less damage caused by the flood, and that services has a dominant share in the Bangkok economy.

Table 8.3 shows the top seven negatively affected provinces and the top four positively affected provinces. Interestingly, there are many provinces positively affected, compared with the baseline scenario. This is because some households and firms move away from severely affected provinces to other areas, and thus

Table 8.3 Top seven negatively affected provinces and top four positively affected provinces

Region	Impact in GRDP (%)
Samut Sakhon	−0.5
Samut Prakarn	−0.5
Ayutthaya	−0.5
Pathum Thani	−0.3
Chachoengsao	−0.1
Saraburi	−0.1
Nakhon Pathom	−0.1
Phuket	0.1
Lamphun	0.1
Chonburi	0.3
Rayong	0.7

Source: IDE/ERIA-GSM 4

some of these other areas will have more industrial activities than shown in the baseline scenario. Especially, Rayong and Chonburi are predicted to see 0.7 and 0.3 % positive impacts, respectively. This can be interpreted as indicating that many companies move their production from Samut Sakhon, Samut Sakhon or Ayutthaya provinces to safer and better locations in other provinces. Lamphun, which has an electronics cluster, follows Rayong and Chonburi. Phuket also gets positive impacts from tourism shifting from Bangkok.

As in Fig. 8.3, other countries, such as Cambodia, Laos, Myanmar and Vietnam, have negligible impacts.[3] This means that replacement of the production lost in Thailand will be largely accomplished within Thailand, mainly led by Rayong and Chonburi provinces. In sum, Thailand as a country has almost 0 % impact. China and Indonesia will have positive impacts though they are almost negligible. This can be supported by JETRO's interview survey of affected companies in January 2012; it reported that among 50 affected companies, 39 answered they would restart operations at their existing locations, while and the other 8 replied that they planned to relocate their production site to other areas of Thailand. The Japan Chamber of Commerce, Bangkok released another survey result showing that among 48 affected manufacturing companies, 41 answered that they would restart operations at their existing production sites and 12 reported they would restart in other areas in Thailand.[4]

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[3] We could not obtain flood damage data for Cambodia in terms of economic values, so we do not assume any damage for Cambodia.

[4] Multiple answers were allowed.

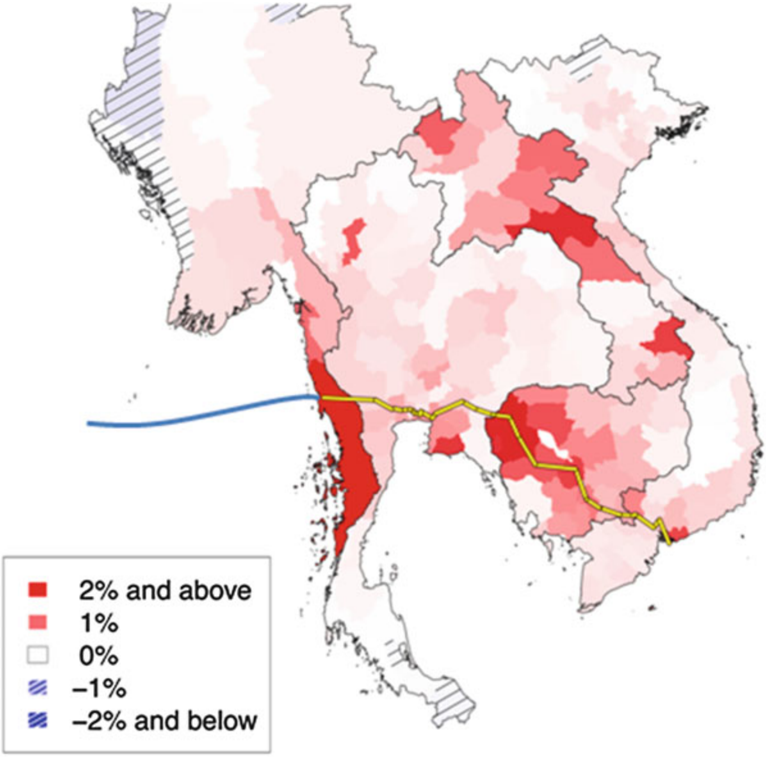

Fig. 8.4 Economic impacts of MIEC (2020). *Source*: IDE/ERIA-GSM 4

3.2 *Recovery Scenario (1): MIEC and NSEC*

At present Thailand, the Greater Mekong Sub-region and ASEAN have many connectivity enhancement projects in hand. To assess the net effect of the negative impacts of the flood and the expected positive impacts from the connectivity enhancement, we run simulations including improving the Mekong-India Economic Corridor (MIEC, Scenario 1A) and the North–south Economic Corridor (NSEC, Scenario 1B). These scenarios are set as follows:

We set up scenario 1A for the Mekong-India Economic Corridor (MIEC). Here a new bridge over the Mekong River at Neak Loueng in Cambodia is constructed. The speed of trucks along MIEC is raised in Cambodia and Vietnam to 60 km/h. Dawei and Kanchanburi are connected by a road, and border crossing facilitation along the MIEC is introduced. Dawei and Chennai (India) are connected via a sea route that is equivalent to other international routes between equally important ports.

Scenario 1B involves the North–south Economic Corridor (NSEC). In this scenario, the speed of trucks along the NSEC is raised in Lao PDR, Myanmar and Vietnam to 60 km/h. Border crossing facilitation along the NSEC is introduced.

Figures 8.4 and 8.5 present economic impacts of the MIEC and the NSEC, given the impact of the flood in the last subsection, respectively. In these scenarios, we do

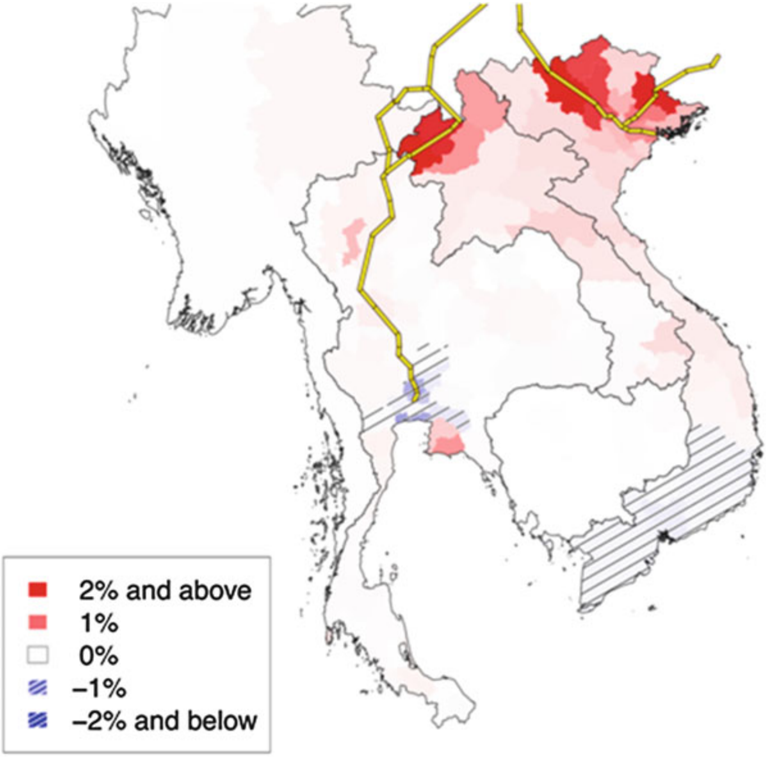

Fig. 8.5 Economic impacts of NSEC (2020). *Source*: IDE/ERIA-GSM 4

not assume increasing speeds of trucks within Thailand, because Thailand already has good national road networks. Even though we recognize some negative impacts of the flooding in these simulations and have no speed enhancement in Thailand, Fig. 8.4 shows that Thailand will overcome the negative shock of the flood through the MIEC development. By comparing Fig. 8.4 with Fig. 8.5, we find that the NSEC has a relatively smaller positive impact on Thailand, because connecting Ho Chi Minh City, Phnom Penh and Bangkok and providing a new gateway toward India, the Middle East and Europe yield much larger benefits to Thailand.[5]

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[5] The CADP report (ERIA 2010) also compared the MIEC and the NSEC using IDE/ERIA-GSM version 3 and concluded that the MIEC has much larger economic impacts than the NSEC.

3.3 Recovery Scenario (2): MIEC, NSEC and Soft Infrastructure Development

We conduct another simulation of soft infrastructure development, together with the MIEC and the NSEC, given the impact of the flood. We assume Thailand, Cambodia, Lao PDR, Myanmar, Vietnam and India will reduce PCBs by 2 % per year, presuming the situation that they are cooperatively improving institutional connectivity. Our second scenario involves Soft infrastructure improvement in addition to the other development and enhancement. Countries participating in the MIEC and NSEC reduce Policy and Cultural Barriers (PCBs) by 2 % per year, in addition to the other development and link enhancement mentioned above.

We also calculated the economic impacts of the MIEC, the NSEC and soft infrastructure development. These measures will help Thailand overcome the negative impact of the flood. Ayutthaya will have a 4.9 % net positive impact, even allowing for the implicit negative impact of the flood. Samut Prakarn and Samut Sakhon have 4.8 and 4.6 % positive impacts, respectively. Rayong, Chonburi and Lamphun which have relatively larger positive impacts caused by the flood will also see further economic benefit.

4 Policy Recommendations and Concluding Remarks

Simulation results show that the long-run impact of the flood in Thailand on markets and production networks may not be as great as previously thought. Positive impacts in Rayong or Chonburi, for example, can only be simulated by a model with CGE setting, including many provinces. At an early stage of the disaster, many partial observations or interviews are collected in severely damaged areas, which may lead to exaggerating the long-run damage. Utilizing IDE/ERIA-GSM with an assumption from the Current Quarter Model (CQM) provides a solution to cope with this bias. In fact a preliminary report of this study, with the message that the long-run impact of the flood might not be as great as previously thought, was conveyed to the National Economic and Social Development Board (NESDB) and the Committee of Permanent Representatives (CPR) member of Thailand in January and February 2012.

We conclude with our findings, policy recommendations and some limitations or challenges. First, minimizing the damage arising from the flood and minimizing future risk are essential. We assume smooth recovery from the flood. If the Thai government had not offered good recovery measures, the flood's negative impacts would be larger. In fact many companies in JETRO's interview survey responded that they wanted to ask the Thai government to provide a good disaster insurance scheme and to develop tangible flood countermeasures.

Secondly, some facilitation measures to help firms move some production blocks from affected provinces to Rayong or Chonburi may contribute to

Thailand's recovery. This does not mean, of course, that we recommend the forced relocation of firms. As reported in the media, many companies are already seeking production sites in industrial estates in Chonburi, Rayong and Lamphun, and developers are planning to establish new industrial estates. Our recommendation is that these movements should not be impeded, even though the government must be aiming for an equitable development of the country.

Thirdly, stimulating R&D activities and innovation is indispensable. In the simulations we assume full recovery of production infrastructure in 2012. However, if Thailand saw a delay in conducting R&D activities and other countries went ahead in 2011, possible negative impacts compared to the baseline scenario would be much larger.

Fourthly, even though we forecast a favorable result from the MIEC, several conditions are required to make it possible. There needs to be a smooth transaction flow between Dawei and the Kanchanburi border. Dawei port should be large and efficient enough to host international carriers, as in Laem Chabang port or Tanjung Priok port because Dawei itself is located far from the major international sea lines.

Fifthly, and finally, the assumptions used in this chapter need to be reviewed repeatedly in order to produce more reliable results. For example, we assumed that Samut Prakan was affected by the flood, based on information from JETRO as in November 2011. Actually Samut Prakan was affected by the flood, but no industrial estates in Samut Prakan were damaged. In this regard, the result for Samut Prakan in Fig. 8.3 should be overestimated, even though some companies in Samut Prakan are in fact now seeking alternative sites considering their vulnerability to flooding. Similarly, the result as of January 2012 did not detect booming demand for construction in 2012. Nevertheless, IDE/ERIA-GSM can be a good tool for assessing the long-run effects of severe disasters and identifying possible remedies.

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